ADDENDUM

ANNUAL PROJECT STATEMENTS 1969-70
FOREST RESEARCH LABORATORY
CALGARY, ALBERTA

Projects Terminated

Land Classification

A 81 - A broad classification of forest land productivity from aerial photographs and extensive land inventory: P. J. B. Duffy.

Soils

A 64 - Relationships between site factors and the growth of lodgepole pine in the Foothills Section of Alberta: P. J. B. Duffy.

A 83 - Planting chance and spacing trials in white spruce on different soils in the Foothills Section of Alberta: P. J. B. Duffy.

Silviculture

A 41 - Seeding habit of the white spruce species in Alberta: R. F. Ackerman

A 54 - Development of regeneration silviculture for white spruce and lodgepole pine in the Foothills Section of Alberta: R. F. Ackerman

A 102 - Point sampling and line plot cruising of merchantable timber stands in Alberta: C. L. Kirby.

A 262 - Thinning of lodgepole pine at the Kananaskis Forest Experiment Station: W. D. Johnstone.

Forest Hydrology

A 131 - Consumptive use of soil moisture by different vegetation types: R. L. Harlan. (Work to be incorporated in proposal - page 165).

A 132 - Erosion hazard studies of surficial deposits supporting spruce/fir stands in the east slopes, Canadian Rockies: N. W. Rutter.

Projects Terminated (continued)

Hydrology .... continued

A 134-2 - Snow accumulation in cutover spruce/fir forests in the Dutch Creek area of the Crowsnest Forest: D. L. Golding.

Fire

A 126 - A preliminary study of the physical characteristics and moisture content of clearcut lodgepole pine slash and white spruce slash in Alberta: A. D. Kiil.

A 127 - A study of hazard and flammability of white spruce and lodgepole pine slash in Alberta: A. D. Kiil.

Forest Products

A 276 - The physical and mechanical properties of white bark pine: T. Szabo and J. B. Kasper.

Economics

A 277 - Wood residues as raw material for pulp, paper and building board in Alberta: R. Burns and J. B. Kasper.

Projects Re-Numbered

A 296 - (previously A/T 135-2) page 157.
Consumptive use of aspen and associated shrubs and grasses: T. Singh.

A 297 - (previously A/T 135-3) page 159.
Rainfall interception by aspen: T. Singh.

A 295 - (previouslythe soils research aspects of A 270) page 33.
Effects of prescribed fire on peaty gleysol and grey-wooded soils under spruce/fir: G. L. Lesko.

A 304 - (previously the control burning aspects of Project A 270) page 295.
Prescribed fire following clearcutting of overmature spruce/fir in the Foothills Section of Alberta: A. D. Kiil.

Corrections

Pages 135, 153 and 356 - A 283 to read A 305: Water holding capacity and infiltration rate of the forest floor under spruce/fir and lodgepole pine stands: D. L. Golding.
(This project was re-numbered from A/T 134-1).

Page 355 - A 81 to read A 80: Seed release from slash-borne lodgepole pine cones: R. F. Ackerman

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FOREWORD

The Annual Project Statements for 1969-70 are presented according to a number of problem area programs which have been consolidated under several research and survey oriented program groups.

This planning procedure aims at developing a rational framework within which important forestry problems, together with the work being conducted on this problems, can be identified. Individual problem area programs may be multi-disciplinary and inter-disciplinary whereby research forces are grouped and brought to bear on the problem for so long as is required to obtain the necessary information. The project remains the basic program element and generally speaking these are uni-disciplinary, i.e., one man's effort.

Each problem area is identified with a brief description of the nature, location and extent of the problem, its economic significance, and the strategy of the research and development studies. Specific project statements and proposals included in the problem area program are grouped together and follow each problem statement.

FOREST RESOURCES RESEARCH

Forest resources research consists of integrated programs of land classification, soils, inventory and mensuration, silviculture, forest hydrology and tree biology. The resources program aims to provide information necessary to improve our knowledge and value of the regional forestry estate and management practices.

PROBLEM AREA PROGRAM

Improved Regeneration of Subalpine Pine Forests

The natural regeneration which follows the logging of subalpine spruce-fir and lodgepole pine forests is generally unsatisfactory. The very slow re-establishment of suitable seedlings together with the slow growth of the seedlings that are available implies that the traditional harvesting methods and regeneration practices seldom produce suitable environments for seed germination and early development of tree seedlings. Research in the problem has advanced to where some of the important silvical and environmental factors affecting regeneration in the Rocky Mountains are well known. The usefulness of this information to forest managers is limited, however, by the necessity to apply the results in a meaningful, economic way. Some preliminary work is being done by applied research and demonstration of different harvesting methods, seedbed preparation and special seeding and planting trials. For lack of personnel the ecological and silvicultural research program is being held on a maintanance basis. However, an active liaison development program is maintained in co-operation with the Alberta Forest Service. Plans are to assess the research needs and resume the regular research work as soon as qualified staff is available. At present work in this problem area is being conducted under the following projects:

A 261: Regeneration of overmature spruce-fir stands in the subalpine region (R. J. Day 1965 - to be assigned)
A 286: Artificial and natural regeneration on cut-over and burned subalpine lodgepole site - F. Endean
A 273*: Evaluation of operational reforestation projects in Alberta - J. Soos.

* Project statement appears under Problem - "Improved Regeneration Foothills Boreal Forest".

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Regeneration of overmature spruce-fir stands in the Subalpine Region.

3. Investigator : R. J. Day (1965) To be assigned.

4. Year of Commencement : 1953

5. Anticipated Year of Completion: Original - 1970

6. Key Words not in Title: Scarification, clear cut, shelterwood, planting, *Picea glauca*, *Abies lasiocarpa*, *Pinus contorta*, SA. 1

7. Activity : Silviculture

8. Problem Area Program : Improved regeneration of subalpine forests.

9. Establishment Project No.: A 261 Branch Project No.: A 261

10. Status : Active

11. Man-years Utilized in Past Year: None

12. Co-operating Agencies : Alberta Forest Service, Blairmore Sawmills Ltd.

13. Location of Work : Blairmore, Alberta.

14. Abbreviated Background Statement: Clearcutting and heavy partial cutting are the common methods of harvesting mature and overmature spruce-fir stands in the Subalpine Region of Alberta. Regeneration of the commercially valuable spruce and lodgepole pine is generally inadequate following these operations and early seedling growth is extremely slow. In addition to the inadequate regeneration response, current and past harvest methods have resulted in hazardous slash accumulations and have contributed to significant losses to windthrow and insect attack.

    Although the project is largely limited to maintenance of forest productivity and feasibility of the various techniques tested to accomplish this objective, the cover-type and region has high watershed value. The management agency must consider the impact of harvest cutting methods and seedbed treatments, such as scarification, on watershed values, as well as the economic well-being of the forest-based communities and industries.

    The main objective of the project is to determine means of harvesting the commercially valuable, but decadent overmature spruce-fir, while maintaining or increasing the productive capacity of the land. To this end a number of associated studies have been initiated, commencing in 1953. The objectives of those studies that remain active in 1969 follow: (a) to determine and compare the regeneration response and growth of regeneration to mechanical scarification and broadcast burning on clearcut areas; (b) to determine the effect of seed crop periodicity on the regeneration response for the above areas; (c) to compare the regeneration and ecological conditions resulting from pre- and post-logging mechanical scarification; (d) to investigate the use of a simple, two-cut uniform shelterwood regeneration method; (e) to determine the survival and growth rate of spruce, lodgepole pine and Douglas-fir planted on clearcut areas and to relate survival and growth rates to micro- and macro-environment.

15. Summary of Progress up to One Year Ago: Test areas were established to compare scarification and broadcast burning between 1953 and 1960. Seedfall, regeneration establishment and growth have been documented with a final measurement on all areas in 1966.

Studies to compare the regeneration and ecological conditions resulting from pre- and post-logging scarification were initiated in 1961. Stocking tallies, germination and mortality records were obtained during the 1961, 1962, 1963 and 1964 seasons. A progress report was prepared in 1963, describing the results to that date. R. J. Day resigned in 1965 but returned on a term appointment in 1967 to bring the study up to date.

Investigation of the two-cut shelterwood system was initiated in 1963. Two 5-acre blocks were established and treatment applied in 1964. Windfall and regeneration response were assessed in 1967.

Examination of survival and growth of spruce, lodgepole pine and Douglas-fir, planted on clearcut areas, was initiated in 1964. Mortality checks were made 3, 6 and 9 weeks after planting in 1964 and in the spring and fall of 1965. During 1965, description of micro-environments of individual seedlings was completed and measurement of soil moisture and macroclimate continued. The micro-environment data were analyzed and documentation of seedling survival and growth continued by Mr. Day in 1967, while on a term appointment.

16. Goals Set One Year Ago: Preparation of final reports by R. J. Day and R. F. Ackerman describing the results to 1967 of all treatments.

17. Accomplishments in Last Year: Data analysis has been completed and a final report prepared by R. J. Day on the application of shelterwood felling. Analyses of data pertaining to plantations on clearcut areas were continued.

18. Goals for Next Year : This project has been on a maintenance basis

since the resignation of R. J. Day in 1965. Two final reports describing the results of shelterwood felling and planting of clearcut areas are now in various stages of preparation by Mr. Day and should be completed by 1970. The project will be terminated upon publication of these reports unless staff is obtained to assume responsibility for completion of the project.

R. F. Ackerman

R. F. Ackerman
Supervisor

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Artificial and natural regeneration on a cut-over and burned sub-alpine lodgepole pine site.

3. Investigator : F. Endean.

4. Year of Commencement: 1969.

5. Year of Completion : Original 1974.

6. Key Words not in Title: Alberta, S.A.1, planting, tubed stock, seeding, Pinus contorta.

7. Activity : Silviculture.

8. Problem Area Program: Improved regeneration of Sub-alpine Forests.

9. Establishment Project No.: A 286 Branch Project No.: A 286

10. Status : Active.

11. Man-years Utilized in Past Year: None.

12. Co-operating Agencies: None.

13. Location of Work : Kananaskis Forest Experimental Station.

14. Abbreviated Background Statement: The burned areas to be used in this project will result from replicated slash-burning trials to be carried out by D. Quintilio. Plots burned at different hazard levels will be utilized.

The prolific regeneration of lodgepole pine following chance fire has long been recognized and the advantages of controlled burning to forest management in the form of reduction of fire hazard, exposure of mineral soil and removal of competing vegetation are well known and accepted. In the case of lodgepole pine, fire produces an additional benefit in hastening seed release from the resin sealed cones. Although a moderate amount of work has been done on the artificial and natural regeneration of lodgepole pine, most of that done in the sub-alpine region has been in connection with scarification and seeding.

It is likely that the east slopes sub-alpine forest will come under heavy exploitation in the future. It is likely that this cutting will be highly mechanized on large clearcuts leaving no standing residual seed source for adequate natural seeding. The likelihood of such a situation makes it necessary to test the efficacy of the techniques of natural and artificial regeneration now available.

The experiment site exemplifies the more difficult sub-alpine site for regeneration; techniques which prove suitable here will certainly have wide applicability in the rest of this forest type.

The objectives of this experiment are:

(a) To compare, on the basis of survival, healthy development and rate of growth, the relative efficiencies of the following methods of regeneration on burnt and unburnt cut-over areas:

   (i) Planting 3 - 0 open-rooted stock

   (ii) Planting 12 to 16 week tubed stock

   (iii) Broadcast seeding

   (iv) Spot seeding with screefing (scarification)

   (v) No seeding or planting, seed from cones in slash

(b) To observe the effects of different intensities of fire on seed trees left after logging:

   (i) as physical damage

   (ii) degree of cone opening and seed yield

(c) To measure cone survival in the slash and seed and seedling yields in burnt and unburnt plots.

This is a reconnaissance study undertaken because an opportunity of cleared and burnt land occurred. Its function is to gain experience and background information and effort has been kept to a minimum compatable with these limited objectives.

15. Summary of Progress up to One Year Ago: Project proposal prepared, seed trees marked for retention.

16. Goals Set One Year Ago: Carry out assessment of seed trees and slash before burning in summer of 1968.

17. Accomplishments in Last Year: Area was not clearfilled in time for burning in 1968, and none of the planned work was done.

18. <u>Goals for Next Year</u>: Carry out assessments of seed trees and slash before and after burning.

F. Endean

F. Endean,
Investigator.

PROBLEM AREA PROGRAM

Development of Improved Regeneration of Foothills Boreal Forests

White spruce and lodgepole pine, the principal coniferous species of the foothills boreal forest, are the backbone of the forest economy of Alberta. Hence the requirement for suitable methods of regenerating the forests needs little justification. Much information has already been gathered on the silvics and silviculture of the foothills forest. Research on seedbed preparation for regeneration commenced in the early 1950's using mechanical scarification and depending on natural seed supply as well as artificial seeding and planting. Treatments were successful on the most favorable sites, but increased knowledge and experience showed that conditions are limited where mechanical scarification can be prescribed and conducted successfully. This fact, together with the high costs of conventional planting, prompted a major research program of container planting beginning in 1962. In co-operation with the North Western Pulp & Power Co., Hinton, and the Alberta Forest Service, container studies were oriented to the questions of seedling survival and growth and the effects of site and seedbed, time of planting, age of stock, and type of container and soil mix. Study areas were located mainly in the Hinton-Edson region. In addition pilot planting trials and operational reforestation projects using container planting were established by North Western Pulp & Power and the Alberta Forest Service.

Along with the research program since 1965 there has been an evaluation of the pilot scale planting in the foothills forest and other operational reforestation projects established by the Forestry Branch, North Western Pulp & Paper, and Alberta Forest Service. The studies involve assessment of seedling performance on a range of sites and seedbed conditions. The results are essential to the research and management program by providing practical demonstrations and experience for recommending improved management practices, defining problem areas for further research and almost equally important, identifying lines of study which are not important.

Research in container planting will increase to include studies of methods of rearing "assisted seedlings" which are best adapted for conditioning and outplanting, the conditioning of seedlings before outplanting and the development of the best type of container and outplanting media.

Other research started in 1967 concerns the silvicultural value of prescribed burning in clear-cut, overmature spruce-fir. Through interdisciplinary research special emphasis is placed on the effect of burning intensities on soil temperature, soil moisture and the nature of seedbed and root environment, competing vegetation and availability of essential nutrients; an evaluation of improvement in planting efficiency, the effect and permanency of site changes in terms of growth and survival of seedlings, and possible site degeneration.

The research now includes five established projects:

A 80 : Seed release from slash-borne lodgepole pine cones - R. F. Ackerman
A 105: Development of container planting in Alberta - R. F. Ackerman
A 268: Evaluation of pilot scale container planting in the foothills section of Alberta - H. J. Johnson
A 270: Prescribed burning following clearcutting of overmature spruce-fir in the foothills section of Alberta - F. Endean
A 273: Evaluation of operational reforestation projects in Alberta - J. Soos.
A 295: Effects of prescribed fire on peaty, humic gleysols and grey-wooded soils under spruce-fir forests - G. L. Lesko.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Seed release from slash-borne lodgepole pine cones.

3. Investigator : R. F. Ackerman

4. Year of Commencement : 1962

5. Anticipated Year of Completion: Original - 1968 Revision I - 1970

6. Key Words not in Title: Pinus contorta, regeneration, seed quantity and quality, serotiny, B.19c

7. Activity : Silviculture

8. Problem Area Program : Improved regeneration of foothills boreal forests.

9. Establishment Project No. A 80 Branch Project No. A 80

10. Status : Active

11. Man-years Utilized in Past Year: None

12. Cooperating Agency : North Western Pulp and Power Ltd., Hinton, Alberta.

13. Location of Work : Hinton, Alberta.

14. Abbreviated Background Statement: During the past decade in Alberta, clear-cutting followed by mechanical scarification has been generally accepted and employed as a regeneration method for the lodgepole pine cover type in western Alberta. Because of the serotinous habit of the species the principal source of seed for regeneration by this method is slash-borne cones. In some cases it is believed that seed loss from the slash-borne cones between logging and seedbed treatment has been an important limiting factor in the regeneration response. This project was therefore initiated to determine: (a) the rate of release, deterioration in quality and loss to squirrels of slash-borne seeds following clear-cutting; (b) the major factors affecting loss of quality and rate of seed release from slash-borne serotinous cones.

15. Summary of Progress up to One Year Ago: Three 5-acre lodgepole pine stands were selected for study and clearcut in 1962. Before logging cone serotiny and seed quality were determined by observation and sampling. After logging the amount and quality of slash-borne seeds were determined by periodic sampling during 1962, 1963, 1964 and 1966. A progress report was prepared in 1966 describing results to 1964. During 1967 processing

of sample material and analysis of data were completed.

16. Goals Set One Year Ago: Prepare a closing report for publication.

17. Accomplishments in Last Year: None -- the closing report was not prepared owing to other obligations.

18. Goals for Next Year : Prepare a closing report for publication:

Ackerman, R. F. 1970. Effect of storage in slash on quantity and quality of lodgepole pine seeds available for regeneration. Departmental publication.

R. F. Ackerman

R. F. Ackerman,
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Container planting in Alberta.

3. Investigator : R. F. Ackerman

4. Year of Commencement : 1962

5. Anticipated Year of Completion: Original - 1972 Revision I - 1970

6. Key Words not in Title: Pinus contorta, Picea glauca, regeneration, soil temperature and seedling growth, B.19 a,b.

7. Activity : Silviculture

8. Problem Area Program : Improved regeneration of foothills boreal forest.

9. Establishment Project No. A 105 Branch Project No. A 105

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.1 Other - 0.6

12. Co-operating Agencies : North Western Pulp and Power Ltd., Alberta Forest Service, Alberta Department of Agriculture.

13. Location of Work : Hihton, Alberta; Kananaskis Forest Experiment Station; Calgary Laboratory.

14. Abbreviated Background Statement: Natural regeneration following pulpwood harvest of lodgepole pine and white spruce is generally inadequate on many productive sites in western Alberta. The high cost of conventional planting and the discouraging results obtained with this treatment to date prompted investigation of container planting as a possible alternative. The technique, if successfully developed, offers most of the advantages of conventional planting, plus the possibility of continuous planting throughout the frost-free season, at a cost substantially less than conventional planting.

A series of studies which constitute this project were initiated in 1962, with the objective of bringing container planting to an operational level as rapidly as possible. These studies cover a wide range of problems associated with the production and field behavior of container seedlings.

(1) Is survival and growth sufficiently good to warrant further development of the technique?

(2) Is the method applicable to a variety of sites and seedbeds?

(3) Can container planting be employed throughout the frost-free season?
(4) What minimum age of stock will give satisfactory results under Alberta conditions?
(5) What is a suitable type of container?
(6) What is the best type of soil mix?
(7) Can the stock be grown in tiers thereby increasing the efficiency of greenhouse production?
(8) What benefit can be derived from weight-sorting seed in the production of seedling stock?
(9) What is the frost tolerance of container-planting stock?
(10) How does air temperature, soil temperature and light act and interact on the growth and morphology of container seedlings?

15. Summary of Progress up to One Year Ago: In 1962, spruce and pine stock varying in age from 4 weeks to 1 - 0 were planted each month of the frost-free season on three aspects of a single land form. In 1963 this trial was repeated using a modified container and planting on a wider variety of sites and seedbeds. Survival and growth measurements on these trials continued through 1968.

In 1964, pine and spruce stock grown in six different containers was set out throughout the frost-free season on both scarified and unscarified seedbeds on two moisture regimes. Survival was measured through 1968 and growth measurements commenced in 1966.

In 1965 and 1966, two soil mix experiments were established employing the 3/4" tube and an Alberta Forest Service container, with a wide variety of potentially useful soil mix prescriptions. Survival has been measured annually through 1968 and growth measurements commenced in 1967.

Greenhouse experiments to determine the feasibility of tiering were completed in 1967 and a report has been published. Greenhouse experiments to determine the effect of seed size on seedling growth were completed in 1968 and a report is now in press.

In 1965 North Western Pulp and Power Ltd. initiated container planting on an operational level with the 3/4" split tube. The Silviculture Section initially co-operated in assessing the results but this aspect of the program has now been transferred to Management Services Section.

16. Goals Set One Year Ago: During 1967-68 field experiments established in 1962 and 1963 were to be completed and a closing report prepared. Field experiments established in 1964, 1965 and 1966 were to be continued. Study of seed size effects was to be completed and a report prepared for publication. Study of frost tolerance and ecology of lodgepole pine and white spruce seedlings were also to be continued.

17. Accomplishments in Last Year: Growth and survival was measured on all field experiments initiated in 1964, 1965 and 1966. Analysis of experiments initiated in 1962 and 1963 was completed and a closing report initiated but not completed. A manuscript describing the effect of seed size on seedling quality was submitted and accepted for publication.

Studies of the frost tolerance and ecology of lodgepole pine and white spruce seedlings were continued as opportunity permitted.

Ackerman, R. F. and J. R. Gorman. 1969. Effect of seed weight on the size of lodgepole pine and white spruce container-planting stock. In press. Pulp and Paper Magazine of Canada.

18. Goals for Next Year : During 1969-70 a closing manuscript will be completed describing the field trial established in 1962-63. Final field measurements of growth and survival will be obtained for the experiments initiated in 1964, 1965 and 1966. Study of the interaction of soil and air temperature on seedling growth and morphology will be continued.

Following a critical review of container-planting research in 1968 it was decided that Project No. A 105 should be brought to a close as rapidly as analysis and reporting of available data permits. Additional research on the problem will be conducted by a research team under the direction of F. Endean. Proposals for this new project are now being processed.

Proposed publication:

Ackerman, R. F. 1970. The effect of month of planting and size of stock on survival and growth of bulleted seedlings in Alberta. Departmental Information Report.

R. F. Ackerman

R. F. Ackerman,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Evaluation of pilot scale container planting in the Alberta Foothills Section.

3. Investigator : H. J. Johnson.

4. Year of Commencement : 1965

5. Anticipated Year of Completion; Original - 1971 Revision I - 1973

6. Key Words not in Title : Pinus contorta, Picea glauca, reforestation, survival, growth.

7. Activity : Liaison and Management.

8. Problem Area Program : Improved regeneration of foothills boreal forests

9. Establishment Project No. A 268 Branch Project No. A 268

10. Status : Active

11. Man-years Utilized in Past Year: Professional - .5 Other - 1.1

12. Cooperating Agency : Northwestern Pulp and Power Ltd., Hinton, Alta.

13. Location of Work : Hinton, Alberta.

14. Abbreviated Background Statement: The objective of this project is to evaluate the present system of container planting developed by Northwestern Pulp and Power Ltd., for white spruce and lodgepole pine on a variety of sites in the Foothills Section of Alberta. Container planting is considered a very promising and economical reforestation alternative and one that is highly adaptable to mechanization. Basic research on container planting has been conducted for the past few years by the Department. This evaluation will complement the research program and provide useful information as to the application of the technique on a wide range of ecological conditions. In addition, the results will assist in defining those conditions requiring alternative regeneration methods and in the recognition of those aspects of container planting that require further research.

15. Summary of Progress up to One Year Ago: Approximately 180 plots generally containing 100 marked seedlings were established in 1965, 1966 and 1967. Plots were established in various conditions in groups of three replicates. First-year tallies of survival were made on plots established in 1965 and 1966. An information report was prepared on the first-year survival results of the 1965 plots.

16. Goals Set One Year Ago : Third-year survival and growth of the container seedlings planted in 1965 to be assessed. First year survival of the 1967 plantings is to be determined.

17. Accomplishments in Last Year: Third year survival and growth of 1965 plantings was measured and recorded. A first-year survival tally of the 1967 plantings was conducted.

Third year tallies and growth measurements were transferred to I. B. M. punch cards and an analysis of variance will be conducted to determine the significance of differences in survival and growth by various environmental factors,,e.g. topographic position, moisture regime, depth to mineral soil, vegetative competition, etc.

18. Goals for Next Year : Publications and Reports:

Dixon, G. H. and J. H. Johnson. 1969. Preliminary evaluation of pilot scale container planting in the Foothills of Alberta - 1967 planting. Departmental Internal Report.

Johnson, H. J. 1969. Third-year survival and growth of container-planted stock in Alberta. Proposed journal publication.

Johnson, H. J. and G. H. Dixon. 1969. Third-year survival and growth of 1965 and 1966 container-planting in Alberta Foothills. Proposed Information Report.

H. J. Johnson

H. J. Johnson
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon. Date: February, 1969.

2. Title : Prescribed burning following clear cutting of over-mature spruce-fir in the foothills section of Alberta.

3. Investigator : F. Endean.

4. Year of Commencement: 1967.

5. Anticipated Year of Completion: Original 1973.

6. Key Words not in Title: Regeneration, planting, container stock, sowing, soil temperature.

7. Activity : Silviculture.

8. Problem Area Program: Improved regeneration of foothills boreal forests.

9. Establishment Project No.: A 270 Branch Project No.: A 270

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.7 Other 2.2

12. Co-operating Agencies: Department of Fisheries & Forestry, - Forestry Branch - Fire section - fire behavior.
Alberta Dept. of Lands & Forests - Fire Protection Section - fire control and authority to burn.
Northwestern Pulp & Power Co. - Research areas, construction of fire lines.

13. Location of Work : Hinton, Alberta.

14. Abbreviated Background Statement: A significant portion of the current and proposed pulpwood harvest of N.W.P.P. and the growing stock in the foothills generally comprises overmature stands of spruce/fir. These stands have persisted for 3 - 4 centuries without interruption by wild fire at high elevation in a cool climate. Apart from the present moribund condition of the growing stock, the main features of these sites are surface layers of unincorporated organic matter 6 - 24" deep, low summer soil temperature and soil moisture levels varying from fresh to saturated. It is almost certain that in terms of productive capacity, these sites are deteriorating as organic matter continues to accumulate, causing even colder and wetter soil conditions and that radical treatments are required to reverse the process.

Natural regeneration is usually inadequate on clearcuts of this forest type, chiefly due to the combination of soil factors described. Mechanical scarification, followed by seeding has not been successful because the equipment is unable to disturb the organic layer and debris sufficiently to expose the mineral soil and produce conditions necessary for seedling establishment and growth. For the same reasons, little confidence is placed in the planting of open rooted or tubed stock on these sites.

It is this double problem of site deterioration and difficulty of regeneration which has stimulated this project and which will assume more widespread proportions as exploitation of this type proceeds.

Burning is a treatment worth testing since it has been widely used in N. America and N. Europe to correct such conditions and carries with it other important benefits such as reduction of fire hazard and improved surface conditions for seeding and planting. With the exception of work done by Ackerman (1961) it has not been critically tested in the spruce/fir type in Alberta. The use of fire in these areas is being approached through careful research because of their hydrological importance and the dry summer climate. Furthermore Swedish work has suggested a reduction of growth potential on burnt sites plus serious damage from the fire associated fungus Rhizina inflata and burning has been widely rejected there for these reasons.

The objectives of this investigation are:

(i) To describe the effects of prescribed burning at a range of intensities on the following site factors which are regarded as of major importance to the establishment and growth of regeneration. (a) Nature of seed bed and root environment in terms of depth moss, L, F and H layers. (b) Ground vegetation regarded as a possible competitor with seedlings. (c) Soil temperature in the seedling rooting zone. (d) Soil moisture.

(ii) To evaluate the effect and permanency of these changes in terms of:

(a) Growth and survival of artificially established seedlings of lodgepole pine and white spruce.

(b) Reversal of site deterioration.

(iii) From these facts:

(a) To decide whether prescribed burning has any silvicultural value on these and similar sites.

(b) To suggest what further investigation is necessary or to suggest techniques which might be put to general use.

15. Summary of Progress up to One Year Ago: Four 15 - 25 acre blocks were selected at each of two different localities, one having organic layers 4 - 8" deep and at the other 12 - 24". Burning treatments were to be applied at three different hazard conditions" (degrees of dryness), one block at each locality being burned at a given level leaving one block at each site as a permanent control.

In each block a 40Lx40L grid was demarcated with steel pegs to serve as a reference system for changes in seed bed conditions and other measurements. Soil conditions varied within each block and a soil survey comprising 33 pits was carried out to describe soil types and their approximate boundaries. One of the most important factors of interest was change in ground level due to burning. An instrument was devised to measure this and approximately 4000 ground level measurements taken prior to burning. Four 40Lx40L permanent vegetation plots were demarcated in each block and all species tallied on two random miliacre quadrats in each plot. The plots and quadrats were then photographed for future reference. Twelve groups of three thermocouples were placed at random in each block to measure soil temperature beneath the litter, beneath the humus and in the mineral soil, before and after burning. The temperature indicated by these was recorded at approximately weekly intervals.

The burning treatments were not applied in 1967 because of unusually high fire hazards for most of the summer, numerous outbreaks of wild fire in other areas and difficulties of fire control logistics and authority. One block was burned on the assumption that other treatments would follow.

16. Goals Set for Last One Year Period:

(i) Select and prepare another block to replace that burned in 1967 (the design depends upon all blocks being burned in same year).

(ii) Repeat all pre-burn measurements, vegetation counts and photographs.

(iii) Carry out detailed humus depth and slash distribution survey, reorganize soil temperature measurements on the basis of 1967 experience.

(iv) Carry out post-burn measurements prescribed in proposal.

17. Accomplishments During Last One Year Period:

(i) All pre-burning measurements, counts and photographs were completed.

(ii) Detailed humus depth and slash distribution survey completed.

(iii) All three plots at one locality were burned and post-burn measurements carried out. None of the three plots at the other locality were burned.

(iv) Soil temperature measurements were carried out as planned.

18. <u>Goals for Next One Year Period</u>: Failure to burn all blocks in one year has destroyed the original intention of the project, which was comparison of results between hazards and localities. The project will now be considered as two separate experiments, the regeneration treatments and measurements prescribed in the project will be applied to the burnt blocks at camp 29 in 1969 and thereafter. A last attempt will be made to burn the blocks at camp 7 but all blocks will be burned on the same day and allowed different rates of smouldering. It is felt that only prolonged smouldering can influence these wet, thick layers. If these burns are successful, the prescribed treatments will also be applied in 1969.

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PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Evaluation of operational reforestation projects in Alberta.

3. Investigator : J. Soos

4. Year of Commencement : 1966

5. Anticipated Year of Completion: Original - 1975

6. Key Words not in Title : conventional planting, container planting, seedling, scarification.

7. Activity : Liaison and Management.

8. Problem Area Program : Improved regeneration - foothills boreal forest.

9. Establishment Project No. A 273 Branch Project No. A 273

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.7 Other - 1.9

12. Cooperating Agency : Alberta Department of Lands and Forests

13. Location of Work : Various Forest Districts in Alberta.

14. Abbreviated Background Statement: Considerable research has been conducted by several investigators in Alberta to develop suitable silviculture techniques for forestation of spruce and pine stands. All research workers have agreed that successful natural regeneration of spruce and pine stands requires some form of site preparation.

More recently research and development in Alberta have provided techniques which have been advanced by industry and provincial forest management agencies to large pilot trials and in some cases regular silvicultural operations.

The Alberta Department of Lands and Forests, alone, scarified each year approximately 14,500 acres of land between 1960 and 1965 with an average annual expenditure of $150,000.. The number of conventional seedlings planted each year increased steadily to a total of 573,000 seedlings in 1965. Trial container plantations were also established in every forest district during 1965 and 1966. Assessment of the results of these large scale trials is vitally important to proper development of silviculture and forest management and as a means of keeping abreast of forest research problems in reforestation.

The objectives of this project are:

(1) To assess the success or failure of specific Alberta Forest Service.

(2) To identify failures and problems to be referred to research for further study.

(3) To make specific recommendations concerning fail areas, suggesting reasons for failures and possible treatment.

15. Summary of Progress up to One Year Ago: Scarification and seeding projects carried out between 1959 and 1961, and container plantations established in 1965 and 1966 were assessed in the Clearwater-Rocky and Peace River Forests. During 1967 additional survival plots were established on areas planted with conventional stock and containers in Clearwater-Rocky, Peace River and Whitecourt Forests. Two information reports were prepared on the success of container planting.

16. Goals Set One Year Ago : Continuation of mortality surveys on all areas assessed in 1966 and 1967 in the Clearwater-Rocky, Peace River and Whitecourt Forests. Reforestation projects in additional forest districts will be examined in 1968 if time permits.

17. Accomplishments in Last Year: (1) Evaluation of survival and height growth of 22 container plantations growing under various environmental conditions (cut-over areas, under young and old aspen stand) in Whitecourt, Clearwater-Rocky, Peace River Forests.

(2) Evaluation of mortality of six conventional plantations in Whitecourt, Clearwater-Rocky, Peace River and Slave Lake Forests.

(3) Establishment of spring and fall seeding study under mature aspen stand and cut-over area near Lodgepole.

(4) Establishment of container and conventional trials under mature aspen stand near Lodgepole.

(5) Study of growth rhythm of lodgepole pine seedlings growing in containers with special regard to soil temperature and moisture.

(6) Establishment of three conventional planting areas in Clearwater-Rocky, Bow and Crowsnest Forests to study the effect of transpiration retardant on the survival and initial growth of spruce and lodgepole pine seedlings.

18. Goals for Next Year : (1) Evaluation of container and conventional Plantations in various Forests.

(2) Completion of mortality study of spring and fall seeding under aspen stand.

(3) Establishment of survival plots in connection with aerial seeding in Clearwater-Rocky Forest.

Publication:

Soos, J. 1969. Evaluation of seeding in the Clearwater-Rocky and Peace River Forests of Alberta. Proposed Information Report.

J. Soos
Investigator

Project No. A 295

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Effects of prescribed fire on peaty, humic, gleysols and grey-wooded soils under spruce-fir forests.

3. Investigator : G. L. Lesko

4. Year of Commencement: 1967

5. Anticipated Year of Completion: Original 1970 Revision I 1972

6. Key Words not in Title: temperature, moisture, nutrients, *Picea glauca Abies lasiocarpa*

7. Activity : Soils

8. Problem Area Program: Improved regeneration of foothills boreal forests.

9. Establishment Project No.: A 295 Branch Project No.: A 295

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.2 Other 1.0

12. Co-operating Agencies: North Western Pulp and Power Ltd., Alberta Department of Lands and Forests.

13. Location of Work : Hinton, Alberta

14. Abbreviated Background Statement: Regeneration of overmature spruce-fir (*Picea glauca* (Moench) Voss., *Abies lasiocarpa* (Hook) Nutt.) stands after clear cutting is a recognized problem in the North Western Pulp and Power Ltd. lease area at Hinton. The main cause of regeneration failures in these forest types is the thick layer of unincorporated organic material and a dense moss cover over the mineral soil.

Successful regeneration of these forest types may be achieved by the partial removal of the surface organic horizon and by the exposure of the mineral soil. Removal of the organic layer with mechanical scarification is either uneffective or uneconomic. An alternative to mechanical scarification is the prescribed burning of logging slash after clear cutting.

To investigate the effectiveness of prescribed fire in obtaining successful regeneration research has been initiated in co-operation with the North Western Pulp and Power Ltd. and

Alberta Department of Lands and Forests. This program is divided into fire, silvicultural and soil research projects.

The objective of the soil study is the evaluation of prescribed fire effects on the following physical and chemical soil properties:

1. soil temperature
2. soil moisture
3. soil reaction
4. essential macro nutrients
5. organic carbon content
6. cation exchange capacity.

15. Summary of Progress up to One Year Ago: 1. Twenty series of the colman soil temperature and moisture units had been assembled for soil temperature and moisture measurements.

2. Two series of colman units were installed in each clear-cut but unburned control area, in the adjacent forest stands and in one clear-cut burned block.

3. Humus samples were collected before and after burning in one block.

16. Goals Set One Year Ago: 1. Collection of soil temperature and moisture data from the installed Colman unit series.

2. Collection of humus samples in six burning blocks before and after burning.

3. Installation of Colman unit series in the six burning blocks.

4. Analysis of data from the one burned block.

17. Accomplishments in Last Year: Measurements of soil moisture and temperature were conducted in the control blocks, adjacent forest stand and in the one burned block. Humus samples were collected before and after burning in three burning blocks. Colman unit series were installed in the three burned blocks.

Evaluation of results from the block burned in 1967 has been completed.

Burnings in the three blocks at Camp 7 were not executed.

18. Goals for Next Year : 1. Continuation of data collection from all installed instruments.

2. Chemical analysis of humus samples collected in the last one-year period.

3. Installation of Colman unit series in the three burning blocks at Camp 7.

4. Collection of humus samples from the three burning blocks at Camp 7 before and after burning.

Publication: Lesko, G. L. Effects of prescribed fire on peaty humic gleysols and grey-wooded soils in a spruce-fir forest. Proposed journal publication.

G. L. Lesko
Investigator

PROBLEM AREA PROGRAM

Improved Regeneration of Mixedwood Boreal Forest

For several years it has become increasingly apparent that satisfactory regeneration is a serious problem to forest land managers in the boreal mixedwood forest. The problem now is urgent because of the adoption of the quota system by the provincial government and the accompanying responsibility of the industry to reforest promptly all logging areas.

Much information has been gathered on the ecology and silviculture of spruce and current research includes studies of harvest fellings, seedbed preparation and response of natural regeneration, planted stock and direct seeding. Future work must emphasize basic silvical and ecological studies in order to understand better the reasons for success or failure of reproduction of commercial species and therefore be able to apply effective silvicultural management. To begin with, the new studies will center on the question of coniferous regeneration on chronically wet sites. Meanwhile established silvicultural pilot trials and comprehensive assessment of operational silviculture are expected to improve existing information and help orient future research in the boreal forest. Projects associated with this problem area are:

- A 260: Regeneration of white spruce in white spruce-aspen-mixedwood stands - J. C. Lees
- A 273: Evaluation of operational reforestation projects in Alberta - J. Soos
- A 294: Reforestation trials in the mixedwood section of Alberta - J. Soos and H. J. Johnson.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon

2. Title : Regeneration of white spruce in Mixedwood stands

3. Investigator : J. C. Lees

4. Year of Commencement : 1963

5. Anticipated Year of Completion: Original 1978

6. Key Words not in Title: Shelterwood, scarification, planting, seeding, Picea glauca, B. 18a.

7. Activity : Silviculture

8. Problem Area Program : Improved regeneration of mixedwood boreal forests.

9. Establishment Project No.: A 260 Branch Project No.: A 260

10. Status : Active

11. Man-years Utilized in Past Year: None

12. Co-operating Agency : Alberta Forest Service

13. Location of Work : Smith, Alberta

14. Abbreviated Background Statement: Studies have been carried out since 1951 in Alberta's spruce-aspen stands to test a variety of harvest cutting methods and to examine white spruce seedling growth on scarified and undisturbed seedbeds. Scarification to provide a receptive seedbed and to reduce vegetative competition has been on an operational basis since 1959. Test areas of the highly successful 2-cut shelterwood system have progressed to the removal felling stage and it remains to determine spruce seedling survival and growth response to overstory removal.

During the course of research on scarification up to 20 percent of seedling mortality on moist and wetter sites was attributed to flooding. As a result, research was initiated in 1963 to determine the tolerance of white spruce seedlings to various periods of immersion.

The above research has been confined to regeneration originating from natural seedfall. There are many advantages to a system applied to spruce-aspen stands which utilizes the current practice of partial cutting, followed by planting or seeding.

The objectives of this project are:

(a) To determine white spruce seedling survival and growth response to overstory removal.

(b) To determine the tolerance of white spruce seedlings to various periods of immersion.

(c) To compare a variety of promising artificial regeneration methods for rapid restocking of conifers under the shelterwood system.

The results of these investigations will provide the basis for recommendations, and eventually for prescriptions pertaining to the regeneration of spruce in mixedwood stands.

15. <u>Summary of Progress up to One Year Ago</u>: Objective (a) Sample areas were selected and overstory treatment introduced in 1966.

Objective (b) One- and two-year old spruce seedlings were immersed in tap water for periods of 3½, 7, 10½ and 14 days. Total mortality resulted from the 14-day immersion but a small percentage of seedlings survived the shorter periods and even repeated immersions for a short time. Two-year-old seedlings were more tolerant of flooding than one-year-old seedlings. In 1965, late in the growing season, trays of 2 and 3-year-old seedlings were immersed in a tank of field stream water. Results showed that tolerance to flooding depended on phenology of the seedlings and further work is planned on this aspect of the study. In 1966 trays of one and two-year-old spruce wildlings were grown in the field and immersed under a light canopy in a tank of field ground water. Immersion periods of 3½, 7, 10½ and 14 days were tested and the experiment repeated monthly during the growing season. Results have yet to be reported.

Objective (c) A five-acre study area was selected, scarification completed, seed spots prepared and seedlings planted in 1966. Germination and survival were measured in 1967.

16. <u>Goals Set One Year Ago</u>: None. The project remained on a maintenance basis during the absence of Mr. Lees on educational leave.

17. <u>Accomplishments In Last Year</u>: None

18. <u>Goals for Next Year</u> : Indefinite. The status and advisability of continued work will be discussed with the investigator upon his return from educational leave.

John C. Lees

R. F. Ackerman
Supervisor

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Reforestation trials in the Mixedwood Section of Alberta.

3. Investigators : J. Soos and H. J. Johnson.

4. Year of Commencement : 1968

5. Anticipated Year of Completion: Original - 1978

6. Key Words not in Title : Picea glauca, conventional planting, container planting, seeding, B. 18.

7. Activity : Liaison and Management.

8. Problem Area Program : Improved regeneration of mixedwood boreal forests.

9. Establishment Project No. A 294 Branch Project No. A 294

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.2 Other - 0.6

12. Cooperating Agency : Alberta Department of Lands and Forests.

13. Location of Work : Whitecourt, Peace River, Footner Lake, Grande Prairie and Slave Lake Forests.

14. Abbreviated Background Statement: A recent amendment to the Alberta Forest Act has resulted in the granting of Quotas of coniferous timber to established logging operators in the Province. The amendment to the Act will result in obvious benefits to the Quota Holder but will also require forest management obligations. Specifically, Quota Holders are responsible for the reforestation of current logging areas to standards specified by the Department of Lands and Forests. The Quota Holder has the option of conducting his own reforestation operations or paying $2.00 per M. f.b.m. of timber logged into a provincial government reforestation fund.

Regardless of whether reforestation is carried out by the operator or the Forest Service a greatly increased program will result. The allowable annual cut of sawtimber for the province, excluding hardwoods, is estimated at 600 million f.b.m. Assuming a reforestation charge of $2.00 per M. f.b.m. the funds available for reforestation in Alberta will be approximately 1.2 million dollars annually. By contrast, expenditures for reforestation during the fiscal year 1966-67 were approximately $200,00.

Consequently, reforestation expenditures may be expected to increase six-fold during the next few years.

Reforestation research relating to conventional planting, container planting, seeding and scarification has been conducted in varying intensities in several Forest Districts of Alberta. It has been most diversified in the B-19, Foothills Section, and as a result the application of promising research results has received more attention than in the northern B-18 Section. The disparity in research effort is explained by the lag in development of the northern forests owing to limited access. The B-18 Section, however, is presently in a period of rapid development and seventy percent of the provincial sawtimber cut will come from this source in the near future.

It is evident that a large program of reforestation trials is required immediately in the mixedwood forests of Alberta. Trials of proven reforestation techniques will provide industry and the Forest Service with leads regarding the application of these techniques to local conditions. It is generally agreed that no one reforestation method will satisfy the diversified conditions of the mixedwood forest. Economic considerations will dictate the method to be used providing that proper biological requirements are satisfied. On some areas a relatively inexpensive method may prove successful; on others a more expensive technique will be required. The final choice will require assessment by qualified personnel to arrive at a satisfactory prescription.

The objectives of this project are:

(1) To provide demonstration areas for forest managers with opportunity to compare several reforestation methods and their success on a given area.

(2) To test spring and fall artificial reforestation techniques.

(3) To obtain cost analyses for various reforestation techniques

(4) To observe the success of reforestation in different years.

15. Summary of Progress up to One Year Ago: None

16. Goals Set One Year Ago : Selection and layout of demonstration areas consisting of 24 acres with access in each of five forest districts. Fall seeding, conventional and container planting will be carried out in 1968

17. Accomplishments in Last Year: Selection and layout of 24 acres of uniform areas were completed near all-weather roads in Whitecourt, Peace River, Footner Lake, Grande Prairie and Slave Lake Forests. Scarification, fall seeding and planting were carried out by the Department of Lands and Forests of Alberta in the above-mentioned Forests.

18. Goals for Next Year : (1) Completion of spring sowing in five Forests.

(2) Selection of additional areas for 1969-1970 reforestation trials in the same Forests.

J. Soos
Investigator

H. J. Johnson
Investigator

PROBLEM AREA PROGRAM

Improved Growth of Foothills Boreal Forests

Well stocked and dense stands of lodgepole pine and associated white and black spruce present a problem in the foothills boreal forest, especially pine stands developing after wildfires. The influence of silvicultural thinning and other improvement fellings on the subsequent development and on the quality of these crops has been recognized. Some limited investigation has been made but much more research is needed. It is recognized that initial spacing problems are becoming critical at a time when planting is being employed at an ever increasing rate and where serious consideration is being given to very early thinning of overstocked lodgepole pine types following wildfire. A high yield silviculturist has been recruited to assume responsibility for this problem area and a new problem analysis will be prepared to guide the research program over the next several years. Emphasis will be placed on intensive management in very young stands; how thickets of lodgepole pine originate and develop; how initial spacing affects tree growth, form and wood quality; at what age density affects their growth potential; how different classes and ages of stands respond to increased growing space and how site affects growth factors, and the response to release after various periods or degrees of suppression. Specific projects related to this problem include:

- A 34 : Development and thinning of young lodgepole pine stands in Alberta - R. F. Ackerman
- A 100: The effect of initial spacing on the growth of lodgepole pine and white spruce - R. F. Ackerman
- * A 103: Growth and yield of white spruce saw timber following improvement cutting in a 70-year-old spruce-aspen pine stand - C. L. Kirby
- ** A 280: Silvicultural demonstrations - J. Krewaz.

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* Project statement appears under Problem - "Tree and Stand Growth Measurement".

** Project statement appears under Problem - "Operation and Maintenance of Field Research Areas".

Project No. A 34

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969.

2. Title : Thinning young lodgepole pine stands in Alberta.

3. Investigator : B. E. Jones (May 1969)

4. Year of Commencement : 1954.

5. Anticipated Year of Completion: Original 1985

6. Key Words not in Title : Stand development, Pinus contorta, B. 19a.

7. Activity : Silviculture

8. Problem Area Program : Improved growth of foothills boreal forests.

9. Establishment Project No. : A 34 Branch Project No.: A 34

10. Status : Active

11. Man-years Utilized in Past Year: None

12. Co-operating Agencies : None

13. Location of Work : McKay, Alberta

14. Abbreviated Background Statement: Pure even-aged stands of lodgepole pine are widespread, both in the Boreal and Subalpine Regions of Alberta. The species often regenerates superabundantly after fire, resulting in young stands which consist, in extreme cases, of as many as $\frac{1}{2}$ million seedlings per acre. Growth of the individual stems in diameter and height is very slow, with either no expectation of a merchantable harvest or a harvest considerably less than potential.

In stands already established intermediate cuttings, or other methods of reducing density, of necessity pre-commercial, are the only remedy. Thinning in young stands before the stagnated thicket stage is reached is desirable from the standpoint of cost and response.

The objective of the project is to determine the effect of single thinnings of varying intensity on the development of dense young lodgepole pine stands and to indicate the limitations of a single thinning as opposed to multiple thinning regimes.

15. <u>Summary of Progress up to One Year Ago</u>: In 1954, three blocks were selected in 22-year-old pure lodgepole pine. Stagnation was not yet apparent but was anticipated. The following treatments were introduced on each block:

1. Single thinning - 5' x 5'.
2. Single thinning - 6' x 6'.
3. Single thinning - 8' x 8'.
4. Multiple thinning (10 year) - initially 6' x 6'.
5. Multiple thinning (50 year) - initially 6' x 6'.
6. Control - untreated.

In addition to the above a single 12' x 12' thinning was included, independent of the three replicate blocks described above.

At establishment in 1954 all trees on each plot were tagged and d.b.h. recorded. The heights of 30 trees on each plot, covering a full range of diameter classes were remeasured and annual terminal leader growth recorded for the period 1950 to 1960 for 15 of the height-sample trees on each plot. A progress report describing the response during the first five years after treatment was prepared in 1961.

16. <u>Goals Set One Year Ago</u> : None. The project has been on a maintenance basis since 1961.

17. <u>Accomplishments in Last Year</u>: None.

18. <u>Goals for Next Year</u> : Staff will be available (B.E. Jones) commencing in May, 1969, to assume responsibility for this and other projects in the field of high-yield silviculture.

In the initial design of this project one treatment incorporated multiple thinnings at 10 year intervals. This treatment, now overdue, and a remeasurement will be undertaken in 1969.

Proposed publication: B. E. Jones, 1970. Development after thinning of young lodgepole pine stands in Alberta. Departmental publication.

R. F. Ackerman

R. F. Ackerman
Supervisor

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969
2. Title : Initial spacing and growth of lodgepole pine and white spruce.
3. Investigator : R. F. Ackerman
4. Year of Commencement : 1963
5. Anticipated Year of Completion: Original - 1985
6. Key Words not in Title : *Pinus contorta*, *Picea glauca*, thinning, stand development, stand density, B.19c
7. Activity : Silviculture
8. Problem Area Program : Improved growth of foothills boreal forest.
9. Establishment Project No. A 100 Branch Project No. A 100
10. Status : Active
11. Man-years Utilized in Past Year: Professional - 0.1 Other - 0.4
12. Co-operating Agency : None
13. Location of Work : Hinton, Alberta
14. Abbreviated Background Statement: The spacing at which trees are grown has a pronounced effect on the growth and development of individual trees and forest stands. Spacing is also the major controllable factor in the management of forest stands. In spite of its obvious importance, little is known in Alberta concerning the effect of spacing on the growth and development of the native spruce and pine. This situation prevails at a time when planting is being employed at an ever increasing rate and when serious consideration is being given to correction of obvious over-stocking following wild fire in the lodgepole pine type.

The objectives of the project are to determine: (a) how initial spacing affects diameter, height and volume growth, tree form and wood quality; (b) at what age and density spacing becomes effective in controlling growth; (c) at what age and density trees are able to fully occupy the site; (d) the release potential after various periods or degrees of suppression.

A secondary objective is to provide material of known history for ecological study of competition between individuals as a mechanism of growth control and to determine the effects of density on the forest environment.

The information gained from this project will provide the basis for management prescriptions with respect to stand establishment by artificial means and for recommendations concerning desirable treatment of existing stands.

15. Summary of Progress up to One Year Ago: In 1963 spruce and pine 3 - 0 stock were planted on five sites at five spacings varying from 200 to 3,200 trees per acre. Fail places were replanted in 1964 and 1965 with the same stock. In 1963 and 1964 the same espacements were established on three sites in dense 5-year-old lodgepole pine regeneration on the Gregg Burn. Base height measurements were obtained on the Gregg Burn plots in 1966 and survival was measured on all planted blocks in 1968.

The project was broadened in 1966 and 1967 by application of identical treatments to 25-year-old dense lodgepole pine stands in the Tee-pee-pole Creek area of western Alberta. Suitable stands were located, plots established and base measurements of height diameter and crown obtained by Management Services Section. Although identical design and treatments were employed in this work as in the espacement studies previously described, it is essentially a study of pre-commercial thinning in young pine and will, in future, be administered with projects having similar objectives.

16. Goals Set One Year Ago : The project was placed on a maintenance basis pending recruitment of a high-yield silviculturist to assume responsibility for this and related studies.

17. Accomplishments in Last Year: The thirty plots (3,000 trees) of that part of the project located in the Gregg Burn were surveyed and mapped to provide an expression of spacing or competition for individual trees.

18. Goals for Next Year : A high yield silviculturist (Mr. B. E. Jones) has been recruited and will arrive in 1969. At that time the project will be reviewed and a program of measurement and reporting adopted.

R. F. Ackerman

R. F. Ackerman,
Investigator

PROBLEM AREA PROGRAM

Improved Growth of Mixedwood Boreal Forests

In an endeavour to develop means to more intensive forest management, research has emphasized stand improvement and harvest cutting in the spruce-aspen mixedwood stands of central Alberta since 1951. A study continues on a number of sites on the improvement of white spruce growth with the removal of competing aspen. Individual spruce trees have responded to treatments and no further work is needed to confirm or amplify the results to date. The problem of increment in mature spruce crops following partial cutting is still receiving attention but no sizeable growth responses have yet been determined. The influence of high yield silviculture on the development and quality of a crop is recognized, and the need for a long-term approach to thinning and other aspects of high yield silviculture including fertilization, will be included in a general problem analysis to be prepared during 1969-70. At the moment there are two projects related to the problem:

A 13 * : Effective aspen competition on white spruce groves in spruce-aspen stands in northern Alberta - J. C. Lees.
A 260: Regeneration of white spruce in white spruce-aspen mixedwood stands - J. C. Lees.

* Project statement appears under Problem - "Improved regeneration of mixedwood boreal forest".

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon

2. Title : Release of white spruce in mixedwood stands.

3. Investigator : J. C. Lees

4. Year of Commencement : 1951

5. Anticipated Year of Completion: Original 1970

6. Key Words not in Title: Thinning, *Picea glauca*, *Populus tremuloides*, B 18a.

7. Activity : Silviculture

8. Problem Area Program : Improved growth of mixedwood boreal forests.

9. Establishment Project No.: A 13 Branch Project No.: A 13

10. Status : Active

11. Man-years Utilized in Past Year: Professional none Other none

12. Co-operating Agencies : None

13. Location of Work : Smith, Alberta

14. Abbreviated Background Statement: Two storied stands are typical of the spruce-aspen forest in Alberta. The aspen, a vigorous pioneer species, forms the overstory for most of the natural rotation of the stands. At about age 55 to 75, however, the spruce grows through the overstory as the older aspen goes into an increasingly decadent stage. While the species are co-dominant competition reaches a maximum and mechanical damage to crowns can alone account for a 20 per cent reduction in net growth of the comercially valuable spruce.

    The objective of this project is to document the effect of removal of the competing aspen on the growth of white spruce of varying age to determine if and when these stands can be profitably thinned. The information gained will contribute directly to prescriptions that can be employed to increase productivity of the spruce component in existing spruce-aspen stands.

15. Summary of Progress up to One Year Ago: Measurements of average periodic annual diameter and height increment for treated and control stems showed that the accelerated growth following release was sustained for 11 years. Differences between released and control stem values were significant with greatest release occurring in the 25 to 45 year age range. In 1962, 18 percent of re-

leased and 22 per cent of control stems showed top damage from whipping by dominant aspen. Poisoning of cut aspen stumps successfully prevented suckering and sprouting of aspen for at least 6 years.

One hundred treated stems with controls were selected and remeasured in 1966 to determine the need for further release. These were aged individually and the variables of age and basal area of competing stems added to the regressions.

16. Goals Set One Year Ago: None. The project remained on a maintenance basis during the absence of Mr. Lees on educational leave.

17. Accomplishments in Last Year: None

18. Goals Next Year : Indefinite. The status and advisability of continued work will be discussed with the investigator upon his return in 1969.

John C. Lees

J. C. Lees
Investigator

PROBLEM AREA PROGRAM

Tree and Stand Growth Measurement

A most urgent problem of practical significance is the need for reasonably accurate information and measurement techniques to express in quantitative terms the status and behaviour of trees and stands in their environment. Mensuration is a means rather than an end in solving forestry problems and the science of measurement and mathematical technique is used in all fields of forestry. Although basic procedures for mensuration and inventory design have been in effect for many years, researchers are striving to refine these methods in terms of local forest conditions and the specific requirements of the management agencies. For several years the regional research program has included studies of repeated forest inventories, stand growth and its relation to density, yield tables, tree volume tables and aerial photo volume tables.

The need is recognized for more information about the theory of tree growth and the inter-relationships of growth, physical environment and the factors of age, species and stand density. More precise ways are required to measure trees and predict growth, tree form, defects and mortality. In this regard tree growth research has taken some new directions over the last two years. Studies of biomass or organic matter production in aspen and lodgepole pine forests have been initiated to determine and evaluate the biological and physical processes which affect productivity and energy flow relationships in the two forest ecosystems. Regional scientists are collaborating closely in the productivity research program with whole tree utilization and pulping investigations conducted by the Vancouver Forest Products Laboratory. There is also co-operation with the logging development program of the Forest Management Institute at Ottawa, and with other biomass and productivity studies of understory species in aspen stands conducted at the University of Calgary Environmental Sciences Centre, Kananaskis.

At present research in this problem area is being conducted under the following projects:

- A 17 : Growth and yield of lodgepole pine in the foothills section of Alberta - R. F. Ackerman
- A 95 : Standard aerial volume tables for lodgepole pine in * west-central Alberta - P.J.B. Duffy
- A 101: Root development and top growth of white spruce in the boreal forest - J.W.B. Wagg
- A 103: Growth and yield of white spruce saw-timber following improvement cutting in a 70-year-old spruce-aspen pine stand - C. L. Kirby

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* Project statement appears under Problem - "Silvical Characteristics of Trees".

A 122: A test of measures obtained from aerial photographs and ground samples for forest management - C. L. Kirby

A 123: Site indices and growth patterns in relation to density, crown size and other factors of the environment - C. L. Kirby

A 176**: Working plan Kananaskis Forest Experiment Station - J. Krewaz

A 287: Structure of biomass and productivity of poplar forests in Alberta - E. B. Patterson

A 291: Organic matter production in lodgepole pine - W. D. Johnstone.

** Project statement appears under Peoblem - "Operation and Maintenance of Field Research Areas".

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Growth and yield of lodgepole pine in the foothills section of Alberta.

3. Investigator : R. F. Ackerman

4. Year of Commencement : 1951

5. Anticipated Year of Completion: Continuous

6. Key Words not in Title: Pinus contorta, stand development, yield tables, management planning, B.19 a,c.

7. Activity : Silviculture

8. Problem Area Program : Tree and stand growth measurement.

9. Establishment Project No. A 17 Branch Project No. A 17

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.1 Other - 0.6

12. Cooperating Agency : Alberta Forest Service.

13. Location of Work : Foothills section of Alberta.

14. Abbreviated Background Statement: There are no adequate yield tables for the lodgepole pine type in Alberta. Rapidly increasing demand for the species, particularly for pulpwood, and the introduction of sustained yield management through the quota system and pulpwood lease agreements emphasize the current need for this management tool. In addition the above developments have prompted an encouraging increase in silvicultural practice designed to increase or maintain productivity on managed areas. Yield tables have a prominent role to play in these activities.

Traditional approaches to the construction of yield tables are not applicable to lodgepole pine because of the extremely wide range of densities characteristic of the species and the effects of overstocking on stand growth and development. The objective of the project is therefore the construction of stand density yield tables. Yields will be reported in terms of V.t.cf., V.m.cf., and V.m.b.f.; supported by stand tables and regressions of average stand diameter, number of stems per acre and basal area. Tables will be constructed employing stand age, site (index) and density (index) as independent variables.

Reduced productivity of lodgepole

pine associated with high stand densities is well documented in Alberta. However, the extent of the loss and the relationship between density, site and productivity are not well known. The tables will have direct application in this regard and at the same time provide a rational basis for prescribing remedial stand treatments. The tables may or may not find application in forest regulation and long-range management planning depending upon the approach taken by the management agencies. Nevertheless at the very least, they will provide a basis for determination of rotation age.

It should be noted that construction and refinement of yield tables is a continuing project. As permanent sample plot re-measurement data becomes available and as measures of site and density change and improve the growth model can and should be improved.

15. Summary of Progress up to One Year Ago: During 1951, 1952 and 1953, 141 permanent and 41 single examination plots were established. The plot data were compiled and preliminary yield tables, based on volume per unit S.Dl, prepared in 1954. Difficulties encountered resulted from the effect of high numbers of stems on both height and volume. It was concluded that a four-variable analysis, incorporating density, and a measure of site independent of density, were necessary for further refinement. Since a four-variable analysis from a relatively small number of plots, by standard procedures, would be a risky venture, it was postulated that the basal area development of a given number of the largest trees determined by core analysis would effectively indicate which plots belong in the same development series. Provided site classification is effective stand density yield tables could then be constructed with a minimum or risk.

The permanent sample plots were remeasured in 1961 and a physiographic site description was prepared by P. J. B. Duffy. During the re-measurement cores were taken to determine development series indices for each plot. During 1962 and 1963 the re-measurement data were compiled and all single examination data re-compiled, using the newly introduced Alberta volume tables.

During 1964 and 1965 the A-17 data were combined with A. F. S. data and the regression Log. H = 2.558 - 9.175 (1/A) -- .229 (log N) developed for possible application as a site index. During the same period site index curves based on unadjusted dominant height were prepared from stem analysis data obtained during the 1961 re-measurement.

During 1967, site index curves were prepared based on the aforementioned regression and tested against the basal area of mature fully stocked stands. This index was found to be superior to unadjusted dominant height and will receive further testing in the analysis that follows.

During 1968 development index

curves, based on the development of the 100 largest trees per acre, were completed. The relationship was found to be largely independent of site and density, simplifying application of the development series concept in growth and yield analysis.

16. Goals Set One Year Ago: Definition of the development of number of stems per acre employing the development series concept. The relationship is to be employed as a density index in the construction of yield tables.

17. Accomplishments in Last Year: Number of stems per acre was defined graphically for one site class to assist in choice of model for computer analysis. In addition Alberta Forest Service data were transcribed for inclusion in the analysis. Goals set for the period were not attained because of temporary loss of technical support.

18. Goals for Next Year :Definition of number of stems per acre by site index will be completed early in 1969 and form the basis of a density index employing number of stems per acre at index age 70. Yield tables will be constructed employing the independent variables age, site index and density index. The tables will be chacked against plot re-measurement data to determine major weaknesses in the assumptions employed in their construction. Proposed publications:

Ackerman, R. F. 1970. Density development in lodgepole pine stands in Alberta. Proposed journal publication.

Ackerman, R. F. and W. Johnstone. 1970. Stand density yield tables for lodgepole pine in Alberta. Proposed departmental publication.

R. F. Ackerman

R. F. Ackerman,
Investigator

Project No. A 95

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Aerial photo volume tables for lodgepole pine in West-Central Alberta.

3. Investigator : P. J. B. Duffy.

4. Year of Commencement: 1960.

5. Anticipated Year of Completion: Original 1966 Revision I 1968
Revision II 1969

6. Key Words not in Title: Soil type, photo measurement.

7. Activity : Soils.

8. Problem Area Program: Tree and stand growth measurement.

9. Establishment Project No.: A 95 Branch Project No.: A 95

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.2 Other 0

12. Co-operating Agencies: Alberta Department of Lands and Forests; Biometrics Research Services, Ottawa.

13. Location of Work : Calgary, Alberta.

14. Abbreviated Background Statement: A study was established to develop aerial photo volume tables for lodgepole pine on different soils in west-central Alberta. A paper was published on a basis of 108 plots which were surveyed in 1960 (Duffy and Meyer 1962). Results of the preliminary work showed that stratification of the forest by soil type might give improved estimates of stand volume using a regression analysis and photo volume tables. The objectives of the study are:

   (a) To compare the accuracy of pine volume tables derived from photo estimates of stand height with those derived from ground estimates;

   (b) To demonstrate the improved accuracy gained from stratifying the forest population by soil types.

   (c) To present several stand aerial photo volume tables for lodgepole pine in terms of total volume per acre in cubic feet and merchantable volume per acre in cubic feet and board feet.

15. Summary of Progress up to One Year Ago: Field work and analyses were completed and a draft manuscript was prepared.

Publications:

Duffy, P. J. B. and M. T. Meyer, 1962. A preliminary study of aerial volume table construction for lodgepole pine in West-Central Alberta. Forestry Chron. 38(2), 212-218.

Duffy, P. J. B., 1965. Estimation of stand volume for air photos. Proceedings of a Seminar on Air Photo Interpretation in the Development of Canada. Interdepartmental Committee on Air Surveys, Ottawa, pp. 26-36.

16. Goals Set Last Year: To revise draft manuscript for departmental publication.

17. Accomplishments in Last Year: Reviewed a statistical analysis and initiated re-write of revised manuscript.

18. Goals for Next Year: To complete revision of the manuscript for departmental publication and terminate the Project.

Publication:

Duffy, P.J.B., Y. Lee and D. M. Brown, 1969. Aerial photo volume tables for lodgepole pine in west-central Alberta (Proposed departmental publication).

"P. J. B. Duffy"

P.J.B.Duffy,
Investigator.

Project No. A 103

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Growth and yield of white spruce following improvement cutting in a 70-year-old spruce-aspen-pine stand.

3. Investigator : C. L. Kirby

4. Year of Commencement : 1962

5. Anticipated Year of Completion : 1983

6. Key Words not in Title : Simulation model, sampling, increment, Picea glauca, Pinus contorta, Populus tremuloides, B19a, crown area, aerial photographs, density, productivity.

7. Activity : Liaison and Management.

8. Problem Area Program : Tree and stand growth measurement.

9. Establishment Project No. : A 103 Branch Project No. : A 103.

10. Status : Active

11. Man-years Utilized in Past Year : Professional .1 Other .1

12. Co-operating Agencies : None.

13. Location of Work : Mackay, Alberta.

14. Abbreviated Background Statement : Management prescriptions for mixed stands in Alberta require the following information.

(a) Stocking required to obtain maximum growth;

(b) Optimum tree distribution in uneven-aged management by size and age classes;

(c) Growth, by species, for various site types; and

(d) The rate of transition from existing to desired growing stock required to maximize growth.

The traditional approach to obtaining this information, by establishment of a relatively small number of permanent sample plots, has not been satisfactory. It has often been difficult or impossible to generalize from the sample to the universe because of site, stand structure and age variations. An alternative approach, determination of individual tree behaviour by techniques that permit conversion to a per-acre basis, offers the following advantages:

(a) Methods are flexible and can include changes in stand density and tree size.

(b) Partial cutting may be more closely evaluated with detailed knowledge of the trees removed and of the trees that remain.

(c) Specific description and assessment of tree mortality is possible.

Objectives : Long term

: To provide a growth model for mixed-wood stands that may be related to physiographic site types applied in forest management.

: Short term

: 1. To develop a suitable competition index for individual tree data.

2. To determine sampling techniques most suitable for the assessment of cutting experiments.

15. Summary of Progress up to One Year Ago : The following point density measurements around selected trees were tested.

(a) Angle summation as indicated by Spurr using a B.A.F. of 10 and 20,

(b) Angle count as indicated by Lemmon and Schumacher using a B.A.F. of 10 and 20,

(c) The summation of $(D.b.h.o.b.)^2$ x (distance in feet from selected tree) of trees within a ten-foot radius,

(d) The basal area of trees within radii of 10 and 20 feet.

In most cases a measure of point density around a selected tree was best done with a relaskop with a "basal area factor" of 10. Measures of crown width, crown height and basal area increment were most highly correlated with this measure of point density. Correlation with measures of point density (BAF 10) are as follows for all trees measured in the thinned and control area.

Factor	r
basal area increment	- 0.30
height	+ 0.00275
crown width	+ 0.34
d.b.h.	+ 0.16
(crown width) (Height)	+ 0.82

The best equations for predicting basal area increment of individual trees in the control, thinned and for the control and thinned area combined are as follows:

Area	Equation	R^2
Thinned N = 49	$B.A._{inc.} = .0112156 + .0000687\ (CW)(H) - .0000786BA$	.66
Control N = 29	$B.A._{inc.} = .0023000 + .00007924\ (CW)(H)$	.77
Thinned and Control N = 78	$B.A._{inc.} = .0066857 + .00007103\ (CW)(H) - .0000433BA$	.68

Where

N = Number of trees sampled

B.A.inc. = Basal area increment for period 1963-67

CW = crown width in feet 1963

H = Total tree height in feet 1963

Equations which utilized d.b.h. instead of (CW)(H) measurements gave practically the same R^2 values as when (CW)(H) was used. Therefore it is suggested that measures of forest growth or impacts upon forest growth may be best obtained from measures of tree height and crown width on large scale aerial photos where adequate number of individual tree measurements within photo-plots may be obtained cheaply. The correlations obtained with present crude measures of crown width will be considerably improved with more refined measures of crown area on large scale aerial photographs.

Using conventional point or plot samples will require 500 to 1000 ground samples in this covertype to give estimates of basal area with ± 1 per cent accuracy at the 95 per cent confidence level. This level of accuracy is usually required to assess thinning experiments and impact studies (insects, fungi, fertilizers). Thus it is clearly evident that conventional ground plot methods are most expensive and that individual tree approaches based on measures obtained on large scale aerial photographs or the ground of crown width and tree height will give better assessment of productivity for a given area.

16. Goals Set One Year Ago : Individual tree location and crown areas will be mapped from large-scale photographs for the study of sampling techniques and growth models. Soil moisture will be measured with a neutron probe to examine the relationship

between soil moisture and competition. A report will be prepared describing the results to date.

17. Accomplishments in Last Year: Soil moisture and temperature on a sampling grid were taken at three intervals using a neutron probe and a stollhardy HL radiometer. Summary of results completed and report in process of being written.

18. Goals for Next Year : Complete preparation of report and terminate project.

Publication:

Kirby, C. L. 1969. Measures of competition and crown size and their relation to growth in a 70-year-old white spruce-pine-aspen stand. Proposed departmental publication.

C. L. Kirby,
Investigator.

Project No. A 122

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Forest inventories of the Kananaskis Forest Experiment Station and Marmot Creek Basin.

3. Investigator : C. L. Kirby

4. Year of Commencement: 1963

5. Anticipated Year of Completion: Original 1968 Revision I 1969

6. Key Words Not in Title: Point sampling, computer mapping, photo-sampling.

7. Activity : Liaison and Management.

8. Problem Area Program: Tree and stand growth measurement.

9. Establishment Project No. A 122 Branch Project No. A 122

10. Status : Active

11. Man-years Utilized in Past Year: Professional - .5 Other - .5

12. Cooperating Agencies: Alberta Forest Service; Biometrics Research Service, Ottawa.

13. Location of Work : Marmot Basin and Kananaskis Experiment Areas.

14. Abbreviated Background Statement: Forest inventories of the Kananaskis Forest Experiment Station and the Marmot Creek Watershed Research Basin provide a wealth of information required for research and development of forest inventory methods. Supporting studies of habitat types and soil types assist in research studies to determine optimum stratification for various purposes, i.e. volume estimates, stand tables, growth, productivity.

    Objectives: (1) To provide forest inventories of the Kananaskis and Marmot Creek research areas. (2) To develop and evaluate photo stratification and sampling techniques using air photo and ground survey data.

15. Summary of Progress up to One Year Ago: Lithographed forest cover type maps in color were prepared for the Marmot Creek Basin and the Kananaskis Forest Experiment Station. A computer mapping program and point sampling compilation programs were developed and applied to the Marmot Creek inventory. Large-scale photo sampling techniques for lodgepole pine stands at the Kananaskis Forest Experiment Station were developed.

16. Goals Set One Year Ago: Preparation of a closing report for publication, describing the Kananaskis Research Forest.

17. Accomplishments in Last Year: Preparation of the following reports -

Kirby, C. L. and R. T. Ogilvie. 1968. The Forests of Marmot Creek Watershed Research Basin. Canada. Departmental publication (In press).

Kirby, C. L. and W. Chow. 1969. An adaptation of "MIADS" for an I. B. M. 360/30. Proposed journal publication

Kirby, C. L. and W. Johnstone. 1969. Estimation of lodgepole pine diameter (b. h.) and stand volumes from measurements on large-scale aerial photographs. Proposed departmental publication.

18. Goals for Next Year :

Kirby, C. L. 1969. Forest Inventory of the Kananaskis Forest Experiment Station. Proposed departmental publication.

C. L. Kirby,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment ; Alberta/NWT/Yukon Date: February, 1969

2. Title : Site indices and growth patterns in relation to density, crown size and factors of the environment.

3. Investigator : C. L. Kirby

4. Year of Commencement: 1963

5. Anticipated Year of Completion: Original - 1969

6. Key Words not in Title: Pinus contorta, Picea glauca, yield, productivity.

7. Activity : Liaison and Management

8. Problem Area Program: Tree and stand growth measurement

9. Establishment Project No. A 123 Branch Project No. A 123

10. Status : Active

11. Man-years Utilized in Past Year: Professional - .2 Other - .1

12. Cooperating Agency : Alberta Forest Service

13. Location of Work :

14. Abbreviated Background Statement: The best single indicator of productivity to date is still the height-age relationship of dominant and co-dominant trees. The Alberta Forest Service growth survey provides an excellent basis to study white spruce and lodgepole pine forests in Alberta. Over 400 clusters of 4 permanent sample plots have been established in uniform covertype and physiographic site. Forestry Branch has provided stem analyses data of 156 white spruce and 192 lodgepole pine. The trees selected are dominants and co-dominants adjacent to the growth plots. The objectives are:

    (a) To develop site index curves for white spruce and lodgepole pine in Alberta.

    (b) To study growth patterns of height, tree volume and form as related to site and stand density.

15. Summary of Progress up to One Year Ago: Site index curves for white spruce and lodgepole pine based on an index age of 70 years at 1.0 foot stump were found to be better than curves based on an index age of 50 years. The 70-year curves were used by the Alberta Forest Service to determine the site index of the growth plot stands.

16. Goals Set One Year Ago: To examine further the effect of density on height growth and crown width and prepare a closing report for publication.

17. Accomplishments in Last Year: Models predicting site index for lodgepole pine and white spruce were developed. These equations may also be used in a growth model to predict height growth once height and age of a tree are defined.

18. Goals for Next Year : Prepare report and terminate the project.

Kirby, C. L. 1969. Standard site index curves for white spruce and lodgepole pine. Proposed departmental publication.

C. L. Kirby
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Structure, biomass and productivity of poplar forests in Alberta.

3. Investigator : E. B. Peterson

4. Year of Commencement : 1968

5. Anticipated Year of Completion: Original - 1971

6. Key Words not in Title: *Populus tremuloides*, *Populus balsamifera*, growth, clones, B. 18a, primary production, ecosystems.

7. Activity : Tree Biology

8. Problem Area Program : Tree and stand growth measurement.

9. Establishment Project No. A 2&7 Branch Project No. A 287

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.7 Other - 1.6

12. Cooperating Agencies : University of Calgary; Environmental Sciences Centre, Kananaskis.

13. Location of Work : Near Smith, Slave Lake and Valleyview, Alberta; Kananaskis Forest Experiment Station; Streeter Basin Experimental Watershed, Nanton.

14. Abbreviated Background Statement: Specific functional properties of terrestrial ecosystems that may influence management decisions are structure, biomass, productivity, ecosystem stability and species diversity. Since there is little information available for these ecological properties in Alberta poplar forests, a broad objective of this project is to measure and describe selected examples of variously structured aspen, balsam poplar and mixed wood forests in terms of these functional relationships. Another specific objective is to compare net primary production by *Populus* species on a given site with net primary production by conifers on the same site.

15. Summary of Progress up to One Year Ago: Progress up to April 1968 included: (a) problem analysis, literature review and preparation of project proposal; (b) selection of sample sites in the Smith - Slave Lake are of central Alberta; (c) supervision of field sampling in *Populus* biomass study by Y. H. Chan, graduate student at the University of Calgary.

16. Goals Set One Year Ago : In the one-year period beginning April,

1968, a major goal was to determine the amount of variation in the relative proportions (weight basis) of above-ground tree components in Populus tremuloides and P. balsamifera of known age up to 40 years. Particular attention was given to variation between ramets within a clone and between adjacent clones on the same site.

A second goal was to describe canopy structure and size of the photosynthetic system in Populus in terms of biomass and leaf area index and in relation to other regularly measured stand parameters.

A third objective was to begin measurements that would allow assessment of the periodicity of leaf-fall and year-to-year variation in leaf production on selected individual trees in the Kananaskis area.

17. Accomplishments in Last Year : The harvest method was used for estimation of fresh and dry weights of the following tree components:

(a) stem wood
(b) wood in branches over 2 cm. dia.
(c) wood in branches under 2 cm. dia.
(d) stem bark
(e) bark on branches over 2 cm. dia.
(f) bark on branches under 2 cm. dia.
(g) foliage including current year twigs

The amount and distribution of dead (non-leaf-bearing) branches and live epicormic branches were obtained on a fresh weight basis only. No estimates of fresh or dry weight were obtained from any of the root systems in the sample clones.

The above data are available from 205 ramets of P. tremuloides and 35 of P. balsamifera ranging from 0.5 to 12.5 in. d. b. h. and representing 22 different clones from the vicinity of Smith and Slave Lake in central Alberta and at Kananaskis and Streeter Basin in southwest Alberta.

Basal diameter, length, weight, number of leaf bunches and vertical position on stem are known for each of the 4240 live branches that were present on the 240 sample trees. Although these data were collected to aid in the ecological description of production structure in the sampled clones, they are also applicable to studies of the influence of branch size and distribution on the design of harvesting and delimbing machines.

In the Streeter Basin study area, biomass measurements on 55 ramets from 4 aspen clones were supplemented with calculations of foliage, branch and stem surface areas to allow comparisons with analogous parameters of surface area in adjacent unforested areas within the experimental watershed.

Data collection on year-to-year variation in leaf production by individual trees is being deferred until appropriate towers and scaffolding are erected for other research purposes in the program of the Kananaskis Environmental Sciences Centre, University of Calgary.

18. Goals for Next Year : Data collection: Harvest methods, used in 1968, will be applied to -

(i) One-year-old sucker stands of aspen that developed on the extensive area of 1968 burn near Slave Lake, Alberta.

(ii) Mixed stands of poplars and conifers at Kananaskis and in the Spring Creek experimental watershed near Valleyview, Alberta.

The sampling of suckers will be in an area where annual harvest sampling can take place on adjacent quadrats in an attempt to improve our understanding of productivity in the early stages of clone regeneration after fire. The sampling in mixed wood stands will be to make species comparisons of productivity on a specific site and for development of hypotheses on relationships between species diversity and total site productivity. Field work in the species diversity aspect of this productivity research will be in collaboration with (i) J. Dennis, on post-doctoral appointment at the Kananaskis Environmental Sciences Centre, who will undertake studies of biomass and productivity of understory species in aspen stands in 1969; (ii) W. D. Johnstone's research on lodgepole pine biomass at Kananaskis.

In response to needs in the Logging Development Program of the Forest Management Institute, biomass sampling methods in poplars will be expanded in 1969 to include for each branch on the tree:

(a) diameter outside bark one inch from the stem;
(b) branch angle from axis of tree;
(c) quadrant of tree on which branch is located.

Reporting - In descending order of priority, reports with the following tentative titles are planned:

Peterson, E. B. Production structure of Populus tremuloides and Populus balsamifera in Alberta. Invited paper for symposium on northwestern vegetation, International Botanical Congress, Seattle, August, 1969.

Chan, Y. H. and E. B. Peterson. Standing crop, leaf area index and caloric values in a Populus tremuloides clone near Calgary, Alberta. Proposed journal publication.

Peterson, E. B. Surface area relations in clones of Populus tremuloides in Alberta. Proposed Information Report.

Peterson, E. B., R. D. Erickson and C. Rudolf. Development of field and laboratory methods for biomass sampling

in _Populus_ forests of Alberta. Proposed Information Report.

Peterson, E. B. Prediction of nutrient cycles from leaf standing crop in _Populus_ forests of Alberta. Proposed Information Report.

Peterson, E. B. and A. K. Hellum. Clone distribution and clonal variation in production structure of _Populus tremuloides_ in central Alberta. Proposed journal article.

E. B. Peterson

E. B. Peterson,
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Organic matter production in lodgepole pine.

3. Investigator : W. D. Johnstone.

4. Year of Commencement: 1969.

5. Anticipated Year of Completion: Original 1970.

6. Key Words not in Title: Pinus contorta, S.A.1, biomass, fibre production, dry matter, photosynthesis, net assimilation.

7. Activity : Silviculture.

8. Problem Area Program: Tree and stand growth measurement.

9. Establishment Project No.: A 291 Branch project No.: A 291

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.8 Other 1.8

12. Co-operating Agency : Vancouver Forest Products Laboratory.

13. Location of Work : Kananaskis Forest Experiment Station.

14. Abbreviated Background Statement: Biomass, a measure of organic matter production expressed on a dry weight basis, is one of the parameters being used to evaluate the biological and physical processes which affect the productivity and energyflow relationships in forest ecosystems. Although there have been numerous studies carried out involving measurement of total biomass, too little attention has been given to the suitability or reliability of the methods used or the results obtained. Any attempt to measure all of the trees present in an area is impractical and a formidable task owing to the massive nature of the trees and the technical problems associated with the handling and weighing of the trees. Consequently, it appears that the only suitable alternative is to resort to a method of sampling to reduce the time and effort spent on data collection. Herein lies the first objective of the project.

The second objective of this project is to study the total organic production of lodgepole pine and white spruce trees; its distribution by various tree components, and variations owing to different stocking densities. Applications of these measurements in addition to the previously stated biomass and productivity aspects include:

a. studies of whole tree utilization similar to the pulping investigations being carried on by Dr. J. L. Keays at the Vancouver Forest Products Laboratory,

b. analyses of fertilizer trials, nutrient flow studies, and studies of the changes in the energy flow budgets of forest sites due to various harvesting methods, and

c. many other less closely related fields such as fire danger appraisal based on fuel estimates, and the development of harvesting methods and harvesting machines.

Material gathered in this project has been sent to the Pulping Section of the Vancouver Forest Products Laboratory for the analysis of the pulping properties of the various components. Data have been sent to the Forest Management Institute to assist in the consideration of ways and means of utilizing dense lodgepole pine stands.

15. Summary of Progress up to One Year Ago: In 1966 a test area was selected in a 100-year old lodgepole pine stand thinned in 1938 to different densities in the Kananaskis Research Forest. Two tenth-acre plots were located in densities of 300 stems per acre (thinned) and 1000 stems per acre (undisturbed). In 1966 data were gathered from 63 lodgepole pine and 12 white spruce trees located in the undisturbed plot. Data were gathered from 22 lodgepole pine trees in the thinned stand in 1967.

Prior to felling each tree was measured for dbh, height, crown length and width. All of the trees in each plot were felled and measurements were taken of total tree weight, total stem weight and merchantable stem weight. On each tree stem analysis was carried out from discs taken at eight-foot intervals to the top of the tree. These discs were weighed to obtain an estimate of the spatial variation in fresh and dry weights throughout the stem. In addition, all of the foliage was collected and the fresh and dry weights determined.

Data gathered from the 63 lodgepole pine trees measured in 1966 formed the basis of a M. F. thesis written during the academic year 1966-67. Seven spruce trees were left in the thinned stand harvested in 1967.

16. Goals Set One Year Ago: To collect material, from the seven spruce trees left standing in the thinned area,

necessary for the pulping studies at the Vancouver Forest Products Laboratory, to establish and harvest a very dense lodgepole pine plot; obtain measures of the roots on the previously harvested plots; and initiate analysis of the sampling techniques.

17. Accomplishments in Last Year: During 1968 the following field work was completed:

(a) seven spruce trees, located in the undisturbed sample plot, were harvested, the components measured, and wood samples, to be used in pulping studies, were transported to the Vancouver Forest Products Laboratory;

(b) the stump and root components of the trees measured in the first and second sample plots were extracted, washed, separated and weighed, and

(c) a third sample plot (1/20th acre) was located in a very dense (5000 stems/acre), 90-year-old plot of lodgepole pine stand. Measurement of the above-ground components was completed on all trees except 10 trees reserved for pulping analysis.

Because the time required to obtain the samples necessary for the pulping analyses was more than previously anticipated it was impossible to extract and measure the below-ground components of the trees located in the third sample plot.

The data gathered on the above- and below-ground component weights of the pine trees from the first and second sample plots were analysed and presented in a paper given at the Mensuration Session of the Annual C.I.F. Meeting held in St. John's, Newfoundland. A report, suitable for an Information Report, which analyses the within and between tree variations in specific gravity and moisture content, is presently being reviewed locally.

18. Goals for Next Year:

(a) The selection, extraction, separation, weighing and shipping of the various components of the reserve trees, in the third sample plot, to the Vancouver Forest Products Laboratory for pulping studies;

(b) The extraction, cleaning, and measurement of the stump and root components of the trees already harvested in the third sample plot, and

(c) The analysis of the data gathered from all three sample plots to:

(i) determine the intensity of sampling required to obtain reliable estimates of the weights of the various components,

(ii) to develop some short-cut sampling methods for the measurement of total and component organic matter production in lodgepole pine stands.

(d) Publication: Johnstone, W. D. Organic matter production in lodgepole pine stands. Proposed journal publication.

W. D. Johnstone

W. D. Johnstone,
Investigator.

PROBLEM AREA PROGRAM

Silvical Characteristics of Trees

A comprehensive program of forest and land management research depends upon having proper knowledge of the biological characteristics and basic behaviour of individual trees and tree species according to their environment and genetic variation. Silvics and plant physiology research make their greatest contribution in the critical stage of the life cycle of the tree which extends from seed production to seedling establishment and early growth. Silvicultural management poses a multitude of problems in this area. At the moment research emphasizes the variability of seed germination and survival and growth in white spruce and lodgepole pine seedlings. Silvical research is being used to determine germination and growth rates and the effects of site genotype and environment on these rates. Another phase emphasizes the physiology of life processes and growth mechanisms to understand and help control the growth development of trees. Attention is focussed upon nutrient levels and light intensity as they affect seedling growth, metabolism and ability to survive moisture stress.

To complement studies of silviculture and utilization of poplar forests, attention has been given to studies of the structure, development and causes of distribution and productivity of aspen forests. The results are being used to derive a site classification for poplar forests as a basis for silvicultural management and utilization.

Tree roots of white spruce have been studied to determine the development of root form among different soils, and to relate the development of root growth to growth in aerial tops of trees. The results attempt to relate total tree growth in terms of site productivity and silvicultural treatment.

Other biochemical and physiological studies complement current research on the interrelationship between the mountain pine beetle-blue stain fungi complex and lodgepole pine. Attention is directed specifically to the mechanism of resinosis induced by bark beetle attack and blue stain fungi to establish the relation in growth activities and moisture stress in the host tree and its response to bark beetle and blue stain attack.

Ecological reserves and unique natural areas are being established for future demonstration and scientific study in the Kananaskis Research Forest. Such areas include typical stands of sub-alpine covertypes, superior specimens of tree species, selected physiographic site types and successional stands. Elsewhere small arboreta and plantations are being established to determine the hardiness, health, form and yearly growth of exotic trees at various regions throughout the province and to compare the development of promising exotic trees with native species.

Projects related to this problem area include:

A 52 : Herbarium and special collections of plant materials (unassigned)

A 101 : Root development and top growth of white spruce in the boreal forest - J.W.B. Wagg.

A 253*: Biochemical and physiological aspects of host resistance to attack and infection by bark beetles and blue stain fungi - D.M. Shrimpton and R.W. Reid.

A 265 : Germination and early growth in white spruce modified by moisture temperature and genotype - A.K. Hellum.

A 272 : Effects of nitrogen phosphates and life intensity on the early growth and metabolism of white spruce and lodgepole pine seedlings - H.M. Etter.

A 274 : Ecological reserves and natural areas Kananaskis Research Forest - J. Krewaz.

A 278**: Soil moisture and temperature in relation to topography, soil, vegetation and climate - G. L. Lesko.

A 281 : Establishment of arboreta and small scale plantations in Alberta - J. Soos.

A 290 : Poplar habitats in the mixedwood section of Alberta - H.G. Anderson

A 287***: Structure, biomass and productivity of poplar forests in Alberta - E.B. Peterson.

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*Project statement appears under problem - "Reduction of Losses from Bark Beetles"

**Project statement appears under problem - "Limiting Factors of Soils in Forest Growth"

***Project statement appears under problem - "Tree and Stand Growth Measurement"

Proposal****: Measuring transpiration of individual trees _in situ_ - R.H. Swanson.

Extra Mural Research F-36 - Induction of flowering in conifers - Richard P. Tharis. Department of Biology, University of Calgary.

****Project statement appears under problem - "Stabilization and Improvement of Water Yield in Forest Areas"

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Collection of plant materials.

3. Investigator : (No professional investigator assigned).

4. Year of Commencement : 1956.

5. Anticipated Year of Completion: A continuing project.

6. Key Words not in Title : Herbarium, seed collection, seed bank, taxonomy, Alberta.

7. Activity : Tree Biology.

8. Problem Area Program : Improved silvical characteristics of trees.

9. Establishment Project No.: A 52 Branch Project No.: A 52

10. Status : Active.

11. Man-years Utilized in Past Year: Professional - Other 0.8

12. Co-operating Agencies : Department of Biology, University of Calgary, and various other agencies depending upon their requests for tree seed, cones or herbarium specimens from the Alberta/NWT/Yukon Region.

13. Location of Work : Region wide.

14. Abbreviated Background Statement: This project accommodates the need for continuous collection and herbarium services to various researchers in the Forest Research Branch and to various other agencies from time to time.

15. Summary of Progress up to One Year Ago: Assignment of a technician as curator of the vascular plant herbarium in August, 1967, resulted in improved maintenance of the existing collection of over 4,000 specimens. A 1967 inventory of the vascular plant herbarium resulted in Information Report A-X-14 by S. J. Zubrowski, "Check List of Vascular Plants in the Forest Research Branch Herbarium, Calgary, 1967".

16. Goals Set One Year Ago: It was anticipated that the scope of this project would be enlarged to include a local cone and seed bank to serve the needs of Regional research projects that require special seed lots that have been collected, processed and stored according to specific objectives.

It was also planned in 1968 that herbarium material would be collected for investigation of clonal differences in the morphology of twigs, leaves, bark and fruit of *Populus tremuloides* and *P. balsamifero*.

17. Accomplishments in Last Year: Because of storage facilities and because of the temporary lack of a forest geneticist in the Alberta-Territories Region, no action was taken on development of seed collection facilities for research purposes.

Herbarium materials were collected from approximately 25 clones of *P. tremuloides* in support of ecological studies of leaf area index in natural aspen stands in central Alberta.

Other activities included: collections and photography of specimens for the 1969 edition of "Native Trees of Canada"; collection of specimens of forest vegetation currently unrepresented in the Calgary herbarium of the Forestry Branch; assistance in identification of vascular plants to various field crews of the regional laboratory.

18. Goals for Next Year : a) continuation of routine collection, processing and storage of herbarium materials;

b) assistance, as required, with identification of vascular plant species for various regional field crews;

c) collection of material and photography of morphological features in *Populus tremuloides* that are diagnostic for clone recognition and clone segregation.

E. E. Peterson

E. E. Peterson,
for: Investigator.

Project No. A 101

PROJECT REVIEW STATEMENT

1. Establishment: : Alberta/NWT/Yukon   Date: February, 1969.

2. Title : Root development and top growth of white spruce and tamarack in the Boreal Forest.

3. Investigator : J. W. Bruce Wagg

4. Year of Commencement : 1963

5. Anticipated Year of Completion: Original 1968 Revision I 1969
Revision II 1970

6. Key Words not in Title: Picea glauca, Larix laricina, morphology, Alberta

7. Activity : Tree Biology

8. Problem Area Program : Silvical characteristics of trees

9. Establishment Project No.: A 101   Branch Project No.: A 101

10. Status : Active

11. Man-years Utilized in Past Year: Professional 1.0 Other 1.3

12. Co-operating Agencies : None

13. Location of Work : Boreal forest stand in west-central Alberta; Kananaskis Forest Experiment Station.

14. Abbreviated Background Statement: The form which root systems of trees develop in different environments has intrigued many researchers, and the development of the above-ground parts, especially the trunk, has received much study. Association of the growth of the roots with the growth of the trunk and branches has been limited mostly to seedlings. This project represents an attempt to define total growth of trees between 35 and 60 years of age.

The over-all objective is to study the relationship between the growth of roots and growth of above-ground parts of trees. Other objectives include: the observation of gross differences between the development of root systems and development of trunks; the development of methodology such as establishing the feasibility and reliability of reconstructing the growth of root systems during past periods of development; and the development of quantitative relationships between the amount of roots and trunks of trees on different sites. Another objective is to show that an annual reciprocity of growth exists between the crown, trunk and roots of an individual tree.

15. Summary of Progress up to One Year Ago: Eight contiguous immature white spruce were excavated from each of two

sites - one on humus and one on sand - and the root systems analyzed in detail. Generalized root-forms were associated with each site. The restricted taproot form was found on sand the the monolayered form on humus. There was considerable variation among trees on each site. The growth in the root systems and trunks was reconstructed by five-year intervals for the life of the trees. While the technique of reconstruction did not give absolute values of the amount of root owing to die-back and breakage it gave relative values that could be used to compare the growth in the roots and trunks of trees. For example one thousand lineal feet of persistent root was associated with one cubic foot of volume in the trunk. A rough draft report of this work was prepared.

The influence of thinning on root growth of white spruce was studied at Kananaskis. Using radial root increment as a parameter of root growth, it was found that root increment increased in most trees before either radial increment of the trunk or height increment of the trunk. A rough draft report was prepared.

To study the reciprocity of growth among the trunk, crown and roots, a 63-year-old tree was excavated at Kananaskis. The number of needles was determined. The total crown was dissected by annual increments only for the last 20 years as accuracy diminished with increasing age. The annual height increment of the trunk and annual volumes were obtained. Roots were measured and aged to obtain lineal growth. The tree, which was 47.3 feet tall and 8.9 inches d.b.h., had 7.9 million persistent needles, 4.5 miles of crown increment, 9.5 cubic feet of trunk and 2.1 miles of root increment. Further data is to be accumulated on the volume and weights of crown and roots and detailed studies of growth patterns in the roots.

16. Goals Set One Year Ago : The goals were the following reports:

Wagg, J.W.B. Development of roots and trunks of white spruce on sand and humus. Proposed Departmental Publication.

Wagg, J.W.B. Post-thinning morphogenesis of trunk and roots in white spruce. Proposed Departmental Publication.

Wagg, J.W.B. Root, trunk and crown development of a white spruce tree. Proposed Can. J. Botany Publication.

17. Accomplishments in Last Year: Work has followed two directions aimed at the completion of reports on earlier work on white spruce and some exploratory field work.

A paper on the "Development of roots and trunks of white spruce on sand and humus" has been completed, including most final illustrations, but has not been submitted for publication.

The continued study of the 63-year-old white spruce produced additional data. It was calculated that the tree during its life produced in excess of 14.7 million needles. It had a total crown volume of 2.7 cubic feet and a root volume of 3.05 cubic feet. A great increase in lineal crown increment 6, 7 and 8 years ago was associated with less than anticipated lineal root increment during the same period. Radial root increments, except for the very young roots, showed the same trend - being small at 6, 7 and 8 years and large 4 and 5 years ago when crown increment was abnormally small. Numerous charts, graphs and photos have been prepared which illustrate the growth and development of the tree with particular emphasis on roots. Data and illustrations have been formulated into the beginning of a rough draft report.

Field work consisted of experimentation with pumps for the hydraulic excavation of roots and a preliminary look at the origin and development of the root-forms of tamarack, which were thought to be closely allied to those of white spruce.

18. Goals for Next Year : To complete the present studies on white spruce. The preliminary study on tamarack is worthy of reporting without or with very little additional field time. No new studies are planned.

J. W. Bruce Wagg

J. W. Bruce Wagg
~~Investigator~~

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February 24, 1969.

2. Title : Germination and early growth in white spruce modified by moisture, temperature and genotype.

3. Investigator : A. K. Hellum.

4. Year of Commencement: 1965.

5. Anticipated Year of Completion: Original 1969 Revision I 1970 Revision II 1971.

6. Key Words not in Title: Picea glauca, seed-weight, seed-age, seed-zone, half-sib, hybrid.

7. Activity : Tree Biology.

8. Problem Area Program: Silvical characteristics of trees.

9. Establishment Project No.: A 265 Branch Project No.: A 265

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 1.0 Other 1.0

12. Co-operating Agency: Alberta Forest Service.

13. Location of Work : Calgary, Kananaskis Forest Experiment Station, Hondo, Alberta.

14. Abbreviated Background Statement: This project was initiated to explain the causes of variation among seedlings of white spruce observed in nature and nursery. White spruce is variable in growth and establishment which leads to problems of rearing, handling and planting. The main objective is to evaluate the influences of temperature, moisture and seed source on germination and early growth. Patterns of variation in seed characteristics among and within forest regions in Alberta are also sought together with the influence of site on seed quality. The results from the study are expected to assist the Alberta Forest Service with its rearing of seedlings, to recommend methods of seed collection and handling, and to establish levels of temperature and moisture for optimum germination.

15. Summary of Progress up to One Year Ago: The following reports were completed:

    (a) Hellum, A. K., 1967. The influence of tall grass and forest shade on air temperatures near moist soil. Bi-Monthly Res. Notes 23(2): 10-11.

(b) Hellum, A. K., 1967. Periodicity of height growth in white spruce reproduction. For. Chron. 43(4) : 365 - 371.

(c) Hellum, A. K., 1968. A case against cold stratification of white spruce seed prior to nursery seeding (proposed departmental publication).

16. Goals Set One Year Ago:

(a) Laboratory tests of temperature effects on germination in white spruce seed to be continued through the next year.

(b) A report on the effects of cold stratification on germination and early growth in white spruce seed lots to be submitted for publication.

(c) Tests of repeated wetting and drying of white spruce seeds conducted at Kananaskis Forest Experiment Station in 1966 and 1967 to be repeated with improved moisture control at Hondo, Alberta.

(d) Prepare a final report on the effects of seedbed type on germination and growth in white spruce seedlings.

(e) Nursery tests were planned for Hondo, Alberta. White spruce seeds from 11 single trees would be seeded to compare results already obtained in the laboratory with those obtainable from a nursery experiment regarding seed weight and source of seed. A report on the laboratory results was in progress.

17. Accomplishments in Last Year: The confounding effect of seed-age on responses to given temperatures delayed this work until new germination equipment was available to complete tests. Results on stratification of white spruce seed suggested that this treatment should be applied only if the specific response of a given seed lot to the treatment is known. Alternate methods of pre-treatment of seed to improve germinative speed and total germination are under study. The effects of drying of white spruce seed, once wetted for nursery seedling, suggested that germination might be severely reduced in some seed lots and not in others. The final report on the effects of seedbed type (rotten woods, sphagnum and perlite) on germination and early growth in white spruce is in final stage of reporting. White spruce seedlings grown for one year at Hondo from 11 provenances (Alberta and Manitoba) were excavated (in part) in 1968. The data have not yet been analyzed.

The efforts to characterize white spruce seeds collected from various parts of Alberta led to the conclusion that seed weight and cotyledon number are potentially good criteria for the description of seed samples. The study of variation in seedling size of white spruce also led to the appraisal of seed weight as related to germination and early growth. Indication of hybridization between white and black spruce in Alberta was also given.

Publications and reports:

Hellum, A. K., 1968. A case against cold stratification of white spruce seed prior to nursery seeding. Canada Dept. of Forestry Publ. #1243, 12 pp.

Hellum, A. K., 1969. Variation in cotyledon number and seed weight in white spruce in Alberta (In press). Paper for symposium on Spruce, Macdonald College, Que., August, 1968.

Hellum, A. K., 1969. Judging seed quality by weight (In press). Research News.

18. Goals for Next Year : Complete preliminary tests of the effects of temperature, moisture and seed weight on germination and early growth in white spruce and to expand temperature tests on germination to include lodgepole pine. Collect and collate seed weight and climatic data for the establishment of a seed zone map for white spruce in Alberta. Assess freezing as an alternate method to cold stratification to promote more rapid and more complete germination. Evaluate effects of topographic position, site, and parent tree age on seed weight in white spruce. Continue search for white spruce seeds which show potential influences of black spruce hybridization.

Proposed publications:

Hellum, A. K., 1969. Germination and early growth in white spruce on specially textured seedbeds of rotten wood and peat moss in the laboratory. Proposed departmental Internal Report.

Hellum, A. K. Seed weight, germination and early growth of white spruce. Proposed journal publication.

Hellum, A. K. Wetting and drying white spruce seed before germination. Proposed Information report.

A. K. Hellum

A. K. Hellum,
Investigator.

Project No. A 272

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Effects of nitrogen, phosphorus and light intensity upon growth, metabolism and drought resistance of pine and spruce seedlings.

3. Investigator : Harold M. Etter

4. Year of Commencement : 1967

5. Anticipated Year of Completion : Original 1973

6. Key Words not in Title : *Pinus contorta*, *Picea glauca*, nutrition, physiology.

7. Activity : Tree Biology

8. Problem Area Program : Silvical characteristics of trees.

9. Establishment Project No.: A 272 Branch Project No.: A 272

10. Status : Active

11. Man-years Utilized in Past Year: Professional 1 Other 1.3

12. Co-operating Agencies : None

13. Location of Work : Calgary

14. Abbreviated Background Statement: A few weeks after germination and with the onset of autotrophic growth, the conifer seedling becomes dependent upon the environment for its supply of mineral nutrients and its capacity to fix CO_2. Man's ability to alter and control the seedling environment has increased recently through the application of agronomic techniques in this area of silviculture. However, problems still arise as these techniques are fitted to specific requirements in the field, nursery, greenhouse or seedling container. Solutions to these problems often require knowledge of the influence of mineral nutrition or light intensity upon the physiology of the seedling.

Attention is focused upon nitrogen form and level, phosphorus level and light intensity as they affect the plant's growth, metabolism and ability to survive acute moisture stress. The study also seeks to define certain mechanisms or sites in the seedling through which these environmental changes exert an influence upon plant growth.

15. Summary of Progress up to One Year Ago: Procedures have been worked out for the extraction and

quantitative determination of soluble carbohydrates, amino-N, starch, and soluble and insoluble proteins. In brief, six-week-old seedlings are dissected into roots, leaves, and stems, and then ground in dry ice. The ground tissue is extracted with a formic acid : alcohol mixture and with 80% alcohol. Centrifugation of the extracts at ca. 20,000 g yields a soluble fraction. The residue is then extracted with tris-HCl buffer (pH8.0) and NaOH to obtain the two protein fractions. Amylase digestion is employed in the extraction of starch. The resulting solutions of the various components are analyzed using methods based upon standard spectrophotometric procedures.

Experiments with lodgepole pine seedlings grown at three nitrate levels have demonstrated that increasing the nitrate supply resulted in plants with a smaller root/leaf weight ratio and a higher percent moisture in the leaves. Increasing the nitrate supply also brought about consistent decreases in soluble carbohydrate and starch contents. Concomitant increases in amino nitrogen and insoluble protein were apparent, particularly in the leaf tissue. Drought survival was assessed by the occurrence of active root tips after a one week recovery period which followed two weeks of drought under controlled environmental conditions. Seedlings grown at the lowest nitrate level exhibited higher survival rates than those grown at the higher levels.

16. <u>Goals Set One Year Ago</u> : Lodgepole pine seedlings will be grown at three nitrate levels to compare their growth, metabolism, and drought survival. When complete results are obtained, similar experiments will be conducted with white spruce using three nitrate and ammonium levels.

17. <u>Accomplishments in Last Year</u>: Experiments with lodgepole pine seedlings growing at three nitrate levels have been completed and the results prepared for publication (1,2). Experiments with white spruce growing at three nitrate levels have also been completed. This work has documented a number of differences between pine and spruce in their metabolic and morphologic responses to nitrate supply. In particular, increasing the nitrate did not result in marked decreases in the soluble carbohydrate and starch contents of white spruce as it did with lodgepole pine. Also, nitrate supply did not have a significant effect upon the drought survival of the spruce seedlings. These results taken together are the first indications of the involvement of soluble or insoluble carbohydrates in a drought resistance mechanism. The results also demonstrate a difference between the two species in the effect of nitrate reduction upon carbohydrate levels within the plant.

The analytical procedures for carbohydrate which are used in this project have proven useful in the development of a rapid germinability test for white spruce (3).

1. Etter, H. M. 1968. Influence of nitrate supply upon alternate synthetic pathways in lodgepole pine seedlings. Proc. Can. Soc. Plant Physiol. 9: 34.

2. ____________ Growth, metabolic components and drought survival of lodgepole pine seedlings at three nitrate levels. Can. J. Plant Sci. (In press).

3. Hocking, D. and H. M. Etter. Rapid germinability test for white spruce. Can. J. Plant Sci. (In press).

18. Goals for Next Year : Experiments with white spruce grown at three ammonium levels will be completed.

All of the biochemical data obtained to date has been obtained from seedlings which have not been subjected to moisture stress. With a view to more precisely defining the possible influence of individual metabolic components upon drought survival, these data will also be obtained for plants which have been stressed.

Another aspect of the environmental physiology of lodgepole pine seedlings will be initiated, namely a definition of the roles of nitrogen nutrition and light intensity in the utilization of CO_2. This work will involve the exposure to $^{14}CO_2$ of seedlings which have been grown for 8 weeks at two levels of nitrate or ammonium and two light intensities, followed by the quantitative determination of radioactivity in the three plant parts and in certain metabolic components.

Harold M. Etter

Harold M. Etter,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Ecological reserves and natural areas, Kananaskis Research Forest.

3. Investigator : J. Krewaz.

4. Year of Commencement: 1966.

5. Anticipated Year of Completion: Continuing.

6. Key Words not in Title: subalpine, SA1.

7. Activity : Liaison and Management.

8. Problem Area Program: Silvical characteristics of trees.

9. Establishment Project No.: A 274 Branch Project No. A 274

10. Status : Active.

11. Man-years Utilized in Past Year: Professional .3 Other .2

12. Co-operating Agencies: Nil.

13. Location of Work : Kananaskis Forest Experiment Station.

14. Abbreviated Background Statement: On the basis of the management plan for the Kananaskis Research Forest, (Internal Report A-10), all stands on the management forest area will have been cut within 70 years. To preserve areas which have developed within the forest under natural conditions and to provide specimens and ecosystems which will be produced only if cultural activities are excluded, selected areas must be set aside and kept in an undisturbed condition.

The practice of silviculture has its basis in the natural succession of forest associations. Natural stands provide a continuing source of information on undisturbed succession and a comparitive basis for evaluating the effect of the cultural treatment of similar stands. Comparison can be made of all aspects of the total environment including microclimate, soil, small mammals, insects, diseases, tree growth, genetics and water yield. Unique or unusual conditions are preserved for their fundamental difference to what is normally expected. These usually provide an example of the variation in some basic factor to otherwise similar ecosystems in the vicinity.

The selection of natural areas is designed to meet the expected requirements of the regional research staff working on the Research Forest. The size of the individual areas must take into account the limited size of the management portion of the forest while at the same time providing spatially adequate representation of the conditions to be preserved. Primary consideration will be given to those conditions which are considered irreplaceable and may be lost in the normal development of the Research Forest. Areas which may be required for specific investigations in the future should be included. The following categories are some reserve candidates: mature and overmature undisturbed stands, young stands of less common species, swamps, muskegs, hangmoors, alpine meadows, gravel Bars, erosion slopes, talus slopes, stream courses, river banks, lake beaches, beaver ponds, natural ponds, rock outcrops, superior trees and stands, common and unique physiographic sites. Reserve areas will be demarcated on the ground and mapped.

15. Summary of Progress up to One Year Ago: To obtain the most suitable reserves the selection of candidate areas has been carried by surveys explicitly made for this purpose and in conjunction with surveys carried out for operational purposes, i.e. cut layout and road location. During 1966 and 1967 about 100 candidate areas were checked out and marked with plastic flagging. In the direct survey procedure, line plot records were checked and aerial photos were scanned for desirable areas. These areas were then inspected on the ground. In conjunction with other surveys areas were noted and later re-examined. Consequently, selection has been a continuing process of checking and elimination.

In selecting representative areas the proportional distribution of common covertypes, surficial materials and physiographic sites over the whole of the Research Forest were the main factors considered. Accessibility was sometimes a secondary factor in selection. These reserves are thus representative of the stands, soils and sites of the Research Forest as a whole. Other, usually smaller, reserves represent special conditions.

16. Goals Set One Year Ago: Selected reserves will be marked on the ground with permanent boundaries. Other candidate reserves will remain tentative pending further investigation and study of other comparable areas.

17. Accomplishments in Last Year: About 100 candidate areas were rechecked during 1968, and 25 reserves are established with temporary markings on the boundaries. The boundaries of the selected areas were mapped and located on aerial photos. A report showing the location of the selected areas on a map and a brief description of each reserve is being prepared.

18. Goals for Next Year : Provision has been made for the procurement of an ecology student for the summer of 1969 to assist in mapping and describing the reserves. This is to establish a base to which successional changes in the future can be compared and with which succession in similar but culturally treated areas can be

related. Emphasis will be placed on mapping by vegetative associations that will permit a reliable measure of any future change in vegetation on a specific area.

The painting of boundaries will proceed as labour becomes available.

Additional reserves may be established as required.

J. Krewaz

J. Krewaz,
Investigator.

Project No. A 290.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969.

2. Title : Poplar habitats in the Mixedwood Section of Alberta.

3. Investigator : H. G. Anderson.

4. Year of Commencement: 1968.

5. Anticipated Year of Completion: Original 1972.

6. Key Words not in Title: Populus tremuloides, P. balsamifera, B. 18a, land classification, regeneration, succession.

7. Activity : Silviculture.

8. Problem Area Program: Silvical characteristics of trees and stands.

9. Establishment Project No.: A 290 Branch Project No.: A 290

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 1.0 Other 0.7

12. Co-operating Agencies: None.

13. Location of Work : Slave Lake and High Prairie.

14. Abbreviated Background Statement: Alberta's poplar forests are the most extensive of any cover type in the province, yet they are currently vastly under-utilized. As more intensive forestry is practiced and new demands are made upon the presently existing wood supply, questions concerning productive potential of land areas in terms of wood fiber must be answered. This can only be done if the landscape is classified in terms of forest growth. In anticipation of an increased demand upon these forests and the land they occupy, this project was established with the following objectives in mind:

(1) To classify the forest land in the mixedwood section for:

(a) potential productivity of aspen and balsam poplar, and

(b) regeneration environment of aspen and balsam poplar.

(2) To map a selected area of the landscape as a test of the usefulness and accuracy of the classification in evaluating potential productivity of poplar.

(3) To determine successional trends in overmature stands of Populus.

The forest land in the Mixedwood Section has been classified in terms of white spruce growth but on those areas where spruce is absent it is difficult to assess productivity. A portion of the present study area has been mapped under the Canada Land Inventory program of ARDA but productive capacities of various land units are based upon coniferous species. How close a relationship, if any, that exists between coniferous growth and that of Populus on the area mapped will be determined by this study.

The regeneration potential of Populus associated with particular plant communities is an aspect to be considered in any management program involving stand manipulation. Successional changes associated with various habitats will have considerable influence on the future condition of present mature stands. Forecasting future supplies of poplar cannot be undertaken until the successional trends in poplar forests are known.

Poplar habitats identified may be used in two other related poplar studies. These are: A 287, Structure, biomass and productivity of poplar forests in Alberta by E. B. Peterson and Physical properties of aspen in Alberta by J. B. Kasper.

15. Summary of Progress up to One Year Ago: The first step in an orientation to a poplar program was discussions with persons in government and industry and the problems associated with poplars. This was followed by an examination of some poplar forests in a portion of Alberta. Some of the literature was reviewed, a problem analysis was written and this was subsequently followed by a formal project proposal.

16. Goals Set One Year Ago:

(a) Select suitable sampling areas from those examined during the summer of 1967 and from aerial photographs.

(b) Identification and familiarization with plant specimens collected during summer 1967.

(c) Collection of field data in the summer of 1968.

17. Accomplishments in Last Year: Ninety stands were examined in 1968 where either Populus tremuloides, P. balsamifera or a combination of these species form the predominant cover type. The sampling area lies between 114°00' and 116°45'W longitude and extends from 54°55' to 56°15'N latitude. Stands range in age from 30 to 140 years with two-thirds

of them in, or exceeding, the 90-year age class. Dominance and canopy coverage values were estimated for the vascular plants while cover-abundance values were recorded for the cryptogams. Additional information collected in each stand included elevation, slope, aspect, landform, drainage, texture of the A horizon, an estimate of stand quality and height, age and d.b.h. of 3-5 dominant ramets. A total of 308 ramets were measured for height and age.

A preliminary segregation of stands is based on cover type. In 18 stands where balsam poplar is either the only tree species or is more abundant than aspen, there are three sub-divisions based upon landform i.e. alluvial, slope and upland types. There are some differences in floristics between these types but they are not sharp.

The remaining 72 stands are separated first on the basis of composition of the tree layer, second on age and third on physiognomy. In this large group are those stands in which aspen is the only tree species and those in which there are minor amounts of balsam poplar. An examination of the vegetation indicates that there are differences in species composition between stands over 75 years and those under this age, hence the reason for separation. The ultimate subdivision of stands within a cover-type and age-group is based on the most prominent strata of the understory. Within each of the aspen stand groups there are the following subdivisions:

1. tall shrub stands where Alnus crispa is dominant
2. medium shrub stands where Rosa and Viburnum are dominant
3. tall herb and grass stands where a number of herbs and grasses predominate
4. low herb and grass stands

There is some correlation between these groupings and the composition of the vegetation although many species occur abundantly in all four groups.

A crude approximation of site index for these stands was derived from aspen site curves for Saskatchewan. A good correlation exists between the balsam poplar types and site index. Stands on the alluvial sites have the highest site index, those on the slope are intermediate and those on the uplands are the lowest. Of the aspen stand groups those in the tall shrub type usually occur on the highest sites while those of the low herb and grass type have the lowest site index. Further refinement in this classification will probably result in a stronger correlation.

18. Goals for Next Year:

(a) Delineate clones in as many of the 90 stands as time permits in the spring and fall of 1969.

(b) Establish plots and analyse vegetation quantitatively.

(c) Collect and analyse soil data including profile descriptions, textural analysis, porosity, aeration, bulk density and field capacity.

H. G. Anderson

H. G. Anderson,
Investigator.

PROBLEM AREA PROGRAM

Genetic Improvement of Trees

The undertaking of tree improvement by selection, tree breeding and introduction is an important and longterm forest research and forest management endeavour. With an expanding reforestation program by the Alberta Forest Service and industry, it is necessary to ensure that the best possible ecotypes and genotypes are being used and that improved varieties of commercial tree species will be available in the future. The Alberta Forest Service and industry have already begun preliminary work in the selection of the elite trees in the production of better seed. It is decisively important to future forest production in the region that there be an active research program in tree improvement and that there be close co-ordination among the research and forest management agencies. The reasoning is that given sufficient knowledge, time and opportunity, tree improvement applications will allow forest management to grow the most trees of the best quality with the highest financial return on their managed forest lands. Regional research in the problem area began in 1966 to determine and evaluate geographic races of lodgepole pine and black spruce as each may be related to particular sets of environmental conditions, especially climatic factors which probably have the largest influence upon the variation in growth rhythm and survival hardiness.

A forest geneticist will join the staff in 1969. Plans for 1969-70 are to continue tree improvement research with emphasis on provenance studies and complete a problem analysis to guide the research program over the next several years.

At the moment there are two projects related to the problem area:

A 267 : Biosystematic studies of growth rhythm in lodgepole pine and black spruce - M. Hagner.

A 281 : Establishment of arboreta and small scale plantations in Alberta - J. Soos.

Project No.: A 267

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969.

2. Title : Biosystematic studies of growth rhythm in lodgepole pine and black spruce.

3. Investigator : M. Hagner

4. Year of Commencement : 1966

5. Anticipated Year of Completion : Original 1969 Revision I 1970

6. Key Words not in Title : Pinus contorta, Picea mariana, genetics, provenance, Alta., B.C., Yukon

7. Activity: : Tree Biology

8. Problem Area Program : Genetic improvement of trees.

9. Establishment Project No.: A 267 Branch Project No.: A 267

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.5 Other 0.5

12. Co-operating Agencies : Alberta Forest Service, University of Calgary, Intermountain and Rocky Mountain Forest and Range Experiment Stations, Forest Service, United States Department of Agriculture.

13. Location of Work : Collection of seed was from Yukon, British Columbia, Alberta, Montana and Wyoming. Growth rhythms studies took place in Calgary.

14. Abbreviated Background Statement: Use of regeneration stock elsewhere than its place of origin can cause gains or losses. The relationships between origin, growing environment, growth and survival have not yet been studied in the Alberta region. Provenance research, designed to simplify and optimize the use of regeneration stock, can be based on observations of differences in growth rhythm between individuals. By studying individual seedlings the variation within local populations can also be estimated. Previous studies in other geographic areas have indicated the possibility of accurately predicting relationships between provenances and survival (hardiness).

The objectives of this study are:

(1) To determine the differences in growth rhythm between provenances and between individuals within provenances.

(2) To determine the differences in growth rhythm between lodgepole pine and black spruce in populations originating from the same stand.

(3) To determine the climatic factors that have the largest influence upon the variation in growth rhythm.

(4) To determine the importance of elevation in interaction with latitude.

(5) To propose regions in Alberta within which regeneration stock can be safely transferred.

(6) To determine if the same order of growth rhythm in a provenance series can be obtained in the growth chamber as in the nursery.

(7) To determine if tagging with C^{14} can be used in studies of growth rhythm in seedlings.

15. Summary of Progress Up to One Year Ago: During the summer of 1966, 36 provenances of lodgepole pine and 9 provenances of black spruce were obtained. Seedlings were planted in the University of Calgary nursery in June, 1967 and between June and September, 1967, each of 6900 seedlings was photographed on four occasions. Seedling vitality was recorded in July and bud setting was recorded in August, 1967. Seedling growth was determined in the laboratory from the summer photographs of seedlings. Laboratory trials were undertaken to develop methods for labelling of wood with C^{14}.

16. Goals Set One Year Ago : Completion of statistical analyses and preparation of two proposed manuscripts for submission to Silvae Genetica.

17. Accomplishments in Last Year: Return of Mr. M. Hagner to Sweden in June, 1968, occurred before completion of reporting on this project. No manuscripts have been received as of March, 1969.

18. Goals for Next Year : Completion of one manuscript, merging the two originally intended, under a suggested title of: A genecological investigation of lodgepole pine and black spruce: variation in annual growth rhythm, seed quality, cone morphology and cotyledons. (Proposed by M. Hagner as a Departmental Publication).

E. B. Peterson

for. M. Hagner
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: April, 1969
2. Title : Arboreta and small exotic plantations in Alberta.
3. Investigator : J. Soos
4. Year of Commencement: 1967
5. Anticipated Year of Completion: Original - 1975
6. Key Words not in Title: hardiness, growth.
7. Activity : Liaison and Management
8. Problem Area Program: Genetic improvement of trees.
9. Establishment Project No. A 281 Branch Project No. A 281
10. Status : Active
11. Man-years Utilized in Past Year: Professional - 0.1 Other - 0.4
12. Cooperating Agencies: Alberta Department of Landa and Forests; Department of Agriculture.
13. Location of Work : Alberta
14. Abbreviated Background Statement: Knowledge on the hardiness and productivity of exotic trees in Alberta is limited. Some preliminary assessment has been made by the Insect and Disease Survey Section of Forest Research Laboratory, Calgary, by detecting the existing exotic plantations in the province and conducting an ocular survey on the insect and disease conditions of these plantations annually. The objectives of this project are:

    1. To determine the hardiness, health, form and early growth of exotic trees in various regions of Alberta.

    2. To compare the height, diameter growth, basal area and volume of promising exotic trees with native species, planted on relatively small areas under forest conditions.

15. Summary of Progress up to One Year Ago: Four small arboreta were established in Footner Lake, Peace River, Rocky, Clearwater and Bow Forests in the early spring of 1967. Three areas consisting of 2.6 acres each were planted with lodgepole pine, Scots pine, Norway spruce, white spruce, Colorado spruce and Siberian larch in Peace River, Clearwater, Rocky and Bow

Forests during 1967.

16. Goals Set One Year Ago: Establishment of an arboretum on each Forest Division and one small exotic plantation in Slave Lake Forest in cooperation with the Alberta Forest Service. Hardiness and survival observations to be made on all areas planted in 1967.

17. Accomplishments in Last Year: (1) Three new arboreta containing 40 species each were established in cooperation with the Alberta Forest Service in Grande Prairie, Lac La Biche and Athabasca Forests.

(2) Additional species and replacements were obtained and shipped to the arboreta in Clearwater, Rocky, Bow, Slave Lake, Peace River and Footner Lake Forests.

(3) Two new exotic plantations were established in cooperation with the Alberta Forest Service in Peace River and Slave Lake Forests, and replacement planting was carried out in Clearwater Rocky and Bow Forests.

(4) Scions were collected from the best Scots pine phenotypes in Rich Valley and were grafted with the purpose of establishing a Scots pine seed orchard at a later date.

(5) Hardiness and mortality observations were completed for the previously established arboreta and exotic plantations.

18. Goals for Next Year: (1) Establishment of one arboretum, possibly in Hinton. (2) Replacement of dead seedlings in the exotic plantations. (3) Continuation of mortality and hardiness observation.

Publication:

Soos, J. 1969. Performance of some exotic and native tree species at Rich Valley, Alberta. Proposed Information Report.

J. Soos
Investigator

PROBLEM AREA PROGRAM

Demonstration of Land Capability for Forestry Uses

Programs of basic and applied research are required to develop principles and techniques for forest land inventory and evaluation of natural productivity and alternative planned uses. Land classification systems are presently being developed in cooperation with industry and the Alberta Forest Service to describe and inventory forest land capabilities. Emphasis is given to study of basic physiographic and forest information on units of forest landscape using classifications from both intensive and reconnaissance surveys. Cooperative studies are being undertaken with specialists in soil science, ecology, forest mensuration and inventory, forest management and forest hydrology to observe and evaluate relationships between land, soil and forest types and to derive meaningful classification systems and mapping units. A number of different representative areas have been classified and mapped according to homogeneous land form, soil, and vegetation units and evaluations have been made as to their potential forest productivity and in other special areas for watershed management.

Plans for 1969-70 are to continue the land classification studies and participate with the Alberta Forest Service in the Canada Land Inventory mapping program. Responsibilities of this program include checking and approval of manuscript CLI forestry maps. New studies related to land classification will emphasize forest climate as one of the fundamental elements which control forest establishment and growth as well as incidence and abundance of forest insects and pathogens. In this regard important features of the forest climate and some of the physical principles underlying them will be studied and evaluated in cooperation with members of the Geography Department, University of Alberta. The initial aim is to prepare a map of Forest-climatic areas of Alberta showing similar climatic characteristics for forest growth.

At present the following projects and project proposals relate to the problem area.

A 82 : A demonstration of differences in forest land productivity between five physiographic land conditions in the foothills section of Alberta - P.J.B. Duffy.

A 138*: Hydrologic classification of wildland soils - G.J. Beke.

A 258 : Canadian Land Capability Classification for Forestry Canada Land Inventory, ARDA - W.D. Holland

*Project statement appears under problem - "Stabilization and improvement of water yield from Forest Areas"

Proposal*: Forest types and tree growth in relation to soil mapping units - G.L. Lesko.

Proposal**: Potential energy available for snow evaporation in winter along the east slopes of the Rocky Mountains in Alberta - D.L. Golding and R.H. Swanson.

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*Project statement appears under problem - "Limiting Factors of Soils in Forest Growth."

**Project statement appears under problem - "Stabilization and Improvement of Water Yield from Forest Areas."

Project No. A 82

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Differences in forest land productivity between five physiographic land conditions, Foothills Section, Alberta.

3. Investigator : P. J. B. Duffy.

4. Year of Commencement: 1962.

5. Anticipated Year of Completion: Original 1967 Revision I 1969

6. Key Words not in Title: Growth prediction, B. 19

7. Activity : Land Classification

8. Problem Area Program: Demonstration of land capability for forestry uses.

9. Establishment Project No.: A 82 Branch Project No.: A 82

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0 Other 0

12. Co-operating Agency : Northwestern Pulp and Power Ltd.

13. Location of Work : Hinton, Alberta.

14. Abbreviated Background Statement: Northwestern Pulp and Power Ltd. has prepared a site classification map for the Company timber limits at Hinton, Alberta. One compartment of 56 square miles was mapped as a pilot project with the assistance of the late W. G. E. Brown, Consultant in Forest Land Classification. Using the compartment as a study area the present project was designed to appraise the suitability of the classification for growth predictions. The objectives of the study are to describe and explain:

    (a) The differences in productivity between five physiographic groups of land;

    (b) The variation in productivity within each group;

    (c) The site factors which are useful in classifying denuded forest land or land supporting on suitable stands for the sample of yield.

15. Summary of Progress up to One Year Ago: Field work was completed in the 1962 field season. Other priority work and the absence of the investigator has required this project to be placed on a maintenance basis until 1968.

16. <u>Goals Set One Year Ago</u>: To complete a report in the 1968-1969 fiscal year.

17. <u>Accomplishments in Last Year</u>: None. The project continued on a maintenance basis with the absence of the investigator.

18. <u>Goals for Next Year</u> : Proposed Information Report will be completed in 1969.

Publication:

Duffy, P. J. B., 1969. A demonstration of differences in forest land productivity between five physiographic land conditions in the Foothills Section of Alberta (A proposed departmental Information Report).

"P. J. B. Duffy"

P. J. B. Duffy,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/ Territories Region Date: February, 1969.

2. Title : Canadian Land Capability Classification for Forestry, Canada Land Inventory, ARDA.

3. Investigator : W. D. Holland.

4. Year of Commencement: 1965.

5. Anticipated Year of Completion: Original 1970 Revision I 1971

6. Key Words not in Title: air photo, soils productivity, forest climates.

7. Activity : Land classification.

8. Problem Area Program: Demonstration of land capability for forest uses.

9. Establishment Project No.: A 258 Branch Project No.: A 258

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 1 Other 1.75

12. Co-operating Agency : Alberta Forest Service.

13. Location of Work : Alberta Canada Land Inventory area. Field work Map 84D, Hines Creek - Cherry Point.

14. Abbreviated Background Statement: This project is a continuing program of the Forest Land Capability Classification sector of the Canada Land Inventory initiated by ARDA in 1965. Advisory services are made available to the province re: interpretation of air photos, soil data, forest productivity data, climatic data and mapping procedures as per Canada Land Inventory guidelines, and map editing of provincial manuscript maps prior to submission to Ottawa for publication.

Preparation of a forest land capability map for the Cherry Point - Hines Creek area (about 3/4 of map sheet 84D) was undertaken in 1968. This mapping will be extended to the entire map sheet in 1969 and will include 1:50,000 and 1:250,000 maps.

The objectives of this project are:

(1) to advise and assist the province in its forest land capability classification program.

(2) to prepare a forest land capability map of all of sheet 84D as per Canada Land Inventory guidelines.

(3) to examine the feasibility of initiating companion research pertaining to problems of soil parent materials, climatic studies, solonetzic soils and their relationships to forest production, soil drainage criteria, soluble salt levels, characteristics of organic horizons, moisture retention, soil density, soil structure, texture, compaction and permeability.

Outstanding problems are the provision and evaluation of soil and climatic data to enable adequate interpretation of land capability for forestry purposes. A statistical model for description of the influence of environmental factors on forest capability is urgently needed.

15. Summary of Progress up to One Year Ago: Progress prior to 1968 is given by the following reports:

Knight, H. 1967. Progress of the Canada Land Inventory in Alberta. Information Report A-X-9. Department of Forestry and Rural Development, Forest Research Laboratory, Calgary, Alberta.

Knight, H. 1967. Some Limiting Factors of Tree Growth in Alberta. Internal Report A-8. Department of Forestry & Rural Development. Forest Research Laboratory, Calgary, Alberta.

Knight, H., J. A. Schalkwyk, J. R. Prokopchuk, N. van Vass, E. Boyacioglue, and R. Pearson. 1967. Land Capability Classification for Forestry in Alberta. Mimeo. Report.

The above reports provide information on the amount of work carried out and issue pleas for research work that will enable the province to achieve their objectives more satisfactorily.

Additional progress was given by these reports:

Holland, W. D. 1967. Report to the Research Sub-Committee. Proceedings National Committee on Forest Land, Department of Forestry and Rural Development, Forest Branch. p.p. 68-72.

Holland, W. D. 1967. Land Capability Classification for Forestry. The Canada Land Inventory. Report No. 4 p.p. 18-21.

16. Gφals Set One Year Ago: The forest capability map of sheet 84-D will be completed for publication.

Section 1 entitled "Methods and Instructions for Site Description" of the proposed manual "Procedures for Forest Land Classification in Alberta" will be completed.

Some preliminary field work and study will be done preparatory to the submission of the new research proposals.

17. Accomplishments in Last Year: Objective 1 (advisory services) was partially accomplished by working in the Alberta Forest Service office from January to May. This provided first-

hand knowledge of working methods used by the Forest Service for Canada Land Inventory mapping. Field trips accompanying Alberta Forest Service survey personnel were made to sheet 83L (south of Grande Prairie) to observe field checking methods. Sampling of selected soils and forest plots was carried out in parts of the east slopes area to augment the data for Project A-64, (P.J.B. Duffy), which in turn provided a preliminary classification for Canada Land Inventory work in this area. A trip along part of the B.C. - Alberta boundary was undertaken in an effort to correlate mapping results where Canada Land Inventory map areas join across provincial boundaries.

Objective 2 was met by the mapping of the southern three-quarters of Sheet 84D. This work envolved photo-interpretation of over 500 aerial photos, field checking, plot sampling and map preparation. Twelve 1:50,000 map sheets were prepared by February, 1969.

Explorations were carried out to interpret climatic information for Canada Land Inventory purposes. Exploratory work was initiated to correlate such physical data as bulk density, compaction (penetrometer data), and macro-pore space (air permeameter) with root growth and productivity. A number of problems, namely a lack of time and inadequate equipment, left this work in an introductory state. Preliminary results suggest that compaction and/or density of some sub-surface soils is a limiting factor to forest growth in this region.

The preparation of the proposed site manual was postponed.

18. Goals for Next Year :

1. Continuation of advisory services.

2. Completion of mapping of the extended map area to the northern portion of Sheet 84D, including preparation of the 1:250,000 map.

3. Review of the manuscript maps of the Canada Land Inventory prepared by the Alberta Forest Service.

4. Preparation of an Internal Report on the results of work carried out as exploratory research.

W. D. Holland

W. D. Holland,
Investigator.

PROBLEM AREA PROGRAM

Limiting Factors of Soils in Forest Growth

Soil science is a service of forestry, and soils together with its physical, chemical and biological qualities is studied from the point of view of its benefit or harm to tree establishment and growth. This problem is a part of the larger ones of silviculture, nursery management, land classification, watershed management and other ecological research.

The capacity of the soil to support a productive forest depends on a series of closely related factors including, available moisture, temperature, nutrients and texture. Knowledge of these factors and the forest requirements of water, free oxygen and various nutrients is at a rather modest level. At this time the purpose and scope of the soil research program is aimed at understanding some of the basic processes of soil-water movement and retention and soil temperature which are directly related to soil site and ecological evaluations in tree growth. Other investigations are being conducted and more are planned on an evaluation of the present taxonomic and mapping units and interpretive soil classification for forest growth. Small scale studies are also being made of prescribed fire effects on physical and chemical soil properties. Specific projects in this problem area include:

A 135*: Infiltration overland flow and sediment as affected by forest cover and its manipulation by Teja Singh.

A 138**: Hydrologic classification of wildland soils by G. J. Beke.

A 295***: Effects of prescribed fire on peaty humid glysols under spruce-fir and Grey Wooded soils. - G. L. Lesko.

A 278 : Soil moisture and temperature in relation to topography soil vegetation and climate by G. L. Lesko.

A 303 : Microbial populations associated with various forest sites by J. A. Dangerfield.

Proposal : Forest types and tree growth in relation to soil mapping units. - G. L. Lesko

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* Project statement appears under problem - "Maintenance and Improvement of Water Quality in Forest Areas"

** Project statements appear under problem - "Stabilization and Improvement of Water Yield in Forest Areas"

*** Project statement appears under problem - "Improved Regeneration of Foothills Boreal Forests"

Project No. A 278

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.
2. Title : Soil moisture and temperature in relation to topography, soil, vegetation and climate
3. Investigator : G. L Lesko
4. Year of Commencement: 1967
5. Anticipated Year of Completion: Original 1970 Revision I. 1971
6. Key Words not in the Title: Picea glauca, Abies lasiocarpa B. 19c
7. Activity : Soils
8. Problem Area Program: Limiting factors of soils in forest growth.
9. Establishment Project No.: A 278 Branch Project No.: A 278
10. Status : Active
11. Man-years Utilized in Past Year: Professional 0.2 Other 1.0
12. Co-operating Agency : Northwestern Pulp and Power Ltd.
13. Location of Work : Hinton, Alberta
14. Abbreviated Background Statement: The knowledge of environmental factors and the requirements of the commercial trees is necessary for sound silvicultural practice. The quantitative values of soil moisture and temperature in relation to space and time in Alberta are not known, although these are environmental factors of great biological importance. The economical importance of soil moisture and temperature is also great, because they influence the establishment and subsequent development of our forests.

The main objectives of the project are:

1. To accumulate information on soil moisture and temperature conditions of some forest types in Alberta.

2. To relate soil moisture and temperature regimes to local climate, edaphic conditions, and floristic composition.

3. To relate soil moisture and temperature to forest stand composition and productivity.

Since soil moisture and temperature regimes directly influence the establishment and subsequent growth of seedlings this project may provide useful information for the regeneration of spruce - balsam forests. The project also will provide results applicable in land classification practices in the study area.

15. <u>Summary of Progress up to One Year Ago</u>: 1. Forest stand, soil and vegetation have been described on 35 sample plots. The forest has been classified tentatively into ten forest types.

2. Ten permanent sample plots were established in five forest types with two observations points in each sample plot. A series of six colman soil moisture and temperature units had been installed at each observation point.

16. <u>Goals Set One Year Ago</u>: 1. Establishment of five microclimatic stations in conjunction with the five studied forest types.

2. Collection of microclimatic soil moisture and temperature data.

3. Laboratory analyses of the soil samples.

17. <u>Accomplishments in Last Year</u>: 1. Five microclimatic stations were established in conjunction with the five studied forest types.

2. Microclimatic, soil moisture and temperature data were collected at each observation point from May to October, at weekly intervals.

3. All soil samples were analysed for color, particle size and soil reaction.

18. <u>Goals for Next Year</u> : 1. Collection of field data as in the last one-year period.

2. Completion of laboratory analyses of the collected soil samples.

Report: Lesko, G. L. Soil moisture and temperature in relation to vegetation and other environmental factors. Internal Report.

G. L. Lesko
Investigator

Project No. A 303

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.
2. Title : Microbial populations associated with various forest sites.
3. Investigator : J. A. Dangerfield
4. Year of Commencement : 1968
5. Anticipated Year of Completion: Original 1970 Revision I 1969
6. Key Words not in Title : nutritional requirements.
7. Activity : Soils Research
8. Problem Area Program : Limiting factors of soil in forest growth.
9. Establishment Project No. : A 303 Branch Project No.: A 303
10. Status : Active
11. Man-years Utilized in Past Year: Professional .75 Other 1
12. Co-operating Agencies : None
13. Location of Work : Hinton, Alberta, Edmonton Laboratory.
14. Abbreviated Background Statement: The microbial population has been shown to fluctuate with fluctuations in associated phenomena. There are many reports of changes in total activity and individual group activity (fungi, actinomycetes, bacteria) produced by changes in temperature, moisture, p^H, and type of organic material available as a carbon source. Much of this work has been conducted in areas other than Alberta, and as a result there is a lack of this type of information pertinent to Alberta conditions. This project is designed to characterize the microbial population found under three forest types common in Alberta as to fluctuation in total population and the nutritional requirement of that population. An effort will be made to correlate these fluctuations with differences in soil temperature, moisture and p^H.
15. Summary of Progress Up to One Year Ago: Work was initiated in 1968.
16. Goals Set One Year Ago : Locate sample plots. Sample soils at monthly intervals and characterize isolated populations from each sampling as to morphology, total numbers and nutritional requirements.
17. Accomplishments in Last Year: Sampling of the selected plots of white spruce, lodgepole pine and aspen poplar

was carried out in May, June, July, August and September. Total counts were carried out on each sampled horizon from the three plots and from these 400 organisms distributed evenly between samples were picked and characterized as to morphology and nutritional requirements. Fluctuations in total populations were plotted graphically so that they can be easily compared with temperature and moisture fluctuations. The nutritional characterizations indicated that a very high proportion of the populations from all sites could grow actively on a simple inorganic media with a glucose carbon source. This indicates a high rate of mineralization of organic materials and a low natural fertility of mineral horizons. The results also indicate the unsuitability of this technique as a means of grouping the forested soil microflora.

18. Goals for Next Year : The results of this study will be evaluated and reported. "Microbial populations associated with various forest sites in Alberta". Upon reporting, this project will be terminated.

Publication :

Dangerfield, J. A. 1969. Microbial populations associated with various forestry sites in Alberta. (Proposed Internal Report).

J. A. Dangerfield,
Investigator.

PROJECT PROPOSAL STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Forest types and tree growth in relation to soil mapping units.

3. Investigators : G. L. Lesko, J. D. Lindsay (Research Council of Alberta)

4. Year of Commencement: 1969

5. Anticipated Year of Completion: 1970

6. Key Words not in Title: Picea glauca, Pinus contorta, Picea mariana.

7. Activity : Soils

8. Problem Area Program: Limiting factors of soils in forest growth.

9. Annual Man-year Requirements: Professional 0.6 Other 0.8

10. Major Equipment Purchases Required for Completion: None

11. Co-operating Agency : Research Council of Alberta

12. Location of Work : Pembina, West of Drayton Valley

13. Background Statement: The Alberta Soil Survey introduced a resolution at the soil survey Advisory Committee meeting in October, 1966, for the establishment of a Forest/Soil Relationship Committee. The formation of such a committee became necessary to aid the Soil Survey in the establishment of a meaningful classification of forest soils.

To date, the mapping units of the Soil Survey are based on soil properties important for the productivity rating of the land for agricultural purposes. Since tree growth and forest management have vastly different requirements than those of the agricultural crops, the present soil classification is not suitable for the establishment of land units with uniform capabilities and management requirements for forestry purposes. To aid the adaption of the present soil classification to the classification of forest soils, an Ad Hoc Forest/Soil Relationship Committee was formed with the participation of Alberta Soil Survey and Canada Department of Forestry Personnel in 1967.

The Ad Hoc Committee advised the initiation of a co-operative pilot project for the study of soil properties in relation to forest composition and productivity. The Department of Forestry in Calgary and the Alberta Soil Survey agreed on the necessity of such a project.

Research efforts for the establishment of relationships between soil and tree growth may follow two broad approaches.

One is when the forest types or tree growth are related to one or more soil properties. The other is when the same is related to soil classification units at various levels.

There is much available reference belonging to the first approach, in the U.S.A. Auten (1945) related yellow poplar site index to soil depth, Coile (1935) studied the growth of shortleaf pine in relation to physical soil properties; Gessel and Lloyd (1950) studied Douglas fir growth in relation to various soil properties. Stoeckeler (1960) found that site index of quaking aspen is better correlated to the physical properties of the soil than to available nutrient status. Pawluk and Arneman (1961) found that the growth of jack pine in Minnesota and Wisconsin is closely related to soil properties determining its moisture regime. Moehring and Ralston (1967) found close relationship between the available moisture of the soil and the diameter growth of loblolly pine.

In Canada, Griffith (1960), McMinn (1960), Eis (1967) found positive relationship between soil moisture and Douglas fir site index in Coastal B. C. Kirby (1962) however, concluded that the growth of white spruce decreased with increasing moisture regime in Saskatchewan.

For interpretative soil classification, growth information is more useful if related to soil classification units. Lesko (1961), Sprout, Lacate and Arlidge (1966) related forest type and site index to soil subgroups, which is a higher category then the soil series used in Alberta by Soil Surveyors as mapping units. U.S.D.A. Soil Conservation Service (1968) studied site index, erosion hazard, equipment restriction and seedling mortality in relation to soil series. This approach seems to be the most useful in creating a meaningful classification of forest soils.

In Alberta, Duffy (1965a, 1965b) studied the relationship betweel soil factors and the growth of lodgepole pine in the Rocky Mountain House area, and white spruce growth in the Mixedwood section of Alberta. Knight and Duffy (1967) classified the Marsh Head Demonstration area at Whitecourt for forest land capability. In these works site productivity was related to surface material and drainage besides other soil factors. However, none of these classification followed the soil survey mapping units used in Alberta.

Jeffrey, Bayrock, Lutnick and Dormaar (1968) classified the Oldman River Basin and related forest types to soil subgroups.

In the presently proposed project, forest types and tree growth will be related to soil survey mapping units besides other soil factors.

Auten, J. T., 1945. Prediction of site index for yellow poplar from soil and topography. J. For. 43, 662-668.

Coile, T. S., 1935. Relation of site index for shortleaf pine to certain physical properties of the soil. J. For. 33, 725-730.

Duffy, P. J. B., 1965a. Relationships between site factors and growth of lodgepole pine (Pinus contorta Douglas var. latifolia Engelm.) in the foothills section of Alberta. Department of For. Publ. No. 1065.

1965b. A forest land classification for the Mixedwood section of Alberta. Department of For. Publ. No. 1128.

Eis, S., 1962. Statistical analysis of several methods for estimation of forest habitat and tree growth near Vancouver, B. C. For. Bull. No. 4, University of B. C., Vancouver.

Griffith, B. G., 1960. Growth of Douglas fir at the University of British Columbia Research Forest as related to climate and soil. Forestry Bull. No. 2, University of B. C., Vancouver.

Gessel, S. P., and W. J. Lloyd, 1950. Effect of some physical soil properties on Douglas fir site quality. J. For. 48: 405-410.

Jeffrey, W. W., L. A. Bayrock, L. E. Lutwick and J. F. Dormaar, 1968. Land-vegetation tipology in the upper Oldman River Basin, Alberta. Forestry Branch, Departmental Publ. No. 1202.

Knight, H., and P. J. B. Duffy, 1967. A forest land capability classification for the Marsh Head demonstration area Whitecourt Forest, Alberta. For. Res. Lab., Calgary, Alberta. Information Report A-X-10.

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Stoeckeler, J. H., 1960. Soil factors affecting the growth of quaking aspen forests in the Lake States, University of Minnesota, Agric. Exp. Station, Tech. Bull 233, 46 pp.

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14. Objectives : (a) To study and establish relationships between forest types, tree growth and soil mapping units.

(b) To establish relationships between tree growth and soil properties.

15. Plan of Attack : In the first field season an effort will be made to locate and describe all forest/soil combinations in the study area. The collected data will be organized into forest types and soil series during the winter. The number of descriptions in each forest type/soil series combinations will be increased to ten in the second field season to make the data more suitable for statistical analysis.

The data collection will be carried off in the following steps:

Field Phase

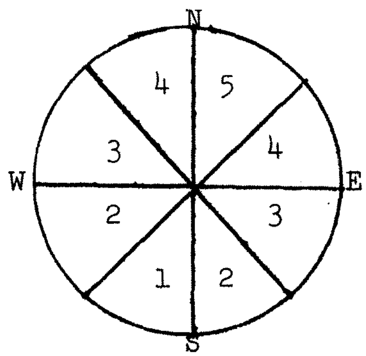
(a) Identification of parent materials from aerial photographs.

(b) Location of sample plots in different topographic positions within parent materials.

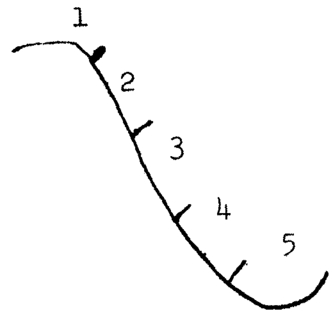
(c) Description of soil and forest in the sample plots. The forest stand will be described on 30 x 30 m sample plots according to tree, shrub, herb and moss layers. The site productivity will be assessed by the measurement of height and age of four dominant trees and by diameter measurement of all trees over one inch diameter (B.H.). All sample plots will be established in mature stands.

To facilitate statistical analysis, the edaphic properties of the sites will be evaluated according to 6 characteristics, each with a possible value from one to five. The value given to each edaphic property increases from dry to wet conditions as follows:

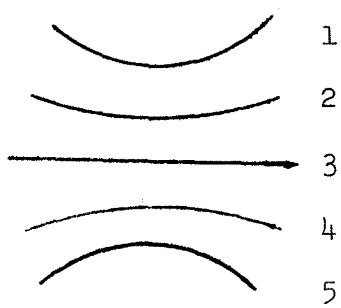
Exposure



Topographic Position



Shape of Contour



Slope

45%+	- 1
30 - 45%	- 2
15 - 30%	- 3
5 - 15%	- 4
0 - 5%	- 5

Slope Length Above Sample Plot

0 - 50 m	- 1
50 - 100 m	- 2
100 - 500 m	- 3
500 - 1000 m	- 4
1000 m +	- 5

Soil Texture

Sand	- 1
Sandy loam	- 2
Loam	- 3
Clay loam	- 4
Clay	- 5

The sum of the six values will give the "edaphic value" of the site.

A soil pit will be excavated on each sample plot and described by the soil surveyor according to genetic horizons; samples collected for laboratory analyses; and the moisture regime estimated according to a scale from one to ten.

In order to cover the full range of soil variations the sample plots will be selected by the soil surveyor.

Laboratory Phase

(a) All sample plots will be organized into forest types according to vegetation composition.

(b) Site index, basal area, number of trees per acre and mean annual increment will be calculated for each plot.

(c) Soil samples will be analysed for:

available moisture
hydraulic conductivity
particle size distribution
soil reaction (pH)
cation exchange capacity
exchangeable cations
carbon, nitrogen
carbon/nitrogen ratio

All stand data will be analysed by Forestry Branch and the laboratory analyses will be carried out by the Alberta Soil Survey.

Data Analysis

The following factors will be analysed for relationships between forest types and soil types.

Forest types/Soil types - graphical.

Analysis of Variance:

Forest types/Edaphic values
Forest types/Moisture index
Forest types/Site index
Soil types/Site index

Simple or Multiple Regression:

Edaphic values/Site index
Moisture index/Site index

Edaphic values/Moisture index
Moisture holding capacity/Site index
Nitrogen content/Site index
Carbon-nitrogen ratios/Site index

16. Goals for Initial One-Year Period: (a) An attempt will be made to locate all forest/soil combinations in the study area and establish and describe sample plots in them according to plans.

(b) To organize the collected data into forest types and soil series.

(c) To analyse the collected soil samples.

G. L. Lesko
Investigator

"J. D. Lindsay"
J. D. Lindsay
Investigator

PROBLEM AREA PROGRAM

Stabilization and Improvement of Water Yield from Forest Areas

Water is an extremely important product of the forested areas of Alberta. The foothills and mountains that comprise the major source area for the prairies water supply, make up only 6% of the area of Alberta. This relatively small area supplies more than 90% of the water in the Saskatchewan River system.

Forest management practices do influence water supply. Watershed research seeks to understand why, how, and how much influence certain practices have on water yield, regime and quality. These three variables are interrelated in that one usually can not be changed without disturbing the other two. However, it is convenient to separate yield and quality and study these independently of each other, but recognizing both are highly dependent upon regime. Therefore, there is a natural division of forest hydrology research into the problems of "Stabilization and improvement of water yields from forested areas" and "Maintenance and improvement of water quality in forest areas".

Past forest hydrology research in Alberta has pivoted around data collection networks to gain a basic knowledge or "feel" for the hydrology of the area. This phase is rapidly drawing to a close. The program now is aimed at solving pertinent problems within specific problem areas, and developing basic process understanding which can be applied in a more general source. All problems now being attacked in forest hydrology are interdisciplinary in that the environmental system is being studied along with specific parameters. Meteorologists, soil scientists, hydrologists and foresters are combining their respective skills in this effort.

There are four major areas to which attention is being addressed: the alpine-grasslands or tundra area; the spruce-fir -larch vegetation complex; lodgepole pine zone; and the aspen-grassland zone. The lodgepole pine area is under present heavy use and management plans are now being drawn up to utilize most of this zone in Alberta. Management information is badly needed for this zone as future water supplies are highly dependent upon maintaining present yields of high quality water from it. A major portion of the research effort is directed toward this area and studies now in effect or being planned are: the influence of chinook winds in removing snow pack; the effect of forest opening size, on snow accumulation and ablation and the aerodynamic-radiant energy exchange relations that describe and explain these effects. Some of these answers should be forthcoming by 1973-75.

The spruce-fir zone is second in importance. It occupies less area than lodgepole pine, but yields more water. For the most part, this zone is reserved for water supply management. Timber operations are restricted to the low altitude portions which overlap with that of lodgepole pine. The past research plan for this area was predicated on the availability of 20-25 years to develop basic processes which could be simulated on a watershed basis for an "optimum" management plan. In anticipation that this much time will not be available, alternate plans are being formulated to test some existing practice that has been shown to yield desirable, if not optimum results, in the United States under similar vegetative and climatic conditions. This program involves timber manipulation in Marmot Creek Basin. The earliest possible date for information on altering water yield is 1975.

Aspen-grassland is of fourth ranking importance in terms of water yield. This zone is one of ground water re-charge and water use. There is little surface runoff. The major problems are stabilization of surface groundwater discharge ("springs") and the encouragement of high infiltration rates through good range management. The present research is aimed at evaluating the effects on infiltration and overland flow of various grazing and timber conversion practices. This aspect will continue. The future program will also include the delineation of groundwater re-charge areas and the vegetative parameters that affect the distribution and utilization of precipitation on these areas.

Of last importance in terms of action program are the alpine areas. These yield high volumes of water, but receive no management. Their principal use is wildlife habitat. There is some possibility for increasing their effectiveness as snow accumulation areas, but the lack of necessity for increased water yield at present precludes immediate research action. This area should receive attention, though, if any water export or interbasin transfers are envisioned. It is potentially the highest yielding area in the summer and fall, the seasons when water supplies are most deficient.

Specific projects related to this problem are:

A 130 : Marmot Creek Experimental Watershed - D.L. Golding.

A 135*: Infiltration, overland flow and sediment as affected by forest cover and its manipulation - T. Singh.

A 137 : Streeter Basin Experimental Watershed - T. Singh.

A 138 : Hydrologic classification of wildland soils - G.J. Beke

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*Project statement appears under problem - "Maintenance and Improvement of Water Quality in Forest Areas"

A 139 : Deer Creek experimental watershed - R.H. Swanson.

A 283 : Waterholding capacity and infiltration rate of the forest floor under spruce-fir and lodgepole pine stands - D.L. Golding.

A 292 : Moisture exchange between the soil profile and the snowpack - R.L. Harlan.

A 296 : Consumptive use by aspen and associated shrubs and grasses - T. Singh.

A 297 : Rainfall interception by aspen - T. Singh.

Proposal : Disposition of water in forest soil - R.L. Harlan.

Proposal : Potential energy available for snow evaporation in winter along the east slopes of the Rocky Mountains in Alberta - D.L. Golding and R.H. Swanson.

Proposal : Measuring transpiration of individual trees <u>in situ</u> - R. H. Swanson.

Project No. A 130

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Marmot Creek experimental watershed.

3. Investigator : D. L. Golding

4. Year of Commencement : 1962

5. Anticipated Year of Completion: This is a continuing project.

6. Key Words not in Title : Hydrology, gauged basin, meteorology, ground water, Alberta, SA 1, spruce, alpine fir.

7. Activity : Forest Hydrology.

8. Problem Area Program : Stabilization and improvement of water yields in forested areas.

9. Establishment Project No.: A130 Branch Project No.: A130

10. Status : Active

11. Man-years Utilized in Past Year: Professional .75 Other 1.5

12. Co-operating Agencies : Meteorological Branch, Canada Department of Transport; Water Survey of Canada and Water Quality Division, Department of Energy, Mines and Resources; Eastern Rockies Forest Conservation Board; Research Council of Alberta; Alberta Forest Service; Water Resources Branch, Alberta Department of Agriculture.

13. Location of Work : Marmot Creek basin, Kananaskis River Valley near Seebe, Alberta

14. Abbreviated Background Statement: Marmot Creek experimental watershed is part of a comprehensive program of watershed research designed to supply information and to develop techniques relative to preservation of watershed values, restoration of damaged areas, and improvement of water supplies. The objective of the program is to increase or maintain water yield, to improve or maintain water quality, and to improve the timing of flow. The Marmot Creek

watershed was the first small watershed project undertaken in the East Slopes (Alberta) Watershed Research Program (now the Alberta Watershed Research Program). It was selected because of the importance of high-elevation spruce-fir forests relative to water yield and because of the extensive logging of this cover type.

The objectives of the project are: (1) to establish the hydrology of spruce-fir forests under existing vegetation conditions, and (2) to carry out forest cover manipulation based on companion studies and other research to determine the hydrologic effects of such treatment.

15. <u>Summary of Progress up to One Year Ago</u>: Surveys have been carried out (forest cover, ground vegetation, and soil) and instrument networks established (meteorological, hydrometric, and groundwater). Measurements from the networks have been gathered from establishment to the present. Companion studies have been carried out on the basin (soil moisture and temperature, hydrologic characteristics of the forest floor, interception), as well as in the Crowsnest Pass (snow accumulation and melting in cutovers).

16. <u>Goals Set One Year Ago</u> : (1) Instrument networks to be maintained and groundwater network to be enlarged, (2) studies by co-operating agencies will continue, (3) field work for Project A283 (water-holding capacity and infiltration rate of the forest floor under spruce-fir and lodgepole pine stands) will be completed, and (4) Project A138 (Hydrologic classification of wildland soils) will continue.

17. <u>Accomplishments in Last Year</u>: The goals as set out in Section 16 were met and the following publications prepared:

Golding, D. L. 1968. Snow measurement on Marmot Creek experimental watershed. Information Report A-X-18, Canada Dept. Fisheries and Forestry, Forestry Branch, Forest Research Laboratory, Calgary, Alberta. 16 pp.

Golding, D. L. 1969. Snow relationships on Marmot Creek experimental watershed. Canada Dept. Fisheries and Forestry Bi-Monthly Research Notes. (In press).

Jeffrey, W. W. and C. R. Stanton. 1968. Snow accumulation in lodgepole pine stands at low elevations. Unpublished report on file with Canada Dept. Fisheries and Forestry, Forest Research Laboratory, Calgary, Alberta.

Kirby, C. L. 1969. Forests of Marmot Creek research basin. Departmental Publication, Canada Dept. Fisheries and Forestry, Forestry Branch, Ottawa. (In press).

Storr, D. 1968. A challenging experiment in applied meteorology. Paper presented at the Can. Met. Soc. Ann. Congr. June 1968, Calgary, Alberta.

18. <u>Goals for Next Year</u> : Measurement data will continue to be gathered from existing networks and groundwater instrumentation will be completed by Research Council of Alberta. Research under way by Meteorological Branch, Water Survey of Canada, and Research Council will continue. Projects A283 (Water-holding capacity and infiltration rate of the forest floor under spruce-fir and lodgepole pine stands) and A138 (Hydrologic classification of wildland soils) will be completed and reports written.

Cabin Creek sub-basin will have layout completed for roads and cut strips for a proposed commercial logging of the sub-basin, which is scheduled for 1973.

The following reports will be prepared:

Golding, D. L. and C. R. Stanton. 1969. Water-holding capacity and infiltration rates of the forest floor under different cover type-aspect conditions on Marmot Creek experimental watershed. (Proposed Journal of Hydrology paper).

Golding, D. L. and C. R. Stanton. 1969. Characteristics of the forest floor on Marmot Creek experimental watershed and their hydrologic implications. (Proposed Departmental Publication).

Harlan, R. L. and D. L. Golding. 1969. Assessing the influence of vegetation on a point measurement of a specific hydrologic parameter using the Bitterlich point-sampling technique. Proposed journal publication.

Jeffrey, W. W., C. R. Stanton and R. T. Ogilvie. 1969. Relation of snow measurement to vegetation types. Proposed Departmental Publication.

D. L. Golding
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon.

2. Title : Streeter Experimental Watershed.

3. Investigator : Teja Singh.

4. Year of Commencement : 1964.

5. Anticipated Year of Completion: Continuing project.

6. Key Words not in Title : Watershed Management, montane aspen forest, grassland, hydrologic processes.

7. Activity : Forest hydrology.

8. Problem Area Program : Stabilization and improvement of water yields in forested areas.

9. Establishment Project No. : A 137 Branch Project No: A 137

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.2 Other 0.3

12. Co-operating Agencies : Research Branch, Canada Department of Agriculture; Water Survey of Canada, Canada Department of Energy, Mines and Resources; Meteorological Branch, Canada Department of Transport; Canadian Wildlife Service; Research Council of Alberta; Hydrology Branch, Alberta Department of Agriculture; Alberta Forest Service; Eastern Rockies Forest Conservation Board; University of Alberta.

13. Location of Work : Porcupine Hills, Nanton, Alberta.

14. Abbreviated Background Statement: The encroachment of fescue prairie by aspen and associated shrubs in southwestern Alberta has occurred mostly in the relatively short time since the settlement of the area nearly 80 years ago. The attendant shift in the understory vegetation along with the consequent decrease in the total area that was previously grassland is a matter of immediate concern among land use managers.

The brush invasion is still active and every year brush is taking over about 0.75% of the total area of the fescue prairie within the southwestern Alberta parkland. The carrying capacity of the brush-invaded grassland is therefore likely to be restored and improved by clearing of woody vegetation and reseeding to grasses.

No guidelines are presently available to land managers in case such clearings are further extended into crown lands. A co-operative watershed management research program was therefore started and an experimental basin selected to determine the hydrologic effects of aspen clearance and conversion to grasses, and to gain information on hydrologic processes before and after the application of treatments.

15. Summary of Progress up to One Year Ago: Continuous records of meteorological, hydrometric, groundwater, water quality and suspended sediment were collected through instrumentation network and sampling stations within the experimental watershed. Field data were also gathered for related reconnaissance and plot studies.

16. Goals Set One Year Ago : Continuation of data collection and completion of groundwater instrumentation.

17. Accomplishments in Last Year: Hydrometric, meteorological and groundwater data were collected through the year; preliminary analysis of the data obtained during previous years was undertaken. In view of the importance of springs as main source for total flow, two 90° sharp-crested V-notch weirs were added to the existing hydrometric network. Watertable observation wells and piezometers were also installed; no further instrumentation for determining groundwater flow systems is indicated in the near future.

Publications :

Lutwick, L. E. and J. F. Dormaar, 1968. Productivity of soil biosequence of the fescue prairie - aspen transition. J. Range Management, 21: 24-27.

Johnston, A. and S. Smoliak, 1968. Reclaiming brushland in southwestern Alberta. J. Range Management, 21: 404-406.

Pawluck, S., T. W. Peters and J. Carson, 1968. Soils of the Porcupine Hills region of Alberta. Can. J. Soil Sci., 48: 77-88.

Stevenson, D. R. and D. A. Davis, 1968. Measurement, tracing and analysis of groundwater-streamflow systems. Paper presented at the Workshop Seminar, Canadian National Committee for I.H.D., Laval University, Sept. 18 and 19, 1967.

Coulson, A. and P. N. Gross, 1967. Measurement of the physical characteristics of drainage basins. Canada Dept. of Energy, Mines and Resources, Tech. Bull. 5.

Singh, T., D. Storr, D. A. Davis and D. R. Stevenson, 1969. Rangeland hydrology research in South Saskatchewan River headwaters. Paper presented at the Twenty-second Annual Meeting of the American Society of Range Management, Feb. 10-14, 1969.

18. Goals for Next Year : Continuation of field data collection, compilation and publication of results under companion projects.

Teja Singh

Teja Singh,
Investigator.

Project No. A 138

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon. Date: February, 1969.

2. Title : Hydrologic classification of wildland soils.

3. Investigator : G. J. Beke.

4. Year of Commencement: 1965.

5. Anticipated Year of Completion: Original 1968 Revision I 1970.

6. Key Words not in Title: soil survey, soil classification.

7. Activity : Land classification.

8. Problem Area Program: Stabilization and improvement of water yields in forested areas.

9. Establishment Project No.: A 138 Branch Project No.: A 138

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 1 Other 1.5

12. Co-operating Agencies: Department of Soil Science, University of Alberta; Research Council of Alberta Soil Survey, Edmonton.

13. Location of Work : Marmot Creek Basin, Kananaskis; Streeter Basin, Nanton; Deer Creek Basin, Sundre.

14. Abbreviated Background Statement: In some places the use and/or suitability of land for range grazing or for timber production is of less value than for water catchment. The steep slopes of the Rocky Mountains are an example of such land.

A lack of information presently exists with respect to the role that soils play in the maintenance of stream run-off in Canadian watersheds. In studies conducted elsewhere determination of the different kinds of soil and their character -- in particular their hydrologic character -- were found to be an essential step in watershed management studies. Therefore, a careful study of the soils in the areas concerned should provide data which may assist in establishing suitable management practices for ensuring optimum water quality and uniform flow.

The objectives are:

(1) Map the soils in three Alberta watersheds (approx. 10 sq. mi.) and evaluate the soils in terms of utilization for watershed management.

(2) Evaluate the present taxonomic and mapping units, as set up by the Canadian Soil Classification Committee, for detailed watershed mapping.

(3) Conduct physical studies in the field and laboratory to estimate surface and sub-surface flow as well as water storage capacities of the selected mapping units.

15. <u>Summary of Progress up to One Year Ago</u>: Preparation of the final soil map of Marmot Creek Basin was nearing completion. Routine chemical and physical analyses of the soils sampled were nearly completed. Infiltration studies were conducted at five locations. Bulk density samples were taken from most of the sampling pits and were analyzed for bulk density and real specific gravity. Samples collected from certain soil horizons for thin-section investigation were being prepared for analysis. The particle size distribution of certain samples confirmed the suspected aeolian origin of the material. Exploratory microscopic and X-ray investigations of this material identified it as volcanic ash.

Correlation of the tentative soil map of Streeter Basin was completed for the east sub-basin. Routine chemical and physical analyses were completed. The bulk density samples collected from established sampling pits had been subjected to bulk density and specific gravity analyses. Soil moisture capacity determinations had been completed.

The detailed soil survey of Deer Creek Basin was conducted in 1967 and a preliminary soil map was prepared. A total of nine profiles were sampled for routine laboratory analysis and for bulk density. These analyses and the moisture capacity determinations were completed.

16. <u>Goals Set One Year Ago</u>: The tentative soil maps of Streeter and Deer Creek Basins will be checked in the field and the final maps prepared. The mapped soils of each basin will be coded and subjected to computer programming.

An interpretive soil classification for watershed management of each basin will be prepared upon completion of the drafting and the analytical work.

The infiltration experiment is to be extended to Deer Creek and Streeter Basins using the statistical design provided by Biometrics Research Services, Ottawa.

The limiting permeability of the soils in each basin will be assessed in the field in June when saturated soil conditions prevail. This is to determine whether the limiting permeability is owing to a particular soil horizon or to a frost-layer.

The surface mineral horizon of each soil in each basin will be investigated for erodibility.

The dominant soil types of each basin will be subjected to X-ray analysis in order to determine the clay mineral distribution.

Thin section and organic matter analyses will be carried out on certain horizons of the alpine and upper montane soils in order to permit proper classification.

The aeolian-material samples from Marmot Creek Basin will be investigated micro-pedologically and mineralogically in order to assess the pedogenic importance of these volcanic ash deposits.

17. Accomplishments in Last Year: The field and laboratory studies, and the checking and drafting of soil maps, have been completed for the three basins. The soil maps have been coded, listed and verified for computer analysis. The analysis has been attempted and computer maps were obtained; although the program needs to be modified for acreages and rates computations. The infiltration experiment was not completed with respect to the statistical interpretation.

Reports and Publications:

Beke, G. J. : Detailed soil survey maps of Marmot, Streeter, and Deer Creek Basin.

Beke, G. J. : Interpretative soil classification for watershed management of rangelands in southwestern Alberta, Canada. Paper presented at the meeting of the International Society of Range Management. February 12, 1969.

18. Goals for Next Year : Preparation of the following proposed reports and publications:

Beke, G. J. & S. Pawluk: The pedogenic significance of volcanic ash layers in soils of the East Slopes (Alberta) Rocky Mountains.

Beke, G. J. : Alberta watershed soils and their hydrologic significance (ph.D. thesis to be presented to the University of Alberta).

Beke, G. J. : Hydrologic classification of wildland soils of the East Slopes (Alberta) Rocky Mountains. Proposed Departmental Publication.

Beke, G. J. : Soil Survey Report of Marmot Creek Basin. Proposed Departmental Publication. (One soil Map).

Beke, G. J. : Soil Survey Report of Streeter Basin. Proposed Departmental Publication (One soil Map).

Beke, G. J. : Soil Survey Report of Deer Creek Basin. Proposed Departmental Publication. (One soil Map).

Beke, G. J. & Pawluk, S.: Alpine soils of Marmot Creek Basin, southwestern Alberta, Canada. Proposed publication. Journal of Soil Science.

Beke, G. J. & Pawluk, S.: Soils under sub-alpine vegetation in Marmot Creek Basin, southwestern Alberta, Canada. Proposed publication. Journal of Soil Science.

Beke, G. J. & Pawluk, S.: Aspen-grassland soils from Streeter Basin, Porcupine Hills, southwestern Alberta. Proposed publication. Journal of Soil Science.

Beke, G. J. & Pawluk, S.: Soils under Lodgepole Pine vegetation in Deer Creek Basin, southwestern Alberta. Proposed publication. Journal of Soil Science.

Beke, G. J. : Completion of experiments on the nature of soil organic matter in Chernozem-like mountain soils and on the nature of the B horizon in mountain soils.

: Computer analysis for a numerical taxonomy of alpine soil analogs.

"G. J. Beke"
G. J. Beke,
Investigator.

PROJECT REVIEW STATEMENT

1. **Establishment** : Alberta/NWT/Yukon **Date**: February 1969

2. **Title** : Deer Creek experimental watershed.

3. **Investigator** : R. H. Swanson

4. **Year of Commencement** : 1963

5. **Anticipated Year of Completion**: None -- This is a continuing project.

6. **Key Words not in Title** : Forest influences, hydrology, gauged basin, meteorology, ground water, lodgepole pine.

7. **Activity** : Forest Hydrology

8. **Problem Area Program** : Stabilization and improvement of water yields in forest areas.

9. **Establishment Project No.**: A 139 **Branch Project No.**: A 139

10. **Status** : Active

11. **Man-years Utilized in Past Year**: Professional 1 Other 1

12. **Co-operating Agencies** : Inland Waters Branch; Surveys and Water Quality Divisions; Department of Energy, Mines and Resources; Meteorological Branch, Department of Transport; Alberta Forest Service, Department of Lands and Forests; Research Council of Alberta, Groundwater Division; Water Resources Branch, Alberta Department of Agriculture; Eastern Rockies Forest Conservation Board.

13. **Location of Work** : Deer Creek Basin at confluence of Deer Creek and Red Deer River. Near Sundre, Alberta.

14. **Abbreviated Background Statement**: The lodgepole pine vegetative community occupies much of the forest reserve area of Alberta. Large lease areas have been sold to pulp operators in the past years. Pulping operations can have good or harmful watershed value; depending upon how they are carried out. However, little is known about the effect of the existing commercial practices on water yield, regime or quality, nor are there any positive alternatives to these whose effects can be predicted with assurance. Therefore in November, 1962, the technical Coordinating Committee on watershed research in Alberta proposed that a gauged basin be established in the lodgepole pine type to complement Marmot basin (spruce-fir) and Streeter Basin (Aspen Grassland) in the East Slopes (Alberta) forest hydrology research program.

This proposal was approved by the Ottawa based Steering Committee in 1963. The basin (Deer Creek) was chosen in 1966 and instrumentation began in 1967.

There were no specific treatment objectives established for Deer Creek in the original proposal. The general objective was to determine the effect of commercial timber harvesting on the hydrology of the area. It appears now that the objectives of Tri-Creek watershed located south of Hinton in the Lodgepole pine type, will achieve much of what Deer Creek was established for. Therefore the Research Corodinating Committee (Successor to the Technical Coordinating Committee) has proposed that Deer Creek be held as an experimental area for small plot studies with only minimal instrumentation maintained, and without near-future large-scale treatment objectives. Their proposal will likely be approved by the Steering Committee.

15. Summary of Progress up to One Year Ago: Progress consisted of: (a) A preliminary groundwater instrumentation network; (b) The installation of a temperature and humidity recorder, precipitation gauge and an anemometer; (c) Clearing of a base line for future surveys; (d) Improvement of access road; (e) Construction of a stop-over cabin and storage facilities; (f) Periodic insect and disease surveys.

16. Goals Set One Year Ago:

a. Installation of permanent stream gauges on each sub basin and main stream.

b. Extension of groundwater instrumentation network.

c. Conduct forest inventory.

d. Aerial photography and construction topographic map.

e. Start monthly water quality (chemical) from each sub basin.

f. Preparation of a hydrologic soils classification and map.

g. Conduct annual insect and disease survey, maintain and service recording instrumentation.

17. Accomplishments in Last Year: Basin activities in 1968 were primarily concerned with further development of

preliminary instrumentation networks and maintenance of established networks and studies. Inland Waters Surveys of the Department of Energy, Mines and Resources installed V-notch weirs in the middle and east sub-basins and at the main stem of Deer Creek. The Water Quality Division of the same department initiated a monthly summer water quality sampling program, taking samples at each weir site in the basin. The Alberta Forest Service in conjunction with the Canada Department of Forestry conducted the forest inventory of the basin and a forest type map is now in preparation. Also through the cooperation of the Alberta Forest Service road access for installation of the weirs, and radio service between the basin and Calgary was possible. The provincial Water Resources Branch flew new aerial photography of the basin and established control points for construction of a topographic map of the basin. A survey and preliminary map of ground vegetation types was prepared by the Canada Department of Forestry. A random snow sampling network covering the whole basin was also established by the department. An annual insect and disease survey of the basin indicated that no serious problems exist.

18. <u>Goals for Next Year</u> : No new descriptive instrumentation will be installed. Stream flow records from the three existing gauges will be taken, analyzed and compiled. One climatic station and precipitation gauge will be maintained.

The basin is operable as an experimental area for various plot studies. Only the permanent cabin will be maintained for living accommodations.

Proposed publication: Jeffrey, W. W., C. R. Stanton, D. Davis, D. Storr, D. R. Stevenson, C. L. Kirby. The selection of an experimental watershed basin. Proposed departmental publication.

R. H. Swanson

R. H. Swanson
Basin Coordinator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Water-holding capacity and infiltration rate of the forest floor under spruce-fir and lodgepole pine stands.

3. Investigator : D. L. Golding

4. Year of Commencement : 1965

5. Anticipated Year of Completion: Original 1969 Revision I 1970

6. Key Words not in Title : Hydrology, Picea engelmanni, Pinus contorta Abies lasiocarpa.

7. Activity : Forest Hydrology

8. Problem Area Program : Stabilization and improvement of water yield in forest areas.

9. Establishment Project No.: A 283 Branch Project No.: A 283

10. Status : Active

11. Man-years Utilized in Past Year: Professional .10 Other .10

12. Co-operating Agencies : None

13. Location of Work : Marmot Creek experimental watershed near Seebe, Alberta

14. Abbreviated Background Statement: The characteristics of the forest floor (i.e., the predominantly organic layers above mineral soil) are important in the context of forest hydrology. The water-holding capacity and infiltration rate of the forest floor are among those factors that determine the rate and amount of overland flow resulting from snowmelt and storms. The mineral-soil layer is usually the limiting factor but for small storms producing precipitation in an amount less than the water-holding capacity of the forest floor and for the initial periods of larger storms, the hydrologic characteristics of the forest floor are major factors determining the rate and amount of overland flow.

Water quality, erosion and timing of streamflow are closely related to amount and rate of surface runoff. Therefore, in the manipulation of forest cover for watershed management the hydrologic characteristics of the forest floor under different cover types must be known and taken into consideration.

The objectives of the study are to determine the type, depth, water-holding capacity, and infiltration rate of the forest floor under nine forest cover-aspect conditions: uncut and partly cut spruce-fir and uncut lodgepole pine on north, east and south aspects. The results of the study are to be used in prescribing treatment (logging) of Marmot Creek experimental watershed in particular and spruce-fir forests on the eastern Rockies of Alberta in general.

15. <u>Summary of Progress up to One Year Ago</u>: Thirty samples of the forest floor were taken from each of the nine cover type - aspect conditions and water-holding capacity was determined for each. Each sample was described both qualitatively and quantitatively as was the plot from which each sample was taken. Infiltration rates were measured <u>in situ</u> using infiltrometer rings connected to constant-head apparatus and Ebermeyer lysimeters.

16. <u>Goals Set One Year Ago</u> : (1) A report to be prepared dealing with the water-holding capacity of the forest floor. (2) A rainfall simulator to be used to check the infiltration rates using the infiltrometer ring.

17. <u>Accomplishments in Last Year</u>: Infiltration rates of the forest floor under the nine cover type - aspect conditions were checked. Instead of writing a separate report for each of the two aspects of the study (i.e., water-holding capacity and infiltration rates) a single report is currently under way.

18. <u>Goals for Next Year</u> : The project will be terminated with the publication of two papers:

Golding, D. L. and C. R. Stanton. 1969. Characteristics of the forest floor on Marmot Creek experimental watershed and their hydrologic implications. (Proposed Department Publication).

Golding, D. L. and C. R. Stanton. 1969. Water-holding capacity and infiltration rates of the forest floor under different cover type - aspect conditions on Marmot Creek experimental watershed. (Proposed Journal of Hydrology Paper).

D. L. Golding
D. L. Golding
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.
2. Title : Moisture exchange between the soil profile and the snowpack.
3. Investigator : R. L. Harlan.
4. Year of Commencement: 1968.
5. Anticipated Year of Completion: Original 1971.
6. Key Words not in Title: Infiltration, vapor transfer, snow melt.
7. Activity : Forest Hydrology.
8. Problem Area Program: Stabilization and improvement of water yields in forest areas.
9. Establishment Project No.: A 292 Branch Project No.: A 292
10. Status : Active.
11. Man-years Utilized in Past Year: Professional .1 Other .1
12. Co-operating Agencies: None.
13. Location of Work : Marmot Creek and Streeter Experimental Watersheds.
14. Abbreviated Background Statement: Considerable emphasis in watershed management within the last several decades has been directed toward management of the seasonal snowpack for water production and regulation of streamflow regimen. Most of the relevant research, however, has dealt solely with observation of snow accumulation as affected by vegetation and topography and means of influencing it by vegetation manipulation and the use of artificial structures. These investigations, for the most part, have been of a purely empirical nature and have not dealt at any depth with the "process" associated with snow accumulation, metamorphism, and ablation or with the hydrologic effects of snowpack management on infiltration, soil-moisture storage, ground-water recharge, streamflow regimen, and other components of the hydrologic cycle. This lack of fundamental research of the inter-relations between the snowpack and the soil becomes readily apparent when one considers the implications of snowpack management and the prescription of forest and land management practices for water production and regulation of streamflow regimen. Consequently, if we are to manage the snowpack on a scientific basis for water production, the "empirical-type" study as has been predominant in watershed management research, must be supplanted by basic research into the physical processes of snow accumulation, metamorphism, and ablation, as well as into the hydrologic role of the snowpack.

15. Summary of Progress up to One Year Ago: None.

16. Goals Set One Year Ago: The goals for the last one-year period were:

(a) selection and instrumentation of field plots in both Marmot and Streeter Experimental Watersheds.

(b) calibration of gamma attenuation equipment.

(c) collection of field data of soil-moisture storage and water content of the snowpack for selected periods during one winter.

(d) analysis of first-year's data and evaluation of results.

17. Accomplishments in Last Year: Progress was restricted in 1968 owing to unavailability of gamma attenuation apparatus until late spring, 1968. Suitable alternative methods of measuring moisture distribution with time adjacent to the soil-snow interface are non-existent. Two sets of paired plots have been established in Marmot Creek Experimental Watershed, one set at 5800 feet and one at 7000 feet MSL in the cirque of Middle Creek sub-basin, for study of moisture exchange phenomena.

18. Goals for Next Year : The goals are:

(1) collection of field data of soil-water storage and snow-water content for selected periods, specifically during periods of chinook and non-chinook conditions.

(2) calibration of gamma attenuation equipment.

(3) analysis of data, evaluation of results, and planning of future research efforts.

R. L. Harlan,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon   Date: February, 1969.

2. Title : Consumptive use of aspen and associated shrubs and grasses.

3. Investigator : Teja Singh.

4. Year of Commencement : 1966.

5. Anticipated Year of Completion: Original 1969   Revision I 1970.

6. Key Words not in Title : Evapotranspiration, soil moisture, montane.

7. Activity : Forest hydrology.

8. Problem Area Program : Stabilization and improvement of water yields in forest areas.

9. Establishment Project Number : A 296   Branch Project No.: A 296

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.5   Other 1.0

12. Co-operating Agencies : None.

13. Location of Work : Streeter Experimental Watershed Porcupine Hills, Nanton, Alberta.

14. Abbreviated Background Statement: Evapotranspiration represents an important component of water budget and accounts for major water loss out of the total amount received on a watershed. Any attempt to increase water yield, therefore, has to contend itself with forest treatments aimed at reducing total evapotranspiration losses.

    Comparative estimates of water use by various vegetation types are needed to decide possible vegetation manipulation treatments that can eventually be applied on Streeter Experimental Watershed. The consumptive use study is, therefore, an essential part of the hydrologic research related to the conversion of aspen and scrub vegetation to grasses.

15. Summary of Progress up to One Year Ago: Gravimetric sampling of soil moisture in successive 1-foot increments through the major root zone was carried out during the active use period in the summer months. Soil samples were also taken for determining bulk density.

16. Goals Set One Year Ago : Continuation of field sampling for data collection during summer, followed by laboratory analyses.

17. Accomplishments in Last Year : The work on field data collection has been completed. Laboratory analysis of samples for determining soil-moisture characteristics is presently in progress.

18. Goals for Next Year : Completion of laboratory and statistical analyses and writing of research results.

Publication :

Singh, T. Soil moisture consumptive use of aspen forest, willow-birch shrubs and associated grassland in southwestern Alberta. Proposed journal publication.

Teja Singh

Teja Singh,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Rainfall interception by aspen.

3. Investigator : Teja Singh.

4. Year of Commencement : 1967.

5. Anticipated Year of Completion: Original 1970.

6. Key Words not in Title : Net rainfall, montane.

7. Activity : Forest Hydrology.

8. Problem Area Program : Stabilization and improvement of water yields in forest areas.

9. Establishment Project No.: A 297 Branch Project No.: A 297

10. Status : Active.

11. Man-years Utilized in Past Year: Professional – Other 0.1

12. Co-operating Agencies : None.

13. Location of Work : Streeter Experimental Watershed, Porcupine Hills, Nanton, Alberta.

14. Abbreviated Background Statement: Interception of rain by tree canopies results in retention of small amounts and is a loss for the amount of precipitation reaching the forest floor. Interception loss further occurs at the forest floor where ground litter causes similar retention and prevents part of precipitation from reaching the mineral soil.

    The study to determine interception losses by aspen canopies was started during summer of 1967 to be combined with a similar study to determine interception losses near the ground surface by measuring litter interception.

15. Summary of Progress up to One Year Ago: Three 100 ft. sq. plots were established to provide measurements for stemflow and throughfall.

    Four random sets of 5 sampling points were selected in each plot to sample throughfall with MSC standard rain gauges. The gauges were moved to the next set of random points after measuring each previous rain storm.

    Five representative trees were also selected in each plot and equipped with stem collars and collecting drums to provide data on stemflow.

16. Goals Set One Year Ago : Collection of field data on stemflow, throughfall and total rainfall.

17. Accomplishments in Last Year: Field data were collected during part of the summer. Trough gauges were also installed.

18. Goals for Next Year : Field data collection during the summer, followed by data analysis and compilation of results for publication.

Teja Singh

Teja Singh,
Investigator.

PROJECT PROPOSAL STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: January, 1969

2. Title : Potential energy available for snow evaporation in winter along the east slopes of the Rocky Mountains in Alberta.

3. Investigators : D. L. Golding, R. H. Swanson

4. Year of Commencement : 1969

5. Anticipated Year of Completion: This study deals with weather patterns - and we are trying to draw reasonably long-term conclusions from short-term data. Some provisional and preliminary results should be forthcoming by 1975 - the overall study to be terminated by 1980.

There will be several minor aspects - instrument selection and modification, local microclimatic effects, and spectacular weather phenomena that will be studies in themselves, and reportable as the overall study progresses.

6. Key Words not in Title: Chinook winds, snow accumulation, climate.

7. Activity : Forest Hydrology

8. Problem Area Program : Stabilization and improvement of water yields in forest areas.

9. Annual Man-year Requirements: Professional 1 Other 2

10. Major Equipment Purchases Required for Completion: It is anticipated that a climatic observation network will have to be established to supplement those now existing. These new stations will be in areas not readily accessible to wheeled vehicles. They will also need servicing at regular intervals throughout the project. Therefore it is envisioned that (1) at least two service technicians will be trained in cold weather survival so that they can take observations throughout the winter, and (2) two new motorized toboggans will be purchased after the network is established -(likely 1970-71).

The cost of the network instruments is more difficult to evaluate. If the atmometer proves reasonably successful, it will be used. Their cost is low - less than $10.00 each. If, however, the atmometers prove unsuccessful, then each station will have to be equipped with a net radiometer, wind velocity, air temperature and vapor pressure recorder.

Therefore, no reasonable estimates of overall costs can be made until after conducting the first year's tests. These require no additional equipment purchases beyond small parts, batteries, chemicals, etc. The total to be held under $200.00.

11. Cooperating Agencies : Meteorology Branch, Department of Transport and Alberta Forest Service with climatic data from the Universities of Calgary and Alberta, National and Historic Parks Branch, and Eastern Rockies Forest Conservation Board.

12. Location of Work : East slopes Alberta's Rocky Mountains.

13. Background Statement : Watershed management to increase water supply or change the time of its delivery is principally snow pack management. Some increases in stream flow can be directly attributed to reduced transpiration/interception with vegetation removal, but total removal usually results in high flood peaks - an undesirable alteration of stream flow regime in most cases. Properly executed timber removal on snow covered watersheds offers the potential of increasing steam flow and delaying water delivery at the same time - both desirable features (Hoover, 1960; Anderson, 1966). To date, such practices have only been tested and proven reasonably effective on watersheds where the principal precipitation input is snow.

The East slopes of Alberta's Rockies produce 90 percent (Jeffrey p. 3) or more of stream flow in the Saskatchewan river system. No reliable figures are available on just how much of this originates as snow but a conservative estimate would be 60 percent. Therefore snow-pack management research should be an important portion of our research program. And it is, as the intensity of work at Marmot Creek indicates.

Marmot Creek represents only a small fraction of the spruce-fir timber zone in Alberta. It and the surrounding area represents an even smaller proportion of the lodgepole pine timber zone. Even for this small area, we do not know to what elevation chinook winds are important in removing the snowpack through sublimination rather than melt. Only a rough guess can be obtained from the existing snow course measurements and from soil moisture measurements which show essentially no soil moisture recharge from snow melt below 6,000 feet elevation (Harlan, personal communication).

As for the rest of Alberta, our knowledge is even more superficial. Only the climatic maps by Longley (1968) give an indication of where chinooks are an important climatic factor. And this is only to the extent that air temperatures are raised above 40°F. It is likely that dry winds at temperatures below 32°F have considerable influence on the removal of snow as well.

Our research problem can be stated simply as "How can we effectively manage forests to manipulate water?". Our goal is to answer this question. The answer is irrelevant unless it can be applied. With snow the major precipitation parameter, then, we must know where and under what circumstances it is a manageable resource. Therefore, this study is proposed.

References

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Brinkman, W. and I. Y. Ashwell. 1968. The structure and movement of the chinook in Alberta. Atmosphere 6(2): 1-10.

Hoover, M. D. 1960. Prospects for affecting the quantity and timing of water yield through snow pack management in southern Rocky Mountain area. Proc. Western Snow Conf. (28th Meeting) pp. 51-53.

Jeffrey, W. W. 1961. Prerequisites and priorities for watershed research in the Eastern Rockies, Alberta. Canada Dept. of Forestry Information Report A-73.

Longley, R. W. 1967. The frequency of winter chinooks in Alberta. Atmosphere 5(4): 1-16.

Longley, R. W. 1968. Climatic maps for Alberta. Univ. of Alberta. Geography Dept. 8 pp.

Marsh, J. S. 1965. The chinook and its geographic significance in southern Alberta. M. S. thesis, Univ. of Calgary. 121 pp. illus.

Wilcox, J. C. 1967. A simple evaporimeter for use in cold areas. Jour. of Water Resources Res. 3(2): 433-436.

14. Objectives : To measure evaporative/sublimative potential at selected points in the winter along the East Slopes area of the Alberta Rockies, construct isolines of evaporative/sublimative potential by 10% intervals of the probability of recurrence each winter.

15. Plan of Attack : 1. Reconnaissance -

(a) Ground reconnaissance along front range roads to determine areal variability of chinook winds as they affect already accumulated snow.

(b) Reconnaissance via light plane for same purpose as (a) except to cover more territory.

(c) Observations from satellite photos of changes in snow accumulation pattern following known chinook periods from ground weather records.

(d) Use of existing weather records where available to construct rough isolines and to evaluate where further data is needed.

2. Purposeful observation -

(a) Snow lysimeter studies to evaluate the effect of chinooks on winter snow evaporation.

(b) A network of evaporimeters or complete climatic stations including recorders for radiation, air temperature, vapor pressure and wind velocity to quantify evaporative potential by areal, elevational and temporal distribution.

3. Consultations with University of Calgary (Ashwell) and University of Alberta (Longley) researchers currently working on chinook winds in populated areas.

16. <u>Goals for Initial One-Year Period</u>: (a) Determine if Ogo-Pogo atmometers (Wilcox, 1967) are suited to use at sub-zero Fahrenheit temperatures. Try to obtain calibrations between atmometers and snow pack evaporation as measured with small lysimeters. Test various lysimeter configurations for usability in the dry snow found in Alberta. These studies will be carried out at Marmot and Streeter Basin in conjunction with Meteorological Branch.

(b) Reconnaissance of area by road and light plane to ascertain ground pattern of disappearance of snow following accumulation and chinook winds.

(c) Satellite photography evaluation to see if present resolution is sufficient to resolve particular topography.

(d) Construction of isolines using presently available weather data from all possible sources.

D. L. Golding
D. L. Golding
Investigator

R. H. Swanson
R. H. Swanson
Investigator

PROJECT PROPOSAL STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Disposition of water in forest soils.

3. Investigator : R. L. Harlan.

4. Year of Commencement: 1968.

5. Anticipated Year of Completion: 1972.

6. Key Words not in Title: Unsaturated flow, evapotranspiration, infiltration, redistribution.

7. Activity : Forest Hydrology.

8. Problem Area Program: Stabilization and improvement of water yields in forest areas.

9. Annual Man-year Requirements: Professional 1 Other 1.5

10. Major Equipment Purchases Required for Completion: None.

11. Co-operating Agencies: None.

12. Location of Work : Kananaskis Research Forest, Marmot Basin, Deer Creek Basin, Mackay, Alberta.

13. Background Statement: Hydrologically-oriented investigations on the disposition of water in and through forest soils were initiated in 1963 by the Forestry Branch under Project A/T-131, "Consumptive use of soil moisture by different vegetation types". These investigations were aimed at gaining some concept of the magnitude of consumptive use by the major forest cover types in western Alberta under different topographic and edaphic situations and providing information for the development of prescribed treatments for vegetative manipulation on experimental watersheds. Since the initiation of the consumptive-use project, however, the purpose and scope of the research program have changed from inventory to process-oriented research — aimed at understanding the basic processes of soil-water movement and retention in porous media. Hence, initial investigations conducted under project A 131 have been incorporated into a more comprehensive and unified program of research. The results from these investigations will be directly applicable to studies on soil-site evaluation, vegetative growth and ecological assessment. Also the results will have implications to management in relation to optimum vegetative densities as related to soil-moisture availability, regeneration and survival probability and fire index.

14. Objectives : The objectives are:

(1) to develop from Darcy's law and the continuity of mass

condition, a mathematical model of three-dimensional transient (unsteady) unsaturated and saturated flow through porous media applicable under natural conditions. The development of such a mathematical model will permit us to treat spatially and timewise variable, saturated and/or unsaturated transient flow through non-homogeneous, anistropic porous media with spatially and temporally variable evapotranspiration,

(2) to incorporate the mathematical model as part of a physically-based synthesis of the hydrologic cycle.

15. Plan of Attack : Using the general equation of flow through porous media as developed from Darcy's law and the continuity equation as a base, the research methodology is:

(1) expansion of unsaturated and saturated moisture-flow theory to two- and three-dimensional cases and the formulation of a digital computer simulation model.

(2) incorporation of spatially variable evaporation and transpiration into the simulation model.

(3) testing of the simulation model with field data for specific test cases.

(4) through generalization and simplification, adapt the moisture-flow model to simulation of gross moisture-flow patterns on an areal basis.

Hence, field investigation and data acquisition will be conducted on two levels of intensity. Firstly, intensive investigation will be conducted to define the exact flow relations within a limited portion of the soil profile (i.e. flow patterns with respect to individual trees or portions of the root system). These investigations will specifically consider soil-water redistribution in response to energy gradients induced by spatial imbalance in infiltration, elevation, or water uptake and transpiration by forest and lesser vegetation. Secondly, investigations will be conducted on a gross scale in which the aim is to define the gross moisture-flow relations on an areal basis, particularly as pertains to areal patterns of soil-water redistribution and evapo-transpiration on mountain watersheds. The primary purpose of the latter type study is to provide field data for adaptation of a rigorous mathematical model of moisture flow to field conditions. Such a model would maintain physical relevance in its controlling parameters, and therefore be applicable as a general model. This model can be contrasted to the purely empirically-based models commonly in use for hydrologic simulation.

Acquisition of test data will include the measurement of moisture storage and matrix potential on test areas for specified periods and the laboratory determination of soil-water characteristic curves and moisture-dependent hydraulic conductivity and diffusivity. Field determination of moisture storage with depth will utilize the neutron-scattering and gamma-attenuation techniques whereas determination of matrix potential will utilize tensiometers and piezometers.

16. Goals for Initial One-year Period: The emphasis during the next one-year period will be upon an intensive literature review and development of the theoretical soil-moisture model. The movement of soil water as induced by moisture uptake and its subsequent transpiration by vegetation will be considered in detail and fitted into general flow model. An attempt to quantify transpirational losses from soil-water flow definition will be made.

Field investigation will emphasize soil-water redistribution about a single tree and flow toward and adjacent to a portion of the root zone. These investigations will be conducted on the Kananaskis Forest Experimental Station. Field measurements will be made on test areas in the Marmot Creek and Deer Creek Experimental Watersheds.

Publications:

Harlan, R. L., Soil-water freezing, snow accumulation and ablation in Marmot Creek Experimental Watershed, Alberta, Canada. Proc. 1969, Western Snow Conf.

Harlan, R. L., Some observations of soil-moisture conditions and the hydrologic implications thereof in the Marmot Creek Experimental Watershed, Alberta, Canada, Department publication.

R. L. Harlan,
Investigator.

PROJECT PROPOSAL STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Measuring Transpiration of Individual trees In Situ.

3. Investigator : R. H. Swanson.

4. Year of Commencement : 1969.

5. Anticipated Year of Completion: 1975.

6. Key Words not in Title : Heat pulse velocity, conducting xylem, sap velocity, sap flow, moisture content, lodgepole pine.

7. Activity : Forest Hydrology

8. Problem Area Program : Stabilization and improvement of water yields in forest areas.

9. Annual Man-year Requirements: Professional .25 Other 1

10. Major Equipment Purchases Required for Completion: None -- yearly maintenance of equipment and small miscellaneous supplies should be approximately $300.00.

11. Co-operating Agencies : None

12. Location of Work : Kananaskis Forest Experiment Station; Mackay, Alberta; Deer Creek Watershed Basin; Streeter Watershed Basin.

13. Background Statement : Transpiration is the process whereby water is evaporated from the soil via a plants water conducting system. The amount of water thus vaporized is a considerable quantity, - up to that which falls as annual precipitation. From the hydrologists point-of-view such vaporization represents a loss in the water budget of a land area.

It has been hypothesized that different species of trees transpire differing volumes of water. Lysimeter and potted plant studies tend to confirm this hypothesis. However, this has never been successfully demonstrated on anything approaching the extent of a watershed - even a very small one. It is likely that differences between individual trees are small - especially on the relatively dry sites found on most mountainous watersheds. None-the-less, the potential for water yield improvement through species conversion is a tantalyzing goal, and it will remain so until proof for or against the hypothesis above is brought forth.

A second hypothesis advanced is that growth and therefore site productivity are directly related to transpiration (Rozenweig, 1968). This aspect has not been a consideration of the author prior to this writing. If this hypothesis is true, then transpiration measurements from individual trees become important in forest management as possible site indicators.

Thus there is a need to obtain accurate estimates of transpiration rates from individual trees under natural conditions. The method that appears most promising at the present time is some sort of tracer technique for determining rates of xylem sap ascent. Dye, radioactive isotopes and heat have all been used as tracers. Of these, the least destructive to the tree, and least harmful to human equipment operator is the heat pulse technique as outlined by Huber & Schmidt, 1937, and Marshall, 1958.

This project proposal is set forth to cover the continuation and finalization of work started by R. H. Swanson in his former capacity as Research Forester with the U.S. Forest Service. The purpose of that work was to develop a method for measuring the transpiration of individual trees <u>in situ</u>. The first 5 years were primarily spent developing an instrument for measuring heat pulse velocity. This development is reported in Swanson, 1962; Skau and Swanson, 1963; and Swanson, 1967. No further instrument development is planned although refinements in those existing will be made from time to time.

The four years following instrument development were spent defining uses for heat pulse velocity measurements without their being indicative of transpiration volume or rate. Also the problems that needed to be resolved before actual field use as an indicator of transpiration rate - relative or absolute - were outlined. These were reported in Swanson, 1967; Swanson and Lee, 1966; Swanson, 1967a. There is still one report forthcoming on the problem aspect - that of a study relating measured evapotranspiration to heat pulse velocities - done in Tempe, Arizona, in July, 1967. This report is currently in review within the Rocky Mountain Forest and Range Experiment Station and should be published in Science during 1969 or early 1970.

Briefly, the material contained in the above-mentioned reports is as follows:

(a) The instrumentation necessary to measure or detect heat pulse velocity is not available as a ready-made instrument, but the components are, and that any reasonably qualified instrument technician can assemble and operate a heat pulse velocity meter.

(b) The heat pulse velocity method for measuring sap movement in diffuse porous woody plants is based on physically and mathematically sound principles. The method is sensitive to sap movement rates 1 cm/hour or greater, provided the proper sensing probe configurations are used. There is no theoretical limitation to the magnitude of the velocity that can be measured. However, the cross section of wood sensed must be homogenous and at least 3 cm in diameter to properly fulfill the qualifications of an "infinite and homogenous" medium(thermally).

(c) As it now exists, the heat pulse method is useful for determining when and if transpiration is occurring. This indication of the transpiration event can be used to determine differences between species in their reaction to environment parameters. Daily patterns of heat pulse velocity are indicative of site conditions - namely, moisture availability - but also of atmospheric vapor deficit and energy supply. The HPV response of a tree to its environment is being considered as an indicator of insect attack resistance by the Rocky Mountain (McCambridge) and Pacific Southwest (Weber) Forest and Range Experiment Stations in the U.S. (I believe that Reid here in Calgary has also considered this application but had little success obtaining readings because of a poorly operating instrument).

(d). Theoretically, transpiration can be measured quite accurately with the heat pulse method. The continuity equation Q = AV describes flow quantity (Q), in terms of the velocity (V) over an area (A). The V of this equation is replaced by a more complex function for sap flux when heat pulse rather than actual sap velocities are used:

$$Q = p\,(Mc + 0.28)(HPV)\,A$$

where:
- Q = Transpiration rate; cc/hour
- p = Wood density; gm/cc
- Mc = Moisture content, d.w.b.; decimal fraction
- HPV = Heat pulse velocity; cm/hour
- A = xylem area actually conducting sap; cm^2.
- 0.28 = the specific heat of wood at $10^{\circ}C$.

The variable terms of significance are Mc, HPV and A.

(e) The problems that must be solved before absolute transpiration can be estimated from heat pulse measurements are:

1) How to obtain HPV measurements representative of the entire conducting area of a tree.

2) The extent of any daily or seasonal variations in moisture content and conducting area.

Relative transpiration rates may be considerably easier to estimate. The results of the study conducted at Tempe (mentioned above) are that heat pulse velocities at a fixed point in the xylem, and at a specified time during mid-day do indicate the whole day transpiration rate of a tree relative to that of the same tree at some earlier or later day. This finding is particularily important as it allows simple comparisons of transpiration rates within a given tree throughout a season - or perhaps even between years. It is imperative that this finding receive field verification, however, before it is widely used.

Thus, the goal of this project is the solution of the problems outlined above, with the eventual successful culmination is a method for measuring the transpiration of intact trees and shrubs <u>in situ</u>.

References

Huber, B. and E. Schmidt, 1937. Eine kompensation method sur thermoelektrischen messung langsamer saftstrome. Ber deutsch. Bot. Ges. 55: 514-529.

Ladefoged, Kjeld, 1960. A method for measuring the water consumption of larger intact trees. Physiologia Plant. 13: 648-658.

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Skau, C. M., and R. H. Swanson, 1963. An improved heat pulse velocity meter as an indicator of sap speed and transpiration. Jour. of geophysical Res. 68(16): 4743-4749.

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______, and Lee, R., 1966. Measurement of water movement from and through shrubs and trees. Jour. Forestry, 64: 187-190.

____________, 1967. Improving tree transpiration estimates based on heat pulse velocity measurements. IUFRO, Munich, 1967; 11 pp.

14. Objectives : For the coniferous tree species of Alberta:

(a) To determine if heat pulse speed is distributed across the sap conducting xylem in a regular pattern that can be closely approximated by a mathematical function.

(b) To determine if the magnitude of heat pulse velocity measurements within a given tree are indicative of the magnitude of the transpiration from that tree.

(c) To develop and refine a technique for estimating, with precision, the water consumption of individual trees in situ.

15. Plan of Attack : The two hypotheses below represent the most likely probabilities that have arisen from the previous work.

Hypothesis I.

Heat pulse velocity values are distributed across the water conducting xylem cross section of a tree in a parabolic pattern essentially the same as that observed for the laminar flow of fluids through pipes.

The general function for this distribution is of the form:

$$(x - h)^2 = 4a\ (y - k)$$

where y = velocity

x = xylem depth from cambium

h, k are co-ordinates of the peak velocity

a is constant term for any given tree

The implications of this hypothesis are:

a. Heat pulse velocity measured at one point in the conducting xylem can be used to describe the mean velocity for the entire cross section.

b. Heat pulse velocity measured at two points within the conducting xylem describes both the conducting area and any areal variation that may occur.

The evidence that this hypothesis is true is scant; only the curves of heat pulse velocity versus xylem depth shown in Swanson, 1965. These curves, when statistically fitted to the above function, show correlations greater than 0.90 in all cases. However, they are all from one group of 6 trees at Fraser, Colorado, data taken from two growing seasons from both lodgepole pine and Engelmann spruce. More proof than this is required for physical significance.

Field measurements to verify the existence of a parabolic or other regular patterned velocity distribution will be made throughout the Spring, Summer and Fall. These will consist of HPV measurements made at $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of the high moisture content xylem depth plus one additional depth randomly selected by 1/8 depth internals between $\frac{1}{4}$ and full depth. Forty individual trees will be selected with as uniform of wet xylem area as possible. Measurements will be made throughout two completed growing seasons on the selected trees.

Hypothesis II.

The average heat pulse velocity attained during the daylight hour each day, when measured at the same point in a tree is indicative of the total days transpiration quantity from that tree.

This takes the empirical form:

$$T = K(HPV) \text{ L/day}$$

where T = Transpiration quantity in 24 hours: liters.

K = Proportionality constant for each individual tree.

(HPV) = Heat pulse velocity.

The implications of this hypothesis are:

a. Heat pulse velocity can be used as an indicator of relative transpiration quantity within the same tree without knowledge of absolute transpiration volume.

b. Once absolute transpiration and the proportionality constant has been determined for a given tree, all further estimates of transpiration can be made from HPV alone.

The evidence supporting this hypothesis - and from which it arose - has not been published at this writing. It is from the Tempe, Arizona, study mentioned in the background above. The finding there was that HPV measured at hourly intervals throughout the daylight portion of a diurnal cycle was related to 24 hour water loss from an aleppo pine with a correlation of 0.98 or better - even though plant moisture stress varied from 15 - 32 atmospheres, and wood moisture content from 64 to 121% during the course of the study.

According to Marshall (1958):

HPV = aupc

where a = fraction of xylem occupied by sap streams.
u = sap velocity.
p = wood and water combined density.

c = wood and water combined specific heat.

Therefore it is not surprising that HPV should reflect the change in moisture content as it is a function of it. What is surprising is that either the total conducting xylem area is constant, or that any variation in it is somehow expressed as an off-setting change in the sap movement pattern within that remaining.

Hypothesis II will be tested by simultaneously measuring the water uptake of and heat pulse velocity of forty individual trees. Water uptake will be measured - similar to the manner described by Ladefoged (1960); heat pulse velocities will be measured hourly throughout the daylight hours at selected intervals. An attempt will be made to determine a functional relationship between K and wet xylem area, tree basal area, d.b.h. and other similar physical tree properties. This experiment cannot be carried beyond one growing season because Ladefoged's method is destructive.

16. <u>Goals for Initial One-year Period</u>:

A. To instrument a total of 80 lodgepole pine with the appropriate heat pulse velocity sensors for verifying both hypotheses above.

B. To describe the physical parameters of these trees in detail.

C. To obtain preliminary results from both experiments.

D. To develop some degree of skill in the application of Ladefoged's water consumption measurement technique.

E. To complete and test all instrumentation necessary go the final completion of these experiments.

R. H. Swanson

R. H. Swanson
Investigator

PROBLEM AREA PROGRAM

Maintenance and Improvement of Water Quality in Forest Areas

Physical and chemical water quality are parameters directly affecting the usability of water. They also influence the biotic community of a stream, lake or reservoir. The degree of treatment to which a city must expose its water supply is directly affected. Finally, each homeowner is directly affected by water hardness. Excess sediment and harmful or undesirable chemicals, therefore, cause both environmental contamination and economic loss.

The water originating in Alberta mountains and foothills is naturally chemically hard. The nature of the underlying material is principally responsible for this. There is little if any knowledge of how land management practices can influence chemical water quality. This then is one area of research involving chemical water, and forest hydrology scientists in a team effort.

Forested watersheds normally yield clear water--nominally free of sediment. Occasional storm events combined with unstable surficial deposits do yield significant sediment, but these are not the major sediment producers. Man's activity is. Numerous studies have shown that the increased sediment resulting from forest activity of any sort but including logging, and geophysical operations is linked directly to the amount of surface soil disturbance--usually road and trail construction. Given proper guidelines for their construction, any operator can keep sediment at a low level. However, there are certain soil types and topographic configurations that are more susceptible to subsequent erosion and sedimentation than others. The delineation of these areas and conditions has been the major research effort in the past. Some of this will continue.

The present and future research effort will be expected to concentrate along two lines. The first is to describe and evaluate the social and economic importance of sediment. There is little pressure on an operator to follow established guidelines, if this costs him more than the damage he causes. Likewise, there is little reason for land management agencies to insist on compliance with guidelines if there is no public concern nor social impact resulting from the damage. This portion then is a matter for the economist and sociologist with cooperation from forest hydrology specialists.

The second line is to provide better means of quantitatively evaluating and predicting the resultants of soil disturbing operations. This involves an application of soil physics to basic research into properties affecting erosion and sediment; on the spot evaluations of existing problem areas with recommendations for the best possible solutions within our present knowledge and surveys to delimit potentially troublesome areas within existing qualitative erosion guidelines. Specific projects are:

A 135*: Infiltration, overland flow and sediment as affected by forest cover and its manipulation - T. Singh.

A 138*: Hydrologic classification of wildland soil - G.J. Beke.

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*Project statement appears under problem - "Stabilization and Improvement of water yield from Forest Areas"

Project No. A 135

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Infiltration, overland flow and sediment yield prior and subsequent to removal of tree cover and conversion to grasses.

3. Investigator : Teja Singh.

4. Year of Commencement : 1965

5. Anticipated Year of Completion: Original 1970 Revision I 1971.

6. Key Words not in Title : Erosion, runoff, montane, aspen.

7. Activity : Forest hydrology.

8. Problem Area Program : Maintenance and improvement of water quality in forest areas.

9. Established Project Number : A 135 Branch Project No.: A 135

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.2 Other 0.8

12. Co-operating Agencies : None.

13. Location of Work : Streeter Experimental Watershed and Porcupine Hills, Nanton, Alberta.

14. Abbreviated Background Statement: A change in vegetation through manipulation of forest cover has adverse effects on infiltration capacities. The mechanical clearing of aspen and breaking up the land to eliminate suckering involve considerable soil disturbance, especially near the surface layers. A reduction in infiltration capacities means more overland flow and increased sediment, primarily during the conversion period until the grass cover is re-established.

The need for more grazing land and higher carrying capacities than those available at present in the brush-invaded areas is expected to provide increased impetus for clearing of aspen and scrub vegetation in coming years. A knowledge of the influence of vegetative and edaphic factors is essential in order to provide a base on which to evaluate and compare the various methods that are to be used in such operations. As only a limited number of treatments can be applied on a watershed basis, the numerous techniques available for making such drastic cover changes can more conveniently be tested and evaluated on small experimental plots.

Three related studies were recognized within the project:

Study A -- Influence of vegetative and edaphic factors on infiltration rates.

Study B -- The effect of aspen removal and conversion to grasses on infiltration rates.

Study C -- The effect of tree cover and manipulation on overland flow and sediment.

15. Summary of Progress up to One Year Ago:

Study A -- The field data collection and the laboratory analyses were completed; statistical analyses were in progress.

Study B -- The collection of field data and most of the laboratory analyses were completed; the remaining laboratory analyses and data processing were in progress.

Study C -- Instrumentation of the control plots was completed.

16. Goals Set One Year Ago :

Study A -- Derive mathematical equations to express infiltration rates.

Study B -- Complete the remaining laboratory and statistical analyses.

Study C -- Start data collection on overland flow, sediment and rainfall.

17. Accomplishments in Last Year:

Study A -- The field data have been analyzed and compiled. The research results have mostly been written for publication.

Study B -- Most of the data have been analyzed and written for publication. Statistical analysis of the remaining data is in progress.

Study C -- Neutron access tubes were installed on the control plots during the summer for determining soil moisture regime throughout the year.

18. Goals for Next Year :

Study A — The study will be terminated on publication of research results.

Study B — Statistical analysis will be completed and the study terminated with publication of research results.

Study C — Collection of field data.

Publications

Singh, T., 1969. Estimating infiltration response of vegetation units in an aspen-grassland watershed. Paper presented at the Fiftieth Annual Meeting of the American Geophysical Union, Washington, D.C.

Singh, T., D. Storr, D. R. Davis and D. R. Stevenson, 1969. Rangeland hydrology research in South Saskatchewan River headwaters. J. Range Management. Abstracts of Papers, p. 7.

Singh, T. Infiltration characteristics of aspen-grassland vegetation of southwestern Alberta as affected by edaphic factors of physical significance. Journal publication.

Teja Singh

Teja Singh,
Investigator.

FOREST PROTECTION RESEARCH

Forest protection research in the Alberta/NWT/Yukon region consists of integrated programs of fire, entomology, pathology and insect and disease surveys and damage appraisals. The program provides information necessary to the formulation of policies and practices for controlling and preventing forest losses.

PROBLEM AREA PROGRAM

Reduction of Losses from Bark Beetles

Bark beetles are the most destructive perennial insect pest in the coniferous forests of western North America. The most intensively studied insect in this group is the mountain pine beetle and the associated blue stain fungi which together are responsible for a significant annual loss of lodgepole, white and ponderosa pine. Objectives of the program are to determine the biology and ecology of the insect and to develop effective and economical means for preventing or controlling their outbreaks by biological, silvicultural or other direct means. Study areas are located in the East Kootenay region of British Columbia where relatively permanent mountain pine beetle populations are established and are accessible from the regional Calgary Headquarters. An important advance in the progress of the study was the recognition in 1960 that factors other than the beetle--pathogens vectored by the insect and response of the tree itself to the invading parasites--play an important, if not a major part, in the death of affected trees. As a result the study was re-organized and the objectives expanded to facilitate reduction in the losses to western pine forests caused by the mountain pine beetle and its associated blue stain fungi.

A premise central to the study is recognition that trees vary in their resistance to attack and infection. Resistance takes the form of resin and resin-like compound formations and it is known that trees vary in their ability to produce these substances. To date studies have emphasized the physical relations between the insect, fungi and the tree. This work is now mainly completed and biochemical and physiological aspects of the study are being expanded. The ultimate aim is a guideline for managing pine forests which will include rating of pine trees and stands as to their potential for supporting mountin pine beetle populations and the selection of trees resistant to bark beetles and blue stain fungi.

Investigations are also being conducted and more are planned for damage appraisal and control of the spruce bark beetle. Aerial and ground surveys have revealed heavy tree mortality in the Crowsnest Forest and other high hazard areas throughout the foothills of southwest Alberta. Methods of insect detection and damage control are known and have been given to forest management. Investigations on the development periods of the spruce bark beetle are being conducted to determine when other major attacks can be expected.

For several years the regional program has included taxonomic studies on the bark beetle genus *Ips*. These bark beetles are particularly destructive in young pine stands and the increasing proportion of such stands resulting from regeneration of logged and burned areas amplifies the economic importance of the insect. An objective definition of the Ips species is fundamentally important to most studies of the biology and ecology of the insect.

Research now related to the bark beetle problem includes the following projects:

A 229 : Role of Blue Stain Fungi in Bark Beetle Infested *Pinus contorta* - H. S. Whitney

A 245 : Biology of the mountain pine beetle - J. H. McGhehey

A 246 : Population studies of the mountain pine beetle - L. Safranyik

A 247 : Factors affecting the attraction of mountain pine beetle - R. F. Shepherd

A 248 : Climate in relation to the mountain pine beetle - J. M. Powell

A 253 : Resistance of *Pinus contorta* to mountain pine beetle and blue stain fungi - R. W. Reid and D. M. Shrimpton

A 249 : Biosystematics of the pine beetle genus *Ips* - G. N. Lanier

A 237 :*Annual forest insect survey - H. A. Tripp

Extra Mural Research - F 22 - Biochemical compounds in the bark and sapwood of lodgepole pine - H. M. Benn, Department of Chemistry, University of Calgary.

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* Project statement appears under Problem-Detection and Estimation of Tree Pest Damage.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Role of blue-stain fungi in bark beetle infested *Pinus contorta*.

3. Investigator : H. S. Whitney

4. Year of Commencement : 1959

5. Anticipated Year of Completion: Original - 1972

6. Key Words not in Title: Pathogenesis, mycangia, host resistance, symbiosis, axenic insects, SA 1, CL.

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from bark beetles.

9. Establishment Project No. A 229 Branch Project No. A 229

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 1 Other - 1.25

12. Cooperating Agency : British Columbia Forest Service.

13. Location of Work : Calgary; East Kootenay Region of British Columbia.

14. Abbreviated Background Statement: The objective of this project is to elucidate the role of blue-stain fungi in the mortality of lodgepole pine and the relation between these organisms and the associated bark beetles. It is believed that this knowledge will assist in attaining the objective of the integrated multidiscipline investigation which is to facilitate a reduction in the losses to western pine forests caused by the mountain pine beetle and its associated fungi.

15. Summary of Progress up to One Year Ago: The blue-stain fungi and yeasts associated with mountain pine beetle attacks on lodgepole pine have been identified. This involved the description of four blue-stain fungi new to science. *Ceratocystis montia* and *Europhium clavigerum* were the most frequent blue-stain fungi and *Hansenula capsulata*, *H. holstii* and *Pichia pini* the most common yeasts. Inoculation of healthy lodgepole pine with *C. montia* and *E. clavigerum* resulted in resinous reactions in the stem similar to those produced by unsuccessful beetle attacks. Uninoculated controls produced a very minor reaction. It was concluded that the blue-stain fungi were largely responsible for the resinous resistant response of the tree. The greater the reaction to fungus inoculation, the greater the resistance to induced beetle attack. Trees were rated resistant or non-resistant but intermediates were not rated satisfactorily. The more apparent cytological

and histological changes in tissues associated with beetle and fungus colonization were described.

Addition of resinous sapwood to growth media inhibited growth of blue-stain fungi whereas non-resinous sapwood enhanced growth; however, volatile components in extracts from both resinous and non-resinous sapwood inhibited growth. There was an apparent direct relationship between severity of stem wounding and success of insect and blue-stain fungi tested on the tissues affected by the wounding. Variations between insects was important in assessing insect-tree interactions in predisposed tree stems.

Axenic bark beetles were produced from surface sterilized eggs in thirty days in autoclaved lodgepole pine phloem supplemented with autoclaved brewers' yeast. Larvae did not grow or pupate in this medium without added yeast. C. montia could be substituted for brewers' yeast but E. clavigerum could not.

Larvae of bark beetle broods raised in slabs became temporarily separated from all culturable micro-organisms and fed in axenic phloem. Normal appearing adult insects were produced when this separation was made permanent. Nine publications and five reports were published up to 1968.

16. Goals Set One Year Ago : To compare the colonization of predisposed and non-predisposed stem tissue by axenic, non-axenic and agnotobiotic bark beetles, and by the blue-stain fungi.

17. Accomplishments in Last Year: Additional evidence confirmed that colonization by the beetle and associated micro-organisms was greater on wounded than on non-wounded stem tissue, but conclusive results were not obtained in experiments designed to examine directly the role of blue-stain fungi. Contrary to previous indications limited growth of the mountain pine beetle was obtained in unsupplemented autoclaved ground phloem. Growth was greatly enhanced by the addition of killed brewers' yeast, mountain pine beetle associated yeasts or the blue-stain fungi. Two contaminants of broods, Trichoderma and Penecillium, inhibited production in the phloem plates. Axenic beetles reproduced axenically in fresh bolts of lodgepole pine.

Resinous reactions were twelve times longer from live than from killed inoculum of Europhium. High dilutions (1:10,000) of Europhium inoculum produced similar but smaller (1/3) resinous reactions compared to full strength. Europhium localized in resistant reactions in trees inoculated two years previously apparently began to grow into unoccupied sapwood after being removed from trees in slabs.

Blue-stain fungi and yeasts were isolated from mycangia in the cardo portion of the maxillae of the pine beetle. Mycangia were observed with a scanning electron microscope.

Cirri of ascospores of C. montia, which stick to the mountain pine beetle, disperse in lodgepole pine resin but not in water. Cultures from dispersed spores appear normal.

18. <u>Goals for Next Year</u> : I plan to undertake a post doctoral transfer of work at the University of California, Berkeley campus. I will join research in progress in a multidiscipline study of bark beetle/tree/disease interactions. Nutritional and environmental requirements for optimum growth and reproduction of blue-stain fungi and the nature of the stimulation produced by blue-stain fungi that cause trees to produce resin will receive special attention.

The following publications are to be completed:

Whitney, H. S. Association of blue-stain fungi and other micro-organisms with mining larvae of the mountain pine beetle. Proposed journal publication.

Whitney, H. S. Rearing mountain pine beetles in autoclaved lodgepole pine phloem supplemented with blue-stain and other fungi. Proposed journal publication.

Whitney, H. S. Growth and reproduction of the mountain pine beetle in lodgepole pine bolts in the absence of blue stain fungi. Proposed journal publication.

Whitney, H. S. Response of lodgepole pine to axenic virgin mountain pine beetles. Proposed departmental Bi-monthly Res. Note.

Whitney, H. S. Response of lodgepole pine to varying concentrations of blue-stain fungus inoculum. Proposed departmental Bi-monthly Res. Note.

Whitney, H. S. A mycangium in <u>Dendroctonus ponderosae</u> with S. H. Farris. Proposed journal publication.

Whitney, H. S. and R. A. Blauel. Dispersion of ascospores of <u>Ceratocystis montia</u> in pine resin. Proposed journal publication.

H. S. Whitney
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969
2. Title : Biology of the mountain pine beetle
3. Investigator : J. H. McGhehey (Resigned 1968)
4. Year of Commencement : 1955
5. Anticipated Year of Completion: Original - 1969
6. Key Words not in Title : *Dendroctonus ponderosae*, life cycle, fecundity behaviour, survival, phenotypic population SA 1, CL
7. Activity : Entomology
8. Problem Area Program : Reduction of losses from bark beetles.
9. Establishment Project No. A 245 Branch Project No. A 245
10. Status : Completed
11. Man-years Utilized in Past Year: Professional - 1 Other - 1.3
12. Cooperating Agencies : National Parks Branch; British Columbia Forest Service.
13. Location of Work : Calgary; Eisenhower Forest Research Station; East Kootenay Region of British Columbia.
14. Abbreviated Background Statement: This was the first project set up to investigate the biology of mountain pine beetle. In the earlier years it was believed studies on the insect itself would yield all the information needed to predict tree mortality and develop methods for reducing damage. The attainable objectives originally set out for the study have been satisfied. Since the study was taken over from R. W. Reid by J. H. McGhehey new objectives were delineated. These have in part been fulfilled. An important unfulfilled objective relates to influence of nutritive qualities of host to brood establishment and survival. This objective will be added to Project A 246 with the termination of A 245.
15. Summary of Progress up to One Year Ago: Factors important to development of broods and flight periods, behaviour of adults beneath the bark and factors directing that behaviour are known. The role of climate is broadly understood. The critical factors determining population abundance are now recognized. Intensive work on those factors is underway in Project No. A 246. During the course of Project No. A 245, three major reports and eight sciantific papers have been published; five additional are in press.

16. <u>Goals Set One Year Ago</u> : Measure differences in reproductive potential and vigour within and between populations of the mountain pine beetle.

17. <u>Accomplishments in Last Year</u>: Preparation of the following publications -

Reid, R. W. The influence of humidity on incubating bark beetle eggs. Can. Ent. (in press).

Reid, R. W. and H. Gates. The effect of temperature and resin on survival of mountain pine bark beetle eggs. Can. Ent. (in press).

McGhehey, J. H. Territorial behaviour of bark beetle males. Bi-monthly Research News.

McGhehey, J. H. Sex ratios of individual broods of the mountain pine beetle. Bi-monthly Research News (in press).

McGhehey, J. H. Female size and egg production of the mountain pine beetle. Can. Ent. (in press).

18. <u>Goals for Next Year</u> : None - Project to be closed, 1969.

"J. H. McGhehey" per R.W. Reid

J. H. McGhehey
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Population studies of the mountain pine beetle.

3. Investigator : L. Safranyik

4. Year of Commencement : 1955

5. Anticipated Year of Completion: Original - 1970 Revision I - 1973

6. Key Words not in Title : Dendroctonus ponderosae, sampling, spatial pattern, insect population quality, lodgepole pine, SA 1, CL

7. Activity : Entomology

8. Problem Area Program : Reduction of losses from bark beetles.

9. Establishment Project No. A 246 Branch Project No. A 246

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 1 Other 1.6

12. Cooperating Agencies : B. C. Forest Service; Crestbrook Forest Industries Ltd., Cranbrook, B. C.

13. Location of Work : Canal Flats; Invermere, B. C.; Eisehhower Field Station; Calgary.

14. Abbreviated Background Statement: The need for studying year-to-year population changes of the mountain pine beetle and for evaluating the importance and mode of action of its various mortality factors are based on the following considerations: The formation of effective control measures have to be based, to a large degree, on the evaluation of the importance of the various mortality factors affecting the population. Also the evaluation of the effectiveness of a control method as well as the establishment of the need for control, must be based on prediction of population levels. This study is also related to Projects A229 and A253 in that the prediction of outbreaks requires, in addition to predicting population levels, an estimate of the proportion of trees which will be in a "susceptible" condition during the flight period of the adult beetles. R. F. Shepherd was responsible for this project until 1964. In 1964 the original project title was retained but the objectives were changed as follows:

(1) Describe the distribution of beetle attacks over the host and the factors that influence this distribution; (2) Develop a sampling system which will be of sufficient sensitivity to permit detection, evaluation and prediction of population changes within

limits of practicability; (3) Assess the effects of various mortality factors on beetle populations; (4)Relate the effects of mortality factors to population changes.

In 1969 an important objective from a terminated project (A245) was incorporated into A 246 in the following form:

Objective 5 - Assess the role of variations in mountain pine beetle phenotypes and abundance in relation to the physical and nutritional quality of the host.

15. Summary of Progress up to One Year Ago: The size, shape and orientation of the optimum "sampling unit" was established by studies of the relation between sampling variance unit, mean clump size and clump orientation of late stage brood and by a time study of sampling units of various sizes by fixed shapes. The gradients of brood and attack density, both vertically and around the circumference of infested trees, were described and a mathematical description of attacks over the host, in terms of bark thickness and d. b. h. was developed. A two-stage sampling system was developed to measure within generation mortalities and population trend. An equation was developed to predict infested bark surface area of lodgepole pine. Three years' data have been collected on woodpecker predation and insect predation and parasitism.

16. Goals Set One Year Ago : Prepare analyzed data for thesis (Ph. D.) and publications. Test various X-ray sampling techniques. Develop equipment to study the colonization of host trees by the attacking female beetles.

17. Accomplishments in Last Year: Experiments were initiated and equipment tested to study the method of colonization of individual tree bark surfaces by the attacking female beetles. The vertical flight intensity profile was studied in relation to wind speeds and temperatures. Two methods of estimating landing frequency, within the clear bole zone, were tested and compared. A thirty-feet-high rotating system of fifteen nets, arranged at two-feet intervals, was tested for studying the vertical flight frequency of beetles in the clear bole zone. The relations between beetle size and height level on the infested stem, beetle size and sex ratio and between speed of emergence and aspect on the stem were studies using "emergence" traps. A study was initiated to investigate the accuracy and efficiency of sampling unit ennumeration by X-ray techniques. Ph. D. thesis: "Development of a technique for sampling mountain pine beetle populations in lodgepole pine", prepared and accepted by the Faculty of Forestry, University of British Columbia.

18. Goals for Next Year : (a) Continue studies of the method and factors affecting colonization of the tree stem by the mountain pine beetle. (b) Complete study on the evaluation of the accuracy and efficiency of sampling unit enumeration by X-ray techniques. (c) Commence studies on the effect of seasonal changes within the host upon brood establishment and survival.

Publications:

Safranyik, L. and K. Graham. 1968. Studies of the relations between the shape and size of the sampling unit and the edge-effect bios of mean brood density. Proposed journal publication.

Safranyik, L. and R. Jahren. 1969. The relations between beetle size and height above ground level in infested lodgepole pine stems. Proposed journal publication.

Safranyik, L. 1969. Mathematical description of vertical attack density gradients on the infested stem. Proposed journal publication.

L. Safranyik

L. Safranyik
Investigator

Project No. A 247

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Factors affecting the attraction of the mountain pine beetle.

3. Investigator : R. F. Shepherd

4. Year of Commencement: 1956

5. Anticipated Year of Completion: Original - 1969

6. Key Words Not in Title: insect behavior, external tree characteristics, attack pattern, SA1, CL

7. Activity : Entomology

8. Problem Area Program: Reduction of losses from bark beetles.

9. Establishment Project No. A 247 Branch Project No. A 247

10. Status ; Completed

11. Man-years Utilized in Past Year: None

12. Cooperating Agency : British Columbia Forest Service.

13. Location of Work : Invermere, B. C.; Eisenhower Field Station.

14. Abbreviated Background Statement: Project was initiated to determine the influence of insect behavior and the influence of external tree characteristics of the tree on the attack pattern of the mountain pine beetle.

15. Summary of Progress up to One Year Ago: Most of the work was completed and presented in publication.
    Shepherd, R. F. 1966. Factors influencing the orientation and rates of activity of Dendroctorus pondorosae Hopkins (Coleoptera:Scolytidae) Can. Ent. 98(5) 507-518.

16. Goals Set One Year Ago: None. Investigator was away on transfer of work.

17. Accomplishments in Last Year: None.

18. Goals for Next Year : Some data on external tree characteristics remain to be analysed and will be combined with similar data collected by L. Safranyik. Future reporting of this will be done under Project A 246.

R. F. Shepherd

R. F. Shepherd,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969
2. Title : Climate in relation to the mountain pine beetle
3. Investigator : J. M. Powell
4. Year of Commencement: 1960
5. Anticipated Year of Completion: Original - 1964 Revision I - 1969
6. Key Words not in Title: *Dendroctonus ponderosae*, *Pinus*, outbreaks, habitat temperatures, valley climate, SA 1, CL.
7. Activity : Entomology
8. Problem Area Program: Reduction of losses from bark beetles.
9. Establishment Project No. A 248 Branch Project No. A 248
10. Status : Reactivated in 1969
11. Man-years Utilized in Past Year: None
12. Cooperating Agency : None
13. Location of Work : Calgary Laboratory; Eisenhower Field Station; Invermere, B. C.
14. Abbreviated Background Statement: Observations have indicated that outbreaks of *D. ponderosae* and other *Dendroctonus* species are often associated with prolonged drought periods. The important role of certain climatic factors in the rate of development of the various stages of the life cycle of the beetle has been shown, and also their effect on its mortality. Climatic factors may also affect the susceptibility of the pine trees to attack. If a method of predicting possible outbreaks based on climatic conditions could be developed, control and management methods may be utilized to good effect.

    Initially the project had wide objectives, but these were abbreviated after the first year of study, because of the pending reassignment of the investigator. The objectives were revised to determine: (1) the historic relationship between the important climatic factors and the occurrence of beetle outbreaks; (2) the relationship between air and sub-cortical temperatures of attacked and unattacked trees at different heights in the stand; (3) the variability in summer climate in a mountain valley.
15. Summary of Progress up to One Year Ago: Data for all phases of the project have been collected

and analysed. Nothing further has been done since 1964 as the project was on a maintenance basis. Several reports and publications have been made. Records of D. ponderosae outbreaks in western Canada were extracted from the literature and a detailed history of outbreaks and timber losses occurring in 15 physiographic regions from 1906 to 1960 was published. A paper giving distribution of the beetle and a cartographic history of outbreaks was also published as a report. A study was made of the climatic fluctuations and trends in British Columbia since the keeping of records, as part of an investigation to show whether relationships exist between trends in climate and beetle populations. Two papers were published, one on annual and seasonal temperature and precipitation trends in British Columbia since 1890, and the other on changes in amounts of sunshine. An unpublished report discussed the occurrence of drought in British Columbia. An analysis of the correlation of fluctuations of seasonal weather and beetle populations produced no significant results when considered over a time scale of 60 years, although many outbreaks occurred during periods of above normal spring and summer temperatures and below normal spring and summer precipitation.

The habitat temperatures of the beetle in lodgepole pine trees was compared with temperatures in non-infested trees and the surrounding air, and published in a paper to satisfy objective (2). The effects of height above ground, aspect, shading, bark thickness and subcortical moisture conditions on temperatures were considered.

Meteorological studies were carried out in 1960 and 1961 using a network of 15 stations in a beetle infested area of the Rocky Mountain Trench to give a better interpretation of local valley conditions. The stations varied in elevation from 2,700 to 5,000 feet and, during the summer, recordings were made of soil temperature and moisture, air temperature, humidity and precipitation, and estimates were made of evaporation. Most of the data has bben analyzed and eight of the stations formed the basis for an unpublished report on the summer climate of a tributary of the Upper Columbia River Valley.

16. Goals Set for Last Year: Further work on an information report to complete studies on aspects of objective (1).

17. Accomplishments in Last Year: Climatic data and trends of major beetle populations in three areas during the mid-1960's were extracted prior to up-dating the proposed information report on relation of major outbreaks to seasonal weather conditions.

18. Goals for Next Year : Complete the project by: preparing information report to complete objective (1) and revise the unpublished report on the summer climate of a

mountain valley to satisfy objective (3).

Powell, J. M. Historical study of the relation of major mountain pine beetle outbreaks in western Canada to seasonal weather conditions. Proposed Information Report.

Powell, J. M. Some topoclimatic features of the summer climate of the Frances Creek valley, a tributary of the Upper Columbia River valley. Proposed Information Report.

J. M. Powell

J. M. Powell
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February
2. Title : Biosystematics of the bark beetle genus Ips.
3. Investigator : G. N. Lanier
4. Year of Commencement : 1967
5. Anticipated Year of Completion: Original - 1969 Revision I - 1970
6. Key Words Not in Title: Coleoptra, Scolytidae, breeding experiments, sex, pheromones, sex ration, gunogenesis karyotypes.
7. Activity : Entomology
8. Problem Area Program : Reduction of losses from bark beetles.
9. Establishment Project No. A 249 Branch Project No. A 249
10. Status : Active
11. Man-years Utilized in Past Year: Professional - 1 Other - 1.3
12. Cooperating Agency : None
13. Location of Work : Calgary Laboratory; Eisenhower Field Station.
14. Abbreviated Background Statement: The increasing proportion of young forest stands resulting from regeneration of logged areas and aforestation of barren lands has amplified the economic importance of the genus Ips. These bark beetles are particularly destructive in young pine stands subjected to drought and in thinned or logged areas. Recent advances such as identification and synthesis of Ips sex pheromones and perfection of methods of sterilization have rendered sophisticated auticidal control techniques theoretically feasible. However, a clear conception of the distributions and definitions of species is paramount to undertaking such a program on a wide scale.

    Workers in other regions are intensively studying the nematodes and mites associated with Ips or using these beetles as laboratory animals in basic studies of insect nutrition, host selection, sex pheromones and sound production. In these areas also objective definition of the Ips species is fundamentally important.

15. Summary of Progress up to One Year Ago: G. R. Hopping completed a taxonomic revision of the North American Ips (Project CZ-14, 1960-1964), but controversy over the status of several closely related species was only partially resolved.

Breeding and cytological studies of selected Ips species was the subject of my Ph. D. thesis at Berkeley. This work confirmed the validity of several controversial species and ratified certain of Hopping's synonymizations. Conversely, it demonstrated that six "species" of spruce-feeding Ips constituted a single valid species with polymorphic females and cast doubt upon the reality of several other species.

16. Goals Set One Year Ago : Commence breeding experiments and cytological studies with species currently available. Correspond with various workers to obtain other species.

17. Accomplishments in Last Year: During the past year over 2000 pairings (breeding tests) involving 12 species and 21 populations were completed. To date 28 of the currently recognized 32 North American Ips have been handled in the laboratory and the experimental phase of this work is 80% complete. The validity of two Ips species new to science and one species which had been synonymized was confirmed by breeding tests and analysis of morphological and cytological characters. Conversely, synonomy of three species was demonstrated. Of the currently recognized fourteen species of spruce infecting Ips, only five names are valid. Twelve of these fourteen names constitute three species with polymorphic females.

Gynogenetic strains of additional Ips species were found. These females invariably proved to be triploid. A cytoplasmic incompatibility system was detected in the I. plastographus group which is somewhat analygous to the "Rh" condition in man.

Publications:

Lanier, G. N. 1968. Ips plastographus (Coleoptera:scolytidae) tunnelling in sapwood of lodgepole pine in California. Can. Ent. 99(12):1334-5.

Lanier, G. N. and D. L. Wood. 1968. Controlled mating, karyology, morphology and sex-ratio in the Dendroctonus ponderosae complex. Ann. Ent. Soc. Amer. 61(2): 517-26.

Lanier, G. N. and E. A. Cameron. 1968. (University of California) Secondary sex characters in the genus Ips de Geer (Coleoptera:scolytidae). Can. Ent. (In press).

18. Goals for Next Year: (1) Complete experimental phase of this project including breeding tests, karyotype determinations, sex pheromones, specificity tests.

(2) Prepare large numbers of paratype and voucher specimens for distribution to museums.

(3) Prepare the following papers for publication:

Lanier, G. N. Biosystematics of the genus Ips I. Group IX. Proposed journal publication.

Lanier, G. N. Biosystematics of the genus Ips II. Groups III and IV. Proposed journal publication.

Lanier, G. N. Specificity of sex pheromones produced by hybrid bark beetles. Proposed journal publication.

Lanier, G. N. A pseudo-Rh factor in Ips plastographus. Proposed journal publication.

Schofer, G. A. and G. N. Lanier. A character for sexing pupae of Dendroctonus ponderosae. Proposed departmental Bi-monthly Research Note.

Wood, D. L. and G. N. Lanier. Interspecific response to the sex pheromone produced by males of the genus Ips de Geer. Proposed journal publication.

G. N. Lanier

G. N. Lanier,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon.

2. Title : Resistance of *Pinus contorta* to mountain pine beetles and blue stain fungi.

3. Investigators : R. W. Reid, D. M. Shrimpton.

4. Year of Commencement : 1965.

5. Anticipated Year of Completion: Original 1972.

6. Key Words not in Title: Terpenes, phenolics, carbohydrates, tissue culture, water, SA1, CL.

7. Activity : Tree Biology.

8. Problem Area Program : Reduction of losses from bark beetles

9. Established Project Number: A 253   Branch Project No. A 253

10. Status : Active.

11. Man Years Utilized in Past Year: Professional 1.5; Other 3.

12. Co-operating Agencies : British Columbia Forest Service.

13. Location of Work : Calgary, Kananaskis Forest Experimental Station, East Kootenay Region of B.C.

14. Abbreviated Background Statement: Previous studies on the relation between mountain pine beetle attacks and tree mortality suggested a major role was played by the tree in determining success of the beetle attack. In fact, it appeared success or lack of success by the beetle and its associated blue stain fungi was determined solely by the tree. Tree resistance was manifest by synthesis of resin and resin-like compounds, hence physiological and biochemical systems and cycles of the tree were involved. Studies into those aspects of resistance were undertaken.

15. Summary of Progress up to One Year Ago: Resistance by lodgepole pine to invasion by blue stain fungi is effected by initial flow of oleoresin followed by a gradual impregnation with heartwood substances of the tissues adjacent to the wound. Volatile components from this wound reaction zone cause inhibition of growth of blue stain fungi.

16. Goals Set One Year Ago: To determine the effectiveness of resins to act as physical barriers to fungal growth, also to test the effects of volatile resins upon the behaviour of

the invading insect. Establish lodgepole pine tissue cultures. Investigate the relation between seasonal xylem growth and the resistant/non-resistant tree response; also the relation of water stresses in the tree with those responses.

17. Accomplishments in Last Year: Shortage of natural resin last summer necessitated that the first two objectives above be postponed. The phenolics compounds produced by the resistant reaction reach a maximum concentration -- approximately 1/3 the concentration observed in heartwood -- within 3 months following wounding. These phenolics are also produced in the non-resistant reaction. Techniques have been developed for a study of the sugars present in lodgepole pine stems. Tissues from lodgepole pine have been successfully cultured.

Resistant and non-resistant trees were found to differ in water stress; stress measurements were about equal between the two groups, during periods of adequate precipitation, but in hot, dry weather non-resistant trees exhibited a greater stress. During periods of hot dry weather stem shrinkage greatly exceeded radial growth. In 1968 the period of most extensive stem shrinkage and water stress coincided with the flight period of the mountain pine beetle. Variations in growth rhythm during the season could not be related with degree of tree resistance or non-resistance.

18. Goals for Next Year : The tissue culture program will be continued to increase growth rates of the cultures and examine their use as experimental material for the formation of wound response compounds. Sugars present in stems of lodgepole pine will be assayed throughout the growing season.

Finalize studies of tree response to blue stain inoculation, bark beetle attack and water stress. Commence exploratory studies of the gaseous environment beneath the bark of infested trees.

Reid

R. W. Reid,
Investigator.

D. M. Shrimpton,
Investigator.

PROBLEM AREA PROGRAM

Reduction of Losses from Defoliating Insects

The principal defoliating insects within the region are the spruce budworm in northern Alberta and Northwest Territories and the forest tent caterpillar on aspen. The spruce budworm is the most widely distributed destructive forest insect in North America. Since 1947 it has been found in most stands of white spruce in the Mackenzie, Liard, Lower Hay and Slave river drainages of the Territories and along the Athabasca, Peace, Wabasca and Chinchaga rivers of northern Alberta. Annual detection surveys since 1955 have provided estimates of the budworm distribution, relative abundance and damage. Endemic and epidemic budworm populations exist in areas presently supporting the main spruce resources of Alberta and the Northwest Territories. There is need for research in essentially three major subject areas: (1) the economic and ecological effect of the budworm on the commercial forest; (2) the biology of the insect and development of techniques for measurement of budworm populations and (3) the formulation of control measures. Up to 1968 the budworm investigations have come under the first item and carried out by the Insect and Disease Survey. To expand budworm research a second project was initiated in 1968 to determine and evaluate the biology of the insect and development of budworm populations. As these and earlier studies continue a technical, biological and economic basis for meaningful control will be possible.

Studies on the forest tent caterpillar in northern and central Alberta have been principally to improve our knowledge of the history of the current outbreak which was first noted in 1957 and reached a peak in 1962 encompassing about 75,000 sq. miles of central and northern Alberta. More specifically these studies have concerned the defoliation forecasts, hatching studies, the parasite complex and the effect of wind dispersal in the spread of insect outbreak. Plans for 1969 are to expand the studies of the forest tent caterpillar to investigate in depth the ecology of aspen defoliators. The forest tent caterpillar will be used to investigate the influence of weather, nutrition, disease and vigor upon the epidemiology of the insect populations. A model of these influences upon insect abundance will be developed to predict numerical changes of the tent caterpillar and other insect species. Emphasis will be given to improved sampling techniques and the establishment of control methods.

After many years investigations on the population dynamics of the lodgepole pine needle miner have been completed. The results of these studies are being published and the project will be terminated in 1969.

Established projects and project proposals related to the problem are:

A 237*: Annual forest insect survey - H. A. Tripp

A 255 : History and impact of the spruce budworm in northern Alberta and Northwest Territories - R. E. Stevenson.

A 288 : Biology of the spruce budworm in northern Alberta and Northwest Territories - H. F. Cerezke.

A 257 : Forest tent caterpillar investigations - A. Raske.

A 242 : Population dynamics and sampling of the lodgepole pine needle miner - R. F. Shepherd.

Project Proposal : Ecology of aspen defoliators - R. F. Shepherd.

* Project statement appears under Problem Detection and Estimation of Tree Pest Damage.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Population dynamics and sampling of the lodgepole needle miner.

3. Investigator : R. F. Shepherd

4. Year of Commencement: 1947

5. Anticipated Year of Completion: Original - 1970

6. Key Words not in Title: Pinus contorta, life tables, behavior, climate, mortality, SA 1.

7. Activity : Entomology

8. Problem Area Program: Reduction of losses from defoliating insects.

9. Establishment Project No. A 242 Branch Project No. A 242

10. Status : Active

11. Man-years Utilized in Past Year: Professional - .5 Other - None

12. Cooperating Agencies: National Parks and Historics Parks Branch.

13. Location of Work : Eisenhower Field Station; Banff National Park; Calgary.

14. Abbreviated Background Statement: Two main objectives have been involved: to determine the impact of needle miner defoliation upon stands in the National Parks and to build a body of information which will significantly contribute to the understanding of epidemiology of pest species. Studies have been under the stewardship of R. W. Stark, J. A. Cook, C. E. Brown and R. F. Shepherd.

15. Summary of Progress up to One Year Ago: Forty-three scientific papers and ten reports were published up to 1967. Studies and data collection are complete.

16. Goals Set One Year Ago: Synthesise the data and complete a mass multiple regression analysis.

17. Accomplishments in Last Year: No progress was made on this project. The investigator was absent on a transfer of work.

18. Goals for Next Year: Complete report and terminate project.

Shepherd, R. F. Monograph on epidemiology of lodgepole needle miner. Proposed Journal publication.

R. F. Shepherd

R. F. Shepherd
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : History and impact of the spruce budworm in northern Alberta and Northwest Territories.

3. Investigator : R. E. Stevenson.

4. Year of Commencement: 1967

5. Anticipated Year of Completion: 1970

6. Key Words not in Title: *Choristoneura fumiferana*, *Picea glauca*, survey, B.18, 19, growth, loss.

7. Activity : Forest Insect and Disease Survey.

8. Problem Area Program: Reduction of losses from defoliating insects.

9. Establishment Project No. A 255 Branch Project No. A 255

10. Status : Active.

11. Man-years Utilized in Past Year: Professional - 1 Other - .7

12. Cooperating Agencies: National Parks and Historic Sites Branch; Alberta Forest Service; Mackenzie Forest Service.

13. Location of Work : Calgary, Northern Alberta, N. W. T.

14. Abbreviated Background Statement: Annual detection and appraisal surveys indicate growth loss, top killing and/or tree mortality is occurring within extensive areas of merchantable white spruce stands. Regeneration within and adjacent to infested mature stands is subject to injury, sometimes lethal. To properly utilize the spruce in the affected areas the Alberta Forest Service has had to re-align cutting priorities and increase the allowable cut.

    Short term objectives of this project are:

    (1) Carry out an annual survey on the geographic distribution and relative abundance of spruce budworm in the Alberta/NWT/Yukon region.

    (2) Determine the history of the spruce budworm infestation in different regions.

    (3) Assess the impact of spruce budworm attacks on growth pattern and survival of spruce stands subjected to varying degrees of prolonged defoliation.

15. Summary of Progress up to One Year Ago: In addition to annual detection and mapping of budworm infestations by aerial surveys, ground checks were conducted during 1967 in all major infested areas. Information revealed that even repeated light infestation as recorded from the air results in considerable top killing and mortality to regeneration.

A summary of the percentage damage in merchantable stands attributable to the spruce budworm is presented below:

Area	Condition of merchantable white spruce		
	dead trees	living trees: dead tops	living trees: no dead tops
	percent	percent	
Mackenzie-Blackwater rivers area	30	60	10
Redstone-Mackenzie rivers area	67	8	25
Long Island-Slave River	77	16	7
Wabasca-Muddy rivers	63	27	10
Wabasca-Senex area (south)	10	34	55
Wabasca-Senex area (north)	21	44	34

16. Goals Set One Year Ago: Continue impact studies, growth loss and mortality. Cooperate in an aerial photography operation over infested spruce stands. Prepare a manuscript on the history of the spruce budworm outbreaks in Alberta and the N. W. T.

17. Accomplishments in Last Year: Annual aerial detection, mapping and ground surveys were continued in 1968. High hazard areas containing a high incidence of dead and badly deformed trees in the Wabasca management units were mapped for the Alberta Forest Service.

Data gathered from ground work in 1968 in the Wabasca outbreak at the epicentre indicated tree mortality at 39 percent while 44 percent of the trees had dead tops. Compared to 1967 this represents a slight increase in tree mortality (from 34%) and a decrease in dead tops (from 49%). At the periphery of the outbreak there has been no tree mortality although 30 percent of the stand, primarily in the co-dominant and intermediate classes have dead tops.

Cross-sectional discs were taken from 24 trees in the Wabasca outbreak to investigate decreases in radial annual increment. Complete stem analysis studies are almost complete. Preliminary investigations conducted in 1967 suggest no spruce budworm activity prior to 1935 in the Wabasca. These fluctuations in radial increment have coincided with fluctuation in severe defoliation as determined by aerial surveys commencing in 1955.

Aerial photography at scales 1:2640 and

1:1320 was taken over 18 sq. miles of the severest attacked area. Within this area a sample strip four miles by one-half mile through the epicentre was photographed in ectrachrome at scales 1:100, 1:200 and 1:300.

A manuscript on "History of spruce budworm outbreaks in Alberta and N. W. T. and their impact on the forest" has been completed for editorial review.

18. Goals for Next Year : Aerial surveys in northern Alberta and the Northwest Territories will be continued over major outbreak areas.

Analysis of stem data collected in 1968 show the Wabasca outbreak will be completed. Tree discs will be taken from outbreak areas in Chinchaga, lower Peace and lower Athabasca. In order to see if budworm attacks have occurred in central Alberta discs for stem analysis studies will be taken from three areas (Grande Prairie, Slave Lake and Lac La Biche) across Alberta some distance south of existing outbreaks.

Short-term appraisal studies and surveys will be conducted with provincial and federal personnel in high hazard areas, where necessary.

Aerial photographs taken in 1968 will be interpreted for incidence of tree mortality defoliation, volume loss and mapping of damage epicentres, and compared with companion data obtained from ground surveys. The economics of ground survey will be compared with aerial survey using photographs.

A report describing annual loss in increment and history of the spruce budworm in the Wabasca outbreak will be prepared.

R. E. Stevenson

R. E. Stevenson
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon   Date: February, 1969

2. Title : Forest tent caterpillar investigations.

3. Investigator : A. Raske

4. Year of Commencement: 1960

5. Anticipated Year of Completion: Original - 1968; Revision I - 1970

6. Key Words Not in Title: Malacosoma disstria, defoliation, sequential sampling, climate, mortality, epidemeology, Alberta.

7. Activity : Forest Insect and Disease Survey.

8. Problem Area Program: Reduction of losses from defoliating insects.

9. Establishment Project No. A 257   Branch Project No. A 257

10. Status : Active

11. Man-years Utilized in Past Year: Professional - .3; Other - .5

12. Cooperating Agency : None

13. Location of Work : Central Alberta; Calgary laboratory.

14. Abbreviated Background Statement: Investigations on the forest tent caterpillar were conducted from 1957 to 1965 under the direction of C. E. Brown with assistance from J. K. Robins. A number of special studies had been initiated as opportunities for profitable investigations arose. A. G. Raske studies two aspects; cold-hardiness of first instar larvae, and individual differences in vigor.

15. Summary of Progress up to One Year Ago: All field work has been completed and the data analyzed.

16. Goals Set One Year Ago: Summarize work done up to the present and prepare report for publication.

17. Accomplishments in Last Year: Data collected in past years have been analyzed. A start was made on the report of survey activities in relation to the forest tent caterpillar.

Publications:

Smith, G. J. and A. G. Raske. Starvation experiments with first instar forest tent caterpillar larvae Malacosoma disstria Hbn. Departmental Bi-Monthly Research Notes 24 (5) 39, 1968.

18. Goals For Next Year: Complete the report that will contain the results of the forest tent caterpillar investigations. Parts of the reports worthy of publication will be condensed for Journal publication.

Proposed Publications:

Raske, A. G. and J. K. Robins. Forest tent caterpillar in Alberta. Departmental Information Report.

Robins, J. K. and A. G. Raske. History of the forest tent caterpillar outbreak in Alberta, 1958-1968. Proposed journal publication.

Raske, A. G. Cold hardiness of first instar larvae of the forest tent caterpillar. Proposed journal publication.

Raske, A. G. Qualitative differences between individuals and colonies of the forest tent caterpillar. Proposed journal publication.

Raske, A. G. The forest tent caterpillar in Alberta. Proposed departmental Information Report.

Raske, A. G. Laboratory winter egg-hatch rate of the forest tent caterpillar. Proposed departmental Bi-Monthly Research Note.

Arthur G. Raske

A. G. Raske,
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Biology of the spruce budworm, in northern Alberta and North West Territories.

3. Investigator : H. F. Cerezke

4. Year of Commencement : 1968

5. Anticipated Year of Completion: Original - 1973

6. Key Words Not in Title : *Choristoneura fumiferana*; *Picea glauca*; sample; defoliation; phenology; B 18, 19.

7. Activity : Entomology

8. Problem Area Program : Reduction of losses from defoliating insects.

9. Establishment Project No. A 288 Branch Project No. A 288

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.4 Other - 1.1

12. Cooperating Agencies : Alberta Forest Service; McKenzie Forest Service.

13. Location of Work : High Level, Alberta; Fort Smith, N. W. T.

14. Abbreviated Background Statement: Important information is lacking on vital aspects of the biology of the spruce budworm. Studies are designed to provide biological and technical information essential to making decisions on control. Objectives are:

    (1) To describe the life history of the budworm, its predators and parasites, and how its life stages relate to the seasonal phenological development of the host.

    (2) To describe distribution of stages of the life cycle within the foliage of the host tree.

    (3) To describe the foliage morphology and distribution on the host as it relates to the selection of the budworm sampling universe.

    (4) To describe the behavior and development of larval stages with respect to their feeding and dispersal patterns.

    (5) To develop methods of collecting, preserving and measuring foliage and budworm material.

15. Summary of Progress up to One Year Ago: Project commenced 1968.

16. Goals Set for Last Year : (a) Locate working areas suitable for field and laboratory studies. (b) Collect data on the budworm life history and on spruce phenology. (c) Set up basic weather recording instruments. (d) Examine methods of spruce foliage sampling and measurements. (e) Establish the feeding and dispersal behaviour of larvae on the host. (f) Test rearing methods for stages of the budworm life cycle and for predators and parasites. (g) Determine the presence of associated defoliator species whose life habits parallel those of the spruce budworm.

17. Accomplishments in Last Year: Budworm infested stands along the Peace, Chinchaga, Wabasca and Slave rivers were located and degrees of defoliation were observed from aircraft. Other infested stands were located from the ground. Pupae collections were made from two different areas, individuals were weighed and reared to determine size, parasitism and percent emergence. Collections of 360 branch samples were made from 30 non-infested trees and the following characteristics were measured on each: shoot length, numbers of terminal buds, branch surface area, number of needles and dry needle weights. Patterns of these characteristics within tree crowns were determined and are being used in the development of budworm sampling techniques. Thirty-two additional branches from budworm defoliated trees were examined similarly. Radial increment patterns were described for all sampled trees. Measurements of spruce phenological data were initiated but are incomplete due to late spring frost damage.

18. Goals for Next Year : (a) Semi-permanent field plots will be established for budworm population measurement. (b) Data will be gathered on the defoliation pattern within trees and between trees. (c) Measurements of spruce phenological development will be made concurrently with sample collections of budworm life stages and daily temperature recordings. (d) Data will be gathered on the within crown distribution pattern of 1-2 selected life stages. (e) Collections of pupae will be made for rearing moths, percentage moth emergence, parasitism and to test female moth attraction. This will contribute toward satisfying objectives 1, 2, 4 and 5.

H. F. Cerezke
Investigator

PROJECT PROPOSAL STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Ecology of aspen defoliators

3. Investigator : R. F. Shepherd

4. Year of Commencement: 1969

5. Anticipated Year of Completion: 1979

6. Key Words Not in Title: population dynamics, insect behavior and vigor, weather, sample methods, defoliation and plant communities.

7. Activity : Entomology

8. Problem Area Program: Reduction of losses from defoliating insects.

9. Annual Man-year Requirements: Professional - 0.8 Other - 2.4

10. Major Equipment Purchases Required for Completion: Recorder \$3,500., Electometer \$700., Portable rearing cabinets \$500., O & M either purchase or rental.

11. Cooperating Agencies:

12. Location of Work : Calgary and Central Alberta.

13. Background Statement: More than one-half of Alberta's forest resources are in aspen but less than five percent of the total annual wood utilization in the Province comes from this species. A great deal of knowledge needs to be obtained on the ecology of aspen as a basic requisite for the development of management principles. The forest tent-caterpillar is a conspicuous element in the ecology of aspen stands over wide areas, and many other defoliators occur which are of local importance.

    Only limited information is available on the influence of the forest tent-caterpillar on aspen stands, census techniques for predicting abundance and control methods. This species is ideal for investigating the influence of weather, nutrition, disease and vigor upon the epidemiology of insect populations. The development of a model of these influences upon insect abundance will be useful in predicting numerical changes of other species as well.

    It is intended that close contact will be maintained and information exchangdd with other researchers and survey personnel studying aspen and aspen insects in this and other regions.

14. Objectives : 1. Determine the impact of aspen defoliation

upon stand ecology. 2. Identify the main factors influencing epidemiology of the forest tent-caterpillar and build a predictive model of their combined effects. 3. Devise sampling techniques for determining and predicting population levels and defoliation mosaics. 4. Establish control techniques. 5. Gather background information on aspen defoliators in general.

15. Plan of Attack : Techniques and procedures common in studies of plant and insect communities will be used with emphasis upon biomathematical analysis. Control techniques may be either chemical or biological and applied to the tree or the insect.

16. Goals for Initial One-year Period: 1. Make ecological observations over a wide range of defoliation and stand conditions. 2. Commence studies on the effect of weather and nutrition on the survival, fecundity, vigor and occurrence of diseases of forest tent-caterpillar. 3. Begin a study on the practicability of various sampling and trapping methods for estimating population densities. 4. Initiate studies on the effect of chemical defoliants and/or bud inhibitors upon aspen trees.

R. F. Shepherd

R. F. Shepherd
Investigator

PROBLEM AREA PROGRAM

Reduction of Losses from Root Inhabiting Insects

Since 1960 research on root inhabiting insects has concentrated upon the Warren's collar weevil which attacks pines and spruce throughout the boreal forest. Objectives are to determine the biology and ecology of this insect, to obtain meaningful criteria to assess the need for control, and to develop effective biological, silvicultural or direct methods of control. Plans are to continue the biological and ecological studies, to continue evaluation of infestations, and to investigate prescribed silvicultural control methods of the collar weevil.

Two projects are associated with this problem.

A 237*: Annual Forest Insect Survey - H. A. Tripp.

A 244 : Biology and Control of Warren's Collar Weevil - H. F. Cerezke.

* Project statement appears under Problem-Detection and Estimation of Tree Pest Damage.

Project No.: A 244.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February 19, 1969.

2. Title : Biology and control of Warren's collar weevil.

3. Investigator : H. F. Cerezke.

4. Year of Commencement: 1960.

5. Anticipated Year of Completion: Original 1968. Revision I 1980.

6. Key Words not in Title: Hylobius warreni, sampling, dispersal, Pinus contorta, regeneration, growth reduction, traumatic ducts, B19.

7. Activity : Entomology.

8. Problem Area Program: Reduction of losses from root-inhabiting insects.

9. Establishment Project No.: A 244 Branch Project No.: A 244

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.6 Other 0.2

12. Co-operating Agencies: Alberta Forest Service, North Western Pulp & Power.

13. Location of Work : Alberta foothills; Calgary Laboratory.

14. Abbreviated Background Statement: Warren's collar weevil attacks pines and spruces throughout the Boreal Forest Region of Canada. In Alberta lodgepole pine is the primary host. Larvae feed in the sub-cortical tissue of root and root collar regions of healthy trees, causing large open wounds and resinosis. Trees of nearly all age classes are susceptible. They may be killed directly from girdling, suffer accumulative growth loss from repeated attack or be exposed, through larval wounds, to root and stem diseases.

Ecological, behavioral and damage appraisal survey studies of H. warreni have progressed to the stage where the status of this pest can be viewed in perspective with regional management plans of lodgepole pine in Alberta. Additional information is now required on the behaviour of the insects within stands subjected to various treatments. Pilot control studies will be implemented when sufficient information is at hand. Remaining unfulfilled objectives within this study are as follows:

(a) Determine the time of initial invasion of the weevil in pine stands subjected to various treatments, and to describe their subsequent pattern of spread as it relates to tree mortality.

(b) Formulate recommendations for weevil control in problem areas.

15. Summary of Progress up to One Year Ago: The geographical distribution of *H. warreni* in Alberta has been described. Populations of the weevil were measured in a variety of untreated pine stands. Weevil abundance has been related to stand age, density, altitude, tree size, duff thickness, clearcutting practices and general site conditions of naturally stocked stands. The behavior, life activities and the sequential timing of these activities in the adult stage have been described. Mortality factors associated with all stages are largely known, as are the effects of larval feeding upon tree wounding and growth. A survey sampling technique was developed for estimating weevil abundance and damage, and was tested in the Alberta foothills. Study plots were established to determine weevil immigration into regeneration and to follow their subsequent attack behavior. Other plots are established to examine the effects of pre-commercial thinning upon population change and tree mortality.

16. Goals Set One Year Ago:

(a) Complete field studies of adult longevity and egg laying patterns.

(b) Complete a survey of *H. warreni* abundance and damage in the Lower Foothills.

(c) Complete final draft of Ph.D. thesis on *H. warreni* and other related papers.

17. Accomplishments in Last Year: Goals (a), (b) and the first part of (c) were completed, and a first draft of one of the short papers was prepared. Cerezke, H. F. The distribution and abundance of the root weevil *Hylobius warreni* wood in relation to lodgepole pine stand conditions in Alberta. Ph.D. thesis submitted to the University of British Columbia, December, 1968.

18. Goals for Next Year: Establish sample plots in clearcut sites, thinned stands and in fertilized stands, where available, at several locations in the Alberta foothills. Gather weevil population and tree data within these plot areas and in those experimental plots established earlier in regeneration pine. Re-examinations of these plots will be required every second year for a period of up to 15 years to satisfy objectives (a) and (b). Prepare the following reports and papers:

Cerezke, H. F. A survey sampling method for the root weevil *Hylobius warreni* wood in lodgepole pine. Proposed journal.

Cerezke, H. F. Silvicultural control of *H. warreni* in the foothills region of Alberta. Departmental.

Cerezke, H. F. Some weevil wounding effects upon resin duct numbers in young lodgepole pine. Proposed journal publication.

Cerezke, H. F. and B. Rowswell. Summary report of survey damage appraisal studies of H. warreni. Proposed Information Report.

Cerezke, H. F. Distribution patterns of the root weevil in lodgepole pine stands of Alberta. Proposed Journal Publication.

H. F. Cerezke

H. F. Cerezke,
Investigator.

PROBLEM AREA PROGRAM

<u>Reduction of Losses from Wood Borers</u>

Wood borer attack in decked or stored logs, firekilled timber, and blowdown is potentially a large timber volume and lumber degrade factor. Investigation was prompted in 1967 by enquiries by the industry and Provincial Government agencies regarding preventive measures to be taken against wood borer attack. Preliminary studies in the insect survey phase have produced some initial results in terms of sampling procedures and the taxonomy of wood borers. Concomitant with the entomological investigations are sawmill utilization studies to measure the degrade loss factor and assess the monetary loss attributable to wood borer damage. These studies will provide the necessary information required to assess the current situation and define problems requiring further research. At the moment one project is associated with this problem.

A 271 : Biology, impact and control of woodborers in Alberta - A. J. Raske and T. Szabo.

Project No. A 271

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Biology, impact and control of wood borers in Alberta.

3. Investigators : A. G. Raske, T. Szabo.

4. Year of Commencement: 1967.

5. Anticipated Year of Completion: Continuous.

6. Key Words not in Title: Cerambycidae, Monochamus, Tetropium, Oberea, Sequential Sampling, Hybridization.

7. Activities : Forest Insect and Disease Survey and Forest Products.

8. Problem Area Program: Reduction of losses from woodborers.

9. Establishment Project No.: A 271 Branch Project No. A 271

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 1 Other 1.5

12. Co-operating Agencies: Alberta Forest Service; Alberta Forest Products Association; Swanson Lumber, Edmonton; Insect Pathology Research Institute, Sault Ste. Marie; Forest Products Laboratory, Vancouver.

13. Location of Work : Kananaskis Forest Experimental Station; Southern and central Alberta.

14. Abbreviated Background Statement: The investigation was prompted by enquiries regarding preventative measures to be taken against wood borers in decked or stored logs. Preliminary field observations at logging sites, in burned forests and areas of windfall show considerable variation in the intensity of woodborer attack. Although variations may be partially explained on the basis of geographical distribution of the various species of woodborers it is more likely that attack is largely dependent upon the relationship of seasonal history of woodborers with the timing of harvest, burn, or blowdown. Prerequisite to seasonal history studies is the necessity for taxonomic work, particularly on the immature stages.

In addition to the entomological aspects of the project, an assessment of the monetary loss is required before realistic control or preventative measures may be recommended. This phase of the work is to be conducted by Mr. T. Szabo of the forest products research section.

15. Summary of Progress up to One Year Ago: A total of over 200 pine and spruce were cut near Whitecourt and Crowsnest Pass during March, June, July, September and December, -- and near Lac La Biche during July, September and December.

To develop a sampling system about 120 decked logs (mostly pine) from Rocky Mountain House and about 30 from Faust were sampled intensively.

The biology of the long-horned woodborer Tetropium velutinum was studied.

A cerambycid flower host list was started and will be expanded.

Insects found under the bark were collected and identified for the purpose of preparing an identification manual for the field staff.

16. Goals Set One Year Ago: Complete the cutting of logs in the Lac La Biche area and continue the selection and sampling of burn and blowdown areas.

Logs cut in Whitecourt, Crowsnest Pass and Lac La Biche and which have been exposed to attack for two seasons to be sampled.

Data from the intensive sampling to be analyzed to develop the sampling systems. Biological data obtained during the course of this sampling to be analyzed and the results prepared for publication.

17. Accomplishments in Last Year: The remainder of the sample logs, about 100, pine and spruce, were cut near Whitecourt, Crowsnest Pass, and Lac La Biche in March and June. Sampling and milling of these logs were postponed because of the absence of Mr. Szabo.

A sequential sampling system for woodborers has been developed from distribution data gathered in 1967 and 1968.

The biology of the long-horned woodborer Oberea schaumii in aspen was studied and the occurrence of at least three other unidentifiable species noted.

The cerambycid flower host list was dropped, as it contributed little to the objective.

Additional insects were collected and photographed for an identification manual for the field staff.

Hybridization experiments were carried out with two closely related long-horned woodborers (*Monochamus oregonensis* x *M. scutellatus*) and with the assistance of G. Lanier, Entomology research, chromosome studies were initiated.

A larval rearing program of woodborers was initiated in conjunction with Dr. Gardiner, from Sault Ste. Marie.

With assistance from Mr. R. A. Blauel, Insect and Disease Survey, a study was initiated to identify the fungi that are associated with woodborer species.

The recent large forest fires in central Alberta gave an opportunity to test the dispersal powers of woodborers. Twenty-four traps were set up traversing the fires.

Preliminary chemical tests to control woodborers were made with PDB (para-dichloro benzene); 18 decks were set up, approximately 20 cu. ft. each, and treated with various dosages of the fumigant.

18. Goals for Next Year: Logs cut in the Crowsnest Pass, Whitecourt and Lac La Biche areas, and which have been exposed for 2 to 3 seasons, will be sampled, then taken to a mill and their products graded.

Hybridization of *Monochamus* species will be continued and expanded, so that Alberta species can be identified. G. Lanier will assist with the chromosome studies.

Chemical control experiments will be continued. Preliminary test will be carried out with a liquid form of PDB. Large commercial log decks will be treated and the treatment evaluated. If possible a railroad box car with woodborer infested lumber will be fumigated with PDB. R. B. Blauel will assist in determining the effect of treatment on fungi.

The sequential sampling system recently developed will be tested and applied. Data on the distribution of *Monochamus* in spruce will be collected and the sampling system adapted to this host of *Monochamus*. Similar data will be collected to develop a sequential sampling system for *Tetropium* in spruce.

Adult woodborers will be captured and eggs obtained from them for larval rearings to establish species identity. Dr. Gardiner, from Sault Ste. Marie, is expected to again be associated with this aspect of the project.

Studies of woodborers in aspen will be continued to determine identity and biology of aspen borers.

Collection of insect found under bark will be continued and immature Diptera will be emphasized.

Proposed Publications:

(1) Raske, A. G., Distribution of woodborer larvae in decked pine logs. Journal publication.

(2) Raske, A. G. and L. Safranyik, A sequential sampling system for woodborers in decked logs. Journal publication.

(3) Raske, A. G., Notes on the biology of *Tetropium parvulum* in spruce. Departmental research notes.

(4) Raske, A. G., Notes on the biology of *Oberea schaumii*. Departmental research notes.

(5) Raske, A. G., Fumigating conifer logs with PDB to control woodborers. Journal of Economic Entomology - Scientific notes.

(6) Raske, A. G. and B. M. Dahl, An annotated list and field key to the insect families commonly found under bark. Departmental information report.

(7) Raske, A. G., Monetary loss in lumber caused by *Monochamus*. Departmental Internal Report.

A. G. Raske,
Investigator.

T. Szabo,
Investigator.

PROBLEM AREA PROGRAM

Reduction of Losses from Bark Diseases

Considerable research effort is being expended on bark diseases and the need for further work is clear. This form of disease is particularly damaging in terms of tree mortality, sub-standard growth and degradation of wood quality. Bark diseases are particularly important because the damage occurs after major costs have been incurred in establishing and protecting young stands. Currently the most damaging disease in this category is Atropellis canker of lodgepole pine. Research on this canker disease in Alberta commenced in 1957 and has been successful in determining and evaluating the biology and epidemiology and the development of silvicultural control to prevent recurrences of the serious conditions that obtain today in many parts of the Region. Other bark diseases are being handled on a disease survey basis, but certain forest tree rusts have reached the stage of detailed research investigation.

Research and surveys now oriented to the bark disease problem includes the following projects:

A 217*: Forest Disease Survey - R. A. Blauel.

A 221 : Biology and control of Atropellis canker of lodgepole pine - J. C. Hopkins.

A 236 : Aerobiology of Comandra blister rust *Cronartium comandrae* - J. M. Powell.

A 254 : Forest tree rusts of western North America - Y. Hiratsuka.

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* Project statement appears under Problem-Detection Estimation of Tree Pest Damage.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Biology and control of Atropellis canker of lodgepole pine

3. Investigator : J. C. Hopkins

4. Year of Commencement : 1957 (previously CP-7)

5. Anticipated Year of Completion: Original - 1968 Revision I - 1969

6. Key Words not in Title: Atropellis phiniphila, Pinus contorta, water movement, resinosis, resistance, B 19, SA 1.

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from bark diseases

9. Establishment Project No. A221 Branch Project No. A221

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 1 Other - 1.6

12. Cooperating Agencies : Alberta Department of Lands and Forests; North Western Pulp and Power Company, Hinton, Alberta.

13. Location of Work : Kananaskis Forest Experiment Station and other areas in Alberta where the disease occurs notably Clearwater and Nordegg.

14. Abbreviated Background Statement: Investigation commenced after the Forest Insect and Disease Survey reported extensive damage by the canker now known to be caused by Atropellis piniphila (Weir) Lohman and Cash. Studies were undertaken to determine the precise nature of the damage to the host, the cause, and, by means of epidemiological and biological studies of the causal agent and its host relationships, to devise control procedures. Subsequent studies have shown the pathogen to be widespread throughout the range of the host in Alberta and to be responsible for much damage, particularly in the main areas of forest utilization. The pathogen is also widespread on lodgepole pine in British Columbia and has been reported from many locations in western North America as far south as New Mexico.

15. Summary of Progress up to One Year Ago: Research on Atropellis canker in Alberta has been successful in achieving the main objectives set forth originally although some gaps in our knowledge remain. Inoculations established Atropellis piniphila as the causal organism. The range of morphological characteristics

exhibited by many isolates in the field and in culture were established. The nutritional requirements in culture were also determined. Many attempts to induce fruiting in culture were unsuccessful although conidia are readily produced. Evidence from several sources supports the hypothesis of conidia functioning as spermatia. Inoculum apparently consists solely of ascospores which are produced from spring to fall and released during wet weather before being air-disseminated.

The sequence of symptom formation and rates of canker development were established together with the histological processes of pathogen-host interaction. In canker regions the abnormally thin annual rings containing large proportions of parenchymatous cells and short thin-walled tracheids, together with blue-stain, reduces pulp fibre quality although the greatest degradation results from the resinosis which prevents debarking. Large cankers render trees unmerchantable as lumber. In some areas multiple stem cankers are common and as many as eighty have been found on a single tree. Mortality can occur but only frequently in suppressed trees. Dye studies have shown the effect of cankers on routes of water transport.

Epidemiological studies have established different patterns of development in southern and central regions which are believed to be related to fire history, stand densities and summer rainfall. In southern areas the disease reaches high incidences only in dense stands where it tends to form pockets. In central and northern regions high incidences occur over large areas in moderately to lightly stocked stands. Resistance within mature trees occurs in a few of the vigorous dominants. It is not known if this resistance shares a common mechanism with the resistance exhibited by all regeneration less than ten years old. Silvicultural controls have been devised from the biological and epidemiological information and are based largely on inoculum manipulation.

16. <u>Goals Set One Year Ago</u> : (1) To study the process of host penetration by ascospore germ tubes; (2) to study the response of hyphae to resin and (3) to study the history of an epidemic within a mixed stand of lodgepole pine and spruce.

17. <u>Accomplishments in Last Year</u>: Ascospores germinated and developed very long germ tubes on moist sterile bark surfaces, indicating no serious toxic residues occurred. But no bark penetration could be detected. Spores beneath resin germinated normally but subsequent germ tube development was abnormal although growth occurred. Sampling to determine the history of an epidemic within a mixed stand of spruce and pine was carried out and the results are being analyzed. An internal report, "Atropellis canker in Alberta: silvicultural control and its biological basis" is being prepared.

18. <u>Goals for Next Year</u> : It is intended to concentrate on completing publications.

Proposed reports and publications:

(1) Hopkins, J. C. Atropellis canker of lodgepole pine: Interruption of water translocation. Proposed Canadian Journal of Botany publication.

(2) Hopkins, J. C. Atropellis canker of lodgepole pine: Histology of canker development. Proposed Canadian Journal of Botany publication

(3) Hopkins, J. C. Atropellis canker of lodgepole pine: Resistance. Proposed Canadian Journal of Botany publication

(4) Hopkins, J. C. Topic concerns an analysis of several infection patterns. Title and journal are undecided.

John C Hopkins
J. C. Hopkins
Investigator

Project No. A 236

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Aerobiology of Comandra blister rust, *Cronartium* comandrae

3. Investigator : J. M. Powell

4. Year of Commencement : 1964

5. Anticipated Year of Completion: Original 1969 Revision I 1971

6. Key Words not in Title: *Pinus*, --Spore dispersal, germination, viability, microflora, fauna, climate, SA 1, B19.

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from bark diseases.

9. Establishment Project No. A236 Branch Project No. A236

10. Status : Active

11. Man-years Utilized in Past Year: Professional 1 Other 1.2

12. Cooperating Agency : None

13. Location of Work : Calgary, Kananaskis Forest Experiment Station, in forested regions of Alberta and National Parks.

14. Abbreviated Background Statement: The rust is a disease of hard pines in North America and attacks *Pinus banksiana*, *P. contorta*, *P. ponderosa* and *P. sylvestris* in Western Canada. The distribution of the rust is not continuous, apparently restricted by the ecological requirements of its alternate hosts, *Comandra* and *Geocaulon*. Although the damage of the rust is not spectacular, the infection may be heavy in trees of all ages and cause mortality by basal or stem girdling. It has recently become a plantation problem in south and southeastern United States and mature stands of lodgepole pine in western United States have been reported with 50 to 98 percent of the trees infected.

The life cycle of this heteroecious rust is similar to that of the white pine blister rust, although the exact environmental conditions necessary for the completion of each state of the life cycle are little known. Important information is lacking on influence of climatic factors upon spread and intensification of aerial borne pathogens. This rust, which has an easily recognizable aeciospore stage was chosen as a suitable organism for studies on those relations. Interim objectives are as follows:

(a) Determine the duration of aeciospore production and factors affecting their release, transport, dispersal and deposition;

(b) Determine the environmental factors affecting aeciospore germination and viability;
(c) Determine the effect of the associated microflora and fauna.

15. Summary of Progress up to One Year Ago: Aeciospore production and duration was followed for four years in a number of locations, including production in two years from individual aecia and aecial pustules. Aecial production was limited by the activity of other fungi, insects and rodents. Fifty-five fungi and bacteria were identified as associated with the rust canker or spores; of these *Tuberculina maxima* and *Cladosporium* sp. are important in reducing the inoculum available. Eighty species of mites and insects were collected in association with the rust. Of these *Epuraea obliquus*, *Paracacoxenus guttatus* and an unidentified Cecidomyiidae, play an important role, and information on their biology was obtained. Annual observations were made on the incidence of rodent, insect and microfloral organisms on 500 cankers at 20 locations, as well as observations on the growth and status of the cankers.

Seasonal and diurnal spore release data were collected during four years, and related to weather. Data were collected on the distance of spore dispersal from natural and experimental sources, and on the rate of spore fall in still air. Spore germination tests were made daily during the spore production period in three years. The temperature, humidity, light and pH requirements for spore germination were established. Different media were evaluated as spore germination substrates. The cytology of the aeciospores and aeciospore germ tubes were described. Inoculations were successful with aeciospores on *Comandra*, very poor on *Geocaulon*, and negative results were achieved on pine. Information was obtained on the build-up of uredial and telial infection on eight *Comandra* plots.

Papers were published on the development of a modified 24-hour spore collector, on a cage for collecting insects from cankers, and the first report of the rust on *P. sylvestris*, and of the hyperparasite *Tuberculina maxima* on *C. comandrae* and other pine stem rusts in Alberta.

16. Goals Set One Year Ago: Complete the requirements for a Ph. D. thesis and prepare manuscripts on a number of aspects of the project. Further limited laboratory tests and field observations and collections were made to round out earlier work.

17. Accomplishments in Last Year: A manuscript of the thesis entitled: "The aerobiology of the aecial state of the comandra blister rust, *Cronartium comandrae* Peck, in Alberta" was completed and approved by the thesis committee. Additional data were collected on distance of spore dispersal and dispersal around a natural source and germination. Measurements and observations were continued on growth rates, damage,and the incidence of associated organisms. One hundred and seventeen species of associated mites and insects have been identified,and sixty-four species of fungi, bacteria and yeasts. A draft of a paper has been prepared on the cytology of the aeciospores and aeciospore germ tubes of *C. comandrae* and *C. comptoniae* with Y. Hiratsuka (Project No. A 254).

18. Goals for Next Year : The thesis requirements will be completed. Attempts

will be made to obtain additional data on distance of aeciospore dispersal, infection and phenology of the various states of the rust: Measurements of growth rates, mortality and incidence of associated fungi, insects and rodent damage will be continued.

The following publications will be prepared:

Powell, J. M. The aerobiology of the aecial state of the comandra blister rust, *Cronartium comandrae* Peck, in Alberta. Ph. D. thesis University of British Columbia.

Powell, J. M., P. J. Maruyama and Y. Hiratsuka. Cytology of the aeciospores and aeciospore germ tubes of *Cronartium comandrae* and *C. comptoniae*. Proposed journal publication.

Powell, J. M. Environmental factors affecting germination of *Cronartium comandrae* aeciospores. Proposed journal publication.

Powell, J. M. Meteorological factors affecting the viability of *Cronartium comandrae* aeciospores. Proposed journal publication.

Powell, J. M. Daily and seasonal dispersal of aeciospores of *Cronartium comandrae*. Proposed journal publication.

J. M. Powell

J. M. Powell
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Forest tree rusts of western North America

3. Investigator : Y. Hiratsuka

4. Year of Commencement: Projects A 232 (1961) and A 254 (1965) were combined and re-designed in 1968.

5. Anticipated Year of Completion: Original - indefinite; Revision I - 1978

6. Key Words not in Title: Uredinales, Cronartium, Pucciniastrum, Peridermium, Melampsora, Chrysomyxa, taxonomy, cytology.

7. Activity : Forest Insect and Disease Survey

8. Problem Area Program: Reduction of losses from bark diseases.

9. Establishment Project No. A 254 Branch Project No. A 254

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0.7 Other - 0.8

12. Cooperating Agency : None

13. Location of Work : Calgary (laboratory and mycological herbarium); Kananaskis Forest Experiment Station; western North America with particular emphasis in Alberta Rocky Mountain Parks; the North West Territories and Yukon Territory.

14. Abbreviated Background Statement: Rust fungi are known to attack vigorously growing plants rather than weakened ones because of their obligate parasitism. Also, damage caused by this group of fungi tend to be intensified by concentrated cultural practices as evidenced by white pine blister rust, wheat stem rust, coffee rust, corn leaf rust, etc.

An estimate of the losses in the region has not been obtained, although damages from several pathogens have been recognized. In addition, certain rust species endemic to western North America have been recognized as serious pathogens in other regions where forestry practices are more intensive.

Since our knowledge of forest tree rusts of western North America is inadequate, basic mycological studies including morphology, taxonomy, cytology and life history studies are required to obtain a comprehensive knowledge of this group of fungi.

Results from this project will give useful information and sound basis to the survey, damage appraisal, and control of diseases caused by rust fungi in our region.

15. Summary of Progress up to One Year Ago: I. Pine stem rusts -

(1) Comparative studies of the nuclear phenomena of the aeciospores and germinating aeciospores of P. harknessii and P. stalactiforme have been completed and published. Further nuclear studies have been carried out with the aeciospore of P. harknessii material from other regions and preliminary nuclear studies of other North American stem rusts have been done.

(2) Studies on temperature and pH requirements for an orange and white spored aeciospore germination of P. harknessii and P. stalactiforme have been completed and published.

(3) White spored P. stalactiforme was discovered in 1960 in a small area in Banff National Park and annual observations were commenced in 1963. Occurrence of this form and the results of the annual observations of canker growth and tree mortality up to 1965 were published in 1966. Annual surveys of the white spored form and the typical yellow spored form in the area were continued.

(4) A study trip to northern Europe (Norway, Sweden, Netherlands, Scotland) was conducted during May and June of 1967 to study germ tube cytology of host alternating and pine-to-pine races or Cronartium flaccidum (Peridermium pini). About 300 fixed slides of germinating spores have been prepared and brought back for further cytological studies. Differences of germ tube morphology between the two races are obvious and significant cytological differences as were found in Cronartium coleosporioides complex in North America are expected. Slides have been stained and microscopical observations have been made.

(5) Study of aeciospore germ tubes of a pine gall rust from Quebec and New Brunswick showed clearly that they are the same as those of western gall rust (Peridermium harknessii). Together with reports from Saskatchewan, Manitoba, Ontario and Wisconsin, transcontinental distribution of P. harknessii is suggested.

(6) Study of aeciospore germ tubes of Peridermium ephedrae from New Mexico indicated an unusual nuclear cycle and a note has been published.

II. Abies and Picea needle rusts -

(1) Pucciniastrum vaccinii complex: Inoculation experiments and preliminary morphological comparisons have been completed.

(2) Yelloe-spored Peridermia on Abies: Morphological comparisons and literature survey have been completed and compilation of results for publication has been started.

(3) Spruce needle rusts: Several inoculation experiments have been done. Inoculation of Pucciniastrum sparsum from Arctostaphylos rubra to Picea glauca was successful. This presents the first record of this rust on Picea in North America.

16. Goals Set One Year Ago : (1) Complete the cytological study of host alternating and pine-to-pine races

of Cronartium flaccidum (Peridermium pini). (2) Complete the germ tube study of P. harknessii from eastern Canada. (3) Continue inoculation experiments, morphological studies and taxonomic treatments of several conifer needle rusts. (4) Continue survey of white spored P. stalactiforme.

17. Accomplishments in Last Year: (1)Comparative cytological studies of european pine-to-pine stem rust, Peridermium pine and western gall rust, P. harknessii have been completed and the results were published.

(2) Occurrence of P. harknessii in eastern Canada was proven from the morphology and cytology of the aeciospore germ tubes.

(3) Significant progress was made on inoculation experiments, morphological studies and taxonomic treatments of several conifer needle rusts.

(4) Annual survey of white spored P. stalactiforme was made.

Publications:

Hiratsuka, Y. and P. J. Maruyama. 1968. Identification of Peridermium harknessii in eastern Canada on the basis of nuclear condition of aeciospore germ tube. Pl. Dis. Reptr. 52: 650-651

Hiratsuka, Y. 1968. Morphology and cytology of aeciospores and aeciospore germ tubes of host-alternating and pine-to-pine races of Cronartium flaccidum in northern Europe. Canadian Journal of Botany 46: 1119-1122.

Reports:

Hiratsuka, Y. and J. M. Powell. Cytology of pine stem rusts from Canada and northern Europe. Canadian Botanical Association at Lakehead University, Fort William, Ontario. June 1968.

18. Goals for Next Year : (1) Complete taxonomic revision of autoecious pine stem rusts including the proposal of a new genus Endocronartium. (2) Continue detailed cytological study of Peridermium pini and P. harknessii and other pine stem rusts. (3) Complete the taxonomic and life history studies of Pucciniastrum sparsum and P. goeppertianum. (4) Start the survey and basic study of Cronartium ribicola in the region. (5) Continue survey of white-spored P. stalactiforme in Banff National Park. (6) Continue inoculation experiments and morphological studies of several conifer needle rusts.

Proposed publications:

Hiratsuka, Y. A new genus Endocronartium for autoecious pine stem rusts (proposed for Canadian Journal of Botany).

Hiratsuka, Y. and L. E. McArthur. Life history and occurrence of Pucciniastrum sparsum in western Canada. (proposed for Canadian Journal of Botany).

Powell, J. M., P. J. Maruyama and Y. Hiratsuka. Cytology of the aeciospores and aeciospore germ tubes of Cronartium comandrae and C. comptoniae (proposed for Canadian Journal of Botany).

Hiratsuka, Y. Taxonomy, morphology and life history of Pucciniastrum goeppertianum complex. (proposed for Canadian Journal of Botany).

Proposed report:

Hiratsuka, Y. and J. M. Powell. Cytology and taxonomy of autoecious pine stem rusts. International Botanical Congress at University of Washington, Seattle, August 1969.

Y. Hiratsuka
Investigator

PROBLEM AREA PROGRAM

Reduction of Losses from Root Diseases.

Root diseases are potentially highly destructive and at the same time they are difficult to investigate effectively because of the many contributing factors that lead to root problems. Present known losses in the Region are mainly from Armillaria mellea in lodgepole pine. The losses have been made more meaningful as results of disease surveys of newly established pure pine stands in areas that formerly supported mixed conifers and intolerant hardwoods. Indications are that the disease is equally operative in trees of all vigour classes and in trees of economic size. Work to date has included general and permanent plot observations together with direct root excavations and chemical control studies. Research will be continued to determine the long-term behaviour of the disease in natural stands and the effects of site, stand conditions, and other infectious and non-infectious agents as possible predisposing factors.

In an endeavour to point the way to intensive nursery management for increased production of high quality coniferous seedlings a basic research program for forest root diseases was started in 1968 at the Edmonton Laboratory. Emphasis is being given to the reactions of the root to attack by micro-organisms as a basic approach to disease control in seedling production.

Projects associated with the root disease problem include:

A 217*: Forest disease survey - R. A. Blauel
A 284*: Armillaria mellea, stem rusts and other destructive agencies in young lodgepole pine stands - J. A. Baranyay
A 285 : Physiology of reactions of roots of tree seedlings to fungal attack - D. Hocking.

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* Project statement appears under Problem-Detection and Estimation of Tree Pest Damage.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969
2. Title : Physiology of reactions of roots of tree seedlings to fungal attack.
3. Investigator : D. Hocking
4. Year of Commencement : 1968
5. Anticipated Year of Completion: Original - 1973
6. Key Words not in Title : resistance, rhizosphere
7. Activity : Pathology
8. Problem Area Program : Reduction of losses from root diseases
9. Establishment Project No. A 285 Branch Project No. A 285
10. Status : Active
11. Man-years Utilized in Past Year: Professional - 10 Other - .25
12. Cooperating Agency : None
13. Location of Work : Edmonton
14. Abbreviated Background Statement: Fungal root diseases are the major cause of mortality among coniferous seedlings in the nursery. There has been a great deal of work on control of such diseases, especially by chemical methods (Vaartaja 1964). Such methods give characteristically irregular results. For progress to be made, it is desirable that greater attention be given to more basic studies.

    Considerable research is underway on general ecology of soil fungi (Parkinson and Waid 1960), on ecology of soil plant pathogens (Baker & Snyder 1965), on rhizosphere fungi (Maliszewska and Moreau 1960), and on mycorrhizae (Harley, 1959; Slankis 1967). Studies of the root-fungus relationships in the disease condition generally are lacking among coniferous species. A direct knowledge of the reactions of the root to attack by micro-organisms could lead to a radically different approach to seedling production, especially in disease control.
15. Summary of Progress up to One Year Ago: Literature review completed.
16. Goals Set One Year Ago : Culture seedlings; isolate pathogens; begin histology and biochemistry studies.
17. Accomplishments in Last Year: Excised roots of lodgepole pine have been maintained in axenic culture for one year,

with three transfers in defined chemical medium. However, growth has been very slow. Axenic intact seedlings have been rapidly grown on defined mineral salts on perlite. Potentially pathogenic fungi have been isolated from diseased seedlings ex nursery beds.

18. Goals for Next Year : Initiate axenic culture of roots and intact seedlings of several other host species, especially white spruce. Study reactions in bi-xenic cultures of several host-fungus pairs, with a principal objective of selecting a suitable system for intensive research. Complete histology of the infection process in simple situations. Begin study of biochemistry of root reaction to attack, in collaboration with other researchers.

D Hocking

D. Hocking
Investigator

PROBLEM AREA PROGRAM

Reduction of Losses from Wood Decay

Wood decay and stain in standing trees are the largest timber volume and degrade loss factors in the Region today and they are likely to remain so until preventive measures are introduced into forestry practice on a greater scale than at the present time. Research in the problem area has advanced to where techniques for estimating decay and stain in standing trees and for identifying the causal agents are well known. The usefulness of this information to forest managers is limited, however, by the necessity to adapt it to local situations. This needs to be done through applied research including estimation of cull in given circumstances and determinations of the utility of defective wood through residue utilization studies. Emphasis on the biological side of decay research is in the infection process and to determine the relative susceptibilities of different tissues to fungal establishment. This basic information is necessary for progress to be made in understanding the consequences of wounds and the prevention of decay and stains. One project is related to this problem:

A 228 : Fungal decay in trees in Alberta - A. A. Loman.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Fungal de:ay in trees in Alberta

3. Investigator : A. A. Loman

4. Year of Commencement : 1965

5. Anticipated Year of Completion: Original - 1969 Revision - continuing

6. Key Words not in Title: White spruce, lodgepole pine, phenolics, heartwood extractives, fungitoxic, resistance, metabolism, enzymes.

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from wood decay

9. Establishment Project No.: A 228 Branch Project No. A 228

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 1 Other - 1.3

12. Co-operating Agency : None

13. Location of Work : Selected merchantable forest stands in Alberta; Calgary Laboratory.

14. Abbreviated Background Statement: The amount of annual volume losses owing to decay and stain in merchantable tree species in Alberta warrants continuing research in special problem areas.

The project incorporates all previous investigations concerned with decay and stains of coniferous tree species in Alberta and provides a vehicle for decay studies in the Alberta/NWT/ Yukon Region. A series of short term studies will be undertaken to elucidate important aspects of fungus infection, establishment, development and inoculum production. Host response to fungus activity, substrate effect on fungus development and fungus effect on the components of the substrate are important aspects of these studies.

Earlier cull surveys and intensive studies of the fungal florae in boreal white spruce and lodgepole pine provide a sound basis for in-depth investigations of the decay processes in these two species. It is hoped that a detailed understanding first of the critical biochemical variables influencing entry and establishment of major decay-producing organisms will permit improved appraisal of decay problems and assist in formulating practical controls.

15. Summary of Progress up to One Year Ago: The current short term study

which commenced in 1965 and is nearing completion is based on the observation that the fungal flora of lodgepole pine is most variable and densest in heartwood tissues which are also richest in fungitoxic substances. The hypothesis was that the predominating lodgepole pine heartwood inhabiting fungi possess enzyme systems capable of catalyzing the transformation of the heartwood phenolic substances.

Results up to a year ago indicated that all laccase producing white-rot fungi tested were capable of detoxifying heartwood phenolic extractives; the non-laccase producing brown-rot fungus Coniophora puteana was capable to a much lesser degree. These results indicated that the toxicity concept of pinosylvin and pinosylvinmonomethyl ether had to be re-examined.

16. Goals Set One Year Ago : (1) Completion of the following four objectives:

(a) To describe the effect of pure fungal cultures on the relative concentrations and molecular structures of the heartwood phenolic extractives in lodgepole pine heartwood meal.

(b) To determine the effect of aerial oxidation on the phenol extractives and its significance in relation to objective (a).

(c) To determine the significance of the fungal succession in lodgepole pine heartwood on the final establishment of Fomes pini through the mechanism which may be revealed by pursuing objectives (a) and (b).

(d) To test the hypothesis that red stain associated with Peniophora pseudo-pini is indicative of the removal of fungitoxic phenolic compounds and hence may function as an indicator of future susceptibility to infection and establishment of the decay fungus Fomes pini.

(2) Initiate experiment to elucidate the biosynthesis of the stilbenes and flavanones in lodgepole pine tracheids.

(3) Attempt to work out a procedure for the synthesis of pinosylvin.

17. Accomplishments in Last Year: Objectives (1a) to (1d) were completed and results were presented to the graduate school of Washington State University in July, 1968, in the form of a Ph. D. thesis entitled: "The effect of some common heartwood-inhabiting fungi of Pinus contorta var. latifolia on pinosylvin, pinosylvinmonomethyl ether, pinobanksin and pinocembrin".

Objective (2) was not carried beyond a

literature review of the theory and the techniques of extraction, separation, purification and identification of precursors to lignin.

Objective (3) was fulfilled with partial success. Although pinosylvin was obtained, yields were low and difficulties were encountered in removing side products.

Early results of experiments involving the use of infrared spectroscopy for the identification of cultures of wood inhabiting fungi were promising. Experimental work is continuing.

18. Goals for Next Year : 1. Publication of parts of the Ph. D. thesis - Loman, A. A. The effect of heartwood fungi of *Pinus contorta* var *latifolia* on pinosylvin, pinosylvinmonomethyl ether, pinobanksin and pinocembrin. Proposed journal publication.

2. Continue the experiment to elucidate the biosynthesis of the flavanones and stilbenes.

3. Continue to develop a satisfactory procedure for the synthesis of pinosylvin.

4. Continue the experimental work with infrared spectroscopy as a tool for the identification of cultures of wood-inhabiting fungi.

A. A. Loman

A. A. Loman
Investigator

PROBLEM AREA PROGRAM

Reduction of Pest Losses to Cones and Seed

For many years studies on cone and seed pests affecting pine and spruce have been carried out by Insect and Disease Survey. These studies have principally been to define the causes and extent of damage in spruce and pine forests. For lack of staff and other urgent entomological and pathological problems no regular research is being done in cone and seed pests. Research needs are recognized, however, relative to the important requirement by forest management to supply adequate amounts of high quality coniferous tree seed for a rapidly expanding program of nursery production. At the moment the survey projects concerned with this problem are:

A 217*: Forest Disease Survey - R. A. Blauel

A 237*: Annual Forest Insect Survey - H. A. Tripp

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* Project Statement appears under Problem - "Detection and Estimation of Tree Pest Damage".

PROBLEM AREA PROGRAM

Reduction of Losses from Dwarf Mistletoes

Dwarf mistletoe attack on lodgepole pine and jack pine forests presents a complex problem. The principal agent is the species Arceuthobium americanum although there are several other mistletoes in Alberta. Infections occur in young pine regeneration and will persist for the life of the stand. Losses are owing to mortality, reduced tree growth and reduced wood quality. It is estimated that the annual volume drain from dwarf mistletoe amounts to approximately 9 million cubic feet in lodgepole pine alone.

Studies of dwarf mistletoe commenced in 1952 with detection surveys for mistletoe damage. Between 1960 and 1962 objectives were expanded to include the definition of the kinds and amounts of mistletoe damage in various forest conditions; the development of aerial photo techniques for improved detection and hazard appraisal; and comprehensive biological studies of reproduction and parasitism by dwarf mistletoe. The ultimate aim is to gather all the necessary information about the behaviour and nature of the disease and its relationship with the host species which will facilitate proper control by silvicultural or other means.

To further the last goal, silvicultural control trials were initiated in 1967 to test the effect of different thinning methods and degrees of dwarf mistletoe eradication. These trials are co-ordinated with, and are replicates of, silvicultural control studies being carried out by the U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station.

The work of documenting the incidence and degree of damage is now mainly completed. The biological aspects of research are being expanded. Silvicultural control and possibly other direct control methods will continue to be studied and improved as more experience is gained in the various facets of the program.

The projects associated with the dwarf mistletoe problem include:

A 217*: Forest disease survey - R. A. Blauel

A 231 : Dwarf mistletoe and its effect on growth and mortality in lodgepole pine stands of Alberta - J. A. Baranyay.

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* Project statement appears under Problem - "Detection and Estimation of Tree Pest Damage".

A 235 : Use of aerial photography in detecting dwarf mistletoe infected lodgepole pine stands - J. A. Baranyay.

A 243 : Factors influencing introduction and parasitism by Arceuthobium americanum - J. A. Muir.

A 275 : Silvicultural control of dwarf mistletoe in young lodgepole pine and jack pine stand - J. A. Baranyay.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Dwarf mistletoe and its effect on growth and mortality in lodgepole pine stands of Alberta.

3. Investigator : J. A. Baranyay

4. Year of Commencement: 1960

5. Anticipated Year of Completion: Original: 1962 Revision I: 1969

6. Key Words not in Title: Arceuthobium americanum, Pinus contorta, Distribution, growth, SA 1.

7. Activity : Pathology

8. Problem Area Program: Reduction of losses from dwarf mistletoe

9. Establishment Project No. A 231 Branch Project No. A 231

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 1/6 Other - None.

12. Cooperating Agency: None.

13. Location of Work : Forested areas of Alberta and Rocky Mountain National Parks.

14. Abbreviated Background Statement: Losses of growth and increased mortality in dwarf mistletoe infected lodgepole pine have been mentioned on numerous occasions in the literature. Attempts have been made in the United States to estimate the volume of loss attributed directly to dwarf mistletoe in lodgepole pine stands. A survey of infected pine stands in Alberta in 1960 showed 61 percent to be heavily infected and 83 percent were older than 80 years. Thus far no attempt has been made to evaluate the effects of the parasite in terms of volume reduction and mortality by site and intensities of infection. Crown lands have been made available by the Alberta Department of Lands and Forests and the National Parks Branch. The objectives of the study are:

    (1) Classify the intensity of dwarf mistletoe infection on the basis of growth reduction in the trees;

    (2) Assess the growth loss and tree mortality from dwarf mistletoe in different age classes for a variety of site conditions and infection intensities.

    The results of this study will serve as a basis for damage appraisal and will help to establish priorities in planning control.

15. Summary of Progress Up to One Year Ago: Field and laboratory work was completed in 1965. Volume reduction and tree mortality were measured in five stands on two sites, (dry and mesic) and four age classes (in the range of 37 to 117 years).

Results show:

(a) Significant volume differences exist only between heavily infected and healthy trees;
(b) Height growth is markedly influenced by mistletoe attack. The effect on tree form is not pronounced although heavily infected trees are thicker at the base and taper more quickly than healthy trees;
(c) Volume reduction ranged from 18 to 31 percent in the four age classes investigated. The greatest volume loss occurred in the stand which was infected for the longest period by dwarf mistletoe;
(d) The volume and quality of trees are seriously affected if infections occur at an early age, e.g., in the first half of their rotation age. Stands are most seriously affected when they have originated from an evenly distributed infected over-story of seed trees, or from some other form of residual stand during the regeneration period. In these circumstances it is unlikely that a commercial stand will develop;
(e) The number of dead and infected trees seems to be directly related to stand age and there is a significant difference in mortality between dry and moist sites.

16. Goals Set One Year Ago: To evaluate the effect of dwarf mistletoe on the growth of the individual tree, comparing growth of the healthy and infected period. To publish the final results.

17. Accomplishments in Last Year: Graphs were prepared for stem analyses of each tree. Approximately 10 to 15 years are needed for the disease to reach an intensity level to cause appreciable growth reduction.

18. Goals for Next Year : To publish the final results and terminate the project.

Baranyay, J. A. and L. Safranyk. Effect of dwarf mistletoe on growth and mortality in lodgepole pine stands in Alberta. Proposed journal publication.

Baranyay, J. A. and J. A. Muir. Is dwarf mistletoe an important disease in Alberta? Proposed departmental publication.

J A Baranyay

J. A. Baranyay
Investigator

Project No. A 235

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Use of aerial photography in detecting dwarf mistletoe infected lodgepole pine stands.

3. Investigator : J. A. Baranyay

4. Year of Commencement : 1961

5. Anticipated Year of Completion: Original 1968 Revision I 1970

6. Key Words not in Title : Arceuthobium americanum, Pinus contorta, color, infrared, SA 1

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from dwarf mistletoe

9. Establishment Project No. A 235 Branch Project No. A 235

10. Status : Active

11. Man-years Utilized in Past Year: Professional 1/6 Other 1/6

12. Cooperating Agencies : Forest Management Research and Services Institute; Interdepartmental Committee, Aerial Surveys, Ottawa.

13. Location of Work : Banff National Park; Calgary.

14. Abbreviated Background Statement: Use of aerial photography to detect heavily infected stands would be a major advance towards a Province-wide survey of this important disease. R. H. Colwell's work in the United States demonstrated the effectiveness of infrared film and different filter combinations in photographing diseased broad-leafed plants. Colwell's method is based on the fact that the spongy mesophyll tissue in trees suffering from some diseases is partially or totally collapsed. This anatomical change results in a loss of infrared reflectance from the disease foliage. The question is: Does lodgepole pine suffer similar anatomical changes when attacked by dwarf mistletoe?

The objectives of this study are: (1) Determine the efficacy of infrared, panchromatic, and color aerial photography for detecting dwarf mistletoe infected stands. (2) Determine the best film-filter combination for the above purpose. (3) Determine the optimal elevation for flight and photography scale for the above purpose. (4) Find the lowest intensity of dwarf mistletoe infection in different age classes of lodgepole pine stands that can be detected by this method. (5) Work out a practical method for Province-wide use if the method proves practicable.

15. Summary of Progress up to One Year Ago: Oblique and vertical photographs were taken at scales of 1:15,840, 1:7920 and 1:2,400 using black and white (aero panchromatic, infrared aero) and color films (Ektachrome aero, Ektachrome infrared). Originally three study areas were selected.

The aerial phase of the work was contracted to Spartan Air Services Limited in 1962. After unsuccessful trials in 1962, 1963 and 1964 the contracting company provided acceptable aerial photographs of the Lake Louise area in 1965. During the 1966 field season a ground survey was conducted and 198 trees were mapped in a circle around the ground marker to help the identification of individual trees on the aerial photographs. Each tree height was measured and the degree of infection determined as a standard for photo interpretation. The project was on a maintenance basis in 1967.

16. Goals Set One Year Ago : Evaluation of different films on the basis of ground survey and preparation of final report. Project to be terminated.

17. Accomplishments in Last Year: An Internal Report (A-12) was prepared which evaluated the films obtained during aerial photography of dwarf mistletoe infected lodgepole pine stands (1962-1967). Ektochrome infrared film was the most suitable for recording visible color changes and showed the greatest potential for detecting mistletoe infections. Results to date indicate further testing of selected film is warranted.

18. Goals for Next Year : Another experiment with Ektachrome infrared and Ektachrome color film is planned in the summer of 1969. The aerial photography will be done under the auspices of the Interdepartmental Committee of Aerial Surveys.

J. A. Baranyay

J. A. Baranyay
Investigator

Project No. A243

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Biology and epidemology of dwarf mistletoe on lodgepole pine.

3. Investigator : J. Muir

4. Year of Commencement : 1962

5. Anticipated Year of Completion: Original 1973

6. Key Words not in Title: Arceuthobium americanum, Pinus contorta, parasites, dissemination, germination, SA 1, B19.

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from dwarf mistletoe

9. Establishment Project No. A243 Branch Project No. A243

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.8 Other 1.3

12. Cooperating Agency : None

13. Location of Work : Calgary; Kananaskis Forest Experiment Station; forested areas of southern Alberta.

14. Abbreviated Background Statement: In the Alberta region surveys indicate 10 percent of the lodgepole and jack pine are infected by dwarf mistletoe. Cumulative losses of up to 34 percent have been recorded in severely infected stands. Biological control studies, largely of silvicultural nature, are in progress at this laboratory (Project A275) and elsewhere. Information important to refinement of present control methods is lacking in the areas of mistletoe epidemology and parasitism. This study was undertaken to provide that information. The objectives are:
(a) record and describe normal intensification in young lodgepole pine stands;
(b) determine the effect of environmental factors on time, frequency and distance of seed dissemination;
(c) determine the effect of environmental factors on growth, flowering and seed production;
(d) determine the influence of hyperparasition on dwarf mistletoe.

15. Summary of Progress up to One Year Ago: Preliminary analysis of data from a number of mistletoe infected stands indicate intensification tends to increase at a uniform rate, and no large differences in rate occurred between stands despite wide differences in inoculum source, stand density, exposure, soil moisture. Rates of intensification have been mathematically described. Ninety percent of seed dissemination occurred within a few days in late August, and variations in amount of seed dispersed were not correlated with any meteorological factors.

In the laboratory hydrogen peroxide was found to be the superior seed surface sterilant. No consistent effects of scarification on germination were detected. Germination and radical growth were greatest at a constant temperature of 16°C.

Incidence and effect of the most important hyperparasite, Colletotrichum gloeosporidoes, has been dedetermined. Mistletoe seeds have been tagged and observations commenced on their germination performance and infection symptom appearance on trees.

16. Goals Set One Year Ago : 1. Summarize data from intensification study.

2. Continue observations of seed dispersal from infected trees and individual dwarf mistletoe plants.

3. Continue field inoculations and observations on naturally dispersed seed and development of infection in growth chambers and greenhouse.

17. Accomplishments in Last Year: It was observed approximately 8 per cent of the dwarf mistletoe seed naturally deposited, or inoculated on trees, in September, 1966, has caused visible infections by September, 1968. Seed dissemination observations were continued, and considerable variation was observed between separate areas. Distance of spread averaged 28 ft. from uniform margins of infected stands and 45 ft. from single residual trees. Three interim reports are in preparation, together with one publication for scientific journal.

18. Goals for Next Year : Determine incubation and latent periods on infected trees in the field. Continue efforts to establish dwarf mistletoe infection on young trees in growth chambers. Determine role of insects in pollination. Establish the phenotypic characteristics of infected and non-infected white spruce.

" J. Muir"

J. Muir,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Silvicultural control of dwarf mistletoe in young lodgepole pine stands

3. Investigator : J. A. Baranyay

4. Year of Commencement : 1967

5. Anticipated Year of Completior : Original 1989

6. Key Words not in Title : *Arceuthobium americanum*, *Pinus contorta*, thinning, disease intensification, tree growth, SA 1, M 2.

7. Activity : Pathology

8. Problem Area Program : Reduction of losses from dwarf mistletoe.

9. Establishment Project No.: A275 Branch Project No.: A275

10. Status : Active

11. Man-years Utilized in Past Year: Professional .10 Other .90

12. Co-operating Agency : U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

13. Location of Work : Southern Alberta foothills, Interior B. C.

14. Abbreviated Background Statement: Lodgepole pine and jack pine the two hosts of lodgepole pine dwarf mistletoe, *Arceuthobium americanum* Nutt. ex Engelm., represent 23 percent of timber volume in Alberta's forests. According to survey estimates, approximately 10 percent of the accessible merchantable pine stands are infected by dwarf mistletoe. Growth impact studies, initiated in 1960 in the Region, indicate that dwarf mistletoe causes up to 32 percent volume loss in some stands. Losses of this magnitude justify control and, at present, silvicultural methods are the most promising.

A silvicultural control study was initiated by Dr. F. G. Hawkworth at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado in 1965. Our own studies and those being carried out in Colorado are similar in experimental design so data from both regions will be comparable.

Objectives are:

(a) To test the effectiveness of different thinning methods to control dwarf mistletoe;

(b) To study disease intensification and tree growth relationships in treated and untreated stands;

(c) To obtain cost figures for silvicultural control of dwarf mistletoe.

15. Summary of Progress up to One Year Ago: Two sets of five ½-acre plots were established in a 27-year-old lodgepole pine stand in the Highwood Ranger District of the Bow River Forest in 1967. The plot data indicate considerable variation of disease intensity on the study area.

In addition to the 5 main plots, a thinning was done on a 0.9-acre block and dwarf mistletoe was eradicated on another 1.7-acre block. Staff trained on the regular pre-marked plots did this work under limited supervision. None of the treated stand was pre-marked. One hundred and six man-hours were spent on thinning of 0.9 acres (120 hrs./acre) and 67.5 man-hours on the dwarf mistletoe eradication of 1.7 acres (40 hrs./acre).

16. Goals Set Last Year ; Establish plots in dwarf mistletoe infected stands.

17. Accomplishments in Last Year : Five sample plots were established in the Beaverdam Lake area in B. C. in a 34-year-old lodgepole pine stand with heavy over-story trees and two sample plots in the Tin Cup Lake area in B. C. in a 39-year-old stand. The rate of infection on these plots varied from 32 to 75 percent. In the Dutch Creek, Alberta, area five sample plots were established in a 23-year-old stand where disease intensity varied from 26 to 54 percent

18. Goals for Next Year : Since it was decided that the study will be restricted to lodgepole pine, only one additional plot (infected control) is needed, to be established at Tin Cup Lake, British Columbia.

J. A. Baranyay

J. A. Baranyay
Investigator

PROBLEM AREA PROGRAM

Detection and Estimation of Tree Pest Damage

Regional annual insect and disease surveys in the forests and shelterbelts are designed to detect outbreaks and record and assess the significance and impact of tree pests on forest stands. Geographic distribution, life history, host range and other factors are also determined. The survey results provide a basis for control recommendations to forest management and assistance and direction in planning necessary research which will be most profitable to insect and disease problems. Including the Yukon and the Mackenzie District the Region consists of 350 million acres (forest zone - 292 million ac., shelterbelt zone - 58 million ac.). Regular ground surveys are supplemented in remote or inaccessible areas by aircraft or boat recconnaisance. Close liaison and cooperation are maintained with industry, the Alberta Forest Service; National Parks, Yukon and Mackenzie District Forest Services, and other municipal and private agencies.

Origins of tree pest problems vary from the initial establishment of the new stands to the mature and overmature softwood forests which cover extensive areas of the subalpine forest and the boreal region of central and northern Alberta. Currently emphasis is on detection and appraisal of the spruce budworm, forest tent caterpillar, spruce bark beetle, and important root and stem diseases of the Region including Armillaria root rot and Atropellis canker disease. Other research is concentrated upon cytological, taxonomic and life histories of important fungus pathogens of forest trees.

Projects related to this problem area are:

A 217 : Forest disease survey - R. A. Blauel.

A 233 : Biotaxonomy of forest fungi - Y. Hiratsuka.

A 237 : Annual forest insect survey - H. A. Tripp.

A 235*: Use of aerial photography in detecting dwarfmistletoe infected stands - J. A. Baranyay.

A 284 : Armillaria stem rusts other destructive agents in young lodgepole pine stands - J. A. Baranyay.

Project Proposal : Elytroderma deformans needle cast disease of pine - R. A. Blauel.

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* Project statement appears under problem "Reduction of Losses from Dwarf Mistletoe".

Project No. A 217

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Forest Disease Survey

3. Investigator : R. A. Blauel

4. Year of Commencement: 1952

5. Anticipated Year of Completion: Continuing project

6. Key Words not in Title: Incidence damage control pathogenicity distribution *Atropellis* *Fomes annosus* *Hypoxylon* *Armillaria* Alberta

7. Activity : Forest Insect and Disease Survey.

8. Problem Area Program: Detection and estimation of tree pest damage.

9. Establishment Project No.: A 217 Branch Project No.: A 217

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.8 Other 8.0

12. Co-operating Agencies: Alberta Forest Service, Eastern Rockies Forest Conservation Board, Provincial and Federal Agricultural departments.

13. Location of Work : Region wide

14. Abbreviated Background Statement: Survey detection information provides an important basis for rating forest disease problems.

Disease detection provides essential services in locating, collecting, determining incidence, delimiting distribution, recording relevant ecological data and establishing the causes of tree diseases. Field and laboratory services including technical advice and assistance are extended to all other groups and agencies concerned with forest disease problems.

Fulfillment of needs is accomplished through:

1. Communication with interested agencies, sections, groups and individuals who desire disease detection information from surveys.

2. Annual field surveys designed to accommodate both general and specific detection tasks.

3. Laboratory assays carried out to discover and isolate disease causal agents.

4. A limited number of pathogenicity tests designed to determine an organism's ability to act as a primary pathogen.

5. Preparation and distribution of reports concerning forest diseases.

Disease appraisal survey provides essential services to management and scientific groups by conducting appraisals of disease incidence, of disease caused damage and of disease control effectiveness.

Field and laboratory services are extended to all groups and agencies with appropriate disease appraisal problems within the region. Fulfillment of need is accomplished through appraisal studies that employ methods and techniques designed to give meaningful answers to specific questions. These studies must be based on firm biological concepts with the problem and goals clearly outlined and defined. Since appraisal work may involve various aspects of forestry, communication and consultation with the appropriate experts is imperative in setting up appraisal studies.

15. Summary of Progress up to One Year Ago: Forest Disease Surveys were first organized in the Alberta/Territories Region in 1952, under the guidance of R. J. Bourchier. Technical field assistance was supplied through the insect survey rangers. The objectives of that period were much the same as today, but emphasis was placed on the general detection goals of discovery and recording disease occurrence and distribution within the Region. Annual checks were carried out to determine degree and spread of infection with resultant information passed on to scientific and forest management agencies.

Insect and disease survey activities were brought together administratively in 1962, and J. A. Baranyay assumed responsibility for the Forest Disease Survey. In 1964 a mycologist, Dr. Y. Hiratsuka, was added to Survey Staff and assumed the responsibilities of Herbarium curator, dealing with identification and biotaxonomic tasks. In 1965 Mr. H. A. Tripp was appointed Section Head to administer and co-ordinate the combined survey. Early in 1967 an appraisal crew was established within surveys to deal with damage, incidence and control appraisal problems requiring extensive examination. Late in 1967 Mr. R. A. Blauel was appointed to the position of Disease Research Officer vacated by Mr. Baranyay.

The advance of survey during the years from 1952 until 1968 can be summarized in stating that many of the general detection objectives have been achieved. This has allowed emphasis to be changed toward meeting the more specific detection and appraisal objectives of Forest Insect and Disease Surveys.

16. Goals Set One Year Ago: 1. An annual survey to detect and ascertain the distribution and abundance of forest diseases.

2. Based on criteria set up by Dr. John Hopkins, to conduct an intensive examination of *Atropellis piniphila* concerning:

(i) Presence on lodgepole pine, hybrid and jack pine with detailed examinations to be made by the rangers in the field with both positive and negative results recorded. Tree species identification were to be based upon morphological and chemotaxonomic characters.

(ii) Northern and northeastern spread of the fungus within the range of its hosts. Examination of 24 specific areas located north and northeast of present known distribution limits. Both positive and negative results were to be recorded.

3. Establish a system for determining infectious agents associated with diseased tree material sent to the laboratory for disease assay. This involved microscopic examinations, culturing techniques, and bio-assay methods.

4. Conduct pathogenicity tests of specific organisms found constantly associated with specific diseases. Black band fungus on pine, spruce needle cast and a species of *Cucurbitaria* were to be tested.

The following disease studies were to be made by the regional appraisal team:

5. Appraisal of Hypoxylon canker damage and incidence.

6. Exotic plantation examinations for native and introduced diseases.

7. Appraisal of *Armillaria mellea* control treatment in the Robb Area.

8. Pilot examinations to determine future appraisal studies for:

a) Incidence of *Echinodontium tinctorium*

b) Fir needle rust

c) Elytroderma deformans

17. Accomplishments in Last Year: 1. The annual general detection survey was completed, with ten limited requests being incorporated into the program. Ranger bi-weekly reports, Ranger summary reports and the annual report of the Forest Disease Survey were written.

2. Intensive examination of Atropellis piniphila: 16 of 24 specific site examinations were made. Field personnel shifts and field season cut-banks accounted for examinations not made.

3. Infectious Disease Assay: This season 46 IDA collections were processed with associated organisms isolated and grown in culture. Identification procedures are now in progress.

4. Pathogenicity tests: The establishment of 17 1/50 acre permanent plots in Kananaskis research forest and the construction of one plant shelter to accommodate testing. Three organisms, black band fungus, spruce needle cast fungus and a Cucurbitaria species were given limited testing.

5. Investigated the epidemiology of hypoxylon canker on Populus species in Alberta with a view towards impact studies. Through consultation with J. Baranyay, E. Peterson, H. Anderson and J. Kasper criteria for examination was established. Twenty-seven permanent sample plots were set up and examined in 1968. A summary of the field work was compiled by the appraisal crew. Compilation and review of program were completed.

6. Exotic plantation examinations: Five exotic species were examined at three sites.

7. Appraisal of Armillaria mellea chemical control plots near Robb was made:

a) to determine the effectiveness of certain chemicals as controlling agents of A. mellea;

b) to identify agents associated with A. mellea disease complex. Trees on seven plots were hydraulically excavated. All pertinent data was recorded and recovery of the organisms associated with root lesion formation was carried out. A complete summary concerning the effectiveness of the chemical control has been prepared. Identifications of the associated organisms are in progress.

8. Incidence of E. tinctorium

Field work was deferred in 1968 owing to shifts in field personnel and a shortened field season.

9. Fir needle rust

A study was initiated to determine the damage potential of fir needle rust. Under the direction of Dr. Y. Hiratsuka a permanent plot was set up in an infected fir regeneration stand near Hinton. Ten trees were tagged and examined. Data necessary to establish the epidemiology of fir needle rust were recorded.

10. _Elytroderma deformans_

A pilot examination was made and a project proposal submitted.

18. _Goals for Next Year_ : 1. Conduct the annual disease detection survey incorporating special detection requests.

2. Complete the intensive _Atropellis piniphila_ examinations.

3. Initiate a _Fomes annosus_ detection program to show the presence and prevalence of the root rot.

4. Continue infectious disease assay procedures and to monitor the fungus populations of log decks under wood-borer control treatments.

5. Continue pathogenicity experiments on the black band fungus, the spruce needle cast fungus and _Cucurbitaria_ sp.. _Hendersonia_ spp. and the Cork bark disease organism will be added to the program.

6. Hypoxylon appraisal

Re-examine all twenty-seven plots. Several new plots will be established and all data collected will be transferred to punch cards.

7. Exotic plantations appraisal

Examine all previous data and evaluate the study.

8. _Armillaria mellea_ control appraisal

A report on the effectiveness of the chemical control and of the organisms associated with the disease complex is being prepared for publication.

9. Echinodontium tinctorium:

Appraise the incidence on Abies species within the region.

10. Fir needle rust appraisal:

Re-examine the sample plot.

11. Appraisal of Atropellis piniphila control

Under the direction of Dr. J. Hopkins, establish plots to appraise a cutting control experiment; tentatively:

a) to clear-cut plots in adjacent infected zones and appraise subsequent regeneration for infections;

b) to mark out plots within the control zone;

c) to mark out plots of infected stands to ensure a source of inoculum near the control plots.

R. A. Blauel

R. A. Blauel
Investigator

Project No. A 233

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Biotaxonomy of forest fungi.

3. Investigator : Y. Hiratsuka

4. Year of Commencement : 1966. Operation and maintenance of Mycological Herbarium is transferred from A 217 in 1969.

5. Anticipated Year of Completion : Continuing.

6. Key Words Not in Title : Mycology, herbarium, fungus serology, immunofluorescent method, tree diseases.

7. Activity : Forest Insect and Disease Survey.

8. Problem Area Program : Detection and estimation of tree pest damage.

9. Establishment Project No.: A 233 Branch Project No.: A 233

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.3 Other 1.8

12. Co-operating Agencies : None

13. Location of Work : Calgary (laboratory, Mycological Herbarium), Kananaskis Forest Experiment Station (greenhouse), Alberta, Rocky Mountain Parks, the Northwest Territories and the Yukon Territory.

14. Abbreviated Background Statement: 1. Our knowledge of forest fungi flora and life histories of many important fungus pathogens of forest trees in the region are poorly known and many undiscovered or unrecognized fungi are expected to be found from the region. It is essential for the forest pathological investigations and survey activities of the region, 1) to secure accurate identification, 2) to maintain and operate the Mycological Herbarium (CFB), 3) to find out life histories of the forest pathogens, and 4) to obtain an inventory of forest pathogens for national distribution records.

2. Many forest tree pathogens when collected do not have proper fruiting structures for positive identification by conventional morphological methods. Furthermore, morphological characteristics are not always dependable. In medical mycology and some other branches of mycology, use of other methods to complement conventional morphological methods is common. Such methods as serological, biochemical and fluorescent microscopical techniques should be tried on forest fungi as simple and reliable methods for identification.

15. Summary of Progress up One Year Ago: 1. Mycological Herbarium (CFB) had been developed to have about 8,000 specimens mainly of forest tree pathogens.

2. Immunofluorescent methods have been tried for two summers for the study of forest fungi.

16. Goals Set One Year Ago : 1. Continue of immunofluorescent method for the study of forest fungi.

17. Accomplishments in Last Year: During the summer of 1968 a graduate student was employed to develop immunofluorescent technique for forest fungi. Because of some technical difficulties and late arrival of equipment, the results were not convincing, but significant information on the method was obtained.

18. Goals for Next Year : 1. Continue study of immunofluorescent techniques for the study of forest fungi.

2. A check list of conifer tree diseases of Alberta will be compiled.

Y. Hiratsuka,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title ; Annual forest insect survey

3. Investigator : H. A. Tripp

4. Year of Commencement : 1948

5. Anticipated Year of Completion: Continuous

6. Key Words not in Title: Incidence, distribution, abundance, damage appraisal, extension services.

7. Activity : Forest insect and disease survey

8. Problem Area Program : Detection and estimation of tree pest damage

9. Establishment Project No. A 237 Branch Project No. A 237

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 1/2 Other - 9

12. Cooperating Agencies : Alberta Forest Service; McKenzie and Yukon Forest Services; other Regional Establishments; and Alberta forest industries.

13. Location of Work : Field work is region wide

14. Abbreviated Background Statement: The insect survey determines annually the status of forest insects in the region with respect to distribution, abundance, and depreciating effects on the forests so as to make recommendations relevant to the proper management of the forest resource. In general, the detection staff (District Rangers) make the initial contacts with forest insect problems by ground or aerial survey. Normally, ocular estimates of the population level is recorded but for certain predetermined species a precise sampling system is employed. When significant damage is suspected an appraisal using specific sampling techniques is conducted by a Survey Appraisal crew. When the biology of the pest and control method are well understood recommendations on remedial action are issued immediately. When the nature and behavior of the past are not completely known, research is conducted by a Survey officer or other entomological researcher.

In the detection survey, insect samples are collected along with ecological data which are recorded on a comprehensive sampling form. The specimens themselves are reared and stored for use as taxonomic reference and studies. The accompanying data are coded and recorded on magnetic tape in Ottawa.

These data serve as valuable information on epidemiology, relationship to stand-types, and in national compilations which record distribution, hosts, prevalence and biological notes relative to seasonal history.

In the Survey the personnel are often involved in widespread sampling in cooperation with researchers from other disciplines within and beyond the Region.

The Survey is responsible for processing enquiries from outside agencies and the general public relative to forest insect and disease problems. To facilitate order and to ensure high quality responses all enquiries are processed through a single individual who reports directly to the Survey Head. Other extension work includes lectures on forest insects and diseases to youth groups and liaison between district rangers and other forestry personnel.

15. Summary of Progress up to One Year Ago: Since the formation of the forest insect survey in Alberta Region in 1948, a comprehensive inventory of regional insects has been obtained, a large amount of ecological data has been collected and published and a good relationship established with outside agencies.

By 1967, over 41,000 insect collections were made, the species identified and the supporting ecological data recorded on punch cards and magnetic tape. The regional museum contains approximately 43,500 specimens representing about 2,000 species. Many other specimens are deposited in the Canadian National Collection in Ottawa. Although previously unrecorded insect species are constantly being discovered the concept of diminishing returns is apparent. Hence, in recent years emphasis has been placed on ascertaining the status of forest insects of economic importance. An appraisal group consisting of three technicians supported by seasonal assistants was formed in 1967. Emphasis has been placed on such insect species as the larch sawfly, needle miner, forest tent caterpillar, wood borers, bark beetles, bruce spanworm, adelgids, weevils, the spruce budworm and others. These studies were generally planned to ascertain epidemiology, life histories, damage, or taxonomy. Those studies on forest tent caterpillar, spruce budworm and wood borers are reviewed under Project Statements A 257, A 255 and A 271 respectively.

The Survey has functioned since its inception as a service organization to other disciplines, other regional establishments and outside agencies. Each year numerous requests to supply material and data in support of other investigations are fulfilled. Enquiries from outside agencies regarding the status of forest insects or diseases are processed. Since 1967, the bulk of such enquiries are channelled through a senior technician who in turn utilizes the knowledge of specialists in Survey and other disciplines.

Results of Survey investigations have been published in the form of the Annual Report of the Forest Insect and Disease Survey, the annual Rangers Report, seasonal reports, special reports on specific forest insects, and contributions to scientific journals.

16. Goals Set One Year Ago: A complete list of goals (Forest Insect and Disease Work Program) is prepared each year and distributed to all Regional Establishments. In brief these are: to continue a general detection survey to locate outbreaks, and to support national compilations, inventories and research investigations within and beyond the Forest Insect and Disease Survey discipline; to maintain a service to outside agencies by fulfilling requests for materials, data and information; to investigate by means of the appraisal group any forest insect problems requiring intensive sampling; and to report on the status of regional forest insects by means of seasonal and annual reports.

Specifically planned for 1968 were:

(a) Close inspection of Marmot, Streeter and Deer Creek experimental watershed basins forests.

(b) Inspection of all Provincial Park forests.

(c) Sequential sampling for Forest Tent Caterpillar egg masses.

(d) Examination of decked saw logs for incidence, abundance and identity of wood borers.

(e) To lecture on forest insects and diseases as requested.

(f) To conduct comprehensive sampling for *Hylobius warreni* as part of Project A 244.

(g) To assist in sampling relative to the spruce budworm impact studies (Project A 255).

Investigations resulting from unforseen events:

(a) Appraisal of wood borer damage in fire-killed timber, north central Alberta.

(b) Investigation of spruce bark beetle outbreak, Crowsnest forest.

17. Accomplishments in Last Year: (1) General detection - A total of 1,275 insect collections or reports which included 2,062 records and about 17,000 insects were processed. About 300 insect collections were placed in rearing

to obtain identifiable stages. All enclosure slips were coded and sent to Ottawa for transfer to magnetic tape.

(2) Aerial Surveys - About 74 hours were spent in the air to detect and map current outbreaks of the spruce budworm, forest tent caterpillar, large aspen tortrix and spruce bark beetle.

(3) Detailed inspection of the Marmot, Streeter and Deer Creek watershed basins to detect forest insects and diseases which could affect watershed values of the forest; report prepared.

(4) Detailed inspection of 39 Provincial Parks to advise on insect and disease conditions. Superintendents of each park advised verbally of survey results.

(5) Sequential sampling for forest tent caterpillar egg masses to predict the 1970 potential.

(6) Sampling of decked logs at four mill sites to determine incidence, abundance and species of wood borers.

(7) Cooperative collections - Requests from researchers of other disciplines, other regional establishments, and universities, to collect bark beetles, bruce spanworm, *Chilocorus* spp., larch sawflies, *Neodiprion* spp., *Pissodes* spp., and cones were fulfilled.

(8) Extension services - During 1968 five lectures on forest insects and diseases were delivered by a senior technician to the Junior Forest Ranger, two to Junior Forest Wardens and one to Junior Forest girls.

A total of 184 enquiries relative to tree pest problems were processed, many of which required on-the-spot inspection. An additional 64 enquiries dealt with non-forest pests.

(9) *Hylobius warreni* - A total of 142 lodgepole pine plots were sampled at 56 locations at various elevations from the International Boundary to near Grande Prairie. Estimates of weevil abundance tended to vary directly as to tree size, stand maturity and duff thickness, but inversely as to stand density. Hazard appears greatest at elevations below 4,600 feet.

(10) Wood borers in fire-killed timber - Extensive sampling in the fire-killed timber south of Lesser Slave Lake revealed very low populations of wood borers and low hazard. The appropriate authorities were advised.

(11) Spruce bark beetles - Aerial and ground surveys revealed heavy tree mortality in the West Castle river and Racehorse Creek areas and high hazard areas throughout the foothills of southwest Alberta. The appropriate authorities were advised to clear-cut the severely damaged stands as quickly as possible.

Survey personnel instructed provincial rangers on methods of detection so that they may revise their management program.

Preliminary investigations on the development periods of the beetles were conducted to determine the year when another major attack may be expected.

(12) Reports and publications -

(a) Petty, J. 1968. Insect and Disease Conditions in Alberta Provincial Parks 1967. Forestry Research Laboratory Calgary. Information Report A-X-16. (11 pages).

(b) Petty, J. 1968. Summary Reports on Forest Insect and Disease Conditions, Alberta Region.
June 15 - (5 pages)
August 15 - (8 pages)
October 15 - (4 pages)

(c) Raske, R. 1968. Entomological aspects of salvage of fire-killed timber. Mimeo report to Alberta Forest Service.

(d) Smith, G. 1968. Insect and disease conditions of Marmot, Streeter and Deer Creek Watersheds. File report.

(e) Stevenson, R. E. and J. J. Petty. 1968. Lodgepole terminal weevil (*Pissodes terminalis* Hopkins) in the Alberta/Northwest Territories Region. Bi-monthly research notes 24 (1):6.

(f) Tripp, H. A. and J. K. Robins. 1968. Forest insect and disease conditions for Alberta/NWT/Yukon Region in Annual Report of the Forest Insect and Disease Survey, Forestry Branch, 1967. Pages 97-107.

(g) Tripp, H. A. and J. K. Robins. 1968. Forest insect and disease survey, Alberta/NWT/Yukon Region, for 1967. (A compilation of reports by District Rangers) Forestry Research Laboratory, Calgary. Information Report A-X-15. (61 pages).

(h) Tripp, H. A. 1968. Annual Report to Eastern Rockies Forest Conservation Board on Insect and Disease Conditions for 1967. File report.

(i) Wilkinson, N. W. 1968. Evaluation of Topically Applied Dimethoate for Control of Lilac Leaf Miner. Jour. Ec. Ent. 61 (6): 1746.

18. Goals for Next Year : (a) In addition to the annual detection survey to ascertain current status of forest insects, it is planned to continue inspections of watershed basins, to provide assistance on the spruce budworm project; to fulfill requests for materials and data and extension services.

(b) A special spruce bark beetle survey will be made to forecast insect intensity, detect incidence and estimate tree volume losses. To forecast populations it is essential to determine if life history is a two- or three-year cycle.

Howard A. Tripp

H. A. Tripp
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : *Armillaria mellea*, stem rusts, other destructive agents in young lodgepole pine stands.

3. Investigator : J. A. Baranyay

4. Year of Commencement : 1968

5. Anticipated Year of Completion: Original - 1988

6. Key Words not in Title : *Cronartium*, *Peridermium*, big game and rodents, SA 1, B 19.

7. Activity : Pathology

8. Problem Area Program : Detection and estimation of tree pest damage.

9. Establishment Project No. A 284 Branch Project No. A 284

10. Status : Active

11. Man-years Utilized in Past Year: Professional - 0; Other - .10

12. Cooperating Agency : None

13. Location of Work : Robb, Alberta

14. Abbreviated Background Statement: *Armillaria mellea* is a widespread disease of pine regeneration in Alberta. The long-term behaviour of the disease in natural young stands is not known, nor whether site, stand conditions, or other non-infectious agents are predisposing trees to the disease.

In Alberta, fire plays a major role in the origin of lodgepole pine, *Pinus contorta* Dougl. var. *latifolia* Engelm. forests. An area of about 1,000 acres between Edson and Robb was burned in May, 1941, and has since been known as the Robb Burn. The conditions of a new stand near Robb, Alberta, as regards *Armillaria*, stem rusts and other damaging agents were investigated in 1953, 1957 and 1958 by Disease Survey Staff. The disease conditions that were apparent in 1957 and 1958 prompted the initiation in 1959 of a more thorough examination based on permanent plots.

The objectives of the study are: (1) Describe the long-term variation of disease occurrence in post-fire natural lodgepole pine stands. (2) Identify and assess the factors affecting the incidence and rate of damage caused by *Armillaria mellea* in post-fire natural lodgepole pine. (3) Recognition of external symptoms of *A. mellea* infection on lodgepole pine to assist in locating incipient attacks in young stands. (4) Record the presence and effect of other infectious and non-infectious agents in the development of lodgepole pine stands.

15. Summary of Progress up to One Year Ago: Seven 1/20-acre sample plots were established in 1959 to sample disease conditions on a wide range of sites. Plots were re-surveyed in 1962. The results of this survey were published in the Forestry Chronicle, Vol. 40, No. 3, in 1964.

The plots are re-surveyed every third year and one plot was re-surveyed each year to register internodal growth of healthy and Armillaria-infected trees.

16. Goals Set One Year Ago : Re-survey one plot to record internodal growth.

17. Accomplishments in Last Year: One plot (No. 7) was re-surveyed to record mortality, spread of Armillaria and the internodal growth of every individual tree. It seems that the disease is mainly spreading in dense patches where competition is predisposing trees.

18. Goals for Next Year : To re-survey plot No. 7. Evaluation of five years' growth data and other data obtained during the 1967 re-survey of all the plots. If results warrant a publication will be prepared.

J. A. Baranyay

J. A. Baranyay
Investigator

PROJECT PROPOSAL STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969

2. Title : Elytroderma deformans, needlecast disease of pine.

3. Investigator : R. A. Blauel.

4. Year of Commencement: 1969

5. Anticipated Year of Completion: 1971

6. Key Words not in Title: Pinus contorta, P. banksiana, impact, systemic infection, damage, infection, inoculum

7. Activity : Forest Insect and Disease Survey

8. Problem Area Program: Detection and estimation of tree pest damage.

9. Annual Man-year Requirement: Professional .2 Other .2

10. Major Equipment Purchases Required for Completion: None

11. Co-operating Agencies: None

12. Location of Work : Kananaskis Forest Experiment Station, Rocky Mountain foothills, Calgary Laboratory.

13. Background Statement: This project is an extension of a pilot study on Elytroderma deformans initiated last year. The disease caused by Elytroderma deformans bears investigation for two important reasons:

(a) Data based on disease detection surveys and a needle cast collecting trip conducted in the fall, 1968, revealed substantial levels of infection present in the commercially important pine stands of the Alberta foothills region.

(b) New information concerning the pathogenisis on Elytroderma on Ponderosa pine in Montana shows a perennial systemic infection that may seriously damage large numbers of trees. It should be noted that preliminary examinations revealed evidence of systemic infection in the lodgepole&jack pines of Alberta.

Elytroderma deformans may be a disease that forest management should be taking into consideration and that it is well within the limits of survey objectives to discern evidence for or against this.

14. Objectives : To ascertain the current and potential disease hazard presented by Elytroderma deformans on the lodgepole pine - jack pine host complex.

15. Plan of Attack : (1) To determine the extent of the systemic infection of Elytroderma deformans within the lodgepole-jack pine host.

Method: To examine in detail a limited number of infected hosts using culturing and microtechnique methods to ascertain the extent of the systemic infection. Most of the work will be done on regeneration- and sapling-sized trees. Naturally infected material is available in the Kananaskis Research Forest and along the lower Forestry Trunk Road.

(2) To determine the time of needle susceptibility to initial spore infection.

Method: Spore inoculation tests conducted at one-week time intervals -- on young pine in the Kananaskis Research Forest.

(3) To determine conditions controlling ascocarp maturation.

Method: Infected potted seedlings will be subjected to various conditions within controlled environmental chambers.

(4) To conduct an impact study determining the effect of Elytroderma on the lodgepole-jack pine host.

Method: To establish small plots (1/50 acre) within infected pine stands of the Kananaskis Research Forest, and along the Forestry Trunk Road. Data relevant to growth loss and growth distortion over a two-year period will be recorded.

(5) To determine disease infection rate and incidence on a limited scale.

Method: To set up a spore trapping procedure and to record new infections in the above mentioned plots.

16. Goals for Initial One-Year Period: (1) To complete the work under objective 1.

(2) To establish the plots, carry on experiments and record data relevant to objectives 2, 4 and 5.

R. A. Blauel

R. A. Blauel
Investigator

PROBLEM AREA PROGRAM

Reduction of Slash Fire Hazard

Logging slash in concentrations is potentially a major fire hazard as well as a hindrance to successful and efficient establishment of natural or artificial regeneration. The problem becomes increasingly important as a result of increased forest harvesting and the trend in industry to large clear-cut areas. Research in the problem of slash hazard reduction has advanced to where methods for quantifying the amoung of slash in standing trees and on the ground are known. Also there is a good understanding of the decay and physical characteristics of slash. Emphasis is now being placed on the diagnostic and quantitative factors of slash fuels, fire weather and in fire behaviour for the application of control burns in slash hazard reduction and effective seedbed preparation for silviculture. Research on the decay aspects of lodgepole pine slash deterioration is nearing completion. Because of case hardening, fungal decay does not appear to change slash form very much. Plans are to continue and expand studies of the physical aspects of fire behaviour.

Projects related to the problem include:

A 226 : Decay of lodgepole pine logging slash - A. A. Loman.

A 289*: Fire intensity and rate of spread in lodgepole pine slash - D. Quintilio.

A 304 : Prescribed fire following clear-cutting of overmature spruce-fir in the foothills section of Alberta - A. D. Kiil.

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* Project statement appears under Problem - "Increased Efficiency of Fire Danger Assessment and Forecasting"

Project No. A 226

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969

2. Title : Decay of lodgepole pine logging slash

3. Investigator : A. A. Loman

4. Year of Commencement : 1952

5. Anticipated Year of Completion: 1969

6. Key Words not in Title: Fungi, moisture, temperature, *Pinus contorta*

7. Activity : Pathology

8. Problem Area Program : Reduction of slash fire hazard

9. Establishment Project No. A226 Branch Project No. A226

10. Status : Reactivated

11. Man-years Utilized in Past Year: None

12. Cooperating Agency : Alberta Forest Service

13. Location of Work : Strachan, Alberta. Calgary Laboratory.

14. Abbreviated Background Statement: Logging slash of lodgepole pine may create serious fire hazard and regeneration problems. Although lodgepole pine logging slash is known to deteriorate slowly, little is known of the effect of environmental conditions created by different cutting methods on rates of deterioration of slash and of the fungi involved.

    This study is designed: (1) to identify the fungi associated with lodgepole pine logging slash; (2) to determine which species of fungi were responsible for the deterioration of slash; (3) to discover a possible fungal succession in logging slash of increasing ages; (4) to study the effects of microclimatic factors in residual stands created by different cutting methods, as well as size and position of individual pieces of slash in relation to the ground, on fungus distribution and fungus activity.

    Results of these investigations will hopefully lead to meaningful recommendations for slash treatment after different cutting methods.

15. Summary of Progress up to One Year Ago: Eighty-one species of fungi were collected from the bark, twigs, needles and wood as sporopheres or as cultural isolates from stained and decayed wood of lodgepole pine slash. Only four of these were consistently and significantly associated with fungal decay. The distribution of the

four active slash decayers was related to their high-temperature tolerance or intolerance and to their temperature optima. High-temperature tolerating *Peniophora phlebioides* Jacks. and Dearden was found near the upper exposed portions of individual pieces of slash, *Lenzites saepiaria* Wulf. ex Fr. predominated in central portions, and high-temperature intolerant *Coniophora puteana* Schum. ex Fr. and *Stereum sanguinolentum* Alb. and Schw. ex Fr. were restricted to areas near the sheltered undersides of individual pieces of slash.

Deterioration of slash commenced with a browning and casting of needles within 2 to 5 years after logging, while bark sloughed off the exposed portions of the stems within 5 to 10 years. The process of fungal decay was associated with case hardening of the outer growth rings of the stems, which resulted in hard cylindrical shells encasing cores in various stages of decay. Slash form changed very little over the years and it is probable that the fire hazard remains high in untreated slash for many years after cutting despite activities of decay organisms.

The following reports and publications have been made:

- 2 scientific publications in the Canadian Journal of Botany;
- 1 interim report;
- 3 reports in the Proceedings of the Western International Forest Disease Work Conference and the Canadian Phytopathological Society.

16. Goals Set One Year Ago: Final slash volume and decay measurements.

17. Accomplishments in Last Year: Final volume and decay measurements were completed.

18. Goals for Next Year : Completion of this project with the following publications:

Loman, A. A. Fungi associated with logging residues of *Pinus contorta* Dougl. var. *latifolia* Engelm. Proposed journal publication.

Loman, A. A. Physical aspects of lodgepole pine slash deterioration. Proposed Departmental publication.

A. A. Loman

A. A. Loman
Investigator

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Prescribed fire following clearcutting of overmature spruce-fir in the Foothills Section of Alberta.

3. Investigator : A. D. Kiil

4. Year of Commencement: 1967

5. Anticipated Year of Completion: Original 1969 Revision I 1970

6. Key Words not in Title: Fire intensity, *Picea glauca*, *Abies lasiocarpa*, fuels.

7. Activity : Forest Fire

8. Problem Area Program: Reduction of slash fire hazard.

9. Establishment Project No.: A 304 Branch Project No.: A 304

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.4 Other 1.0

12. Co-operating Agencies: Alberta Forest Service
North Western Pulp and Power Co. Ltd., Hinton, Alberta.

13. Location of Work : Hinton, Alberta.

14. Abbreviated Background Statement: A significant portion of the current and proposed pulpwood harvest of North Western Pulp and Power Ltd. is from overmature stands of spruce-fir (*Picea glauca* (Moench) Voss, *Abies lasiocarpa* (Hook) Nutt.). Natural regeneration is generally inadequate following clear cutting of this type mainly because of irregular natural seed supply and unfavourable seedbed. Cultural treatments probably in combination with artificial regeneration are considered necessary if the Company is to fulfill its obligation to regenerate the cut-over forest adequately and promptly.

In the overmature spruce-fir stands one of the problem site types for regeneration is characterized by a surface layer of moss and unincorporated organic material 6 to 24 inches deep, depending on moisture. It is probable that site deterioration is active and will continue with increasing accumulation of organic material and colder, wetter soils than at present if the process is not interrupted. A primary requirement for successful regeneration is a seedbed in which dry litter and thick humus barriers are removed or reduced and some moist topsoil is exposed or mixed with humus. Scarification can effect improvement in the seedbed but because of wet soils and excessively deep organic layers on the sites, satisfactory mineral soil exposure is not obtainable by normal blade and/or drag operations. The recognition by forest management and research agencies that scarification is not a panacea and a renewed interest in the potential of prescribed burning resulted in the initiation of this project.

This project was designed to answer questions in two main areas, regeneration silviculture and fire behaviour, but only the fire aspects are considered in this statement. The fire research objectives are as follows:

(a) Investigate the techniques and logistics of prescribed fire and fire behaviour in the overmature spruce-fir fuel type.

(b) Evaluate the effects of prescribed burning in terms of:

(i) slash hazard
(ii) fuel moisture
(iii) burning indices
(iv) fire intensity

(c) Determine the relationship between the United States Buildup Index and the moisture content of the L, F, and H layers in spruce-fir stands and in clear-cut areas.

The experience and research findings from this large-scale prescribed burning experiment will be used as a basis for making recommendations for further research and to evaluate the potential of this tool for practical use.

15. Summary of Progress up to One Year Ago: Four 15- to 25-acre blocks were selected on each of two site conditions, shallow organic and deep organic. At each site, three blocks were prepared for burning in 1967 and one block was set aside as a permanent control.

Weather instrumentation was established and maintained at each site to provide the data for calculating daily spread and build-up indices. Weight-and-size- distribution of slash, lesser vegetation, moss and humus were determined for each burning block. Sixty, 2 by 3 foot forest floor samples were separated by L, F and H layers, weighed and oven-dried for moisture content determinations. Twenty-four sampling points were established in each block to facilitate assessment of fuel consumption and depth of burn.

One four-acre test plot and one 15-acre experimental block were burned in 1967. Fuel consumption and depth of burn were measured.

16. Goals Set One Year Ago: Prepare one additional block for burning (to replace that burned in 1967) and burn all six blocks. Data will be collected from each burning block according to plan. Compile and analyze field data. Prepare draft manuscript for publication.

17. Accomplishments in Last Year: Three blocks - one at each of low, moderate and high fire hazard - were burned at the shallow organic site. The three deep organic blocks were not burned owing primarily to a lack of suitable burning conditions. For the burned blocks, field data was collected according to plan. At each of the two sites, three one-square- foot duff samples were taken in the control block and in the adjacent stand about twice weekly to determine the volume and moisture distribution in these fuels. Compilation and analysis of field data is nearing completion.

Reports and publications: Kiil, A. D. 1968. Fuel consumption by a prescribed burn in spruce-fir logging slash. (The Forestry Chronicle (In press).

Kiil, A. D. 1968. Basic considerations in the planning and use of prescribed fire. Information Report (In press).

18. Goals for Next Year : Burn all three deep organic blocks in one burning period, i.e. afternoon or evening. On each block data will be collected according to plan. Complete compilation and analysis of field data and prepare the following reports.

Kiil, A. D. 1970. Some aspects of prescribed burning in spruce-fir logging slash. (Proposed departmental publication).

Kiil, A. A. 1970. The amount and distribution of moisture in L, F and H layers under spruce-fir stands and on clearcut areas (Proposed departmental Bi-monthly Research Note).

A. D. Kiil
Investigator

PROBLEM AREA PROGRAM

Increased Efficiency of Fire Danger Assessment and Forecasting

Forest fire danger tables are fundamental for forest protection in planning and coordinating fire detection and control procedures at regional and local levels. The present inability to evaluate adequately fire behaviour in every situation is a major problem in the development of improved fire control practices and safe efficient fire suppression operations. Broadly, the objectives of the fire danger assessment and forecasting research program are to analyze and evaluate different combinations of fuel, weather and topography so as to predict fire behaviour at stages of ignition, development and spread; to develop systems for fuel-type classification and mapping; to identify associations of fuel elements that will cause a predictable rate of fire spread or difficulty of control under specified burning conditions; to evaluate the need for modification of the existing and preparation of additional fire danger and fire hazard tables for Alberta, and to study the beneficial use of fire in Alberta for silviculture and hazard reduction. Studies of hazard flammability of white spruce and lodgepole pine slash and a detailed program of planning and use of prescribed fire have been established in conjunction with regeneration silviculture problems. Research in the problem area has advanced to where much of the physical characteristics and moisture content of pine and spruce slash are known as well as the effect on hazard reduction of various slash treatments. Review has also been made of wildfire reports and data in relation to forest fire danger rating systems in Alberta.

From an economic view it is essential that there be an increased effort in fire control within the region, consequently the research program will emphasize basic studies of the physical characteristics of forest fuels and the interrelationships of weather and fuel factors which affect fire behaviour. New and improved fire laboratory facilities will be available and plans have been made in cooperation with the Alberta Forest Service to establish a special reserve area for fire research and demonstration in the Slave Lake Region. At the moment the following projects relate directly to the problem:

A 128 : A study of forest fires in relation to forest fire danger rating in Alberta - A. D. Kiil.

A 304*: Prescribed fire following clearcutting of overmature spruce-fir in the foothills section of Alberta - A. D. Kiil.

A 289 : Fire intensity and rate of spread in lodgepole pine slash - D. Quintilio.

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* Project statement appears under Problem - "Reduction of Slash Fire Hazard".

Project No. A 128

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Forest fires in relation to forest fire danger rating in Alberta.

3. Investigator : A. D. Kiil

4. Year of Commencement : 1963.

5. Anticipated Year of Completion: Original 1968. Revision I 1972

6. Key Words not in Title : Fire behaviour, fire weather, fire reports.

7. Activity : Forest fire

8. Problem Area Program : Increased efficiency of fire danger assessment and forecasting.

9. Establishment Project No.: A128 Branch Project No. A128

10. Status : Inactive

11. Man-years Utilized in Past Year: Professional 0.2 Other 0.2

12. Co-operating Agencies : Forest Protection Branch, Alberta Forest Service.

13. Location of Work : Edmonton

14. Abbreviated Background Statement: A forest fire danger rating selected fire danger factors into one or more numerical indices of fire potential. By taking into account the same items in the same way, the danger index gives the same result when used by different people. It does not, however, indicate the same fire conditions to all people who use ut as a tool in aid of fire control management.

Up until 1966, the Alberta Forest Service used the Alberta and Alberta East Slope versions of the Canadian Fire Danger rating system. This system was replaced in 1966 by the U.S. National fire danger rating system which is still in use today. The ever-increasing sophistication of fire control operations requires at least a corresponding improvement in fire danger rating systems. It is likely, therefore, that existing indices will need to be modified or new indices developed when a major change is required. The introduction of a revised or new danger rating system should be accompanied by an assessment of its ability to differentiate between good and bad fire days. This objective can best be fulfilled by determining the relationships between selected fire danger indices and actual fire occurrence, rate of spread, area burned and length of fireguard built or held.

This project has the following objectives:

(1) To compare the reliability of the U.S. National and the new Canadian National (when available) danger rating systems in terms of their ability to differentiate between good and bad burning days.

(2) To make recommendations for further research and to recommend procedures for the use of various indices that will help to make them a more valuable tool in fire control management.

15. Summary of Progress Up to One Year Ago: Over 3,000 forest fire reports, covering the seven-year period from 1957 to 1963 were made available for the analysis by the Alberta Forest Service. Individual fire reports were examined and the following information was extracted: fire location, time of year, fire size in acres, predominant fuel type, danger index, rate of spread in acres per hour, and length of fireguard built or held in feet. For the three-year period from 1961 to 1963, fire weather data from over 100 Alberta Forest Service weather stations was compiled and analyzed to determine what per cent of the days were classed as falling into a particular danger class.

The extracted information was analyzed by Forest or Division, fire cause, year, season and danger class. Preliminary results of the analysis were included in a report entitled "A problem analysis of forest fire research in Alberta (1964)".

16. Goals Set One Year Ago : Preparation of a closing report.

17. Accomplishments in Last Year: Preparation of a closing report.

Kiil, A. D. and D. Quintilio. 1968. Forest fires and fire danger rating in Alberta, 1957 - 1963. Information Report. In press.

A decision was made to keep this project as a vehicle for periodic evaluations of danger rating systems used in Alberta.

18. Goals for Next Year : Plans for next one-year period are indefinite but work may be resumed when the new Canadian danger rating system becomes available for field use. The decision to proceed with an assessment of the reliability of the U.S. National and the new Canadian National danger rating systems will depend primarily on the number of usable fire reports available for analysis.

A. D. Kiil
Investigator

Project No. A 289

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: March, 1969.

2. Title : Fire intensity and rate of spread in lodgepole pine slash

3. Investigator : D. Quintilio

4. Year of Commencement: 1968

5. Anticipated Year of Completion: Original 1971

6. Key Words not in Title: Prescribed burn, danger rating, slash hazard, behaviour, *Pinus contorta*, SA 1.

7. Activity : Fire

8. Problem Area Program: Increased efficiency of fire danger assessment and forecasting.

9. Establishment Project No.: A 289 Branch Project No.: A 289

10. Status : Active

11. Man-years Utilized in Past Year: Professional 0.8 Other 0.4

12. Co-operating Agency : Alberta Forest Service

13. Location of Work : Kananaskis Research Forest

14. Abbreviated Background Statement: The clear-cut method of harvest in lodgepole pine adds large volumes of slash to the site. The slash creates a formidable fire hazard and the logging creates a regeneration problem. Prescribed burning, with its two immediate objectives - 1) slash hazard reduction and 2) silvicultural preparation of the site, is then a potentially useful management tool.

Properly prescribed fire can effectively reduce fuel quantity, prepare a seedbed, reduce competition from vegetation and improve the nutrient regime on a given site. To accomplish this consistently, however, with predictable results and at a level of risk acceptable to management requires basic knowledge of fire behaviour relative to fuel volume, arrangement and moisture content.

The ultimate objective of this project is the development of a rational basis for prescribed burning in the lodgepole pine type in the Subalpine and a slash hazard table in terms of rate-of-spread and moisture content of fuels that can be used both for prescribed burning and fire suppression. The initial objectives however are necessary to gain some concept of the fire intensity and rate of spread under a range of build-up indices.

An accompanying study (A 286) has been initiated by F. Endean to examine the silvicultural implications of the prescribed burning undertaken in this project.

15. Summary of Progress up to One Year Ago: Preparation of project proposal.

16. Goals Set Last Year : In 1968, sixteen 1-acre burning plots were to be established, the forest cover harvested, and the slash burned under prescribed conditions.

17. Accomplishments in Last Year: Experimental plots were established on a 25-acre area and all relevant stand and site information obtained. Logging was completed but not early enough in the fire season to permit completion of the burning program with uniform slash conditions. As a result, burning of the plots has been delayed until 1969. All fire lines have been constructed and documentation of fuel characteristics completed. A single test burn was also undertaken to assure that the fire plan for the experiment is satisfactory.

18. Goals for Next Year : Complete the burn on the 16 plots under prescribed hazard conditions and measure rate of spread, fire intensity and depth of burn.

"D. Quintilio" per RW Reid
D. Quintilio
Investigator

PROBLEM AREA PROGRAM

Increased Efficiency in Fire Suppression Methods

Fire suppression methods must be constantly strengthened on the basis of what research and development and fire-control experience have made known. Even small improvements in offensive capabilities of air and ground suppression methods may help contain small fires which otherwise would escape. Locally in co-operation with the Alberta Forest Service the research and development program has concentrated on the systematic use of fire-bombing aircraft with water and fire retardant chemicals. Field tests of different combinations of air tankers and fire retardants were made in 1967 and 1968. Initial field tests are completed and results are being evaluated. Prepared guidelines for the use of air tankers and fire retardants in Alberta will be completed within a year. At present there is one project directly related to the problem:

A 279 : Field tests of fire retardants in Alberta - J. E. Grigel.

Project No. A 279

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Field tests of fire retardants in Alberta.

3. Investigator : J. E. Grigel

4. Year of Commencement: 1968

5. Anticipated Year of Completion: Original 1970

6. Key Words not in Title: Chemical control, aerial suppression, airtankers.

7. Activity : Fire

8. Problem Area Program: Increased efficiency of fire suppression methods.

9. Establishment Project No.: A 279 Branch Project No.: A 279

10. Status : Active

11. Man-years Utilized in Past Year: Professional 1 Other 2.5

12. Co-operating Agencies: Protection Branch, Alberta Forest Service.

13. Location of Work : Edson and Slave Lake, Alberta.

14. Abbreviated Background Statement: Both land- and water-based firebombing aircraft play an important role in the suppression of wildfires. The use of such aircraft for quickly striking at small wildfires and aiding ground crews in suppressing large wildfires has increased the efficiency of the forest fire control agencies. The utilization of airtankers and fire retardants in Alberta is increasing and a sizable portion of the overall fire suppression bill is comprised of airtanker and fire retardant costs.

The effectiveness of airtankers in retarding or extinguishing wildfires greatly depends upon the type of fire retardant used. Drop characteristics of different materials vary, thus the ground distribution patterns and effectiveness of the retardant drops vary. Interception of retardant loads by crown canopies may have an influence on the "effective" patterns formed by aerially-applied retardants.

Objectives are: 1. to determine through calibration tests: a) the distribution patterns of fire retardant drops by an airtanker on to an open area; and b) the distribution patterns and extent of crown penetration of fire retardant drops on to representative forest cover types.

2. to establish guidelines for the use of airtankers and fire retardants in Alberta.

The ground distribution patterns formed with different airtanker/fire retardant combinations provide a relative comparison of the effectiveness of these combinations. The minimum application rates of fire retardants necessary to retard or extinguish fires burning in different fuels under varying burning conditions provide a means for directly rating the effectiveness of airtanker/fire retardant combinations. At present, such data are lacking. However, rates of application are being determined by the Forest Fire Research Institute, Ottawa. The results of the FFRI study when combined with the results of this project will provide the necessary information for directly rating airtanker/fire retardant combinations.

Results of this project will enable the selection of the most suitable type(s) of airtanker and fire retardant, and provide guidelines for the use of airtankers and fire retardants during wildfire operations. Results will be included in a computer-oriented study on airtankers being conducted by the Forest Fire Research Institute.

15. Summary of Progress up to One Year Ago: Preliminary field investigations were made in 1967. Procedures for air drop tests in open areas and forest stands were modified and/or developed. A series of drop tests using the Snow Commander S-2D airtanker and GELGARD F short-term fire retardant was conducted to provide background information for this project.

The success of long-term retardants in the Western United States and British Columbia will undoubtedly lead to their introduction into other areas. Two long-term retardants which have proven effective in aerial fire suppression activities in these regions are Phos-Chek 205 and Fire-Trol 100. An extensive literature review indicated that little information concerning the drop characteristics of these two retardants and GELGARD F retardant, which is used in Alberta, is available.

16. Goals Set One Year Ago: A series of air drop tests with the Snow Commander S-2D airtanker using Phos-Chek 205 and Fire-Trol 100 will be carried out. The drops will be made in an open area and three representative forest types; lodgepole pine, white spruce, and white spruce-aspen. Air drops using GELGARD F retardant will supplement the 1967 drop tests. However, emphasis will be placed on the long-term retardant drops because of their likely introduction and subsequent de-emphasis in the use of GELGARD F.

The possibility of conducting air drop tests with PBY Canso skimmer-type waterbomber, using both water and GELGARD M retardant, will be explored.

17. Accomplishments in Last Year: 1. Twenty-nine drop tests were made with the Thrush Commander and Snow Commander S-2D airtankers using Phos-Chek 205 and Fire-Trol 100. The Thrush Commander is a modified and larger version of the Snow Commander. The addition of the Thrush aircraft necessitated the omission of the test drops in the white spruce stand. Air drops using GELGARD F were also omitted because of the introduction of long-term retardants on wildfire operations. This series of drop tests is complete.

2. Forty-three drop tests were made with the PBY Canso waterbomber using water and GELGARD M. The drops were released onto an open area, and white spruce and white spruce-aspen stands. This test series is complete. The nitrogen-injection system for mixing GELGARD retardant in the PBY Canso was evaluated during the air drop tests.

3. TX-350, a potential long-term fire retardant was field tested. Mixing, handling and storage tests and four air drops with the Thrush Commander were made in conjunction with the long-term retardant drop tests.

4. Data analysis of the 1967 Snow Commander S-2D/GELGARD F air drops has been completed; analysis of the 1968 air drop test data has been partially completed.

5. Reports: Grigel, J. 1969. Evaluation of TX-350 -- a new long-term fire retardant. Internal report.

Grigel, J. 1969. Evaluation of the nitrogen-injection system for mixing GELGARD fire retardant in skimmer-type waterbombers. Information report (In press).

Grigel, J. 1969. Fire retardant tests in Alberta. Research News, Department of Fisheries and Forestry - Canada. January-February 1969.

18. Goals for Next Year : 1. Complete analysis of 1968 air drop test data and publication of results.

2. Prepare guidelines for use of airtankers and fire retardants in Alberta.

3. Reports: Grigel, J. Air drop tests with the Snow Commander S-2D airtanker and GELGARD F fire retardant. Proposed information report.

Grigel, J. Air drop tests with the PBY Canso waterbomber in Alberta. Proposed information report.

Grigel, J. Air drop tests with Phos-

Chek 205 and Fire-Trol 100 long-term fire retardants. Proposed information report.

J. E. Grigel
Investigator

FOREST PRODUCTS RESEARCH

Forest products research in the Alberta/NWT/Yukon region is concerned with wood utilization and harvesting. The work program is aimed at improving utilization of small dimension timber, wood recovery of poplars and increased production of quality products. Work includes industrial liaison and technical advisory services. When necessary, local products problems are referred to the Forest Products Laboratories at Vancouver and Ottawa.

PROBLEM AREA PROGRAM

Improved Utilization of Trees

The long term economic prosperity of the region is dependent largely on permanent and maximum productive capacity of its commerical forest lands. An assessment of forest utilization shows problems of major proportion in such areas as poplar utilization, efficient economic use of small dimension timber and in residue utilization. In most cases an inter-disciplinary research program is needed if better use of the species and the small timber resources is to be obtained.

A vital area of research need is the poplars which occur in pure or mixed stands on approximately 65 per cent of the 57,000 square miles of highly productive forest land in Alberta. The various alternatives for the portions of this productive forest land that now support the Populus species appear to be: (1) minimal protection or management action, (2) conversion to agricultural land uses, (3) conversion to coniferous forest types, (4) management for other products and services, such as water wildlife and recreation, and (5) management for pulp, fibre board, particle board or chemical products. In the absence of economic demands for use of the forest lands that now supports poplar the first of the five alternatives will probably predominate. This circumstance however, will allow comprehensive research of this forest land and its component species to precede management decisions. Effective encouragement, maintenance or conversion of poplar forest will, as with any other forest species, be dependent upon a knowledge of the biology of the species present and upon an understanding of the functional relationships within the ecosystems concerned. Improved utilization of poplar species will be dependent in part, upon the knowledge of relationships between wood quality and site. Research emphasis in this problem area includes studies designed to improve our ecological knowledge of poplar forests and to assess geographic variation of various physical wood properties to establish methods of estimating wood quality in poplar stands. Other studies to assess and evaluate total organic matter production in poplar and lodgepole pine are aimed at intensifying our basic knowledge that will provide total utilization and more intensive forest management.

Other studies are seeking new information of the effect of heartshake on spruce lumber recovery and the relationship between the occurrence of heartshake and stand and site conditions. This knowledge is immediately useful to improve the precision of log grades, improve the grading systems and provide data for evaluating standing timber for defect.

At the moment research bearing on this problem area include the following projects:

A 282 : Effect of heartshake on spruce lumber recovery in northern Alberta - T. Szabo.

A 287*: Structure, biomass and productivity of poplar forests in Alberta - E.B. Peterson.

A 290**: Poplar habitats in the mixedwood section of Alberta - H.G. Anderson.

A 291*: Organic matter production in lodgepole pine - W.D. Johnstone.

A 293 : Physical properties of aspen in Alberta - J. Kasper.

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*Project statements appear under problem - "Tree and Stand Growth Measurement"

**Project statement appears under problem - "Silvical characteristics of Trees"

Project No. A 282

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Heart Shake and spruce lumber recovery in northern Alberta.

3. Investigator : T. Szabo.

4. Year of Commencement: 1968.

5. Anticipated Year of Completion: Original 1968. Revision I 1970.

6. Key Words not in Title: Picea glauca cull, degrade, spiral grain.

7. Activity : Forest Products.

8. Problem Area Program: Improved utilization of trees.

9. Establishment Project No.: A 282 Branch Project No.: A 282

10. Status : Active.

11. Man-years Utilized in Past Year: Professional .25 Other .50

12. Co-operating Agencies: Alberta Department of Lands & Forests, Alberta Forest Products Association, Vancouver Forest Products Laboratory.

13. Location of Work : Footner Lake Forest.

14. Abbreviated Background Statement: The quality of a forest stand is measured by the grades of the products it could produce. This important factor enters into appraisal of the stumpage value of a particular timber type or timber sale.

In the past, sawmill operators have been concerned with the problem of low lumber recovery owing to heart shake in old growth spruce stands, at several locations in Alberta and northern British Columbia. Major problem areas are Keg River, Athabasca and Fox Creek in Alberta and Chetwynd in British Columbia. Past studies conducted by the Alberta Forest Service and Vancouver Forest Products Laboratory dealt only with the approximate loss in lumber recovery owing to heart shake. No attempt was made to relate the shake problem to forest stand conditions. The object of this study is to investigate the loss in lumber recovery owing to heart shake in white spruce and to establish the relation between heart shake and stand conditions.

15. Summary of Progress up to One Year Ago: Problem analysis and literature review were completed. The sample area was selected and a sawmill study completed.

16. Goals Set One Year Ago: Study will be completed in 1969.

17. Accomplishments in Last Year: The first study was completed. The Alberta Forest Service requested that the project be continued and proposed another sampling location. J. A. McIntosh presented a paper at the 1968 Annual Meeting of the Alberta Forest Products Association in Edmonton.

Reports:

Szabo, T. and J. A. McIntosh, 1969. An investigation of defective white spruce in Alberta. Department of Fisheries and Forestry. Internal Report. 14 p.

18. Goals for Next Year : Complete a second mill study, evaluate results and prepare a closing report.

T. Szabo

T. Szabo,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.
2. Title : Physical properties of aspen in Alberta.
3. Investigator : James B. Kasper.
4. Date of Commencement: 1968.
5. Anticipated Year of Completion: Original 1971.
6. Key Words not in Title: specific gravity, ring width, moisture content, *Populus Tremuloides*, cull, volume growth.
7. Activity : Forest products.
8. Problem Area Program: Improved utilization of trees.
9. Establishment Project No.: A 293 Branch Project No.: A 293
10. Status : Active
11. Man-years Utilized in Past Year: Professional 1 Other 2½
12. Co-operating Agencies: Alberta Department of Lands and Forests, Forest Products Research Laboratory, Vancouver, B. C.
13. Location of Work : Poplar forests of Alberta, Calgary Laboratory, Forest Products Laboratory, Vancouver, B. C.
14. Abbreviated Background Statement: In order to promote the utilization of aspen it is necessary to define the raw material in parameters that industry requires, i.e. specific gravity, volume and cull. This information is also required for future research in aspen utilization. Reviews of published data provide general information on the properties of aspen wood but do not indicate the variations of aspen in Alberta. Collection of information on the physical properties of aspen on a province-wide basis is required for establishment of basic relationships between wood properties and forest site, and defining factors for estimating wood quality in poplar stands.
15. Summary of Progress up to One Year Ago: Completed problem analysis, completed initial literature review, prepared project proposal, select sample plot locations.
16. Goals Set One Year Ago: Establish final field methods, obtain measurements and wood samples from approximately 70 sample plots and begin laboratory analysis of physical properties of wood.

17. Accomplishments in Last Year: Final methods were established and 24 plots were sampled and laboratory analysis of wood samples completed.

18. Goals for Next Year : Sample 50 plots and complete required laboratory work. Establish necessary computer programs and evaluation of results.

James B. Kasper

James B. Kasper,
Investigator.

FOREST ECONOMICS RESEARCH

Forest economics research and services seek to clarify and demonstrate the economics of forestry, forest industries and the regional research programs. It provides information required by forest management to formulate policies and practices intended to promote optimum use and protection of forest resources. Studies are also aimed at appraisal of regional research policy and programs, to assist in providing for the efficient allocation of forestry research funds and staff. Because of recent staff changes, there are no established projects at this time. A senior forest economist is now available; research needs are being assessed and program plans prepared for the next several years.

LIAISON, DEVELOPMENT AND FORESTRY SERVICES

Liaison, development and forestry services program in the Alberta/NWT/Yukon region aims to provide information necessary to improving the value of forest research results and the definition and evaluation of management and protection problems. While strongly oriented to research development and demonstration, the program is integrated with those of other research groups to deal with the applied phases of problem area programs. Where it is appropriate individual liaison and development projects are included under resources or protection research groups.

PROBLEM AREA PROGRAM

Improved Forest Tree Nursery Production

Under current practice the problems encountered in forest tree nurseries result from inefficient knowledge of the nutritional requirements of the tree species used, the soil treatments, cultural operations, handling operations and the susceptibility to damage from pests. The problem is urgent because the production of high-grade vigorous planting stock is essential to any long-term planning in the regeneration silviculture program. The Province of Alberta is already committed to a policy of sustained yield forestry involving reforestation of cutover and burned areas. The uncertainties of natural regeneration in many areas lead to the necessity of using both conventional and assisted tree seedlings.

A collaborative program of research and especially development in applied work was established by the Forestry Branch in 1967 with the Provincial Tree Nursery at Oliver. Initial work is concentrated on nutrition and fertilization, applied nursery operations and disease control. The program is being built to complement the silvicultural and protection research programs being conducted by the Branch in the Region. The necessary information on the initial phases of the nursery research and development studies will be available by 1973-74. An active program of investigation should be expected to continue and become more comprehensive as the regular nursery operations improve and as conditions of production change. The projects associated with the nursery program include:

A 285*: Physiology of reactions of roots of tree seedlings to fungal attack - D. Hocking.

A 300 : Nutrition and fertilization of nursery seedlings - D. Hocking.

A 301 : Nursery operations - D. Hocking.

A 302 : Nursery disease control - D. Hocking.

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*Project statement appears under problem - "Reduction of Losses from Root Diseases"

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.
2. Title : Nutrition and fertilization of nursery seedlings.
3. Investigator : D. Hocking.
4. Year of Commencement : 1967.
5. Anticipated Year of Completion: Original 1973.
6. Key words not in Title : *Picea glauca*, *Pinus contorta*, Alberta.
7. Activity : Liaison and Management.
8. Problem Area Program : Improved tree nursery production.
9. Establishment Project No.: A 300 Branch Project No.: A 300
10. Status : Active.
11. Man-years utilized in Past Year: Professional .25 Other .70
12. Co-operating Agencies : Alberta Department of Lands and Forests, Alberta Department of Agriculture.
13. Location of Work : Alberta Tree Nursery, Oliver.
14. Abbreviated Background Statement: The Province of Alberta is committed to a policy of sustained yield forestry involving reforestation of cut-over and burnt-over areas. The uncertainties of natural regeneration, scarification, and direct seeding lead to a necessity in some areas for planting seedlings, either conventional or assisted - by some sort of container. The large areas to be planted and the difficulty of site and climate require large-scale production of high-grade, vigorous planting stock.

Prior to 1967, the Alberta Tree Nursery at Oliver was operated without regular, planned fertilization of seedbeds or transplant fields, owing in part to a lack of knowledge of plant requirements. Production of container seedlings by the Alberta Department of Lands & Forests was initiated in 1967 and encountered serious problems arising in part from poor nutritional status of the seedlings.

The objectives of this project are:

1. To determine the fundamental nutritional requirements of major Alberta forest tree species.

2. To develop practical application of chemical fertilizers suitable for soil and climate conditions prevailing at the Oliver Nursery, and for container seedlings.

15. Summary of Progress up to One Year Ago: A problem analysis during 1967 revealed the areas where research was necessary and a literature review gave information on nutrient requirements of other species and fertilizer regimes at other nurseries. Soil analyses of areas at the Oliver Nursery indicated acute phosphorus deficiency and low nitrogen in all areas.

Necessary equipment was obtained and experiment plans developed for greenhouse sand cultures of important species and for seedbed experiments the following year.

16. Goals Set One Year Ago :

1. Determine macro-element nutrition for *Picea glauca*, *P. pungens*, *Pinus contorta*, and *P. sylvestris* through sand cultures with top-irrigation, drained to waste.

2. Establish seedbed and field-plot trials of commercial fertilizers, following greenhouse pot-tests for phytotoxic levels.

3. In co-operation with Alberta Dept. of Agriculture, prepare a fertilizer working plan for the Oliver Nursery, especially seedbeds and current transplanting fields.

4. Test nutritional levels obtained in early results from No. 1 above, for raising of container seedlings. In addition test the use of K alone (without N or P) for "physiological hardening-off" of container seedlings.

5. Establish nursery and field trial plantings of containers grown under fertilization regimes of No. 4 above.

17. Accomplishments in Last Year:

1. Excellent growth of all four species studied was obtained under the best of the nutritional regimes studied in sand cultures. Two repetitions in time were completed of the experiment. Early results indicated appropriate N.P.K. ratios for fertilization of seedbeds and of container seedlings.

2. Pot-scale tests indicated no loss of germination at levels of urea up to 200 lbs/acre and superphosphate up to 1000 lbs/acre. Field and seedbed trials of commercial fertilizers for white spruce and Colorado spruce and for lodgepole pine were established and first-year assessments made.

3. A fertilizer working plan was prepared and put into effect by the Nursery management. New soil samples were taken in autumn 1968 for testing to provide data for a rational working plan in 1969.

4. Excellent growth of container seedlings of white spruce and lodgepole pine was obtained on a liquid fertilizer regime based on results in No. 1 above. Losses of lodgepole pine to root-rot wiped out the stock, but seedlings of white spruce were planted in the nursery and in the field (at Rocky Mountain House), on dry and fresh sites.

5. Early results suggest that high K "physiological hardening-off" does not aid initial survival.

18. Goals for Next Year :

1. A final repetition of the sand culture macro-nutrient experiment will be run. Foliar analyses will be performed on the seedlings produced and the data analyzed and written up.

2. Re-assessments will be made of field and seedbed fertilizer experiments. Mid-summer top dressings with urea will be tested.

3. Further soil samples will be taken. Data from Nos. 1 and 2 above should enable optimum fertilizer prescriptions to be drawn up. Full data will be made available to Nursery personnel to enable them to assume fertilizer planning in future.

4. Nursery and field trial plantings of container seedlings will be re-assessed for survival and early growth, reflecting their fertilizer regimes during greenhouse rearing.

5. An ad hoc trial of "Osmocote" slow-release fertilizer will be established for rearing of container seedlings of white spruce and lodgepole pine. Seedlings whose containers contain "Osmocote" will be raised with a complete fertilizer and planted out in nursery and field. Initial survival will be assessed in the autumn.

Reports and Publications :

Hocking, D. Macroelement requirements in Alberta for _Picea glauca_, _P. pungens_, _Pinus contorta_, and _P. sylvestris_. (Proposed journal publication).

D. Hocking,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Data: February, 1969.

2. Title : Nursery operations.

3. Investigator : D. Hocking

4. Year of Commencement : 1968

5. Anticipated Year of Completion: Original 1974

6. Key Words not in Title : soil amelioration, pruning, stock density control.

7. Activity : Liaison and Management.

8. Problem Area Program : Improved tree-nursery production.

9. Establishment Project No.: A 301 Branch Project No.: A 301

10. Status : Active

11. Man-years Utilized in Past Year: Professional .25 Other .50

12. Co-operating Agencies : Alberta Department of Lands & Forests, Alberta Department of Agriculture.

13. Location of Work : Alberta Tree Nursery, Oliver.

14. Abbreviated Background Statement: The need for raising tree seedlings has been outlined in the background for related Project No. A 300 (Nutrition and fertilization of nursery seedlings). The Oliver Nursery has developed since 1952 on an ad hoc basis, initially under the Alberta Department of Lands & Forests, then under the Department of Agriculture to produce shelterbelt stock. After 1963, forest tree seedling production was again started, and with implementation of the quota system requiring reforestation of exploited areas in 1966, the need for seedlings greatly increased.

In the early period of the nursery, much of the labour requirement was met with voluntary labour from the nearby prison and mental institution. With greatly increased production, it has become imperative to mechanize many operations previously performed by hand labour.

The present site is mostly of a clay-loam texture, with highly undulating topography in some areas, leading to large local variation in soil p^H and nutrient constitution. Furthermore, owing to the ad hoc and piecemeal development of the nursery on an available site, it was found that much capitalization precluded consideration of an alternative site when forestry operations increased.

This project will deal with improvements in nursery general practices, including soil treatments and chemical and mechanical innovations for seeding, weed control, cultural operations, and seedling handling.

15. Summary of Progress up to One Year Ago: Considerable time was devoted initially to liaison and advisory work.

Discussion with the Nursery Management led to adoption of the policy of scalping and levelling of seedbed areas, at a rate of several acres annually as finances permit.

Counts of stand densities in a number of seedbeds of different planting years showed wide variations, ranging from a desirable 40 plants per square foot to the extreme of 320 plants per square foot.

16. Goals Set One Year Ago :

1. Test additions of sand and organic matter for soil texture amelioration.

2. Test the addition of sulphur to lower soil p^H in seedbeds of high p^H.

3. Initiate a series of seedbed germination tests at 3 rates of sowing, to determine optimum stand densities and "nursery factor" (loss estimate).

4. Root-prune several seedbeds at several frequencies on split-plots, as an ad hoc study of effects.

5. Determine periodicities of root growth in order to rationalize root-pruning operations in future.

6. Fumigate some seedbeds prior to sowing, as a weed control treatment. This relates also to Project No. A 302 (Nursery disease control).

17. Accomplishments in Last Year:

1. A major experiment was established testing the addition of sand, peat, sulphur, and fumigation (see Nos. 1, 2, 6 above) to seedbeds in a Latin Square design. Seeds of 3 lots of white spruce and 1 lot of each of Colorado spruce and lodgepole pine, each at 3 sowing rates (50, 100, and 150 viable seeds/sq.ft.), were sown into each plot of the Latin Square of soil treatments; replicated 3 times in randomized blocks (see No. 3). Fumigation gave good control of weeds up to mid-August.

2. Seedbeds of 1-0 and 2-0 white spruce and of 2-0 lodgepole pine were root-pruned in June and August on a split-plot basis. Before and after samples were taken and root-prints made photographically to follow the effects (see 4).

3. Root observation frames were made and seedlings transplanted into them, but problems of moisture relations and root manipulation arose and no useful data were gathered. The frames are being re-designed.

18. Goals for Next Year :

1. Stand density counts will be made in all plots described in 17-1 above. Soil samples will be taken for P^H and nutrient status determinations.

2. Further sowings will be made at 3 sowing rates in single plots replicated 3 times in randomized blocks, for repetition in time of the seedbed germination tests.

3. Seedlings root-pruned in 1968 will be lifted and root development examined. Further root prunings will be carried out, including lateral or vertical root pruning.

4. Observations of periodicity of root growth will be made by destructive sampling at weekly intervals from new seedbeds and from 1-0 and 2-0 of white spruce and lodgepole pine. Assessment will be on the basis of relative numbers of new white root tips.

5. All seed lots of white spruce and lodgepole pine sown in spring 1969 will be sampled and assessed for the effect of routine stratification on germination and initial growth.

For white spruce, all lots will be stratified and 2 oz. samples will be sown in an adjacent bed as a control. For lodgepole pine, all lots will be sown without stratification and 2 oz. samples will be stratified and sown in an adjacent bed as an experiment. For all lots of both species, both stratified and unstratified, laboratory germination tests will be carried out at the time of sowing.

6. The effect of mudding roots upon tolerance of brief exposure to drying out will be explored.

D. Hocking,
Investigator.

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February,1969.

2. Title : Nursery disease control.

3. Investigator : D. Hocking

4. Year of Commencement : 1968

5. Anticipated Year of Completion: Original 1973

6. Key Words not in Title : damping-off, poplar cankers, chemicals, biological and cultural controls.

7. Activity : Liaison and Management

8. Problem Area Program : Improved tree-nursery production.

9. Establishment Project No. : A 302 Branch Project No.: A 302

10. Status : Active

11. Man-years Utilized in Past Year: Professional .25 Other .50

12. Co-operating Agencies : Alberta Department of Lands and Forests, Alberta Department of Agriculture, Manitoba-Saskatchewan Region.

13. Location of Work : Edmonton Laboratory, Alberta Tree Nursery, Oliver.

14. Abbreviated Background Statement: The need for raising tree seedlings has been outlined in the background for related Project No. A 300 (Nutrition and fertilization of nursery seedlings). At the Oliver Nursery, factors other than diseases have in the past been the limiting factors to stock quality and production. With improvements in fertilization and general management, disease conditions will become more prominent.

There are already, however, two disease complexes which have been causing significant damage. One is damping-off in coniferous seedbeds and in container seedlings. The other is cankering of poplars in stooling beds and in lined-out cuttings.

15. Summary of Progress up to One Year Ago: The condition of poplar stooling beds at the Oliver Nursery was so severe, there being no shoot not diseased, that it was recommended to the Nursery Management that they be uprooted and burned. This was done, and poplar whips (for cuttings) are now shipped from the Horticultural Station, Brooks, where cankering is a lesser problem.

Damping-off in seedbeds was assessed to range from 5% up to 35%, while losses to container seedlings ran as high as 80%. Discussions with Dr. Carlson of Manitoba-Saskatchewan Region established areas of research interest. Manitoba-Saskatchewan will perform primary screening of candidate fungicides, while Alberta will co-operate with field tests of promising materials.

16. Goals Set One Year Ago :

1. Assess cuttings of poplar whips supplied from Brooks for presence of canker organisms.

2. Initiate surface-sterilization of poplar cuttings as a routine practice by soaking for 20 minutes in 2% "Semesan", before storage (method after Ford and Waterman 1952).

3. Test sealing of cut ends of cuttings by dipping into latex, wax, or tree paint, to reduce the most susceptible infection court.

4. Assess results of 2 and 3 above in terms of mortality, growth, and disease incidence after operational lining-out in the field.

5. Test in greenhouse and seedbeds, 12 candidate fungicides for control of damping-off, as supplied by Dr. Carlson.

6. Test seedbed fumigation with Vapam, to control damping-off.

17. Accomplishments in Last Year:

1. Leaf scales and lenticels of cuttings from Brooks were found to be 100% infected by canker organisms.

2. A dipping tank and baskets were made in the nursery workshops for operational surface sterilization of cuttings by soaking in 2% "Semesan".

3. Cuttings sealed with latex, wax or tree paint all survived equally well as cuttings only "Semesan"-treated.

4. Cankering was reduced to less than 1% on lined-out cuttings, as compared to 100% incidence in 1967 without surface sterilization.

5. All 12 fungicides gave significant control of damping-off in the seedbed tests; but losses in the greenhouse varied significantly among replicates, so no significances could be drawn from the treatments.

6. The Vapam-fumigated seedbeds were sown with lodgepole pine, white spruce and Colorado spruce, each at 3 sowing rates.

18. Goals for Next Year :

1. Compare disease incidence, mortality and growth of poplar cuttings soaked in 2% "Semesan" or in 2.2% "Semesan Turf Fungicide", which is to replace "Semesan" as a standard product.

2. Write a report on operational surface sterilization of poplar cuttings.

3. Repeat greenhouse and seedbed tests of chemicals for control of damping-off.

4. Test further new candidate fungicides for damping-off control, supplied by Dr. Carlson.

5. Count stand densities in seedbeds in Vapam-fumigated seedbeds to determine losses.

6. Test aseptic methods of raising container-seedlings, including surface-sterilization of seed.

D. Hocking,
Investigator.

PROBLEM AREA PROGRAM

Agricultural Zone Forestry and Amenity Planting

The concept of agricultural zone forestry in Alberta has become sharply emphasized as the increasing needs of land utilization, soil conservation and water conservation become defined. Shelterbelt plantings are used extensively for soil and water conservation, protection of highways, drainage ditches and dugout water reservoirs and for the development of recreational areas and other aesthetic purposes. The shelterbelt research program was implemented in 1967 to provide assistance and technical advice for proper silvicultural practice and effective use of shelterbelts. It is felt that the greatest advances can be made by way of applied research with emphasis on the use of proper species and planting sites, establishment practices, care and replacement and design in composition of shelterbelts. Close liaison and cooperation is maintained with the Plant Products Division, Alberta Department of Agriculture. Initial studies in this program area include the following projects:

A 298 : Shelterbelt trials demonstrations - K. Froning.

A 299 : Performance of tree shrubs species in shelterbelts of Alberta - K. Froning.

Project No. A 298

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon   Date: February, 1969.

2. Title : Shelterbelt trials and demonstrations.

3. Investigator : K. Froning.

4. Year of Commencement: 1967.

5. Anticipated Year of Completion: A continuing project.

6. Key Words not in Title: windbreaks, planting, spacing, provenance, Alberta.

7. Activity : Liaison and Management.

8. Problem Area Program: Agricultural zone forestry and amenity planting.

9. Establishment Project No.: A 298   Branch Project No. A 298

10. Status : Active.

11. Man-years Utilized in Past Year: Professional 0.6 Other 0.5

12. Co-operating Agencies: Canada Dept. of Agriculture - Research Station, Lethbridge.
Canada Dept. of Agriculture - Research Station, Beaverlodge.
Alberta Dept. of Agriculture - Plant Industry Division.
Canadian Penitentiary Service - Drumheller Institution.
Chemical Industry - Chipman, Niagara, Green Cross, Allied, Fisons.

13. Location of Work : Agricultural regions of Alberta.

14. Abbreviated Background Statement: Much valuable shelterbelt research has been carried out by scientists in the United States. Of particular interest to research and management agencies in Alberta are results from studies in the Northern Great Plains including: Wilson and Cobb (1923), Johnson and Cobb (1928), Harrington and Morgan (1930), Jensen and Harrington (1930), Scholtz (1935), Towle (1929), Aune, Hurst and Osenburg (1934), Matthews and Clarke (1937), George (1936, 1943, 1939, 1948, 1953), Wilson (1937), Ware (1936), Cram (1960), Cram and Brack (1953), Dawson (1966), Read (1964) and Munns and Stoeckler (1946).

Differences in soil and climate in Alberta from that of the Great Plains make it necessary not only to test research and operations results and conclusions obtained in the Northern Great Plains, but also to find new and improved methods and species for Alberta shelterbelts (Baranyay 1967). As a result of a shelterbelt survey in Alberta, Baranyay (1964) recommended provenance studies for various conifers and hardwood species and also suggested that spacing and species composition be tested. Baranyay also concluded that transportation and poor planting practices were frequently responsible for low survival of shelterbelt plantings.

The number of poorly established, deteriorated and inefficient shelterbelts in Alberta also indicates that investigations should be made of practical and useful rehabilitation practices. Results of investigations could be of immediate benefit to shelterbelt owners in Alberta.

15. Summary of Progress up to One Year Ago: Problem analysis.

16. Goals Set One Year Ago:

(a) Shelterbelt establishment:
(1) Preplanting treatment of coniferous shelterbelt stock to relate the survival and early development of some conifers in terms of pre-planting treatment and handling.

(b) Shelterbelt management:
(1) To examine and select candidate shelterbelts for prescribed treatment and investigation, and to initiate application of treatments on a limited scale.

(c) Shelterbelt species and provenance trials:
(1) To plant and maintain single-row hedge plantings on the property of the Drumheller Institution, and to establish these rows at various spacings with as many species as available through the Alberta shelterbelt program.

(2) To line out and care for ponderosa pine provenance trial transplants on the property of the Drumheller Institution. The stock, originating with the U. S. Forest Service, comprise 4900 seedlings from 70 sources.

17. Accomplishments in Last Year:

(a) Shelterbelt establishment:
(1) The pre-planting treatment of coniferous shelterbelt stock was carried out and results suggest that a more detailed study on some aspects of storage and handling can provide more specific answers.

(b) Shelterbelt management:
(1) Numerous shelterbelts which are well suited for prescribed treatment have been located and some have been treated on a pilot scale, including weeding, sanitation and thinning.

(c) Shelterbelt species and provenance trials:
  (1) Shelterbelt species available through the Alberta shelterbelt program have been planted at various spacings on the experimental area of the Drumheller Institution.

  (2) Completion of lining out of ponderosa pine provenance material.

  (3) Maintenance and treatment of newly established plantations and future planting sites.

18. <u>Goals for next year</u>:

(a) (1) Establishment of demonstration field shelterbelts in the Drumheller and Brooks areas by utilizing several species planted at various spacings.

  (2) Planting trials involving evaluation of deep planting and the use of chemicals at the time of planting.

(b) (1) Establishment and treatment of plots in shelterbelts to demonstrate treatments and effects.

  (2) Herbicide trial in an established field shelterbelt near Camrose.

(c) Shelterbelt species and provenance trials:
  (1) Field planting and establishment of ponderosa pine provenances.

  (2) Field planting and maintenance of additional trial species.

K. Froning

K. Froning,
Investigator.

Project No. A 299

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/Territories Region Date: January, 1969.
2. Title : Performance of tree and shrub species in shelterbelts of Alberta.
3. Investigator : K. Froning.
4. Year of Commencement: 1968.
5. Anticipated Year of Completion: Original 1970.
6. Key Words not in Title: windbreak, growth, hardiness, climate, soil.
7. Activity : Liaison and Management.
8. Problem Area Program: Agricultural zone forestry and amenity planting.
9. Establishment Project No.: A 299 Branch Project No.: A 299
10. Status : Active.
11. Man-years Utilized in Past Year: Professional 0.3 Other 0.4
12. Co-operating Agency : Alberta Department of Agriculture.
13. Location of Work : Agriculture zones of Alberta.
14. Abbreviated Background Statement: Experience has shown that off-site planting is frequently responsible for poor shelterbelts in Alberta. Often personal preference has been the major criterion used by the landowner in planning shelterbelts and often this preference has been based on success and aesthetic value of a particular species in a different climatic and soil zone.

    Environmental conditions may be directly responsible for poor establishment and slow growth or indirectly responsible by predisposing trees of low vigour to insect and disease damage. Frequently this leads to the failure of an otherwise well-designed and maintained shelterbelt.

    Species suitability investigations for various sites have been undertaken by George (1953) and Hoag (1965) in the Northern Great Plains region of the United States. The results of these investigations however, can only provide leads to the selection of species as climate and soils differ considerably from those in Alberta.

    In 1963 Baranyay (1964) conducted a broad survey of shelterbelts in Alberta, and made a tentative evaluation of species performance on various sites. In a later report Baranyay (1967) recommended intensive studies to relate species performance to climatic and edaphic factors.

Field information on species performance is necessary if shelterbelt management is to depart from single-species shelterbelts and the inherent risk of monoculture.

Preparation of a comprehensive zone map for shelterbelt management will be a basic document for the assessment of established shelterbelts and in planning future operations and research. Several types of zone maps are now available (a) Alberta Horticultural Guide (Anon. 1965) (b) Shelterbelt region of Alberta (Baranyay 1964) and (c) Map of plant hardiness zones in Canada (Ouellet and Sherk 1967). The results of these studies together with other material will be used to develop the new suitability map for shelterbelt species.

15. Summary of Progress up to One Year Ago: Project initiated in January, 1968.

16. Goals Set One Year Ago: 1. Study of soil survey reports and map sheets and evaluation of climatological data.

2. Review of silvical characteristics of species which are of importance in the shelterbelt program.

3. Survey of existing shelterbelts.

17. Accomplishments in Last Year: Soil survey reports have been analyzed and soils have been grouped and mapped according to broad textural classes.

An intensive literature review of silvical characteristics of various species has been initiated. The field survey is about 25% complete.

18. Goals for Next Year : 1. Completion of field survey of existing shelterbelts.

2. Completion of review of silvical characteristics of important Alberta shelterbelt tree and shrub species.

3. Analysis of climatological data with respect to establishment and growth of trees and shrubs.

Publication: Froning, K. The silvical characteristics of some important shelterbelt tree and shrub species in Alberta. Proposed Information Report.

K. Froning

K. Froning,
Investigator.

PROBLEM AREA PROGRAM

Operation and Maintenance of Field Research Areas

Kananaskis Forest Experiment Station is operated in the Region for the pursuit of special lines of research and for demonstration of silvicultural and other forest management procedures. Station headquarters is located 6 miles south of the Trans-Canada higheay in the Kananaskis River Valley which forms the front range of the Rocky Mountain east slopes. The research forest has a total area of 23 square miles of predominantly sub-alpine forest, occupied mainly by lodgepole pine with small admixtures of spruce and aspen. The field and laboratory facilities are used chiefly by forest hydrology, pathology, tree biology, mensuration and silviculture activities. The University of Calgary maintains an Environmental Sciences Centre at the Station headquarters and full use is made of the Kananaskis Research Forest. The work done by University staff in biology, zoology and the physical sciences is of major interest to the Forestry Branch and co-operation and the exchange of information are regular.

There is a management plan for the Research Forest and the policy is to give priority to research projects and create forest conditions that will meet the requirements of the research staff. Experimental fellings on a semi-commercial scale to illustrate and test harvest and cultural methods in representative stands are conducted throughout the area. On areas not specifically required for research or demonstration, the object is to harvest the forest to create an age-class distribution of stands in the classical normal forest concept.

Other forest management and protection demonstrations are being established throughout the Region as small-scale trials and developmental research. The object is to promote the application and appreciation of advanced research technology by all users of the forest resources. The following projects are directly related to the problem area:

A 176 : Working plan, Kananaskis Forest Experiment Station - J. Krewaz.

A 280 : Silvicultural demonstration - J. Krewaz.

Project No. A 176

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon Date: February, 1969.

2. Title : Working Plan Kananaskis Forest Experimental Station.

3. Investigator : J. Krewaz.

4. Year of Commencement: 1937.

5. Anticipated Year of Completion: Continuing.

6. Key Words not in Title: management, lodgepole pine, white spruce, subalpine, SA1.

7. Activity : Liaison and Management.

8. Problem Area Program: Operation and maintenance of field research areas.

9. Establishment Project No.: A 176 Branch Project No. A 176.

10. Status : Active.

11. Man-years Utilized in Past Year: Professional .6 Other .9

12. Co-operating Agencies: None.

13. Location of Work : Kananaskis Forest Experiment Station.

14. Abbreviated Background Statement: In 1930 the Federal government set aside 63 square miles of forest in the Kananaskis River Valley to conduct research into forestry problems of the Alberta Region. A considerable proportion of the earlier research work of the Region was carried out at the Kananaskis Forest Experiment Station but gradually projects were established throughout the province. Subsequent changes in boundaries reduced the area of the Kananaskis Research Forest to 23 square miles. Eleven square miles are classed as productive forest and the remainder is composed of protection forest and non-productive land types. Most stands are 70 and 100 years old.

A management plan for the Research Forest was drawn up in 1967. The primary objective of the plan is to create forest conditions that will meet the present requirements of the regional staff and that will improve until the full potential of the forest as a research area has been exploited. Concomitant with the attainment of this objective will be the creation of an age class distribution of stands in the classical normal forest concept.

Two complementary projects (A280) Silvicultural Demonstrations and (A 274) Ecological Reserves and Natural Areas, Kananaskis Research Forest complete the basic organization of the forest for research development.

The application of the most technologically advanced procedures will be stressed in all operation work within the limits of economic feasibility. Pilot scale trials of promising procedures evolving from current research will be made and successful trials will be incorporated operationally. Demonstrations of successful trials may be established on other suitable areas in the Region. Unsuccessful pilot scale trials will be examined to determine where further research may be required.

All current research and demonstration areas and other reserves are fully protected at all times. New areas for these purposes may be established at any time on unprotected areas.

15. Summary of Progress up to One Year Ago: Following establishment of the station, research and forest management activities were conducted on various parts of the forest resulting in changes in composition and structure of some of the original stands. These operations affected about 1,000 acres with the largest portion in the categories of empirical thinning and selection cutting. There was no extensive clear-cutting except for 100 acres of over-mature spruce fir which were cut in a saw-log operation during 1951-53. These operations produced a considerable variety of products including fuelwood, saw-timber, poles, piling pulpwood, mine timbers, fence rails, posts, Christmas trees and landing-strip markers. A limited road system was developed to service the operations.

In 1936 a grid system of 836 sample plots was established on the Research Forest to provide growth and inventory information. These plots were remeasured in 1946 and again in 1961.

In 1966 the terms of reference for the operational organization of the Kananaskis Research Forest were set out in Internal Report A-4: 18 miles of primary road system were surveyed with transit and mapped to provide horizontal control for aerial photo mapping and for operational ground mapping; the location of compartment boundaries was completed on the ground with the cutting of 80 chains of line to a 6-foot width.

In 1967 the management plan for the Kananaskis Research Forest was set out in Internal Report A-10. All strips designated for cutting in the first 10 years under the management plan were located and marked on the ground (1200 acres). A preliminary ground survey was made of road requirements to service those strips in this group which were not accessible. Production commenced on a complete series of compartment maps on two scales of 10 and 20 chains to the inch for operational records. Master reference maps of the research forest by activity (research projects, reserves, etc.) were prepared for record purposes.

16. Goals Set One Year Ago: Conditional on the sale and completion of cutting on areas now being advertised a survey of the cutovers will be made to evaluate regeneration conditions and locate potential problem areas. Facilities and methods of artificial regeneration will be planned and prepared. Access requirements for the remaining 670 acres of the first 10-year cut will be completed and $4000 will be expended on road construction and improvement. The preparation and revision of maps will be continued.

17. Accomplishments in Last Year: During 1968 a timber sale for the disposal of 1200 acres was advertised and although considerable interest was shown by several parties, no bids were received. This is owing largely to the fact that individual operators are interested only in one specific product where our silvicultural and operational requirements demand clear-cuts. Fluctuating markets in saleable products discourage operators from entering into long-term contracts. The appearance of a pulpwood market would solve the timber disposal problem.

Subsequently some contractors requested portions of individual strips by permit sale. Clearcutting operations were carried out on one research area and four management cutting strips and to date an estimated 80 acres have been cut over during 1968. Currently three operators are working in the Research Forest and two others have expressed intention to operate this winter. The total area of the cutting strips being cut and those proposed to be started this winter is about 400 acres. Preliminary plans for regenerating cutover areas have been made (surveys, seed production, ground preparation, artificial regeneration).

A road construction and improvement program was carried out on the Kananaskis Research Forest. There were 4.8 miles of road improved and 5.5 miles of road constructed. In total work was carried out on 10.3 miles of road at a total cost of $3,875 (including culverts) or at an average cost of $387 per mile.

With the commencement of cutting operations, the authorized Departmental system of record keeping was set up and routine supervision of operators, scaling of products and maintenance of map records started.

Work continued on the production of 10 and 20 chain compartment maps for operational use.

Road location work was carried out for the 3 miles of road proposed for construction in 1969 but completion of this work has been deferred until road construction funds again become available.

18. Goals for Next Year : During the next year timber disposal on the 1200 acres designated for cutting in the first 10 years under the management plan will continue. It is hoped to have these areas cut over by 1975 at the latest. With the expected improvement in markets indicated by the continuing expansion of the economy, the demand for wood in the Kananaskis area should increase.

Pilot scale trials of container planting will be made this summer. Five to ten thousand container seedlings will be produced in the greenhouse for trial planting on recent cutovers. A limited quantity of nursery stock will be started in the greenhouse nursery for trial and demonstration plantings in 1971 and 1972. By 1971 the production of container stock will become fully operational to meet the regeneration requirements on cutover areas. Seeding will be used operationally where the chances of success are considered to be good and the use of bare-root stock will be used operationally only when other methods are not suitable.

Stands of different species found on the Research Forest will be examined for seed production areas. The objective of selecting such stands is to improve the genetic stock of artificially regenerated stands and to demonstrate the importance of seed source. Current estimates are that each generation of selected stock increase wood volume production, per acre by 3-10%. Seed procurement from better stands on the Research Forest will provide a long-term evaluation of this expectation under relatively controlled conditions. Scion material for the establishment of seed orchards will be obtained from any suitable source, on or off the Research Forest.

An operational report for 1968 is being prepared.

J. Krewaz,
Investigator.

Project No. A 280

PROJECT REVIEW STATEMENT

1. Establishment : Alberta/NWT/Yukon. Date: February, 1969.

2. Title : Silvicultural demonstrations.

3. Investigator : J. Krewaz.

4. Year of Commencement: 1967.

5. Anticipated Year of Completion: A continuing project.

6. Key Words not in Title: Forestry, extension, plantation, thinning.

7. Activity : Liaison and Management.

8. Problem Area Program: Operation and maintenance of field research area.

9. Establishment Project No.: A 280 Branch Project No.: A 280

10. Status : Active.

11. Man-years Utilized in Past Year: Professional .1 Other .03

12. Co-operating Agencies: Nil

13. Location of Work : Alberta/Territories Region.

14. Abbreviated Background Statement: The development of an improved technology for the economic and social utilization of the forest resource is dependent on scientific research. Technological innovations produced by research programs must be communicated to people at the operational level of industry and government and to individual operators. Observable on-the-ground demonstrations provide a direct means of presenting the most beneficial methods of manipulating the forest environment. That is, they serve as an extension educational program by providing the professional and the public with needed information on methods of most efficiently achieving desirable results. Although based on highly technical scientific research the information can only be presented at this level as a usable product, that is in practical and popular terms.

Successful innovations should be demonstrated and applied promptly because in a long-term investment industry such as wood production even small initial economies and gains are compounded over the long term of one rotation. Improvements made in other forest resource fields are perpetuated indefinitely.

The purpose of demonstrations under this project is to promote the application and appreciation of advanced silvicultural technology by all users of the forest resources.

15. Summary of Progress up to One Year Ago: During 1966 and 1967 an inventory survey of inactive research project areas on the Kananaskis Research Forest was made to evaluate existing plantations and stand treatments for possible use as demonstrations of forestry practices. New plantations were established and work was done on improvement of older plantations.

Of 10 older plantations 5 were considered potentially usable for demonstration purposes providing additional work was carried out in release and clean-up of the stands. About 8 acres of a Douglas fir plantation were released from an overmature aspen overstory.

Approximately 10 acres of native and exotic species were planted but the extreme drought in 1967 resulted in very heavy mortality, even on the moist sites.

16. Goals Set One Year Ago: Treated stands and other areas selected for demonstrating specific silvicultural methods, practices or techniques will be marked and identified on the ground, and mapped. A report on these areas and recommendations for future work on the project will be prepared.

17. Accomplishments in Last Year: During 1968 two stand treatment areas on the Kananaskis Research Forest and one area on the Departmental Reserve at Strachan were examined and included as potential demonstration areas.

A preliminary site trail was established at the Kananaskis Research Forest to demonstrate important physiographic sites and forest types.

A quarter-ace plantation of ponderosa and white-bark pine container stock raised in the Station greenhouse was established in the Kananaskis Station.

18. Goals for Next Year : Demonstration areas are potentially useful to all research disciplines and a co-ordinated Regional approach to this method of information dissemination would be most effective. This program would require some uniformity in qualitative standards, descriptive material (signs, pamphlets), a registry of location of areas and provision for the physical maintenance of the areas and signs.

Since these areas would be subject to continuous public scrutiny the physical presentation is equally as important as the technical. The need for the proper design and maintenance of signs may be evaluated by the emphasis commercial, industrial and public institutions place on them as a vehicle for public information.

A permanent demonstration site trail will be started at the Kananaskis Forest Experiment Station in 1969. This will demonstrate physiographic sites and forest types and relate research in different disciplines to forest resource development.

With the cutting of about 80 acres of mature stands on the Kananaskis Research Forest in 1968, work will commence on establishing demonstrations pertaining to forest regeneration. Areas demonstrating seed production stands, seedbed preparation, artificial regeneration methods (seeding, container planting, bare-root planting) will be established.

Some planting, seeding and fertilizing will be carried out on recent cutovers in conjunction with the proposed site trail.

J. Krewaz,
Investigator.

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