STUDY STATEMENTS

1975 - 76

NORTHERN FOREST RESEARCH CENTRE

CANADIAN FORESTRY SERVICE

MAY, 1975

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

INDEX TO STUDY STATEMENTS

PROJECT NOR - 1

Detection and Appraisal of Tree Pests and Vegetative Disturbances

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Detection and Appraisal of tree pests and vegetative disturbances.

2. Title: Forest tree rusts of western North America.

3. New: Cont.: X 4. No.: NOR 026

5. Study Leader: Y. Hiratsuka

6. Key Words: *Cronartium*, *Pucciniastrum*, *Peridermium*, *Melampsora*, *Chrysomyxa*, cytology, morphology, taxonomy, Uredinales, inoculation experiment, pathogenicity.

7. Location of Work: Edmonton (laboratory, greenhouse and mycological herbarium), Kananaskis Forest Experiment Station, Western North America with particular emphasis on Northern Region (field).

8. Problem:

Rust fungi are known to attack vigorously growing plants rather than weakened ones because of their obligate parasitism. Damage caused by this group of fungi tend to be increased by intensive cultural practices as evidenced by such cases as, white pine blister rust in North America, poplar rusts in Europe, comandra blister rust of hard pines in southeastern North America, and wheat stem rusts and coffee rust in many parts of the world.

An estimate of the losses attributable to forest tree rusts in the region has not been obtained but significant growth loss and mortality of several major forest tree species, including lodgepole pine, jack pine, white spruce, black spruce, balsam fir and subalpine fire, have been suggested. In addition, several rust species endemic to the region have been recognized as serious pathogens in other areas where forestry practices are more intensive.

Our knowledge of western forest tree rusts has been inadequate to solve present and future problems which are and will be caused by this group of fungi and studies of this group of fungi on identity, life history, host range, cytology, morphology, distribution and pathogenicity are necessary.

9. Study Objectives:

General:

To acquire a comprehensive knowledge and to improve diagnostic capability on the forest tree rusts of western North America with particular emphasis on the Northern Region in terms of identity, host range, life history, distribution and pathogenicity.

Specific:

To study aspects of cytology, taxonomy, life history and host-parasite relationship of conifer needle rusts, pine stem rusts, and poplar-conifer rusts of the region, and related species in the world.

10. Resources:

a. Starting date: 1968 Projects A-232 (1961) and A-254 (1965) were combined and redesigned in 1968.
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.5 (Y. Hiratsuka)		
Supp.	0.7 (P. J. Maruyama)		
Casual	Nil		
Total	1.2	O & M funds req'd:	

11. Progress to Date:

1. Comparative studies of the nuclear phenomena of the aeciospores and germinating aeciospores of *P. harknessii* and *P. stalactiforme* have been completed and the results have been published. Further nuclear studies have been carried out with the aeciospores of *P. harknessii* material from other regions. Similar studies with *C. comptoniae* and *C. comandrae* were completed and results have been published.

2. Studies on temperature and pH requirements for an orange and white stored aeciospore germination of *P. harknessii* and *P. stalactiforme* have been completed and published.

3. White spored *P. stalactiforme (Cronartium coleosporioides* f. *album)* 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 outlined.

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 of *Cronartium flaccidum (Peridermium pini)*. About 300 fixed slides of germinating spores have been prepared and brought back for cytological studies. Significant differences between the two races were found and the results have been published.

5. Study of aeciospore germ tubes of pine gall rust from Quebec and New Brunswick showed clearly that they are *Peridermium harknessii* rather than *Cronartium quercuum* as previously reported. A note has been published.

6. Study of aeciospore germ tubes of *Peridermium ephedrae* from New Mexico indicated an unusual nuclear cycle and a note has been published.

7. *Pucciniastrum vaccinii* complex: Inoculation experiments and preliminary morphological comparisons have been completed.

8. Yellow-spored Peridermia on *Abies*: Morphological comparisons and literature survey have been completed and compilation of results for publication has been started.

9. Spruce needle rusts: Several inoculation experiments have been done. Inoculation of *Pucciniastrum sparsum* from *Artostaphylos rubra* to *Picea glauca* was successful. This presents the first record of this rust on Picea in North America and the results have been published.

10. Taxonomic revision of pine stem rusts, including the establishment of a new genus for autoecious species, is completed and results have been published.

11. Morphological study of forest tree rusts by scanning electron microscope is in progress and significant results have been obtained. Two papers on the subject have been published.

12. Surveys of the occurrence of *Tuberculina maxima* on pine stem rusts have been undertaken. Two papers on the occurrence have been published.

13. Field and herbarium surveys of the occurrence of the pine stem rusts in Canada have been carried out and distribution maps were prepared.

14. The first draft of the proposed publication "Pine stem rusts of Canada" has been completed and in press.

15. Modified and improved sets of terminology of spore states in Uredinales (rust fungi) were proposed at the First International Mycological Congress (1970) and a comprehensive paper on the subject has been published.

16. To clarify the nomenclatural confusion created by the discovery of a new life cycle of pine stem rusts, conservation of the generic name *Peridermium* has been proposed and published in Taxon.

17. Serious damage caused by two pine stem rusts to a lodgepole pine plantation in central Alberta was studied and a report has been published.

18. Study trip to Japan, India and Korea was successfully carried out and several significant results on pine stem rusts and other tree rusts have been obtained.

12. Goals in 1974-75:

1. Gall development of western gall rust will be studied by scanning electron microscope, cell maceration technique and other histological and cytological methods.

2. Start a study on epidemiology of western gall rust on lodgepole pine in managed forest.

3. Revise the ms of a departmental publication "Pine stem rusts of Canada" for final review.

4. Complete a morphological study of *Chrysomyxa* of North America.

5. Complete the ms on ontogeny of spore markings of pine stem rusts for a journal publication.

6. Compile the "Check list of Uredinales in Alberta" for information report.

7. Study the results and examine the specimens obtained from the study trip to Asia in 1973.

Goals added in 1974-75:

8. Present a symposium paper on the terminology, cytology and taxonomy of rust fungi at Post IAMS Contress Mycological Meeting in Tottori, Japan.

9. Analyse the annual surveys of the white-spored stalactiform blister rust (see Section 11-3) carried out from 1963 to 1972 at Altrude Creek, Banff National Park, and to complete a report.

10. With termination of NOR-094 last year, the completion of two manuscripts from the study were to be reported through NOR-026.

11. Give two lectures and a laboratory session on tree rusts as a part of a forest pathology course at the University of Alberta.

13. Accomplishments in 1974-75:

1. Gall structure and development of western gall rust has been studied by scanning electron microscope, cell maceration technique and various histological methods. Significant results on cell morphology, fibre orientation, and cytological variations of gall tissue and healthy tissue have been obtained.

2. Epidemiological study of western gall rust in managed forest was not carried out due to other commitments.

3. Departmental publication, "Pine stem rusts of Canada" is now in press and to be published in June 1975. This is a well illustrated monograph of all Canadian pine stem rusts covering aspects of identification, hosts, distribution, morphology, life cycle, cytology, damage, epidemiology and control.

   Y. Hiratsuka and J. M. Powell. 1975. Pine stem rusts of Canada. Forestry Technical Report No. 4. 109p.

4. Morphological comparisons of all North American species of *Chrysomyxa* (spruce needle and cone rusts) have been completed. Significant observations on surface structure of aeciospores and urediniospores have been made.

5. A paper on the ontogeny of spore markings of pine stem rusts has been published. The results obtained from electron microscope observations suggested that the spore ornamentation started by growth of hyaline structure within a growing primary cell wall and subsequently been exposed by the removal of the primary wall matrix, presumably by reabsorption.

   D. M. Henderson and Y. Hiratsuka. 1974. Ontogeny of spore markings on aeciospores of *Cronartium comandrae* and peridermioid teliospores of *Endocronartium harknessii*. Can. J. Bot. 52:1919-1921.

6. Compilation of the "Check list of Uredinales (rust fungi) in Alberta" is in progress.

7. Several significant results have been obtained from study trip to Asia in 1973 including 1) the discovery of pine-to-pine species of fine needle pine stem rust (*Endocronartium* sp.) in northern Japan by germination technique; and 2) comparative study of two newly found fine needle pine stem rusts in Korea and northern Japan which alternate with *Pibes* as well as *Pedicularis*. The results will significantly affect the taxonomy and nomenclature of pine stem rusts including our native species.

8. Presented a symposium paper at Post IAMS Congress Mycological Meeting in Tottori, Japan, Sept. 1974.

   Y. Hiratsuka. 1974. Spore morphology, nuclear cycle and terminology of rust fungi. Proceedings of Post-Congress (IAMS) Mycological Meeting, Tottori. p.5.

9. The white-spored stalactiform rust data was analyzed, a paper prepared and published.

   Powell, J. M. 1975. Additional note on the incidence of *Cronartium coleosporioides* f. *album* on lodgepole pine. Pl. Dis. Reptr. 59:32-34.

10. a. One manuscript "Pine stem rusts of Canada" has already been mentioned above (13-3) as in press.
    The other manuscript mentioned has been published.

    Powell, J. M. 1974. The role of natural biological agents in controlling a pine stem rust (*Cronartium comandrae*) Blue Jay 32:75-79.

    b. Two papers on the insects from the cankers and the litter samples under comandra blister rust cankers have been prepared.

    Powell, J. M. and L. S. skaley. 1975. Arthropods from forest litter under lodgepole pine infected with the comandra blister rust. Information Report NOR-X-130. 33p.

    c. A lecture entitled "*Comandra* - Comandra blister rust - pinus relationships" was presented to a plant ecology course at the University of Alberta.

11. Gave two lectures and a laboratory session on tree rusts as a part of a forest pathology course at the University of Alberta.

14. Goals for 1975-76:

1. Present a symposium paper on the taxonomy, cytology and morphology of rust fungi at Purdue University in June as a part of special rust taxonomy symposium.

2. Complete a paper on taxonomy and morphology of *Pucciniastrum geoppertianum* (a fir needle rust).

3. Continue to compile the "Check list of Uredinales in Alberta".

4. Continue studies of gall formation and infection of western gall rust and prepare a paper on this subject for presentation at Canadian Botanical Association meeting in Saskatoon in August.

5. Conduct inoculation experiments and morphological comparisons of *Cronartium ribicola* and *C. coleosporioides* in our region and compare the results with information obtained in Asia in 1973.

15. Publications:

Up to 1974-75

Powell, J. M. and W. Morf. 1965. The occurrence of *Tuberculina Maxima* Rost. on *Cronartium* rust infected trees in Alberta. Can. Dept. For., For. Ent. and Path. Br., Bi-Mon. Prog. Rept. 21(1):3.

Powell, J. M. 1966. A white spored *Peridermium stalactiforme* in Alberta. Plant Disease Reporter, 50:114.

Powell, J. M. and W. Morf. 1966. Temperature and pH requirements for aeciospore germination of *Peridermium stalactiforme* and *P. harknessii* of the *Cronartium coleosporioides* complex. Can. J. Bot. 44:1597-1606. + 1 plate.

Hiratsuka, Y., W. Morf and J. M. Powell. 1966. Cytology of the aeciospores and aeciospore germ tuber of *Peridermium harknessii* and *P. stalactiforme* of the *Cronartium coleosporioides* complex. Can. J. Bot. 44, 1639-1643. III Plates.

Hiratsuka, Y. and E. J. Gautreau. 1966. Occurrence of *Cronartium comptoniae* in Alberta and the Northwest Territories. Pl. Dis. Reptr. 50, 419.

Hiratsuka, Y., L. E. McArthur and F. J. Emond. 1967. Clarification of the identity of two needle rusts of alpine fir, *Pucciniastrum geoppertianum* and *P. epilobii* in Alberta. Can. J. Bot. 45, 1913-1915.

Hiratsuka, Y. and P. J. Maruyama. 1968. Nuclear condition of the germ tubes of *Peridermium ephedrae*. Mycologia 60, 437-438.

Hiratsuka, Y. and P. J. Maruyama. 1968. Identification of *Peridermium harknessii* in eastern Canada on the basis of nuclear condition of aeciospore germ tubes. 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. Can. J. Bot. 46, 1119-1122. IV plates.

Hiratsuka, Y. and J. M. Powell. 1969. Cytology and taxonomy of autoecious pine stem rusts. (Ab.). XI International Botanical Congress. Seattle, Washington, Abstracts: 91.

Hiratsuka, Y. 1969. *Endocronartium*, a new genus for autoecious pine stem rusts. Can. J. Bot. 47, 1493-1495.

Powell, J. M. and Y. Hiratsuka. 1969. Nuclear condition and germination characteristics of the aeciospores of *Cronartium comandrae* and *C. comptoniae*. Can. J. Bot. 47, 1961-1963. 2 plates.

Hiratsuka, Y. 1970. Identification and morphology of the aecial state of *Pucciniastrum sparsum* in northwestern Canada. Can. J. Bot. 48, 433-435.

Hiratsuka, Y. 1970. Emergence of the aeciospore germ tube of *Cronartium coleosporioides* (*Peridermium stalactiforme*) as observed by scanning electron microscope. Can. J. Bot. 48, 1962.

Krebill, R. G. and Y. Hiratsuka. 1971. Possible life cycle and nuclear condition of *Peridermium ephedrae*. Southwestern Naturalist 16:431-459.

Powell, J. M. 1971. Occurrence of *Tuberculina maxima* on pine stem rusts in western Canada. Can. Plant Dis. Surv. 51(2):83-85.

Powell, J. M. 1971. Additional records of *Mycodiplosis* larvae (Diptera:Cecidomyicdae) feeding on rust fungi. Can. Plant Dis. Sum. 51(2):86-87.

Hiratsuka, Y. 1971. Spore surface morphology on pine stem rusts of Canada as observed under a scanning electron microscope. Can. J. Bot. 49, 371-372. 6 plates.

Hiratsuka, Y. 1973. Sorus development, spore morphology, and nuclear condition of *Gymnosporangium gaeumanii* ssp. *albertense*. Mycologia 65:137-144.

Hiratsuka, Y. 1973. The nuclear cycle and the terminology of spore states in Uredinales. Mycologia 65:432-443.

Hiratsuka, Y. 1973. Nuclear cycle, taxonomy, and nomenclature of autoecious pine stem rusts in North America and Europe. Rep. Tottori Mycol. Inst. 10:243-248. (In Japanese with English summary.)

Powell, J. M. and Y. Hiratsuka. 1973. Serious damage caused by stalactiform blister rust and western gall rust to a lodgepole pine plantation in central Alberta. Can. Dis. Surv. 53:67-71.

Hiratsuka, Y. Proposal to conserve the generic name *Peridermium* (Link) Schmidt and Kunze with a conserved type species *Aecidium eleatinum* Alb. and Schw. (Fungi Imperfecti Uredinearum). Taxon. 23:428-429.

1974-75

Listed under each goal in "Accomplishments in 1974-75 (13)".

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 033

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Detection and appraisal of tree pests and vegetative disturbances.

2. Title: Forest insect and disease survey.

3. New: Cont.: X 4. No.: NOR 033

5. Study Leader: W.G.H. Ives, Y. Hiratsuka, H. R. Wong, R. A. Blauel

6. Key Words: Detection, appraisal, distribution, parasites, hosts, damage, predators, biological control, hazard, susceptibility, stability, management, parks, recreation, symptoms, damage, effluents, easement atmosphere.

7. Location of Work: Throughout region.

8. Problem:

Forest insects and diseases annually destroy or degrade large quantities of otherwise usable wood fibre. They cause important damage to nursery plantations, shelterbelts and park plantings which have high aesthetic or shelter values. The relations between insects, diseases and their hosts are complex and often obscure. Many of the problems confronting resource managers have their origin in insect or disease activities, but in other instances unsuspected factors may be responsible for the damage, and the insects or diseases are of secondary importance. Correct diagnoses therefore require a highly trained technical and professional staff.

The data collected by the Survey provide essential information on life cycles, ecology, natural control agents, distribution and general abundance, which is of value to research entomologists, pathologists and other biologists. Many of the species reported by the Survey have a wide distribution, and the regional data are part of a larger body of data collected by this and other regions. There is a feeling in some quarters that this body of data has limited value, and that enough information on insect and disease outbreaks has already been collected. For some organisms, there is some truth in this argument, but for many species the statement is not true. The spruce budworm, for example, reaches outbreak proportions perhaps every 35 to 75 years, and the 35 year period covered by the Survey usually contains data on only one outbreak. Recent work has shown that the general information collected by the Survey can be used in a meaningful manner to help explain fluctuations in insect abundance. Requests for surveys and advisory services in environmental pollution problem areas are being directed with increasing frequency to the Canadian Forestry Service. The Forest Insect and Disease Survey (FIDS) can handle many of these requests.

The gathering of background information on the distribution and abundance of insect and disease pests in the Prairies Region has largely been completed. We know which pests are important, and where they are most likely to occur. The need for routine detection surveys has therefore decreased and, since management agencies are much closer to the problem than we are, they should be able to report any suspected damage. Although we will continue to monitor known outbreaks, we have decided to drop routine detection surveys and to concentrate our efforts on what might be called extension entomology and pathology emphasizing impact and appraisal aspects. To facilitate this work we are establishing and strengthening contacts with provincial and federal agencies, and are initiating a number of training programs in the form of field trips, lectures or seminars, that are aimed at improving the capability of personnel in these agencies to diagnose the more common problems themselves. We will investigate any reported problems, and give advice on what the organism is and on control procedures, if available. This approach, we believe, will make better use of available resources and should improve the service that we are able to provide to management agencies concerned with problems involving shade and forest trees.

In the summer of 1975, one man will be stationed at Winnipeg and will conduct special and routine impact and appraisal surveys in Manitoba. Two men will be stationed at Prince Albert during the summer and will be engaged primarily in extension work on insect, disease and pollutant problems in Saskatchewan. Three men will be stationed in Edmonton, and will engage in similar activities in Alberta. Two men will spend most of their time collecting material and taking pictures for the proposed brochure(s) on insect and disease pests of the Prairie Provinces.

9. Study Objectives:

   a. To gain an improved knowledge of forest insects and diseases in the region for the purpose of minimizing damage to trees and shrubs attributable to these organisms and to provide an advisory service to management agencies and the public.

   b. Provide management agencies with diagnostic impact and appraisal services relating to effects of insects, diseases, climatic influences and pollutants on trees and shrubs and other types of vegetation.

10. Resources:

a. Starting date: 1941 at Winnipeg and Indian Head
b. Estimated year of completion: Continuing
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.5	(W.G.H. Ives)
	0.5	(Y. Hiratsuka)
	0.5	(H. R. Wong)
	0.8	(R. A. Blauel)
Supp.	1.0	(vacant)
	1.0	(J. Petty)
	1.0	(V. B. Patterson)
	1.0	(F. J. Emond)
	1.0	(J. J. Lawrence)
	1.0	(J.C.E. Melvin)
	0.3	(P. J. Maruyama)
	1.0	(R. M. Caltrell)
	1.0	(A. E. Campbell)
	1.0	(J. P. Susut)
	1.0	(G. N. Still)
	1.0	(R. C. Tidsbury)
	1.0	(N. W. Wilkinson)
Casual	___	
Total		O & M funds req'd:

11. Progress to Date:

Infestations of all the major forest insects have been assessed since the inception of the Survey and more recently a large amount of information on diseases of the region has also been obtained. Much of this information has been stored on magnetic tape or punch cards for easy analysis and retrieval. Life cycles and other biological data have been obtained for most of the major insects and diseases within the region. Numerous impact and appraisal surveys have been carried out in response to special needs.

Pest conditions in the Prairies Region during 1972 were highlighted by the continued increase in forest tent caterpillar populations in Manitoba and Saskatchewan and by the occurrence of a large area of spruce infected with needle rusts in Alberta. Forest tent caterpillar defoliation occurred at scattered locations across central Manitoba and in parts of northern Saskatchewan and a major outbreak appears to be developing. Spruce budworm populations remained at much the same levels as in 1971, with most of the defoliation confined to the Sprucewoods and Interlake areas of Manitoba. Large aspen tortrix populations were on the increase across the Region and, in Manitoba, were often mixed with forest tent caterpillar. Defoliation by the fall cankerworm increased in Manitoba and Saskatchewan, and was especially noticeable in metropolitan Winnipeg. Jack pine budworm infestations also increased in severity in the Sandilands Provincial Forest in Manitoba. The birch skeletonizer caused moderate to severe damage in parts of Saskatchewan and Manitoba and defoliation by the yellow-headed spruce sawfly was widespread and severe in the agricultural areas, especially in Alberta and Saskatchewan.

The spruce budworm and spruce beetle infestations in Alberta have both subsided. No special budworm survey in Alberta was required, and the survey for the spruce beetle indicated that the 1972 survey will be the last required for that insect, although checks will have to be made by the ranger in the area in case there is a resurgence in populations. Stand deterioration in the reserve block was evaluated, and an annual examination will be required for a number of years, since many dead trees are still standing. The spruce budworm infestation continued in the Sprucewoods area of Manitoba, and was surveyed by staff from the Winnipeg sub-office.

Work continued on the maintenance and improvement of the regional insect and disease reference collections.

Editing of historical data on insects neared completion.

Printouts of insects and diseases collected in each of the western national parks were obtained. Annotated check lists of forest fungi collected in Yoho and Kootenay National Parks were published. Similar lists for insects collected in Waterton Lakes National Park and in the Kananaskis Forest Experiment Station area neared completion. Lists of insects collected in each of the remaining western national parks were being compiled.

The progress in the various advisory services was as follows:

Ground surveys of insect and disease conditions in Waterton Lakes National Park were conducted, data were extracted from the historic file and a hazard rating was devised. The report "Insect and Disease Hazard in Relation to Stand Stability", by J. Petty and W.G.H. Ives was completed and submitted to the National and Historic Parks Branch where it was favorably received. No field work was done in 1971-72. In 1972-73, information on forest insects and diseases in Prince Albert National Park were summarized, field surveys to supplement this information were completed, and work began on preparing color-coded hazard maps for the entire park.

A limited but fairly intensive aerial and ground check of vegetation in the vicinity of Thompson, Manitoba, revealed two areas, in total of approximately 50 square miles, where damage was occurring due to effluents released from the International Nickel Company plant in Thompson. Damage varied from incipient to severe. The surveys were carried out in cooperation and with assistance from the Manitoba Government and the International Nickel Company. Two reports were submitted to the agencies concerned.

An aerial survey with ground checks was carried out over a recently developed natural gas field in western Alberta and within long established oil and natural gas fields in other parts of that Province. No significant damage to vegetation was detected with the exception of a few minor damage areas resulting from well blow-outs. A report was submitted to appropriate Alberta Government agencies.

A ground check was made of vegetation damage resulting from a blow-out from a high pressure condensate line in western Alberta. Resultant gas-liquid mixture caused some discoloration of adjacent foliage, which extended a distance of two miles from the pollutant source. A report was submitted to the appropriate Alberta Government agencies.

In 1972-73 the following was accomplished:

The Thompson Smoke Easement Survey

An aerial reconnaissance, a ground appraisal and a ground truthing were carried out in the suspect fume damaged forest areas around Thompson, Manitoba. The fume damaged areas were delineated and current levels of damage were documented at 14 different sites. Ground truthing was coordinated with remote sensing procedures conducted by CCRS.

Smelter Fume Damage near Flin Flon

A preliminary air and ground appraisal was performed to determine the effects of ore smelting air pollutants on the forest in the Flin Flon-Creighton areas of Manitoba and Saskatchewan. Apparently damaged areas were located and some preliminary documentation of the damage was carried out. A brief ground truthing complemented low level multispectral imagery obtained from CCRS.

The Effects of the Cement Production Industry on the Forest Community in the Exshaw Area

A survey was conducted to assess the condition of the forest community subjected to the air pollutants from the cement production industry near Exshaw, Alberta. Sampling of vegetation, stem analysis and other documentation procedures were performed.

The Effects of Potash Industry Pollutants on Trees and Shelterbelts near Guernsey, Saskatchewan

A preliminary survey was conducted in the Guernsey, Saskatchewan area to determine and document the effects of the potash production industry on trees and shelterbelts. Some of the vegetation examined was found to be damaged, symptoms and foliar analysis indicating chemical burning.

The Impact of Air Pollutants from the Alberta Tar Sands Oil Extraction Industry on the Surrounding Forest

A survey was conducted to determine the impact of the pollutants on the forest community near several sulphur dioxide monitoring stations located in the area. It was also determined that the monitoring stations were located out of the main air pollutant impingement area.

Forest Damage Resulting from a Light Hydrocarbon Spray Released From a Gas Pipeline

To delineate the area of damage, and to determine plausible restoration procedures, an appraisal was performed to determine the extent and progression of damage to the forest subjected to the spray.

The Effects of Air Pollutants from the Gas Processing Industry on the Forest Community in the Rocky Mountain Foothills

The survey is contributing to the detection aspects of an in-depth study to determine the effects of sulphur pollutants on the forest community. In 1972, a joint brief by the Canadian Forestry Service and the Environmental Protection Service was presented at a hearing conducted by the Alberta Government, concerning an application by Gulf Oil of Canada Ltd., for exemption from minimum sulphur recovery guidelines.

Pollutant Damage to the Forest Community in the Swan Hills Area

A preliminary detection and appraisal survey revealed that the forest community is being affected by gas flaring, sulphur gas releases, hydrocarbon coating, condensate spraying, saline pipelines ruptures and oil spills.

The Effects of Air Pollutants from the Prince Albert Pulpmill on the Surrounding Forest Community

A small area of air pollutant damage was noted near the Prince Albert pulpmill. A preliminary appraisal survey was conducted and a report issued.

Other brief assessments of pollutant releases were conducted during the field season at the request of provincial forest management and environmental agencies. These assessments included determination and documentation of pollutant effects. The problems included a volatile hydrocarbon release in the Black Diamond area, a sulphur gas release in the Crossfield area, battery site air pollutants in the Savanna Creek area, spray drifting in the Penhold area, suspect pollutant damaged forest near the Blue Ridge gas processing plant and summertime discoloration of street trees in Prince Albert.

A successful air photo survey technique was devised and has been used by the Alberta Forest Service (AFS) to map red belt areas. Two sample areas were examined three times, and some of the areas mapped by AFS were ground checked during the winter. It appeared that it will be possible to relate gross symptoms of original damage to the eventual fate of some trees.

The equipment for aerial surveying of dwarf mistletoe was designed and tested.

Ground checks indicated the aerial surveys to be reliable in the detection of mistletoe infections.

Management Unit A7 in the Athabasca Forest was surveyed and the data obtained supplied to the AFS, who have used it in preparing type maps of the area, in which mistletoe infection is indicated by one of three categories.

In 1973-74 the following was accomplished:

There were no significant changes in the status of major insect or disease pests in the Region in 1973. As in 1972, spruce budworm defoliation was largely confined to the Sprucewoods and Interlake areas of Manitoba, although some damage was noted in Alberta. Forest tent caterpillar infestations in Manitoba and Saskatchewan increased slightly, but not as much as had been expected, while those in Alberta remained fairly static. Most infestations of the large aspen tortrix declined, although there were still some patches of moderate to severe defoliation in Manitoba and Saskatchewan. The yellow-headed spruce sawfly continued to cause severe defoliation in the agricultural areas of the Region, while the fall cankerworm and jack pine budworm caused localized damage. Populations of the larvh sawfly were generally low throughout the Region, except for an area south of The Pas in Manitoba.

Two species of needle rusts on spruce and a combination of two leaf spot organisms on balsam poplar again caused considerable discoloration of the foliage of these trees in Alberta. Other foliar diseases were common in various parts of the Region. Fire blight and climatic damage were reported from a number of localities.

Work continued on the maintenance and improvement of regional insect and disease reference collections.

Annotated check lists of insects of Riding Mountain, Prince Albert, Elk Island, Jasper, Banff, Kootenay, Yoho and Waterton Lakes National Parks and Kananaskis Forest Experiment Station require only introductions to be ready for printing. This will be a No. 1 priority in January and February and will be out before March 31. The annotated check lists of diseases for Prince Albert and Riding Mountain National Parks have been postponed until 1974-75 because of the large quantity of newly collected material.

The report on insect and disease hazard for Prince Albert National Park was completed and submitted to National and Historic Parks Branch.

Athabasca Tar Sands Oil Industry Emissions and Effects on the Surrounding Forest

Survey and impact assessments were conducted at the request of the Government of Alberta in cooperation with the Alberta Department of Environment, Alberta Forest Service and Great Canadian Oil Sands Co. Ltd.

A survey was conducted to detect forest injuries within suspect impingement areas. Aerial surveillance techniques, aerial photo documentation methods, ground survey and ground truthing procedures were utilized. The areas surveyed displayed some foliar discolorations. However, in the areas ground truthed, discolorations were attributable to water inundations, early fall senescense, leaf diseases and leaf insects rather than sulphur gas releases. In addition, forest vegetative receptor response plots were established at three locations near continuous ambient air monitors in order to provide baseline data on the condition of the forest community for future comparative examinations. Ground cover vegetation (lichens, bryophytes, and higher plants), epiphytic corticular lichens, and tree species were documented giving the vegetative data base wide gaseous pollutant sunsitivity.

Potash Production Emissions and Shelterbelt Species in Central Saskatchewan

Assessments were made at the request of the Government of the Province of Saskatchewan in cooperation with the Saskatchewan Department of Environment, Air Pollutant Control Branch.

Examinations of shelterbelts were conducted around four potash processing operations (Alwinsal, Potash Co. of America, Allan Potash Co. and Central Canada Potash of Canada). Documentation during examination included data, photographs and vegetative samples. It was found that foliar discolorations and necrosis, leader die backs, broomings and clumping occurred in many of the shelterbelts growing near the potash operations. These symptoms and injuries to shelterbelts varied, dependent on the specific potash operation (reflecting the pollutant emission levels released by each operation) the proximity to the potash operation (reflecting the dispersal pattern of the pollutant), and the tree species (reflecting the tolerance of the tree species to the pollutant). Results from laboratory analysis of the vegetation samples show a correlation between the presence of high concentrations of potash production pollutants in tissues and injury and symptom expression. Also, a field trial design regarding possible future assessment was submitted to the Saskatchewan Air Pollutant Control Branch.

Oil and Gas Industry Pollutant Releases in the Greater Swan Hills and other Forest Areas

At the request of the Government of the Province of Alberta and in cooperation with the Alberta Forest Service and the Alberta Department of Environment, aerial and ground survey assessments were made of:

a. Salt water spill and disposal problems:

Problem definition was done at six sites. Data gathered concerned detection, symptom identification, tree species sensitivity, current forest impact, impact event sequence, and cleanup effectiveness. Two areas were selected for more intensive examination of the movement and impact of chlorides. The areas were bench marked (site data were gathered), soil and foliar samples were collected for analysis and photo documentation was completed.

b. Condensate releases:

Assessments were conducted at two sites. Forest vegetative responses, response sequence, symptom production, and tree species sensitivity were examined. A field trial procedure for reclamation of the Strachan area condensate release was submitted.

c. Oil spills:

Assessments were made at two sites; one a fresh spill (1973) and the other a seven year old spill. Multispectral imagery was obtained and data were collected concerning detection of the spills, the impact of the oil on forest vegetation and the effectiveness of reclamation procedures.

d. Sulphur pollutant releases:

Preliminary assessments of trees and forest vegetation were conducted for various sulphur pollutant incidents: sulphur fires, oil and gas well blow-outs, battery sites, valve and/or transmission line leakages, oil and gas well servicing procedures, sulphur stockpile pouring, and sulphur stockpiles.

The assessments included sample collecting and photographic documentation of forest tree and vegetation symptom expression, species sensitivity, injury and damage.

Aerial color and infrared photography and UV scanning of a portion of the Swan Hills problem areas was performed by CCRS and integration of this imagery with ground truth data is underway.

Forest Survey of the Thompson Smoke Easement and Smelter Fume Impacts Around Flin Flon

Forest survey work in these areas was conducted in response to requests from the Government of the Province of Manitoba and done in cooperation with the Manitoba Department of Mines, Resources and Environmental Management.

Efforts were concentrated on the evaluation and interpretation of the 1972 and 1973 multispectral imagery obtained from CCRS and the processing of vegetative samples and the analysis of data obtained in the field during 1971 and 1972. The integration of this information clearly demonstrates that significant impacts from air pollutants have occurred in the two areas, indicates the complexity of forest responses to smelter fumes and shows the need for additional efforts to accurately determine forest response sequence and impact progression.

The Response of Shelterbelts in Southern Saskatchewan to Sulphur Gas Pollutants

Examinations were made at the request of the Government of the Province of Saskatchewan and done in cooperation with the Saskatchewan Department of Environment, Air Pollutant Control Branch.

Examinations of several farm shelterbelts were conducted near oil well battery sites in the Kisby area of southern Saskatchewan. Documentation included data, photographs and foliar samples. Shelterbelt species around a farmstead near one of the battery sites displayed acute foliar symptoms typical of multiple, high concentration sulphur gas fumigations.

General Detection of Forest Pollutant Incidents

Several reports were made of suspect forest pollutant incidents by the ranger staff at various locations in the prairies region. This information was made available to the appropriate resource management agencies. A few preliminary impact assessments were conducted where expedient.

Ground truthing of air photos of red belt in the Cadomin-Luscar area has been completed.

Observation of surviving trees was carried out on four occasions and two sample plots established. Activities of root diseases and bark beetles was recorded. One ground survey of five days duration was made, many photographs were taken and observations noted. No aerial survey was made.

An appraisal survey of insect and disease damage to reproduction pine in scarified cutting blocks on the North Western Pulp and Power lease near Hinton was carried out in the fall of 1973. In all, 281 plots were examined in 46' blocks on 3 working circles. The results are summarized in a report that has been prepared.

A study on insects associated with trees killed by a release of hydrocarbon condensate near Strachan, Alberta, has been completed and a report written.

12. Goals for 1974-75:

1. The detection and appraisal of insect and disease outbreaks in forested areas will continue, augmented by aerial surveys where warranted. Particular attention will be given to accessible forested areas presently under utilization, and to high use recreational areas. Increased emphasis will be placed on extension work, especially in Alberta and Saskatchewan.

2. Maintenance and improvements of regional insect and disease reference collections will be carried out.

3. Prepare annotated check lists of insects collected in Prince Albert and Riding Mountain National Parks.

4. In cooperation with management agencies within the region to provide a survey and assessment of air pollution effects on vegetation in forested regions. The areas to be surveyed will be determined after requests for inspection have been received and cannot be specified at this time.

5. Red belt studies will consist primarily of a follow-up of weekened trees in the Cadomin-Luscar area to determine the effects of bark beetles and possible Armillaria on the Surviving trees.

6. A report on the equipment used in aerial survey of dwarf mistletoe will be completed, if not already published.

7. Prepare a report on insects of poplar catkins.

13. Accomplishments in 1974-75:

1. The status of most major insect and disease pests in the Region remains much the same as in 1973. Spruce budworm defoliation in Manitoba was confined mainly to the Spruce Woods and Interlake areas, while in Alberta damage was again restricted to northern areas. Forest tent caterpillar infestations showed a moderate increase in area, particularly in Manitoba, where hordes of larvae in the Interlake and Alonsa areas caused consternation among local residents. Large aspen tortrix populations were very low, except for a small area in Alberta. Fall cankerworm continued to cause severe damage in central Manitoba and in a few urban areas in Saskatchewan. The yellow-headed spruce sawfly decreased in abundance, although some severe damage was reported. Populations of the jack pine budworm increased in southern Manitoba, and defoliation on planted pine in the Spruce

Woods Provincial Forest caused concern. Larch sawfly populations remained much the same as in 1973.

The needle rusts on spruce, that had been so widespread in Alberta for the past two years, declined markedly in 1974 and only small areas of infection were reported. The leaf spots on balsam poplar, reported in 1973, also declined. However, two leaf spot organisms on aspen caused widespread damage, primarily in Saskatchewan and Alberta. Climatic damage was widespread, but permanent injury does not appear to be severe.

Increased emphasis was placed on extension work, particularly in Saskatchewan.

The following reports were prepared:

Emond, F. J. *et al*. 1974. Forest Insects and Diseases in Eight Western Canadian Parks 1973. 17 p. NOR-X-90.

Emond, F. J. and G. N. Still. 1974. Forest Insect and Disease Conditions in Manitoba Provincial Parks 1973. 17 p. NOR-X-91.

Patterson, V. C. *et al*. 1974. Forest Insect and Disease Conditions in Alberta Provincial Parks 1973. 14 p. NOR-X-93.

Petty, J. *et al*. 1974. Forest Insect and Disease Conditions in Saskatchewan Provincial Parks and Trans-Canada Camp Grounds 1973. 31 p. NOR-X-95.

Robins, J. K. *et al*. 1974. Annual District Reports: Forest Insect and Disease Survey, Prairie Region 1973. 55 p. NOR-X-73.

2. Maintenance and improvements of regional insect and disease reference collections continued.

3. The following reports were prepared:

Caltrell, R. M. and J.C.E. Melvin. 1974. Forest Insects Collected in Elk Island National Park 1948-1971. NOR-X-111.

Gautreau, E. J. and J.C.E. Melvin. 1974. Forest Insects Collected in Waterton National Park 1948-1971. NOR-X-

Gautreau, E. J. and J.C.E. Melvin. 1974. Forest Insects Collected in Kananaskis Forest Exp. Stn. 1948-1971. NOR-X-88.

Mortenson, K. *et al*. 1974. Forest Insects Collected in Prince Albert National Park 1948-1971. 40 p. NOR-X-108.

Smith, G. J. and J.C.E. Melvin. 1974. Forest Insects Collected in Yoho National Park 1948-1971. NOR-X-105.

Smith, G. J. and J.C.E. Melvin. 1974. Forest Insects Collected in Kootenay National Park 1948-1971. NOR-X-110.

Still, G. N. et al. 1974. Forest Insects Collected in Banff National Park 1948-1971. 37 p. NOR-X-104.

Still, G. N. et al. 1974. Forest Insects Collected in Riding Mountain National Park 1948-1971. NOR-X-106.

Susut, J. P. and J.C.E. Melvin. 1974. Forest Insects Collected in Jasper National Park 1948-1971. NOR-X-107.

4. Brief appraisals by individual rangers were made in a number of areas. Pollutant sources round which these forest and tree stress detection surveys were conducted include the following:

Grande Prairie area for sump spills and condensate releases; a battery site of the Kisby area oil fields, Saskatchewan; a potash operation in Saskatchewan; a smelter at Flin Flon, a pulp mill at The Pas, a steel industry at Selkirk, an oil field battery site in the Virden-Roselea area, refinery operations in the Transcona area, refinery operations in the Brandon area, and the pulp mill at Pine Falls, all in the province of Manitoba; the gold (arsenic) extraction process industry near Yellowknife, Northwest Territories. Clients were notified as necessary, and field reports are on file.

Surveys of a more intensive nature were carried out in the following areas:

Vicary Creek area of an acid release to determine forest recovery and lag time impacts; New Norway area for gas pollutant injuries of trees and native vegetation in the area; Regina plains area regarding decline of shelterbelts from a suspect pollutant; Jasper Transmountain pipeline pump station, of the surrounding trees; Edson area, of effects of a sulphur fire; Kimberly, B. C., for effects of underground sulphur fires on the forest. Clients were notified as required.

The following file reports were prepared:

Blauel, R. A. and G. J. Smith. 1974. New Norway well site examination.

Blauel, R. and D. Hocking. 1974. Impact of an ammonia release on trees.

Hocking, D. 1974. Preliminary Survey of the Forest Condition near the Transmountain Pipeline Pumping Station.

Hocking, D. 1974. Effects on the Forest of Sulphur Dioxide from a sulphur Fire near Edson, Alberta.

Hocking D. 1974. The forest impact of sulphur dioxide fumes from underground combustion of sulphide ores near Kimberley, B. C.

Petty, J. and R. C. Tidsbury. 1974. Shelterbelts in the Regina Plains area.

Smith, G. J. and R. A. Blauel. 1974. Vicary Creek Valley well site re-examined.

Major impact and appraisal surveys were conducted in the following areas. Reports are in process.

Judy Creek area, of forest cover responses to a saline pollutant released underground from a pipeline break; Swan Hills area, of a forest area subjected to a recent saline water surface release; Tar Sands area, where an impingement area survey and establishment of new vegetative response plots were completed; Windfall and South Kaybob Gas Plant areas, of the influence of gas plant emission on the forest; the Pine Point area, of the impact of effluent releases from the mining and milling operations on the surrounding forest.

Data compilation and analysis is underway concerning the Pine Point, Athabasca Tar Sands, Judy Creek and Swan Hills areas.

The following reports were completed:

Blauel, R. A. and D. Hocking. 1974. Problems of chloride and heavy metal contamination in: Proceedings on reclamation of disturbed lands in Alberta. NOR-X-116

Hocking, D. 1974. Interim report on long-term impact on the forest of emissions from a sulphur extraction plant.

Hocking, D. 1974. Decline of the forest in the Pine Point area, N.W.T.

The following work was completed concerning the Thompson smoke easement. A summer field survey was conducted with subsequent laboratory analysis of samples performed. Data analysis and integration of all field data with aerial imagery was completed and a report (NOR-X-115) was issued on the entire 1972-74 survey findings. A hearing concerning the Thompson smelter was called by the Manitoba Clean Environment Commission, and the Manitoba Environmental Unit requested participation by Canadian Forestry Service with the report filed in support of a pollutant containment position. Evidence and data were prepared and presented at the hearings and new information concerning composition of the smelter emissions was gained. After temporary hearing ajournment a brief field foray was conducted where samples of cryptogams and snow were collected for analysis of arsenic and other contaminates released by the smelter.

Laboratory analysis and data compilation were prepared on these collections. Also in response to Commission requests about the Thompson forest, data was summated concerning historical development of forest injury in the area, long term ecosystem impacts and reclamation possibilities. A supplementary report to NOR-X-115 concerning these matters was written and filed with the Commission. At hearing resumption CFS further participated as expert witness concerning forest impacts, submitted additional sample evidences and fully established forest damages as resultant from the smelter operation. The hearing was again temporarily adjourned. The next meeting scheduled in June will include a field trip to view the forest damages.

The following reports were prepared:

Blauel, R. A. and D. Hocking. 1974. Air pollution and forest decline near a nickel smelter. NOR-X-115.

Hocking, D. and R. A. Blauel. 1974. Supplementary information for the Manitoba Clean Environment Commission on Air Pollution and Forest Decline near a Nickel Smelter.

A week long in-service training course concerning the survey of forest pollutant problems was conducted for the FIDS technical staff.

The following file report was written:

Blauel, R. A. 1974. Survey field problem definition regarding forest pollutant occurrances.

In addition information, 35 mm slides and sample materials concerning several forest pollutant problems were prepared for presentation purposes.

Two lectures and laboratory sessions were presented as part of a forest pathology course at the University of Alberta, and two lectures were presented to engineering students in an air pollutant course at the University of Alberta.

5. The Cadomin red belt study plot was examined and figures indicated an increase of mortality due to Armillaria mellea in 1974 by 12.5% to a total of 36.5%. Observations indicated another 10-12% will die in 1975.

Observations of red belt which occurred in the 1973-74 winter were made throughout the Cadomin and Jasper areas.

The following report was prepared:

Robins, J. K. and J. P. Susut. 1974. Red belt in Alberta. NOR-X-99. July 1974. 6 p.

6. Mr. Robins retired before completing the report.

7. The following report was prepared:

   Wong, H. R. and J.C.E. Melvin. 1974. Insects of Aspen catkins in the Canadian Prairies. Northern Forest Research Centre, Edmonton, Alberta. 27 p. NOR-X-76.

Accomplishments not in 1974-75 goals:

The following report was prepared:

Patterson, V. B. 1974. Regeneration M.rtality Survey in North Western Pulp and Power Lease at Hinton. 14 p. NOR-X-80.

14. Goals for 1975-76:

1. Known outbreaks of defoliating insects will be monitored as required. At the moment, these include forest tent caterpillar in the three Prairie Provinces, eastern spruce budworm in Manitoba and in the Fort McMurray area of Alberta, jack pine budworm in Manitoba, possibly western spruce budworm in Alberta, and fall cankerworm on the Red and Assiniboine Rivers in Manitoba.

2. The reported infestation of Sclerodeiris canker in Jasper National Park will be evaluated. (Hiratsuka)

3. In Manitoba, limited detection surveys will be conducted in forested areas, particularly parks and high value fibre-producing areas.

4. Training seminars or courses will be given to staff of as many provincial and federal agencies as possible, in order to better acquaint them with common insect and disease pests of their area, with the anticipation that they will eventually be able to diagnose the more common problems.

5. Reported instances of damage attributable to insects, diseases or pollutants will be investigated, and wherever possible the cause of the damage determined and the remedial action prescribed, if available.

6. Illustrations for brochures on forest insects and diseases will be obtained whenever the required material is available. Some pictures will be taken in the field, others in the laboratory, depending upon circumstances. Assistance will also be given in the preparation of texts for brochures.

7. Available information, collected by our own staff and by other agencies, will be collated into an annual report outlining known pest problems in the Region.

8. Red belt studies will consist of a follow-up of conditions in the original plot and the establishment of additional plots in areas with different degrees of initial damage, in order to better assess the full impact of red belt in the area.

9. Maintenance and improvement of regional insect collection (Wong and Melvin).

   a. Enlarge and update the Edmonton collection by sending various groups of insects to specialists in Canada and United States for identification.

   b. Amalgamate parts of the Calgary and Winnipeg reference collections.

   c. The coding and correction of enclosure slips to facilitate the storing and retrieval of such data on magnetic tapes at the Biometric and Computer Science Branch, Ottawa.

   d. The rearing of forest insects to obtain determined mature and immature material for the reference collection.

10. Diagnostic services for forest insects (Wong and Melvin).

   a. Provide diagnostic services on mature and immature insects including their damage for in-service personnel and other agencies such as federal and provincial personnel and private citizens.

   b. Provide and check entomological nomenclature for personnel of the Northern Forest Research Centre.

   c. Provide information on life history and seasonal occurrence on forest insects in the Canadian Prairies for provincial, federal and university personnel and the general public.

   d. Provide specimens and data to taxonomists engaged in revisionary or systematic studies of certain groups of insects.

   e. Lecture and arrange displays of forest insects and their damage for students from the university and technical and public schools touring the Northern Forest Research Centre.

   f. Improve on the diagnostic services by studying the life history, seasonal development, hosts and parasites of the more common insects of the Canadian Prairies.

11. Following goals will be carried out by the forest disease diagnostic and taxonomic service group (Hiratsuka, Lawrence, Maruyama).

a. Disease reference collection (Mycological Herbarium) will be maintained and upgraded. Emphasis will be placed on filing of specimens from previous years to the herbarium.

b. A fungus culture collection which contains more than 500 living cultures of major forest fungi will be reorganized and maintained. The collection had been maintained by wood decay study group but after discontinuation of the project, it was left unattended for several years.

c. Specimens of tree and shrub diseases, and other forest fungi will be identified for pest extension personnel of FIDS, liaison and service personnel and others in the Centre, and for outside agencies.

d. A check list of forest fungi collected in Prince Albert and Elk Island National Parks will be compiled.

e. An annotated check list of major diseases of trees and shrubs of the region will be prepared.

f. Illustrated glossary of forest pathology and forest mycology will be prepared.

12. Limited evaluations of suspect pollution damage will be made when the situations warrant such action. Possible areas are: Tar Sands, Flin Flon, Yellownkife and Carmacks.

13. A pre-season forecast of anticipated insect and disease problems for the summer of 1975 will be made.

14. Meetings will be held from time to time with officials of various agencies in order to facilitate the implementation of the foregoing goals.

15. The following reports will be completed (Blauel):

The Forest Condition and Ecological Benchmarking in the Athabasca Tar Sands Area.

Salt Water Spill Problems in the Forest.

Survey of a Forest Community near a Cement Production Industry.

16. R. A. Blauel will participate as a member of the Mackenzie Delta Gas Working Group. Summations of past survey information on natural vegetation problems resultant from the gas and oil extraction industry will be utilized in developing site specific guidelines for the assessment of the environmental impact of the Mackenzie Delta Gas Development.

15. Publications:

Reports published in 1974-75 are shown under accomplishments by goals.

16. Signatures:

Investigator

Program Manager

Investigator

Director G. T. Silver

Investigator

Investigator

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Detection and appraisal of tree pests.

2. Title: Sawfly systematics

3. New: Cont.: X 4. No.: NOR 058

5. Study Leader: H. R. Wong

6. Key Words: Tenthredinoidea, Nearctic Region, distribution, hosts, keys, life history, morphology, new genera, new species, biogeography, revision, symphyta, evolution, phylogeny.

7. Location of Work: Edmonton, Alberta

8. Problem:

To study the systematics of the sawflies of Canada. Until sawflies are identified, they cannot be discussed or treated in a scientific way. Accurate identification of pest species can determine their area of spread and assist in confining their damage to a restricted area. Systematic studies can provide the means of making predictions and generalizations about probable habits, distribution, future importance of newly discovered species, and clues on possible methods of control. It is the means by which an orderly system is provided for storing information about sawflies and is an important retrieval device.

Success in this study is excellent provided time, funds and technician assistance are available. Since I am the only one in Canada, at the present time, actively engaged in the systematic study of sawflies, any results obtained would add to the knowledge of this group of insects in Canada, and their role in our environment. Such knowledge would also aid certain biological and ecological studies in North America.

The material is made available by a number of agencies requesting identification services, in particular the Forest Insect and Disease Surveys across Canada. Species identification is generally based on the microscopic examination of the extracted genitalia, which are mounted on slides. After comparison with available types, any new species are described and illustrated together with other pertinent information on host, life history, distribution, immature stages, phylogeny etc. Keys are constructed to assist in future identification.

9. Study Objectives:

a. To make systematic studies of the sawflies of Canada, noting their mature and immature forms, distribution, host, seasonal occurrence, importance to forestry, subspecies, strains and phylogenetic relationships.

b. To separate the various sawfly species by means of keys, descriptions and illustrations.

c. To study the evolution and biogeography of the more important sawfly genera.

d. To study the external and internal morphology of the more economic sawfly species.

10. Resources:

a. Starting date: 1950
b. Estimated year of completion: a continuing project Revised:
c. Estimated total Prof. man-years required: indefinite
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. 0.5
Supp. 0.0
Casual 0.0
Total 0.5 O & M funds req'd:

11. Progress to Date:

The value of cocoons in determing families and genera of sawflies has been published. Sawfly larvae of the subfamily Nematinae attacking conifers in the Canadian Prairie have been identified.

The Nearctic species of *Pristiphora* have been studied and several species placed in synonymy or in other sawfly genera, other species were found to be Holarctic in distribution and not restricted to North America or Eurasia. A phylogenetic study has been made of *Pristiphora* in an effort to obtain an understanding of the relationship of the species and the circumstances under which they evolved.

Descriptions have been published on the external morphology of the male, female and ultimate larval instar of the larch sawfly; and the intersexes and gynandromorphs of this insect.

The sawfly genus *Decanematus* was discovered to be new to North America and the genus *Micronematus* in North America was found to be a synonym of the European genus *Eitelius*.

New species were described in the following genera: *Pristiphora* (Brazil, Canada and U.S.A.); *Allantus* (Canada and U.S.A.); *Decanematus* (Canada); *Pristola* (Canada), *Melastola* (Canada and U.S.A.); and *Susana* (Canada).

Larval descriptions have been published on species in the following sawfly genera: *Anoplonyx*, *Platycampus*, *Tenthredo*, *Nematus*, *Pikonema*, *Nematinus*, *Dimorphopteryx*, *Arge*, *Croesus*, *Cimbex*, *Trichiosoma*, *Empria*, *Priophorus* and *Pristiphora*.

Diagnostic keys to species in the following genera have been published: *Pristiphora* (South American adults), *Eitelius* (North American and European adults), *Allantus* (North American adults with black hind tibiae), *Decanematus* (North American, Japanese and European adults) *Pristola* (North American adults), *Melastola* (North American adults) and *Sharliphora* (Eurasian adults).

Diagnostic keys to genera of the tribe Pristolini and strains of *Pristiphora erichsonii* have been published. Two new genera *Sharliphora* and *Melastola* were established in the family Tenthredinidae.

It has been determined that the use of Mahalanobis D^2 statistic and discriminant function analysis failed to separate populations of the larch sawfly, which were resistant or susceptible to the parasite *Mesoleius tenthredinis*.

The European spruce sawfly has been discovered for the first time in southeastern Manitoba along with the parasite, *Palexorista bohemica*, which was released against it in eastern Canada.

A brochure was prepared on the life history, damage and control of the three birch leaf-mining sawflies in the Prairies.

The *Pristiphora* section of the new Hymenoptera of America north of Mexico synoptic catalog was revised for Dr. D. R. Smith, Washington, D. C.

The study of the external morphology and genitalia of over 2,000 specimens of the larch sawfly indicate five strains. Two Eurasian strains (Ambleside and Thirlmire) were accidentally introduced into Canada from England by 1913. The Ambleside strain is resistant to the parasite *Mesoleius tenthredinis*. The early infestations in North America were caused by the native strains (Aweme and Fernie) and the later infestations by the introduced strains. The fifth strain (Salzburg) is confined to Eurasis.

12. Goals for 1974-75:

1. Identify sawflies in the Canadian National collection and for various entomologists in Canada and the United States.

2. Prepare for publication on "The identification, distribution and origin of the strains of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera:Tenthredinidae) in North America.

3. Continue work on the revision of the genus *Pristiphora*.

13. Accomplishments in 1974-75:

    1. Devoted about 0.20 man-years in identifying sawflies in the Canadian National collection, the Edmonton collection, and for various entomologists in Canada and the United States.

    2. Published: "The identification and origin of the strains of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera:Tenthredinidae) in North America. Can. Ent. 106:1121-1131. 1974.

    3. Revised the coniferous feeding species of the *abietina* group of *Pristiphora*.

14. Goals for 1975-76:

    1. Identify specimens of *Pristiphora* submitted by Dr. D. R. Smith, Systematic Entomology Laboratory, Agricultural Research Service, USDA, Washington.

    2. Publish the results on the revision of the *abietina* group of *Pristiphora*.

    3. Continue work on the revision of the genus *Pristiphora*.

15. Publications:

Up to 1974-75

Lejeune, R. R. and H. R. Wong. 1949. Distribution of larch sawfly in Manitoba and Saskatchewan. Canada, Dept. Agric., For. Biol. Div., Bi-monthly Prog. Rept. 5(6):2.

Wong, H. R. 1950. Sawfly larvae of the subfamily Nematinae attacking conifers in the forests of the Canadian Prairies. Master thesis. Michigan State University: 1-33.

Wong, H. R. 1951. Cocoons of some sawflies that defoliate forest trees in Manitoba and Saskatchewan. Ann. Rept. Ent. Soc. Ontario 82:62-67.

Wong, H. R. 1954. Common sawflies feeding on white birch in the forested areas of Manitoba and Saskatchewan. Can. Ent. 86:154-158.

Wong, H. R. 1955. Nearctic larvae of the genus *Anoplonyx* (Tenthredinidae: Hymenoptera). Can. Ent. 87:224-227.

Wong, H. R. 1956. Preliminary notes on intersexes and gynandromorphs of the larch sawfly. Can. Ent. 88:545.

Wong, H. R. 1956. Common *Tenthredo* larvae feeding on deciduous trees in the Canadian Prairies (Tenthredinidae:Hymenoptera). Interim Rept. Forest Biology Lab: 19-25.

Wong, H. R. 1957. Sawflies of the genus *Platycampus* Schiodte on trembling aspen in the Canadian Prairies. Canada, Dept. Agric., For. Biol. Div., Bi-monthly Prog. Rept. 13(4):2.

Wong, H. R. 1958. The morphology of the adult of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Tenthredinidae:Hymenoptera). Interim Rept. Forest Biology Lab., Winnipeg 1958-1: 1-43.

Wong, H. R. 1958. The morphology of the ultimate larval instar of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Tenthredinidae: Hymenoptera). Interim Rept., Forest Biology Lab., Winnipeg 1958-1: 1-16.

Wong, H. R. 1960. Evolution of the sawfly genus *Pristiphora*. Doctor of Philosophy in Entomology Thesis. University of Illinois: 1-113.

Wong, H. R. and H. H. Ross. 1960. New Nearctic species of the genus *Pristiphora* Latreille (Hymenoptera:Tenthredinidae) Can. Ent. 92(3): 193-1.

Wong, H. R. 1960. Evolution of the sawfly genus *Pristiphora* Diss. Abs. 21(6): 1676.

Wong, H. R. 1963. The external morphology of the adults and ultimate larval instar of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Hymenoptera:Tenthredinidae). Can. Ent. 95:897-921.

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Wong, H. R. 1968. *Decanematus*, a sawfly genus new to North America (Hymenoptera:Tenthredinidae). Can. Ent. 100(1):84-86.

Wong, H. R. 1968. *Pristiphora gelida*, a new species from Alaska (Hymenoptera:Tenthredinidae) J. Nat. Hist. 2:185-186.

Wong, H. R. 1968. A revision of the tribe Pristolini (Hymenopters: Tenthredinidae) Can. Ent. 100:1049-1057.

Wong, H. R. 1969. Reassignment of the *ambigua* group of *Pristiphora* to a new genus *Sharliphora* (Hymenoptera:Tenthredinidae). Can. Ent. 101:332-335.

Wong, H. R. 1969. *Pristiphora acidovalva*, a new sawfly on willow (Hymenoptera:Tenthredinidae). Can. Ent. 101:970-972.

Wong, H. R. and W.G.H. Ives. 1969. The European spruce sawfly in Manitoba. Bi-monthly Res. Notes. 25(6):47.

Wong, H. R. 1972. The spread of the European spruce sawfly *Diprion hercyniae* (Hymenoptera:Diprionidae) in Manitoba. Can. Ent. 104:755-756.

Wong, H. R. and H. E. Milliron. 1972. A Canadian species of *Susana* on western juniper (Hymenoptera:Tenthredinidae) Can. Ent. 104:1025-1028.

1974-75

Wong, H. R. 1974. The identification and origin of the strains of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera:Tenthredinidae), in North America. Can. Ent. 106:1121-1131.

16. Signatures:

H R Wong.
Investigator
per RWR

R W Reid
Program Manager

GTSilver
Director G. T. Silver

NOR 089

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Detection and appraisal of tree pests and vegetative disturbances.

2. Title: Analysis and synthesis of Forest Insect and Disease Survey historical data and information.

3. New: Cont.: X 4. No.: NOR 089

5. Study Leader: W. G. H. Ives

6. Key Words: Population trends, computer mapping, data retrieval, insects and environment.

7. Location of Work: Edmonton and Ottawa

8. Problem:

The large body of data collected by the Forest Insect and Disease Survey since its inception has never been thoroughly examined to determine what information it contains regarding population trends and the environment.

Some of the data on general distribution and abundance and on rates of parasitism were in reports or on raw data sheets, but had not been transferred to forms suitable for computer input. Similarly, the format used by the Meteorological Branch of the Department of Transport for summarizing their weather data was not suitable for some of the analyses, and additional summaries had to be prepared.

This study has undertaken to consolidate all of the available information on common insects and weather records for Manitoba and Saskatchewan into a format suitable for computer input, and to subject these data to a thorough examination. Writing of the necessary computer programs will be undertaken by staff in Ottawa.

9. Study Objectives:

To determine if the large amount of data on insect infestations collected by the Forest Insect and Disease Survey during the past years can be utilized to help explain fluctuations in populations of forest insects, and thus lead to a better understanding of the factors contributing to insect outbreaks.

10. Resources:

a. Starting date: 1969
b. Estimated year of completion: Indefinite Revised: I 1974 II 1976
c. Estimated total Prof. man-years required: 3
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. 0.1 (W.G.H. Ives)
Supp.
Casual
Total 0.1 O & M funds req'd:

11. Progress to Date:

Annual infestation histories (1945 to 1968) for 11 of the most common forest insects in Manitoba and Saskatchewan have been mapped, the data transferred to special forms and then recorded on punch cards and edited. Parasite rearing or dissecting records for 15 of the more common forest insects have been transferred to specially designed forms suitable for computer input, and the data key punched and edited. Temperature and precipitation data from the Monthly Record have been transferred to special forms, key punched and edited.

Requests for the writing of a number of computer programs to summarize the above data were submitted to Ottawa.

The numbers of heat units during a fixed overwintering period and a shifting early larval feeding period for the forest tent caterpillar, *Malacosoma disstria* Hbn., were calculated from official weather data and related to known infestations or outbreaks of this insect in the Prairie Provinces and Ontario. Years with increasing populations had cooler overwintering periods and warmer early feeding periods than did those with decreasing populations. A single year with a relatively cool winter and an unusually warm spring occurred two to four years before the first reported defoliation for all known infestations at each of 10 weather stations. Most population collapses were accompanied by cool springs and some by warm winters. The same general pattern prevailed for infestations in southern Ontario, when compared with the number of heat units at Toronto for the period 1860 to 1969. Favorable temperatures are therefore believed to be primarily responsible for triggering the onset of outbreaks of the forest tent caterpillar, and unfavorable temperatures are believed to be a major factor in their termination. The results should aid in predicting when and where outbreaks are likely to occur.

Outbreaks of the spruce budworm were found to be related to heat units above various thresholds. The numbers of heat units above 40°F from September 15 to estimated emergence and below 0°F from October 1 to May 1 tended to be lower for years with increasing populations than for years with decreasing populations when pairs of years for infestations at a number of stations were compared. On the other hand, the numbers of heat units above 50°F for a 6-week period following the estimated date of peak third-instar were higher for increasing populations than for decreasing populations. Calculation of these variables (plus rainfall for the same 6-week period as above) over a 40-year period at a number of stations, showed that weather conditions before and during outbreaks tended to be more favorable than during non-outbreak periods. A manuscript was prepared and submitted for local and outside review.

12. Goals for 1974-75:

1. If not already finished, complete the manuscript on weather and outbreaks of the spruce budworm.

   Proposed title: Weather and Outbreaks of the Spruce budworm, *Choristoneura fumiferana (Lepidoptera:Tortricidae).*

2. Begin preliminary investigation of possible relationships between weather and other defoliating insects. Possible candidates are the large aspen tortrix, the jack pine budworms and the larch sawfly.

3. Any work with the historic file and ancillary data held in Ottawa will depend entirely on what progress is made in preparing the summaries requested in 1970. If no progress is made during the coming year, I feel that the data should be transferred to NFRC.

13. Accomplishments in 1974-75:

1. Ives, W.G.H. 1974. Weather and outbreaks of the spruce budworm, *Choristoneura fumiferana*. Information Rept. NOR-X-118. November, 1974. 28 pp.

2. Time did not permit any work on this goal.

3. Ottawa lost the programmer assigned to this project before he had prepared a program to prepare the desired summaries, and consequently no summaries were received.

14. Goals for 1975-76:

1. If time permits, begin preliminary investigation of possible relationships between weather and other defoliating insects. Possible candidates are the large aspen tortrix and jack pine budworm.

2. Hopefully, if a programmer is assigned to this study as promised, summaries of historic data may yet be forthcoming. Otherwise the task seems too large to handle locally with available resources and probably should be dropped. I would favor this action if no programmer is assigned by Ottawa during 1975-76.

15. Publications:

Up to 1973-74

Nil

1973-74

Ives, W.G.H. 1973. Heat units and outbreaks of the forest tent caterpillar, *Malacosoma disstria (Lepidoptera:basiocampidae)*. Can. Ent. 105:529-543. (Listed as *In Press* last year).

1974-75

Ives, W.G.H. 1974. Weather and outbreaks of the spruce budworm, *Choristoneura fumiferana*. Information Rept. NOR-X-118. November, 1974. 28 pp.

16. <u>Signatures</u>:

Investigator

Program Manager

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Detection and estimation of tree pests and vegetative disturbances.

2. Title: Dutch elm disease detection and diagnosis

3. New: Cont.: X 4. No.: NOR 110

5. Study Leader: V. Hildahl

6. Key Words: Entomology, pathology, detection, appraisal, insect control, disease control, tree species.

7. Location of Work: Manitoba

8. Problem:

Nature of Study:

Dutch elm disease is a potential and serious hazard to elms in the prairie sections of the Region. The pathogen was first discovered about 1933 in the northeastern United States. Since then it has spread north and eastward into Canada and westward in the United Stated to Idaho and Colorado. At the present time it has affected about 80 per cent or more of the natural range of American elm in North America. In 1973, the pathogen was positively diagnosed from dying American elms on the University Campus at Fargo, North Dakota. The discovery of the disease in this area is of importance to Manitoba because it places the disease approximately 60 miles nearer and definitely establishes it in the Red River Valley. In areas where the disease has been prevalent for several years, the host tree has been practically eliminated. How severely elms will be affected in southern Manitoba (and the prairie sections) is difficult to predict, but if the impact is as great as it has been in the areas outlined above the economic and aesthetic loss would be incalculable.

Benefits of Study:

Major benefits of the study will be to maintain the aesthetic values and pleasant environments associated with American elms in rural, urban and park areas; which would otherwise be completely destroyed. In many urban centres (including Winnipeg) throughout the prairie region

American elm represents up to 80 per cent of the tree cover.

Probability of Success:

Early detection and proper sanitation are important factors in controlling Dutch elm disease. In areas where these practices have been emphasized elm losses have been reduced to 1-2 per cent annually.

9. Study Objectives:

Study objectives are primarily: 1. to carry out systematic detection diagnostic services leading to early discovery of the Dutch elm disease in the Region; and 2. provide technical guidance and assistance to provincial, municipal and urban governments with respect to control techniques if and when the disease is detected in the province. An important advisory function pertaining to the Dutch elm disease study is serving as a member on a Provincial Advisory Committee on Tree Protection established by the Minister of Agriculture.

10. Resources:

a. Starting date: 1970
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required: -
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years V. Hildahl 0.3

11. Progress to Date:

Since 1970, the elm disease investigations in southern Manitoba have involved ground and aerial reconnaissance. Detection surveys have been conducted along all river valleys, and in urban centres and rural areas where major concentrations of American elm occur. Approximately 3,500 suspect trees (trees with characteristic external symptoms--flagging, dead branches or dieback in the crown) have been sampled, of which about 35 per cent exhibited evidence of peripheral stain in the wood. Laboratory diagnosis of material from these trees has indicated widespread infections of *Fusarium* wilt, *Verticillium* wilt, and occasional occurrence of *Cephalosporium* wilt. All of these wilts are part of the elm disease complex. The fungus *Ceratocystis ulmi* which causes Dutch elm disease has not been isolated from sample material in Manitoba to date.

Aerial photography using infrared and color film was carried out in 1973 along the Red River as an aid to early detection of elm diseases, especially Dutch elm disease. Two scales of photography were obtained as follows: high-level photography was taken of the area from Winnipeg to Emerson at 10,000 feet AGL using 3" lens and low-level photography from St. Norbert to Glenlea at 1,000 feet AGL using 12" lens. The aerial photography was carried out by the Remote Sensing Group, Northern Forest Research Centre.

12. Goals for 1974-75:

    1. Continue detection surveys in American elm stands throughout southern Manitoba, and provide diagnostic services as required for cooperating agencies.

    2. Continue ground truthing of aerial photography (both high-level and low-level) in 1974.

    3. Complete Information Report entitled "Dutch elm diseases of elm in Manitoba."

    4. Provide technical advisory services to provincial and municipal governments, particularly in relation to sanitation practices recommended for reducing the impact of Dutch elm disease (the Province of Manitoba and City of Winnipeg are currently initiating a program of sanitation to remove all dead and dying American elm wood along the Red River south for a distance of 5 to 10 miles.

13. Accomplishments in 1974-75:

    1. Detection surveys were continued along the Red and Assiniboine watersheds, and diagnostic services were provided for samples submitted by civic and provincial agencies. Four hundred and thirty-two trees were examined, and sample material was taken from 154 for laboratory culturing. All results were negative with respect to Dutch elm disease.

    2. Ground truthing (involving 23 man-days) of aerial photography was completed along the Red River in 1974. There appears to be no clear indication that unhealthy elms can be detected by infrared or color photography unless early visual symptoms are already evident. However, dead or partially dead trees can be readily detected, and defoliation is clearly defined.

    3. Information Report entitled "Elm Diseases in Manitoba," was not completed due to other priorities. A preliminary draft has been prepared and should be ready for review by June, 1975.

    4. Technical advisory services to provincial and municipal governments were continued, particularly in relation to sanitation programs and control procedures for the Dutch elm disease.

    5. Hildahl, V. 1974. Dutch elm disease and the Manitoba situation. In: Proceedings R.C.G.A. National Turfgrass Conference.

14. Goals for 1975-76:

    1. Continue detection (aerial and ground) surveys throughout areas of concern in southern Manitoba, and provide diagnostic services as required for cooperating provincial and municipal agencies.

2. Continue to provide technical services to cooperating agencies concerned with the Dutch elm disease problem, especially in relation to sanitation practices and control procedures.

3. Complete Information Report entitled "Elm Diseases in Manitoba," including interpretation of aerial photography.

15. Publications:

Up to 1974-75

Hildahl, V. 1971. Dutch Elm Disease, a Threat to Prairie Elms. The Prairie Garden (published by Winnipeg Horticultural Society).

1974-75

Nil

16. Signatures:

J Johnson
Investigator
for V. Hildahl

R. Reid
Program Manager

G.T. Silver
Director G.T. Silver

PROJECT NOR - 2

Improved Forest Land Inventory and Classification Methods

NOR 016

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Improved Forest Land Inventory and Classification Methods.

2. Title: Study of soil moisture and temperature in relation to topography, soil, vegetation and climate.

3. New: Cont.: X 4. No.: NOR 016

5. Study Leader: G. L. Lesko

6. Key Words: *Picea glauca, Abies lasiocarpa, Pinus contorta*, forest types, microclimate.

7. Location of Work: Hinton, Alberta.

8. Problem:

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 at the present although these are environmental factors of great biological importance. Soil moisture and temperature regimes directly influence the establishment and subsequent growth of seedlings. Therefore, this project may provide useful information for the regeneration of spruce-fir forests, and results applicable in land classification and silvicultural practices in the study area.

The probability of success, and application of the results, especially in silvicultural research, is high.

Outline of the methods used:

1. Forest types of the study area were identified.

2. One-tenth acre sample plots were established in the different forest types, and described according to soil, vegetation, and edaphic properties. Diameter, height, and age of the trees were measured for the calculation of the site index and basal area. Four sampling points were established in each of the five forest types selected for detailed studies.

3. Colman fiberglass soil moisture units were installed at 10, 20, 30, 50, 70 and 100 cm depth at two places within each plot. Readings were taken with a Backman A.C. ohmmeter at weekly intervals during the growing season.

4. A microclimatic station was established in each forest type including a hygrothermograph, and rain gauge.

5. Soil samples were collected for physical and chemical analyses.

9. Study Objectives:

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

b. To relate soil moisture and temperature regimes to microclimate, edaphic conditions, and floristic composition.

c. To relate soil moisture and soil temperature to forest productivity.

d. To find a method for the estimation and expression of ecosystem moisture regime.

10. Resources:

a. Starting date: 1967
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 0.6
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man years

Prof.	0.3		
Supp.	0.3		
Casual	-		
Total	0.6	O & M funds req'd:	$200

11. Progress to Date:

The project was initiated in 1967 with the study of forest types and soils within the North Western Pulp and Power Limited lease area, near Hinton. Vegetation, forest stand and soils were described on 35 sample plots. Ten tentative forest types were established on the basis of the obtained information. These forest types cover an environmental range from dry lodgepole pine to black spruce swamp forest. Five commercial forest types were chosen out of the ten for the establishment of 10 permanent plots for the study of soil moisture and temperature. A series of six Colman fiberglass soil moisture units with thermistors have been installed at two observation points within each permanent plot.

In the spring of 1968, five microclimatic stations were established in conjunction with the five forest types under study. Data collection were started at the same time, including soil temperature, soil moisture, air temperature, relative humidity and precipitation. Air temperature and relative humidity were recorded continuously while soil moisture and temperature, and precipitation were observed once a week. Laboratory analyses of soil samples were also initiated in 1968.

Preliminary assessment of the existing data suggest that soil temperatures in general are lower than the optimum, and differences in soil temperatures between forest types are substantial during the growing season. Tree growth also seems to be influenced more by soil temperature than by moisture deficiency.

Moisture regime of a forest site is determined by five factors, namely soil moisture, soil temperature, saturation deficit of the air, solar radiation and wind velocity. These external factors regulate the moisture tension in the trees with unknown relative importance. Because of many possible combinations of these factors, and their unknown relative importance, the comparison of forest site moisture regimes is very difficult and uncertain. Therefore, an effort was made to reduce these five factors to a single quantitative value for easy comparison. After much consideration I have selected the "potential internal moisture stress" as a measure of forest type moisture regime. This measure reflects the combined effects of all factors involved in moisture regime, and easily comparable from site to site. For further information on this idea I refer to the publication under 15.

Pressure bomb measurements of internal moisture tension in white spruce, lodgepole pine, and in black spruce were correlated with saturation deficit of the air, soil moisture tension, and with soil temperature. Results of multiple regression analyses indicate statistically significant relationships with 0.44 to 0.90 squared multiple correlation coefficients (R^2) in different species and forest types.

Analysis of soil samples is complete and the data partly analyzed and summarized.

12. Goals for 1974-75:

    1. To complete data analysis and reporting, as follows:

       Journal publications:

       1. Soil moisture and temperature conditions in five forest types in west central Alberta.

       2. Relationships between internal moisture terrain of trees and ambient environmental factors.

       Information Reports

       1. Summary of microclimatic data from five forest types near Hinton, Alberta.

       2. Forest types and associated soils near Hinton, Alberta.

13. Accomplishments in 1974-75:

    Most of the data analysis was completed. Reporting was not accomplished owing to other assignments and commitments.

14. Goals for 1975-76:

    1. Complete data analysis.

    2. Complete and publish the following Information Report.

       - Forest types and associated soils near Hinton, Alberta.

15. Publications:

    Up to 1974-75

    Lesko, G.L. 1970 Considerations in the quantitative evaluation of ecosystem moisture regime. In Proc. 3rd. Forest Microclimate Symp. Canadian Forest Serv. Alberta Territories Region, Calgary, Alberta. pp. 69-75.

    1974-75

    Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 067

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Improved forest-land inventory and classification methods.

2. Title: Landforms and productive capacity of forest and wildland.

3. New: Cont. 4. No.: NOR 067

5. Study Leader: S. C. Zoltai

6. Key Words: Biophysical land classification, site.

7. Location of Work: Manitoba, Saskatchewan, Alberta, Northwest Territories, Yukon.

8. Problem:

The qualities of the land determine its biological productivity and will greatly influence the most advantageous use of the land in harmony with other uses. Land classification, designed to meet the needs of all renewable natural resource managers would form the basis of development and management of the land.

The development of a land classification system, suitable for different terrain and climatic conditions, is the logical basis for land use and integrated management plans. A plan firmly rooted in the natural qualities of the land would eliminate the wasteful trial and error development prevalent in some areas.

When fully developed and demonstrated on a practical scale, land classification cay be applied by various provincial or federal agencies.

9. Study Objectives:

    a. To correlate landform with forest productivity as a basis for predicting the biological productivity of different lands.

    b. To develop a method of classifying ecologically significant segments of the Earth's surface.

10. Resources:

    a. Starting data: 1966
    b. Estimated year of completion: 1970 Revised: 1975
    c. Estimated total Prof. man-years required: -
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nsl
    f. 1974-75 man-years

Prof.	0		
Supp.	0		
Casual	0		
Total	0	O & M funds req'd:	-

11. Progress to Date:

Contribution made to the development of the Bio-physical Land Classification System. Pilot areas in Manitoba, Saskatchewan and Northwest Territories were classified and mapped in different physiographic regions. Established a national sub-committee on Wetland Classification. Study NOR 066 was integrated into this study. In future, objectives and goals of NOR 066 will be pursued under NOR 067.

Authored a paper on Wetland Classification in Canada, and co-authored a paper on Bio-physical Land Classification, both presented at the Fourth North American Forest Soils Conference, Quebec.

12. Goals for 1974-75:

Continue to co-operate in the development of a wetland classification for Canada.

13. Accomplishments in 1974-75:

Authored a paper on the perennially frozen peatlands of northwestern Canada. Published a report on the distribution of coniferous tree species at the Prairie-Forest Ecotone.

Terminated study. Continued co-operation in the development of a wetland classification for Canada will proceed on an informal basis.

14. Goals for 1975-76:

Nil. Study terminated.

15. Publications:

Up to 1974-75

Adams, G.D. and S.C. Zoltai. 1969. Proposed open water and wetland classification. In: D.S. Lacate, Guidelines for Bio-physical land classification, Dept. Fish & Forestry, Publ. 1264.

Zoltai, S.C. 1968. Geormorphology and land units of the St. Walburg area, Saskatchewan. Can. Dept. Forestry and Rur. Dev., Inf. Report MS-X-10, 8 pp.

Zoltai, S.C. 1968. Preliminary report on the Cormorant Lake pilot project, Manitoba. In: Biophysical Land Classification Pilot Projects, Can. Land Inventory, 41-127.

Zoltai, S.C., E.T. Oswald and C. Tarnocai. 1969. Land Classification for land evaluation: Cormorant Lake pilot project. Can. Dept. Fisheries and Forestry, For. Br., Inf. Rept. MX-X-20, 31 pp.

Zoltai, S.C. 1969. Geomorphology of the Waterhen River area, Saskatchewan. Can. Dept. Fisheries and Forestry, For. Br., Inf. Rept. MX-X-19, 10 pp.

Zoltai, S.C. 1970. Biophysical land classification system and survey. Proc. 8th meeting, Can. Soil Surv. Comm., Ottawa, pp. 139-145.

Zoltai, S.C. 1972. Geomorphology of the Amisk Lake area, Saskatchewan. Environment Canada, Can. For. Serv., Inf. Rept. NOR-X-16, 13 pp.

Zoltai, S.C., Pollett, F.C., Jeglum, J.D. and Adams, G.D. *In Press*. Developing a wetland classification for Canada. Proc. 4th North Am. Forest Soils Conf., Quebec, Aug. 20-25, 1973.

Jurdant, M., Lacate, D.S., Zoltai, S.C., Runka, G.G. and Wells, R. *In Press*. Biophysical land classification in Canada. Proc. 4th North Am. Forest Soils Conf., Quebec, Aug. 20-25, 1973.

1974-75

Zoltai, S.C. 1975. Southern Limit of coniferous trees on the Canadian Prairies. Nor. For. Res. Centre, Info. Rept. NOR-X- 128, 12 pp.

Zoltai, S.C. and Tarnocai, C. 1975. Perennially frozen peatlands in the western Arctic and Subarctic of Canada. Can. J. Earth Sci., 12: 28-43.

16. Signatures:

S.C. Zoltai
Investigator

Program Manager

G.T. Silver
Director G.T. Silver

NOR 109

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Improved forest-land inventory and classification methods.

2. Title: Development of remote sensing techniques for forest and land inventory.

3. New: Cont.: X 4. No.: NOR 109

5. Study Leader: C. L. Kirby

6. Key Words: Forest and land inventory, multispectral, multidate, multiscale photography and ERTS imagery, spectral signatures, information systems.

7. Location of Work: Alberta, Saskatchewan, Manitoba and Territories. Peace River and Kananaskis Forest Experiment Station, Alberta, Lac La Ronge, Saskatchewan.

8. Problem:

There is a need for improved forest-land inventory information to guide forest management where increased investments in harvesting, stand improvement, regeneration and protection from fire, insects and disease are being made. In Alberta, over 90 per cent of present forest inventory is over ten years old and becoming obsolete. Changes in forest cover resulting from growth, fire, cutting, insect and disease attack, dams and reservoirs, oil and mineral exploration and development have all contributed to a need for a new provincial inventory suitable for provincial and regional planning. In addition, there is a need to bridge a technological gap in forest management, where new cameras, films, multispectral imagery, thermal scanning and computer mapping and information storage and retrieval systems may all greatly improve forest inventory techniques. The area will also serve as a ground truth area for the satellite programme (ERTS) which will commence in 1972.

The benefits will be improved decision making in forest and wildland management with decreased costs for forest-land inventory.

The probability of applying ERTS imagery for mapping of cutover, fires, flooding and other changes in forest-land larger than 300 feet square is very high, if satellite imagery can be distributed to user groups economically and timely.

Similarily with small-scale photography the application potential is well demonstrated on the P-6 management unit. Improved forest and soil type maps may be obtained from small (1:120,000) scale IR ektachrome photography. In addition, regression equations using average stand height, percent species composition and percent crown closure may be sufficiently accurate to predict stand volumes for most of the forest management planning requirements in the boreal forest region.

Large-scale photo sampling techniques can give an improved estimate on stand mortality, species composition, individual tree vigor and stand volumes. More sophisticated equipment than presently available in Alberta is required to make stand volume estimate feasible. Equipment required: radar altimeter and differential parralax measuring devices with encoders.

The methods used were to obtain various scales, film filter and seasons of photography through cooperative arrangements with the AFS, NFRC and FMI. Contracts for some of the photography were let through the ICAS and during the last two years, CCRS has supplied small 1:120,000 and 1:40,000 aerial photography and satellite imagery at a sacle of 1:1,000,000.

In 1970, forty sample locations were selected in the centre of merchantable covertypes to develop large-scale photo sampling methods for management unit P-6.

A long narrow plot 1 x 5 chains, divided into 5 tenth-acre plots was established on the large-scale aerial photographs usually at right angles to the flight line, where possible, for accurate determination of scale on a 5-chain base line measured on the ground and pinpointed on the aerial photographs.

After location of the plot on the ground, one of the tenth-acre plots was selected randomly for stem analysis to provide information on gross and net tree volumes, and to relate photo measures of tree height and crown area to ground measures of dbh and volume. Stem analysis data on over 4,000 trees was obtained mainly for white spruce, aspen and lodgepole pine to develop regression equations to estimate individual tree diameter and volume from ground and photo measurements. On the remaining 4 tenth-acre plots: a tally by species, of dbh and percent visible defect was made; and two dominant or codominant trees were selected for height measurement and their locations were pinpointed on the aerial photographs.

9. Study Objectives:

a. To develop application of small-scale multispectral photography and satellite imagery for forest and land type mapping.

b. To develop large-scale aerial photo sampling methods for: estimating damage to forest stands, timber volumes and estimates of regeneration.

c. To develop and apply computer programs for:

1. Ground and photo sampling of forest stands.

2. Estimating site index and tree volumes for white spruce and lodgepole pine.

3. Mapping information, storage and retrieval.

10. Resources:

a. Starting data: 1970
b. Estimated year of completion: 1973 Revised: 1975
c. Estimated total Prof. man-years required: -
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. -
Supp. -
Casual -
Total - O & M funds req'd: -

11. Progress to Date:

The following has been completed:

1. Tree volume (TCFV) and site index equations.

2. Computer program to compile plot information.

3. P-6 plot information compiled.

4. Forest cover and soil type map lithographed.

5. Regression equations to predict dbh from large-scale photos.

6. Evaluated small and medium scale photography and ERTS imagery.

7. Obtained through contract a study of spectral signatures at the KFES.

8. Obtained magnetic tapes of a P-6 ERTS scene for development of computer recognition and analysis of ERTS images.

9. Applied to KFES and Marmot Basin inventories a comprehensive remote sensing legend system for the ecological characterization and annotation of natural and altered landscapes using small-scale (1:60,000) and ERTS imagery.

10. Developed regression equations to predict softwood stand volumes from measures of average stand height and per cent softwood on small-scale 1:120,000 IR ektachrome photography.

11. Drafts of two manuscripts for information reports have been completed.

    - Kirby, C.L. Multistaged Forest Inventory in the Boreal Forest Region. N.F.R.C. Information Report.

    - Kirby, C.L. Site index equations for white spruce and lodgepole pine in Alberta.

12. Goals for 1974-75:

    1. Publication of 2 reports, as follows:

        - Kirby, C.L. Multistaged Forest Inventory in the Boreal Forest Region. N.F.R.C. Information Report.

        - Kirby, C.L. Site index equations for white spruce and lodgepole pine in Alberta. For. Chron.

    2. Terminate study. Original study objectives not satisfied. Will be pursued under C.F.S.-1 and NOR-17-142.

13. Accomplishments in 1974-75:

    Drafts of two manuscripts for publication as information reports have been completed: They are

    1. A Multistaged Forest Inventory in the Boreal Forest Region (P-6).

    2. Site index equations for lodgepole pine and white spruce.

Kirby, C.L. 1973. Forest and land inventory using ERTS imagery and aerial photography in the boreal forest region of Alberta, Canada. pp. 6 + 8 Figs. Third ERTS Symposium, Washington, D.C.

1974-75

Kirby, C.L. 1974. Temporal analysis of ERTS imagery in the Boreal Forest Region. The Cdn. Surveyor, Vol. 28.

16. Signatures:

C.L. Kirby
Investigator

Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Improved forest-land inventory and classification methods.

2. Title: Climatic zonation for the forested areas of the Prairie Provinces.

3. New: Cont.: X   4. No.: NOR 115

5. Study Leader: J. M. Powell

6. Key Words: Forest climatology; climatic classification; bioclimatic zones; forest classification; statistical climate map; B5, B14, B15, B16, B17, B18, B19, B20, B21, B22, B23a, B27, SA1, M5, L11, L12.

7. Location of Work: Edmonton laboratory and various districts in the region.

8. Problem:

Over the last few years it has become apparent that a climatological classification of our forested regions is needed to serve as a tool and reference for other forestry research. Members of the Program Coordination Group have expressed the desirability of having climatic classifications developed from the forestry point of view both at the national and regional level (Powell 1970). In the Northern Forest Region it is especially needed for stand establishment studies, tree provenance trials, site and productivity classifications, and for assistance in delineating hazard areas for disease and insect organisms and for fire protection. It would have proved useful for the Prairie forest land classification under the Canadian Land Inventory program. It would undoubtedly be used as background information by a number of Federal and Provincial Departments undertaking resource of economic-social studies in the forested areas of these provinces.

Climatic classification maps exist for the agricultural areas of these provinces, but the extension of these maps into the forested areas is not necessarily desirable. Other more universally applied classifications such as Koeppen, Thornthwaite or their modifications when applied to the Prairies rarely delineate forest regions into more than one or two climatic classes which is inadequate for meaningful forestry work.

In Alberta, a preliminary study was started in 1969 in conjunction with the Canada Land Inventory program (NOR 015), with the initial aim to prepare a map of forest climate areas of a portion of the province between 53° and 56°N. This study employed factor analysis of 75 input variables of climatological data for a 15-year period providing a statistical climate map. The resulting boundaries were then adjusted or smoothed through experience gained with the operation of a mobile thermo-dew point recorder in selected areas of the study region. The findings of this study, which formed the basis of a master's thesis are presently under review for publication. The method will be utilized as the starting point for this study. This classification method is based solely on climatic variables and their interactions, without resorting to the inclusion of non-climatic variables which has been characteristic of practically all previous classifications. The technique which employs factor analysis followed by grouping analysis, has great flexibility which lends itself to numerous uses since the individual user is presented with a series of groupings which can be generalized or used to give detailed delineation.

9. Study Objectives:

To classify the climate of the main forested regions of the Prairie Provinces, such that areas having similar climatic regimes can be delineated on a map.

10. Resources:

a. Stating date: 1971
b. Estimated year of completion: 1975 Revised: 1977
c. Estimated total Prof. man-years required: 0.9
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.5		
Supp.	0.1		
Casual	-		
Total	0.6	O & M funds req'd:	$400

11. Progress to Date:

All climatological stations in the forested areas and the adjacent predominantly agricultural areas in the Prairies and portions of adjacent provinces and territories were considered for inclusion in the study if they had six or more years of summer (April to September) temperature and precipitation data during the period 1961-1970. In a few cases, stations with only 4 or 5 years of record were included to fill large gaps in the geographical distribution, expecially in northern Saskatchewan and Manitoba where the network is relatively sparse and where often only precipitation is recorded by a climatological or forestry fire weather station. The number of stations selected for inclusion in the fringe predominantly agricultural areas was limited by financial considerations as only $2,000 was initially available to purchase climate data from the Atmospheric Environment Service (AES). A total of 343 stations were slected for the study, 205 in Alberta, 60 in Saskatchewan, 68 in Manitoba and 10 outside the Prairie Provinces. All daily information available on Card type #4 (AES) was obtained on magnetic tape for the selected stations for the period 1961-1970, with prime emphasis given to the available temperature and precipitation data. Temperature and precipitation data for 92 stations operated by the Alberta Forest Service (AFS) was obtained for the year 1970 separately.

Difficulty was experienced in obtaining access to the AES tapes using computers available locally, but eventually the 10 years of data on the tapes was printed out for checking for missing data. Problems were later encountered of integrating the AFS 1970 data with the AES data. Analysis was therefore initially restricted to Saskatchewan-Manitoba data. Preliminary analysis was carried out for the 128 stations to provide the base data for the factor analysis. A decision was made to employ fewer variables than the original number of 75 used in the preliminary study. The variables used totalled 37 including mean daily maximum and minimum temperatures for the period May to September, number of days above 28, 32 and 42°F for each month, the frost free period and killing frost free period, monthly preciptation totals, monthly water deficiency, actual evapotranspiration, and elevation, latitude and longitude. The dropped variables from those used in the preliminary study all showed a high dependence on some other variables in the matrix, thus we are left largely with a matrix composed of independent variables. In the calculation of the water balance, initially a soil storage level of 4 inches was assumed, but this has now been adjusted to 2 inches as calculations were not consistent.

12. Goals for 1974-75:

1. The separate analysis for the Saskatchewan-Manitoba and Alberta areas (including the new stations) will be combined and a map delineating similar summer climatic regimes for the study area will be produced, along with maps for the individual climatic variables employed in the analysis. The final map will be compared with forest cover and other available maps.

2. The preliminary results will be presented at two scientific meetings, giving emphasis to two different aspects of the study, and a draft report describing methodology and final result will be prepared.

3. A start will be made on draft reports presenting associated climatic parameter data generated during the study.

4. To help delineate certain class boundaries, mobile temperature traverses and other observations may be made in the field. This phase will also involve an assessment of the representativeness of the climatic stations used in the analysis so that indicated boundaries can be modified.

5. Produce simplified climatic descriptions of the climatic regions established.

   (Aspects of the above goals will be undertaken in cooperation with the Contractor for a proposed Science Related Contract).

6. The mobile thermo-dew point traverse technique was applied to a potential tree nursery site near Clyde, Alberta, to detect any occurrence of local frost pockets, for the Alberta Forest Service.

13. Accomplishments in 1974-75:

1. All additional stations were added into the data bank, however, the analysis was not run with the additional 43 stations because of static on the tape distorting the readout. Also the contractor was not able to have the data from Marmot Creek and Streeter Creek Watershed Basins prepared for the tapes. Further polynomial regression analyses were carried out for 29 stations in the Alberta and 25 stations in the Saskatchewan-Manitoba metworks to generate missing data. More than two-thirds of the 38 Alberta stations were reincorporated after they satisfied the F ratio requirements. A factor analysis, having an input 23 variables, and a Hierarchical Profile Grouping procedure gave an optimal 21 groups for delineating climatic regions in the forested areas of the three Prairie Provinces. A preliminary map was prepared using this grouping. The variable of May water deficiency is now being dropped as it proves to be negligible. The use of a 10-year period of record rather than a 'normal' 30-year period

Maps delineating similar summer climate regimes for the Saskatchewan-Manitoba area were completed for two class groups (9 and 13) using the Hierarchical Profile Grouping procedure rather than the grouping procedure employed in the preliminary study. The number of input variables was reduced to a minimum matrix of 23 independent variables. Analysis was carried out separately for Saskatchewan and Manitoba then the two areas were "married" together. Initially little generation of missing data was carried out in an effort to minimize the volume of calculations required. On checking the preliminary maps some stations are obviously classified in a particular grouping because of their missing data. Data is now being generated for these probably misclassified stations or other stations are being looked at as possible substitutes in areas where alternating stations are available. A preliminary comparison of the map was made with Rowe's Forest Regions map and this showed that we should try and increase the coverage of stations on our southern boundary as no obvious boundary was indicated between prairie and parkland. Data has now been obtained for an additional 27 stations in this southern zone, 4 in the extreme northeast and 6 possible substitute stations. This data is now being incorporated into the study data bank for analysis. Data from five stations of the larch sawfly study in southeast Manitoba was put on tape and is ready for incorporation into the study data bank.

The Research Contract work with the 205 Alberta stations was well advanced. The data from the two sources was combined, quality controlled and checked. Means were calculated, including those for potential evaportranspiration, printed out and checked. Stations with incomplete data were indicated and generation of missing data by polynomial regression was underway. The recently acquired data included 7 Alberta stations which will have to be included in the data bank. We also wish to include a station from Marmot Creek and Streeter Creek Watershed Basins. The data for these two stations is being assembled.

A report on the methodology used in the preliminary study and the resulting climatic zonation map has been published. A description of the study, methodology and results of preliminary study was also presented to a meeting of the Canadian Meteorological Society (Alberta Centre). A second report from the preliminary study describing the mobile thermo-dew point traverse technique and the results from the Spring Creek Basin survey has been reviewed and revised (by MacIver) for further editorial comment.

has been compared and substantiated as a valid criteria for this study. Multiple Discriminant Analysis is now being used to establish the degree of stability of the resulting climatic groupings.

2. A paper was prepared and presented at the Canadian Association of Geographers, Western Division meeting in March entitled "Climatic Classifications of the Prairie Provinces: a new classification for the forested areas". This indicated the inadequacies of earlier classifications for the forested areas, briefly described method and gave maps for Alberta and the Saskatchewan-Manitoba areas separately. This paper was later expanded with emphasis on the Alberta preliminary results and accepted for publication in "Occassional Papers in Geography" with the title "Climatic Classification of the Prairie Provinces: a new preliminary classification for the forested area of Alberta". A second paper entitled "Factor Analytic Approach to Climatic Classification" was prepared for a meeting in Toronto but due to a mix-up in program scheduling was not presented. This paper may still be presented at a "Friends of Climatology" meeting in March. A further paper "A factor analytic climatic classification of the forested areas of the Prairie Provinces" was accepted for the 12th Conference on Agriculture and Forest Meteorology in April and is presently being prepared for presentation and a summary for pre-printing. A draft report covering the Contract aspects of the study has been received.

3. No draft reports presenting associated climatic parameter data were initiated pending receipt of Contract report.

4. No field work was carried out but some preliminary assessment was made of the representiveness of some of the climatic stations. A second report from the preliminary study describing the mobile thermo-dew point traverse technique and the results from the Spring Creek Basin survey has been revised (by MacIver) for further editoral review.

5. A start was made to produce simplified climatic descriptions of the climatic regions established, based on the variables that distinguish them.

6. The report "Temperature traverses near a potential tree nursery site, east of Clyde, Alberta" was completed for the Alberta Forest Service. It included an assessment of the mobile traverses run in the area, an indication of likely areas for frost pockets, and a review and estimation for the likely frost-free period in the area. Recommendations were made for further studies and the possible establishment of a temperature recording network on the site.

14. Goals for 1975-76:

1. All reporting on the Contract (KL015-4-0736) will be completed by the end of March 1975; this will include a report describing methodology and results of the study, and the return of all raw and generated data in a readily accessible format and other relevant analytical data.

2. A report describing methodology and final result of the study will be prepared for publication as an Information Report. A scientific journal publication will also be considered, which may include a comparison with other available maps including forest cover.

3. The paper for the 12th Conference on Agriculture and Forest Meteorology will be completed and presented. Hopefully the other paper (see Section 13.2) can be presented at a climatology meeting in eastern Canada and will concentrate on the statistical method employed and the method for adjusting for missing data. Another paper "A new climatic classification for the forested areas of the Prairie Provinces" has been submitted for possible presentation at the Annual Meeting of the Canadian Association of Geographers in May.

4. An assessment will be made of the study results and especially the associated generated climatic data to see whether it will be worthwhile to publish any of this ancillary data. If it is, a draft report will be initiated. The assessment will also include any recommendation for further work.

15. Publications:

Up to 1974-75

Powell, J.M. 1970. A forest climate classification for Canada - Discussion. pp. 227-228. In: Powell, J.M. and C.F. Nolasco (Eds.). Proc. Third Forest Microclimate Symposium, September 1969. Can. For. Serv., Alberta/Territories Region, Calgary, Alberta. March.

MacIver, D.C. 1970. A technique of thermo dew-point recording in northern Alberta. (Summary) pp. 188. In: Powell, J.M. and C.F. Nolasco (Eds.). Proc. Third Forest Microclimate Symposium, September 1969. Can. For. Serv., Alberta/ Territories Region, Calgary, Alberta. March.

MacIver, D.C. 1970. Macroclimatic zonation in northern Alberta. Univ. Alberta, M.Sc. thesis. 187 pp.

MacIver, D.C., W.D. Holland and J.M. Powell. 1972. Delineation of similar summer climatic regimes in central Alberta. Envir. Can., Envir. Management, Northern Forest Research Centre, Edmonton. NOR-X-30. 32 pp.

Powell, J.M. 1973. Forest Climatology in Alberta. Paper presented to the Canadian Meteorological Society (Alberta Centre). Edmonton, April 3.

1974-75

Powell, J.M. and D.C. MacIver. 1974. Climatic classifications of the Prairie Provinces: a new classification for the forested areas. Paper presented at the Annual Meeting, Western Division, Canadian Association of Geographers, Lethbridge. March 16.

Powell, J.M. 1974. Temperature traverses near a potential tree nursery site, east of Clyde, Alberta. Envir. Can., North. For. Res. Cent., File Rept. Study NOR-039. June, 18 pp.

Powell, J.M. and D.C. MacIver. 1975. Climatic classifications of the Prairie Provinces: a new preliminary classification for the forested areas of Alberta. Can. Assoc. Geogr., Western Div., Occasional Papers in Geography. (*In Press*)

16. Signatures:

J. M. Powell

Investigator

Program Manager

G.T. Silver

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY PROPOSAL STATEMENT

1975 - 76

Responsiblity Centre: NORTHERN FOREST RESEARCH CENTRE

February 25, 1975

1. Project: Improved Forest Land Inventory and Classification Methods.

2. Title: Forest types and their relationships to soil series in the P-6 Forest Management Unit.

3. New: X Cont: 4. No.: NOR 983

5. Study Leader: G. L. Lesko

6. Key Words: *Picea glauca, Abies balsamea, Populus tremuloides,* boreal forests.

7. Location of Work: P-6 Management Unit, Peace River District.

8. Problem:

Alberta Forest Service intends to use P-6 as an integrated forest management pilot area. In order to set up the most advanced management system they need to know the forest types within the area and their relationships to the edaphic component and forest productivity. Inventory work and soil classification are already completed for the area, leaving only the forest type component missing. The Alberta Forest Service requested our organization to supply this missing information.

The probability of success, and application of the result is very high.

Outline of the methods to be used:

1. Forest vegetation will be described within soil series, already established by L. Knapik of Alberta Soil Survey, on the field.
2. Site index and basal area of the stands will be measured.
3. The forests will be organized into forest types on the basis of their vegetation composition.
4. The productivity of each forest type will be established and their relationships to soil series will be indicated.

5. Soil series with similar forest types will be grouped to form soil management units.

6. Management implications of soil management units will be described.

9. Study Objectives:

1. To classify the forest into forest types.

2. To find relationships between forest types, soil series, forest productivity.

3. To provide useful information to Alberta Forest Service in the formation of forest compartments.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 0.9
d. Essential new major equipment items for 1975-76 with cost: Nil
e. Essential new major equipment items beyond 1976 with cost: Nil
f. 1975-76 man-years

Prof.	0.4			
Supp.	0.4			
Casual	-			
Total	0.8		O & M funds req'd:	$3,000

11. Progress to Date:

N/A

12. Goals for 1974-75:

N/A

13. Accomplishments in 1974-75:

N/A

14. Goals for 1975-76:

1. To complete all field work.

2. To initiate analysis of collected data.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

PROJECT NOR - 3

Development of Economic Guidelines for Allocating Resources for Resource Management and Research

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April 1, 1975

1. Project: Development of economic guidelines for allocating resources for resource management and research.

2. Title: An assessment of the forest-based economy of the Prairie Provinces.

3. New: Cont.: X 4. No.: NOR 123

5. Study Leader: A.G. Teskey, J.H. Smyth

6. Key Words: Sawmills, pulp mills, multiplier, linkages, benefits, economic impacts.

7. Location of Work: Northern Forest Research Centre, Edmonton, Prince Albert, Regina, Winnipeg.

8. Problem:

To provide a comprehensive statistical description of some major economic impacts of forestry and forest-based industry to the provincial and local economies of Manitoba, Saskatchewan, and Alberta, for the purpose of more effective utilization and management of forest resources.

This study will provide a statistical information base for NFRC management of research programs for more rational allocation (and management) of the laboratory's resources. In addition it will provide provincial forest resource administrators and managers with a better understanding of the benefits (e.g., income and employment) generated by the respective provincial forest industries.

The probability of success in terms of achieving the study objectives is almost 1. The probability of the results or conclusions reached being put into practice or being seriously considered in policy formulation is not readily known as it is almost totally dependent upon the decisions of individuals other than the investigators.

The methods employed in this study can be viewed as survey methods in general. Data collection from government, industry and the general public is conducted by telephone, letter and personal interview. In some cases, data is collected by the use of questionnaires.

9. Study Objectives:

   a. To describe the land and forest resources of the region by province.

   b. To identify and describe some of the major product flows from forest to consumer including the raw wood requirements of selected wood-using industries.

   c. To identify and estimate the major economic benefits and impacts of the forest resource and its utilization by provinces.

10. Resources:

   a. Starting date: 1972
   b. Estimated year of completion: 1974 Revised: 1975
   c. Estimated total Prof. man-years required: 1.3
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.2	(A.G. Teskey)	
Supp.	1.0	(J.H. Smyth)	
Casual	-		
Total	1.2		O & M funds req'd: $1,000

11. Progress to Date:

Collection of resource base data was completed and analysed for Manitoba and Saskatchewan. Very little progress was made with Alberta. Surveying of wood-using firms was approximately 90 per cent completed, but only 66 per cent completed with the wholesale-retail lumber dealers in the 3 provinces. Analysis of results was underway. A directory of primary wood-using industries was compiled for 1972 and published. The third and final meeting of the Ad Hoc Steering Committee for NOR 123 was held in Winnipeg Nov. 29/73. Mr. J.M. Taylor of the Western Forest Products Laboratory left C.F.S. in Sept./73 reducing the professional man-year input by 0.5.

12. Goals for 1974-75:

   1. Finish collecting residual data needed for completion of the study.

   2. Complete editing and analysis of survey results from late returns.

   3. Write three Information Reports, one each for Alberta, Saskatchewan and Manitoba. These will be detailed reports with the complete findings of the study recorded for each province. A suggested title is "Employment, Income, and Product Utilization in Saskatchewan's (Alberta's, Manitoba's) Wood-using Industry". Changing the province would be required for the other two.

4. Prepare a condensed version of the highlights of the study as a Departmental publication for wide distribution throughout the region and elsewhere.

5. Revise, update and publish a 1974 edition of the "Directory of primary wood-using industries in Alberta, Saskatchewan and Manitoba, 1973" as an Information Report.

6. Participate in the development of DREE Forestry Subsidiary Agreements with provincial governments.

13. Accomplishments in 1974-75:

1. Data collection completed.

2. Editing and analysis completed.

3. Draft reports were written and circulated for comment as follows:

Teskey, A.G. and J.H. Smyth. Employment, Income, Products and Costs in Manitoba's Primary Wood-Using Industry, 1972. Northern Forest Research Centre, Edmonton, Alberta. Information Report, draft, July 1974. 119 pages.

Teskey, A.G. and J.H. Smyth. Saskatchewan's Forest Industry and Its Economic Importance. Northern Forest Research Centre, Edmonton, Alberta. Information Report, draft, August 1974. 161 pages.

Teskey, A.G. and J.H. Smyth. The Economic Importance of Sawmilling and other Primary Wood-Using Industries in Alberta, 1972. Northern Forest Research Centre, Edmonton, Alberta. Information Report, draft, March 1975. 162 pages.

4. Not done because the background work wasn't finished.

5. Completed. First printing of 500 copies was distributed within the first two months of publication. A second printing of 300 copies is nearly distributed also.

Teskey, A.G. and J.H. Smyth. A Directory of Primary Wood-Using Industries in West-Central Canada, 1973. Northern Forest Research Centre, Edmonton, Alberta. Information Report, NOR-X-83, May 1974. 224 pages.

6. Participated in the development and revision of the Sask.-DREE Background Economic paper supporting their proposed forestry subsidiary agreement.

14. Goals for 1975-76:

    1. Complete Final publication of: (see item 3 under Section 13).

    2. Write an Issue of Forestry Report on the economic importance of primary wood-using industries in West-Central Canada.

    3. Provide economic input into DREE regional forestry planning as required.

15. Publications:

    Up to 1974-75

    Teskey, A.G. and J.H. Smyth. 1973. A Directory of Primary Wood-using Industries in Alberta, Saskatchewan, and Manitoba, 1972". Northern Forest Research Centre, Edmonton, Alberta. Information Report NOR-X-59. June, 1973. pp. 154.

    1974-75

    (See Sect. 13 Item 5)

16. Signatures:

A. G. Teskey
Investigator

Program Manager

G. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April 1, 1975

1. Project: Development of economic guidelines for allocating resources for resource management and research.

2. Title: An economic evaluation of public investment in natural resource development and its impact on farm growth and the regional economy.

3. New: Cont.: X 4. No.: NOR 134

5. Study Leader: A.G. Teskey

6. Key Words: Input-output, linear programming, polyperiod, multiplier.

7. Location of Work: Winnipeg and Edmonton.

8. Problem:

Public, as well as private, investments can and often are evaluated in terms of their costs and benefits, either before they are implemented or after. In the case of public investment in regional development programs, such as drainage, land clearing, and land acquisition in the Interlake ARDA-FRED Plan, cost-benefit analysis fails to measure many important impacts. For example, a cost-benefit analysis may indicate greater benefits than costs from land clearing (Pareek, 1972), but is incapable of assessing the effect of these profits on the growth of individual farms in the region. Shifts in growth patterns of individual farms may results in larger and fewer farms in the area and in turn lead to changes in other sectors of the region's economy.

Given that the main objectives of regional development include the improvement of living standards, increasing incomes and more employment opportunities for the depressed areas' inhabitants, public programs that result in fewer and larger farms, production of different types of crops and livestock, and changing requirements in the kinds and amounts of inputs used, necessitate evaluation beyond a macro cost-benefit analysis.

The purpose of this study is to develop a methodology that allows the dynamics of the farm economy to be incorporated in the analysis, relates the resulting changes to the region's economy and makes possible an assessment of impacts that result from the dynamics of public investment before the programs are undertaken.

Increases net benefits from regional development programs can be obtained for the residents of depressed areas since proposed programs can be simulated, thereby testing the outcome of proposed policies before they are actually implemented and modified where desirable. This reduces the amount of costly trial and error that often accompanies a new program of public spending. Similarly, it allows more benefits with less costs to be achieved from the general tax dollar.

Essentially the method to be used involves two major components. An input-output model for the regional economy under study is used in conjunction with a polyperiod firm growth model. In simplified terms, representative farms are chosen and optimum farm management plans are aggregated for the region and compared with the agricultural vectors of the I/O Table for the same period. Then the representative farms are allowed to grow into the future through the polyperiod growth models. At some future time period these farms are aggregated and modified to provide the new vectors of a future I/O Table for the region's economy. Other sectors of the Table are also estimated for this future date and then the multipliers are calculated for the agricultural sector. These multipliers reflect the dynamics of farm growth influenced in part by the public resource development programs of the initial time period.

9. Study Objectives:

a. To develop a model for evaluating the dynamic effects of public investment in resource development on the agriculture sector and other components of a regional economy and apply this methodology to the Interlake area of Manitoba.

b. To simulate the model for variations in levels of public expenditures on land clearing, drainage, and acquisition programs in Manitoba's Interlake as a sensitivity analysis of the model to determine those parameters that are most critical to the model.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: 1972 Revised: 1975
c. Estimated total Prof. man-years required: 1
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.8 (A.G. Teskey)		
Supp.	-		
Casual	-		
Total	0.8	O & M funds req'd:	$1,650.00

11. Progress to Date of Last Review:

    1. The literature review was completed and a rough draft of an introduction to the study, review of literature, and conceptual framework of analysis was completed.

    2. The approach to the problem has been generally decided upon in consultation with my major advisor, Dr. J.A. MacMillan.

12. Goals for 1974-75:

    1. Construct a polyperiod linear program to simulate farm firm growth.

    2. Identify representative farms and apply the above LP model.

    3. Use these growth model results to determine changes in agriculture production over time in the Interlake.

    4. Revise the 1968 input-output table for the Interlake by estimating the expected interindustry coefficients to obtain in 1971, 1976 and 1981. This will give a partially dynamic input-output analysis.

    5. Solve these estimated input-output tables for employment and income effects.

    6. Simulate the effects of Government land development programs through representative farms, the region's agricultural economy and the urban impacts resulting from changes in the input-output models by introducing above program impacts into farm growth models.

13. Accomplishments in 1974-75:

    None of the goals listed above were accomplished as no time or money was expended on study 134 during 1974-75.

14. Goals for 1975-76:

    1. To complete study 134 by pursuing the goals set out for 1974-75.

15. Publications:

    Up to 1974-75

    Nil

    1974-75

    Nil

16. Signatures:

A. G. Teskey
Investigator

W. F. Denger
Program Manager

G. T. Silver
Director G.T. Silver

PROJECT NOR - 4

Improved Growth and Yield of Managed Stands

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: The effect of initial spacing on the growth of lodgepole pine.

3. New: Cont.: X 4. No.: NOR 008

5. Study Leader: W.D. Johnstone

6. Key Words: *Pinus contorta*, thinning, stand development, stand density, B.19c.

7. Location of Work: Hinton, Tee-Pee Pole Creek and McKay, Alberta, Sandilands, Manitoba

8. Problem:

Although growing space has a pronounced effect on the development of individual trees and forest stands, little is known in Alberta concerning the effect of spacing on 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 the correction of over-stocking of lodgepole pine following wildfire by pre-commercial thinning. In order to determine the optimum thinning regime a study was established in 1954 in a pure stand of 22-year-old lodgepole pine trees. The following treatments were carried out in each of three blocks:

1. Single thinning to 5' x 5' espacement.

2. Single thinning to 6' x 6' espacement.

3. Single thinning to 8' x 8' espacement.

4. Multiple thinning - initially to 6' x 6' then after 50 years reduced by 40% basal area.

5. Multiple thinning - initially to 6' x 6' then every 15 years reduced by 30% basal area.

6. Control, untreated.

In addition an unreplicated 12' x 12' treatment was included. All trees were measured in each treatment plot in 1954 and remeasured in 1960 and 1969. The next thinning is due in 1984.

In order to determine the influence of spacing on the growth of very young trees the study was expanded 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. In 1963 and 1964 the same espacements were established on three sites in dense 5-year-old pine regeneration on the Gregg burn. In 1966 and 1967 identical treatments were applied in a 25-year-old pine stand in the Tee-Pee Pole Creek area of western Alberta. In 1969 the planted parts of the study were abandoned because the very poor survival invalidated spacing comparisons.

9. Study Objectives:

   a. To determine how spacing affects diameter, height and volume growth, tree form and wood quality.

   b. To determine at what age and density spacing becomes effective in controlling growth.

   c. To determine at what age and density trees are able to fully occupy the site.

   d. To determine the release potential after various periods or degrees of suppression.

   e. 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.

10. Resources:

   a. Starting date: 1954
   b. Estimated year of completion: 1985
   c. Estimated total Prof. man-years required: 2.2
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.0	
Supp.	0.0	
Casual	-	
Total	0.0	O & M funds req'd: -

11. Progress to Date:

1954 - treatments introduced, all trees tagged and dbh recorded, and the heights of 30 trees covering the range of dbh classes measured in each plot at McKay.

1960 - height - sample trees remeasured and annual terminal leader growth for the period 1950-60 recorded at McKay.

1963 - 3-0 spruce and pine planted at 5 spacings on 5 sites in Gregg burn.

1963 and 1964 - same 5 espacements established in 5-year-old pine stands on 3 sites in Gregg burn.

1966 - initial height measurements obtained in Gregg plots.

1966 and 1967 - identical treatments applied to 25-year-old pine stands in Tee-Pee Pole Creek area.

1968 - survival measurements in planted trials.

1968 and 1968 - trees in Gregg plots surveyed and mapped.

1969 - planted trials abandoned because of very poor survival.

1969 - heights and diameters remeasured, treatment 5 rethinned, and stem analysis samples collected at McKay.

1970 - McKay height and diameter data from 1954, 1960 and 1969 compiled and analyzed, and stem analysis samples measured on an Addo-X tree ring counter.

1970 - Gregg plots maintained (corner posts and tree tags renewed, and ingrowth removed).

1971 - Gregg plots measured (dbh, height, crown length, crown width).

1972 - Tee-Pee Pole Creek plots measured (as above).

1973 - Biological agents which have been affecting the growth and survival of the trees in the Gregg burn plots have been identified.

1974 - Corner posts and treatment signs renewed in Gregg burn plots.

12. Goals for 1974-75:

1. To publish the results obtained to date from the McKay thinning trials.
2. Renew corner posts and treatment signs in the Gregg burn plots.

13. Accomplishments in 1974-75:

1. Preliminary analysis of data from the McKay thinning trials carried out and it was decided that publication was not warranted at this time.

2. Corner posts and treatment signs renewed in Gregg burn plots.

3. Incorporated spacing experiments for jack pine and red pine into this study. (Previously NOR-079). Remeasurement of these experiments anticipated in 1978.

14. Goals for 1975-76:

1. Prepare Study Progress Report.

(Gregg burn remeasurement due 1976-77).
(Tee-Pee Pole Creek remeasurement due 1977-78).
(McKay thinning remeasurement due 1979-80).

15. Publications:

Up to 1974-75

Holmes, J.R.B. 1961. Development of young lodgepole pine after thinning. Can. Dep. Forest., Forest Res. Br., Mimeo 61-21. pp. 11.

1974-75

Nil

16. Publications:

W.D. Johnstone
Investigator

Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

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

3. New: Cont.: X 4. No.: NOR 009

5. Study Leader: W.D. Johnstone and I.E. Bella

6. Key Words: *Pinus contorta*, stand development, yield tables, management planning, B.19a,c.

7. Location of Work: Foothills section of Alberta.

8. Problem:

There are no adequate yield tables for the lodgepole pine type in Alberta. Although the reduction in stand productivity with high stand density has been well documented in Alberta, the extent of the loss and the relationship between density, site and productivity are not well known. Yield tables are necessary therefore for rational sustained yield management (through the quota system and pulpwood lease agreements), and silvicultural practice (i.e., for prescribing remedial stand treatments). In order to determine the effect of site and stand density on the yield of pure lodgepole pine stand data were obtained from 865 permanent and single examination sample plots. For each plot data were obtained on the following: total age, site index, mean dbh and height, number of stems and basal area per acre, and total cu. ft., merch. cu. ft. (4.6" dbh, 4" top), sawlog cu. ft. (8.6" dbh, 6" top) and sawlog f.b.m. (8.6" dbh, 6" top) volumes per acre. Graphical and regression techniques will be used to prepare yield tables which expression mean stand height and dbh, and number of stems, basal area and volume per acre as functions of stand density, site, and age. The tables are to be checked against the permanent sample plot re-measurement data.

9. Study Objectives:

   a. To construct a variable-density yield table.

10. Resources:

a. Starting date: 1951
b. Estimated year of completion: Orig. - cont. Revised: I-1972
II-1973
III-1984

c. Estimated total Prof. man-years required: 1.8
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.1	(Johnstone 0.1)		
Supp.	0.1			
Casual	0.0			
Total	0.2		O & M funds req'd:	$200.00

11. Progress to Date:

1951, 1952 and 1953 - 141 permanent and 41 single examination plots established.
1954 - preliminary yield table prepared.
1961 - permanent sample plots remeasured
1964 and 1965 AFS sample plot data obtained and combined with CFS data.
1967 - new measure of site developed and tested.
1968 - development index obtained.
1969 and 1970 - all data coded and analysis initiated.
1971 - preliminary analysis carried out.
1973 - paper entitled "Variable stand density yields of natural lodgepole pine stands in Alberta" presented at the "Management of Lodgepole Pine Ecosystems" Symposium in Pullman, Washington.
1974 - 85 CFS permanent sample plots relocated, remeasured and analyzed.

12. Goals for 1974-75:

1. Publish variable-density yield table (Johnstone).

2. Remeasure CFS permanent sample plots (Johnstone).

3. To obtain, localize and test A.R. Stage's (U.S.F.S., Moscow, Idaho) prognosis model of lodgepole pine stand development (Bella).

13. Accomplishments in 1974-75:

1. Variable-density yield table prepared and presently undergoing local review (Johnstone).

2. 85 CFS permanent sample plots remeasured, analyzed, and data incorporated into variable-density yield table (Johnstone).

3. Stage's model was obtained and is being tested with local data (Bella).

14. Goals for 1975-76:

    1. Publish variable-density yield table in department's Technical Report series (Johnstone).

    2. Prepare Study Progress Report.

15. Publications:

Up to 1974-75

Ackerman, R.F. 1954. Preliminary yield tables. In: Smithers, L.A. 1961. Lodgepole pine in Alberta. Can. Dep. Forestry, Bull. 127.

Johnstone, W.D. 1975. Variable stand density yields of natural lodgepole pine stands in Alberta. In Management of lodgepole pine ecosystems. Symposium proceedings. (D.M. Baumgartner, Ed.) Wash. St. Univ., Pullman. Vol. 1:186-207.

1974-75

Nil

16. Signatures:

W. D. Johnstone
Investigator

R. F. Ackerman
Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Growth and development of thinned and untreated stands of jack pine.

3. New: Cont.: X 4. No.: NOR 045

5. Study Leader: I.E. Bella

6. Key Words: *Pinus banksiana*, tree and stand growth, density, yield, stocking site, yield tables, thinning methods and intensities.

7. Location of Work: Various locations in Manitoba, Saskatchewan and Alberta.

8. Problem:

Jack pine is one of the most widely occurring species in the Boreal Forest. It regenerates readily and grows relatively fast even in dry, sandy soils. Improved management of the species requires reliable methods of forecasting growth and yield of stands of different density and site quality. This kind of information is also necessary to make decisions about density control treatments designed to increase merchantable yield or shorten rotation. This information is needed now and its use is assured as it becomes available.

Methods:

This study is made up of a series of thinning experiments. In the earlier ones, where trees were individually selected and cut, the intensity of thinning was defined in an arbitrary fashion, usually on the basis of crown class designation. In the more recent experiments, intensity was defined by spacing, basal area, of SDI. In strip thinning, intensity is the function of residual strip width, while the width of the cut strip is constant. Stands were thinned once in all but one experiment. Stand ages and site conditions usually differed by studies. Measurements and remeasurements: dbh to 1/10 inch of all trees, height of sample trees only. In most selective thinning experiments, the trees on the plots were mapped.

9. Study Objectives:

To determine the effect of different types and intensities of thinning on subsequent growth and yield of jack pine.

10. Resources:

a. Starting date: as early as 1921.
b. Estimated year of completion: these studies generally extend over the life of the stand.
c. Estimated total Prof. man-years required: 2.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	-	
Supp.	0.1	
Casual	0.1	
Total	0.2	O & M funds req'd: $400.00

11. Progress to Date:

Sample plots have been established and thinning treatment carried out where required. Trees on the plots were measured and remeasured. Empirical yield tables and interim results of the thinning experiments have been published.

12. Goals for 1974-75:

1. Obtain tree measurements from sample plots used in a time study to evaluate growth response to thinning in the future.

2. Complete the analysis of the current jack pine data on strip thinning and publish results either as an Information Report, or a note in the Forestry Report or a journal.

3. If feasible, remeasure the second series of plots (20 at Badger, Manitoba) in the jack pine strip thinning experiments in the fall of 1974, if not this should be done in the spring of 1975.

4. In cooperation with the Information Section (Ross Waldron), prepare a practical thinning prescription for inclusion in a bulletin on jack pine management.

5. Analyse the first 15-year growth and yield data from Study #3 (see table) and publish results as warranted.

6. Co-operate with J. Soos in the analysis of a thinning-fertilization study of young lodgepole pine.

13. Accomplishments in 1974-75:

1. Tree measurements were taken on sample plots areas in a time study to evaluate growth response to thinning.

2. Analysis of 10-year growth data after strip thinning jack pine has been completed and the results published.

3. A second series of jack pine strip thinning plots in SE Manitoba were remeasured in the fall of 1974.

4. Preparation of a practical thinning prescription has been deferred as no work has started yet on the planned bulletin on jack pine management.

5. Analysis of the first 15-year growth and yield data from a merchantable selective thinning study (#3) has been completed and the results published.

6. Co-operated with J. Soos in the analysis of a thinning-fertilization study in young lodgepole pine and the first draft of a report has been prepared.

14. Goals for 1975-76:

1. Remeasure the third series of jack pine strip thinning plots (10) in SE Manitoba.

2. Take the additional measurements required and prepare a report for publication on the thinning and fertilization study of young lodgepole pine.

15. Publications:

Up to 1974-75

Wilson, G.M. 1950. Thinning 30-year-old jack pine, Nisbet Forest Reserve, Saskatchewan. Can. Dept. Resour. and Develop., Silv. Leafl. No. 52. pp. 3.

Wilson, G.M. 1952. Thinning jack pine, Nisbet Forest Reserve, Saskatchewan. Can. Dept. Resour. and Develop., Silv. Res. Note 99. pp. 24.

Cayford, J.H. 1961. Results of a 1927 jack pine thinning in Saskatchewan. Can. Dept. For., Tech. Note 107. pp. 13.

Cayford, J.H. 1964. Results of a 1920 jack pine thinning in western Manitoba. Can. Dept. For., Publ. No. 1077. pp. 8.

Bella, I.E. 1966. Strip thinning jack pine thickets with a "Drum Chopper" in Manitoba. Information Report MS-X-3, pp. 9.

Bella, I.E. 1968. Jack pine yield tables for southeastern Manitoba. Can. Dept. Fish. Forest., Forest Branch, Publ. No. 1207. pp.15.

Steneker, G.A. 1969. Strip and spaced thinning in overstocked jack pine and black spruce stands. Can. Dept. Fish. and Forestry. Information Report MS-X-16. pp. 14.

Bella, I.E. and J.P. DeFranceschi. 1971. Growth of young jack pine after mechanical strip thinning in Manitoba. Can. Forest. Serv., Information Report A-X-40. pp. 20.

Bella, I.E. 1972. Growth of young lodgepole pine after mechanical strip thinning in Alberta. Can. Forest. Serv., Information Report NOR-X-23. pp. 16.

Bella, I.E. and J.P. DeFranceschi. 1974. Analysis of jack pine thinning experiments, Manitoba and Saskatchewan. Dept. Env., C.F.S. Publ. No. 1338. 21 p.

1974-75

Bella, I.E. Growth response of young jack pine to mechanical strip thinning, Manitoba. C.F.S. Info. Rep. NOR-X-102. 11 p.

Bella, I.E. and J.P. DeFranceschi. Commercial thinning improves growth of jack pine. C.F.S. Info. Report NOR-X-112. 22 p.

16. Signatures:

I.E. Bella
Investigator

Program Manager

Director G.T. Silver

SUMMARY OF ACTIVE THINNING EXPERIMENTS IN PINE,

1973

Study No.	Location	Soil and Site	Stand age at establishment	Date of	Date of remeas.	No. of plots	Plot size (acres)	Thinning Method	Thinning Intensity
1	Prince Albert, Sask.	Medium to coarse sand, dry to moderately Dry	30	1949	1954 1964	2	1.0	Regular Spacing	Control, no thinning Thinned: Heavy - 7 x 7 ft
			40	1949	1954	2	1.0		Control, no thinning Thinned: Heavy - 7 x 7 ft.
			60	1949	1954 1964	2	1.0		Control, no thinning Thinned: Light - 9 x 9 ft.
2	Sandi-lands, Man.	Stratified sand and gravel outwash; moist	15	1952	1957 1962 1967 1971	16	0.1	Low selection thinning to specified Stand Density Index every 5 years, except in 1971	Control, no thinning - 2 plots Thinned: To 40%, 50%, 60%, 70% 80%, 100%, and 120% of control SDI; 2 plots each
3	Sandi-lands, Man.	Medium sand; fresh	40	1958	1963 1968 1973	20	0.1	Merchantable Selection thinning, low and crown. Only trees with dbh over 4" were removed.	Control, no thinning - 4 plots Thinned: Heavy low 4 plots Light low 4 plots Heavy crown 4 plots Light crown 4 plots

SUMMARY OF ACTIVE THINNING EXPERIMENTS IN PINE, 1973 (Continued)

Study No.	Location	Soil and Site	Stand age at establishment	Date of establishment	Date of remeas.	No. of plots	Plot size (acres)	Thinning: Method	Thinning: Intensity
4	Sandilands Forest Reserve, Manitoba	Sand, fresh	9	1964	1965 1968 1973	15	.002 - .007	Mechanical Strip-thinning	Control: 5 plots Thinned 1-way: 5 plots Thinned 2-way: 5 plots
		Sand, fresh	11	1967	1969	5	.002 - .007	Mechanical Strip-thinning	Thinned 1-way: 5 plots
		Sand, moist	9	1964	1965 1968 1973	15	.002 - .007	Mechanical Strip-thinning	Control: 5 plots Thinned 1-way: 5 plots Thinned 2-way: 5 plots
		Sand, moist	11	1967	1969	5	.002 - .007	Mechanical Strip-thinning	Thinned 1-way: 5 plots
		Sandy till, fresh	13	1965	1967 1970 1974	10	.002 - .007	Mechanical Strip-thinning	Control: 5 plots Thinned 1-way: 5 plots
		Sandy till, fresh	17	1966	1968 1970	10	.002 - .007	Mechanical Strip-thinning	Control: 5 plots Thinned 1-way: 5 plots
		Sand, dry	13	1965	1967 1970 1974	10	.002 - .007	Mechanical Strip-thinning	Control: 5 plots Thinned 1-way: 5 plots
5	Duck Mtns.		11	1948	1968	5	.25	Selection & Strip	Control: 2, Strip: 1, 7x7: 1; 5x5: 1
6	Bow River Forest, Alta.	till, fresh to moist	30	1971		20	.002 - .007	Mechanical Strip-thinning	Control: 6 plots Thinned 1-way: 14 plots
7	Hinton, Alta.	Till, fresh	16	1973		18	.025	Selective thinning with a brush saw	Thinned: 6-7 ft spacing

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Selective cutting in white spruce-trembling aspen stands.
   Study (a) - improvement cutting, white spruce-aspen stands,
   Study (b) - competition in a white spruce-aspen stand.

3. New: Cont.: X 4. No.: NOR 073

5. Study Leader: G.A. Steneker

6. Key Words: Competition, diameter increment, *Picea glauca, Populus tremuloides*, B18a Forest Section, production, suppression, silviculture.

7. Location of Work: Divide Forest Reserve and Dore Lake Road, Saskatchewan

8. Problem:

Nature of Study:

The study involves the application of silvicultural technique in the form of release cuttings.

Benefits from Study:

Benefits are expected to be increased fibre yields.

Probability of Success:

Chances for success are good. Trees are expected to respond to release. Degree of response must be determined.

Use of Results:

Release cuttings are costly. With the present low management intensity chances are that results will not be put to use.

Methods Used:

Study (a)

Permanent sample plots were selected in middle-aged spruce-aspen stands and release cuttings were carried out, leaving the best quality spruce for a final cut. Uncut portions of the stand were used as controls. Pertinent stand data were collected before and after treatment.

Study (b)

Individual spruce trees were selected in a middle-aged spruce-aspen stand. Position and size of competitors in the vicinity of these trees, was noted, in order that growth of individual spruce trees could be related to their position within the stand.

9. Study Objectives:

   a. Through release cuttings, to increase the merchantable volume production of residual white spruce trees in spruce-aspen stands.

   b. To assess competition around individual spruce trees, based on the proximity and size of competitors, and develop a numerical expression of competition using the size of and proximity of competitors.

10. Resources:

   a. Starting date: 1961
   b. Estimated year of completion: 1971 Revised: 1975
   c. Estimated total Prof. man-years required: -
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.0	
Supp.	0.0	
Casual	-	
Total	0.0	O & M funds req'd: -

11. Progress to Date:

Since 1961 two white spruce-aspen stands were selected in which operational release cuttings were carried out. The spatial arrangement of trees in another white spruce-aspen stand was mapped for the purpose of assessing competition. 1971 remeasurement compiled and final report initiated.

12. Goals for 1974-75:

   1. Publish final report and terminate study.

      Steneker, G.A. 1974. Operational release cutting in white spruce-trembling aspen stands. Northern Forest Research Centre, Information Report.

13. Accomplishments in 1974-75:

Final report published and study terminated.

14. Goals for 1975-76:

None. Study terminated.

15. Publications:

Up to 1974-75

Nil

1974-75

Steneker, G.A. 1974. Selective cutting to release white spruce in 75 to 100-year-old white spruce-trembling aspen stands, Saskatchewan. N.F.R.C. Info. Rep. NOR-X-121.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Mathematical stand growth models for aspen.

3. New: Cont.: X 4. No.: NOR 075

5. Study Leader: I.E. Bella

6. Key Words: *Populus tremuloides*, tree and stand growth, stand development density-competition effects, clonal structure, yield, stocking, site, ecological systems, models, simulation.

7. Location of Work: Manitoba and Saskatchewan, some of the analysis at University of British Columbia.

8. Problem:

A general method is needed to forecast growth and yield of aspen for a variety of stand conditions. Of primary interest now is the effect of stand density on merchantable yield both in treated and in untreated stands. Predicting response to fertilization is likely to be a problem in the near future. Such information is a prerequisite to more efficient forest management. Even partial success and preliminary results would be valuable and would be used as became available.

The complexity of this problem, arising largely from the clonal habits of the species, makes it impractical to attempt a solution using conventional techniques only, i.e., sampling and experimentation. Systems modelling and computer simulation is the approach that may provide answers at a reasonable cost in a relatively short time and is used in this study.

9. Study Objectives:

To forecast growth and yield of aspen stands growing under a range of site and density conditions using a stand growth model developed for this purpose.

10. <u>Resources</u>:

a. Starting date: 1968
b. Estimated year of completion: 1973 Revised: 1978
c. Estimated total Prof. man-years required: 2.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

	Prof.	0.1		
	Supp.	0.1		
	Casual	-		
	Total	0.2	O & M funds req'd:	$100.00

11. <u>Progress to Date</u>:

1. Identified the major components of tree growth and mortality, and developed general structure for the stand model.

2. Pooled data from related project; analyzed growth-competition relations and developed a new competition model.

3. Collected data on tree size distributions (living and dead) and on early development of sucker stands and obtained growth-competition data from other sources.

4. Conducted initial test-runs with the stand model.

5. Completed problem analysis and established thinning trials in very young (under 10 years old) stands in Alberta and Saskatchewan.

6. Incorporated thinning trials previously administered under NOR 072 into this study.

7. Clonal identity of each tree was described on a number of permanent sample plots selected from old aspen thinning experiments. This information is necessary to remove clone related variation in diameter increment in analysis of growth-competition relationship. It was found that a large majority of trees on any one plot belonged to the same clone; an advantage in the analysis of general growth-competition relations but somewhat restrictive in the study of competition effects in aspen stands.

12. <u>Goals for 1974-75</u>:

1. Design and conduct a study to test the hypothesis H1 that initial (1 to 10 years) sucker density has an important effect on tree growth and stand development, using growth data from the remeasurement of a thinning study in very young aspen.

2. Gain working knowledge of Stage's model by first using it for prognosis of lodgepole pine stand development with his parameters. Then in co-operation with W. Johnstone (NOR 009), derive parameters using Alberta data to cover stand conditions in this region. With the acquired knowledge of using this system, adapt the model by deriving the necessary parameters and coefficients for aspen.

3. Demonstrate the use of this model to forest managers and write Information Report that would serve as a user's manual.

13. Accomplishments in 1974-75:

1. H1 was accepted based on the analysis of growth data obtained from the remeasurement of a thinning study in juvenile aspen stands. A draft of a report has been prepared.

2. There were several problems encountered in testing Stage's stand prognosis model. First, there were some programming errors so the model would not run. After rectifying this, we found that it gave some quite erratic growth estimates with our test data. It seems that this model needs considerably more testing and refinement than originally anticipated, before it could be used operationally even for lodgepole pine.

   Adaption of this model to lP in Alberta required either the replacement, or at least a comparison of basic growth regressions (ΔD and ΔH) in the model with those derived from local data. Required data are being obtained from three sources: (1) AFS growth plots, (2) NWPP-S CFI plots at Hinton, and (3) W.D. Johnstone's lP thinning studies.

   After appropriate screening of these data, there were about 1,000 tree increment records available for the regression analyses (about 500, from 150 plots from the AFS, and also 500 from about 100 plots from Hinton). Growth data from the thinning study were set aside for an independent test of the model that uses localized growth regressions.

   Our regression analyses gave somewhat disappointing results with considerably lower R^2 values than those of Stage (max 0.60 vs .80). After the effect of tree size (Dbh or H) was removed, the other independent variables had only marginal significance. CCF, as a measure of crowding or competition was particularly weak. Possible reasons: (1) the relatively poor precision of diameter, and especially height measurements of sample trees results in high variation in increment values for slow growing species; (2) Unless stocking and density is uniform over the entire plot,(which is very unlikely), CCF values calculated on a plot basis may misrepresent actual competition around the sample tree. This means it would be desirable, or indeed necessary, to make a careful evaluation of each sample plot in the field based on those criteria, particularly in the vicinity of sample tree(s).

   Because of these problems, no work has been started on adopting this model to aspen.

3. Goal 3 was deferred.

14. Goals for 1975-76:

1. Publish results in "Growth-density relations in juvenile aspen sucker stand" as an Info. Report.

2. Prepare a program report on the testing and adaption of Stage's stand prognosis model. (Include in the Project progress report).

3. Prepare Study Progress Report.

15. Publications:

Up to 1974-75

Bella, I.E. 1968. Estimating aerial component weights of young aspen trees. Can. Fish. Forest. Info. Dep. MX-X-12, pp. 36.

Bella, I.E. 1969. Competitive Influence-Zone Overlap: A competition model for individual trees. Can. Dept. Fish. Forest. Bi-Monthly Res. Notes 25(3): 24-25.

Bella, I.E. Simulation of growth, yield and management of aspen, Forest. Chron. 47(1): 41. (Abstract of a thesis.)

Bella, I.E. A new competition model for individual trees. Forest Sci. 17: 364-372.

Bella, I.E. 1972. Simulation of growth: A new approach to yield forecasting. In: Aspen Symposium Proceedings, USDA Forest Service. General Technical Report NC-1. pp. 103-108.

Bella, I.E. and J.P. DeFranceschi. 1972. The effect of logging practices on the development of new aspen stands, Hudson Bay, Saskatchewan. Info. Report NOR-X-33, pp. 20.

Bella, I.E. and K. Hunt. 1973. Kraft pulping of young trembling aspen from Manitoba. Can. J. For. Res. 3: 359-366.

1974-75

Steneker, G.A. 1974. Thinning of trembling aspen *(Populus Tremuloides* Michaux) in Manitoba. C.F.S. Info. Report NOR-X-122.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

SUMMARY OF ACTIVE THINNING AND OTHER GROWTH STUDIES IN ASPEN (Continued)

Study No.	Location	Soil and site	Stand age at establishment	Date of	Date of remeas.	No. of plots	Plot size (acres)	Thinning Method	Thinning Intensity
5	Hudson Bay, Sask.								
	Winter cut			1966	1967 1968 1969	526		(This is a study on the effect of logging practices on the development of new aspen stands.)	
		Clay loam	1		1971		.0005		
	Summer cut			1967	1968 1969 1971 1972	400			
6	Hudson Bay, Sask.	Clay loam fresh to moist	3			42	.0023	Selection and Strip	Control, no thinning 6 plots in each age group. Strip thinned: 10' wide residual strips alternating with cut strips 4',6',8' and 10' wide. 6 plots for each cut strip width in each age group (8 plots for 10' cut strip in 5 year old) Selection thinned: 3'x3' and 4'x4' spacing. 6 plots per treatment in 3- and 6-year old stand, 3 plots per treatment in 5-year old.
			6	1972	1974	42			
	Slave Lake Alberta	Sandy loam fresh	5			38			

[a] plots subsequently thinned in 1965 to specified basal area.

SUMMARY OF ACTIVE THINNING AND OTHER GROWTH STUDIES IN ASPEN

Prepared March 3, 1975

Study No.	Location	Soil and site	Stand age at establishment	Date of establishment	Date of remeas.	No. of plots	Plot size (acres)	Thinning: Methods	Thinning: Intensity
1 (MS133)	Turtle Mtn. For. Res.	Non telluric mesic clay loam til	11	1948	1953 1960 1965 1971	4	0.2	Regular spacing and alternate strips	Control, no thinning - 2 plots Thinned[a]: 5'x5', 7'x7', and 20' alternate strips - 1 plot each
2 (MS155)	Pelly, Sask.	Non telluric mesic clay loam till	14	1951	1957 1962 1967 1972	14	0.2	Thinned to fixed SDI every 5-years	Control, no thinning - 2 plots Thinned: to 120, 100, 80, 70, 60, and 50% of SDI of control in 1951 - 2 plots each intensity
3 (MS146)	Riding Mountain Nation-al Park	Non telluric mesic clay loam till	14	1950	1960 1965 1971	4	0.1	Regular spacing	Control, no thinning - 1 plot Thinned[a]: 8'x8', 10'x10', 12'x12' - 1 plot each
		Telluric mesic silty clay loam till	23	1950	1960 1965 1971	8	0.2	Regular spacing	Control, no thinning - 2 plots Thinned[a]: 8'x8', 10'x10', 12'x12' - 2 plots each
4 (MS232)	Porcupine Mountain Swan River, Manitoba							Thinning and pruning	

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.
2. Title: Spacing experiments for conifers.
3. New: Cont.: X 4. No.: NOR 079
5. Study Leader: I.E. Bella
6. Key Words: *Picea glauca, Pinus banksiana, P. resinosa,* damaging agents, growth and development, survival.
7. Location of Work: Various parts of Manitoba.
8. Problem:

Planting is becoming an increasingly important method of reforestation and afforestation. Growth and yield in plantations depends, to a large extent, on the spacing of trees and on the selection of appropriate species for planting. Therefore, related information is a prerequisite for efficient forest management that uses planting as a method of stand establishment.

Establishment: 1963- and -1964. Four spacings were used: 4 x 4, 6 x 6, 8 x 8, and 10 x 10, 49 trees (7 x 7 matrix) on each plot with a surround of two rows. Each spacing was replicated four times per species per area. Trials established for the three species in Manitoba were:

Picea glauca - at Riding Mountain on fresh till.
- In Sandilands forest Reserve on fresh sand.

Pinus banksiana - in Sandilands Forest Reserve on dry and/or fresh sand.

P. resinosa - in Sandilands on fresh sand.

9. Study Objectives:

To determine growth and development of three indigenous conifer species, *Picea glauca, Pinus banksiana* and *P. resinosa* at various spacings on major site types, so that optimum spacing can be selected for specific management objectives in future planting.

10. Resources:

a. Starting date: 1963
b. Estimated year of completion: continuing Spacing experiments are to be maintained for a full rotation, unless heavy mortality makes this unfeasible.
c. Estimated total Prof. man-years required: 0.5
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. -
Supp. -
Casual -
Total - O & M funds req'd: -

11. Progress to Date:

The spacing trials were established in the spring of 1963 and 1964. First year mortality was filled in the first spring following planting. A cursory examination to determine mortality trends and general health status of trees was done in the autumn of 1971.

Spacing trials with adequate survival were remeasured in the late summer of 1973. One replication of the jack pine trials that were located south of Sandilands (on dry sites), were abandoned because of excessive mortality due to a severe drought in 1967.

12. Goals for 1974-75:

1. Complete the analysis of current remeasurement data and if warranted, prepare an Information Report entitled: "Early development of three native conifers at different spacings in Manitoba".

2. Terminate study by transfer of administration to study 008 (the effect of initial spacing on the growth of lodgepole pine).

13. Accomplishments in 1974-75:

1. Completed the analysis of current remeasurement and published the results.

2. Terminated study. Future work will be administered under NOR 008. (Next remeasurement is due in 1978).

14. Goals for 1975-76:

None. Study terminated.

15. Publications:

Up to 1974-75

Bella, I.E. 1967. Development of jack pine and Scots pine in the Spruce Woods Forest Reserve, Manitoba. Can. Dept. Forest., Publ. No. 1171. pp. 15.

Bella, I.E. 1968. Growth of white spruce planted in the Turtle Mountains. Forest. Chron. 44(3): 45-46.

1974-75

Bella, I.E. 1974. Early results of spacing studies of three indigenous conifers in Manitoba. C.F.S., Info. Report NOR-X-113. 10 p.

16. Signatures:

I. Bella
Investigator

L. Carlson (?)
Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 6, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Transformation and movement of applied nitrogen in selected lodgepole pine stands.

3. New: Cont.: X   4. No.: NOR 102

5. Study Leader: J. Baker

6. Key Words: Ammonium-nitrogen, nitrate-nitrogen, amino sugar-nitrogen, amino acid-nitrogen, humin nitrogen, soil horizon, moisture tension.

7. Location of Work: Edmonton, Hinton, Alberta (Edson map sheet 83F)

8. Problem:

Nature of Study:

This is principally a study to determine soils response to applied nitrogen. It emphasizes the influence of soil properties on the transformation, movement, immobilization, and distribution of soil nitrogen. It also seeks to evaluate the modifications brought about within the several soil nitrogen fractions as a result of artificially applied nitrogen.

Benefits expected:

In conjunction with the growth measurements obtained in study NOR-4-122, it is expected that information gained in this phase of the project will provide a base for interpretation of stand performance and growth response. In addition, results obtained in this trial will provide information important in deciding the profitability of artificial fertilization of forested areas dominated by these and similar soil types.

Probability of success:

Initial results, so far as soil responses to nitrogen applications are concerned, suggest that fertilization of these and similar soil would prove profitable. Growth and foliar analyses results will have to be considered also before any judgement can be made regarding the likelihood of success.

Probability of practical application of results:

Should both stand and soil responses indicate the probability of success, it would seem reasonable that forest operators (logging and lumber industry) and forest managers (parks and recreation) would be keenly interested in the practical application of results to increase productivity, especially so in view of the decreasing land base available to them.

Method used:

Two phases of this study have been initiated. In the field various installations on treated and untreated plots (study NOR-4-122) have been carried out. Sampling of soils, vegetation and the various installations will be done on an annual basis to monitor effects of nitrogen applications on soil nitrogen distribution, foliar composition and stand growth - initial (first growing season) and residual (subsequent growing seasons) effects are to be studied.

The laboratory study is not to duplicate field conditions but to investigate the influence of certain environmental factors such as soil moisture and temperature, atmospheric temperature and humidity and soil type on the distribution of nitrogen in the various soil nitrogen fractions, on the uptake of nitrogen and its influence on tissue composition and the relationship between these and seedling growth.

9. Study Objectives:

To determine the influence of soil properties on the transformation, distribution and accumulation of the various soil nitrogen fractions, ammonium-nitrogen, nitrate-nitrogen, humin-nitrogen, etc., resulting from soil nitrogen applications within selected lodgepole pine stands.

10. Resources:

a. Starting date: laboratory - early spring 1972
field - late spring-summer 1972
b. Estimated year of completion: 1975
c. Estimated total Prof. man-years required: 1.5
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.5	
Supp.	0.5	
Casual	0.1	
Total	1.1	O & M funds req'd: $8,00.00

11. Progress to Date:

Soil and foliar analyses have been done on two different occasions since fertilization. Two reports on H-status and one on P-status in Coalspur and Mercoal soil types have been completed.

12. Goals for 1974-75:

1. More emphasis will be placed on the sampling of stemflow, throughfall and grossfall solutions and less on the soil solution samples as this approach seems to offer a better possibility of estimating fertilizer effects; there is much less chance of contamination in these solutions than in those from soil water traps. A different type of soil solution trap will be tested and several of these will be installed on selected plots.

   Fractionation studies of nitrogen and phosphorus will be continued if time and resources permit. Soil sulphur should also receive attention and attempts at fractionation may be a profitable venture. Since half my time is allotted to the sulphur dioxide pollution study some of these goals may be unrealistic.

2. Publication of two reports

   a. Soil nitrogen disposition two seasons after fertilizer application, 1974.

   b. Phosphorus fractionation in two Alberta forest soils, 1974.

13. Accomplishments 1974-75:

1. Analysis of stemflow, throughfall, grossfall and other solutions were discontinued this past summer (1974) as analyses of these proved inconclusive. In addition, the traps in one entire area of study (Wampus)were rendered useless by bears or other woodland creatures. Stemflow troughs were pulled off trees and other collecting containers were knocked over and contents lost. The New Road area suffered similarly but not as badly as Wampus.

   Plots were soil-sampled in all study areas both during active growth (July) and dormancy. Our data indicate that the distribution of nutrients in the soil in these two seasons of the year differ greatly and may account for some of the differences noted in the analyses of P. & N. Sulfur values are not available as the equipment for accurate S analysis has just recently arrived. This equipment is now being set up and S. determinations will be made on all soil samples collected this summer & fall.

   Much time was spent in laboratory analyses of soil samples for treated and untreated plots. Results so far have been less than satisfactory perhaps, because forest soils are of a heterogenous nature and perhaps also to the fact of applying methods developed for analysis of cultivated soils. In the phosphorus fractionation that which supposedly is $(Ca)_3(PO_4)_2$ actually appears to be $FePO_4$; that which is supposed to be $FePO_4$ is $AlPO_4$. As a result much time has to be spent in the laboratory in the development of a procedure that will more exactly identify the phosphorus fraction. Similar developmental work is in process for N and hopefully (with the S-equipment) for S.

2. Two reports were completed:

   a. Baker, J. 1975. Soil nitrogen disposition in two Alberta forest soils during the second season after fertilization. N.F.R.C. File Report.

   b. Baker, J. 1975. Effects of fertilization on phosphorus status in two forest soils. (Submitted to Can. J. For. Res.).

14. Goals for 1975-76:

No resampling of these plots is anticipated for the coming season. We have sufficient samples in cold storage for all anticipated laboratory analysis. One exception to this may be the sampling of soil solution ceramic samplers installed in various locations in the study area last summer.

Complete analyses of soils in cold storage for N, P & S will continue this year. These analyses (for 1974 samples) should supply up-to-date information regarding N, P & S status and distribution in the soil as well as residual effect of application. It is hoped that this year will see the termination of this phase (soils) of study 102. A journal report will be attempted using soil samples from artifically formed Mercoal soil profiles which have been used for seedling growth for the past four years. These profiles have been allowed to thoroughly equilibriate during this time and so should be fairly representative of field soils, but will provide for a much better possibility for duplication of results.

15. Publications:

Up to 1974-75

Baker, J. 1973. Nitrogen fractionation of two forest soils in Alberta. Inf. Rept. NOR-X-63.

1974-75

Baker, J. 1975. Soil Nitrogen disposition in two Alberta forest soils during the second season after fertilization. File Rept.

Baker, J. 1975. Effects of fertilization on phosphorus status in two forest soils. Submitted to the Canadian Jour. of Forest Res.

16. Signatures:

J. Baker

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Fertilization of established lodgepole pine stands.

3. New: Cont.: X 4. No.: NOR 122

5. Study Leader: W.D. Johnstone

6. Key Words: *Pinus contorta,* B.19a, tree nutrition, nutrient deficiencies, nitrogen, phosphorus, sulphur.

7. Location of Work: Hinton, Alberta

8. Problem:

   Considerable interest is being expressed by forest management agencies in the use of fertilization as a means of increasing productivity particularly in view of the successful commercial applications by the Scandinavians. No published information is presently available in Alberta to indicate the levels of fertilization which will maximize lodgepole pine growth over a range of site and age classes. In order to develop a general prediction relationship between fertilizer input and response, a study was initiated on two soil types and in two age classes (30 and 70 years) in 'normal' density pine stands in the Hinton area. The experimental design chosen was a "central composite rotatable second order" design expanded to include a conventional 2^3 complete factorial. Twenty-four treatment combinations were applied in each of three blocks in each age-soil type amounting to a total of 288 treatment plots. Prior to treatment soil and foliar samples were collected from each area by Mr. W.D. Holland, samples of the current year's foliage were collected in each plot, and a complete dbh tally was taken in each plot. The fertilizers (combinations of nitrogen, phosphorus, and sulphur) were applied before the growing season in 1972 and samples of the current year's foliage was collected after the 1972 and 1973 growing season.

9. Study Objectives:

   a. To predict the combination of levels of nitrogen, phosphorus, and sulphur fertilization that optimizes the growth response of lodgepole pine on each of a range of site types and age classes in the lower foothills region of Alberta, by means of estimating "a response surface".

b. To examine the possibility of using either foliar content or soil characteristics, or a combination of both as a diagnostic tool for fertilization.

10. Resources:

a. Starting date: 1970
b. Estimated year of completion: 1980 Revised: 1985
c. Estimated total Prof. man-years required: 2.3
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.2	
Supp.	0.2	
Casual	-	
Total	0.4	O & M funds req'd: $600

11. Progress to Date:

1970 - Plot centres located in field, and soil and foliage samples taken and analyzed by Mr. W.D. Holland.

1971 - Plot boundaries located, tree dbh's tallied for all trees, and height-diameter data measured.

Pre-treatment foliage collected and analyzed.

1972 - Fertilizers applied before 1972 growing season.

First post-treatment foliage samples collected and analyzed.

1973 - Second post-treatment foliage samples collected and analyzed.

Study Establishment Report completed.

1974 - Computer program to analyze study design developed in cooperation with CASD.

12. Goals for 1974-75:

1. Preliminary analysis of the results of the foliage analysis.

2. Publication of Information Report describing baseline data for soils and foliage (Holland).

13. Accomplishments in 1974-75:

    1. Preliminary analysis of foliage analysis was carried out. These data will be used in the final report.

    2. Information Report describing baseline data for soils and foliage is in draft form (Holland).

    3. Computer program to analyze study design developed in cooperation with CASD.

    4. Greenhouse fertilization study for refining and testing study design initiated.

14. Goals for 1975-76:

    1. Completion of greenhouse fertilization study, analysis of results and reporting if appropriate.

    2. Comprehensive examination of field plots to decide whether or not to commence final measurement of study in 1976-77.

15. Publications:

Up to 1974-75

Johnstone, W.D. 1974. Fertilization of established lodgepole pine stands. Study establishment report. Unpubl. file report. 23 ms pp.

1974-75

Nil

16. Signatures:

W.D. Johnstone

Investigator

R. Ackerman

Program Manager

G.T. Silver

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 19, 1975

1. Project: Improved growth and Yield of Managed Stands.

2. Title: Assessment of regeneration stocking standards in Alberta

3. New: X 4. No.: NOR 984

5. Study Leader: I.E. Bella. Co-operating agency: Alberta Forest Service

6. Key Words: minimum stocking and site, post logging treatment, *Pinus contorta* var. *latifolia, P. banksiana, Picea glauca, P. mariana.*

7. Location of Work: Alberta

8. Problem:

As harvesting of the forest resource increases in Alberta, it becomes necessary - particularly after clear-cutting - to make special efforts to ensure the perpetuation of forest tree cover for sustained wood fibre yields as well as other benefits. The Alberta Forest Service has to ascertain that cut-over areas are adequately restocked by appropriate tree species within a reasonable length of time.

To define "adequate stocking" is not easy, as any relevant information we now have comes from old growth stands that originated after wild fires and developed from dense regeneration into dense stands, with high supression mortality throughout their life. Such stands at harvest may contain 500 to 1,000 trees per acre. This means that as much as 95% of the original trees could have succumbed to mortality along the way.

Our second growth stands that follow clear-cutting will develop through a very different route. Initial density of regeneration is generally much lower,mortality is less dramatic during stand development, but final number of trees at harvest (and also yield) may not differ greatly from stands grown in a dense regime. However, below a certain level of stocking the utilization of the resources of the site by trees is incomplete and thus yield would decline.

The minimum adequate stocking for full utilization of the site by trees at a given time would depend on, and vary with, site conditions, species characteristics and also with anticipated use of the tree crop, utilization standards and logging practices. The effects of site and species characteristics are relatively permanent and predictable; whereas factors relating to utilization continually change with time and are unpredictable. So in second growth management of regeneration chief consideration should be placed on the effect of site and species.

Benefit Expected:

Information on adequate minimum stocking of regeneration is needed by the forest manager to evaluate regeneration success, and in decisions whether planting and/or other treatment is required on a given area. Wrong decisions can mean waste of funds, or a substantial reduction of yield at harvest.

Probability of Success:

Probability of success for obtaining useful information is good, even if it would only mean gathering and synthesizing all the relevant published results to provide some "quick and dirty" practical answers. Because of the complexity of the problem this may have to suffice to some degree, as more exacting results would take much too long to obtain.

Probability of Practical Application of Results: is beyond doubt as the A.F.S. needs and requested this information.

Method Outline:

1. Define the minimum number of trees per unit area that are required for complete occupation of the site half way through the rotation (age 40) for the four study species using information gathered from published and unpublished sources and from field sampling if required.

2. From the above minimum density at 40 years, derive miminum density at age 10, confirming this with tree growth information from thinning and spacing studies, and additional data collected from individual trees growing in relatively open stands. Also define possible sources and magnitude of mortality and consider the effect in estimating minimum density at 10 years of age.

3. Conduct a sampling survey to develop relationships between density in number of trees and stocking per cent for each study species and conditions and classes so that stocking per cent can be tied to stand development (usually expressed in number of trees).

9. Study Objective:

To provide information needed by forest managers for efficient management of second growth stands, on the minimum level of regeneration stocking required at 10 years after logging in lP, jP, wS and bS stands on different sites to ensure complete utilization of the site at least halfway through rotation (i.e., by 40 years) and so to ensure a reasonably high merchantable wood production.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1977
c. Estimated total Prof. man-years required: 1.6
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	.8	
Supp.	.8	
Casual	-	
Total	1.6	O & M funds req'd: $2,900

11. Progress to Date:

In discussing with A.F.S. personnel the problem has been defined and a tentative plan of attack developed. The A.F.S. is to provide technical assistance in field work, as well as in selecting sampling areas for the study.

12. Goals for 1974-75: N/A

13. Accomplishments in 1974-75: N/A

14. Goals for 1975-76:

1. In co-operation with the A.F.S. choose specific locations to study regeneration density and stocking of lP and wS on cutovers close to 10 years old. Allocate sampling to the more important CLI (site) productivity classes present on scarified or on unscarified areas:

   - design and conduct sampling necessary to develope density (NT) over stocking (percent from mil-acre quadrats) relations;
   - test for differences between groups and combine groups as warranted;
   - interpret these results in practical terms.

2. Try to define minimum density (in NT/unit area) for full site occupancy by CLI classes for lP and wS (published information from old growth stands) that would ensure acceptable yield at harvest.

3. Collect information on tree growth under open stand conditions ((1) from spacing studies, (2) from W. Johnstone's sampling of young stands (3) from thinning studies and (4) from single tree examinations in

stands over 25 years). More important variables would be: age, site (good, average, poor; or CLI classes) and elevation for lP.

- Develope growth regressions from these data (dependent variables: ΔD, ΔBA and possibly ΔH).

4. Define the amount, and if possible the causes of mortality (insect, disease, wind, snow, sleet, wildlife) in relatively open stands up to age 40 years, and assess their relative importance.

5. Using the above growth regressions (#3) estimate average tree size for different site classes at age 40, assuming maximum potential (open) growth rate to that age.

6. From this average dbh, estimate number of trees per acre needed at age 40 for 80% crown cover (considered complete crown closure by the AFS) using appropriate CW/D relationships based on open grown trees (adapted from published sources). Increase this number in proportion to expected mortality to estimate minimum number of trees per acre needed at age 10 to ensure 80% crown cover at 40 years.

7. Interpret the results of these analyses and make recommendations on minimum stocking standards for lP and wS.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Juvenile growth rates for pine and spruce in Alberta.

3. New: X Cont.: 4. No.: NOR 985

5. Study Leader: W.D. Johnstone. Co-operating agency - Alberta Forest Service

6. Key Words: *Picea mariana*, *Picea glauca*, *Pinus contorta*, rotation age, allowable annual cut.

7. Location of Work: Alberta

8. Problem:

Nature of Study:

This study is being initiated in response to a direct and specific request made by the Alberta Forest Service. A reliable estimate of juvenile growth rates (i.e., of regeneration) is required for judicious regulation of cut layout (i.e., removal of residual blocks) and cutting cycle (i.e., determination of rotation age and allowable annual cut). Present growth and yield work has generally been limited to natural stands older than 20 years of age. Consequently, we know little about the growth of our native commercial tree species from establishment to age 20, which is perhaps the most critical from a forest management point of view.

Benefits Expected:

Information obtained in this study would assist the forest manager in assessing cut layout regulations (i.e., the socalled "6-8 foot" rule) and in determining rotation age and allowable annual cut.

Probability of Success:

The probability of obtaining useful information is excellent.

Probability of Practical Application of Results:

The chances that the results will be applied in a positive manner are very good.

Methods Used:

No firm methodology has yet been established. The study will encompass the entire province. Samples will be collected from defect-free trees with the objective of developing height/age relationships for the 200 largest trees per acre. Sampling will be generally limited to second-growth stands and growth to the 6-8 foot level is of prime interest.

9. Study Objectives:

To determine the juvenile growth rates for pine and spruce in Alberta.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years req'd: 0.4
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-year

Prof.	0.4		
Supp.	0.4		
Casual	0.2		
Total	1.0	O & M funds req'd:	$1,350

11. Progress to Date:

Preliminary discussions have been held with the Alberta Forest Service to delineate the problem and to discuss possible approached. Once a detailed methodology has been developed further discussions will be held at which time the possibility of the A.F.S. contributing technical and financial assistance will be examined.

12. Goals for 1974-75: N/A

13. Accomplishments in 1974-75: N/A

14. Goals for 1975-76:

1. To develop study methodology.

2. To complete sampling and measurements.

3. To analyze and report results.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

W.D. Johnstone

Investigator

R. Ackerman

Program Manager

G.T. Silver

Director G.T. Silver

NOR 986

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 26, 1975

1. Project: Improved growth and yield of managed stands.

2. Title: Survival and growth after logging of alpine fir, black and white spruce residuals and advance growth.

3. New: X Cont.: 4. No.: NOR 986

5. Study Leader: W.D. Johnstone. Co-operating agency - Alberta Forest Service

6. Key Words: *Abies lasiocarpa, Picea glauca, Picea mariana,* stocking standards, logging residuals, post-logging release.

7. Location of Work: Alberta

8. Problem:

Nature of Study:

This study is being initiated in response to a direct and specific request made by the Alberta Forest Service. This is principally a study to determine the quality and growth of both advance growth (i.e., young understory trees) and logging residuals (i.e., old unmerchantable trees) in order to evaluated their potential contribution to second-growth stands.

Benefits Expected:

The information obtained in this study will be used by the A.F.S. to evaluate the advisability of including advance growth and/or logging residuals in the reforestation stocking standards. This is an immediate problem which requires a quick answer.

Probability of Success:

The probability of obtaining valuable information of immediate use to the A.F.S. is excellent.

Probability of Practical Application of Results:

The results forth-coming will be put to an immediate practical application.

Methods Used:

Because of the short lead-time no firm methodology has been established. Sampling may be carried out on a province-wide scale or limited to a specific of provincial forests (i.e., the Bow River-Crowsnest Forest for alpine fir and white spruce, and the Edson Forest for white and black spruce). Samples to determine the quality and growth of advance growth and logging residuals will be collected in second growth stands.

9. Study Objectives:

To determine the quality and growth, after logging, of alpine fir, black and white spruce advance growth.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years req'd: 0.3
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.3		
Supp.	0.3		
Casual	-		
Total	0.6	O & M funds req'd:	$1,150

11. Progress to Date:

Preliminary discussions have been held with members of the A.F.S. to define the problem and to determine how the problem can best be answered. Further discussions will be held once a detailed methodology has been developed at which time the A.F.S. may be prepared to provide both financial and technical assistance.

12. Goals for 1974-75: N/A

13. Accomplishments in 1974-75: N/A

14. Goals for 1975-76:

1. To develop study methodology.
2. To complete sampling measurements.
3. To analyze and report results.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

W.D. Johnstone

Investigator

R. Ackerman

Program Manager

G. Silver

Director G.T. Silver

PROJECT NOR - 5

Reduction of Losses by Improved Fire Suppression Methods

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 10, 1975

1. Project: Reduction of losses by improved fire suppression methods.

2. Title: Fire retardant and airtanker tests and application.

3. New: Cont.: X   4. No.: NOR 037

5. Study Leader: R. G. Newstead

6. Key Words: Airtankers, helitankers, retardants, aerial suppression, airtanker accuracy, effectiveness, drop patterns.

7. Location of Work: Throughout region.

8. Problem:

This operational research study is oriented towards the immediate needs and requests of client agencies, namely Provincial and Territorial Forest Services. The intent is to improve aerial suppression methods by optimizing the use and effectiveness of available airtankers, helitankers and retardants. Results from this study complement those of NOR 128, 131 and 130. Benefits accruing will include reductions in fire suppression costs, and areas burned as well as limiting damage to the forest resource by enhancing operational effectiveness in the control of wildfires by fire control agencies.

Through continuous cooperative effort and liaison with client agencies the probability of application of study results will be high in the long run, although technological and financial considerations may somewhat affect the degree of utilization in the short run.

Results from this study will see almost immediate use because they will be aligned with present client policies, needs and objectives. Past experience supports this assessment.

Method:

The methods associated with this study involve the use of a wide variety of fixed and rotary-wing airtankers normally employed in fire suppression operations within the region. Similarly there are a variety of fire retardants, both long-term and short-term which form an integral part of this study. Retardant drop pattern tests, airtanker effectiveness evaluations, and fire retardant mixing, quality control and effectiveness investigations all involve closely integrated field laboratory study procedures. Air drop grids are established and calibrated to determine drop patterns under controlled conditions and often involve the preparation and supervision of contractual arrangements. Airtanker and helicopter retardant delivery systems are evaluated under controlled test conditions on the air drop grid and on wildfire operations. Retardant mixing and application criteria are observed and evaluated in the combustion laboratory and during field operations for both existing and new retardant products. Much related data is accumulated and disseminated through cooperation with other fire operations and research agencies and through communication with client agencies.

9. Study Objectives:

1. To measure and evaluate the drop patterns of various airtanker/fire retardant combinations, including helicopters.

2. To evaluate fire retardants and determine the optimum application required to slow and/or stop fires burning in different fuels under varying burning conditions.

3. To observe and evaluate the effectiveness of airtankers and helitankers using retardants during fire suppression operations.

4. To develop new retardant mixing systems and evaluate these on wildfire operations.

5. To optimize aerial fire retardant application and supporting activities, presuppression planning and allocation of resources in terms of reduced costs and increased benefits.

10. Resources:

a. Starting date: 1968
b. Estimated year of completion: 1978
c. Estimated total Prof. man-years required: 5.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	1.0
Supp.	1.0
Casual	0.3
Total	2.3

11. Progress to Date:

Within this study, the use of fire retardants, long-term in particular, has been promoted to regional fire control agencies and, due in part to that liaison, development and service activity, fire retardants are now in common use with concomitant improvement in air drop effectiveness. Likewise in full cooperation with client agencies, the advantages of more effective airtankers and the operations logistics of same have been promoted in this region. General acceptance by several agencies has resulted in improved aerial fire suppression, particularly through better initial attack.

Air drop patterns have been delineated for most airtankers and helitankers in use in the region in aid of improved aerial suppression throughout the region. Portable ground mixing units and retardant mixing systems within aircraft have been developed and are being utilized to good effect by fire control agencies.

Fire control agencies within the region, by their cooperative attitude, have permitted our staff to greatly improve our own capabilities and knowledge of fire suppression activities. This learning process is a continuing element of our cooperative studies with regional agencies.

Additional Progress:

Study of mixing and storage of long-term fire retardants in Alberta demonstrated that quality control could not be achieved unless higher-powered mixers with better impellers were adopted and either extended storage were terminated or more efficient recirculation methods developed.

A preliminary draft of specifications for long-term fire retardants was well-received by client agencies. It is subject to continuing revision to incorporate user suggestions, up-date technical information, and take cognizance of potential environmental impacts.

Corrosion tests indicated that Fire Trol 100 and 931 severely affect magnesium alloy AZ63-T4, but these two retardants and Phos Chek 202XA have only slight to moderate effects on Alcladding and aluminum alloy 7075-T6.

12. Goals for 1974-75:

1. Further evaluate airtanker drop accuracy under simulated initial attack conditions as opportunity permits.

2. Provide guidance and technical assistance to the Alberta Forest Service in evaluation of the following:

a. AFS designed and constructed a 300-gallon Monsoon bucket with emphasis on controlled gate opening and fluid flow control for both water and long-term retardants. These tests will assist in maximizing effectiveness of this bucket through improved drop patterns.

b. AFS designed and constructed in-line retardant eductor as employed in fixed-wing and helitanker operations.

c. On board calibration of the short-term retardant injection system used in contracted Canso airtankers.

d. Fixed-wing airtanker inspection programme with particular emphasis on tanking and gating design and efficiency. To include training of an AFS inspection team.

e. Assumed benefits of using the short-term retardant (water thickener) Tenogum as related to the rheologic properties of this commercial product.

3. Let a contract for the assessment of "on-site" effectiveness of airtankers and retardants on wildfire suppression operations.

4. Contract for additional testing of corrosive and other degradational properties of long-term chemical fire retardants as they affect metal alloys used in aircraft construction and other metals and materials in common use at airtanker bases.

5. Enroll study leader in graduate programme at University of Alberta combining agricultural economics, operations research, and forest fire science.

6. Prepare the following publications:

   Newstead, R. G. and J. Niederleitner. Guidelines on the specifications and use of long-term fire retardants. Information Report.

   Newstead, R. G. and J. Grigel. The operational use of helitankers in forest fire control. Information Report.

   Newstead, R. G. and J. Grigel. A review of airtanker delivery systems. Information Report.

Goal added in 1974-75:

7. Participate in provincial and federal forest service training sessions.

13. Accomplishments in 1974-75:

1. Completed second year retardant drop accuracy tests in Alberta with two pilots flying B-26 airtankers. A total of 12 individual pilots on two types of airtankers (B-26 and Canso) were utilized over the 2-year period. The test sites for the drop trials were similar, i.e. 50-60 foot standing timber on a 20% slope. Smoke targets were generated from the top of a 45 foot mast to simulate a spot fire.

   Several constraints were encountered during the trials:

   a. Smoke volume insufficient and inconsistent (caused confusion for pilots trying to relate smoke emission point to base of target).

   b. Dropping water for the tests versus retardant (complaints from tanker B-26 pilots as to unfamiliarity with the drop characteristics of water).

   c. Water drops not visible in the canopy during successive drops in order for bird-dog officer and pilot to use as reference markers to close in on target.

   d. Tactics used by bird-dog officer sometimes questionable (pilot/bird-dog officer discrepancies).

   Results indicate that the B-26 pilots (7 in total) scored an average of 39% accuracy with a low of 13% and a high of 63%. The Canso pilots (5 in total) scored an average of 63% with a low of 30% and 3 pilots at a high of 80%.

   Therefore all Canso drops were more accurate than all B-26 drops.

   A final report on this 2-year project is being prepared.

2. Provided technical assistance to the Alberta Forest Service in the following investigations:

   a. Re-scheduled to 1975 evaluation of the Alberta Forest Service 300-gallon Monsoon bucket at request of AFS.

   b. Re-scheduled to 1975 field evaluation of the Alberta Forest Service in-line powdered retardant eductor also because of a low fire incidence in areas where eductor bases are located and delayed introduction of these units.

   c. Inspected and calibrated short-term retardant injection systems used in contract Canso airtankers; trained AFS personnel to perform this recurring task.

d. Inspected fixed-wing airtankers and trained Alberta Forest Service inspection team to make future inspections.

e. Deferred evaluation of the short-term retardant, Tenogum, until an improved powder injection system is available in water skimming aircraft.

f. Tested Fire-Trol 100 dry form to determine the extent of impurities (sand, silt) found in its attapulgite clay component. Results of these tests forwarded to Alberta Forest Service for inclusion in subsequent fire retardant contracts.

3. In cooperation with Alberta Forest Service, contracted with C. E. Hardy to develop a method of evaluating on-site effectiveness of airtankers in fire suppression. Contractor proposed a preliminary evaluation technique and data-collection form but was unable to test it for lack of fire activity. Final report received recommending (a) collection of extensive data on tree crown characteristics of regional forest types, (b) static testing of airtankers, (c) use of data from (a) and (c) to calculate expected retardant interception and through-fall, (d) data collection scheme for operational air-drop evaluation.

4. Did not contract for additional study of corrosive and/or degradational properties of long-term retardants because information already obtained appeared adequate, and U. S. Forest Service has major contract in progress.

5. Study leader entered graduate study program at University of Alberta.

6. Contractor has submitted report on use of fire retardants in Canada; (final report held in abeyance pending revisions and upgrading of interim retardant specifications).

Lieskovsky, R. J., R. Kruger, and R. G. Newstead. June 1974. Problems in Mixing and Storage of Long-term Retardants in Alberta. NOR-X-94. (Replaces file report NOR-Y-68.)

Grigel, J. E., R. J. Lieskovsky, and R. G. Newstead. February 1974. Air Drop Tests with Helicopters. NOR-X-77.

Grigel, J. E. December 1974. Role of the Helitanker in Forest Fire Control. NOR-X-123.

Additional Accomplishments:

7. Participated in the following training activities:

Northwest Lands & Forest Service Ass't. Resource Officers, Yellowknife; retardant dropping demonstration, Hay River.

Parks Canada warden training at Yoho, Prince Albert, and Jasper National Parks.

Alberta Forest Service bird-dog officers, Grande Prairie.

Department of Northern Saskatchewan, Prince Albert.

14. Goals for 1975-76:

1. Assess on-site and/or simulated effectiveness of airtanker/ retardant combinations through contract, Alberta Forest Service cooperation, and NFRC resources.

2. Provide technical assistance to the Alberta Forest Service in the following investigations:

    a. Performance evaluation of the Alberta Forest Service 300-gallon Monsoon bucket.

    b. Evaluation of the Alberta Forest Service in-line powdered retardant eductor at permanent airtanker bases.

3. Provide consultation to Department of Northern Saskatchewan, Manitoba Department of Mines, Resources and Environmental Management, and Northwest Lands and Forest Service; determine their needs for technical services and research, and incorporate in future NFRC research plans.

4. Construct a fire retardant spray apparatus for the Fire Laboratory for testing required application levels of fire retardants on different fuels under various burning conditions.

5. Continue enrollment of study leader in U. of A. graduate studies.

6. Prepare publications on:

    Grigel, J. E. and R. G. Newstead. A Review of Airtanker Retardant Delivery Systems.

    Newstead, R. G. and R. J. Lieskovsky. Pilot Accuracy Trials in Alberta and Saskatchewan.

7. Participation in regional training sessions where and when requested.

15. Publications:

Grigel, J. E. 1969. Preliminary Evaluation of TX-350 - A New Long-Term Retardant. Forestry Branch, Dep. Fisheries and Forestry, Internal Rep. A-20.

Grigel, J. E. 1969. Evaluation of the Nitrogen Injection System for Mixing Gelgard Fire Retardant in the PBY Canso Water Bomber. Forestry Branch, Dep. Fisheries and Forestry, Internal Rep. A-21.

Grigel, J. E. 1969. An Injector System for Mixing Gelgard Fire Retardant on Land Based Airtanker Operations. Forestry Branch, Dep. Fisheries and Forestry, Internal Report A-22.

Grigel, J. E. 1970. The Use of Airtankers for Fire Suppression in Canada. Can. For. Serv., Dep. Fisheries and Forestry, Internal Rep. A-33.

Grigel, J. E. 1970. Fire Retardants and Their Use in Western Canada. Can. For. Serv., Dep. Fisheries and Forestry, Inform. Rep. Z-X-38.

Lieskovsky, R. J. 1971. Drop pattern for Twin Otter Membrane Tank System. Can. For. Serv., Dep. Environ., Internal Rep. NOR-2.

Grigel, J. E. 1971. Air drop tests with Fire-Trol 100 and Phos-Chek 205 fire retardants. Can. For. Serv., Dep. Environ., Inform. Rep. NOR-X-8.

Grigel, J. E. and Lieskovsky, R. J. 1972. A comparison of the B-26 and Thrush Commander airtankers. Can. For. Serv. Dep. Environ., Inform. Rep. NOR-X-17 (Replaces unpublished Internal Report NOR-6).

Bradford, Samuel A. 1973. Corrosion of metals in fire retardants. Can. For. Serv., Dep. Environ., Inform. Rep. NOR-X-66.

Lieskovsky, R. J., Kruger, R., and Newstead, R. G. 1974. Problems in mixing and storage of long-term retardants in Alberta. Can. For. Serv., Dep. Environ., Information Rep. NOR-X-94. (Replaces file report NOR-Y-68).

Grigel, J. E., Lieskovsky, R. J., and Newstead, R. G. 1974. Air drop tests with helitankers. Can. For. Serv., Dep. Environ., Inform. Rep. NOR-X-77.

Grigel, J. E. 1974. Role of the helitanker in forest fire control.

In addition the following contributions have been prepared for:

Forestry Report Vol. 1, No. 1
- Short and long-term fire retardants.
- The B-26 airtanker.

Forestry Report Vol. 2, No. 1
- Portable helitanker retardant systems for the Yukon.
- B-26 airtanker air drop tests with liquid concentrate.
- PBY Canso air drop tests with Gelgard retardant.

- Sikorsky S58T drop tests with Phos-Chek retardant.
- Modification of chemical injection system in the PBY Canso airtanker.
- Airtanker simulation model.

Forestry Report Vol. 3, No. 1
- Recent airtanker drop tests.
- Quality control - a must.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 128

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 10, 1974

1. Project: Reduction of losses by improved fire suppression methods.

2. Title: Assessment and development of fireline systems.

3. New: Cont.: X 4. No.: NOR 128

5. Study Leader: D. Quintilio

6. Key Words: Fuel types, fire behaviour, bulldozers, airtankers, handcrews

7. Location of Work: Region-wide.

8. Problem:

The greatest percentage of the suppression budget is usually allocated to aircraft, bulldozers, and handcrews employed to build fireline. To maximize the effect of each suppression dollar by planning for optimum resource allocation, agencies require fundamental knowledge of production rates and effectiveness of the above techniques. To date little information exists describing line building capabilities of fireline systems, hence efficiency is much below acceptable levels. Along with assessing existing fireline systems the study will develop new techniques and concepts with modern capabilities.

This work will create a data bank of productivity rates for existing and potential fireline systems, which will eventually be used for optimum allocation models. Preliminary information from this study and NOR 037 and NOR 131 has already been incorporated into an initial attack simulation model (NOR 130).

Probability of success is high since all agencies are actively involved in assisting research crews to document productivity rates directly on the fireline. Extent of data collected in 1973, however, will depend primarily on the severity of the fire season. Preliminary data and analysis have already been presented to one agency and this will reflect in the 1973 operations.

Methods:

1. Ground attack systems

   a. Major fuel types are stratified according to resistance to control.

   b. A time and motion study has been designed to document productivity of bulldozers and hand crews.

   c. The use of explosives will be developed for fireline use and effectiveness, cost and productivity will be compared to handline work.

2. Air attack systems

   a. Available drop patterns of airtankers and helicopters will be reviewed to determine fireline construction rates under ideal conditions.

   b. Wildfires will be assessed to determine deviation of fireline construction rates under operational conditions, i.e., drop accuracy, drop height and speed, actual load carried.

   c. An aerial ignition device for backfiring and burnout will be developed and tested utilizing methods pioneered in Australia.

   d. An aerial marking device for relocating reported fires by initial attack crews will be developed utilizing the low frequency transmitter principle of wildfire tracking systems.

9. Study Objectives:

   a. To provide accurate productivity rates of bulldozers, handcrews, and airtankers for fireline building in regional fuel types.

   b. To develop experimental fireline systems utilizing modern techniques.

10. Resources:

   a. Starting date: 1972
   b. Estimated year of completion: 1978
   c. Estimated total Prof. man-years required: 3.5
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.5	(Quintilio)
Supp.	1.0	(Ponto)
Casual	0.3	
Total	1.8	

11. Progress to Date:

The study was introduced to the Alberta Forest Service and cooperative guidelines were formed to facilitate the initial summer's work. A standardized format was prepared for the data collection pertaining to ground attack systems. This was reviewed by AFS field personnel and finalized for use during 1972. CFS personnel manned spring fires in the Whitecourt and Slave Lake Forest Districts and the format was improved based on field experience. Four hundred field forms were distributed to selected AFS districts for 1973 use.

All remaining regional agencies have been approached, through the Sub-Committee on Fire Protection, for cooperative commitments similar to those arranged for Alberta.

Both the aerial ignition system and the aerial marking device were developed at the Northern Forest Research Centre. The systems are being prepared for field testing during 1973.

A field trial was designed for the Boreal Region to test the application of explosives for fireline construction. CIL donated 1,000 feet of prima-cord and line building capabilities were demonstrated in five major fuel types: (1) aspen, (2) pine, (3) muskeg, (4) white spruce and (5) slash. Northern agencies have been briefed on the results and are expected to use limited amounts of cord on an operational basis during 1973.

A prescribed burn was conducted at Steen River in cooperation with the Alberta Forest Service. Participating CFS personnel (Dubé, Quintilio, Niederleitner, Lieskovsky) monitored fire behavior, long and short term retardant effectiveness, backfiring, prima-cord explosive, and infra-red imagery associated with the burn. A summary file report is listed under publications.

Both the aerial ignition system and electronic fire marker were field tested and demonstrated during 1973. A final Information Report (including blueprints) detailing operational use of the ignition system was published. The electronic marker is considered operational in Alberta with the planned construction of 44 units for 1974.

The bulldozer fireline assessment format was introduced to provincial agencies during the annual Fire Plans Course at Hinton, May 19, 1973. Two hundred forms were distributed to sector and cat boss personnel and a field exercise was conducted on the school forest. Fourteen fires were subsequently monitored by the Alberta Forest Service and data for 29 miles of fireline construction were received at NFRC. These reports will be grouped with 1972 CFS data.

NFRC personnel collected data on wildfires in Alberta and NWT and 78 miles of bulldozer and 5 miles of handline observation are documented.

12. Goals for 1974-75:

    1. Continue monitoring of wildfires as a means of building data banks for airtanker, bulldozer, and handcrew productivity rates in regional fuel types. Encourage agencies to continue their participation and assistance.

    2. Summarize 1972-1973-1974 bulldozer data and prepare report.

    3. Supervise contract NOR-5-1.

    Added Goal:

    4. Participate in the Darwin Lake prescribed burning study.

13. Accomplishments in 1974-75:

    1. Obtained data from an additional 20 miles of bulldozer line (contributed principally by Alberta Forest Service field staff) and 2 miles of handline construction. Described study to industry and provincial representatives at Hudson Bay, Saskatchewan.

    2. Deferred report on bulldozer productivity for one year as a result of adding Item 4.

    3. Obtained report on contractual study of handline construction rates in relation to fuels; used data in NOR 130. The contractor (Professor P. J. Murphy) has developed a unique method for expressing production rate as a function of fuels, which will be tested in 1975.

    4. Provided alternate leadership and miscellaneous services to CFS/AFS experimental burning study at Darwin Lake, Alberta.

14. Goals for 1975-76:

    1. In cooperation with the Alberta Forest Service plan criteria for their continuation of the study once CFS results and reports are completed.

    2. Continue monitoring wildfires throughout the region as a means of building data banks for airtanker, bulldozer and handcrew productivity rates.

    3. Supervise handcrew contract with Professor P. J. Murphy, University of Alberta.

    4. Publish the following reports:

Quintilio, D. 1975. Fire control application of bulldozers. Infor. Report.

Murphy, P. J. and D. Quintilio. 1975. Handcrew fireline production rates in Alberta fuel types. Infor. Report.

15. Publications:

Up to 1974-75

Lait, G. R. and W. C. Taylor. 1973. Backfiring and burnout techniques used in the Yukon. Information Report NOR-X-43. Can. For. Serv., Northern Forest Research Centre. Edmonton, Alberta.

Ponto, R. L. and G. M. Lynch. 1973. Use of electronic markers to relocate small forest fires. Information Report NOR-X-61. Can. For. Serv., Northern Forest Research Centre. Edmonton, Alberta.

Ponto, R. L., D. Quintilio, P. Bihuniak, and G. R. Lait. 1974. An incendiary priming and release mechanism for backfiring from aircraft. Information Report NOR-X-75. Can. For. Serv., Northern Forest Research Centre. Edmonton, Alberta.

Dubé, D. E. 1973. Fire control methods in the Black Spruce - Labrador Tea - Cladonia fuel complex. File Report, Northern Forest Research Centre. Edmonton, Alberta.

1974-75

Ponto, R. L. 1974. Electronic fire marker being tested in Canada. USDA Forest Serv. Fire Management 35(2):15.

16. Signatures:

D. Quintilio
Investigator

R W Reid
Program Manager

G T Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 10, 1975

1. Project: Reduction of losses by improved fire suppression methods.

2. Title: Initial attack strategy and resources in fire suppression operations.

3. New: Cont.: X 4. No.: NOR 130

5. Study Leader: D. Quintilio

6. Key Words: Detection, fire behaviour, airtankers, simulation modelling, hand crews, helicopters.

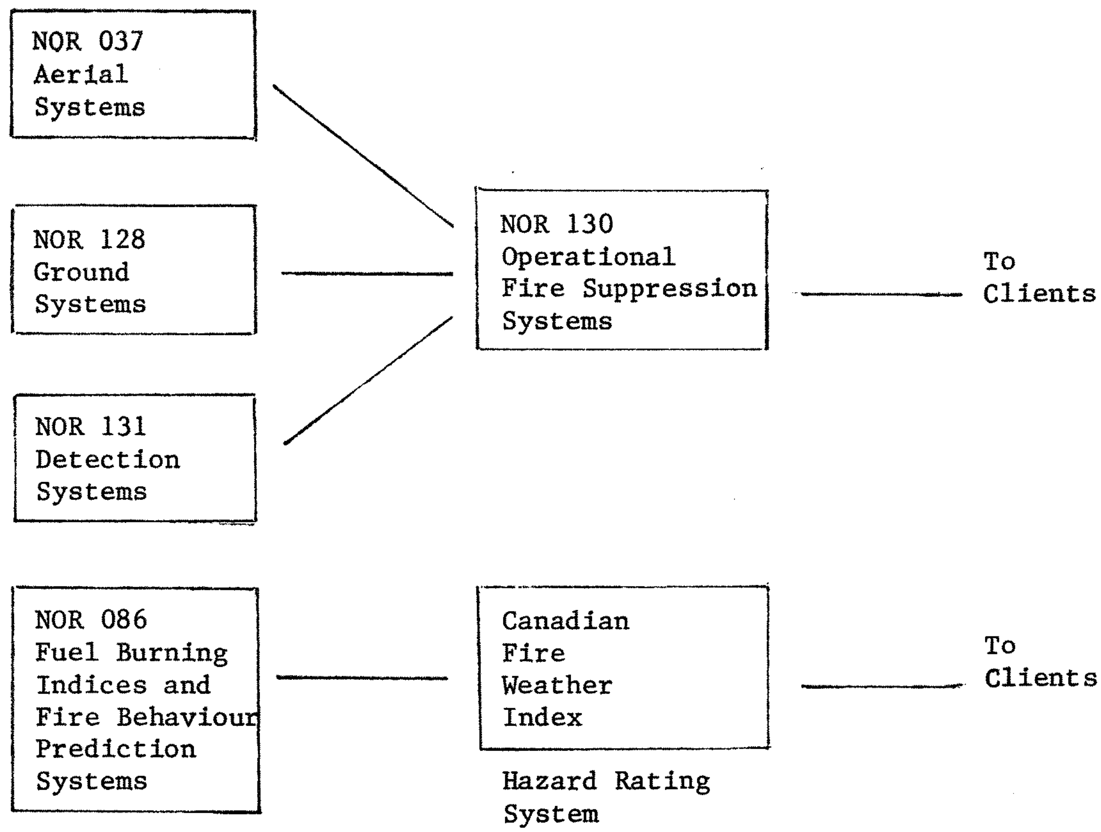
7. Location of Work: Northern Forest Research Centre.

8. Problem:

Fire control agencies serviced by the Northern Forest Research Laboratory in Edmonton spend between 10 and 15 millions of dollars annually on fire suppression. At least an equal amount is lost in the form of damage to various resources. In the past, fire control expenditures have been justified on the basis that fire damage must be reduced "at all cost". In the future, fire protection agencies will see greater competition for the fire control dollar.

In the defence of future budget requests fire protection agencies must place a greater emphasis on planning, including resource valuation. Suppression strategy and allocation must then be geared more closely to existing resource values and fire behaviour to obtain maximum value of fire control dollar. The fire manager urgently requires guidelines specifically derived for the initial attack stage since benefits are maximized when the fire is controlled in its early growth stage. Data from the studies will be integrated into systems developed within this study.

The Alberta Forest Service is cooperating in the development of an initial attack simulation model for Whitecourt Forest District. It is designed to provide a relative assessment of initial attack systems and if the model proves satisfactory it will be introduced as an operational decision-making aid.



Methods:

- Review agency operations to delineate and define the problem, and to select a prototype forest district.

- Construct a study team of Alberta Forest Service field personnel, Alberta Forest Service headquarters personnel, Canadian Forestry Service personnel, and systems analyst consultant.

- Conduct weekly meetings to determine the variables for a simulation model.

- Sort and transfer 10-year fire and weather data to IBM-360 tape.

- Compile line building capability of the initial attack systems.

- Design flow chart for the initial attack model.

- Programme and run the model.

- Analyze results and present guidelines.

9. Study Objectives:

    1. To develop a simulation model for assessing initial attack systems over a range of burning conditions.

    2. To provide guidelines for suppression strategy and optimum combinations of men and equipment to achieve successful initial attack.

    3. To promote and extend research results to client agencies through lectures and training sessions.

10. Resources:

    a. Starting date: 1972
    b. Estimated year of completion: 1973 Revised: 1978
    c. Estimated total Prof. man-years required: 3.4
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years

Prof.	0.5	(Quintilio)
Supp.	0.0	
Casual	0.0	
Total	0.5	

11. Progress to Date:

An inter-agency study group was formed to develop a simulation model for three initial attack methods, i.e. helicopters, airtankers, and ground crews. Important variables were documented and ten years of fire and weather data transferred to IBM-360 tapes. Coding, programming and de-bugging were completed and the model was run with System 1 input (hand crews).

12. Goals for 1974-75:

    1. Following completion of the second (airtankers) and third (helicopter w/bucket) model runs, the CFS-AFS study team will review the combined summaries and submit recommendations on the application of the simulation model.

    2. Discuss input data, initial attack model, and results with FFRI personnel and determine the studies relationship with the proposed Fire Management Centre.

    3. Complete the following report:

    Quintilio, D. *et al.* 1974. Simulated initial attack using helicopters, ground crews, and airtankers. Information Report.

    4. Continue promotion on training related to the regional use of CFWI.

5. Participate in national Task Force study to provide a CFWI User's Manual and new metric CFWI tables in 1976.

13. Accomplishments in 1974-75:

1. Completed model development and summarized hand crew, helicopter and airtanker results and, at the request of the Alberta Forest Service, expanded the model to consider a B-26 and Canso in System 2 (airtankers) and a 204B in System 3 (helicopters). Report in preparation (delayed by study leaders assignment to FWI Task Force).

2. Deferred discussion of the simulation model with the FFRI pending final analysis.

3. Report not completed due to other commitments.

4. Participated in FWI training sessions at Yellowknife, N.W.T.; Prince Albert National Park, Sask.; Jasper National Park, Alberta.

5. Assigned to national FWI Task Force October, 1974; prepared contribution to User's Manual for January 31, 1975 deadline; continuing assignment.

14. Goals for 1975-76:

1. Review results of simulation model with the Alberta Forest Service; develop new goals and appropriate research direction.

2. Participate in FWI Task Force development work.

3. Supervise R & D contract for further initial attack simulation with Prairie-Agri Management Consultants.

4. Publish Information Report:

Quintilio, D. *et al.* 1975. Simulated initial attack using helicopters, ground crews, and airtankers.

15. Publications:

Up to 1974-75 - Nil

1974-75 - Nil

16. Signatures:

D. Quintilio
Investigator

R. Reid
Program Manager

G. T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 20, 1974

1. Project: Reduction of losses by improved fire suppression methods.

2. Title: Evaluation and planning of fire detection, surveillance and communications systems and methods.

3. New: Cont.: X 4. No.: NOR 131

5. Study Leader: J. Niederleitner

6. Key Words: Aerial patrols, lookouts, forestry communications, weather data collection, storm tracking wildfire smoke emission, wildfire mapping.

7. Location of Work: Alberta, National Parks, Yukon and Northwest Territories.

8. Problem:

The study consists of an analysis of fire records as well as of on-site evaluations of existing wildfire detection - mapping and communication systems.

Research is done on factors influencing the performance and efficiency of such systems.

The results of the study will enable user agencies to increase the efficiency of their fire surveillance systems thereby reducing total fire loses and minimizing fire suppression costs.

Since some of the user agencies in the region are, at this time, not operating a fully developed fire surveillance system the study is bound to meet with a certain measure of success.

Much of the results achieved in this study so far are already being implemented, and the prospects of further findings being put to practical use are excellent since most phases of the study are based upon users requests.

The following general course of action is being followed:

1. Discussion with respective user agencies to define and outline the problems to be solved.

2. On-site evaluations of existing installation and systems as well as analysis of available data.

3. Formulation of objectives and arbitrary financial constraints to be considered when designing the new system.

4. Design of new systems or modifications of existing systems in order to achieve optimal returns under given local conditions and accepted constraints.

5. Assistance to user agency during implementation as well as research through short term projects solving day to day problems that have a bearing on systems design and operation.

9. Study Objectives:

a. Develop plans for wildfire surveillance and communications systems for the Northwest Territories, and other clients, on request.

b. Identify the most advantageous detection medium (alternative) for given conditions.

c. Define and identify factors influencing the design of wildfire detection and communication systems.

d. Develop effective wildfire mapping and surveillance techniques.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion:
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

1975-76 man-years	Prof.	0.0	
	Supp.	2.0	(Niederleitner, Ogilvie)
	Casual	0.0	
	Total	2.0	

11. Progress to Date:

1. Conducted a field survey of the existing detection system (8 lookouts, 2 radio repeater stations) and located, flagged and photographed five proposed new lookout and radio repeater sites in the Yukon Territory as part of a new proposed combination ground-air detection system.

2. Inspected and photographed for further evaluation all existing lookout sites in the Wood Buffalo National Park (6).

3. Completed a familiarization survey in respect to fire detection requirements and a field evaluation of all existing lookout and communications relay sites in the Northwest Territories. Also located and flagged three new lookout and radio relay sites as a part of a new expanded ground-air detection system.

4. Purchased a "Barnes Airborne Fire Spotter", designed and built an independent self-contained power supply unit and aircraft mount and field tested the instruments on single engine fixed-wing patrol aircraft. Tests in 1973 proved inconclusive because of lack of targets in the test area.

5. Conducted limited tests with a "Tivicon" television camera and the AGA Thermovision 680 system to establish their application in wildfire intelligence work. The AGA Thermovision appeared to be useful in mop-up work and in detecting hold-over and ground fires. Further tests are warranted.

6. Sets of small scale aerial photography and satellite imagery were secured over a study area in the Slave Lake Forest, containing fire scars of various vintage. It was established that 1:120,000 aerial infra-red false color photography is a suitable medium for mapping fire damage in a variety of forest cover.

7. Concluded work as member of a joint AFS Detection Task Force 69-4. This work is summarized in:

   Joint Task Force AFS 69-4 (Korsten, H., R. S. Miyagawa, J. Niederleitner). 1974. Detection System Analysis. Unpublished report to S. R. Hughes, Head, Forest Protection Branch, AFS.

8. Prepared the following reports:

   a. Wildfire Detection Study, Yukon Territory Telecommunications Supplement. (Draft of a progress report to the Yukon Forest Service.)

   b. Intermediate Report, Wildfire Detection Study, Mackenzie Forest. (Draft of a progress report to the Mackenzie Forest Service.)

   c. Interim Report, Wood Buffalo National Park, Wildfire Detection System. (Draft of a progress report to the Wood Buffalo Park administration.)

   d. Infra-red Scanners for Cold Trailing. (Draft of a progress report to the Alberta Forest Service.)

12. Goals for 1974-75:

1. Finalize and mark all proposed continuous detector and communications sites in the Northwest Territories (weather and availability of aircraft permitting) and find still needed sites for Yukon on topographic maps.

2. Establish several suitable continuous detector locations in the Wood Buffalo National Park in order to complete the present lookout system.

3. Devise and carry out a series of tests in cooperation with the Alberta Forest Service designed to establish the application of the new Thermovision 750 system as a tool for inspecting wildfire and prescribed burn mop-up.

4. Test the Barnes Airborne Fire Spotter on an operational basis as infra-red aid to the aircraft observer.

5. As a joint venture with the Alberta Forest Service test a group of six lightning sensors for their value as auxiliary instruments at manned lookout sites.

6. Prepare or finalize seen area map for all existing and proposed fixed detector sites in the Yukon Territory, in the Northwest Territories and in the Wood Buffalo National Park (time permitting).

7. Let and administer contracts on a computer simulation approach to test air patrol-lookout relationship in N.W.T.

Goal added in 1974-75:

8. Provide training and consulting services to client agencies.

13. Accomplishments in 1974-75:

1. Established, checked in the field and flagged the location of 15 new proposed continuous detector (lookouts) and communications relay sites in the Northwest Territories along the Mackenzie Corridor. Excepting two sites of dubious value in the Inuvik district, this concludes the field work in the N.W.T.

2. Completed the field work in Wood Buffalo National Park by locating the remaining sites needed for the lookout system.

3. Experimented with the AGA Thermovision System 750 on wildfires in Alberta. The system proved satisfactory in respect to being operated in a small helicopter. Otherwise no conclusive results were obtained because generally moist conditions prevented the development of ground fires.

4. The Barnes Airborne Fire Spotter was flown for one week on air patrols in the settlement fringes of the Slave Lake Forest. The scanner was of little value because of its sensitivity to sunlit roads and fields.

5. Testing of "Quality Technology" lightning stroke counters in Alberta had to be abandoned after a grid of sites was established because the manufacturer was unable to deliver the counters before the end of the fire season.

6. Aside from four sites in the Yukon Territory all visible area maps for all existing and proposed lookout sites in the Yukon, the Northwest Territories and the Wood Buffalo National Park were completed. (Total of 30 sites.)

7. Because of lack of funds no computer simulation contract was let.

8. Gave lectures and training courses in basic photo interpretation for fire managers, procurement and interpretation of fire reconnaissance photography and infra-red imagery, and lookoutmen training courses at the Yukon Forestry Training School at Whitehorse and at the Forest Technology School at Hinton.

9. Prepared file reports to the client agencies:

   Intermediate Report, Wildfire Detection Study Yukon Territory.

   Progress Report, Wildfire Detection Study Northwest Lands and Forest Service.

14. <u>Goals for 1975-76</u>:

1. Complete all reporting in respect to the work done in the Yukon Territory, in the Wood Buffalo National Park and the Northwest Territories. Publish the detection/communication plan for the Yukon and the detection plan for N.W.T. as information reports.

2. Help the Northwest Lands and Forest Service and the Wood Buffalo National Park administration in implementing the recommendations contained in the submitted reports by guiding construction crews to the respective sites, advise on type of installations to be used, etc.

3. Provide fire management agencies with consultation and training in the field of fire detection, surveillance or communications as requested.

4. Investigate the feasibility of using the AGA Thermovision 750 system for detecting hold-over or ground fires during actual operating conditions. This is a joint venture with the AFS who will provide assistance in the form of flying time, instrument rental and manpower.

5. Complete seen area mapping of the remaining Yukon sites.

6. Initiate work on the fire detection systems in Saskatchewan and Manitoba.

15. Publications:

Up to 1974-75

Niederleitner, J. 1971. Remote Sensing in Forest Fire Control, Report on Symposium June 1971, Missoula, Montana. Information Report NOR-1.

Northern Forest Research Centre - Forestry Report
Vol. 1 - 1 March 1971 - pp.8.
Vol. 2 - 1 July 1972 - pp.8.
Vol. 3 - 1 June 1973 - pp.8. (Infra-red assistance to the aerial observer)
Vol. 3 - 3 Oct. 1973 - pp. 12. (Mapping burned-over forests)

These reports described in abbreviated manner results of current research at NFRC in fire suppression and fire behaviour.

Niederleitner, J. and G. R. Lait. 1972. Tivicon television camera: A new fire line reconnaissance tool; laboratory trials. Can. For. Serv., Internal Report NOR-15.

Niederleitner, J. 1972. Demonstration of AGA Thermovision System 680 in Edmonton. Can. For. Serv., Miscellaneous Report NOR-Y-16.

Niederleitner, J. 1973. Infra-red assistance to the aerial observer. Forestry Rep. 3(1), June.

Niederleitner, J. 1973. Mapping burned over forests. Forestry Rep. 3(3), Oct.

1974-75

Nil

16. Signatures:

J. Niederleitner
Investigator

R. J. Reid
Program Manager

G. T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 10, 1975

1. Project: Reduction of losses by improved fire suppression methods.

2. Title: Problem analysis: The role of fire in forest and intermingled vegetation in the Prairie Provinces, Rocky Mountains, and Far North.

3. New: Cont.: X 4. No.: NOR 980

5. Study Leaders: G. R. Fahnestock and D. E. Dubé

6. Key Words: Fire ecology, fire history, fire cycle, fire type, fire climax, fire scar rating, let burn policy.

7. Location of Work: Region wide.

8. Problem:

Within broad climatic limitations, fire has been the most important single, natural influence on vegetation throughout the region for about the past 10,000 years. Areal and temporal patterns of burning have varied. Fire intensity, matched to fuels and weather, has influenced the woodland/prairie ecotone, the mountain forests and the boreal forests. Fire has played a significant role in the dynamic stability of the region's ecosystems. The "natural" fire regime has been obscured by man's intervention. Resource management problems are developing which require an understanding of the historical role of fire.

9. Study Objectives:

Undertake and complete a problem analysis relating to short and long term effects of forest fires, consequence to natural succession of various suppression treatments, and definition of broad guidelines for fire management with particular reference to National Parks.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1975 Revised: 1976
c. Estimated total Prof. man-years required: 6
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	2.0
Supp.	1.0
Casual	0.0
Total	3.0

11. Progress to Date:

    N/A. New Study

12. Goals for 1974-75:

    1. Review literature on fire history and fire ecology of the region.

    2. Assemble, compile, and duplicate available fire records and fire history maps of the Provinces, Territories, and Parks.

    3. Make reconnaissances of Jasper, Wood Buffalo, Riding Mountain and/or Prince Albert National Park and determine what opportunities exist for fire ecology studies that will contribute to improved fire management.

    4. Draft a problem analysis relative to objectives.

    5. Publish the following:

       Dubé, D. E. Early plant succession following fire in the subalpine forest of the Canadian Rockies.

       Fahnestock, G. R. and D. E. Dubé. Opportunities for fire ecology research in the prairies, Rocky Mountains and boreal forests of Canada: a problem analysis.

    Additional Goals:

    6. Prepare draft of Master of Science Thesis, "Early Plant Succession Following Fire in the Subalpine Forest of the Canadian Rockies", by D. Dubé.

    7. Provide leadership and fuel-measurement service for CFS/Alberta Forest Service cooperative experimental burning project at Darwin Lake, Alberta.

    8. Inventory surface fuels and related vegetational characteristics of 13 stands of known age near Hinton, Alberta.

    9. Provide consultation regarding interpretation of fire-related characteristics of vegetation along the "eco-trail", Kananaskis Forest Experiment Station.

    10. Participate in training conferences at Yellowknife, N.W.T.; Jasper, Prince Albert, and Yoho National Parks; Hudson Bay, Sask.; gave three lectures to forestry classes at U. of Alberta, two talks on fire ecology to school organizations in and around Edmonton, and two seminars each at U. of New Brunswick and U. of Minnesota.

11. Publish the following: 1) Douglas, G. W. 1974. Ecological impact of chemical fire retardants. Inform. Rep. NOR-X-109

12. Participate in the following meetings:

    a. 15th Tall Timbers Fire Ecology Conference sessions in Missoula, Montana, and Portland, Oregon; present paper.

    b. Fire Working Group of North American Forestry Commission, Jasper Alberta.

    c. U. S. National Parks - Wilderness Fire Management Workshop, Missoula, Montana.

13. <u>Accomplishments in 1974-75</u>:

    1. Began review of pertinent literature.

    2. Obtained available fire summaries and maps (or access to them) for Alberta, Saskatchewan, Manitoba, and Wood Buffalo, Prince Albert, and Jasper National Parks.

    3. Made limited reconnaissance of Wood Buffalo and Jasper National Parks. In Wood Buffalo the reconnaissance consisted of

        a. Locating sites that provided a broad range of vegetation types and ages and were easily accessible.

        b. Observing a 1971 burn and noting the rapid recovery of vegetation, the obvious importance of hydrological factors on the vegetation, the uneveness of fire intensity and the conspicuousness of bulldozer fire lines.

        c. Discussion of priorities with Parks personnel and gathering historical records.

        d. Preparing a prospectus for an exploratory study. (Fahnestock, G. R. and D. Dubé. 1974. The natural and historic role of fire in Wood Buffalo National Park).

    In Jasper National Park the reconnaissance consisted of

        a. Briefly examining the vegetation of the lower reaches of the park. (valley bottoms and lower slopes) and noting the apparent effect on the vegetation of man-caused historical fires and protection subsequent to them.

        b. Discussion with Parks personnel of current management policies and practices and alternatives to them.

        c. Preparing a prospectus for a preliminary study (Fahnestock, G. R. 1974. An opportunity for fire ecology research in Jasper National Park).

4. Rescheduled writing of problem analysis to 1975-76 because the Darwin Lake project prevented completion of necessary background investigations.

5. Rescheduled publications to 1975-76 for same reason.

6. Completed draft of Master of Science Thesis, "Early Plant Succession Following Fire in the Subalpine Forest of the Canadian Rockies", by D. Dubé.

7. Provided leadership and fuel-measurement service for CFS/Alberta Forest Service cooperative experimental burning project at Darwin Lake, Alberta.

8. Inventoried surface fuels and related vegetational characteristics of 13 stands of known age near Hinton, Alberta.

9. Provided consultation regarding interpretation of fire-related characteristics of vegetation along the "eco-trail", Kananaskis Forest Experiment Station.

10. Participated in training conferences at Yellowknife, N.W.T.; Jasper, Prince Albert, and Yoho National Parks; Hudson Bay, Sask.; gave three lectures to forestry classes at U. of Alberta and two talks on fire ecology to school organizations in and around Edmonton.

11. Publish the following:

    Douglas, G. W. 1974. Ecological impact of chemical fire retardants. Inform. Rep. NOR-X-109.

12. Had the following accepted for publication or published:

    a. Fahnestock, G. R. 1975. Fires, Fuels, and Flora as Factors in Wilderness Management: the Pasayten Case. 15th Tall Timbers Fire Ecol. Conf. Proc. (In press).

    b. Attended and prepared minutes for the 9th Fire Management Study Group of the North American Forestry Commission.

    c. Dubé and Fahnestock attended U. S. National Parks - Wilderness Fire Management Workshop in Missoula, Montana.

14. <u>Goals for 1975-76</u>:

    1. Complete Master of Science Thesis, "Early plant succession following fire in the subalpine forest of the Canadian Rockies", by D. Dubé.

    2. Complete literature review on fire history and fire ecology in the territory served by NFRC.

3. Assemble fire records and maps in form suitable for ready reference.

4. Make reconnaissances of Prince Albert and Riding Mountain National Parks.

5. Write fire ecology problem analysis based on the above and directed towards the stated needs of management agencies with emphasis on the development of broad guidelines for fire management with particular reference to National Parks.

6. Participate with Canadian Wildlife Service in prescribed burning study in Prince Albert National Park.

7. Participate in training sessions of client agencies and meetings relevant to study content.

15. Publications:

Douglas, G. W. 1974. Ecological impact of chemical fire retardants. Inform. Rep. NOR-X-109.

Fahnestock, G. R. 1975. Fires, Fuels and Flora as Factors in Wilderness Management: the Pasayten Case. 15th Tall Timbers Fire Ecol. Conf. Proc. (In press).

16. Signatures:

George R. Fahnestock
Investigator

Program Manager

Investigator

Director G. T. Silver

PROJECT NOR - 6

Reduction of Losses by Improved Fire Danger Forecasting

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 10, 1975

1. Project: Reduction of losses by improved fire danger forecasting.

2. Title: Controlled burning in forest management.

3. New: Cont.: X 4. No.: NOR 085

5. Study Leader: Z. Chrosciewicz

6. Key Words: *Pinus banksiana*, *Picea mariana*, *Picea glauca*, *Populus tremuloides*, climates, sites, fuels, drought.

7. Location of Work: Hadashville, Manitoba and Candle Lake, Saskatchewan.

8. Problem:

Many cut-over areas in Manitoba and Saskatchewan are characterized by (a) substantial accumulations of logging slash (fire hazard problem), (b) frequent incidences of various parasites (sanitation problem), (c) insufficient reproduction of conifers due to unfavourable seedbed conditions (silvicultural problem), and (d) rapid reversions to grass, shrubs and inferior hardwoods (silvicultural problem).

However, available information indicates that the post-cutting conditions can be effectively rectified through a rational use of burning either in presence of seed trees or followed by direct broadcast seeding as in cases of facilitating pine and spruce reproduction, and through a burning alone as in cases of improving asexual aspen reproduction on some more productive sites. Conversion of other sites either from brush or from diseased and poorly growing aspen to some of the better suited conifers is also quite feasible by the use of burning followed by seeding or planting with subsequent application of herbicides as needed.

There are indications that the use of burning as a basic treatment will be much less expensive than mechanical operations serving a similar purpose. Added benefits at no extra cost will normally include elimination of slash fire hazard on all treated sites and a high degree of sanitation on pest-infested sites, both of which cannot be effectively realized by mechanical means. However, little is known in Manitoba and Saskatchewan about the minimum drought requirements for burning the desired amounts of fuels involved and, without this knowledge, the chances of successful and economical use of fire for any well-defined purpose are extremely small. Study NOR 085 is designed to furnish the necessary data in relation to the following variables:

<u>Southeastern Manitoba</u>
Climate: boreal-temperate, moist subhumid

<u>Central Saskatchewan</u>
Climate: moderate-boreal, medium subhumid

<u>Forest Types</u>
Jack pine, black spruce, aspen, white spruce-aspen

x

<u>Cut-Over Sites</u>
dry, fresh, moist

x

<u>Drought Conditions</u>
indices 3, 6, 9, 12 in the old system
or their equivalents in the new system

x

<u>Seasons of Burning</u>
spring, summer, fall

<u>Experimental Level</u> → <u>Operational Level</u>
0.4-acre treatment units → 20-acre plus treatment units

Various weather, fuel, site and vegetation studies associated with the individual burns will aid in the factorial evaluation of the burns themselves, and post-burn seeding or planting of conifers will often be required to make the findings more meaningful. Other related studies will include the determination and evaluation of effects on seedbed quality, tree reproduction, plant succession and certain soil properties. The results will be published in the form of tables, prediction curves and recommendations for practical field use by resource managers.

Due to reorientation of regional research effort in 1970, it has been decided to confine this program to jack pine sites only. The decision is reflected in various sections of this statement, including the revised year of completion.

9. Study Objectives:

The study includes integrated elements of fundamental and applied research with specific aims of burning directed toward:

1. Elimination of slash fire hazard (minimal reduction of raw-humus depth).

2. Sanitation of fungus-, insect-, and mistletoe-infested sites (minimal to moderate reduction of raw-humus depth).

3. Improvement of aspen asexual reproduction (moderate reduction of raw-humus depth).

4. Preparation of sites for planting pine and spruce (moderate reduction of raw-humus depth).

5. Preparation of sites for seeding pine and spruce (moderate to substantial reduction of raw-humus depth).

6. Development of raw-humus-reduction curves for predicting the outcome of burning over a wide range of drought conditions by major forest types, sites, climates and seasons of burning.

7. Using the curves under (f), development of prescriptions based on minimum drought and burning requirements for each of the objectives listed under (a) to (e).

8. Delineation of essential control requirements based on the anticipated fire behaviour as related to weather and fuel conditions at the time of burning.

9. Evaluation of cost-benefit relationships at the operational level of burning.

10. Evaluation of all burns in terms of the establishment and growth of forest reproduction.

10. Resources:

a. Starting date: 1968
b. Estimated year of completion: 1983 Revised: 1976
c. Estimated total Prof. man-years required: 0.6
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.6	(Chrosciewicz)
Supp.	--	
Casual	--	
Total	0.6	O & M funds req'd.:
		SR Cont.:

11. Progress to Date: (end of 1973-74)

A series of meetings with the provincial forest services led to the submission and approval of a comprehensive project plan (FRE MS 107) in 1969. Since then, forty-seven burns were carried out on jack pine cutover areas in southeastern Manitoba and central Saskatchewan. Forty-three of them were 0.4-acre experimental burns covering a range of sites, fuels and drought conditions, and five of them were large-scale operational burns totalling some 320 acres. Various seeding and planting treatments were tested in connection with individual burns. Other related activities included (a) publication of four papers mostly on a similar work with controlled burning in central Ontario, (b) assessment of conditions after two provincial control burns on a black spruce site in southeastern Manitoba, (c) analysis of data as they became available from the jack pine burns in southeastern Manitoba and central Saskatchewan, and (d) preparation of some material for publication.

12. Goals for 1974-75:

1. Assessment of post-burn conditions (plant succession and tree regeneration) on more recent experimental and operational burns in central Saskatchewan.

2. Reporting on the physical aspects of burning in both Manitoba and Saskatchewan:

   a. Chrosciewicz, Z. 1974. Regeneration of black spruce by burning lowland cutover in southeastern Manitoba - in preparation for For. Chron.

   b. Chrosciewicz, Z. 1974. Large-scale operational burns for slash disposal and conifer reproduction in central Saskatchewan - in preparation for Information Report.

   c. Chrosciewicz, Z. 1974. Experimental burning on clearcut jack pine sites in southeastern Manitoba - intended Information Report.

   d. Chrosciewicz, Z. 1974. Experimental burning on clearcut jack pine sites in central Saskatchewan - intended Information Report.

3. Goal added: If necessary, revision of the following papers:

   e. Chrosciewicz, Z. 1974. Evaluation of fire-produced seedbeds for jack pine regeneration in central Ontario - prepared for Can. J. For. Res.

   f. Chrosciewicz, Z. 1974. Correlation between wind speeds at two different heights within a large forest clearing in central Saskatchewan - prepared for Can. J. For. Res.

13. Accomplishments in 1974-75:

1. Assessment of post-burn conditions was carried out as planned. This included a regeneration survey on 18 plots.

2. Paper "a" was prepared and submitted for publication to the Canadian Journal of Forest Research. Papers "b" , "c" and "d" are nearing completion as Information Reports.

3. Paper "e" was revised and published by the Journal. Paper "f" was revised and resubmitted to the Journal.

14. Goals for 1975-76:

1. Assessment of post-burn conditions (plant succession, tree reproduction, etc.) on recently treated areas.

2. Submission of the following for publication:

Chrosciewicz, Z. 1975. Large-scale operational burns for slash disposal and conifer reproduction in central Saskatchewan.

Chrosciewicz, Z. 1975. Experimental burning on clear-cut jack pine sites in southeastern Manitoba.

Chrosciewicz, Z. 1975. Experimental burning on clear-cut jack pine sites in central Saskatchewan.

Chrosciewicz, Z. 1976. Jack pine regeneration following burning and seeding treatments in central Saskatchewan.

3. Termination of this study and transfer of unfinished segments re fuels vegetation and fire behavior to NOR 086.

15. Publications:

Chrosciewicz, Z. 1967. Experimental burning for humus disposal on clearcut jack pine sites in central Ontario. Can. Dep. For. Rur. Dev., Publ. No. 1181. 23 p.

Chrosciewicz, Z. 1968. Drought conditions for burning raw humus on clearcut jack pine sites in central Ontario. For. Chron. 44(5):30-31.

Chrosciewicz, Z. 1970. Regeneration of jack pine by burning and seeding treatments on clearcut sites in central Ontario. Can. Dep. Fish. For., Inf. Rept. 0-X-138. 13 p.

Kiil, A. D. and Z. Chrosciewicz. 1970. Prescribed fire - its place in reforestation. Can. Coun. Res. Min., For. Reader, Pap. No. 7..... also For Chron. 46(6):448-451.

Chrosciewicz, Z. 1971. The growth response of young jack pine to moderate and extreme stand densities. Bi-Monthly Res. Notes 27(1):6.

Chrosciewicz, Z. 1971. Silvicultural uses of fire. Can. Forestry Serv., Prairies Reg., Forestry Rep. 1(1):4-5.

Chrosciewicz, Z. 1973. Controlled burning in Saskatchewan. Can. Forestry Serv., N.F.R.C. Forestry Rep. 3(1):7.

Chrosciewicz, Z. 1974. Evaluation of fire-produced seedbeds for jack pine regeneration in central Ontario. Can. J. For. Res. 4(4):455-457.

16. <u>Signatures</u>:

Z. Chrosciewicz
Investigator

Ron Reid
Program Manager

G. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 10, 1975

1. Project: Reduction of losses by improved fire danger forecasting.

2. Title: Burning indices for major fuel types.

3. New: Cont.: X 4. No.: NOR 086

5. Study Leader: Z. Chrosciewicz

6. Key Words: Canadian Forest Fire Weather Index, fire behaviour, danger rating.

7. Location of Work: Hondo and Slave Lake, Alberta - plus other areas as needed.

8. Problem:

Intensive fire control management requires improved methods of assessing and forecasting fire danger for all major fuel types over a wide range of weather and site conditions. Although such methods would not prevent fires from occurring, they would undoubtedly result in substantial reduction of losses through better planning and implementation of various fire control measures all the way from prevention to suppression.

A good start in the development of such methods was made with the publication of the new Canadian Forest Fire Weather Index tables in 1970. The main index as well as the component codes are designed to summarize and rate the important weather variables that affect the ignition and spread of forest fires. The entire system provides means for daily rating of fire danger across the country. However, as the system uses primarily weather-dependent scales, it does not provide means for rating fire behaviour in specific fuels.

The second phase, then, would be the development of burning indices for important fuel types by major sites and climates within the Region. Studies of moisture relationships in different fuels will help to determine the degrees of deviation from the standard curves as originally used in working out the Fire Weather Index. Experimental ground burns and observations of natural crown fires will provide data on fire behaviour over a wide range of weather and site conditions for each of the fuels. The resulting tables will then relate some of the main characteristics of ground and crown fires to the Fire Weather Index and its component codes. This in turn will provide means for a more precise rating and forecasting of fire danger for major fuel types within the Prairies Region.

9. Study Objectives:

1. To assist fire control agencies in promoting the use of the new Canadian Fire Weather Index.

2. To develop fire spread and intensity tables for major fuels as supplements to the Fire Weather Index.

10. Resources:

a. Starting date: 1970
b. Estimated year of completion: 1973 Revised: 1980
c. Estimated total Prof. man-years required: 5.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.4 (Chrosciewicz)		
Supp.	1.0 (Gordey)		
Casual	0.3		
Total	1.7	O & M funds req'd:	
		SR Cont.:	

11. Progress to Date: (end of 1973-74)

The new Canadian Fire Weather Index was introduced to the Region in 1970 through a series of training sessions for user agencies. During the same year, forty-eight 100 by 100-foot plots were established for burning in stands of jack pine, aspen and white spruce-aspen, between Hondo and Slave Lake, Alberta. Following a pilot burn in 1971, thirteen spring burns were carried out on aspen plots in 1972. Starting early in 1973, Z. Chrosciewicz took responsibility for this study from D. Quintilio due to general reassignment of duties, and since then fifteen additional 100 by 100-foot plots were established in the Slave Lake area for burning in lowland black spruce. Other work in 1973 included weather and fuel moisture studies in each of the four forest types (jack pine, aspen, white spruce-aspen and black spruce) to determine how closely the daily Fire Weather Index and its component codes represent the actual stand conditions. Also, heat content determinations were done on some important fuels from each of the four forest types to provide means for a more precise fuel classification.

12. Goals for 1974-75:

1. Maintenance of weather instrumentation from mid-April to at least mid-August.

2. Continuation of sampling green (crown) and dead (ground) fuels for moisture content determinations in stands of jack pine, aspen, white spruce-aspen and black spruce, with the aim to cover more fully the normal drying range for the area.

3. Analysis and preparation of available data in a form suitable for publication.

4. Participation in national effort to develop a Universal Fire Behaviour Index System.

5. Goal added. Preparation of a problem analysis re seasonal changes in moisture content of conifer foliage.

13. Accomplishments in 1974-75:

1. Because of writing commitments in Study NOR 085, no weather instrumentation was maintained.

2. For the same reason, only green foliage of common conifers (jack pine, white spruce, balsam fir and black spruce) was sampled to determine seasonal variations in its moisture content. Some 1,680 samples were involved (4 species x 4 foliage ages x 5 replications x 21 weekly or semi-monthly samplings).

3. All moisture data were computed and plotted as they became available.

4. Sessions on the development of a Universal Fire Behaviour Index System were attended.

5. A brief problem analysis was prepared re seasonal change in foliar moisture of conifers and their probable effects on the incidence and magnitude of forest fires.

14. Goals for 1975-76:

1. Continuation with the sampling of green foliage for one month (June) to determine the consistency of periodic highs and lows in its moisture content.

2. Analysis of foliage-moisture data and submission of a report for publication.

3. In preparation for burning in 1976, initiation and completion of stand inventories (trees, shrubs, ground vegetation, dead dimensional fuels, litter, duff, etc.) on 16 jack pine plot near Hondo, Alberta. If time permits, the inventory work will be extended to black spruce plots near Slave Lake, Alberta.

15. Publications:

Kiil, A. D., R. J. Lieskovsky and J. E. Grigel. 1973. Fire hazard classification for Prince Albert National Park, Saskatchewan. Can. Dep. Environment, Canadian Forestry Service, Information Report NOR-X-58. 26 p.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

PROJECT NOR - 7

Reduction of Damage from Pollutants in the Atmosphere

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 12, 1975

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Symptomology of atmospheric effluent effects on the forest.

3. New: Cont.: X 4. No.: NOR 114

5. Study Leader: D. Hocking, R. A. Blauel

6. Key Words: Sulphur gases, vegetation, lodgepole pine, white spruce.

7. Location of Work: Region-wide.

8. Problem:

   Industrial effluents discharged into the atmosphere in a number of locations have a real, imagined, or potentially deleterious effect upon adjacent trees and other plant life. Government agencies and the general public at all levels are expressing concern. Industrial groups are apprehensive as to restrictions which may be applied. Regulatory agencies in many instances lack essential scientific information describing cause and effect relations. Provincial government agencies, industry and the public request involvement by the Canadian Forestry Service in this environmental problem in the form of cooperative research programmes, detection and assessment surveys, and advisory services.

9. Study Objectives:

   a. Describe macro and micro symptoms on forest vegetation resulting from known amounts of single and combined (synergistic) atmospheric industrial effluents, with collections of specimens, microscope slides, and photographs.

   b. Define the event sequence in which symptoms are produced.

   c. Develop diagnostic techniques based on specific symptoms.

   d. Discern macro and micro injury thresholds under different environmental conditions.

   e. Develop a species sensitivity index for different environmental conditions.

f. Define the environmental conditions and sequences leading to species sensitivity.

g. Define predispositional results of pollutants.

h. Test the Federal Air Quality Objectives for air pollutants under defined environmental conditions.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: Revised: 1980
c. Estimated total Prof. man-years required: 40
d. Essential new major equipment items for 1975-76 with costs:

Fumigation chamber	$40,000
CO_2 analyzer	15,000

e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

	Prof.	0.4	(Hocking 0.2)
			(Blauel 0.2)
	Supp.	0.7	(Fenn)
		1.0	(Chamber technician)
	Casual	0.3	
	Total	2.4	O & M funds req'd:

11. Progress to Date:

Good relations and cooperative working arrangements have been established with Provincial and Federal Government agencies involved with air pollution problems and with industry and the public in the field. The Canadian Forestry Service is regarded within the region as an important contributor of information relating to air pollution effects on vegetation.

Permanent sample plots have been located and vegetation described, in vicinity of gas processing plants and oil sands processing plants; including plume impingement areas.

A growth chamber has been designed with sophisticated equipment and controls specifically for air pollutant studies. Delivery was expected in March, 1974, but the contracting company went bankrupt.

Permanent monitoring plots in the Rocky Mountain House and Fort McMurray area were documented by detailed color photography and by sample collection. Further work on this aspect is now transferred to Study NOR

Plume impingement areas near the Aquitaine Gas Plant were studied by contract (Study NOR-7-710). Final report was issued.

Study of the effects of aqueous solutions of SO_2 on foliage was suspended owing to resignation of staff; is now transferred to Studies NOR 974 and 978.

An industry-government workshop was sponsored in cooperation with the Research Secretariate of the Alberta Department of the Environment. Good working contacts were made, extended or strengthened. Proceedings were published.

The herbarium and color slide reference collections were expanded and now constitute perhaps the most complete such collections in Western Canada.

12. Goals for 1974-75:

    1. Set up, stabilize and calibrate air pollutant chamber.

    2. Run exploratory trials to "shake-down" chamber performance.

    3. Run detailed experiments on one species at one set of environmental conditions.

    4. Attempt further field fumigations.

    5. Maintain reference collections of slides, photographs and specimens.

13. Accomplishments in 1974-75:

    1 - 3. No progress was made with these goals owing to bankruptcy of the supplying contractor.

    4. No field fumigations were attempted for lack of laboratory data.

    5. Progress was made on sorting and cataloguing reference collections of slides, photographs and specimens.

14. Goals for 1975-76:

    1. Clear backlog of field reference collection work on forest species foliar materials by sorting and processing only top priorities. Fill revealed gaps in field symptomology. Continue collections.

    2. Prepare a color handbook of comparative symptomology for regional forest species exposed to air pollutants designed for use in the field.

    3. Order and supervise construction of the air pollutant fumigation chamber, and dependent on delivery to begin set up, stabilization and calibration of the chamber and ancillary equipment.

    4. Adapt micro-chamber to pollutant use and stabilize and calibrate it and ancillary equipment.

    5. Attempt exploratory exposures on micro-chamber and describe symptoms produced.

15. Publications:

Up to 1974-75

Loman, A. A. 1972. Atmospheric sulphur dioxide and foliar sulphur content. NOR-Y-48.

Loman, A. A., R. A. Blauel and D. Hocking. 1972. Sulphur dioxide and forest vegetation. NOR-X-49.

Blauel, R. A. 1972. Comments on vegetation section of the Canadian Petroleum Association submission to the Environment Conservation Authority, Alberta Department of the Environment, Edmonton. NOR-Y-73.

Blauel, R. A. 1973. Intervention by CFS-EPS on application by Gulf Oil for exemption from minimum sulphur recovery efficiency guidelines of the Energy Resources Conservation Board, Government of Alberta. January 5, 1973. File Report.

Hocking, D. and D. Reiter (Eds.) 1973. Proceedings of a workshop on sulphur gas research in Alberta. NOR-X-72. 21 papers.

Hocking, D. 1973. Some terms for symptoms on plants exposed to sulphur gases. In: NOR-X-72.

Rowe, R. D. 1974. Delineation of Plume and Impingement Areas from a Sour Gas Processing Plant.

File Reports

Hocking, D. 1974. Effects on the forest of sulfur dioxide from a sulfur fire near Edson, Alberta.

Hocking, D. 1974. Preliminary survey of the forest condition near the Transmountain Pipeline Co. Ltd. pumping station at Jasper, Alberta.

Hocking, D. The forest impact of sulfur dioxide from underground combustion of sulphide ores near Kimberley, B. C.

16. Signatures:

Drake Hocking
Investigator

Rene Reid
Program Manager

R A Blauel
Investigator

G Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 12, 1975

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on forest soils.

3. New: Cont.: X No.: NOR 970

5. Study Leader: J. Baker

6. Key Words: Soil profile, soil horizons, grey wooded soils, phosphate absorption, ammonium-nitrogen, sulphur compounds, air pollution, heavy metals.

7. Location of Work: Region wide.

8. Problem:

Nature of Study:

This study is necessitated by the fact that industrial operations emit various compounds into the atmosphere. These compounds react with the total environment and have the potential of causing serious damage.

The proposed study will concentrate in the first instance on the effects of sulphur emissions on soil characteristics. In addition to the direct effects of these emissions on the total and available forms of sulphur in the soil, attention also will be given to those transformations of an indirect nature.

Benefits expected:

Agencies, concerned with the potential hazards of air pollutants on the environment frequently lack essential scientific information describing cause and effect relationships. Information obtained from this study should prove beneficial in assessing both the immediate and long term hazards to the soil environment.

Probability of success and practical application:

Regardless of how the results of this study are evaluated and interpreted, success seems assured. If results show positive adverse effects of atmospheric sulphur pollutants on the soil environment, then regulatory agencies will be in possession of additional essential information to set meaningful and safe limits on levels of atmospheric pollutants. On the other hand, if there are no real serious threats to the soil, any previous apprehension, on the part of the various interested agencies, may be dismissed.

Methods used:

There will be both laboratory and field work associated with this study. In the laboratory, soil columns composed of the essential horizons from unexposed soil material will be subjected to known total amounts of sulphur dioxide. These soil columns will then be leached with water and percolate analyzed for changes in various chemical constituents. In addition, the leached soil solids will be analyzed for these chemical constituents. The field work will mainly involve sampling soil at various stations within and without the sulphur impingement area. The field work will mainly be used for studying long term effects of pollutants on the soil from sites in close proximity to industrial operations.

9. <u>Study Objectives</u>:

To determine the influence of air pollutants, in the first instance sulphur dioxide gas, on: 1) amount, form and region of accumulation of chemical constituents in the soil, 2) soil micro-flora, especially sulphur and nitrogen organisms, 3) sulphur availability in the soil and the effect of this on sulphur up-take by plants.

10. <u>Resources</u>:

a. Starting date: 1974
b. Estimated year of completion: 1976
c. Estimated total Prof. man-years required: 0.8
d. Essential new major equipment items for 1975-76 with costs:
   Atomic absorption spectrophotometer $15,000
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.4	
Supp.	0.5	
Casual	0.3	
Total	1.2	O & M funds req'd:

11. <u>Progress to Date</u>:

See accomplishments for 1974-75.

12. <u>Goals for 1974-75</u>:

Installation of sampling sites will be completed at Aquitaine and a further six sites will be developed at Fort McMurray. Additional control sites (2) will be established at Aquitaine. A sampling site will include:

1) Collection of through fall precipitation
2) Collection of gross fall precipitation
3) Collection of stem flow precipitation
4) Collection of litter fall (debris)
5) Installation of ceramic water samplers at the base of test trees
6) Installation of Pb 0_2 plates at several levels in test trees to estimate cumulative SO_2 impingement
7) Establishment of soil sampling sites
8) Analysis of soil solution and solids including survey of N and S organisms in soil

13. Accomplishments in 1974-75:

Sampling sites at Aquitaine were relocated and completed. An additional six sampling sites were installed at the Fort McMurray area.

Both areas were sampled throughout the growing season; stem flow readings, gross fall readings and throughfall readings were taken. Litter fall traps were not installed as the stand crown at the various sampling sites was not sufficiently closed to warrant installations.

Soil samples were taken (fall 1974) and these have been stored in the cold room.

Analysis of soil samples and solutions from Aquitaine have been started. Volumes, pH measurements, conductivities have been initiated on the Aquitaine samples, not yet on the McMurray samples. Difficulty has been experienced in establishing control samples (uncontaminated with sulfur either with SO_2 or with dust) so that data from these may be compared with those thought to be within the impingement area and thus sulfur contaminated.

Conductivity values of L-F-H samples from within the so-called impingement zone are higher than those from sites which were installed as controls. Values for mineral soils both within and without the SO_2 contaminated zone are essentially similar.

Soil pH values of both litter and mineral soil from sites within the SO_2 impingement area were lower than those from control sites. This was true of both water and Ca Cl_2 pH values. This would suggest that acidification is taking place probably from some kind of sulfur contamination. One site, South Aquitaine, is especially acidic compared to other sites. This particular site could be influenced by sulfur dust. This is the only site showing appreciable iron and aluminum in the extracts which suggests that the increased acidification is accompanied by increased solubilization of iron and aluminum oxide coatings.

Methodology for the study of the soil micro-flora is well underway. Techniques for the numbering, isolation and purification of cultures are developed. Identification of isolates is now in progress.

A report "Atmospheric Sulfur Compounds and their effect on Soil" is under review presently. These results were taken from a laboratory study.

14. Goals for 1975-76:

    1. The identification of the soil micro-flora will continue.

    2. With the arrival of the sulfur analysis apparatus and sufficient support help, SO_4-S, Fe, Al, etc. of soil samples taken last fall (1974) will continue.

15. Publications:

    Up to 1974-75 - Nil

    1974-75 - Nil

16. Signatures:

J Baker
Investigator

R Reid
Program Manager

G Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 12, 1975

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on biochemical processes of the forest vegetation.

3. New: Cont.: X 4. No.: NOR 974

5. Study Leader: S. S. Malhotra, D. Hocking

6. Key Words: Photosynthetic fixation, lodgepole pine, photosynthetic pigments, aqueous sulphur dioxide, Na $H^{14}CO_3$, biomass, spectrophotometry, pigment metabolism, *in vivo, in vitro*.

7. Location of Work: Northern Forest Research Centre and University of Alberta, Edmonton.

8. Problem:

One of the major concerns in industrialized areas is the emission of effluents into the atmosphere. Most of these effluents have a great potential to cause irreversible damage to forest trees and other vegetation. Since there is not enough information available either on direct or indirect effects of air pollutants on plant life, regulatory agencies have difficulty in applying any meaningful and effective restrictions.

Sulphur dioxide is the principal atmospheric pollutant in many industrial areas. Research on this gas has been mostly limited to physiological studies (work with intact tissues) and description of the necrotic symptoms which develop on plant leaves. The mechanism of SO_2 toxicity at molecular level has not been examined in detail. An understanding of the biochemical mechanism of SO_2 toxicity in forest species would help to explain their pollution sensitivity and would provide information on the effects (positive or negative) of low levels of sulphur dioxide on biomass production. The regulating agencies when supplied with this vital information will be in a better position to set more rational levels of SO_2.

Since SO_2 has been shown to cause discoloration of leaves, we will examine the effects of SO_2 on the photosynthetic fixation of $^{14}CO_2$

by lodgepole pine seedlings, and investigate the interaction between this gas and photosynthetic pigments extracted from forest trees.

9. Study Objectives:

To determine the effects of air pollutants on some of the central biochemical processes in forest species.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: Revised: 1980
c. Estimated total Prof. man-years required: 8.8 (including 1974-75)
d. Essential new major equipment items for 1975/76 with costs: Ultracentrifuge $20,000
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	1.0	
Supp.	0.7	
Casual	-	O & M funds req'd:
Total	1.7	

11. Progress to date:

a. Preliminary work on $H^{14}CO_3$ incorporation studies was completed.

b. Needles from pine seedlings were exposed to aqueous SO_2. The various pigments were extracted from treated and untreated tissues and changes in pigment metabolism were determined by means of spectrophotometry, polarography and enzyme analysis.

12. Goals for 1974-75:

To determine SO_2 effects on the photosynthetic activity of lodgepole pines, the following will be done:

1. The plant material will be treated with known concentrations of aqueous SO_2, incubated with $NaH^{14}CO_3$, and allowed to photosynthesize for different lengths of time under known environmental conditions. After the treatment, the rate of photosynthesis will be determined from the amount of radio-activity incorporated into the products of photosynthesis.

2. Pigments from pine seedlings will be exposed to aqueous SO_2 *in vivo* and *in vitro*. The various pigments will be extracted from treated and untreated plants and changes in pigment metabolism will be determined by means of spectrophotometry.

Goals added during 1974-75:

Isolate chloroplasts from pine tissue treated with various concentrations of aqueous SO_2 and determine photosynthetic efficiency in terms of rate of Hill reaction.

13. Accomplishments in 1974-75:

1. Preliminary work on $H^{14}CO_3$ incorporation into photosynthetic products was completed. The colour quenching curves for radioisotope counting were made. A suitable method for $H^{14}CO_3$ incorporation was developed and trial runs were made by treating plant material with known concentrations of aqueous SO_2 and further incubating it with $NaH^{14}CO_3$. After incubation, the rate of photosynthesis was determined from the amount of radioactivity incorporated into the products of photosynthesis. The preliminary results suggested a decrease in the rate of incorporation with increasing concentrations of SO_2.

Added Accomplishments:

The chloroplasts were isolated from pine needles that had been treated with aqueous SO_2. The effect of SO_2 on photosynthetic efficiency (Hill reaction activity) was determined by means of polarography and and expressed in terms of oxygen evolution. The ability of isolated chloroplasts to evolve oxygen decreased at high concentrations of SO_2.

2. Various pigments were separated from pine tissue exposed to different concentrations of aqueous SO_2 and the changes in pigment metabolism were determined. Even very low concentrations of SO_2 that did not produce any visual symptoms caused biochemical injury to the tissue by interfering with the pigment metabolism.

14. Goals for 1975-76:

In order to determine the biochemical threshold levels of SO_2, the effects of SO_2 will be studied on the following mechanisms:

1. Incorporation of $H^{14}CO_3$ into photosynthetic products (photosynthetic efficiency).

2. Respiration of whole tissue by the use of Warburg apparatus.

3. Amino acid metabolism by the use of gas chromatography.

4. Write-up and report the results obtained in 1974-75.

5. Initiate gas phase studies of photosynthetic activity and respiration to confirm trends determined in aqueous phase studies.

15. Publications:

Up to 1974-75 - Nil

1974-75 - Nil

16. Signatures:

Drake Hocking
Investigator

Ron Reid
Program Manager

Investigator

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 12, 1975

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on sub-cellular structure of forest vegetation.

3. New: X Cont.: No.: NOR 978

5. Study Leader: S. S. Malhotra

6. Key Words: Sub-cellular structural organization, necrotic symptoms, electron microscopic analysis, aqueous sulphur dioxide, fixation, staining.

7. Location of Work: Northern Forest Research Centre and University of Alberta, Edmonton.

8. Problém:

Sulphur dioxide is one of the most toxic constituents of polluted air. It has a great potential to cause irreversible damage to forest trees and other vegetation. Since there is not enough information available either on direct or indirect effects of SO_2 on plant life, regulatory agencies have difficulty in applying any meaningful and effective restrictions. Studies on this gas have been mostly limited to acute or chronic injuries. Low concentrations of SO_2 that do not produce any visible symptoms (before chronic injury symptoms) may affect growth by interfering with the sub-cellular structure.

The mechanism of SO_2 action at the level of sub-cellular structure has not been studied in detail. At low concentrations, the effects of SO_2 on vegetation may be due to (a) interference with some of the biochemical processes in plants, (b) interference with the sub-cellular structural organization, (c) combination of (a) and (b). Integrated studies comprising biochemical (Study-7-974) and electron microscopic analysis would help to explain the effects of low levels of SO_2 on biomass production. The regulatory agencies when supplied with this vital information will be in a better position to set more rational levels of SO_2.

9. Study Objectives:

To determine the effects of SO_2 on sub-cellular organization and relate these results with those obtained by the biochemical studies (Study NOR-7-974).

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: Finished in 1974-75.
c. Estimated total Prof. man-years required: 0.6 (including 1974-75)
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.1
Supp.	-
Casual	-
Total	0.1

O & M funds req'd:

11. Progress to date:

The effect of various concentrations of aqueous SO_2 on sub-cellular structural organization was determined during 1974-75.

12. Goals for 1974-75:

To determine the effects of various concentrations of SO_2 on sub-cellular structure of forest species.

13. Accomplishments in 1974-75:

Three different developmental stages of pine needle tissues (old, middle-aged and young tissue) were treated with various concentrations of aqueous SO_2 and the ultrastructural changes (chloroplast and mitochondria) were observed by means of electron microscopy. The older tissue appeared to be more sensitive to SO_2 injury than the younger tissue.

14. Goals for 1975-76:

1. Write up and report the results. Proposed title: "Effect of SO_2 on Hill reaction and ultrastructure in lodgepole pine".

2. Terminate study.

15. Publications:

Up to 1974-75 - Nil

1974-75 - Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 12, 1975

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: The fate of atmospheric sulphur compounds.

3. New: Cont.: X 4. No.: NOR 979

5. Study Leader: D. Hocking, J. Baker

6. Key Words: Air pollution, sulphur dioxide, hydrogen sulphide, isotope partitioning, acid precipitation.

7. Location of Work: Region-wide.

8. Problem:

   Industrial effluents discharged into the atmosphere in a number of locations have a real, imagined, or potentially deleterious effect upon adjacent trees and other plant life. Government agencies and the general public at all levels are expressing concern. Industrial groups are apprehensive as to restrictions which may be applied. Regulatory agencies in many instances lack essential scientific information describing cause and effect relations. Provincial government agencies, industry and the public request involvement by the Canadian Forestry Service in this environmental problem in the form of cooperative research programmes, detection and assessment surveys, and advisory services.

   Of particular concern to regulatory agencies is the potential long-term effect of atmospheric emissions. Predictions of long-term effect depend on an accurate and detailed understanding of the fate of the emissions: where do they go?

9. Study Objectives:

   a. Develop and apply methods for measurement of atmosphere-borne sulphur compounds wherever they are removed from the atmosphere: by settle-out, by precipitation, and by active assimilation.

b. Using data from (a) above, develop and refine a "sulphur budget" for an individual source of emissions.

c. Apply "sulphur budgeting" to other sources for which data are available or can be gathered.

10. <u>Resources</u>:

a. Starting date: 1974
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 4
d. Essential new major equipment items for 1975-76 with costs:
Conductivity meter $800
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.4	(Hocking 0.3)	
		(Baker 0.1)	
Supp.	0.5	(Ridgway 0.5)	
Casual			
Total	0.9		O & M funds req'd:

11. <u>Progress to Date:</u>

Plots have been established for the measurement of sulphur "settling-out" and in rainfall near the Aquitaine Ram River gas plant and near Fort McMurray, in cooperation with Drs. M. Nyborg and F. Bentley (Soil Science, University of Alberta). A sampling programme has been initiated for the partitioning of atmosphere and soil contributions to sulphur in vegetation. Separation is by characteristic stable isotope proportions determined by mass spectrometry, in cooperation with Dr. R. Krouse (Physics, University of Calgary).

Determinations on samples collected in 1973-74 suggest significant direct uptake of atmospheric SO_2 by trees and lichens. Much more sulphate is present in intercepted than in open rainfall. Intercepted rain is also consistently significantly more acid.

12. <u>Goals for 1974-75</u>:

1. Continue collection of precipitation and settle-out data.

2. Establish further plots in the Fort McMurray area.

3. Analyze vegetation, soil, and atmospheric sulphation plate samples from around Aquitaine for isotope proportions.

4. Collect similar samples from the Fort McMurray area.

13. <u>Accomplishments in 1974-75</u>:

1. Samples were collected around Aquitaine and analysis is in progress.

2. Eight plots were established near Fort McMurray.

3. Preliminary determinations of stable isotope proportions around Aquitaine were completed and a repeat run was started.

4. Preliminary samples were collected near Fort McMurray.

14. Goals for 1975-76:

1. Continue collection of precipitation and settle-out data.

2. Analyze further, carefully partitioned soil, vegetation and atmospheric sulfation plate samples; for stable S isotope proportions from Aquitaine.

3. Collect similar samples from near other emission sources.

15. Publications:

Up to 1974-75

Baker, J., D. Hocking, and M. Nyborg. 1973. Effect of atmospheric sulphur dioxide on the pH or rain intercepted by forest trees. In: Hocking and Reiter (Eds.) Proceedings of a workshop on sulphur gas research in Alberta. NOR-X-72.

1974-75

Hocking, D. and M. Nyborg. 1974. The problem of soil acidification by sulfur dioxide. In: NOR-X-116. Proceedings of a Workshop on reclamation of disturbed land in Alberta. D. Hocking and W. D. Macdonald (Eds.).

16. Signatures:

Drake Hocking
Investigator

R. Reid
Program Manager

J. Baker
Investigator

G.T. Silver
Director G. T. Silver

PROJECT NOR-8

Reduction of Damage from Disease Causing Agencies

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Reduction of damage from disease causing agencies.

2. Title: Biology and epidemiology of dwarf mistletoe on lodgepole and jack pine.

3. New: Cont.: X 4. No.: NOR 029

5. Study Leader: J. A. Muir

6. Key Words: *Arceuthobium americanum, Pinus contorta, Pinus banksiana,* detection, damage, spread, infection, parasites, control.

7. Location of Work: Boreal Forest and Rocky Mountain Range.

8. Problem:

Dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.), a seed plant which is parasitic on conifers, is widespread but sporadic, and occasionally causes severe damage to lodgepole pine and jack pine in western Canada. Generally, sufficient information is on hand for effective management of dwarf mistletoe on lodgepole pine appropriate to current management intensities, but very little is known of dwarf mistletoe epidemiology and biology on jack pine. Methods are needed for extensive surveys to detect and appraise infestation by dwarf mistletoe. A low-level aerial detection survey was developed recently for infested jack pine forests. For jack pine, damage caused by dwarf mistletoe is known in general terms, and in some areas of intensive management a detailed study may be required to relate damage to infestation, tree age and site quality. In high-use areas such as campgrounds, the hazards of dwarf mistletoe infested trees are unknown. Particularly large witches brooms which appear subject to wind breakage are formed on infested jack pine. Reasons for the formation of such large brooms on jack pine are unknown, and large brooms may be related to the apparently greater damage by mistletoe on jack pine than lodgepole pine.

Effective control of dwarf mistletoe infestation can be obtained by extensive clearcutting and destruction of all infested trees. However, alternative control methods are needed for situations where clearcutting is aesthetically or otherwise unacceptable, where infestation occurs in small areas, and where individual infested trees need treatment. For effective control treatments and a basis for judging the priority of situations for control treatment, specific epidemiological information, such as the rate of spread of infestation, is needed for dwarf mistletoe on jack pine. Areas where dwarf mistletoe is reportedly absent, such as forest zone B19a investigated to determine possible natural control of infestation and risks of infestation particularly in relation to management practices.

9. Study Objectives:

   1. Determine and demonstrate methods for extensive surveys of dwarf mistletoe infestation.

   2. Determine impact (damage) and spread of dwarf mistletoe on jack pine.

   3. Determine methods to control infestation of jack pine.

   4. Continue and complete previously established studies of dwarf mistletoe epidemiology on lodgepole pine.

10. Resources:

   a. Starting date: 1962
   b. Estimated year of completion: 1973 Revised: 1975
   c. Estimated total Prof. man-years required: 2.0
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

1975-76 man-years	Prof.	1.0
	Supp.	1.0
	Casual	
	Total	2.0

11. Progress to Date:

Aspects of the biology and epidemiology of dwarf mistletoe in young lodgepole pine that have been determined include: rate of increase of infestations; occurrence and spread of infections in relation to density of infection sources; timing, rate and distance of seed dispersal; biology of seed germination; and identification and effects of fungal parasites of dwarf mistletoe. Progress to 1968 was summarized in three internal reports. An extensive study of the development of infections from naturally and artificially inoculated seed was established and data were compiled, coded and key-punched. Analyses of this data are underway.

In 1972 the study was expanded to include dwarf mistletoe on jack pine. Literature was reviewed, and field conditions in Manitoba, Saskatchewan and Alberta were examined. An extensive survey of infestation of jack pine was conducted in northeastern Alberta and results were plotted on the clients' maps. Distinctive features of dwarf mistletoe infestation on aerial photographs were found and reported. A proposal for remote sensing of infestation was accepted by the Canadian Centre of Remote Sensing, but was not completed. Colour infra-red photographs of dwarf mistletoe infestation in the study area were taken by C. Kirby and P. Van Eck.

12. Goals for 1974-75:

1. Complete the following reports and work on dwarf mistletoe of lodgepole pine:

   a. Dwarf mistletoe infection sources and infestation of young lodgepole pine. Phytopathology.

   b. Occurrence and effects of *Colletotrichum gloeosporiodes* on dwarf mistletoe in young lodgepole pine. Canadian Journal of Forest Research.

   c. Lodgepole pine dwarf mistletoe: seed dispersal and germination. Canadian Journal of Forest Research or Canadian Journal of Botany.

   d. Analyze and report observations of development of dwarf mistletoe infections from seed.

2. Other reports:

   Low-level aerial survey of jack pine dwarf mistletoe (co-authorship with J. Robins). Information Report.

3. Conduct a review and problem analysis for dwarf mistletoe of jack pine.

4. Obtain and evaluate small-scale colour and colour infra-red photographs for detecting dwarf mistletoe infestation of jack pine.

13. Accomplishments in 1974-75:

1. a. Manuscript "Infection sources and incidence of dwarf mistletoe in young lodgepole pine" submitted to Canadian Journal of Forest Research.

   b. Manuscript "Effects of a fungal hyperparasite of dwarf mistletoe on young lodgepole pine" submitted to Canadian Journal of Forest Research.

   c. Manuscript "Dwarf mistletoe seed dispersal and germination in southwestern Alberta" undergoing second local review. Can. Journal For. Res.

d. Observations of development of infections on seed have been coded, compiled, key-punched on cards, and are being analyzed. For Canadian Journal of Forest Research or Canadian Journal of Botany.

2. Other reports: "Low-level aerial survey ..." is incomplete because of retirement of J. Robins.

3. A file report on jack pine dwarf mistletoe is being completed.

4. Photographs were obtained but have not yet been evaluated.

5. Other accomplishments:

"Photosynthesis by dwarf mistletoe seeds" submitted to Bi-monthly Research Notes.

Consultation and advise on dwarf mistletoe detection and control were provided on three occasions to the Alberta and B. C. Forest Services.

14. Goals for 1975-76:

Complete manuscripts. Terminate study.

15. Publications:

Up to 1974-75

Muir, J. A. 1965. (Dwarf mistletoe) Parasitic effects and reproductive ability. Can. Dep. For. Ann. Rep. For. Ent. and Path. Branch. p.130-131.

Muir, J. A. 1967. A bibliography of recent publications on the dwarf mistletoe *Arceuthobium americanum*. Can. Dep. For. Inform. Rep. A-X-13. 9p.

Muir, J. A. 1967. Occurrence of *Colletotrichum gloeosporioides* on dwarf mistletoe (*Arceuthobium americanum*) in western Canada. Plant Dis. Reptr. 51:798-799.

Muir, J. A. 1968. Biology of dwarf mistletoe (*Arceuthobium americanum*) in Alberta. Can. Dep. Fish. and For., Int. Rep. A-15. 29p.

Muir, J. A. 1968. Epidemiology of dwarf mistletoe (*Arceuthobium americanum*) in Alberta. Can. Dep. Fish. and For., Int. Rep. A-16. 20p.

Muir, J. A. 1968. Incidence of the fungal parasite, *Colletotrichum gloeosporioides* and its possible effects on intensification of dwarf mistletoe (*Arceuthobium americanum*). Can. Dep. Fish. and For., Int. Rep. A-17. 9p.

Muir, J. A. 1970. Dwarf mistletoe spread in young lodgepole pine stands in relation to density of infection sources. Bi-mon. Res. Notes 26(5):49.

Muir, J. A. 1972. Increase of dwarf mistletoe infections on young lodgepole pine. Can. J. For. Res. 2:413-416.

Muir, J. A., J. K. Robins, and J. P. Susut. 1972. Dwarf mistletoe survey in the Athabasca forest, Alberta: ground check of infestation. Can. For. Serv., Nor. For. Res. Centre NOR-Y-43. 19p.

Muir, J. A. 1973. *Cylindrocarpon gillii*, a new combination for *Septogloeum gillii* on dwarf mistletoe. Can. J. Botany 51: 1997-1998.

Muir, J. A. and J. K. Robins. 1973. Detection of dwarf mistletoe of jack pine on aerial photographs. Plant Disease Reporter 57:951-954.

Muir, J. A. 1973. Aerial photographs used to detect infestation of jack pine forests by dwarf mistletoe. Proc. 21st Western Int. Forest Disease Work Conf. Estes Park, Col. October 2-5. p.85-89.

Muir, J. A. 1973. Lodgepole pine dwarf mistletoe on Douglas fir in Alberta. Bi-Mon. Res. Notes 29:25-26.

Muir, J. A. 1973. Dwarf mistletoe damage. Forestry Report. Northern Forest Research Centre 3(3):8.

16. Signatures:

R. Reid
Investigator
for Muir

R. Reid
Program Manager

G.T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Reduction of damage from disease causing agencies.

2. Title: Reduction of losses from canker and dieback.

3. New: Cont.: X 4. No.: NOR-044

5. Study Leader: H. Zalasky

6. Key Words: Frost burl, frost canker and dieback, bark pitch pocket, low temperature, hyper- and hypoplasia, interlocking and spiral grain, brachiate tracheids, sclereid-like cells, scabby bark, conifers, hardwoods.

7. Location of Work: Region-wide.

8. Problem:

Studies of distribution of hosts and geographic distribution and the histology of the bark and wood damage by low temperature was undertaken in 1971 to define the impact and symptoms on trees of different species. Investigations included annual rejuvenating capability, development and maturation of still-living woody tissues in annual growth rings around the frost canker, and freeze-killing of new abnormal tissues. In frost hollows and frost risk localities, frost cankers are perennial because of the annual monthly or seasonal pattern of freeze-thaw conditions. Freeze-thaw is defined as a drastic variation between the high temperature during the day, the low of the night and the high of the next day regardless of season or month of the year. The range in which diurnal temperatures are required to drop from a high to a low and rise again to effect damage in plant tissues is known from field observations and from cell biology experiments. In nature wind-chill may bring on a risk of frost even if the temperature is slightly above freezing such as 33° to 35° F.

Physiographically our land mass, bordered by the cold pre-Cambrian Shield in the east and the Rockies in the west, rises sharply westward from the Manitoba escarpment. It is influenced by a cold Continental air mass pressure system from the Arctic and by a warm air mass from the Pacific. The two systems bring about rapid diurnal freeze-thaws so common during the winter months along the eastern slopes of the Rockies with greatest turbulence and gusty winds. Risk of frost is also increased by radiation diurnal cooling in broad valleys throughout the region. Disked surfaces tend to be cold and raised surfaces warm; but on long slopes night frost settles at the bottom and top of the slopes, and the warm layer is sandwiched in between. Risk of frost injuries increases from east to west and the eastern slopes of the Rockies have the greatest instability of temperature.

In reforestation, frost risk areas should be designated for wild-life use rather than timber because of stand openings and successions of herbaceous ground cover suitable for grazing. Such designations may be permanent, or temporary if a complete canopy cover is established. But trees with deformed crowns make a useful habitat for larger nesting birds rather than timber for fiber use.

Low temperature damage may have some impact on redirection of disease appraisal, research on regeneration by natural or artificial means, and on some of the cultural practices such as hardening-off of seedlings, pruning, thinning and selection of adaptable species.

9. Study Objectives:

a. To assess variability of hardiness of poplar to frost canker and dieback for clones under field conditions.

b. To provide advisory services to outside agencies on establishment and maintenance of planted poplars.

c. To compile manuscript on role of winter injury and process of dieback and target canker formation.

d. To study similar dieback and canker condition in other hardwoods and in conifers affected by low temperature damage under natural and artificial conditions.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: 1973 Revised: 1975.
c. Estimated total Prof. man-years required: 3
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1974-75 man-years Prof. 1.0

11. Progress to Date:

Frost damage in woody stems results in a dual phenomenon that of killing areas of the cambium and of stimulating the uninjured cambium to produce chimeral tissues or burl. The oblique and whorled arrangement of these tissues, their disorientation from the longitudinal-radial arrangement of normal woody tissues, and their darker color characterizes the morphological features of chimeral bark and sapwood. The darker color is due to the gummy and resiniferous ray tissues most of which die and form a continuous overlay in the phloem and a continuous underlay in the sapwood. Burl sapwood is mostly cross-grained except for the upper part of the growth ring which may be straight grained. The phloem overlay of ray tissues in conifer and hardwood species investigated is also provided with a covering or pseudocork.

The pseudocork has several layers of cells devoid of cell contents, the upper cells having dentate thick walls and recurvate lobes, and the lower layers of cells having angular thin walls. The rays within the phloem and sapwood contain two-cell types, regardless of the species. The dead sclereid-like cells are empty and have thick netted walls and the living cells are isodiametric and often have tube-like structures protruding from the walls.

In cell deformities, hyperplasia and hypoplasia of sapwood tissues, the somatic deviations induced by low temperature are very similar to that induced by the fungi, *Keissleriella* and *Rhytidiella*. However, these fungi do not induce an underlay of ray tissues in the sapwood and the rays within differ only in the structure of the sclereid-like cell which does not have a netted wall. The fiber tracheids in poplar occur less frequently in low temperature-induced than in fungus-induced chimeral sapwood. They appear, as in most chimeral tissues of hardwoods, more like the vascular tracheids with distinct pits but with or without rounded ends.

During cell division, chimeral meristim becomes somatically distinct from the normal diploid cambial daughter cells by heteroploidy and fragmentation of chromosomes. Differentiated cells are distinct also due to changes in size and shape, in the presence of composite structures and in the arrangement and position of perforations in vessels. The composite structures are due to failure of cell plate formation during cell division.

12. Goals for 1974-75:

1. To obtain pathognomic data on reconstruction of cambium, phloem and xylem of field treated trees in clearcut areas held by North Western Pulp and Power Ltd. and after treatments in the spring and fall of 1973.

2. To determine duration and time of season when occlusion wood is formed. To be continued.

3. To complete construction of an electronic cell and to determine the rate of loss and thermal diffusion from tissues adjacent to the target freezing area in the stem.

4. To evaluate multinucleation and cellular aberration during the production and development of burl hyper- and hypoplastic tissues.

5. To complete the following manuscripts for journal publication:

   Zalasky, H. Low temperature induced cankers and burls in test conifers and hardwoods. Can. J. Botany.

   Zalasky, H. Cell and tissue deformities in burl and canker induced experimentally by low temperature. Can. J. Botany.

   Zalasky, H. Septoria canker and leaf spot in test seedlings of native species of poplar. Can. J. Botany.

   Zalasky, H. Frost damage in poplar. Forestry Chron.

   Zalasky, H. Structure of burl tissues in frost canker of poplar. Can. J. Botany.

   Zalasky, H. Hyperplastic and hypoplastic tussues evaluated by aberration and diversity in nucleation and cell groupings. Can. J. Botany.

   Zalasky, H. Structural malformation in woody tissues of *Malus* following experimental frost injury. Plant Sci.

   Zalasky, H. Frost injury in Caragana. Plant Sci.

13. Accomplishments in 1974-75:

Goals 1 and 2 were not fully realized because technical support was reassigned to another project. The material was photographed in the field but no further technical work was undertaken.

Goal 3. The construction of an electronic cell or the purchase of such equipment as an alternative was abandoned because of insufficient funding and technical help.

Goal 4. The study of mitotic chromosome changes, multinucleation, hyperplasia and hypoplasia in low-temperature induced chimeral tissues has been completed in pine and poplar.

Goal 5. Papers submitted to the Can. J. Botany:

Zalasky, H. Low temperature induced cankers and burls in test conifers and hardwood.

Zalasky, H. Structure of burl tissues in frost canker of poplars.

Zalasky, H. Hyperplastic and hypoplastic tissues evaluated by aberration and diversity in nucleation and cell groupings. (Manuscript revised and resubmitted).

Zalasky, H. Cell and tissue deformities in burls and cankers induced experimentally by low temperature. (Under revision and resubmission).

Manuscripts with the author and in different stages of preparation or review:

Zalasky, H. Septoria canker and leaf spot in test seedlings of poplar. Can. J. Botany.

Zalasky, H. Frost damage in poplar. Forestry Chron.

Zalasky, H. Structural malformation in woody tissues of *Malus* following experimental frost injury. Plant Sci.

Zalasky, H. Frost injury in caragana. Plant Sci.

14. Goals for 1975-76:

1. Compile data and prepare manuscripts on abscission tissues in twigs affected by early autumn frost and on structure of sapwood rust gall.

2. Complete manuscripts of Goal 5 (1974-75) for journal publication.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Harry Zalasky
Investigator

Ben Reid
Program Manager

GSilver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Reduction of damage from disease causing agencies.

2. Title: A bark disease of poplar.

3. New: Cont.: X 4. No.: NOR 069

5. Study Leader: H. Zalasky

6. Key Words: *Populus balsamifera, Rhytidiella moriformis, Phaeoseptoria, Caliciopsis, Amphisphaeria.*

7. Location of Work:

8. Problem:

All stages of rough-bark disease of *Populus balsamifera* was discovered in 1964-65 in Saskatchewan and Manitoba. Pure stands of the fungus in infected bark simplified isolation. A project was formalized after the first initial pathogenicity test was successful. Pathogenicity and life cycle studies proved to be promising enough to include the fungus in tests for resistant host as a next step in research and development initiated at Winnipeg prior to 1969. However, closure of the laboratory prompted abandonment of the progeny testing programme in poplar under project leader Dr. K. Roller.

9. Study Objectives:

   a. To provide knowledge on pathogenicity, tree damage symptomatology, and cultural characteristics of *R. moriformis*.

   b. To determine various aspects of the life history and host-parasite relationship, nutritional and physiological requirements; to describe the fungus and its related species.

   c. To provide advisory services to outside agencies on establishment and maintenance of planted poplars.

10. Resources:

    a. Starting date: 1965
    b. Estimated year of completion: 1969 Revised 1971
       Revised 1974
    c. Estimated total Prof. man-years required: Nil
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years Prof. Nil
       Supp. Nil
       Casual Nil

11. Progress to Date:

Two reports were prepared in 1974, one dealing with cell deformities and chimeral tissues induced by *Rhytidiella moriformis* and one dealing with a new species of *Rhytidiella* which was described.

Rhytidiella moriformis and *Keissleriella emergens* infections in bark of balsam poplar stimulate the cambium to produce hyperplastic and hypoplastic deformed xylem, each group consisting of variable combinations of tracheids, vessel elements and wood parenchyma. Deformities were accompanied by composite cell structures, rapid aging of thick-walled ray cells, and lateral perforations in vessel elements. Morphogenetically, host tissues are chimeral as evidenced by stunting, incomplete cell-plate formation, hyperplasia and hypoplasia. *Rhytidiella baranyayi*, a new species, was found in cork bark of aspen, a disease confined to localized areas of the stem. The fungus occurs in the interior mainland of British Columbia.

12. Goals for 1974-75:

Complete histological investigation on pathogenicity and complete preparation of manuscript.

Zalasky, H. Histology of host-parasite relationship of *Rhytidiella moriformis* infection in poplar bark.

Additional goal for 1974-75

Coauthor and describe new species of *Rhytidiella* suspected of causing cork bark or aspen

13. Accomplishments in 1974-75:

1. Zalasky, H. Cell deformities in bark and sapwood caused by *Rhytidiella moriformis* and *Keissleriella emergens* infections in poplar. Can. J. Botany. In Press.

2. Funk, A. and Zalasky, H. *Rhytidiella baranyayi* n. sp., associated with cork bark of aspen. Can. J. Botany. In Press.

3. Goals completed and study terminated.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Harry Zalasky
Investigator

R. Reid
Program Manager

G. T. Silver
Director G. T. Silver

PROJECT NOR - 9

Reduction of Damage from Insects

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1975

1. Project: Reduction of damage from insects.

2. Title: Impact, biology and control of the spruce budworm in Alberta and Northwest Territories.

3. New: Cont.: X 4. No.: NOR 023

5. Study Leader: H. F. Cerezke

6. Key Words: *Choristoneura fumiferana, C. biennis, Picea glauca,* sample, defoliation, clearcutting, regeneration, pheromone.

7. Location of Work: Edmonton

8. Problem:

The recent large-scale outbreak of the spruce budworm in the prairie provinces, Yukon and NWT peaked in 1967-68 and declined over large areas in 1969-70. Smaller infestations have persisted since. Most infestations occurred in commercial mature-overmature white spruce stands along major river drainages and in several park and recreational areas. Defoliating damage during the outbreaks resulted in tree mortality, growth losses, dead tree tops, increased fire hazard and decreased aesthetic appearance, and caused concern to several agencies. In response to these, research efforts have been directed toward improving monitoring techniques, assessing hazard and examining control strategy.

9. Study Objectives:

a. Determine the biology and hazard of the budworm in northern spruce forests and suitable techniques for estimating its abundance.

b. Determine the formulation of control measures when required.

10. Resources:

a. Starting date: 1968
b. Estimated year of completion: Field studies completed 1974; new requests transferred to NOR-143 (973).
c. Estimated total Prof. man-years required: 0.2
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.2	
Supp.		
Casual		
Total	0.2	O & M funds req'd.

11. Progress to Date:

Budworm infestations have been monitored in northern Alberta annually since 1968; outbreaks have persisted in the Athabasca and Footner Lake Forests. Information on these outbreaks has been conveyed to AFS who have maintained an active interest.

Analyses of 360, 46 cm (18-inch) branch tips from non-infested spruce trees have been completed for describing several characteristics related to budworm sampling and damage assessment. Data were compiled on the pattern of tree-top killing in spruce forests and on radial increment patterns of budworm-injured and uninjured trees.

Biological information on budworm life history, behavior, survival and development in relation to host phenology and temperature has been gathered from field plots established near High Level and Ft. McMurray.

Several sampling techniques to monitor the spruce budworm have been applied, including branch sampling with pole pruners, tree felling, tree climbing and by moth trapping with virgin females and synthetic sex attractant. The sex attractant was field tested in a variety of spruce forests near High Level, Ft. McMurray and Kootenay National Park, and found to work well with populations of *C. fumiferana* and *C. biennis* in Alberta.

Preliminary studies were made to determine general defoliation patterns within tree crowns of different stand character in order to follow cumulative changes with outbreak development and with respect to timber harvest operations; these studies are incomplete. Field plots were established by planting seedlings on clearcut sites to examine dispersal and subsequent damage by budworm larvae originating from adjacent mature timber.

Laboratory studies have examined rearing techniques and of early larval feeding damage to buds of greenhouse-grown spruce seedlings.

12. Goals for 1974-75:

No field studies are planned but time is required to complete the reporting of research results. Three reports are proposed to summarize most of the publishable material related to Objective (1). Approximate titles of proposed Indormation Reports are as follows:

1. Analysis of foliage patterns in white spruce crowns as a basis for sampling spruce budworm populations and its damage.

2. Sex attractant trap tests of *Choristoneura fumiferana* in Alberta and their potential as a survey tool in northern spruce forests.

3. Spruce budworm development in northern Alberta in relation to spruce phenology and heat units.

Goals added in 1974-75:

4. Examine timber lease areas in Footner Lake and Athabasca Forests and provide Alberta Forest Service with an assessment of budworm damage and hazard for their use in management.

13. Accomplishments in 1974-75:

1. A report was prepared which summarizes data on foliage characters in white spruce crowns and recorded as follows:
"Studies of white spruce foliage and growth patterns, and spruce budworm damage in northern Alberta". File Report NOR-023, 24 pp. After initial review, information in this file report on damage impact was extracted and expanded into a second report as follows, and reviewed locally as Information Report:
"Spruce budworm impact studies in spruce forests of northern Alberta", 15 pp.

2, 3. No progress made toward these goals because of commitments of Goal #4 and expanded duties in NOR-143 (973).

4. At the request of Alberta Forest Service, two budworm infestations in timber lease areas in Northern Alberta were examined. In the first, assistance was provided to AFS personnel for on site recognition of spruce budworm and its damage, and for incorporating budworm damage defects into an inventory cruise. In the second area, a field trip was made to examine the condition of infested trees in residual blocks of timber. Foliage samples were reared to obtain an index of the overwintering population and wood discs were examined for growth deterioration. A brief file report is in preparation to serve AFS in their review of management plans for the lease area.

14. Goals for 1975-76:

1. Complete the proposed Information Report: "Spruce budworm impact studies in spruce forests of northern Alberta".

2. Prepare a file report on the "Sex attractant trap tests of *Choristoneura fumiferana* in northern spruce forests of Alberta".

3. Prepare a report for Bi-Monthly Res. Notes on "Spruce budworm development in northern Alberta in relation to spruce phenology and heat units".

4. Terminate this Study and handle all new enquiries on spruce budworm under Study NOR-143 (973).

15. Publications:

Up to 1974-75

1. Cerezke, H. F. 1971. Spruce budworm. Forestry Report, Environment Canada, Edmonton 1(4):7

2. Sanders, C. J., G. R. Daterman, R. F. Shepherd and H. F. Cerezke. 1974. Sex attractants for two species of western spruce budworm, *Choristoneura biennis* and *C. viridis* (Lepidoptera: Tortricidae). Can. Ent. 106:157-159.

16. Signatures:

Herbert F. Cerezke
Investigator

Ron Reid
Program Manager

Gitsilver
Director

NOR 024

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1975

1. Project: Reduction of damage from insects.

2. Title: Biology and control of Warren's root collar weevil.

3. New: Cont.: X 4. No.: NOR 024

5. Study Leader: H. F. Cerezke

6. Key Words: *Hylobius warreni*, *Pinus contorta* var. *latifolia*, regeneration, growth reduction, stand treatments, B19, sampling.

7. Location of Work: Alberta foothills, Edmonton

8. Problem:

   H. warreni is trans-Canadian in distribution, occurs in most native spruce and pine forests in the Prairie provinces and southern NWT, and is abundant on high productivity sites of lodgepole pine along the Alberta foothills and in moist sites of white spruce and jack pine in central Saskatchewan and western Manitoba. Healthy trees are attacked when a few years old and until mature. Girdling damage by larvae causes death of trees and growth losses, which may cumulate during life of tree. Damage has been most severe (up to 63% mortality) in plantation-type situations, indicating this insect to be a potential economic pest during at least the first 30 years after seeding and planting.

9. Study Objectives:

   Broad objective is to obtain information to make concrete recommendations for weevil control. Specific objectives are:

   a. To determine the subsequent population changes and damage patterns of the weevil in young pine stand subjected to thinning.

   b. Determine experimentally the relationship between amount of girdling and its effects on tree growth.

10. Resources:

a. Starting date: 1960
b. Estimated year of completion: 1975
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. 0.2
Supp.
Casual
Total 0.2 O & M funds req'd:

11. Progress to Date:

Considerable background knowledge on the biology of *H. warreni* and its damage in lodgepole pine stands in Alberta has been accumulated from 1961 to 1972. Information was obtained on the geographical distribution of *H. warreni*, its life cycle development in the Alberta foothills, on sampling and collecting techniques and identification of some mortality factors. Data were obtained on the behaviour patterns of adults in relation to mating, egg-laying, feeding, dispersion and daily and seasonal activity. Populations were studied in several different forest conditions and patterns of attack on the host were determined, history of attacks and relationships between weevil numbers and several forest parameters such as tree age and size, stand density and depth of duff material. Populations were followed over a five-year period in a pulp-cutting area to determine survival of the weevil in cut stumps and to evaluate clearcutting as a method of control. Studies were made of girdling effects on trees having 50% of the root-collar circumference girdled by larvae, and of changes in the resin duct system. A study, completed in 1972, examined growth losses on pine girdled various amounts around the root-collar circumference to simulate weevil feeding injury. Two fifth-acre plots, thinned in 1967, were re-examined for weevil populations and damage in 1969, 1971, and 1973. A thesis, several reports and publications summarize much of these data.

A survey of weevil abundance and damage was made in five pine regeneration sites established on clearcuts. Two of the sites had respectively 10% and 23% tree mortality from weevil girdling. Tree damage was most prevalent on rich growing sites of low density stocking, suggesting that the weevil is not an important thinning agent in densely stocked stands.

12. Goals for 1974-75:

1. Undertake field studies to assist in locating pine regeneration plots and assisting pre- and post-treatment examinations of trees chemically treated for weevil control by Drouin and Kusch (NOR 132).

2. Re-tag thinned plots for upkeep of trees is necessary if thinned-plot study to be continued.

   Prepare first drafts of 3 and 4 as follows:

3. "The spacial and temporal patterns of distribution of the weevil, *Hylobius warreni* Wood, in lodgepole pine stands in Alberta" Proposed Journal publication.

4. "Behaviour patterns of *Hylobius warreni* Wood in relation to mating, egg-laying, feeding, dispersion and daily and seasonal activity" Proposed Journal publication.

5. Work toward publishing: Cerezke, H. F. Effects of partial girdling on growth in lodgepole pine with application to damage by the weevil *Hylobius warreni* Wood. Submitted as journal paper to Can. J. For. Res.

6. Commence preparation of Information Rpt. or Pest Leaflet on *H. warreni* in Prairie Provinces aimed at Management Agencies (suggested 4 - 8 pp).

13. <u>Accomplishments in 1974-75</u>:

1. Assistance was provided in locating field plots for chemical control tests under NOR-132 and in establishing larval populations.

2, 3, 4 and 6. No progress made due to insufficient time and expanded duties under NOR-143 (973).

5. Completed

   Cerezke, H. F. 1974. Effects of partial girdling on growth in lodgepole pine with application to damage by the weevil *Hylobius warreni* Wood. Can. J. For. Res. 4:312-320.

14. <u>Goals for 1975-76</u>:

1. Resample thinned plots in 1975 for measurement of weevil populations and accumulated damage history since 1967. This will conclude field work on this Study.

2. Complete preparation of the proposed journal publication: "The spatial and temporal patterns of distribution of the weevil, *Hylobius warreni* Wood in lodgepole pine stands in Alberta".

3. Prepare first draft copies if time permits of:

   (a) "Behavior patterns of *Hylobius warreni* Wood in relation to mating, egg laying, feeding, dispersion and daily and seasonal activity". (Proposed Journal publ.).

(b) Technical Report on *H. warreni* in the prairie provinces aimed at forest management agencies.

4. Terminate this study and handle all future requests on *H. warreni* under NOR-143 (973).

15. Publications:

Up to 1974-75:

Cerezke, H. F. 1967. A method for rearing the root weevil, *Hylobius warreni* (Coleoptera: Curculionidae). Can. Ent. 99:1087-1090.

Cerezke, H. F. 1969. The distribution and abundance of the root weevil, *Hylobius warreni* Wood in relation to lodgepole pine stand conditions in Alberta. Ph.D. thesis, University of British Columbia, xvii + pp. 221.

Cerezke, H. F. 1970. A method for estimating abundance of the weevil, *Hylobius warreni* Wood, and its damage in lodgepole pine stands. For. Chron. 46:392-396.

Cerezke, H. F. 1970. Biology and control of Warren's collar weevil, *Hylobius warreni* Wood, in Alberta. Internal Report A-27. pp. 28.

Cerezke, H. F. 1970. Survey report of the weevil, *Hylobius warreni* Wood, in the foothills of Alberta. Internal Report A-38. pp. 40.

Cerezke, H. F. 1972. Effects of weevil feeding on resin duct density and radial increment in lodgepole pine. Can. J. For. Res. 2:11-15.

Cerezke, H. F. 1973. Some parasites and predators of *Hylobius warreni* in Alberta. Bi-monthly Res. Notes 29:24-25.

Cerezke, H. F. 1973. Survival of the weevil, *Hylobius warreni* Wood, in lodgepole pine stumps. Can. J. For. Res. 3:367-372.

Cerezke, H. F. 1973. Bark thickness and bark resin cavities on young lodgepole pine in relation to *Hylobius warreni* Wood (Coleoptera:Curculionidae) Can. J. For. Res. 3:599-601.

Cerezke, H. F. and V. Hildahl. 1973. Insect and rodent damage associate with regeneration. Forestry Report 3(2):2-3.

Cerezke, H. F. 1974. Effects of partial girdling on growth in lodgepole pine with application to damage by the weevil *Hylobius warreni* Wood. Can. J. For. Res. 4:312-320.

16. Signatures:

Herbert F. Cerezke
Investigator

Ren Reid
Program Manager

GStelter
Director

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1975

1. Project: Reduction of damage from insects.

2. Title: Biology, impact and control of woodborers.

3. New: Cont.: X 4. No.: NOR 025

5. Study Leader: H. F. Cerezke

6. Key Words: Cerambycidae, *Monochamus*, *Tetropium*, white spruce, pine, sampling.

7. Location of Work: Entire Region and Edmonton.

8. Problem:

Requests are received annually from industry and provincial forestry personnel for information on hazard, expected damage, life history, identification and methods of control of woodborers attacking freshly-cut and fire-killed timber, and insect material found in finished wood products. Most of these requests are handled by telephone, letter or short personal visit. However, special surveys are required from time to time such as in examining fire-killed timber for hazard and salvage logging or examining log decks to establish effectiveness of chemical spray treatment.

9. Study Objectives:

   a. Develop new or improve existing sampling systems for estimating numbers of woodborers in logs of different dimension, species and for fire-killed, blowdown and freshly-cut trees decked and undecked.

   b. Investigate complaints of clients and make recommendations for control of woodborers where possible.

10. Resources:

    a. Starting date: 1967 by A. Raske and T. Szabo
       1970 by H. F. Cerezke
    b. Estimated year of completion: 1975
    c. Estimated total Prof. man-years required:
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years Prof.
       Supp.
       Casual ___
       Total O & M funds req'd:

11. Progress to Date:

The following summarizes progress by Raske.

Ecological and biological studies of *Monochamus* spp. and *Tetropium* spp. in Alberta were made. Other cerambycid and buprestid species were studied to a limited extent from pine and spruce logs; identifications of these were made.

A larval rearing program of woodborer species was undertaken with Dr. Gardiner of Sault Ste. Marie to establish species identity in larval stages. Hybridization studies were conducted with crosses of *Monochamus oregonensis* and *M. scutellatus* to establish their taxonomic relationships. The identification of chromosome pairs was assisted by Dr. G. Lanier.

Pine and spruce logs have been sampled in various parts of Alberta to establish densities of woodborers in decked and undecked logs, and in relation to position on log and position within decks. From the pine log data a sequential sampling plan was developed, with input by L. Safranyik, for estimating the degree of *Monochamus* infestations. Infested logs were sawn and the lumber product graded to establish a relationship between *Monochamus* damage intensity and percentage value-loss.

The effect of time-of-year of log felling was studied in relation to attack density of *Monochamus*. The study suggested that logs cut in the fall and early winter were least attractive to *Monochamus* during the following summer while logs felled during late winter, spring and summer were most attractive.

Preliminary tests of the chemical PDB (Para-dichloro benzene) were made on small experimental log decks. Results of these tests for control of woodborer larvae were promising.

Several reports and publications summarize most of these date; see list under item #15.

Studies by Cerezke examined white spruce logs for development, survival, attack density, damage characteristics and adult size of *Monochamus scutellatus*. These studies are completed and the data have been analyzed.

Information on woodborer damage and hazard was provided to several agencies, including an assessment of woodborer hazard in fire-killed timber (see file report NOR-Y-25, 1972).

12. Goals for 1974-75:

1. Complete pest leaflet of: "Biology, damage and control of the white-spotted sawyer beetle in logs".

2. Prepare proposed Journal paper as follows: "Population and damage relationships of *Monochamus scutellatus* in tree-length white spruce logs in northern Alberta". Suggested for Can. Ent. or Can. J. For. Res.

13. Accomplishments in 1974-75:

1. Final draft and approval completed on Technical Report: Cerezke, H. F. 1975. White-spotted sawyer beetle in logs. (NOR-X-129), 8 pp.

2. First draft of proposed journal paper almost complete for: Cerezke, H. F. Population and damage relationships of *Monochamus scutellatus* in tree-length white spruce logs in northern Alberta.

3. Survey of woodborers made in fire-killed timber in the Swan Hills at request of Alberta Forest Service and Simpson Timber Co. File Report prepared for their use as follows: Cerezke, H. F. 1974. Survey of the woodborer, *Monochamus scutellatus* in fire-killed timber in the "Judy Creek Burn", Whitecourt Forest, 9 pp.

4. Several additional queries on woodborer problems handled by telephone and letter.

14. Goals for 1975-76:

1. Terminate this study and transfer all remaining work and future queries on woodborers to NOR-143 (973).

15. Publications:

Published and Unpublished Reports:

Safranyik, L. and A. G. Raske. 1970. Sequential sampling plan for larvae of *Monochamus* in lodgepole pine logs. Journ. Econ. Ent. 63:1903-1906.

Lanier, G. N. and A. G. Raske. 1970. Multiple sex chromosomes and configuration polymorphism in the *Monochamus scutellatusoregonensis* complex (Coleoptera:Cerambycidae) Can. J. Genet. Cytol. 12:947-951.

Dahl, B. M. 1971. Mortality of *Monochamus* larvae in slash fires. Bi-Monthly Research Notes, 27:12.

Raske, A. G. 1973. *Tetropium parvulum* elevated to species rank and contrasted to *T. cinnamopterum* in morphology and host preference (Coleoptera:Cerambycidae). Can. Entomol. 105:745-755.

Raske, A. G. 1973. Notes on the biology of *Tetropium parvulum* (Coleoptera:Cerambycidae) in Alberta. Can. Entomol. 105:757-760.

Raske, A. G. 1973. Taxonomic relationship between *Monochamus scutellatus* and *M. oregonensis* (Coleoptera:Cerambycidae). Can. Entomol. 105:795-806.

Raske, A. G. 1973. Relationship between felling date and larval density of *Monochamus scutellatus*. Bi-Monthly Res. Notes 29:23-24.

Raske, A. G. 1969. Insect families common under bark in Alberta, annotated check list and keys. Internal Report A-24. pp. 60.

Raske, A. G. and L. Safranyik. 1970. Sequential sampling plan for determining infestation and damage levels of *Monochamus* (Coleoptera:Cerambycidae) woodborers in decked lodgepole pine logs in Alberta. Internal Report A-26. pp. 12.

Raske, A. G. 1972. Biology and control of *Monochamus* and *Tetropium*, the economic woodborers of Alberta (Coleoptera:Cerambycidae) Internal Report NOR-9. pp. 48.

Cerezke, H. F. and F. J. Emond. 1972. An assessment of woodborer hazard in merchantable timber after the 1972 "Martin Hills Burn", Slave Lake Forest, Alberta. File report NOR-Y-25. pp. 6.

Cerezke, H. F. 1973. Results of an examination of cut pine and spruce logs for woodborer damage in the Swan Hills. pp. 3.

Cerezke, H. F. 1974. Survey of the woodborer, *Monochamus scutellatus* in fire-killed timber in the 'Judy Creek Burn', Whitecourt Forest. File Report, 10 pp.

Cerezke, H. F. 1975. White-spotted sawyer beetle in logs. Information Report NOR-X-129, 8 pp.

16. Signatures:

Hubert F Cerezke
Investigator

Ren Reid
Program Manager

G.T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 20, 1975

1. Project: Reduction of damage from insects.

2. Title: Larch sawfly biological control.

3. New: Cont.: X No.: NOR 061

5. Study Leader: J. A. Muldrew

6. Key Words: *Pristiphora erichsonii, Olesicampe benefactor, Mesoleius tenthredinis, Mesochorus dimidiatus,* parasites, encapsulation, hyperparasites, *Larix,* Boreal Region "B".

7. Location of Work: Throughout Northern Forest Region.

8. Problem:

This study is an attempt to control the larch sawfly by the introduction of exotic biotic natural enemies. Tamarack is the fastest growing conifer in the Boreal forest. If protection from the larch sawfly could be obtained there would undoubtedly be an increased use of tamarack for pulpwood, sawtimber, piling, poles, ties, veneer, etc., and its use in forest plantings would increase. Moreover, with sawfly control, *Larix* spp. would be used more frequently in park, boulevard and home-ground ornamental plantings. The benefits from success would be reduced mortality of tamarack and appreciable increases in the total incremental growth of tamarack and western larch. The increased vigor of tamarack would allow it to better fulfill its role in the ecology of the forest as a pioneer species invading areas not previously occupied by trees.

The project is a success to date in that host populations have been reduced to a low level in the areas where the parasite has been present for five or more years.

Because of the success in Manitoba, releases of *O. benefactor* have been made in New Brunswick, Nova Scotia, Prince Edward Island, Maine and Minnesota and consideration is being given to making releases in British Columbia and in the larch plantations of southern Ontario.

9. Study Objectives:

   a. To achieve biological control of the larch sawfly.

   b. To contribute to the population dynamics study of the larch sawfly by determining the factors affecting parasite effectiveness, abundance and impact.

   c. To monitor the spread of *Olesicampe benefactor* from release points in Manitoba, Saskatchewan, Alberta and the Northwest Territories.

   d. To monitor the incidence of parasitism of *O. benefactor* by the hyperparasite *Mesochorus dimidiatus* Holmgren.

10. Resources:

   a. Starting date: 1950
   b. Estimated year of completion: 1975 Revised: 1976
   c. Estimated total Prof. man-years required: 1
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	1.0	(J. A. Muldrew)	
Supp.	0.6	(R. M. Smith)	
Casual			
Total	1.6		O & M funds req'd.:

11. Progress to Date:

The death of *Mesoleius tenthredinis* eggs in the resistant larch sawfly strain was found to be due to their encapsulation by host blood cells. The spread of the resistant strain from Manitoba almost to the limits of tamarack was monitored. A strain of *M. tenthredinis* from Bavaria was found to have a greater ability to avoid encapsulation in the resistant sawfly than had the "native" strain. Hybridization experiments showed this ability was transmitted as a dominant factor. Releases of this strain in Manitoba have resulted in lower levels of encapsulation and a progressively increasing percentage parasitism by *M. tenthredinis*. From 1961 to 1964, six species of parasites from overseas were released. One of these, *Olesicampe benefactor*, is well established. Parasites reared from hosts collected in Manitoba have been successfully relocated in Saskatchewan, New Brunswick, Nova Scotia and Maine. Where first released, parasitism reached a high level within three to four years and has remained high. Host densities have progressively decreased and life table data indicate that *O. benefactor* has played a key role in causing this. The parasite is dispersing well. Studies were completed on differentiating the smaller hosts parasitized by *O. benefactor* from the larger normal hosts. The hyperparasite *Mesochorus dimidiatus*, which attacks *O. benefactor* in Europe, was recovered from three release points in Manitoba. Studies in cooperation with the Entomology Research Institute, Ottawa, revealed that the hyperparasite had a holarctic distribution before *O. benefactor* was released in America.

In 1967, *O. benefactor* was recovered 1.7 miles north of the Pine Falls release point and 1.8 miles south. Corresponding figures for 1968 were 7.2 and 8.3 miles. In 1969 it was recovered about 45 miles from the release point and in 1970 had reached the Rennie life table plot, a distance of 65 miles. In 1971 a spectacular population explosion accompanied by long range dispersal was detected. The known distribution covered an egg-shaped area extending from Lake Winnipeg to Fort Frances and Ignace in Ontario, a maximum distance of about 225 miles from the point of release. The rates of parasitism averaged 90% for nearly half of the total area. In 1972 the parasite spread eastward and southward about 50 miles from the 1971 boundary. Parasitism by *O. benefactor* at the 1971 boundary increased from close to 0 in 1971 to about 50% in 1972. A marked decrease in larch sawfly populations occurred throughout eastern Manitoba and western Ontario in 1972 and 1973 and workers from the GLFRC were unable to collect sufficient larvae to determine dispersal in Ontario. Heavy sawfly infestations occurred near The Pas, Manitoba, both 9 miles north and 40 miles south of the 1968 release point but *O. benefactor* was not present in these although it was found to have attacked over 80% of the hosts in light infestations up to two miles from the release point.

At the Pine Falls release plot where larch sawfly density had been decreasing progressively from over 500,000 cocoons per acre in 1964, a low of 871 was reached in 1972. From 1969 to 1972 the rate of attack by *O. benefactor* dropped from 94% to 50% at Pine Falls, probably due to the increasing scarcity of larch sawflies and the effect of *Mesochorus dimidiatus* which reached a high attack rate against *O. benefactor*. No larch sawflies were found in sampling this plot in 1973.

Releases of *O. benefactor* were made in 1972 by placing out "small" larch sawfly cocoons and the estimates of parasites released were: Jarvie, Alberta - 1,139; Primrose Lake, Alberta - 1,283; Grovedale, Alberta - 469 and Hay River, Northwest Territories - 856. A release of 240 *O. benefactor* was made in a light sawfly population near Ellscott, Alberta, in 1973.

Parasitism by the Bavarian strain of *M. tenthredinis* in the Rennie plot decreased from a high level in 1970 to a low level in 1972 as *O. benefactor* moved in and increased to a high rate of attack, indicating that *M. tenthredinis* discriminates against hosts already attacked by *O. benefactor* as was found by workers in Europe.

12. Goals for 1974-75:

1. To find areas where collecting sawfly larvae parasitized by *O. benefactor* is practicable and to collect and rear to the cocoon stage up to 25,000 of such parasitized hosts to provide parasite material for release in Nova Scotia and British Columbia in 1975. This program contingent upon outside funding.

2. To complete publications, the tentative titles of which are:

    a. Dispersal of the introduced larch sawfly parasite, *Olesicampe benefactor* from the Pine Falls release point, 1966 to 1972.

    b. History and etiology of two major continental outbreaks of the larch sawfly in North America.

    c. Releases of *Olesicampe benefactor* in Alberta and the Northwest Territories in 1972 (Information Report).

3. Monitoring the 1972 release points in Alberta and the N.W.T. and the 1973 release near Ellscott for establishment of *O. benefactor* by collecting larvae both for rearing to the cocoon stage and for preservation for parasitism estimation by the clearing technique.

4. To monitor the dispersal of *O. benefactor* and *M. dimidiatus* in western Manitoba and Saskatchewan.

<u>Goals added in 1974-75</u>

5. To contribute to the monograph "Aerial control of forest insects in Canada", edited by M. L. Prebble, as senior author of the larch sawfly chapter.

13. <u>Accomplishments in 1974-75</u>:

1. A survey was carried out in Manitoba and western Ontario to determine if locations could be found where it would be feasible to make mass collections in 1975 to obtain parasites for release purposes in Nova Scotia and other areas in Canada. Three areas were found where collecting was practicable; near Elma, McMunn and South Junction in Manitoba. Rearing the collected larvae produced a total of 17,600 larch sawfly cocoons. Percentage parasitism by *O. benefactor* was 89, 58 and 82 respectively for the three locations. The value of the collections as a source of *O. benefactor*, however, was largely negated by high rates of attack on this parasite by the hyperparasite *Mesochorus dimidiatus*. Dissections of parasite larvae made when the rearing program was completed revealed attack rates by *M. dimidiatus* of 94%, 96% and 50% respectively. Rearing results of a random sample of 400 "small" cocoons drawn from the 10,000 on hand indicated an expected emergence of approximately 300 *O. benefactor* and 2,400 *Mesochorus dimidiatus*. Although parasitism by *M. dimidiatus* was relatively low at South Junction, dissection of collections from Ontario even more distant from the Pine Falls release point than this revealed high percentage attack by this species (e.g., Stratton - 89, Emo - 89, Fort Frances - 100).

   Numerous collections of sawfly larvae were made in an area extending east to Thunder Bay and north to Horseshoe Lake (70 miles north of Pickle Lake). Most of these samples await analysis but results to date indicate a marked decrease in the apparent rate of dispersal (estimated at 80 miles per year for 1970-1972). Possible explanations are: the great decrease in the number of adult *O. benefactor* available for long distance dispersal due to high rates of attack by *M. dimidiatus*, the low sawfly densities in the newly-invaded areas and the lack of the proper weather conditions required for long distance dispersal.

2. a) Completion of this paper awaits the examination of the remaining cleared larvae collected during the 1972 survey in Manitoba and Ontario and the analysis and incorporation of additional data (mainly parasitism estimates based on head capsule measurements) collected in the 1974 survey.

   b) A preliminary set of maps illustrating the 1940 to 1970 outbreak has been completed. The compilation and collation of extensive data pertaining to this outbreak and the one that began in 1880 is almost complete. When complete, the final maps will be drawn and the paper written. Work on this paper was postponed in 1974-75 awaiting the completion of publication 2 a) which was given priority so that it could be finished while the subject was topical.

   c) The data has been compiled and analyzed but writing the report was postponed awaiting completion of the publication described in 1 a) and possibly the obtaining of information on whether establishment resulted from all of these releases.

3. The release of 240 *Olesicampe benefactor* in a light population of larch sawfly near Ellscott, Alberta, in 1973 was successful; a parasitism of 14% being obtained for a sample of 200 larch sawflies collected near the release point in 1974.

4. Near the 1968 release point at The Pas, Manitoba, high rates of attack by *O. benefactor* were found in locations up to 10 miles from the release point with no evidence yet of attack by *M. dimidiatus*. Sawfly populations were low in these locations but were very high (100% defoliation) in "The Bog" about 45 miles south of The Pas, but here no evidence of the presence of *O. benefactor* has as yet been obtained.

5. The larch sawfly chapter for the monograph "Aerial control of forest insects in Canada", edited by M. L. Prebble, was completed and the paper has been accepted for publication.

14. <u>Goals for 1975-76</u>:

   1. To complete publications, the tentative titles of which are:

      a. Dispersal of the introduced larch sawfly parasite, *Olesicampe benefactor* from the Pine Falls release point, 1966 to 1974.

b. History and etiology of two major continental outbreaks of the larch sawfly in North America.

2. a) To monitor the 1972 release points in Alberta and the N.W.T. and the 1973 release near Ellscott for establishment of *O. benefactor* by collecting larvae both for rearing to the cocoon stage and for preservation for parasitism estimation by the clearing technique.

   b) To report on the release program for *O. benefactor* in Alberta and the N.W.T. as the results warrant.

3. To monitor the dispersal of *O. benefactor* and *M. dimidiatus* in western Manitoba and Saskatchewan.

15. Publications:

Up to 1974-75

Muldrew, J. A. 1950. *Mesoleius aulicus*, a parasite of the larch sawfly. Bi-Mon. Prog. Rept., Can. Dept. Agric. 6(6):2.

Muldrew, J. A. 1953. The natural immunity of the larch sawfly (*Pristiphora erichsonii* (Htg.)) to the introduced parasite (*Mesoleius tenthredinis* Morley), in Manitoba and Saskatchewan. Can. J. Zool. 31:313-332.

Muldrew, J. A. 1955. Parasites and insect predators of the larch sawfly. Can. Ent. 87:117-120.

Muldrew, J. A. 1956. Some problems in the protection of tamarack against the larch sawfly, *Pristiphora erichsonii* (Htg.) For. Chron. 32:20-29.

Muldrew, J. A. 1964. Liberation of Bavarian *Mesoleius tenthredinis* (Morl.) against the larch sawfly. Bi-Mon. Prog. Rept., Can. Dept. For. 20(2):2-3.

Turnock, W. J. and J. A. Muldrew. 1964. Liberations of additional species of parasites against the larch sawfly. Bi-Mon. Prog. Rept., Can. Dept. For. 20(2):3.

Muldrew, J. A. 1964. The biological control program against the larch sawfly. Proc. Ent. Soc. Man. 20:63.

Muldrew, J. A. 1965. The biological control program against the larch sawfly. Proc. North Cent. Br. Ent. Soc. Amer. 20:157.

Muldrew, J. A. 1967. Biology and initial dispersal of *Olesicampe (Holocremnus)* sp. nr. *nematorum* (Hymenoptera:Ichnenmonidae), a parasite of the larch sawfly recently established in Manitoba. Can. Ent. 99:312-321.

Elliott, K. R. and J. A. Muldrew. 1967. A knockdown metal cage for rearing larch sawfly larvae. Can. Ent. 99(3):321-323.

Hinks, J. D. and J. A. Muldrew. 1968. Clearing and staining insect larvae to detect internal parasites. Manitoba Ent. 2:81-84.

Turnock, W. J. and J. A. Muldrew. 1971 *Pristiphora erichsonii* (Hartig), larch sawfly (Hymenoptera:Tenthredinidae). In: Biological control programmes against insects and weeds in Canada 1959-1968. Commonw. Inst. Biol. Contr. Tech. Commun. 4 175-194.

Turnock, W. J. and J. A. Muldrew. 1971. Parasites. In: Toward Integrated Control. Proceedings of the Third Annual Northeastern Forest Insect Work Conference, New Haven, Connecticut. February 17-19, 1970. 59-87.

Turnock, W. J. and J. A. Muldrew. 1973. Characteristics of *Bessa harveyi* (Diptera:Tachinidae) suggesting the historic introduction of the larch sawfly to North America. Manitoba Ent. 6:49-53.

Muldrew, J. A. 1973. Larch Sawfly, a biological control success story. Forestry Report, Can. For. Serv., Edmonton 3(2):1-2.

Reports

Muldrew, J. A. 1953. Population studies on *Bessa harveyi* Bi-Mon. Prog. Rept., Dept. of Agric. 9(3):2.

Muldrew, J. A. 1959. Studies on the distribution and inheritance of the resistance of the larch sawfly to *Mesoleius tenthredinis* Morley. Interim Rept., For. Biol. Lab., Winnipeg. pp.52.

Turnock, W. J. and J. A. Muldrew. 1964. Biological control attempts against the larch sawfly, *Pristiphora erichsonii* (Htg.) in Manitoba, 1961-1963. Information Report, For. Ent. Lab., Winnipeg. pp.40.

Muldrew, J. A. and W. J. Turnock. 1965. Biological control attempts against the larch sawfly, *Pristiphora erichsonii* (Hartig), 1964. Interim Res. Rept., Forest Ent. Lab., Winnipeg. pp.35.

Muldrew, J. A. 1965. Biological control against the larch sawfly *Pristiphora erichsonii* (Htg.) in Canada. Interim Res. Rept., Forest Ent. Lab., Winnipeg. pp.73.

16. Signatures:

J. Muldrew
Investigator

R. Reid
Program Manager

G. T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 18, 1975

1. Project: Reduction of damage from insects.

2. Title: Natural control of the larch sawfly.

3. New: Cont.: X 4. No.: NOR 098

5. Study Leader: W.G.H. Ives

6. Key Words: *Pristiphora erichsonii*, *Larix*, population dynamics, ecosystem modelling, biological control.

7. Location of Work: Manitoba and Edmonton.

8. Problem:

Since 1940, defoliation by the larch sawfly has severely affected larch growth and survival throughout Canada. Because of these attacks, larger trees have died - younger trees have failed to produce normal growth. Unless methods of preventing larch sawfly attacks can be developed, large areas of land will continue to be unproductive and planting programmes utilizing larch for fibre production or aesthetic purposes cannot be encouraged.

The large body of data amassed since the study of larch sawfly population dynamics was started in 1956 has never been thoroughly analyzed. This study was established to undertake these analyses.

9. Study Objectives:

   a. To elucidate the population dynamics of the larch sawfly by exploring the ecological relationships between the insect and its environment.
   b. To expose possible methods of reducing the damage done by the larch sawfly.
   c. To determine the effects of sawfly defoliation of host stands.

10. Resources:

a. Starting date: 1966
b. Estimated year of completion: Indefinite Revised: 1976
c. Estimated total Prof. man-years required: 1.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. 0.2 (W.G.H. Ives)
Supp. 0.4 (R. M. Smith)
Casual ___
Total 0.6 O & M funds req'd:

11. Progress to Date:

The major effort within this project has been in planning and directing the implementation of projects designed to develop and test sampling techniques, to determine the relationships between variables in the system, and to apply existing analytical procedures to the population data. Comprehensive syntheses have been delayed because the sawfly populations were declining throughout most of the history of the project. A minor peak of populations occurred in the years 1965-1968 and the data now cover an almost complete gradation.

Sampling procedures have been thoroughly reviewed. Essential data for studying the impact of *Olesicampe benefactor*, *Mesochorus dimidiatus* and the Bavarian strain of *Mesoleius tenthredinis* can be collected with less staff than previously utilized by eliminating time-consuming or specialized sampling procedures. The first category has been dictated by cuts in student support, the latter by loss of key personnel.

Flow charts have been prepared outlining procedures to be followed for calculating the proportions falling into various categories for data collected on larvae at three periods in the life cycle: 1. feeding larvae; 2. falling larvae; and 3. larvae in cocoons. These data sources provide a comprehensive set of estimates of the various parameters and require approximately 300 different estimates to give all possible combinations of factors. Summaries of mortality and survival based on samples of feeding larvae, falling larvae and larvae in cocoons have been prepared. Data on adult populations have been coded and have been sent to Biometrics Research Services for key punching.

Populations were listed in a simplified life table format, and subjected to Varley-Gradwell key factor analyses to determine which stages were related to total generation mortality. The key factor (or factors) apparently operated in the cocoon plus adult period (the two were combined), since the K values for this period showed a close relationship to the total K. A breakdown of mortality during the cocoon plus adult period showed that two factors had a large amount of variation. These factors were small mammal predation and the effects of adverse moisture during larval drop and late summer after the cocoons were spun in the moss or duff. When these two factors, which seemed to be complementary, were added together they appeared to be the key factor.

Population data for three plots (Pine Falls, Rennie and Seddon's Corner) were collected for the complete 1972 generation of the larch sawfly, thus adding to the amount of data available for analysis.

12. Goals for 1974-75:

    1. Continue analyses of existing data on larch sawfly populations.

    2. If these analyses proceed favorably prepare a paper summarizing the results. A tentative title is "The dynamics of larch sawfly populations (Hymenoptera:Tenthredinidae)"

13. Accomplishments in 1974-75:

    1. Analyses of existing data on larch sawfly populations were completed.

    2. A manuscript entitled "The Dynamics of Larch Sawfly Populations in Southeastern Manitoba" was prepared and is currently under review.

    Accomplishments not in goals for 1974-75:

    Available sawfly population data and related information were compiled into a file report for distribution to serious students of population dynamics who may wish to subject the data to additional analyses.

14. Goals for 1975-76:

    1. Complete the revision of the above manuscript and submit it for publication (probably as a Departmental Publication).

    2. Examine ancillary data on other invertebrates for possible inter-relationships. If any found, consider if results warrant publication.

15. Publications:

    Up to 1974-75

Anonymous. 1964. Larch Investigation Team of Winnipeg. Population dynamics of the larch sawfly. Can. Ent. 96:160-161.

Buckner, C. H. 1957. Population studies on small mammals of southeastern Manitoba. Jour. Mammal. 38:87-97.

Buckner, C. H. 1957. Home range of *Synaptomys cooperi*. J. Mammal. 38:132.

Buckner, C. H. 1958. Mammalian predators of the larch sawfly in eastern Manitoba. Proc. Tenth Internat. Congr. Ent. (1956) 4:353-361.

Buckner, C. H. 1959. Mortality of cocoons of the larch sawfly, *Pristiphora erichsonii* (Htg.) in relation to distance from small-mammal tunnels. Can. Ent. 91:535-542.

Buckner, C. H. 1959. The assessment of larch sawfly cocoon predation by small mammals. Can. Ent. 91:275-282.

Buckner, C. H. 1964. Metabolism, food capacity and feeding behaviour in four species of shrews. Can. J. Zool. 42:259-279.

Buckner, C. H. 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba. J. Mammal. 47:181-194.

Buckner, C. H. and W. J. Turnock. 1965. Avian predation on the larch sawfly *Pristiphora erichsonii* (Htg.) (Hymenoptera: Tenthredinidae). Ecology 46:223-236.

Heron, R. J. 1960. The relative effects of cocoon submergence on the mortality of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera : Tenthredinidae) and its parasite *Bessa harveyi* (Diptera: Tachinidae). Ann. Ent. Soc. Am. 53:476-481.

Heron, R. J. 1961. A note on temperature and postdiapause development of the larch sawfly and its parasite *Bessa harveyi* (Tnsd.). Can. Ent. 93:431-433.

Heron, R. J. 1966. The reproductive capacity of the larch sawfly and some factors of concern in its measurement. Can. Ent. 98:561-578.

Heron, R. J. 1967. Heat tolerance of last-instar larvae of the larch sawfly. Can. Ent. 99:1150-1156.

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16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 132

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1975

1. Project: Reduction of losses from insects.

2. Title: Controls for pests of shade, shelterbelts and ornamental trees and shrubs.

3. New: Cont.: X 4. No.: NOR 132

5. Study Leader: J. Drouin

6. Key Words: Efficacy, spraying, toxicology, pesticides, registrations, residuals, formulations.

7. Location of Work: Prairie Region.

8. Problem:

Insects and disease cause injury and/or mortality to ornamentals, shrubs and shade tree plantings. Economically these high cost plantings have amenity values greatly surpassing their forest counterparts resulting in more frequent requests to the Canadian Forestry Service concerning their condition. Frequently controls known to be safe and effective cannot be subscribed because they are not registered for the specific organism. All chemicals must be registered by Federal law, through Canadian Department of Agriculture, Ottawa.

Many chemicals (including microbials) are known to be effective and biologically safe but are registered for a very limited number of pests. In most instances there is a need to obtain additional field data before these chemicals can be recommended for use against other pests. The most important part of the study will involve gathering the necessary technical data to support Canadian registration of the successful candidate materials.

Resource managers in parks and recreation areas and citizens in both urban and farm locations expect the Canadian Forestry Service to provide information on the occurrence of pests, their damage potential and more importantly on effective, low cost, low hazard control measures that are non-damaging to the environment. An integrated approach by supplementing natural means with chemical or biological controls is not only warranted but essential.

This study serves as a vehicle for the expansion of work on pest problems under a single coordinating project. Studies anticipated to extend longer than three (3) years will not be initiated.

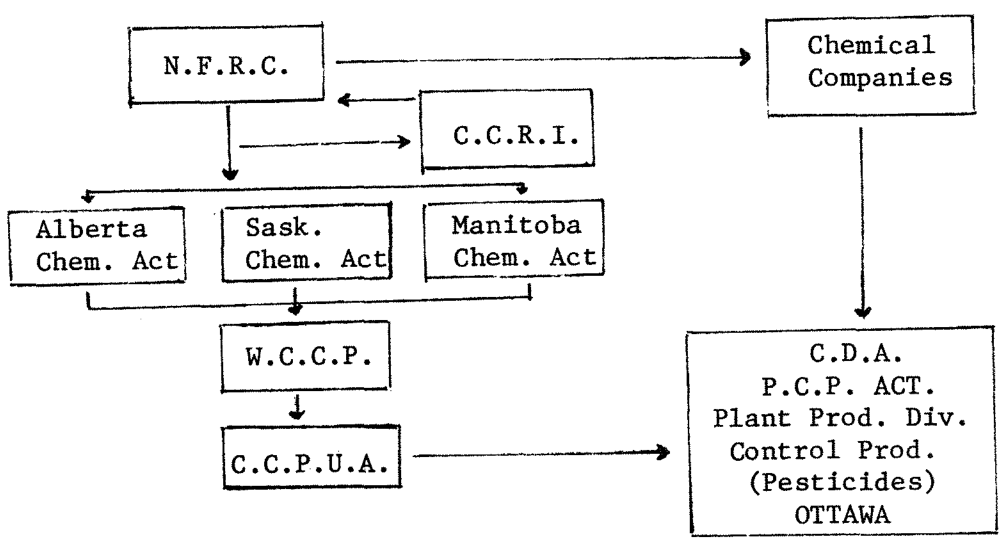
Where controls are not feasible, or economically or biologically justified, such will be reported and included in Canadian Forestry Service control recommendations to the chemical firms.

A shade and shelterbelt pest priority outline has been established and is subject to annual review to meet current demands. The target pests have been selected from those recommended by the Canadian Forestry Service field staff, the Western Committee on Crop Pesticides and as compiled by the Chemical Control Research Institute.

The programme initiated in 1972 was primarily spray applications with a mist blower and numerous soil drenches and bark paint evaluations. Field trials using these methods will continue in 1973, particularly in the soil drench and bark paint evaluation techniques using systemics (tests have proven very successful) as an effective, low hazard, (drift) low cost, (minimal equipment) control.

During 1973 field trials will also be expanded to the use of a newly designed, specialized high pressure, hydraulic ground sprayer unit with 4 interconnected 45 gallon stainless steel tanks enabling the operator to conduct multiple efficacy trails concurrently at one location.

A schematic of other organizations in relation to chemical controls of insects and diseases.



9. Study Objectives:

   1. To develop control methods for pest or disease problems using Chemical, microbial and/or integrated control methods.

   2. Efficacy trials for various dosages and formulations to determine percent mortality of target species and phytotoxicity.

   3. Provide data to aid registration recommendations for selected chemical products.

10. Resources:

   a. Starting date: 1972
   b. Estimated year of completion: 1974 Revised: 1978
   c. Estimated total Prof. man-years required: 0
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.		
Supp.	2.0	
Casual		
Total	2.0	0 & M funds req'd.

11. Progress to Date:

Implemented a working unit, established contacts at the Federal, Provincial levels, municipal agencies and private industries involved in the use, manufacture and distribution of pesticides, and related products. Determined and selected safety clothing, equipment, ground spray instruments, techniques and methods. Established a pest priority list of 13 insect species requiring control recommendations. Conducted 59 efficacy trials on 11 insect species of which 43 were mist blower applications, 7 were bark paints and 9 were soil drenches. Analyzed the data, summarized the results and submitted performance reports to 9 chemical firms, report of trials and conclusions to the Western Committee on Crop Pesticides and prepared a file report on the trials and results. Twenty-five insecticides were tested at 99 field trials on 20 insect species in Alberta-Saskatchewan in 1973. Two specialized Ulta Low Volume insecticides were tested under 7 field trials, 28 were soil drenches, 3 bark paints using 12 and 3 septemic insecticides respectively.

Trials using spray equipment consisted of 48 backpack mist blower and 13 hydraulic applications. Collaborated with C.C.R.I., C.W.S. and Fisheries Research Board (Manitoba) on a large scale spruce budworm aerial spray program in the Spruce Woods For. Reserve using Fenitrothion @ 0.6 a.i./acre, the microbials (bt.), Thuricide and Dipel @ 0.25 0.50 lb/acre and Sevin 4 Oil under the terms of agreement with the Environmental Management Division to evaluate efficacy of microbials on spruce budworm, evaluate air-emulsion spray adjuvants (foams), hardware and song/game birds and small mammals censusing.

Analysed the data, submitted performance reports to 14 chemical firms, submitted a summary of 95 trials to Pesticide Research Report (C.C.P.U.A.), product performance report on ULVA to Rotospray Systems, report of trials, conclusions and recommendations to Western Committee on Crop Pesticides (WCCP), report on insecticide field development to joint Can. Ent/Alta. Ent. Societies at Banff, input into technical sessions on Biocides by Alta. Environmental Conservation Board. Prepared Information Report NOR-X-81 and a special report to CCRI on Furadan (carbofuran) trials for proposed registrations.

12. Goals for 1974-75:

Continue efficacy trials on top half dozen pest problems in the region with a more intensive evaluation on target and non-target species and of fewer pesticides:

1. Bt (*Bacillus thuriengensis*) microbial dosage studies on forest tent caterpillars in Alberta also large scale trials with Gardona and Sevimol and effects of these treatments on the target species as well as on birds and small mammals.

2. Continue poplar root collar studies with Furadan and Temik at reduced formulations and at up to 50 lbs/acre.

3. Continue soil drench trials on yellow-headed spruce sawfly with Temik and spray trials with carbaryl (Sevin), Cygon 4E and Malathion to obtain additional data for supporting product registration.

4. Soil drench trials on pear slug, birch leaf miner and Hylobius weevil with Cygon 4E, Furadan, Temik and on larch shelterbelt at Sangudo for sawfly using similar products.

5. Fungicidal control of poplar leaf spots in shelterbelts with benomyl and thiophanate to augment product registration data in support of L. W. Carlson's nursery trials including the effects on birds/small mammals.

6. Continue trials on *Lithocolletis* sp. with reduced formulations of Baygon (propoxur).

7. Fungicidal controls of *Monilmia* sp. fungus on Saskatoon as at #5 and control of fruit maggot with systemics.

8. Preliminary trials on controls of carpenterworm attacks in poplar shelterbelts at Crowfoot with systemics and fumigants.

9. Evaluation of air-emulsion spray adjuvants and foam producing spray emission equipment on spraying systems gun.

13. Accomplishments in 1974-75:

During 1974, 24 insecticides and 2 fungicides were tested for their efficacy. Eighteen insect species and 2 fungal species were the target organisms. A total of 77 different evaluations of efficacy were made at 16 sites in Alberta-Saskatchewan using 4 applications methods. These consisted of 28 soil drenches, 27 ultra low volume 13 hydraulic and 9 mist blower applications.

Good to excellent results were obtained on 63 efficacy trials. As a result six pesticides will be/have been registered, one of which is labelled for restricted use on 2 insect species. See appendix for pesticides, trial types, insect pest and percent controls.

1. Completed B.t. (*Bacillus thuriengensis*) studies on 2 acre plots with Dipel and Thuricide HPC-X and obtained 75 and 70 percent controls respectively. As a result, Dipel as well as Lannate L has been submitted to Ottawa for registration to control forest tent caterpillar on shelterbelt and ornamentals by the manufacturer. (Goal 1)

2. Completed the poplar root collar studies with Furadan, Temik and Cygon. Chemical controls, biology and damage will be published in the Can. Jour. of For. Research. (Goal 2)

3. Completed soil drench evaluations on yellow-headed spruce sawfly and air-emulsion trials with excellent results. Both manufacturers of Furadan & Temik are seeking registration in shade and ornamentals. (Goal 3)

4. Completed 6 soil drench trials on pear slug with excellent results (see appendix), 3 soil drench trials on Hylobius weevil with excellent results with Cygon. Larch sawfly foliar sprays gave excellent controls with Cygon and Basudin. (Goal 4)

5. Completed fungicidal control trials of poplar leaf spots with 62 percent control with NF44 70 WP and 75 percent control with Benlate 50W. (Goal 5)

6. Completed leaf miner (*Lithocolletis* sp.) studies with Baygon, Imidan and Basudin with very good results. (See appendix)

7. No fungicidal controls undertaken on *Monilmia* Sp. fungus or cherry midge due to endemic populations. (Goal 7)

8. Tentative trials on carpenterworm infestation on balsam poplar at Crowfoot with long residuals (i.e. Gardona, Lorsban) but results less than desired.

9. Results with Triton A/F, adjuvant, foamer were very good, reducing spray drift by 70-80 per cent, gave more efficient coverage, particularly in coniferous stands through the excellent visibility of the foam on foliage sprayed. A spreader-

sticker Triton B-1956 was used in most hydraulic and mist blower applications with very good results. Results with A.t. plus 526, 540, AL1034 (Atlas Chemical) were less than desired due to low recommended rate per gallon. (Goal 9)

10. Analysed the data and submitted performance reports to 14 chemical firms, submitted a summary of pesticide efficacy trials covering 1972 to 1974 (230 trials) to the Pesticide Research Report for publication by the Canadian Committee on Crop Pesticide Research in Agriculture (CCPUA) and a summary of 2 fungicide trials to the Fungicide and Nematocide Tests publications, Raleigh, North Carolina.

11. Performance reports on ultra low volume sprayer and formulations to Rotospray Systems Ltd., Turbair Ltd. and in adjuvants/foamers to Atlas Chemicals and Rohm and Haas Ltd. (Goal 9)

12. Report of trials, conclusions and recommendations to the Western Committee on Crop Pesticides (WCCP) and material for a brief submitted to Biocide hearings by the Alberta Environmental Conservation Board.

13. Completed studies of needle miner on Colorado spruce and submitted report "Chemical control of spruce needle miner in Alberta" by J. A. Drouin and D. S. Kusch to Bi-monthly Research Notes.

14. Prepare Pest Leaflet on Pear Slug *Caliroa cerasi* Linn. and reviewed chemical controls for the proposed pest leaflets on Birch Leaf Miner, and Cankerworm.

15. Prepared an information report "Insecticide Field Trials in Shade and Shelterbelt Trees in Alberta and Saskatchewan 1974 by J. A. Drouin and D. S. Kusch 1974, NOR-X-131.

14. <u>Goals for 1975-76</u>:

Many of the chemical controls for numerous insect species are outdated, deal with one aspect only (generally foliar) of application omitting other excellent, economical and recent controls available. As a result the need for these additional registered materials for pest controls on forest, ornamental and shelterbelt trees and shrubs is becoming more evident. A large number of insecticides (33) and chemicals tested since 1972 require one more year of field trials to complete the data required prior to proposing registration. Our main effort will be directed towards this goal.

1. Complete the data requirements on foliar applications for Cygon 4E, Zectran 2E, Thiodan 4E, Sevin 50WP, Galecron 50 EC, Lannate L, Basudin 50 EC, Supracide 40 EC, PP505 10G, Imidan 1E, Nexion 25W, Lorsban 25WP, Malathion 50EC, Volaton 50EC, Orthene 75WP, K840, Baygon 1.5EC, Gardona 75WP, and RH218 50 EC.

2. Complete boxelder twig borer control studies with foliar sprays, air-emulsion spray adjuvants and efficacy of the various contact/ systemic insecticides.

3. Biology, chemical control of the chokecherry midge *Contarinia virginianiae* (Felt), using foliar sprays and systemic insecticides (WCCP request).

4. Continue foliar spray and air-emulsion spray adjuvant trial on the yellow headed spruce sawfly and soil drench tests with new systemics.

5. Foliar spray applications for the control of birch leaf miner.

6. Continue evaluations on air-emulsion spray adjuvants, foams (and hardware) to complete data required for registration for use in shade, shelterbelt and ornamentals.

15. Publications:

Up to 1972

Nil

Drouin, J. A. and D. S. Kusch. 1973. Summary of Insecticide Field Trials on Shade and Shelterbelt Trees in Alberta, 1972. Can. Dept. of Environment, N.F.R.C., Edmonton, Alta., File report NOR-Y-66.

Drouin, J. A. and D. S. Kusch. 1974. Insecticide Field Trials on Shade and Shelterbelt Trees in Alberta and Saskatchewan. 1973. Environment Canada, Forestry Serv., N.F.R.C., Edmonton, Alta. Information Report NOR-X-81.

16. Signatures:

J. A. Drouin
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R. W. Reid
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G. T. Silver
Director G. T. Silver

1974 Field Trials — Drouin - Kusch..NOR132

Trial No.	Type	Chemicals	Insects
1	SD	Fur. 10G	Pop. bore
2	SD	Fur. 10G	"
3	SD	Fur. 4.8	"
4	SD	Fur. 4.8	"
5	SD	Cygon 4E	"
6	SD	Cygon 4E	"
7	SD	Temik 10G	"
8	SD	Temik 10G	"
9	SD	Temik 10G	"
10	SD	Cygon 4E	Twig bore
11	SD	Cygon 4E	"
12	SD	Fur. 10G	"
13	SD	Fur. 10G	"
14	ULV	Gardona	Lace bug
15	ULV	Systemic	"
16	H	Dipel	FTC
17	H	Thuricide	"
18	H	Orthene 75SP	"
19	H	Sevimol 4	"
20	H	Gardona	"
21	H	RH 218	"
22	H	Imidan 50WP	"
23	MB	Lannate L	"
24	MB	Supracide	"
25	SD	Fur. 10G	YHS
26	SD	Temik 10G	"
27	SD	PP 505 10G	"
28	MB	Cygon 4E	FTC
29	MB	Malathion	"
30	ULV	Malathion	"
31	ULV	Resmethrin	"
32	ULV	Gardona	"
33	ULV	Vapona	"
34	SD	Fur 10G	P. slug
35	SD	Temik 10G	L. miner
36	ULV	Vapona	Lace bug
37	ULV	Malathion	Aphid
38	SD	Fur. 10G	Weevil
39	SD	Temik 10G	"
40	SD	Cygon 4E	"
41	ULV	Resmethrin	YHS
42	MB	NF 44	Leaf spot
43	MB	Benlate	"
44	ULV	Resmethrin	Archips
45	H	Sevimol	YHS
46	H	Basudin 50EC	"
47	H	Cygon 4E	"
48	H	Imidan 1E	"
49	H	Basudin 50EC	L. Sfy
50	H	Cygon 4E	"
51	SD	Fur. 10G	P. slug
52	SD	Fur. 4.8	"
53	SD	Cygon 4E	"
54	SD	Volaton	"
55	ULV	Resmethrin	L. Sfy
56	SD	Orthene	P. slug
57	MB	Baygon 1.5	L. miner
58	MB	Imidan 1E	"
59	MB	Basudin 50EC	"
60	SD	Fur. 10G	Sawfly
61	ULV	Resmethrin	L. beetle
62	ULV	Resmethrin	Lace bug
63	ULV	Malathion	"
64	ULV	Resmethrin	P. slug
65	ULV	Systemic	"
66	ULV	Gardona	"
67	SD	Fur. 10G	L. miner
68	ULV	Resmethrin	Wte. fly
69	ULV	Resmethrin	Aphid
70	ULV	Malathion	"
71	ULV	Systemic	"
72	ULV	Gardona	"
73	ULV	Vapona	"
74	ULV	Systemic	"
75	ULV	Resmethrin	"
76	ULV	Vapona	"
77	ULV	Systemic	"

SD = 28
ULV = 27
HYD. = 13
MB = 9
77

SD = Soil drench
ULV = Ultra low volume
HYD = Hydraulic
MB = Mistblower

Chemicals used in 1974

No	Type	Pest	Rt. (a)	% (b)
		Furadan 10G		
1	SD	S. calcarata	F	36
2	SD	"	F	29
12	SD	P. willingana	P	01
13	SD	"	P	00
25	Sd	P. alaskensis	E	90
34	SD	C. cerasi	E	100
38	SD	H. warreni	P	12
51	SD	C. cerasi	E	84
60	SD	N. ribesii	E	100
67	SD	G. syringella	E	95
		Furadan 4.8EC		
3	SD	S. calcarata	P	23
4	SD	"	F	42
52	SD	C. cerasi	E	86
		Cygon 4E		
5	SD	S. calcarata	E	77
6	SD	"	E	100
10	SD	P. willingana	G	66
11	SD	"	F	26
28	MB	M. disstria	E	100
40	SD	H. warreni	E	86
47	H	P. alaskensis	E	100
50	H	P. erichsonii	E	100
53	SD	C. cerasi	E	86
		Temik 10G		
7	SD	S. calcarata	F	42
8	SD	"	F	34
9	SD	"	F	30
26	SD	P. alaskensis	E	95
35	SD	G. syringella	E	100
39	SD	H. warreni	G	54
		Basudin 50EC		
46	H	P. alaskensis	E	95
49	H	P. erichsonii	E	100
59	MB	Lithocolletis	E	100
		Imidan 1E		
48	H	P. alaskensis	E	100
58	MB	Lithocolletis	E	100
		Imidan 50WP		
22	H	M. disstria	G	75
		Sevimol 4		
19	H	M. disstria	E	100
45	H	P. alaskensis	E	100

No	Type	Pest	Rt. (a)	% (b)
		Orthene 75SP		
18	H	M disstria	E	100
56	SD	C. cerasi	E	81
		Gardona 75WP		
20	H	M. disstria	E	95
		Lannate L		
23	MB	M. disstria	E	100
		Supracide 40EC		
24	MB	M. disstria	E	100
		Baygon 1.5EC		
57	MB	Lithocolletis	E	100
		RH 218 50EC		
21	H	M. disstria	E	95
		PP 505 10G		
27	SD	P. alaskansis	E	90
		Malathion 50EC		
29	MB	M. disstria	E	100
		Volaton 50EC		
54	SD	C. cerasi	E	78
		Dipel 3.2% bt.		
16	H	M. disstria	G	75
		Thuricide HPC		
17	H	M. disstria	G	70
		Benlate 50WP		
43	MB	S. musiva	G	75
		NF 44 70WP		
42	MB	S. musiva	G	62

Also see ULVA

(a) = Rating

(b) = Percent Control(based on Abbott's formula)

1974
Ultra Low Volume Applications

NOR 132

No	Pest	Rt.	%	No	Pest	Rt.	%
	Resmethrin 0.69%				Tetrachlorvinphos 2.5%		
31	M. disstria	E	100	14	C. pallipes	G	66
41	P. alaskensis	E	100	32	M. disstria	G	70
44	A. cerasivotana	P	20	66	C. cerasi	E	100
55	P. erichsonii	E	100	72	Aphidae	G	60
61	P. cavicollis	E	100				
62	C. pallipes	E	89		Malathion 4.5%		
64	C. cerasi	E	100	30	M. disstria	E	100
68	T. vaporariorum	E	100	37	Aphidae	E	100
69	Aphidae	E	81	63	C. pallipes	E	100
75	Aphidae			70	Aphidae	E	96
	Systemic ---				Vapona-Methoxychlor 6%		
15	C. pallipes	G	63	33	M. disstria	E	85
65	C. cerasi	E	100	36	C. pallipes	P	25
71	Aphidae	E	100	73	Aphidae	E	83
74	Aphidae	E	99	76	Aphidae	E	98
77	Aphidae	G	68				

Rt.= Rating

% = Percent control baedd on Abbott's formula.

Malacosoma disstria Hbn

No.	Chemicals	Type	%
16	Dipel 3.2 bt.	H	75
17	Thuricide HPC	H	70
18	Orthene 75SP	H	100
19	Sevimol 4	H	100
20	Gardona 75WP	H	95
21	RH 218 50EC	H	95
22	Imidan 50WP	H	75
23	Lannate L	MB	100
24	Supracide 40EC	MB	100
28	Cygon 4E	MB	100
29	Malathion 50EC	MB	100
30	Malathion	ULV	100
31	Resmethrin	ULV	100
32	Tetrachlorvinphos	ULV	70
33	Vapona-Methoxychlor	ULV	85

Aphids

37	Malathion	ULV	100
69	Resmethrin	ULV	81
70	Malathion	ULV	96
71	Systemic	ULV	100
72	Tetrachlorvinphos	ULV	60
73	Vapona-Methoxychlor	ULV	83
74	Systemic	ULV	99
75	Resmethrin	ULV	65
76	Vapona-Methoxychlor	ULV	98
77	Systemic	ULV	68

Saperda calcarata Say

1	Furadan 10G	SD	36
2	Furadan 10G	SD	29
3	Furadan 4.8EC	SD	23
4	Furadan 4.8EC	SD	42
5	Cygon 4E	SD	77
6	Cygon 4E	SD	100
7	Temik 10G	SD	42
8	Temik 10G	SD	34
9	Temik 10G	SD	30

Corythucha pallipes Parsh

14	Tetrachlorvinphos	ULV	66
15	Systemic	ULV	63
36	Vapona-Methoxychlor	ULV	25
62	Resmethrin	ULV	89
63	Malathion	ULV	100

Gracillaria syringella Fabr.

35	Temik 10G	SD	100
67	Furadan 10G	SD	95

Trialeurodes vaporariorum

68	Resmethrin	ULV	100

Caliroa cerasi Linn

34	Furadan 10G	SD	100
51	Furadan 10G	SD	84
52	Furadan 4.8EC	SD	86
53	Cygon 4E	SD	86
54	Volaton 50EC	SD	78
56	Orthene 75SP	SD	81
64	Resmethrin	ULV	100
65	Systemic	ULV	100
66	Tetrachlorvinphos	ULV	100

Pikonema alaskensis Roh.

25	Furadan 10G	SD	90
26	Temik 10G	SD	95
27	PP 505 10G	SD	90
41	Resmethrin	ULV	100
45	Sevimol 4	H	100
46	Basudin 50EC	H	95
47	Cygon 4E	H	100
48	Imidan 1E	H	100

Neodiprion abietis Harr.

41	Resmethrin	ULV	100

Proteoteras willingana Kft.

10	Cygon 4E	SD	66
11	Cygon 4E	SD	26
12	Furadan 10G	SD	01
13	Furadan 10G	SD	00

Hylobius warreni Wood

38	Furadan 10G	SD	12
39	Temik 10G	SD	54
40	Cygon 4E	SD	86

Pristiphora erichsonii Htg.

49	Basudin 50EC	H	100
50	Cygon 4E	H	100
55	Resmethrin	ULV	100

Lithocolletis sp.

57	Baygon 1.5EC	MB	100
58	Imidan 1E	MB	100
59	Basudin 50EC	MB	100

Archips cerasivorana Fitch

44	Resmethrin	ULV	20

Nematus ribesii Scop.

60	Furadan 10G	SD	100

Pyrrhalta cavicollis Lec.

61	Resmethrin	ULV	100

Septoria musiva Pk.

42	NF 44 70WP	MB	62
43	Benlate 50WP	MB	75

Percent control based on Abbott's formula.

1974 Application Types

Soil Drench

No	Chemical	Pest
1	Fur. 10G	Pop. bore
2	Fur. 10G	"
3	Fur. 4.8	"
4	Fur. 4.8	"
5	Cygon 4E	"
6	Cygon 4E	"
7	Temik 10G	"
8	Temik 10G	"
9	Temik 10G	"
10	Cygon 4E	Twig bore
11	Cygon 4E	"
12	Fur. 10G	"
13	Fur. 10G	"
25	Fur. 10G	YHS
26	Temik 10G	"
27	PP 505 10G	"
34	Fur. 10G	P. slug
35	Temik 10G	L. miner
67	Fur. 10G	"
38	Fur. 10G	Weevil
39	Temik 10G	"
40	Cygon 4E	"
51	Fur. 10G	P. slug
52	Fur. 4.8	"
53	Cygon 4E	"
54	Volaton 50EC	"
56	Orthene 75SP	"
60	Fur. 10G	Sawfly

Mist Blower

No	Chemical	Pest
23	Lannate	FTC
24	Supracide	"
28	Cygon 4E	"
29	Malathion	"
42	NF 44	L. spot
43	Benlate	"
57	Baygon	L. miner
58	Imidan	"
59	Basudin	"

Hydraulic

No	Chemical	Pest
16	Dipel	FTC
17	Thuricide	"
18	Orthene	"
19	Sevimol	"
20	Gardona	"
21	RH 218	"
22	Imidan	"
45	Sevimol	YHS
46	Basudin	"
47	Cygon 4E	"
48	Imidan	"
49	Basudin	L. Sfy
50	Cygon 4E	"

Ultra Low Volume

No	Chemical	Pest
14	Tetra -	Lace bug
15	Systemic	"
36	Vapona -	"
62	Resmethrin	"
63	Malathion	"
30	Malathion	FTC
31	Resmethrin	"
32	Tetra -	"
33	Vapona -	"
41	Resmethrin	YHS
44	Resmethrin	Archips
55	Resmethrin	L. Sfy.
61	Resmethrin	L. beetle
64	Resmethrin	P. slug
65	Systemic	"
66	Tetra -	"
68	Resmethrin	Wte. fly
37	Malathion	Aphids
69	Resmethrin	"
70	Malathion	"
71	Systemic	"
72	Tetra -	"
73	Vapona -	"
74	Systemic	"
75	Resmethrin	"
76	Vapona -	"
77	Systemic	"

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 20,1975

1. Project: Reduction of damage from insects.

2. Title: Biological control of forest tent caterpillar.

3. New: Cont.: X 4. No.: NOR 133

5. Study Leader: J. A. Muldrew

6. Key Words: *Malacosoma disstria*, *Sarcophaga aldrichi*, *Pseudosarcophaga affinis*, parasites, nuclear-polyhedrosis virus, Boreal Region "B", trembling aspen (*Populus tremuloides*).

7. Location of Work: Northern Forest Research Centre and Region.

8. Problem:

The forest tent caterpillar shows large population fluctuations with outbreaks of 3 - 6 years duration occurring at intervals of 6 - 16 years. Successive complete defoliation for three or more years can cause death of aspen but the more common effect is a reduction of diameter growth of up to 90%. Aesthetic benefits in recreation areas and home sites are reduced. Complaints and requests for control are common during outbreaks.

It is planned to develop methods of mass-rearing adults of *Sarcophaga aldrichi* and *Pseudosarcophaga affinis* and release them in considerable numbers during the initial stages of an outbreak in selected localities. Areas where outbreaks of the host are likely to occur will be determined using the method outlined by W.G.H. Ives using weather data. Adult parasites will be contaminated with nuclear and possibly cytoplasmic polyhedrosis virus shortly before releasing them into a population (possibly by spraying them with a suspension of the viruses). Since only the early stages of the host are susceptible to the NPV, increased control from this disease would be hoped for in the generation following the spraying. Since third to fifth instar hosts are susceptible to the CPV, this disease may produce more control in the year of release. Control populations will be studied. G. R. Stairs (Can. Ent. 98:1100) sprayed virus over small areas of an infestation in 1963 and found that it had spread over 700 square miles by 1965. He concluded further that "*S. aldrichi* in the system may be essential to the rapid development of epizootics" (Ann. Rev. Ent. 1972, 17:355). The possibility of obtaining contaminated parasite adults by incorporating virus in the larval food medium will be studied.

9. Study Objectives:

   1. To control outbreaks of 'he forest tent caterpillar in selected areas and reduce the duration and severity of outbreaks over larger areas by the introduction of large numbers of virus-carrying parasites to initiate epizootics.

   2. To develop methods for mass-rearing the sarcophagids *S. aldrichi* and *P. affinis*.

10. Resources:

   a. Starting date: 1973
   b. Estimated year of completion: 1978
   c. Estimated total Prof. man-years required: 3
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.0	(J. A. Muldrew)	
Supp.	0.0	(R. M. Smith)	
Casual			
Total	0.0		O & M funds req'd:

11. Progress to Date:

A literature survey was carried out. Consultation was made with Dr. G. R. Stairs on various aspect of the problem. Initial rearing studies using salmon and liver and mixtures of these were carried out. Field estimates of parasitism were made in conjunction with making mass collections of cocooned forest tent caterpillar pupae to obtain parasite material.

Sarcophaga aldrichi adult females commonly lived for over 60 days in oviposition cages. The highest rates of oviposition were obtained using pieces of hog liver covered by aspen leaves and placed adjacent to empty forest tent caterpillar cocoons.

In rearing, pieces of liver or liver slurry proved better than fish (salmon or northern pike) or mixtures of fish and liver.

Survival was better with raw food as compared to heat-sterilized food. Hog-liver slurry containing 0.6% formaldehyde was superior to untreated liver slurry and slurry containing 0.2%, 0.4% and 0.8% formaldehyde. Desiccation of food was a problem in both rearing parasites and obtaining oviposition and an enclosed system was constructed by which air was first brought to 70% RH and then passed through a container containing a germicidal lamp (30 watt UV) before entering the enclosed rearing chamber.

12. Goals for 1974-75:

Work on this study is to be held in abeyance for one year due to other commitments.

13. Accomplishments in 1974-75:

Advantage was taken of the finding of virus-killed larvae in the field to collect a supply of virus and identify it. A supply of puparia of *Sarcophaga aldrichi* was maintained for future studies and in the process the rearing technique was improved by developing a method of obtaining living larvae from mated, mature parasite adult females; by rearing the larvae in a growth chamber and by adding sphagnum moss to the rearing containers to obtain puparium formation within them.

14. Goals for 1975-76:

Work on this study is to be held in abeyance until the publications of Study NOR 061 are completed.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR 143 (973)

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 27, 1975

1. Project: Reduction of damage from insects

2. Title: Control and damage impact of insects injurious to trees and shrubs.

3. New: X 4. NOR 143

5. Study Leader: H. F. Cerezke

6. Key Words: Forest habitats, shelterbelts, woodlots, parks and recreational areas, plantations, seed orchards, tree nurseries, urban landscapes, pesticides, insecticides, cultural control, integrated control, growth losses, population sampling.

7. Location of Work: region wide

8. Problem:

In the prairie provinces there exists the need to examine entomological problems which arise annually and seasonally, often on short notice, and cause concern in forested areas, park and recreational areas, nurseries, shelterbelts, private wood lots and ornamental plantings in urban and rural landscapes. In most cases, such problems may only require identification of the insect organism or other causal agents, and control recommendations are made according to established procedures, such as by chemical, pruning, tree removal or no controls. The nature of the recommendations are dictated by an assessment of the hazard of the insect and its potential damage, and to some extent by the wishes of the owner(s) or forest manager. Staff of the Insect and Disease Survey and Pest Control Officers of C.F.S., and of other extension specialists of federal, provincial and municipal departments fulfill most of these needs.

Other entomological problems arise which require more comprehensive examination or short term studies. These may include population surveys in spruce budworm-infested timber, bark beetle hazard prediction, woodborer hazard in fire-killed timber, identification of causes of mortality and tree damage in plantations and natural regeneration, development of special sampling techniques to measure insect abundance and to assist pre- and post-spray application in shelterbelts, urban and park areas, life cycle studies to establish proper timing of controls and impact studies to measure growth losses, predict long term effects on tree form, growth pattern and aesthetic value. Studies may also be initiated which can lead to new strategies of control or to increase effectiveness of control such as by integration of two or more control methods, such as with use of cultural techniques, biological agents, pheromones and other insect-specific chemicals. Opportunity may also exist to undertake field trial demonstrations for testing control procedure and long term effectiveness.

The main benefits of this study will be to advise and up-date information on insect control in new problem areas and to complement the services offered under studies NOR 033 and NOR 132. Increasing public awareness, more intensive forest management practices and increasing demands on the environment such as in park and recreational areas, have all contributed in recent years to many new and varied enquiries of entomological concern. This is a vehicle study and is aimed at fulfilling the needs of special enquiries.

9. Objectives:

1. To maintain up-to-date information on insect problems of trees and shrubs common to the region, laws related to pesticides and their usage, insect control methods and effects of pesticides on the environment.

2. To provide information on insect control, abundance, hazard and damage impact in new areas of concern to various clients.

10. Resources:

a. Starting date: October, 1973
b. Estimated year of completion: Indefinite
c. Estimated total prof. man-years required:
d. Essential new major equipment for 1975-76 with costs:
e. Essential new major equipment beyond 1976 with costs: Unknown
f. 1975-76 man-years

Prof.	0.6 (H. Cerezke)		
Supp.			
Casual			
Total	0.6	O & M funds req'd:	

11. Progress to date:

Knowledge has been accumulated for providing C.F.S. representation at Western Committee on Crop Pesticides, Alberta Pest Control Advisory Committee, and for reviewing and editing reports prepared under Study NOR 132. Service has been provided to the University of Alberta and to the Northern Alberta Institute of Technology for lectures on forest entomological problems to students and staff.

12. Goals for 1974-75:

    1. Maintain information on pesticide registrations, laboratory and field trial testings of pesticides through Plant Products Division (CDA), CCRI and various other chemical, Federal and Provincial agencies.

    2. Establish an inventory, through literature review, on the life histories, host damage and distributions of 10 - 15 priority pest species in the prairie provinces.

13. Accomplishments in 1974-75:

    1. Preparatory work undertaken for attendance and participation at Western Committee on Crop Pesticides (1974) and on Alberta Pest Control Advisory Committee. Assisted with 1975 revisions of Chemical Control Recommendations on Crop Pesticides (section on Ornamental Trees, Shrubs and Shelterbelts). Delivered lecture to University of Alberta students in forest entomology, conducted field tour for U. of A. forest entomology students near Hinton, presented illustrated talk on forest entomological problems to staff of Saskatchewan Dept. of Tourism and Renewable Resources, and provided review and editing services under Study NOR-132.

    2. Established an inventory of about 160 insect and mite species considered for inclusion in the proposed Information publication on "Insect Pests of Trees and Shrubs of the Prairie Provinces and N.W.T." Held meetings with F.I.D.S. staff to discuss format of this publication and to arrange for assistance and scheduling of workload to accumulate bibliographies of each insect pest. A number of these are complete. A sample format report on one insect was prepared. A search of the F.I.D.S. color slide collection was made and those of potential illustrative use were selected.

14. Goals for 1975-76:

    1. Complete the bibliography on remaining insect species with assistance of F.I.D.S. for proposed Information Publication.

    2. Write and edit descriptions of as many insect or insect groups as time will permit for proposed Information Publication.

    3. Provide guidance to F.I.D.S. photographers for accumulating color illustrations of insects and damage for proposed Information Publication.

    4. Provide Canadian Forestry Service representation and input into the following committees:

        (a) Western Committee on Crop Pesticides
        (b) Alberta Pest Control Advisory Committee
        (c) Saskatchewan Pest Control Advisory Committee
        (d) C.F.S. contact officer for Pest Control Products Act, re Trade Memorandum 104
        (e) Shelterbelt Sub Committee of Western Committee Shelterbelt and Horticulture

5. Provide information and consulting services to various clients seeking information on insect control, abundance, hazard and damage impact related to forest management problems, including new requests on spruce budworm, root weevil and woodborers. These requests were formerly handled under NOR-023, -024 and -025, respectively.

6. Complete the proposed journal publication as indicated in NOR-025 as follows:

   Cerezke, H. F. Population and damage relationships of *Monochamus scutellatus* in tree-length white spruce logs in northern Alberta.

15. Publications:

Up to 1974-75: Nil

16. Signatures:

Herbert F. Cerezke
Investigator

Program Manager

Director G. T. Silver

PROJECT NOR - 10

Improved Regeneration Methods for Commercial Forest Species

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

DATE: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Effects of prescribed fire on Peaty Humic Gleysol and on Gray Wooded soils under spruce-fir forest.

3. New: Cont.: X 4. No.: NOR 004

5. Study Leader: G. L. Lesko

6. Key Words: Soil temperature, soil moisture, mineral nutrients, *Picea glauca, Abies lasiocarpa.*

7. Location of Work: Hinton, Alberta.

8. Problem:

   Prescribed fire is a possible method of seedbed improvement for regeneration, therefore its effect on soil properties must be known.

   The study will show if the fire is harmful, beneficial or neutral to soil properties. The probability to find answers to these questions is high.

   The results will not be put into practice because they serve as background information.

   Method: Measurement of soil properties before and in successive years after prescribed fire.

9. Study Objectives:

   a. To determine the moisture and heat regimes of the above soil after prescribed fire.

   b. To determine long and short-term effects of fire on soil reaction, essential macro nutrients, organic carbon content and cation exchange capacity.

10. Resources:

a. Starting date: 1967.
b. Estimated year of completion: 1980.
c. Estimated total Prof. man-years required: 0.5
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.1	
Supp.	0.1	
Casual	-	
Total	0.2	O & M funds req'd: Nil

11. Progress to Date:

a. Field measurements of soil moisture and temperature were conducted for 5 years.

b. Soil samples were collected in four successive years to study chemical changes.

c. Chemical analysis of the samples are completed.

d. Preliminary results were summarized in an Internal Report in 1971.

12. Goals for 1974-75:

1. Continue soil analysis and data compilation.

2. Publish report "Short term effects of prescribed fire on soil properties in west-central Alberta." Journal.

13. Accomplishments in 1974-75:

1. Soil analyses were completed and some progress was made in data analysis.

2. Publication of the proposed report was not achieved, because of heavy involvements in task forces and committees during last year.

14. Goals for 1975-76:

1. Further preparation of the data towards the report on "short term effects of prescribed fire on soil properties in west-central Alberta".

15. Publications:

Up to 1974-75

Lesko, G. L. 1971. Some early effects of the prescribed fire in spruce-fir slash on soil properties. Forest Research Laboratory, Calgary, Alberta. Internal Report.

Lesko, G. L. 1972. Immediate effects of a prescribed fire on soil properties. Forestry Report, C.F.S., Northern Forest Research Centre, Edmonton, Alberta. Vol. 1 No. 6 pp. 4. Miscellaneousl

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved Regeneration Methods for Commercial Forest Species.

2. Title: Nursery operations

3. New: Cont.: X 4. No.: NOR 039

5. Study Leader: L. W. Carlson

6. Key Words: Root pruning, storage and packing, storage mold, disease control, *Septoria, Marssonina,* seedling mortality, *Populus, Pinus, Picea,* conifer seedbed culture, containerized seedling rearing, quality control.

7. Location of Work: Northern Forest Research Centre, Edmonton; Alberta Provincial Tree Nursery, Oliver; Alberta Horticultural Research Centre, Brooks; Saskatchewan DNR Forest Nurseries, Prince Albert and Big River; PFRA Tree Nursery, Indian Head, Saskatchewan; Pineland Nursery, Hadashville, Manitoba; Yukon Forest Service, Whitehorse.

8. Problem:

Nature of Study:

Presently it costs about 3 cents to produce a seedling of plantable size. The average annual production in the Northern Forest Region nurseries is approximately 8 million conifer seedlings, with operating costs of about 400,000 dollars. Recently (1969) losses in jack pine outplantings in Manitoba were 45% or one million seedlings. Also a recent survey of regeneration in all three Prairie Provinces indicates very poor survival of outplantings of white spruce and lodgepole pine (NOR-X-31). There is evidence in many cases that mortality was related to problems in the Nursery system and they appear to be both cultural and pathological. Solving these problems and others like them could possibly prevent similar losses in the future.

Two large government nurseries in the Northern Forest Region are involved in the production of shelterbelt and parks nursery stock. The problems of rearing are mainly cultural and require some attention. As with coniferous stock, storage, packing and shipping present the major problems.

Demands on the nursery for production are always high. With limited amount of space and money they are expected to produce certain numbers of trees at a certain quality. There is need then for information that will help cut costs, increase the effective use of land, and maintain quality.

Probability of success: Excellent

Probability of results being put into practice: Good

Method used:

Definition of problems

Consultation with nursery managers
Through information from Nursery Monitoring.

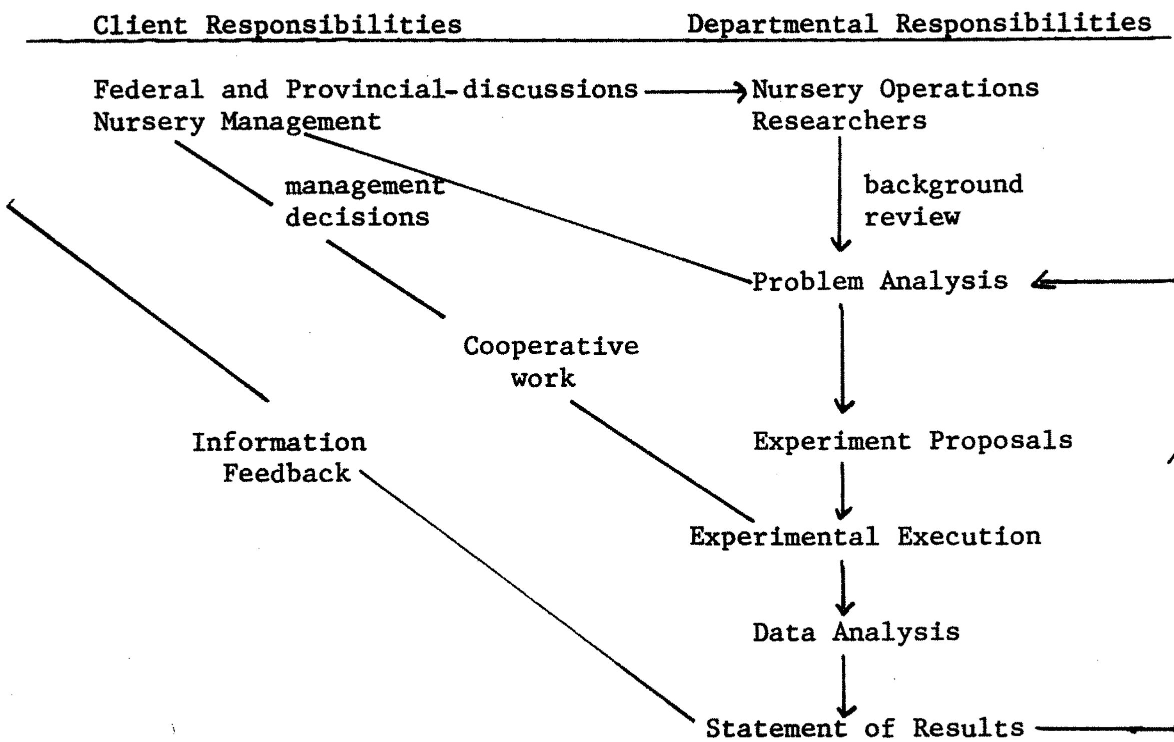
Determine priority of problem - relating to demands for the crop.

Scientific investigation of the problem

Experiments set with proper consideration for statistical analysis.

Results to be fed back to the nursery system as soon as possible.

Problem analysis flow chart:



9. Study Objectives:

   a. To improve general nursery practices, including seedling handling, disease control, weed control, cultural operations, and inovations for seedbed treatments.

   b. To design, test and ultimately to seek adoption by provincial forest nurseries of a monitoring and quality control system for production of nursery stock which will aid in defining crop potential, crop losses, and factors contributing to the losses and their relative importance.

10. Resources:

   a. Starting date: 1968
   b. Estimated year of completion: 1978
   c. Estimated total Prof. man-years req'd: 2.0
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil

f. 1975-76 man-years	Prof.	0.4	
	Supp.	1.2	
	Casual	Nil	
	Total	1.6	O & M funds Req'd $3000

11. Progress to Date:

1. Seedbeds of 1-0 and 2-0 white spruce and 2-0 lodgepole pine were root pruned. Assessments were made at lifting time. Root growth showed marked seasonal changes in regard to time of root pruning.

2. Outplantings of 3-0 jack pine, lodgepole pine and white spruce from storage and packing trials showed Sw survives better than pines in storage. The data obtained indicates that air-tight packing and storage at 35-40°F (1.7°C-4.4°C) is not as good as storage in bales of unsealed plastic lined boxes. The latter method is now used at 2 of 3 prairie forest nurseries.

3. All regional government nurseries were visited in 1973. Particular problems arising from visits to the Pineland Nursery, Hadashville, Manitoba, led to trials on the effect of pentachlorophenol on red pine and jack pine containerized seedlings. The trials were conducted in the NFRC greenhouses in specially built chambers. They showed that mortality of red pine and jack pine seedlings grown in the nursery greenhouses was directly related to exposure to PCP fumes. It was recommended that all PCP treated wood be removed from the greenhouses. This recommendation was carried out and the succeeding greenhouse crop was free of fume damage. Liaison was carried out with both the Yukon Forest Service and the Alberta Forest Service regarding the selection of nursery sites. The latter has involved considerable effort on the part of other professionals at the NFRC.

4. Studies of spacing poplar cuttings beds were continued at the Oliver Nursery (APTN) and data on cuttings yields were taken for the first time in November, 1973. These data show, as expected for the first harvest year, that closer spaced stools yield more cuttings per acre than the wider spaced material. Also noted was that wider spaced stools produced more cuttings per stool than the closer spaced stools. Although new beds were established at Brooks in 1973 (95% survival after the first month), they had to be abandoned due to poor cultivation practices at the station. (Roughly 45% survival at the end of the growing season).

5. Quality monitoring of present year's seedlings, shipped for outplanting, was carried out at the Oliver Nursery, Prince Albert Nursery, and at the Pineland Nursery. Seedlings of the same age varied in size according to seedlot number, and

in some cases according to the field where they were grown. Quality monitoring of seedbeds was carried out only at the Prince Albert Nursery on one field of jack pine and two fields of white spruce. The first year results indicate the monitoring system can reduce nursery seedbed inventory time by approximately 85%. The system was started at Pineland, but dropped due to the lack of fields to work in. The system was not started at Oliver because of weed problems in the fields.

6. Chemical control studies of poplar leaf spots have been completed. It was shown that three fungicide benomyl applications, 10 days apart, starting in late June gave effective control of the diseases. The recommendation of leaf spot control was given to PFRA Nursery and they have been successful in controlling the poplar leaf spots with the three spray applications.

7. The Yukon Forest Service was advised on the development of a nursery site and on the need for proper facilities.

12. Goals for 1974-75:

1. To continue surveying regional government nurseries, to contact regional private nurseries for problem assessment, and perform related liaison functions.

2. To continue to study the effects of spacing in poplar cuttings beds on the yield of usable cuttings. (New beds will be established and maintained in the NFRC Nursery Area in 1974 if space is made available).

3. To continue the study of effects of fungicides in controlling storage molds of conifer seedlings with special emphasis on overwinter storage. The trials will be carried out at the Prince Albert Nursery and the Oliver Nursery.

4. To continue to monitor the quality of conifer seedlings being shipped from the three provincial nurseries (Alberta, Saskatchewan and Manitoba).

5. To continue the quality monitoring program for seedbeds at the Prince Albert Nursery as set up in 1973.

6. To prepare a Journal publication on "Fungicidal control of poplar leaf spots".

7. To prepare a Journal publication on "The effects of pentachlorophenol fumes on containerized conifer seedlings".

8. To prepare a Journal publications on "Mold control on stored conifers".

9. Preparation of rearing manual previously assigned under NOR-106 (Endean).

10. To assist the Saskatchewan Department of Tourism and Renewable Resources in selecting a site for a new nursery.

11. To advise Parks Canada on regeneration problems of five trails in Yoho National Park.

12. To advise Parks Canada and University personnel on propagation of native tree and shrub species.

13. Accomplishments in 1974-75:

1. The regional nurseries were visited in 1974. Particular problems arising from visits to the nurseries led to investigations of irrigation systems and fertilizer application at Oliver; to sampling and investigation of soil problems at Indian Head (PFRA Tree Nursery). The professional input to the latter program was acquired from NOR-135. Both problems were answered to the satisfaction of the client. Numerous other visits were made to Oliver and Prince Albert where advice was given on standard nursery practice and on containerized seedling culture. Liaison was carried out with the Yukon Forest Service regarding shrub and tree hardiness trials near Whitehorse (this terminated our commitment to the YFS). All pertinent information is recorded in a File Report for this study. A meeting was arranged between provincial nurserymen and federal researchers and nurserymen where problems of production and management were discussed. The proceedings will be the subject of a file report under this study and will act as a basis of setting priorities for future nursery related studies.

2. Data collected on poplar cuttings beds spacings was similar to that collected in 1973, except there were greater numbers of cuttings overall. New spacing trials were established using "Northwest" poplar at the Prince Albert Nursery as space in the NFRC Nursery area was not made available.

3. The effects of fungicides in controlling storage molds of conifer seedlings stored overwinter were shown to be beneficial, particularly in studies at Prince Albert, however the Alberta data were inconclusive.

Carlson, L. W. and R. Huber. 1975. Jack pine storage molds. p....*In.* C. W. Averra (Ed), Fungicide Nematicide Tests, Results of 1974. A.P.S. Vol 30 *In Press.*

4. The quality of bareroot conifer seedlings being shipped from the three provincial nurseries has been recorded and pertinent information passed on to the respective nurseries. The data were similar to those from 1973. Each seedlot sampled was measured for ht., dry wt of roots and shoots, and shoot/root ratio given. Considerable variation was shown between different seed lots.

5. The quality monitoring progrm for seedbeds at Prince Albert was continued with the collection of 2nd year data. The data confirm that the method used can substantially reduce inventory time at the nursery without sacrificing accuracy. New sample seedbeds were set up in 1974. This program is being instituted at the Alberta Provincial Tree Nursery with only an advisory input by this lab.

6. Carlson, L. W. 1974. Fungicidal control of poplar leaf spots. Can. Plant. Dis. Surv. 54:81-85.

7. Carlson, L. W. and L. D. Nairn. 1975. Phytotoxic action of pentachlorophenol and captan on containerized red pine and jack pine seedlings. Tree Planters' Notes. *In Press.*

8. See publication under goal No. 3.

9. The assignment was taken over from NOR-106 and due to the lack of time and to desire of the project leader to obtain more information this goal has had its completion delayed for 1-2 years.

10. Three professionals and one technical staff member assisted in the selection of a new nursery site for the Saskatchewan Dept. of Tourism and Renewable Resources.

    Edwards, I. K., W. D. Holland, and L. W. Carlson. 1974. Assessment of potential tree nursery sites near Hudson Bay, Saskatchewan. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alta. Inf. Rep. NOR-X-119.

11. Damage to the environment of Mt. Hurd in Yoho National Park by machines making fire trails was assessed and recommendations for rehabilitation (regeneration of native species) were made. All pertinent data and comments are in a file report under this study.

12. Advice was given to Park Canada on problems of propagation of native shrub and tree species. To accomplish this some plant material is being propagated for demonstration. Similar advise, tending and data collection was made for university personnel.

Nyborg, M., W. B. McGill, L. W. Carlson, and W.D. Holland, 1974. Methods of establishing plant growth after heavy oil spills. *In,* D. Hocking and W. R. MacDonald (Ed), Proceedings of a workshop on reclamation of disturbed lands in Alberta. NFRC Inf. Rep. NOR-X-116 p. 139-150.

14. Goals for 1975-76:

1. To survey regional government nurseries, to contact regional private nurseries for problem assessment, and to perform related liaison functions.

2. To obtain 3rd year and 1st year yield data on spacing in poplar cuttings beds at Oliver and Prince Albert respectively.

3. To study the effect of fungicides in controlling storage molds of conifer seedlings with special emphasis on overwinter storage and method of fungicide application. The trials will be carried out at the P. A. nursery and the Oliver nursery (This includes journal publication).

4. To obtain 3rd and 2nd year data on the quality monitoring program for seedbeds at Prince Albert and to introduce this program to the Big River nursery.

5. To test the effectiveness of using special cropping schedules for increasing the organic matter content of Prince Albert nursery soils.

6. To advise Parks Canada on propagation and planting techniques for native species to be used in rehabilitating damaged sites.

7. To prepare a rearing manual for containerized seedlings.

15. Publications

Up to 1974-75

Carlson, L. W. 1974. Cuttings beds cankers (Timing). p. 124. *In:* E. I. Zehr (Ed.), Fungicide-Nematicide Tests, Results of 1973, Amer. Phytopath. Soc. Vol. 29.

Holland, W. D. and I. K. Edwards. 1973. Site investigation for location of Alberta Forest Service Tree Nursery. N.F.R.C. Info Rept. NOR-X-68.

Edwards, I. K. and W. D. Holland. 1973. Further site investigations for location of Alberta Forest Service Tree Nursery. N.F.R.C. Info. Rept. NOR-X-78.

Carlson, L. W. 1974. Cuttings beds cankers (fungidides). p. 124. *In*. E. I. Zehr (Ed.), Fungicide-Nematicide Tests, Results of 1973, Amer. Phytopath. Soc. Vol. 29.

Hocking, D. 1972. Nursery practices in cold storage of coniferous seedlings in Canada and the United States. Tree Planter's Notes 23:26-29.

Hocking, D. and W. B. D. Ward. 1972. Late lifting and freezing in plastic bags for overwinter storage of white spruce. Tree Planter's Notes 23:24-26.

Hocking, D. and R. D. Nyland. 1971. Cold storage of coniferous seedlings: A review. Appl. For. Res. Ind., SUNY, Res. Rept. 6: pp. 70.

Carlson, L. W. 1971. Greenhouse facilities provide a research opportunity. Forestry Report 1(2):3.

Carlson, L. W. 1970. Mortality in 1969 spring-planted jack pine plantations in Manitoba. Dept. of Fisheries and Forestry. <u>Confidential Report.</u> pp. 25.

Carlson, L. W. 1972. Survival of 2-0 and 3-0 jack pine seedlings outplantings in southeastern Manitoba. Canada Dept. of Envir., Forestry Service, Bi-Monthly Res. Notes 28(4):25-26.

Carlson, L. W. 1972[b]. Jack pine in southeastern Manitoba: A compendium of research, 1967-1970. V. Mortality in 1969 spring-planted jack pine plantations, Northern Forest Research Centre Info. Rept. NOR-X-50E.

Etter, H. M. and L. W. Carlson. 1973. Sugar contents, relative water content, and growth after planting of stored lodgepole pine seedlings. Can. J. Plant Sci. 53:395-399.

<u>1974-75</u>

Carlson, L. W. 1974. Fungicidal control of poplar leaf spots. Can. Plant. Dis. Surv. 54:81-85.

Carlson, L. W. and R. Huber, 1975. Jack pine storage molds. *In* C. W. Averra (Ed.), Fungicide-Nematicide Tests, Results of 1974. A. P. S. Vol. 30. *In Press*.

Carlson, L. W. and L. D. Nairn, 1975. Phytotoxic action of pentachlorophenol and captan on containerized red pine and jack pine seedlings. Tree Planters' Notes. *In Press*.

Edwards, I. K., W. D. Holland and L. W. Carlson, 1974. Assessment of potential tree nursery sites near Hudson Bay, Sask. N.F.R.C. Info. Report NOR-X-119.

Nyborg, M. W. B. McGill, L. W. Carlson and W. D. Holland, 1974. Methods of establishing plant growth after heavy oil spills. *In* D. Hocking and W. R. MacDonald (Ed.) Proc. of workshop on reclamation of disturbed lands in Alberta. N.F.R.C. Info. Report NOR-X-116, p. 139-150.

16. Signatures:

Lester W. Carlson
Investigator

Program Manager

Director

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: The role of fire in the ecology of jack pine.
   Study (a) Ecological effects of burning.
   Study (b) The effect of depth to water table on tree seedling growth.

3. New: Cont.: X   4. No.: NOR 047

5. Study Leader: H. P. Sims

6. Key Words: *Pinus banksiana*, root, growth, competition, nutrients, burn, mammals, *Picea mariana*, *Picea glauca*, *Pinus resinosa*.

7. Location of Work: Sandilands Provincial Forest, Manitoba

8. Problem:

In our northern forests fire is an important factor in the life cycle of jack pine, a pioneer species particularly well adapted to succession following wild fire. However, regeneration following harvest of this valuable timber species is often a problem and efficient methods of seedbed and site preparation are being sought. By investigation of the role of fire in the life cycle of jack pine and by determination of specific fire effects on the environment and on the establishment and early growth of this species it is hoped that prescribed fire can be eventually utilized as an efficient, effective regeneration method.

Several areas were prescribed burned and vegetation, soil nutrients and microclimate (temperature and moisture) studied on the burned sites.

Observations and plot studies in southeastern Manitoba suggested that in sandy soils the most significant edaphic factor influencing forest growth and distribution is depth to water table. Mean 50-year site indices for jack pine *(Pinus banksiana)* varied from 40 on dry sands without water table influence to 54 on moist sands with late-season water table depths of 4 to 5 feet. Vigorous black spruce *(Picea mariana)* understorey frequently occurred in moist sandy soils and was absent in dry sandy soils.

For the purpose of testing this hypothesis a greenhouse experiment was initiated in March, 1961 to study the response of tree seedlings to a gradient of depth to water table on an artificial slope. Although behaviour of mature trees is not necessarily borne out by the behaviour of seedlings, it was assumed that if variations in depth to water table produce variations in growth response of seedlings, a relatively similar pattern may be exhibited by mature trees. Moreover, seedling survival determines, to a large extent, mature forest distribution patterns. The results find application in ecological classification of the land for management and silviculture.

The use of tree seedlings is also of immediate practical application. In reforestation, knowledge regarding seedling growth and survival is of extreme importance in directing the more costly practices to these sites that promise to yield maximum returns. For this reason the two other regionally important conifer species, red pine *(Pinus resinosa)* and white spruce *(Picea glauca)* were also included in the experiment. Both species are rare as stand components of present mature stands in southeastern Manitoba, but are of immediate importance for planting.

9. Study Objectives:

   a. To determine the effects of fire on the environmental factors affecting germination, growth and development of jack pine.

   b. To test the hypothesis that in sandy soils, depth to water table is the most significant edaphic factor influencing forest growth and species distribution.

10. Resources:

    a. Starting date: 1961
    b. Estimated year of completion: 1973 Revised: 1975
    c. Estimated total Prof. man-years required: 0.2
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years Prof. 0.1
    Supp. -
    Casual Nil
    Total 0.1   O & M funds req'd: Nil

11. Progress to Date:

Study (a)

In 1964 a combined fire research program was initiated in south-eastern Manitoba to study the use of fire for seedbed and planting site preparation (MS 245), fire behaviour (MS 603) and ecological effects of prescribed burning (MS 243). Prior to 1964 some ecological studies had been carried out on wild fire areas.

From 1961 to 1969 root and stem growth characteristics of jack pine seedlings in the age class one-to-ten years were studied on four burned over sites.

From 1964 to 1972 ecological effects of prescribed burning were studied on five areas. Effects on lesser vegetation, physical and chemical soil characteristics, and rodent populations were studied.

Progress reports were prepared annually to 1968 for each of the two studies combined under this project. In 1964 a paper was published on the root growth of jack pine on a burned over dry site.

In 1968 a paper was published on effect of extracts of burned pine litter on germination of jack pine seed.

In February, 1970 a paper was published on the recovery of vegetation after a light burn on a mixed pine-hardwood cover.

In 1973 a manuscript on reinvasion of rodents on burned areas was published.

In 1974 a manuscript on effects of prescribed burning on physical soil properties was submitted to Journal of Forest Research. Preparation of a second manuscript on effects of prescribed burning on vegetation was started.

Study (b)

Seedlings of four tree species were grown in two soil-filled tanks each containing soil from a different site. A continuously renewed water table was adjusted to six inches at the bottom of each tank.

Tanks were watered to simulate summer showers. At the end of the experiment all seedlings were removed and height, diameter, and ramification of tops were measured. Root systems were measured and seedlings were oven-dried and weighed. Soil texture, pH, permanent wilting percentage, field capacity, organic matter content, and total exchange capacity were measured. The experiment was repeated except that three grasses were grown in the tanks to provide competition.

Four reports have been published and the study terminated.

12. Goals for 1974-75:

Preparation of two publications from dissertation material -

1. The effects of prescribed burning on some physical soil properties of dry sites in southeastern Manitoba.

2. Vegetation development following prescribed burning of dry sites, southeastern Manitoba.

13. Accomplishments in 1974-75:

1. A manuscript "The effects of prescribed burning on some physical soil properties of dry sites in southeastern Manitoba" had been submitted to J. of For. Research.

2. Manuscript "Vegetation development following prescribed burning of dry sites, southeastern Manitoba" is in initial stages of preparation.

14. Goals for 1975-76:

1. Completion of manuscript on vegetation development following burning in southeastern Manitoba.

2. Preparation of manuscript "The effects of prescribed burning on some chemical soil properties of dry sites in southeastern Manitoba".

15. Publications:

Up to 1974-75

Study (a)

Sims, H. P. 1964. Root development of jack pine on burned over dry sites in southeastern Manitoba. Canada Dept. of Forestry. Publ. 1061.

Sims, H. P. 1968. Effects of water extracts of burned pine duff on germination of jack pine seed. Bi-monthly Research Notes 24(2).

Sims, H. P. and N. G. Bruce. 1969. Recovery of vegetation and its effects on survival of planted jack pine seedlings after a light burn on a mixed pine-hardwood cutover. Pulp and Paper Magazine of Canada, February, 1969.

Sims, H. P. 1973. Some ecological effects of prescribed burning on cutover jack pine (*Pinus banksiana)* sites southeastern Manitoba. Ph.D. dissertation submitted in fulfillment of requirements, Duke Unviersity - Accepted.

Sims, H. P. and Charles H. Buckner. 1973. The effects of clear-cutting and burning of *Pinus banksiana* forests on the populations of small mammals in southeastern Manitoba. Amer. Midl. Nat. 90(1):228-231.

Study (b)

Mueller - Dombois, D. and H. P. Sims. 1966. Response of three grasses to two soils and a water table depth gradient. Ecology 47:644-648.

Sims, H. P. and D. Mueller - Dombois. 1968. Effect of grass competition and depth to water table on height growth of coniferous tree seedlings. Ecology 49:597-603.

1974-75

Nil

16. Signatures:

H. P. Sims
Investigator

L. Ackerman
Program Manager

G.T. Silver
Director G.T. Silver

NOR 048

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Ecological characteristics of seedbeds created by a middle-buster plow.

3. New: Cont.: X 4. No.: NOR 048

5. Study Leader: H. P. Sims

6. Key Words: *Pinus banksiana*, microclimate, strip cut, germination, mortality.

7. Location of Work: Sandilands Provincial Forest, Manitoba.

8. Problem:

Scarification is necessary in order to obtain acceptable restocking of jack pine cutovers in Manitoba. The method of scarification under study creates five seedbed types. Determination of the relative capacities of the seedbeds created for germination, survival and growth, will assure that maximum benefit can be obtained from investment in this treatment.

Scarification is required for both seeding and planting. Cost of planting is increasing significantly and therefore maximizing growth by astute selection of planting microsite will yield long term benefits. If seeding can adequately replace planting on some sites, the cost benefits will be both immediate and long term.

The probability of successful practical application of results is very good; new scarification equipment (shark finned barrel scarifiers) creates essentially similar seedbeds.

Germination, survival and growth of seeded jack pine and survival and growth of planted jack pine (2-0 stock) was recorded on the five seedbeds. Cause of mortality was recorded. Measured parameters were related to temperature and moisture conditions of seedbeds.

9. Study Objectives:

   a. To assess germination and growth potential of jack pine seedlings on five seedbeds.

   b. To determine some of the more important biotic and microclimatic factors causing mortality.

10. Resources:

   a. Starting date: 1962
   b. Estimated year of completion: 1972 Revised: 1975
   c. Estimated total Prof. man-years required:
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	Nil	
Supp.	Nil	
Casual	Nil	
Total	Nil	O & M funds req'd: Nil

11. Progress to Date:

In 1962, 1963 and 1964 the study was carried out on three strip-cut sites scarified with a middlebuster plow. Seed spotting and planting was done on five seedbeds created by the plow and measurements of germination, mortality and height growth were related to soil temperature and moisture measurements.

In 1964, 1965 and 1966 the study was carried out more intensively on a dry site.

A progress report was prepared annually to 1969.

One manuscript was published in 1973.

Seeding trials, according to prescription of a 1970 publication (see publications), but omitting seed treatment for protection against rodents and birds, are being carried out in southeastern Manitoba under the supervision of Mr. L. D. Nairn.

12. Goals for 1974-75:

Complete publication of manuscripts and terminate study.

13. Accomplishments in 1974-75

   1. Manuscript "Evaluation of seedbeds for jack pine regeneration in southeastern Manitoba" completed (Envir. Can. Can. For. Serv. Inf. Rept. NOR-X-87).

2. Manuscript "Temperature and moisture conditions on a plowed jack pine strip act in southeastern Manitoba" submitted to Journal of Forest Research.

3. Study terminated.

14. Goals for 1975-76:

None. Study terminated.

15. Publications:

Up to 1974-75

Sims, H. P. 1970. Germination and survival of jack pine on three prepared cutover sites. Can. Dept. Fisheries & Forestry, Canadian Forestry Service. Publ. 1283.

Walker, N. R., H. P. Sims and R. F. DeBoo. 1971. Deer browsing in jack pine plantations in southeastern Manitoba. Canadian Forestry Service Info. Rept. A-X-43.

Sims, H. P. 1972. Jack pine in southeastern Manitoba; a compendium of research, 1967-1970. II Survival and growth of jack pine on prepared seedbeds. Canadian Forestry Service Info. Rept. NOR-X-50B.

1974-75

Sims, H. P. 1975. Evaluation of seedbeds for jack pine regeneration in southeastern Manitoba. Environment Canada. Can. For. Service Info. Rept. NOR-X-87.

Sims, H. P. 1975. Temperature and moisture conditions on a plowed jack pine strip cut in southeastern Manitoba. Submitted to Can. J. For. Res.

16. Signatures:

H. P. Sims
Investigator

Program Manager

G. T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: The use of prescribed burning in jack pine management in southeastern Manitoba.

3. New: Cont.: X 4. No.: NOR 049

5. Study Leader: H. P. Sims

6. Key Words: Regeneration, *Pinus banksiana*, planting, seeding, barrel scarification, site preparation.

7. Location of Work: Sandilands Provincial Forest, Manitoba

8. Problem:

By sheer persistence, jack pine cutovers in Manitoba and some in Saskatchewan are being restocked. Essentially, an area is scarified, planted with nursery stock, and replanted as necessary. Federal research, most notably on site preparation methods, has contributed to current regeneration successes.

However, there is in this procedure considerable room for refinement and cost reduction. This has been made especially so by the recent availability of improved methods of site preparation (e.g., barrel scarification and prescribed burning) and by the promises of new regeneration techniques such as the use of "assisted (container) seedlings". Moreover, direct seeding has not been adequately investigated as an economic alternative to planting.

Fall and spring seeding and planting of jack pine are being tested at various intervals after burning or burning and scarifying. Survival and growth of planted stock and germination, stocking and growth of germinants on direct seeding plots are measured each fall for two years, and at five years.

9. Study Objectives:

   a. To determine the effect of post-burn intervals before planting and seeding.

   b. To compare the success of seeding and planting on areas burned, burned and scarified, and scarified.

10. Resources:

   a. Starting date: 1967
   b. Estimated year of completion: 1968 Revised: 1976
   c. Estimated Total Prof. man-years required: 0.2
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.1		
Supp.	0.1		
Casual	Nil		
Total	0.2	O & M funds req'd:	100

11. Progress to Date:

Accomplishments to beginning of fiscal year under review:

First, second and third year spring and fall seeding and planting have been completed on areas logged during the winter of 1966-67 and treated (burned, burned and scarified, scarified only) in 1967.

First and second year examinations of the results of the first, second and third year spring and fall seeding and planting have been completed.

The fifth year examination of the first and second spring and fall seeding and planting has been completed.

12. Goals for 1974-75:

The fifth year examination of the third year spring and fall seeding and planting will be completed. This will be the final field measurement of this study.

13. Accomplishments in 1974-75:

The fifth year examination of the third year spring and fall seeding and planting was completed.

14. Goals for 1975-76

   1. Compilation and analysis of data; preparation of publication.

   2. Terminate study.

15. Publications:

Up to 1974-75

Walker, N. R. and R. C. Dobbs. 1968. The use of prescribed burning in jack pine management in southeastern Manitoba. Internal Report MS-74:15 pp.

Walker, N. R. 1969. The use of prescribed burning in jack pine management in southeastern Manitoba. Internal Report MS-92:10 pp.

1974-75

Nil

16. Signatures:

N. P. Sims
Investigator

R. Ackerman
Program Manager

G. T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: The effect of rooting volumeon the growth of lodgepole pine and white spruce seedlings.

3. New: Cont.: X 4. No.: NOR 105

5. Study Leader: L. W. Carlson

6. Key Words: container seedlings

7. Location of Work: Northern Forest Research Centre, Edmonton.

8. Problem:

Optimum rooting volume for coniferous container seedlings at different stages of their nursery growth has never been determined. Previously container size has been decided by convenience and economics. Preliminary investigations showed a reduction in size in the first 20 weeks in rooting volumes of less than 2.5 cu. ins. This study was designed to show optimum rooting volume up to age 20 weeks.

A knowledge of optimum rooting volume would allow growers to obtain near maximum growth in a given time and to decide on necessary outplanting size based on limiting container volume. The knowledge would also have application in bare root culture.

The probability of success was high. The results of a preliminary investigation had already been put into practice in Alberta, by adopting 2.5 cu ins, as minimum size. Refinements were anticipated by growers.

A laboratory experiment was designed testing seven volumes from 0.60 cu ins. to 32.0 cu ins. and testing four volumes (0.6, 2.0, 8.0, 32.0) in three combinations (1:1, 1:3, 1:6) of diameter and height. Growth was measured by destructive sampling at 4, 8, 14 and 20 weeks.

9. Study Objectives

   1. To determine whether rooting volume (in cylincrical form) affects the growth of lodgepole pine seedlings in their first twenty weeks from germination.

   2. To determine whether the manner in which a given volume is constituted (ratio of diameter/height) affects seedling growth.

10. Resources:

   a. Starting date: 1971
   b. Estimated year of completion: 1972 Revised: 1976
   c. Estimated total Prof. man-years required: 0.1
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.1	
Supp.	-	
Casual	-	
Total	0.1	O & M funds required: Nil

11. Progress to Date:

Experimental work and data analysis complete for both spruce and pine 1st draft of publication on spruce completed and being revised. Publication on pine has been accepted by the Canadian Journal of Forest Research.

12. Goals for 1974-75:

Revise manuscript for lodgepole pine and prepare manuscript for white spruce.

   1. The effect of rooting volume on the early growth (lodgepole pine seedlings).
   2. The effect of rooting volume on the early growth (white spruce seedlings).

13. Accomplishments in 1974-75:

   1. Manuscript on the effect of rooting volume on the early growth of lodgepole pine seedlings has been revised and accepted for publication by the Can. J. For. Res.

      Endean, F. and L. W. Carlson 1975. The effect of rooting volume on the early growth of lodgepole pine seedlings. Can. J. For. Res. *In Press*.

   2. Manuscript on spruce vs rooting volume has been prepared and is in the first draft and review stage.

14. Goals for 1975-76:

1. Revise manuscript for white spruce and submit it for publication.

2. To reexamine data on volume and data on growth in different rearing schedules with possibility of publishing article for nursery men.

15. Publications:

Up to 1974-75

Endean, F. 1971. The effect of available rooting volume on the growth of lodgepole pine seedlings. N.F.R.C. Internal Report A-42.

1974-75

Endean, F. and L. W. Carlson 1975. The effect of rooting volume on the early growth of lodgepole pine seedlings. Can. J. For. Res. *In Press*.

16. Signatures:

Lester W. Carlson
Investigator

[signature]
Program Manager

G.T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Outplanting trials of the BC/CFS plugs and the RCA sausage containers in Alberta.

3. New: Cont.: X 4. No.: NOR 111

5. Study Leader: H. J. Johnson

6. Key Words: Reforestation

7. Location of Work: Alberta

8. Problem:

In the past researchers working on reforestation problems in the Prairie Provinces have not had the benefit of reliable data from large-scale trials or operations on which to rate the field performance of a reforestation technique. This "feed-back" is essential as the information will have a strong influence on the direction and scope of reforestation research in the region. Consequently, trials commenced in 1971 to compare two promising plug types of greenhouse reared seedlings (BC/CFS plugs and RCA sausages) with conventional bare-root plants from standard production runs. It was realized that further research was required on optimum rooting volume, conformation of the plug, rearing schedules and the hardening-off process. However, this is being done concurrently with the initial pilot trials. The trials are being replicated over six representative sties in the province over a three-year period (1971, 1972 and 1973).

9. Study Objectives:

The objective of this study is to provide survival and growth data of promising root-plug reforestation methods for the benefit of forest management agencies and the stand establishment research group.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: 1976 Revision 1:1978 Revision 2: 1979.
c. Estimated total Prof. man-years required: 1.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.2		
Supp.	0.5		
Casual	0.3		
Total	1.0	O & M funds required:	$2,000.

11. Progress to date:

Six locations in Alberta and one in Northwest Territories were selected with F. Endean for the establishment of performance trials of the BC/CFS Styroplugs and R.C.A. Peat Sausages. Stock was reared in N.F.R.C. greenhouses according to specifications developed at the centre. Plantations were established in 1971, 1972 and 1973. Because of severe damage to plantations by rabbits and extreme drought it was necessary to add replicates in 3 areas in 1974. Generally each plantation consisted of 2,000 Styroplugs and 2,000 R. C. A. Sausages with 500 Conventional 3-0 seedlings planted for comparison. In most locations the number of seedlings planted was doubled to test both spruce and pine.

A remeasurement schedule was set up to monitor the plantations 3 and 5 years after planting. To date first year measurements have been made on all plantations and 3rd year measurements on the 1971 plantations. Progress reports have been prepared for all establishments first year remeasurements and the one third year remeasurement.

12. Goals for 1974-75:

1. First year survival and growth measurements will be made of stock planted in 1973. These results will be submitted to the Alberta Department of Lands and Forests and the Regional Stand Establishemnt Group as a report of preliminary results.

2. Conclude establishment of plantations by replanting three areas (Grande Prairie, Crowsnest and Fort Smith) hit hard by rabbits and extreme drought.

3. Prepare manuscript for container planting symposium, Denver, Colo., utilizing data from NOR-111, 118, 073 and 113.

13. Accomplishments in 1974-75:

1. First-year survival and growth measurements were made on trials planted in 1973. This included collection of sample seedling's for dry weight determinations. A progress report was prepared and submitted to the Alberta Department of Lands and Forests.

   Walker, N. R. 1975. Outplanting Trials of the British Columbia Forest Service/Canadian Forestry Service Plugs and the Research Council of Alberta Sausage Containers File Report.

2. Failed plantations were replanted in three areas during 1974 (Grande Prairie, Crowsnest and Fort Smith). Failures to the three plantations were due to rabbits and extreme drought. This concluded the establishment of plantations for the trial.

3. Available results from NOR-10-111 and results from NOR-17-118, NOR-17-073 and NOR 17-113 were combined and prepared for a Container Planting Symposium at Denver, Col.

   Johnson, H. J. 1974. Canadian Forestry Service Container Planting Trials in Alberta, Saskatchewan and Manitoba. Proceedings of the North American Containerized Forest Tree Seedling Symposium, Denver, Colorado. August 26-29, 1974.

14. Goals for 1975-76:

1. First year survival and growth measurements will be made on all areas planted in 1974.

2. Third-year remeasurements will be made of areas planted in 1972.

15. Publications:

Up to 1974-75

Johnson, H. J. 1974. Canadian Forestry Service Container Planting Trials in Alberta, Saskatchewan and Manitoba. Proceedings of North American Containerized Forest Tree Seedling Symposium, Aug. 26-29, 1974.

16. Signatures:

H. Johnson
Investigator

K. Ackerman
Program Manager

Gschwer
Director

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Nursery soil fertility and seedling growth.

3. New: Cont.: X 4. No. NOR 135 (formerly 909)

5. Study Leader: I. K. Edwards

6. Key Words: Nutrient uptake, plant nutrition, *Pinus contorta, Pinus banksiana, Picea glauca.*

7. Location of Work: Oliver, Alberta and Prince Albert, Saskatchewan.

8. Problem:

Nature of Study:

Growing bare root and containerized coniferous stock under different fertilizer regimes and cultural practices in provincial nurseries in order to optimize production.

Benefits to be expected from the solution:

a. Higher quality of seedlings in terms of height, weight, top/root ratio and higher survival in stand establishment.

b. Reduced growing cycle in the nursery thus affording more efficient use of resources.

Probability of success:

High but progress will be slow. Seedlings are grown in nurseries for three years before being field-planted. Besides, subsidiary work may be necessary to establish firm conclusions about certain treatments either in the nursery or at field sites.

Probability of results being put into practice:

Potentially high but decision rests entirely with provincial nursery management. Demonstration plots may be necessary to accomplish implementation.

Method used:

Seedlings are grown in the nurseries in the presence of different combinations of N, P and K fertilizers. The optimum combination will be selected according to seedling quality in the nursery and on field survival. Support studies of cultural practices will provide data on such aspects as best nutrient source, time and method of fertilization.

9. Study Objectives:

   a. To determine the nutrient requirements of coniferous species being produced in the nurseries and greenhouse.

   b. To determine the effect of nutrient regime in the nursery on the performance of out-planted stock.

   c. To determine the effects of seedling density, fertilizer type, time and method of placement on seedling growth.

   d. To determine the effect of irrigation on the loss of nutrient ions from the soil.

   e. To determine the effect of soil amendments on the availability of nutrient ions.

10. Resources:

   a. Starting date: 1971
   b. Estimated year of completion: 1978
   c. Estimated total Prof. man-years required: 5.8
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major items beyond 1975 with costs: Nil
   f. 1975-76 man-years

Prof.	0.9	
Supp.	1.5	
Casual	0.3	
	2.7	O & M funds required: $2,700.

11. Progress to Date:

Prince Albert, Sask.

1. Soil analyses for transplant fields and recently cleared areas completed. Both sets of data will be incorporated in a final report on fertility status of the nursery.

2. Experimental plots were established to determine the effects of N, P & K on seedling growth. Plots set up to test the effects of timing of fertilization were destroyed by blowing sand.

3. Lysimeters were installed in certain fields to try to determine the effect of irrigation on loss of nutrients.

Oliver, Alberta

4. Established experiment to test the effect of N, P, K on growth but after two years it had to be abandoned on account of weeds.

Edmonton, Alberta

5. Began container experiment in greenhouse to determine the effect of nutrition on the growth of conifers.

12. Goals for 1974-75:

Prince Albert, Sask.

1. To reseed white spruce and jack pine to test the effect of timing of fertilization and the effect of various peat-sulphur combinations. Plots for this purpose were destroyed in 1973 by blowing sand.

2. To collect growth data from N, P, K experiment plots established in 1972.

3. To complete the analysis of leachate collected to determine the effect of irrigation on loss of nutrients.

4. To publish the report "Soil fertility status of the transplant areas of the Prince Albert Tree Nursery, Saskatchewan.

Oliver, Alberta

5. To reseed white spruce and lodgepole pine to determine the optimum requirement of N, P and K. Plots for this purpose were were overgrown by weeds in 1973.

Edmonton, Alberta

6. To complete the greenhouse experiment with container-grown Pl and Sw seedlings, to analyse and report the data obtained.

7. To assess potential nursery sites near Hudson Bay, Saskatchewan and prepare a report.

8. To chemically analyze irrigation water used in the greenhouse at the Hadashville Tree Nursery, Manitoba and to advise on a water-quality problem.

9. To chemically analyze soil and seedlings from conifer seedbeds at the Indian Head Tree Nursery, Saskatchewan and to advise on plant growth problems.

13. Accomplishments in 1974-75:

Prince Albert, Sask.

1. Reseeded 64 plots each of white spruce and jack pine to test the effect of timing of fertilization and peat-sulphur applications.

2. Collected growth data for N, P, and K fertilization plots established in 1972. Foliage has been chemically analysed and both growth and nutrition data are being statistically analysed.

3. Completed analysis of leachate collected in 1973-74 and in 1974-75. The data show that nutrient loss through leaching is higher from the more fertile soils.

4. The final report on the fertility status of the transplant areas was not published as anticipated. Preparation of the report was delayed on account of back log in work load of support staff and of unscheduled work.

Oliver, Alberta

5. Reseeded white spruce and lodgepole pine on mylone-treated plots to determine the optimum requirements of N, P and K. With contract funds for weeding, the plots can be suitably maintained.

Edmonton, Alberta

6. Completed experiment with container seedlings to determine the optimum fertilizer treatment during growth in the greenhouse. Data have not been reported as anticipated because of unscheduled work.

7. Assessment of potential nursery sites near Hudson Bay, Sask. completed and a report prepared.

8. Investigation of water quality problem in greenhouse at Hadashville completed and a file report has been prepared.

9. Investigation of growth problem in conifer seedbeds at Indian Head nursery completed and a file report has been prepared.

14. Goals for 1975-76:

Prince Albert, Saskatchewan

1. To continue the experiments on a) timing of application of fertilizers and b) peat and sulphur amendments.

2. To initiate an experiment to determine the effects of fertilization in solid and liquid forms.

3. To initiate an experiment to determine the effect of various sources of nitrogen and phosphorus on growth. Greenhouse experiments will provide background information for the field study.

4. To collect and analyze more leachate samples from fields subjected to different cropping cycles.

Oliver, Alberta

5. To continue N, P, K experiment begun in 1974-75. No new work is planned.

Edmonton, Alberta

6. To prepare a report, "Nutrient requirements of container seedlings during growth in the greenhouse".

7. To initiate an experiment to determine the effect of seedling nutrition on the ability to tolerate drought stress.

   In the production of container seedlings, manipulation of nutrient regimes has been used along with other factors to induce dormancy and to develop cold hardiness. A similar approach is planned here as drought hardiness is essential to the ultimate performance of spring and summer planted stock in the region.

15. Publications:

Up to 1974-75:

Edwards, I. K. 1973. Soil fertility status of the seedbed area of the Prince Albert Tree Nursery, Saskatchewan. Information Report NOR-X-46.

Holland, W. D. and I. K. Edwards. 1973. Site investigation for location of Alberta Forest Service Tree Nursery. Information Report NOR-X-68.

Edwards, I. K. and W. D. Holland. 1973. Further site investigation for location of Alberta Forest Service Tree Nursery. Information Report NOR-X-78.

1974-75

Edwards, I. K., W. D. Holland and L. W. Carlson, 1974. Assessment of potential tree nursery sites near Hudson Bay, Saskatchewan. N.F.R.C. Info. Report NOR-X-119.

Edwards, I. K. 1974. Quality of water and nutrient solution being used in container program at Hadashville nursery, Manitoba. N.F.R.C. File Report NOR-135.

Edwards, I. K. 1974. Assessment of problems in new conifer seedbeds at Indian Head tree nursery, Saskatchewan. N.F.R.C. File Report NOR-135.

16. Signatures:

I. K. Edwards
Investigator

Program Manager

G. T. Silver
Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Effect of chemical amendments on salinization.

3. New: Cont. X 4. No.: NOR 136 (formerly NOR 932)

5. Study Leader: I. K. Edwards

6. Key Words: Solonetz, soluble salts, drainage, exchangeable sodium, *Picea glauca, Pinus contorta.*

7. Location of Work: Oliver, Alberta

8. Problem:

Nature of Study:

Removing excess salts, (mostly associated with sodium), from clayey nursery soil by leaching in the presence of chemical amendments in order to improve its productivity. The amendments include sulphur, ammonium nitrate, ammonium sulphate, ferrous sulphate, calcium sulphate and aluminum sulphate.

Benefits to be expected from the solution:

a. Increased production of nursery stock, especially conifers.

b. Achievement of a more desirable balance of exchangeable cations in the soil, i.e., reduced amounts of sodium relative to calcium and magnesium.

Probability of success:

High. It is very likely that the field portion of the study will require a system of underdrainage, at least on a relatively small scale, to facilitate percolation of water through the subsoil. To date, there has been no commitment on the part of nursery management to install one but probably they could be persuaded to do so. A basic aim of the study is to provide management with data on the effectiveness of different ameliorative agents and to assess the possibilities for reclamation. Should it be found that reclamation is not likely without the incorporation of a drainage system, then management would be informed and any further decision would be theirs.

Probability of results being put into practice:

This will depend entirely on the provincial agencies concerned. The results of the study will enable these agencies to make decisions concerning the management of a substantial portion of soils at the nursery. The affected area comprises about two-thirds of the acreage at the nursery and therefore any amelioration of the soil should have a beneficial impact on seedling production.

However, the high clay content of the soil renders it most unsuitable for growing coniferous species. The topography is undulating and proper drainage will be difficult to attain without prior levelling. In agricultural areas, deep plowing(to a depth of 18-24 inches) has improved productivity on similar soils and this might be a viable alternative at the nursery. Therefore, implementation of any research results will depend on the economic implications as seen by management.

Outline of method used:

Soil collected from the salt-affected area will be placed in columns and leached after treatment with chemical ameliorative agents. Analysis of the leachate and finally, the soil itself, will help to determine the effectiveness of these agents in displacing certain cations, e.g., sodium, from the exchange complex.

The more promising of these agents will be checked on nursery plots seeded with lodgepole pine and white spruce. At the nursery, suction lysimeters will be used to collect samples of soil leachate for analysis.

Adequate subsurface drainage is essential to the success of the nursery phase of the study. The preliminary laboratory work is being used to screen the six ameliorative agents.

9. Study Objectives:

1. To determine the effects of various kinds of chemical amendments on the cation-exchange characteristics of saline and alkali soils.

2. To determine the amount of leaching needed for the removal of excess soluble-salts from the profile.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion 1974. Revised 1975.
c. Estimated total Prof. man-years required: 1.2
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1975-76 man-years

Prof.	0.1		
Supp.	Nil		
Casual	Nil		
Total	0.1	O & M funds required:	Nil

11. Progress to Date:

1. Salt affected soils at the nursery have been delineated and data collected on certain physical and chemical characteristics.

2. Leaching of the soils in columns in the presence of ammonium nitrate and ammonium sulphate was initiated but rate of leaching was very slow.

12. Goals for 1974-75:

1. Determine hydraulic conductivity of undisturbed soil cores.

2. Complete leaching of soil columns.

3. Analyze leachate and residual soil.

4. Report results of evaluation of ameliorative agents.

13. Accomplishments in 1974-75.

1. Hydraulic conductivity was determined on undisturbed soil cores. The values were extremely low.

2. Leaching of soil columns was incomplete but terminated on account of its impracticability.

3. Leachate samples were collected and analyzed. These showed substantial amount of salt still being removed from the columns.

4. Preparation of final report not completed as scheduled on account of unexpected commitments.

14. Goals for 1975-76

1. To complete preparation of a final report, "Characteristics of certain soils at the Provincial Tree Nursery, Oliver, Alberta".

2. To terminate the study.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

I.K. Edwards

Investigator

R. Ackerman

Program Manager

G.T. Silver

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Seedling root regeneration

3. New: Cont.: X 4. No.: NOR 137 (formerly NOR 969)

5. Study Leader: L.W. Carlson

6. Key Words: Root regeneration potential (RRP), conifers, *Pinus*, *Picea*, seedling storage, seedling survival.

7. Location of Work: Northern Forest Research Centre, Edmonton, Bow Forest, Slave Lake Forest, Grande Prairie Forest, Alberta.

8. Problem:

Nature of Study

Survival of conifer seedlings in outplantings in the prairie region forests has been the subject of considerable concern. After extensive surveys it is suggested that poor survival is primarily due to poor operational procedures. In most cases the conditions of presently produced seedlings is such that there should not be any cause for concern if proper field operational procedures are followed. Control over field operations, however, is not within the scope of the present CFS research program. The above statement of seedling quality does not mean there is not any room for their biological improvement. It has been stated that we still do not know the limits of seedling growth and that more background research is needed if we are going to press those limits (Larson, Proceedings of the North American containerized Forest Tree Seedling Symposium). This type of research is included in the scope of the CFS program.

One such physiological process in conifer seedlings that requires better understanding is root regeneration. This process is singled out over others because it has a direct effect on seedling survival after outplanting (Stone and Schubert, J. For. 57: 837-841).

Environmental factors affecting root regeneration of conifer seedlings have been studied and shown to be both nursery related and planting site related (Krugman and Stone, For. Sci. 12: 451-459; Stone and Jenkinson, For. Sci. 16: 230-239). However nursery conditions had the more profound effects. These and other studies have also shown that root regeneration of conifers is periodic and that the greatest potential (root regeneration potential-RRP) for root growth occurs just prior to budbreak in the spring when the shoot is dormant.

Survival of bare root stock from the prairie region nurseries usually does not become a problem as planting occurs in the spring before budbreak. However some fall plantings occurs and success is variable depending on the time of seedling lifting (Krugman and Stone point out the effect of cold night exposure on RRP, which could explain the variable results.

The situation where bare root stock was used almost exclusively is rapidly changing with the heavy commitment to use containerized seedlings. The use of these seedlings has extended the planting period to include the entire summer. Growing conifer seedlings in containers on a year around basis does not allow for normal seasonal development (i.e. natural photoperiod, cold night exposure, etc.). These factors are needed to produce buds and "deep rest" (it is the period just prior to breaking dormancy of buds when the RRP is highest). Regardless of the time of year that seedlings are planted they should be in a physiological state similar to the onset of budbreak for the best root growth to occur. This can be attained by regulating the environment to bring the seedlings into dormancy, but requires an elaborate physical plant where millions of seedlings are concerned. Another approach is to apply erogenous hormones to the seedlings that would leave them in the desired physiological state. Knowledge of the latter technique is vague, but offers the most efficient method of handling containerized seedlings. To utilize this technique more of the basic physiology of root regeneration should be investigated.

Survival of conifer seedlings is related to rapid root regeneration after outplanting. The quality of root regeneration at any particular point in time can be measured and to some extent predicted (Stone and Jenkinson, For. Sci. 16: 230-239). This process is time consuming and in its present state of development is limited in scope. To become an effective tool in improving and monitoring conifer seedling quality the measure of root regeneration potential (RRP) has to be clearly defined and evaluation techniques have to be improved.

9. <u>Study Objectives</u>:

   a. To determine if white spruce and lodgepole pine seedlings demonstrate periodicity to root development.

   b. To develop rapid methods of testing the RRP of conifers.

c. To determine the physiological nature of root regeneration.

d. To develop methods of applying results for improving containerized seedling culture.

10. Resources:

a. Starting date: 1973
b. Estimated year of completion: 1976 Revised: 1979
c. Estimated total Prof. man-years required: 2.5
d. Essential new major equipment items for 1975-76 with costs: Rhizometer $1,500
e. Essential new major equipment items beyond 1976 with costs: 2 additional Rhizometers $3,000
f. 1975-76 man-years

Prof.	0.5
Supp.	0.8
Casual	0.3
Total	1.6

O & M funds req'd: $1,000

11. Progress to Date:

1. First year results indicated a positive correlation between RRP, as measured in greenhouse tests, and field survival one year after planting. It was speculated that minimum root production to allow survival is between 1 and 10 roots per plant.

2. Lighting during storage at 35°F (1.7°C) had no appreciable effect on the RRP of either lpp and Sw seedlings.

3. During the first year of growth, root systems of lodgepole pine showed distinct periods of growth which corresponded generally with periods of slower growth of the tops. During the second year of growth, root systems of white spruce did not show any periodic response until after the new shoots began to grow.

12. Goals for 1974-75:

1. To continue for one more year the study of the relationship of RRP to field survival of lodgepole pine and white spruce seedlings from several sources with final field results to be taken in the summer of 1975.

2. To continue to investigate the periodicity of first and second year root growth of white spruce and lodgepole pine seedlings.

3. To study the effect of the photosynthetic capability of lodgepole pine on its root regeneration potential.

13. Accomplishments in 1974-75:

1. While first year results indicated a positive correlation between RRP as measured in greenhouse tests, and field survival one year after planting the following years results are not as positive. Because of the time consuming procedure including extensive field work it is suggested a different approach to the problem be investigated.

2. Periodicity of root growth of conifers, whether in their 1st or 2nd year of growth, was similar to patterns observed in previous years. The periodic response, seen more clearly be comparing shoot/root rations, lasts from 1-2 weeks normally with an occasional 3 week response. It has been suggested that dry weight measurements of growth are questionable and that tests for total proteins would be more sensitive and quicker.

3. Data on the effect of photosynthetic capability of lodgepole pine on its RRP was inconsistent. Several factors that could be responsible were faulty equipment and poor quality seedlings. This approach should be reviewed when more sophisticated equipment and techniques become available.

14. Goals for 1975-76:

1. To take final field results of the RRP relationship to outplanting survival of lodgepole pine and white spruce.

2. To obtain data on periodicity of growth (root and shoot) using tests of total proteins and compare them with seedling dry wt data.

3. To investigate the effect of dwarfing agents (growth regulators) on the root regeneration of conifers (Since root growth seems associated with non-activity in the shoot, growth regulators that restrict shoot growth may stimulate root activity).

4. To study the relationship between initial root surface area and the root regeneration potential of conifer seedlings.

5. To prepare a file report on the methods and results of RRP studies to date.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. <u>Signatures:</u>

Lester W. Carlson
Investigator

R. Ackerman
Program Manager

GtSilver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: A co-operative pilot reforestation project in Alberta

3. New: X Cont.: 4. No.: NOR 961

5. Study Leader: J. Soos

6. Key Words: Reforestation, pilot trials, container seedlings.

7. Location of Work: Slave Lake Forest and Bow/Crow Forest, Alberta

8. Problem:

The responsibilities of the Alberta Forest Service for reforestations include old cut-over, old and new burns, contract work for quota holders on new cut-over and a variety of lands presently classified as unproductive. The responsibility is extensive in terms of area and variety of conditions and problems.

Traditionally the C.F.S. has co-operated with the A.F.S. and industry in achieving reforestation objectives by research in regeneration silviculture and related disciplines and by providing services as required. In this context the C.F.S. conducted surveys to assess the success of past reforestation programs. These surveys have shown that, by and large, reforestation programs conducted by the A.F.S. have not achieved stated objectives, and have raised serious doubts concerning the utility of current operational programs, and related research conducted by the C.F.S.

The severity of the problem has been recognized by both the Alberta Forest Service and the Canadian Forestry Service. In joint discussion a number of contributing factors have been suggested. These include inadequate staffing, inexperienced field staff, inadequate planning, poor quality stock and stock handling, inadequate site preparation and selection, and the low priority given to reforestation relative to other activities of the A.F.S. and C.F.S. In addition it was proposed that presently available knowledge on reforestation in Alberta is not being utilized. Further research on the biology of seedling growth, ecological requirements of our species and reforestation practices would be of dubious value until present knowledge is embodied in operational programs and a framework exists for acceptance of new knowledge. Accordingly, agreement has been reached to initiate a co-operative, pilot-scale reforestation program in two Alberta Forests. Forests.

The benefits of this program to the A.F.S. include better returns from their investment in reforestation, on-the-job training of staff, assistance in planning and conduct of operations and a clearer appreciation of biological problems that can yield to research. The benefits to the C.F.S. include identification of relevant research problems and better assurance, and satisfaction, that the research conducted will be effective and meaningful in terms of the problem used to justify its initiation and conduct.

The probability of success of this project depends largely on the degree of co-operation exercised by the two agencies and the ability of the C.F.S. to provide the required technical expertise. Many technical and logistical factors are involved that must be negotiated as the project develops. Current indications are that these negotiations will be successful.

The methodology to be used is presently being negotiated but agreement has been reached on the following:

1. Objectives - as stated in this proposal.

2. Identification of work areas - Slave Lake and Bow/Crow Forests.

3. Formation of program committee consisting of

    (a) Forester i/c Silviculture, Department Lands and Forests.

    (b) Liaison Forester, Department Lands and Forests.

    (c) Program Manager, Canadian Forestry Service.

    (d) Project Leader, Canadian Forestry Service.

    (e) Regional Silviculturists, Slave Lake and Bow/Crow Forests, Department Lands and Forests.

4. Drafting and acceptance of general co-operative agreement.

5. During 1974 - participation and review by project leader and regional staff (A.F.S.) of 1974 reforestation program. To be followed by joint preparation of work plans and monitoring procedures for 1975, 1976 and 1977 programs, and submission of plans to committee for approval.

9. Study Objectives:

   a. To test the hypothesis that application of presently available knowledge of sites and reforestation techniques will achieve reforestation objectives.

   b. To identify specific problems, biological or operational, that will yield to research or operational changes.

   c. To provide training, and insight into reforestation problems for both Alberta Forest Service and Canadian Forestry Service staff.

   d. By achieving the above objectives, to assure that reforestation programs conducted by the Alberta Government are successful.

10. Resources:

   a. Starting date: 1974
   b. Estimated year of completion: 1980 Revised: 1975
   c. Estimated total Prof. man-years required: -
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years Prof. -
      Supp. -
      Casual -
      Total - O & M funds req'd: -

11. Progress to Date:

   1. An agreement was drafted and signed by A.F.S. and C.F.S. outlining in general terms the objectives and scope of the project and the contribution of each service.

   2. Introductory meetings were held with A.F.S. regional and headquarters staff in the Slave and Bow/Crow Forests.

12. Goals for 1974-75:

   1. Become familiar with and document all aspects of the 1974 reforestation program in the Slave and Bow/Crow Forests.

   2. In co-operation with A.F.S. staff plan, organize and prepare work plans for the 1975 program. Work plans to constitute a full description of the program including site selection, description and preparation, reforestation methods, monitoring and the roles of the co-operating services.

13. Accomplishments in 1974-75:

   1. Field work was initiated in summer 1974 to document all aspects of the reforestation program in the Slave and Bow/Crow Forests.

2. Work plans, which were to form the basis of this study, were not initiated owing to the resignation of the study leader.

3. Study terminated. No action taken to replace the study leader or to reassign the study.

14. Goals for 1975-76:

Nil. Study terminated.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESERACH CENTRE

Date: March 20, 1975

1. Project: Improved regeneration methods for commercial forest species.

2. Title: Appraisal of natural regeneration on recent jackpine cut-overs on the Prince Albert Pulp Company Limits in Central Saskatchewan.

3. New: X Cont.: 4. No.: NOR 977

5. Study Leader: J. Ball

6. Key Words: Anchor chains, clear-cut, survey, prescriptions, *Pinus banksiana* Lamb, B18a.

7. Location of Work: Candle Lake, and other areas on the Prince Albert Pulp Company Limits in Central Saskatchewan.

8. Problem:

Jackpine is the most widely distributed pine species in Canada and, as such, is now widely harvested. Recent (Canadian Forestry statistics 1968, The Minister of Industry, Trade & Commerce) inventories indicate that it is the second most abundant conifer in Saskatchewan.

Since 1967, the Prince Albert Pulp Company has harvested 84,000 acres of its 18,000 square mile limits which have produced approximately equal amounts of spruce (species) and jackpine(S. Smith, Silvicultural Forester, Prince Albert Pulp Company Limited, Personal Communication 1973).

Various observational studies, both in Ontario and in the Prairie Provinces, demonstrate the inadequacy of regeneration following clear-cutting (Cayford, Chrosciewicz and Sims 1967, A review of Silvicultural Research in Jackpine).

To date, the Prince Albert Pulp Company Limited has treated 16,622 acres of their cutover land to regenerate jackpine using shark-finned barrels and anchor chains.

On these areas, scarification has several advantages over planting:

1. Low costs (approximately $6/acre).

2. Good results (actually overstocking in some cases).

3. Highly mechanized (60 acres/day with two machines).

The planting alternative has several severe limitations.

1. High costs (at least $35/acre).

2. Poor survival (50 percent mortality is not uncommon in prairie plantations).

3. Labour problems (planting bare root stock is a primitive type of labour demanding more supervision and additional assistance with transport and storage of stock than supervising two maching operators).

4. Good jackpine planting stock has been somewhat difficult to obtain from prairie nurseries.

Shark-finned barrels and anchor chains (as designed by the Ontario Department of Lands and Forests) have been found superior to other types of scarifying equipment in seedbed preparation in jackpine cut-overs in Northern Ontario.(1.Brown, G. 1966. A Modified Barrel Scarifier, Ontario Dept. of Lands and Forests, Timber Br., Silv. Sec., Silv. Notes No. 6, 8 p. 2. Morawski, J.R. 1966. Site Preparation, Ontario Dept. of Lands and Forests, Timber Br., Silv. Sec., Silv. Notes No. 8, 8 p.)

However, the application of this scarification method has been comparatively recent and, in Central Saskatchewan, for example, operational trials using these scarifiers had not hardly begun prior to 1969. Since this time, large acreages have been treated (by the Company) and, so far, information as to the potential and/or limitations to the success of these treatments on various existing site conditions in this region has been lacking.

As a result, the Prince Albert Pulp Company Limited has requested the Canadian Forestry Shrvice to conduct an assessment of these trials. Current indications are that suggestions emanating from this appraisal and/or recommendations from subsequent research would be implemented by the Company.

9. Study Objectives:

To assess stocking of jackpine regeneration on areas scarified by the Prince Albert Pulp Company during 1969, 1970, and 1971.

10. Resources:

   a. Starting date: 1974
   b. Estimated year of completion: 1975
   c. Estimated total Prof. man-years: -
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years Prof. -
      Supp. -
      Casual
      Total - O & M funds req'd: -

11. Progress to Date:

A reconnaissance of many of the 1969, 1970 and 1971 scarifications was carried out in the early summer of 1974. All scarifications three years old or older were then examined using sequential sampling techniques. Data have been compiled and analysed; a publication is expected later this year.

12. Goals for 1974-75:

1. To carry out a regeneration survey on all areas scarified during 1969, 1970 and 1971 (5,115 acres) and all areas with a similar logging history that were not treated (approximately 2,500 acres). Large blocks would be split up into 100 acre units to be sampled sequentially.

2. To sample sequentially each block or sub-block to determine:

   a. stocking
   b. stem/acre
   c. mineral soil exposure

   These data would be collected from each quadrat or list quadrat.

3. To describe general features of each "block":

   a. moisture regime
   b. seedbed surface
   c. vegetative competition
   d. amounts of slash, duff, litter
   e. residual hardwoods
   f. felled hardwoods
   g. aspen suckers and shading
   h. photographs

4. To stratify these data according to:

   a. original cover type or at least

(i) pure jackpine
(ii) jackpine-spruce or spruce-jackpine
(iii) jackpine-aspen or aspen-jackpine

b. logging history
c. post logging treatment
d. Prepare report for publication and terminate study.

13. Accomplishments in 1974-75:

1. All areas scarified in 1969, 1970 and 1971 were surveyed.

2. Twenty-three 200 acre blocks were sequentially sampled as planned.

3. General features of each block were described as planned.

4. Data were stratified by year of scarification and by area.

14. Goals for 1975-76:

Nil. Study terminated.

15. Publications:

Up to 1974-75

Nil

1974-75

An information report, An appraisal of natural regeneration on scarified jack pine cutovers, Saskatchewan, is now being reviewed locally.

16. Signatures:

L. Ceckerman for J. Ball.
Investigator

L. Ceckerman
Program Manager

GTSilver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March, 1975

1. Project: Improved Regeneration Methods for Commercial Forest Species.

2. Title: A reconnaissance to determine the stocking status of high quality sites in Eastern Saskatchewan.

3. New: X

4. No.: NOR 988

5. Study Leader: J. Ball

6. Key Words: Silviculture, white spruce, aspen cut-overs, burns, B18a,B15, Canada Land Inventory.

7. Location of Work: C.L.I. Forestry Site classes two, three and four located mainly in the Mixedwood section of the B18a in Eastern Saskatchewan.

8. Problem:

Concern has been expressed over the future of wood supplied in Eastern Saskatchewan where there are said to be thousands of acres of highly productive sites which have been degraded to scrub and brushland through a history of "selective" logging and repeated burns.

This problem of low productivity on high sites following disturbance is fairly common in the B18a where the incapability of white spruce to regenerate itself adequately and establish well stocked stands is a generally recognized fact.

The Pasquia Hills and Hudson Bay areas have consistently produced large timber (indicative of high sites) for over half a century. The forest industry in this area is expanding rapidly, and the resource base of good quality timber is shrinking. Economically, it is advisable to return currently unproductive good quality sites to full production with site classification and accessibility determining priority of reforestation attempts.

Representatives from the various local industries and the provincial government through the Saskatchewan Regional Advisory Committee have asked for a study to determine the magnitude of poor stocking problems on highly capable sites. If the assessment indicates a need, this study will provide the information base required for design of R & D program to return the land to a productive state.

9. Study Objectives:

a. To obtain a stocking and status estimate of highly productive forest sites in Eastern Saskatchewan.

b. To make this fundamental data available for forest land management.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1977
c. Estimated total Prof. man-years required: 1.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.7	
Supp.	0.7	
Casual	-	
Total	1.4	O & M funds req'd: $1,500

11. Progress to Date:

In anticipation of further work, those lands classified by C.L.I. as capability classes 2, 3 & 4 were located on the Pasquia Hills, Hudson Bay, Pas, Swan Lake and Duck Mountain map sheets.

12. Goals for 1974-75:

N/A. New study.

13. Accomplishments in 1974-75:

N/A.

14. Goals for 1975-76:

1. Through discussion with N.F.R.C. and Provincial personnel, design survey to accomplish study objectives.

2. To carry out a field survey of selected representative areas to determine the status of these in terms of current stocking, and regeneration.

3. To prepare a report summarizing the findings and make recommendations for future work.

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

R. Ackerman for F. Ball

Investigator

R. Ackerman

Program Manager

G.T. Silver

Director G.T. Silver

PROJECT NOR - 12

Genetic Improvement of Commercial Forest Species

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Genetic improvement of commercial forest species.

2. Title: Provenance tests for coniferous species.

Experiment a. (Formerly MS 187) Provenance experiments with the white spruces of Manitoba and Saskatchewan.
Experiment b. (Formerly MS 089) Red pine (*Pinus resinosa*) provenance experiment.
Experiment c. (Formerly MS 088) Scots pine (*Pinus sylvestris*) provenance experiment.
Experiment d. (Formerly MS 234) A test of twelve Norway spruce provenances from northern Europe and Siberia -- Riding Mountain Research Area.
Experiment e. (Formerly MS 019) All-range jack pine provenance experiment, Manitoba-Saskatchewan sub-experiment.
Experiment f. (New) Geographic variation in black spruce. Northern Region component.

3. New: Cont.: X   4. No.: NOR 050

5. Study Leader: J. I. Klein

6. Key Words: Geographic variation, seed sources, seed zones, Alberta, Manitoba, Saskatchewan, exotic species, *Picea abies*, *Picea glauca*, *Picea mariana*, *Pinus banksiana*, *Pinus resinosa*, *Pinus sylvestris*.

7. Location of Work: Wasagaming, Vassar, Piney, Oakbank, Sundown and Carberry, Manitoba; Big River, Holbein, and Indian Head, Saskatchewan.

8. Problem:

This study comprises provenance experiment with six conifer species. Five are sub-experiments of cooperative investigations initiated by Petawawa Forest Experiment Station. The white spruce experiment was undertaken by the District Forest Officer stationed in Winnipeg.

Each experiment involves establishment of plantations containing populations of varying geographic origin, and comparison of performance among populations over an extended number of years.

Application of the results of this experiment is expected to lead to improved productivity of forest plantations, in consequence of increasing genetic suitability of seed source. All of the component experiments are capable of yielding some progress toward this goal. None is capable of disposing of the provenance question as a research problem for an important plantation species in this Region.

Operational application of the results will depend upon their inherent practical value, and on availability of seed from the desired sources. Interest of provincial foresters in using improved seed seems assured. Prospects for practical application appear relatively good for the Scots pine experiment, but immediately available seed is limited to that produced in the test plantations. Probable usefulness of the white spruce and red pine experiments is limited by the small number of provenances tests in relation to their geographic range. The jack pine and black spruce experiments are likely to offer greater practical benefits east of this Region. Early growth in the Norway spruce test appears to offer little promise of immediate practical usefulness, but this prospect may improve in the years to come.

All six experiments share the familiar general procedure for provenance testing. Planting stock is grown from seed of known and varying geographic origin. Seed is usually collected from several to many trees of each source population. Replicated plantations are established in one or more locations. The experimental unit is a plot containing some number of trees from one source. Performance of the trees from each source is observed and scored periodically for as long as the test is deemed worthy of maintenance. Inferences are drawn from the performance scores, about expected performance of trees that might be grown from seed originating in some area about the tested provenances, when planted on sites similar to the experimental plantation site.

9. Study Objectives:

    1. To screen populations of conifer species for possible usefulness for planting in various areas within the Northern Region.

    2. To obtain an indication of the probable usefulness of further provenance testing or similar research with the species under trial and to guide the planning of such research.

    3. To obtain information on patterns of geographic variation in the species under trial.

    4. To identify adapted genotypes among the introduced populations for further breeding use.

10. Resources:

a. Starting date: white spruce: 1955, red pine: 1958, Scots pine: 1960, Norway spruce: 1960, jack pine: 1968, black spruce: 1971.
b. Estimated year of completion: indefinite and various.
c. Estimated total Prof. man-years required: 10
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.4	
Supp.	0.3	
Casual	-	
Total	0.7	O & M funds required: $1,000

11. Progress to Date:

White spruce

In May, 1959 a plantation was established near Wasagaming, Manitoba, with transplants of 14 Ontario and Quebec populations, plus one each from Manitoba and Saskatchewan. Ontario and Quebec stock had been sown at Petawawa Forest Experiment Station. All planting stock except for the Saskatchewan population had been lined out, without replication, at the Riding Mountain National Park nursery since spring, 1956. The plantation is in random block design with 4 replicates and 49-tree square plots. Transplants of 13 Manitoba and Saskatchewan populations plus one Ontario population were planted near Wasagaming in September, 1959. Several provenances were represented by one single-tree progeny. Plantations lacking three of the western populations were established near Big River, Saskatchewan and Vassar, Manitoba in September and October, 1959. Planting stock production for the three latter plantations was carried out in nurseries near the respective planting sites, in unreplicated plots. Each of these three plantations has three replicates with 25-tree square plots. The Big River plantation is spaced 4 x 4 feet, the others 6 x 6 feet.

Height measurements, morphological descriptions, and phenology were recorded during the nursery phase for all populations. Survival and condition for all plantations were recorded in 1960. Dead seedlings were replaced in the western origin plantations in 1960. Height, survival, and condition were recorded for all plantations in 1961, for the Big River plantation in 1965, and for the Wasagaming plantations in 1966 and 1970. Chemical and mechanical weed control was done in some years. In 1973 the four plantations were examined for evaluation of their future status. The Wasagaming and Moodie plantations were judged to merit further measurement, but the Big River plantation was so heavily browsed as to be useless.

Red pine

A plantation was established near Piney, Manitoba, in May, 1958, with four-year-old transplants produced at Petawawa Forest Experiment Station.

Nine populations from Ontario, Quebec, Michigan, and New Brunswick were arranged in five randomized blocks, with 49-tree square plots at 4 x 4 foot spacing. Red pine of local origin was planted in single rows between plots, and in two rows surrounding the planting. The plantation has been measured three times, most recently in June, 1973.

Scots pine

Planting of this test was accomplished in May, 1960, near Carberry and Piney, Manitoba. The three-year-old transplants (2+1) were produced at Petawawa Forest Experiment Station. The plantations contain 10 populations from the U.S.S.R. and one from Finland. A four-replicate, randomized block design was used, with 49-tree square plots at 6 x 6 foot spacing. Scots pine transplants (2+2) grown from Manitoba seed collections of unknown origin were planted in single rows between plots and as a two-row surround. The two Manitoba plantations, plus two plantations in Saskatchewan of the same age and having the same populations, were measured in September 1974. Height and diameter were measured in all four plantations. Stem defects, insect attacks, and cone production were scored as warranted. The Saskatchewan plantations are located near Holbein and Indian Head.

Norway spruce

Three-year-old transplants of 12 populations were received from Petawawa Forest Experiment Station in May, 1960, and lined out promptly in the Riding Mountain National Park nursery near Wasagaming. Seven of the populations were of U.S.S.R. or Poland provenance, three from Swedish stands of German origin, and two were collections from adapted trees at Petawawa. In May, 1962, 400 trees of each population were planted without replication near Wasagaming. In May, 1963, a plantation was established in the same locality, using trees left in the nursery from the 1962 plantation, supplemented with trees of three populations supplied by Petawawa Forest Experiment Station. The 1963 plantation is in random block design with eight replicates and 9-tree square plots at 8 x 8 foot spacing. Two rows of planted white spruce form an outer perimeter for each portion of the 1963 plantation. The 1963 plantation has been measured four times, most recently in May, 1973. The 1962 plantation was examined in October, 1973, for assessment of its possible usefulness as a source of hardy breeding material.

Jack pine

Seed of 81 populations of range-wide provenance was sown at Birds Hill Research Nursery near Oakbank, Manitoba in 1969. Seedlings from two spring-sown replicates were planted near Sundown, Manitoba in May, 1972. Seedlings from the two fall-sown replicates were planted near Smeaton, Saskatchewan in June, 1972. The Smeaton plantation was unsuccessful, for reasons not readily apparent. The Sundown plantation has 5 replicates in lattice-square design, with

4-tree row plots, at a spacing of 6 x 6 feet. Survival and condition of the planted seedlings at Sundown were recorded in June, 1973.

Black spruce

Sowing of about 100 populations of range-wide provenance was done at the Alberta Provincial Tree Nursery near Edmonton in May, 1971. Seedlings of about the same number of populations, with a few substitutions, were started in containers in May, 1972 and lined out at the same nursery in May, 1973.

Observations and measurements to determined time of initiation and cessation of height growth were made on 47 selected populations at the nursery during the 1974 growing season. Site preparation for three plantations, selection of populations for each plantation, and lifting and packing of planting stock were also done in 1974.

12. Goals for 1974-75:

White spruce

Nil

Red pine

Prepare an Information Report entitled "Growth of Red Pine Populations in Manitoba" based on the 1973 measurement, and assess the value of further maintenance of this experiment.

Scots pine

1. Measure the four plantations in Manitoba and Saskatchewan following the 1974 growing season.

2. Begin data processing and drafting of a report on the results.

Norway spruce

Prepare an Information Report entitled "Survival and growth of Norway spruce populations in Manitoba" based on the 1973 measurement, and assess the value of further maintenance of this experiment.

Jack pine

Nil. Another plantation should be established for this experiment, but it is proposed that this goal be deferred for one year.

Black spruce

1. Tend the seedlings and transplants at the Alberta Provincial Tree Nursery.

2. Record growth and phenology in the populations.

3. Select planting sites and arrange scarification for planting in spring 1975.

4. Stake out the planting sites following scarification.

5. Select populations to be used in the plantations.

13. Accomplishments in 1974-75:

White spruce

Nil

Red pine

Drafting of the Information Report was not done, owing to lack of professional time. Most of the required data analysis for the report has been done. Some findings are presented in the recently completed study progress report.

Scots pine

1. The four plantations were measured in autumn 1974. Height and diameter were measured in all plantations. Cone production, insect attack, and stem quality were scored as warranted.

2. Data processing has not been started owing to lack of support staff time.

Norway spruce

Processing of the 1973 measurement data has not been started owing to lack of support staff time, hence no progresss has been made on preparation of an Information Report.

Jack pine

Nil

Black spruce

1. Weeding fertilizer application, watering, and vertical root-pruning were carried out during the growing season. The plants were lifted, labelled, packed, and placed in cold storage during November.

2. Observations on time of flushing, and periodic measurement of leading shoots to determine time of height growth completion, were made on about 1300 plants of 47 selected populations. Some information may be gained from these data, but environmental conditions precluded the attainment of full value from them.

3. Planting sites were selected and scarified near Mafeking, Manitoba; Nipawin Provincial Park, Saskatchewan, and Peace River, Alberta.

4. The Manitoba and Saskatchewan sites were staked out, but the Alberta site was scarified too late in the year to leave time for staking out.

5. A source list of the populations selected for the three plantations is presented in the recently completed study progress report. This study consumed 0.38 professional man-years in 1974.

14. Goals for 1975-76:

White spruce

Measure the plantations near Vassar (Moodie) and Wasagaming, Manitoba.

Red pine

Prepare an Information Report entitled "Growth of Red Pine Populations in Manitoba", based on the 1973 measurement, and assess the value of further maintenance of this experiment.

Scots pine

Nil.

Norway spruce

Analyze the data from the 1973 measurement.

Jack pine

1. Measure the plantation near Sundown, Manitoba, following the fourth growing season from planting.

2. Draft an establishment report for the same plantation.

Black spruce

1. Establish three test plantations on the site prepared in 1974.

2. Record survival during the first growing season in plantation.

15. Publications:

Up to 1974-75

Haig, R.A. 1963. Project MS-234. A test of twelve Norway spruce provenances from northern Europe and Siberia--Riding Mountain Research Area. Canada, Dept. of Forestry, Forest Res. Br. Estab. Rep. 63-MS-20. 5 pp. + App.

Klein, J.I. 1971. Performance of Russian Scots pine populations in Manitoba and Ontario. Canada, Dept. of the Environment, Canadian Forestry Serv. Inform. Rep. NOR-X-2. 12 pp.

Roller, K.J. 1967. Tree improvement in the Manitoba-Saskatchewan Region. Proc. 10th Meet. Comm. Forest Tree Breed. Can., Vancouver, B.C., Sept. 1966. Part 2:123-143.

Roller, K.J. 1968. Mortality and height growth of red pine provenances in Manitoba. Bi-monthly Res. Notes 24(4):34-35.

Roller, K.J. 1971. Survival and height growth of Norway spruce in central Manitoba. Bi-monthly Res. Notes 27(4):28.

Roller, K.J. 1971. Provenance trial with white spruce of different seed sources in central Manitoba. Proc. 13th Meet. Comm. Forest Tree Breed. Can., Prince George, B.C., Aug. 1971. Part 1:97-100.

Waldron, R.M. 1960. Provenance experiments with the white spruce of Manitoba and Saskatchewan. Canada, Dept. of Northern Aff. and National Resources, Forestry Br., Forest Res. Div. Progress Rep. 4 pp.

Waldron, R.M. 1963. Provenance experiments with the white spruce of Manitoba and Saskatchewan. Canada, Dept. of Forestry, Forest Res. Br. Progress Rep. 63-MS-10. 3 pp.

Wheaton, M.P.H. 1960. Provenance experiments with the white spruce of Manitoba and Saskatchewan. Canada, Dept. of Northern Aff. and National Resources, Forestry Br., Forest Res. Div. Progress Rep. 28 pp.

1974-75 Nil

16. Signatures

J I Klein

Investigator

L L Ackerman

Program Manager

G T Silver

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Genetic improvement of commercial forest species.

2. Title: Breeding jack pine for the Northern Region. I. First selection cycle.

3. New: Cont.: X 4. No.: NOR 051

5. Study Leader: J. I. Klein

6. Key Words: *Pinus banksiana*, progeny test, family test.

7. Location of Work: Sundown, Marchand, Stead, Oakbank, Manitobà; Smeaton, Meadow Lake, Saskatchewan; Whitecourt, Alberta.

8. Problem:

This study is the first step in an applied breeding program, aiming to identify superior genotypes within a gene pool assembled from the wild base population. Genotypes identified as superior will then be propagated by provincial forestry agencies for establishment of seed orchards. Seedlings grown from seed produced in the orchards, or produced in source stands identified as superior, will form stands expected to be more productive than either plantations from unimproved seed or natural regeneration.

The design of the study virtually assures that most of the available genetic variation in the base population will be effectively exploited as genetic gain. The magnitude of this variation in the base population, hence the actural amount of genetic gain to be expected, will not be known until study results are analyzed. No results from a similar study for this species have been reported.

Application of the study's results will involve establishment and management of seed orchards by provincial forestry agencies, and establishment of plantations using the seed produced in them. An additional application, compatible with that above, would involve management for seed production of natural stands identified as being genetically superior by the study results. Forestry officials in Saskatchewan and Manitoba have expressed interest in the study. Their willingness to invest resources in production of improved seed will doubtless be influenced by the magnitude of genetic gain achieved, and the importance of artificial regeneration of jack pine at the time improved genotypes are identified.

The area of jack pine planting interest in the Region was divided into three breeding districts, e.g., eastern Manitoba, western Manitoba and eastern Saskatchewan, and central Saskatchewan west to eastern Alberta. In each breeding district, family tests will be established on representative sites, using open-pollinated progenies of parent trees selected primarily within each district. Each family test will include 216 families in cubic lattice design. The eastern district test has 15 replicates and 4 tree plots, hence 60 trees per family and nearly 13,000 plot trees. The central and western district tests will probably have 12 replicates with the same plot size distributed on two sites in each district, hence 48 trees per family and 10,368 total plot trees per district. The total number of plot trees for the three breeding districts is thus nearly 35,000.

Clone banks will be developed to preserve the parental genotypes. Family performance, in terms of productivity and stem quality, will be scored periodically for ranking of parental genotypes, identification of superior progeny genotypes, and estimation of genetic gain. Whenever estimated genetic gain appears adequate for the purpose, scoring results will be supplied to provincial forestry agencies for establishment of seed orchards or designation of natural stands for seed production management. Successive measurements of the progeny test plantations may lead to establishment of additional seed orchard acreage having different composition from the earlier ones, to reflect changes in performance scores.

9. Study Objectives:

To produce jack pine seed genetically improved in terms of economic yield.

10. Resources:

a. Starting date: 1966
b. Estimated year of completion: 2001. Revised:
c. Estimated total Prof. man-years required: 15
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.6	
Supp.	1.2	
Casual	0.3	
Total	1.8	O & M funds req'd: $3,500

11. Progress to Date:

Collection of breeding materials, seed processing, grafting of scions from parent trees, and planting of primary grafted ramets in preliminary clone banks was begun in October 1967 and completed July 1972.

The eastern breeding district family test was sown at Birds Hill Research Nursery near Oakbank, Manitoba in autumn 1969. In spring 1972 the test was planted near Sundown, Marchand, and Stead, Manitoba. The test comprises 215 families and 1 control lot in 15 replicates with more than 12,000 plot trees. Survival and condition were recorded in spring 1973. Height was measured in October 1973 and April 1974. Statistical analysis of this measurement is in progress. An experimental seedling seed orchard using 220 eastern district families was planted near Oakbank in June 1972.

Planting stock for the western district family test was reared in fold-up plastic containers in summer 1973 and winter 1974. This test, with 214 families and 2 stand progenies, was planted in 12 replicates in spring 1974, south of Meadow Lake and north of Smeaton, Saskatchewan. Fencing of the plantation was done during the summer of 1974.

One hundred eighty three secondary ramets of eastern district clones are now lined out near the site of the permanent eastern district clone bank near Oakbank. Another 25 secondary ramets of western district clones are in pots. About 6,500 ramets are required to complete the permanent clone banks.

12. Goals for 1974-75:

1. Prepare Information Report entitled "Progress through 1973 on study NOR 051 - Breeding jack pine for the Northern Region". Anticipated length about 50 pages.

2. Collect scions from preliminary clone bank at Oakbank, and graft 550 secondary ramets for permanent clone banks at Oakbank and in Alberta.

3. Pot 1,200 rootstocks for 1975 grafting.

4. Plant secondary ramets from 1973 grafting in permanent clone bank at Oakbank.

5. Carry out required maintenance in preliminary clone bank near Whitecourt, Alberta.

6. Measure remaining 9 replicates of eastern district family test before commencement of 1974 growing season.

7. Tend western district family test seedlings during their second growth period and second chilling period.

8. Measure western district family test seedlings following completion of their second growth period.

9. Plant the western district family test, and fence the plantations.

10. Pursue acquisition of land near the NFRC for use as the site of permanent clone banks, an arboretum, and demonstration plantations.

11. Carry out required maintenance in seedling seed orchard at Oakbank.

13. Accomplishments in 1974-75:

1. About 2 months were spent drafting sections on "Rationale", "Breeding Districts", and "Parent-tree Selection" for the proposed Information Report. Completion of the study progress report for this program satisfies part of the need for this goal.

2. About 480 grafts were made by a contractor, using scions collected at Oakbank and in the other preliminary clone bank at Whitecourt. The success rate was low for the Oakbank scions, owing to inappropriate storage conditions.

3. 1200 rootstocks were potted, and about 800 to 900 will be available for 1975 grafting.

4. 54 secondary ramets not eaten by mice or otherwise killed during the 1973-74 winter were lined out near the clone bank site at Oakbank. Another 129 ramets grafted in 1974 were lined out in the same location in September. Further cultivation was done on the clone bank site during the summer.

5. Fertilizer application, rootstock pruning, required re-labelling, weeding, and ramet measurement were carried out in the preliminary clone bank near Whitecourt.

6. Measurement of the remaining 9 replicates of the eastern district family test was carried out in April 1974.

7. Seedlings for the western district family test were given a second growth period in the greenhouse from November 1973 to February 1974, then chilled in the greenhouse until they were planted.

8. Height was recorded for all plot seedlings of the western district family test on the permanent performance record following the second greenhouse growth period.

9. The western district family test, comprising 214 families and two stand collections in 12 replicates on 4 sites, was planted in May and June of 1974 and fenced during the summer of 1974.

10. A half-section of Crown land has been reserved for genetics research following an intensive search. Location is the east half of section 36, township 52 range 11 west of the fifth meridian.

11. Tree labels were moved to where they would be easily visible and would not girdle the main stem, on all surviving trees of the seedling seed orchard plantation at Oakbank. It was observed that the plantation would probably be ready for the first thinning in 1975.

This study consumed 0.62 professional man-years in 1974.

14. <u>Goals for 1975-76</u>:

1. Collect scions from preliminary clone banks at Oakbank and Whitecourt, and graft 1500 to 2000 secondary ramets for permanent clone banks. About half of the grafts are scheduled to be made in the winter of 1975-76.

2. Pot 1,200 rootstocks for 1976 grafting.

3. Select, scarify, and stake out planting sites for the central district family test.

4. Sow and rear seedlings for the central district family test.

5. Measure the western district family test after the second growing season from planting.

6. Thin the seedling seed orchard at Oakbank.

15. <u>Publications</u>:

Up to 1974-75

Klein, J.I. 1969. Breeding jack pine for the Manitoba-Saskatchewan Region. In Proc. 11th Meet. Comm. For. Tree Breed. Can., MacDonald College, P.Q., Aug. 1968. Part 2, pp. 111-114.

Klein, J.I. 1970. Breeding by population synthesis. In Second World Consultation on Forest Tree Breeding, Washington, D.C., Aug. 1969. Food and Agr. Org. of the United Nations, Rom. Vol. 2, pp. 1227-1234.

Klein, J.I. 1971. The pine genetics program in Manitoba and Saskatchewan. In Proc. 12th Meet. Comm. For. Tree. Breed. Can., Quebec, P.Q., Aug. 1970, Part 2, pp. 133-134.

Klein, J.I. 1971. Tree improvement in the Prairies Region, 1970-71. In Proc. 13th Meet. Comm. For. Tree. Breed. Can., Prince George, B.C., Aug. 1971. Part 1, p. 95.

Klein, J.I. 1973. Selection and mating for production of second-cycle populations for a jack pine breeding program in western Canada. In Selection and breeding to improve some tropical conifers. Edited by Burley, J. and Nikles, D.G. Commonwealth Forestry Institute, Oxford University, England and Dept. of Forestry, Queensland, Australia. Vol. 2, pp. 449-455.

Klein, J.I. 1973. Establishment of jack pine family test plantations in eastern Manitoba, 1972. Can. Dept. Environ., Can. For. Serv., Edmonton, Alberta Int. Rept. NOR-17. 37 p.

Klein, J.I. 1973. A jack pine seedling seed orchard of unusual design. 21st Northeast For. Tree Impr. Conf., Fredericton, N.B., Aug. 1973.

1974-75 Nil

16. Signatures:

J I Klein
Investigator

Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Genetic improvement of commercial forest species.

2. Title: Breeding improved white spruce for the Northern Region.
I. Geographic variation study.

3. New: Cont.: X 4. No.: NOR 117 (Previously NOR 116 and 117)

5. Study Leader: J.I. Klein

6. Key Words: *Picea glauca*, provenance test, clinal variation, seed zones, artificial regeneration, forest tree improvement.

7. Location of Work: Several test sites throughout the Region, none selected to date.

8. Problem:

Forestry officials in the three provinces of this Region have expressed strong interest in reforestation with white spruce. This interest provides the impetus for a program to improve the genetic quality of white spruce planting stock. The program which is being undertaken to this end will comprise a number of components that will be autonomous with respect to procedure and immediate objectives, but which share the aim of improving the genetic quality of white spruce planting stock used for forest planting in this Region. Hence it may be convenient to group all such components under one general title, "Breeding improved white spruce for the Northern Region", and under one study leader, but to document progress on each separately under its own title.

The geographic variation component has the purpose of optimizing exploitation of the Region's natural white spruce seed production plant. This purpose is to be pursued by means of observations on phenology and productivity of a number of populations on a number of test sites, with populations and sites chosen to promote the maximum yield of germane information for the resources expended. With a favorable outcome, it should be possible to select a native seed source for any planting location in the Region, with assurance that the source chosen is close to the best in existence for that location.

While this degree of success cannot be confidently assumed in advance, some improvement relative to current practice can; moreover, effectiveness of this program is expected to be particularly enhanced by the combination of short-term trials and field performance trials. The comparative simplicity of controlling seed origin in reforestation practice, promotes the likelihood that experimentally demonstrated gains will be put into practice.

In the planning of study procedure, it was assumed that the most productive seed source for a plantation will vary according to planting location within the Region, and that such changes in relative productivity of seed sources can be predicted, given the right information. It would be conceptually simple, but expensive, to obtain this information by establishing perhaps 10 to 15 test plantations across the Region, each with a Region-wide set of 100 or more populations. Some cost reduction can be achieved by recognizing that seed procurement can proceed more conveniently within provinces, hence directing the initial research effort toward intra-provincial variation. A further contribution to cost efficiency is to be sought by augmenting the generality of a small amount of expensive field performance data with information extracted from a large amount of inexpensive phenological data.

Trials will be established in Alberta as soon as resources become available. The results will be immediately applicable for seed source selection in Alberta, and the pattern information so obtained may augment the value of smaller provenance experiments currently being initiated by the provinces of Manitoba and Saskatchewan. Short-term trials of phenological behaviour will be established as six widely distributed locations in Alberta. There will be considerable overlap among test locations with respect to populations tested, but for each location, population sampling will be most dense in the broad vicinity of the test location. Long-term field performance trials will be planted at two locations, of distinctly different climate. All populations in the field trials will be included in at least two short-term trials, but not all populations used in the short-term trials will be included in the field trials. Multi-variate analysis will be applied to the joint results, in order to relate productivity to source and test-site climatic parameters, and to phenological response parameters of the source populations. Results from the short-term trials will have to be analyzed first, in order to derive the phenological response parameters.

9. Study Objectives:

   a. To determine the magnitude of genetic variation among natural populations of white spruce within each of the three prairie provinces and over the entire Northern Region.

   b. To identify populations of superior genetic quality for areas within the Region where white spruce is likely to be planted.

c. To derive prediction models for populations productivity based on that portion of the observed variation found to be correlated with factors of source and plantation environment, and with phenological behaviour.

d. On the basis of 1, 2, and 3, to establish procedures for advantageous use of Northern Region white spruce populations in artificial regeneration.

10. Resources:

a. Starting date: 1972
b. Estimated year of completion: Indefinite Revised: 1975
c. Estimated total Prof. man-years required: -
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	Nil		
Supp.	Nil		
Casual	Nil		
Total	Nil	O & M funds req'd:	Nil

11. Progress to Date:

A study proposal statement was drafted and approved. A list of Alberta white spruce seed lots, with collection locations, was compiled from the Provincial Tree Nursery card file. From this list, seed lots were chosen for inclusion in short-term trials at six locations. A study plan was drafted for the first phase of a research program designed for selection of populations for direct sowing, to be conducted by the Alberta Forest Service.

Continuing discussions with the Alberta Forest Service revealed that their primary interest lies with selection of populations for direct sowing, rather than for planting. Hence the goal for 1973-74 was modified to preparation of a plan for the first phase of a research program dealing with population performance after direct sowing on scarified forest sites. Such a plan was drafted and submitted to the Alberta Forest Service, requiring 0.15 professional man-years.

12. Goals for 1974-75:

1. Provide follow-up consultation to Alberta Forest Service, as required, in connection with the study plan submitted in 1973-74.

2. It became apparent during 1974-75 that the resources required to pursue the objectives of this study would not be forthcoming. Accordingly the study was terminated.

13. Accomplishments in 1974-75:

1. Consultation continued with Alberta Forest Service as required.

2. Study terminated. Consultation will continue with A.F.S. and U. of A.

on an informal basis as these organizations attempt to implement a white spruce program.

14. Goals for 1975-76:

Nil. Study terminated.

15. Publications:

Up to 1974-75

Klein, J.I. 1973. Genetic variation among natural populations of Alberta white spruce in establishment after direct sowing. I. Population response to environmental variation in the boreal region. Unpublished study plan submitted to Alberta Forest Service.

1974-75

Nil

16. Signatures:

J I Klein
Investigator

Program Manager

G Silver
Director G.T. Silver

PROJECT NOR - 13

Maintenance and Improvement of Water Yield and Quality

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality

2. Title: Research coordination in the Alberta Watershed Research Program; Marmot, Streeter, Deer Creek, Tri-Creeks, Cache Percotte, Spring Creek Experimental Basins.

3. New: Cont.: X 4. No.: NOR 017

5. Study Leader: R.H. Swanson

6. Key Words: Hydrology, forest climate, gauged basin.

7. Location of Work:

Marmot Basin	115°09'05" W	50°56'57" N
Streeter Basin	114°03'48" W	50°06'59" N
Deer Creek Basin	115°08'00" W	51°39'24" N
Cache Percotte	117°30'00" W	52°23'00" N
Tri-Creeks	117°15'00" W	53°09'00" N
Spring Creek	117°51'11" W	54°55'06" N

8. Problem:

The principal need for this project is to clearly identify the role of the Canadian Forestry Service in the coordination of research activities within the Alberta Watershed Research Program. Since the inception of the Alberta (East Slopes) Watershed Research Program in 1960, the Canadian Forestry Service has supplied the research coordinator. His role historically has been to suggest projects, deal with cooperators in furthering their research within Marmot, Streeter and Deer Creek experimental basins, and to provide a focal point for information exchange. He was also responsible for bringing numerous cooperating agencies together to form working groups to plan and carry out joint research projects.

In 1969 this role was changed. A sharp distinction between cooperative and coordinated research was defined and the program was expanded to include all of Alberta. Two programs were recognized: a cooperative effort with little or no coordination; and a problem oriented effort with a research-management coordinator in charge. In the cooperative program, each cooperator was more or less placed on his own initiative to conduct any research as long as it did not conflict unduly with other cooperators, and did not involve a vegetative or topographic treatment that would significantly alter the natural hydrologic regime of any basin or sub-basin. Within each experimental basin, a large number of independent research studies are being conducted both by members of the Canadian Forestry Service, and by the cooperating agencies. Those conducted by the Canadian Forestry Service are covered separately as studies in themselves.

The problem oriented phase became the coordinated effort. Each basin has a treatment phase during which it no longer is used merely as a place to do research, but becomes in itself a research project. Each basin when established had a problem oriented treatment phase.

Marmot:

1. Are the present high altitude spruce-fir forest timber harvesting guidelines effective in maintaining watershed condition and suitable water quality?

2. How can non-commercial spruce-fir stands be harvested to improve water supplies?

Streeter:

Does aspen-brush removal and subsequent grazing deteriorate range land-watershed quality?

Deer Creek:

What influence does lodgepole pine commercial harvesting operations (technique not spelled out) have on watershed condition and water quality and yield?

Tri-Creeks:

Will a change in operating procedures to allow large block or continuous clearcut from the present forty-acre strips be detrimental to watershed condition and water quality as fish habitat?

Spring Creek:

Are high flood peaks associated with the farm lands in the vicinity a result of agricultural clearing and operations?

Cache Percotte:

What is the influence of various harvesting techniques and systems on watershed condition, water quality and yield?

These problems require carefully designed and executed experiments to insure that the results satisfy the objective. Thus coordination now involves planning research projects and/or demonstrations aimed at solving specific watershed problems and enlisting the aid of cooperating agencies in carrying out these plans. This coordination role has been divided between management and research with the Alberta Forest Service furnishing the management coordination. This is a significant step as prior to 1969, no person or persons were specifically charged with planning a coordinated research program. Relevant research was more a fortunate happenstance than the result of planned activity.

9. Study Objectives:

To coordinate the efforts of cooperating agencies toward fulfilling the following:

a. To learn how to manage forested public lands for the protection of existing water supplies and the enhancement of future supply by alteration of regime or yield through timber harvesting.

b. To broaden the overall knowledge base in hydrology of range lands, forest land and alpine areas.

c. To propose and to test specific land management practice designed to increase annual water yield, retard flood peaks or improve on-site watershed condition.

d. To evaluate and test existing land management practice with respect to their influence on the hydrologic regime of specified test areas.

e. To act as consultant and adviser in proposing and evaluating the influence of various land management practice on the local and regional surface and groundwater hydrology.

10. Resources:

a. Starting date: 1960
b. Estimated year of completion: continuing function - no terminus.
c. Estimated total Prof. man-years required: .7 per year.
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man years Prof. - 1.7 (0.8 Swanson, 0.4 Golding, 0.3 Rothwell, 0.2 Singh)

Supp.	1.4	
Casual	0.3	
Total	3.4	O & M funds req'd: $3,870.00

11. Progress to date: (Coordination aspect only. Research covered under appropriate study statement).

Marmot:

a. Data has been collected from the various networks describing climate, ground and surface water hydrology. Some data collection, originally a part of various research projects but extended beyond the completion of such projects, has been discontinued due to non-interest in the data.

b. Roads were flagged on Cabin Creek in preparation for construction. These roads were budgeted for by the Eastern Rockies Forest Conservation Board and approved for 1971 construction. Contracts were signed with Kendall Lumber Ltd. for cutting right-of-way timber, and M. Jackson Construction Ltd. for clearing and piling, and grade construction. Work commenced on August 31, 1971, and was completed on September 27, 1971.

c. The responsibility for proposing and laying out the commercial harvesting test on Cabin Creek was assigned to the Alberta Forest Service.

Harvest blocks ranging from 12 to 29 acres in size were outlined on the Marmot topographic maps. Several studies designed to evaluate the effect of these harvest blocks were either planned or started. The Marmot snow survey was intensified in the total harvested area in anticipation of altered snow distribution after harvest. Three of the proposed 8 harvest blocks were flagged out on the ground in Marmot, Cabin sub-basin.

Negotiations between Alberta Wastershed Research Program, Alberta Forest Service, and Spray Lakes Lumber Co. were completed for the Marmot commercial cut. Harvest was to have commenced July, 1973 but was postponed one year at the request of Spray Lakes because of the poor condition of the Kananaskis road during its re-construction.

Four snow pillows, 12 anemometers, 2 hygrothermographs, 39 soil moisture access tubes, 4 ground water wells, 20 thermographs and one additional transpiration plot were installed to evaluate this harvest. An automatic sediment sampler was installed on Marmot main stem to evaluate sediment resulting from the road construction. The data from these new installations are being collated for publishing with the regular annual Marmot compilation.

d. A contract for the hydrologic modelling of Marmot basin was awarded to University of Guelph.

The hydrologic model of Marmot was completed. The model was developed using 1969-71 data from Marmot and was tested in predicting 1972 streamflow. Predictability is excellent.

Streeter:

a. Streamflow data collection from the three sub-basins was reduced from continuous recording to periodic manual reading. Data collection continued from the main stream as part of the Water Survey of Canada's regional inventory network.

b. The original plan to treat and gauge the effect of such treatment through changes in the water balance was scrapped. The basin is too "leaky" to allow a proper water balance computation; and the effect of any vegetation treatment would be too minor to observe changes in the entire basin's water balance. The program was re-oriented toward on-site evaluation of vegetation treatments, and the effect of such on local spring discharge regimes.

Deer Creek:

a. The basin has been maintained as an experimental area for plot studies. Data from the main streamgauge was collected and is available from Water Survey of Canada. Climatic data is available from the Department of Transport, Meteorological Branch.

b. In February 1971, renewed seismic activity in the Deer Creek area, resulted in one line being cut into the basin. It was later discovered that Deer Creek had never been withdrawn from any sort of use entry - mineral or timber. A request for such withdrawal was subsequently prepared for EFRCB. The request was granted. Deer Creek basin is now properly withdrawn from all use other than research.

Tri-Creeks:

Tri-Creeks data has been compiled. The Alberta Forest Service is seeking a full time forest hydrologist to manage this research program. The on-site impact of North Western Pulp and Power Ltd.'s present harvest in the area is being evaluated, in a joint effort by the Water Management Service, Atmospheric Environment Service, Alberta Forest Service, North Western Pulp and Power Ltd. and CFS.

Spring Creek, Cache Percotte:

a. Spring Creek - no coordination activities.

b. Cach Percotte - the status of this basin has been resolved, it will be used mainly for student projects in conjunction with the Forest Technology School. No treatment is planned.

Contact has been maintained with Cache Percotte and Spring Creek coordinators.

Other:

The coordinator has served as advisor and agency contact to the Environmental Protection Service in its role of assessing the proposed Mackenzie Valley Highway.

The Research Coordinating Committee served as a forum for a cooperative impact assessment of timber harvest on water yield, sediment, and climate in the North Western Pulp and Power Co.'s lease at Hinton. The results are reported under NOR-14-121.

12. Goals for 1974-75:

1. Supervise Marmot commercial harvest.
2. Finalize Streeter basin and Tri-Creeks treatment - evaluation plan.
3. Coordinate road - bank revegetation study.
4. Publish Marmot mathematical model.
5. Continue to advise on northern developments.
6. Continue assistance to cooperators in all basins.
7. Preparation of Study Progress Report.
8. Preparation of Project Progress Report for Project NOR-13.
9. Publish:

Golding, D.L. (editor) 1974. Managing forest lands for water: proceedings of research-management seminar held at Edmonton, Alberta, January 1970. N.F.R.C. Information Report NOR-X-13.

Rothwell, R.L. 1974. Erosion control measures for logging and road construction. In: Proc. Practical Forest Watershed Management Workshop, April 23-24, 1974, Cranbrook, B.C. Assoc. B.C. Prof. For., Faculty of Forestry and Centre for Cont. Education, U.B.C.

Rothwell, R.L. 1974. Erosion control on forest roads. In: Proc. Environmental Considerations of Road Construction. A short course of Instruction for Forest Road Builders and Field Men, Oct. 8-11, 1974, Forest Tech. School, Hinton.

Golding, D.L. 1974. Watershed management practices on Marmot Creek basin. In: Proc. Practical Forest Watershed Management Workshop, April 23-24, 1974, Cranbrook, B.C. Assoc. B.C. Prof. Foresters, Faculty of Forestry, and Centre for Cont. Education, U.B.C.

10. Present Papers:

Singh, T. and Y.P. Kalra. 1974. Estimating yield of dissolved constituents in the stream of a mountainous watershed. 55th Annual Mtg. A.G.U. Washington, D.C. April 8-12.

Singh, T. 1975. Yield of total dissolved solids from an aspen-grassland and a spruce-fir watershed. 28th Annual Mtg. Soc. Rge. Manage., Mexico City, Mexico. Feb. 10-14.

11. Text revision for new publication:

Rothwell, R.L. Watershed Management guidelines for logging and road construction. NFRC Info. Rpt. A-X-42.

13. <u>Accomplishments in 1974-75</u>:

1. Marmot commercial harvest was carried out under the supervision of the coordinator.

2. Streeter Basin treatment plan was presented to Steering Committee of AWRP and is being expanded in view of their comments.

3 Tri-Creek treatment plan is being revised in view of North Western Pulp and Power's decision to conduct winter logging instead of summer logging.

4. Road-bank erosion and revegetation initiated in the Hinton-Edson area. This study is a cooperative one between the Province of Alberta, North Western Pulp and Power Ltd., and Canadian Forestry Service. Two erosion control methods were tested and evaluated at five road stream crossings. Preliminary results indicate the use of logging debris as a "brush mulch" and seeded grass, are more effective for erosion control than grass alone. Study is scheduled to continue in 1975-76. Expected termination date 1977. First year progress review submitted as a file report. A study proposal statement has been prepared for this study.

5. Marmot mathematical model has not been published but work is continuing on preparation for publication. An abstract of a paper, has been accepted by the organizing committee for the Symposium on Mathematical Models in Hydrology to be held in Czechoslovakia, September, 1975. The paper is currently being prepared.

6. The coordinator continued to advise on northern developments, particularly the Mackenzie highway.

7. Assistance to cooperators in all basins was continued.

8. Study Progress Report was not prepared.

9. Progress report for Project NOR-013 was not prepared.

10. Published:

Golding, D.L. (editor). 1974. Managing forest lands for water: proceedings of research-management seminar held at Edmonton, January 1970. N.F.R.C. Information Report NOR-X-13.

Rothwell, R.L., 1974. Esosion Control measures for Logging and Road Construction. In: Proceedings, Practical Forest Watershed Management Workshop, April 23, 24, 1974, Cranbrook, B.C. Assoc. B.C. Professional Foresters, Faculty Forestry, B.C. and Centre Continuing Education, U.B.C.

Rothwell, R.L. 1974. Erosion Control on Forest Roads. In: Proceedings of, "Environmental Considerations of Road Construction, A Short Course of Instruction for Forest Road Builders and Field Men", Oct. 8-11, 1974, Forest Technology School, Hinton, Alberta. (*In Press*).

Golding, D.L. 1974. Watershed management practices on Marmot Creek basin. In: Proc. Practical Forest Watershed Management Workshop, April 23-24, 1974, Cranbrook, B.C. Assoc. B.C. Prof. Foresters, Faculty of Forestry and Centre for Continuing Education, U.B.C.

11. Present papers:

Singh, T. and Y.P. Kalra. 1974. Estimating yield of dissolved constituents in the streams of a mountainous watershed. Paper presented at the 55th Annual Meeting of the American Geophysical Union, Washington, D.C., April 8-12, 1974.

Singh, T. 1975. Yield of Total dissolved solids from an aspen-grassland and a spruce-fir watershed. Paper presented at the 28th Annual Meeting of the Society For Range Management, Mexico City, Mexico, February 10-14, 1974.

12. Text revision completed of:

Rothwell, R.L. Watershed Management guidelines for logging and road construction. NFRC Information Report A-X-42.

14. <u>Goals for 1975-76</u>:

1. Evaluate the effect of harvesting Marmot on water yield, timing, sediment production, water quality, snow accumulation and melt. (Swanson, Golding, Hillman, Rothwell and Singh).

2. Finalize Streeter basin treatment and arrange for financing the treatment. (Golding)

3. Publish Marmot mathematical model. (Golding)

4. Present paper "A model to predict temporal distribution of streamflow after harvesting a forested mountain watershed", at the Symp. on Mathematical Models in Hydrology, Czechoslovakia, Sept. 8-13, 1975.

5. Continue to advise on northern development. (Swanson)

6. Continue assistance to cooperators in all basins. (Swanson)

7. Carry out simulation modelling of the chemical constituents of the waters of Marmot Creek, to obtain the change in such constituents over time and under varying input conditions. (Singh)

8. Prepare Study Progress Report for NOR-017

9. Prepare Project Progress Report for NOR-013.

10. As co-author with Don Storr, prepare paper for Western Snow Conf. on April 1974 snowstorm relating snowpillow data and precipitation recording gauge with elevation.

15. <u>Publications</u>:

Up to 1974-75

Annual report to Steering Committee (each year since 1968).

Swanson, R.H. 1970. Local snow distribution is not a function of local topography under continuous tree cover. New Zealand Journal of Hydrology 9(2): 292-298.

Swanson, R.H. 1971. Forest habitat inventory requirements for watershed management. In: Proceedings of symposium on forest and land inventory for management, Kirby and Nolasco, eds: Northern Forest Research Centre, Canadian Forestry Service, Edmonton. pp. 73-78.

Swanson, R.H. and Stevenson, D.R. 1971. Managing snow accumulation and melt under leafless aspen to enhance watershed values. Proceedings 39th Annual Western Snow Conf., Billings, Montana. pp. 63-69.

Swanson, R.H. 1972. Small openings in poplar forest increase snow accumulation. Proceedings IHD, WMO, UNESCO joint symposia on the Role of Snow and Ice in Hydrology, Sept. 5-14, 1972, Banff, Canada.

Swanson, R.H. 1972. Forest hydrology in Canada - more water probably not wanted. Proceedings 7th World Forestry Congress, Oct. 4-18, 1972, Buenos Aires, Argentina.

Swanson, R.H. 1973. Annual report to the Steering Committee.

Swanson, R.H. and Wyldman, E.C. 1973. Annual Report January 1973 - December 1973. Alberta Watershed Research Program. Approx. 40 pp. Mimeo.

Swanson, R.H. 1973. IHD report on Marmot, Streeter, Deer Creek basins, the clear harvesting impact study and transpiration study.

Department of the Environment. 1973. Land use and Resource Development in the East Slopes of Alberta. Watershed portion. A brief presented to the Government of Alberta, Environment Conservation Authority. July 1973. pp. 150.

Forestry Reports, Vol. 3, No. 4. Timber Harvest - Its Impact on Water, Sediment and Wildlife Production.

Swanson, R.H. 1973. Lecture notes on Land use Hydrology, VII Familiarization Seminar on Hydrology. IHD, University of Alberta, Aug. 27-Sept. 14, 1973. pp. 21. Mimeo.

1974-75

Golding, D.L. (editor). 1974. Managing forest lands for water: proceedings of research-management seminar held at Edmonton, January 1970. N.F.R.C. Information Report NOR-X-13.

Rothwell, R.L. 1974. Erosion Control measures for Logging and Road Construction. In: Proceedings, Practical Forest Watershed Management Workshop, April 23,24, 1974, Cranbrook, B.C. Assoc. B.C. Professional Foresters, Faculty Forestry B.C. and Centre Continuing Education, U.B.C.

Rothwell, R.L. 1974. Erosion Control on Forest Roads. In: Proceedings of, "Environmental Considerations of Road Construction, A Short Course of Instruction for Forest Road Builders and Field Men", Oct. 8-11, 1974, Forest Technology School, Hinton, Alberta. (*In Press*).

Golding, D.L. 1974. Watershed management practices on Marmot Creek basin. In: Proc. Practical Forest Watershed Management Workshop, April 23-24, 1974, Cranbrook, B.C. Assoc. B.C. Prof. Foresters, Faculty of Forestry and Centre for Continuing Education, U.B.C.

Singh, T. and Y.P. Kalra. 1974. Estimating yield of dissolved constituents in the streams of a mountainous watershed. Paper presented at the 55th Annual Meeting of the American Geophysical Union, Washington, D.C., April 8-12, 1974.

Singh, T. 1975. Yield of Total dissolved solids from an aspen-grassland and a spruce-fir watershed. Paper presented at the 28th Annual Meeting of the Society For Range Management, Mexico City, Mexico, February 10-14, 1974.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 082

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-6

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality.

2. Title: Potential energy available for snow evaporation in winter along the east slopes of the Rocky Mountains in Alberta.

3. New: Cont.: X 4. No.: NOR 082

5. Study Leader: D.L. Golding

6. Key Words: Chinook winds, snow accumulation, climate, foehn, meteorology.

7. Location of Work: Alberta East Slopes.

8. Problem:

Watershed management to increase water supply or change the timing of its delivery is principally snowpack management in areas such as Alberta. Some increase in streamflow can be directly attributable to reduced transpiration and interception following vegetation removal, but total removal often results in high flood peaks, in most cases an undesirable alteration of streamflow regime. Properly executed timber removal on snow-covered watersheds has the potential of increasing streamflow and delaying water delivery at the same time. Both of these are generally desirable features.

The east slopes of Alberta's Rocky Mountains produce 90% or more of the streamflow in the Saskatchewan River System, at least 60% of which originates as snow. Snowpack management is an important part of land management for water values. In some years much of the snowpack in particular areas is evaporated by chinook activity. However, we do not know to what elevation chinooks are important in removing snowpack, or the probability of recurrence from year to year.

The climatic maps of Longley (1968) give some indication of where chinooks are an important climatic factor, but this is based only on the criterion of air temperatures being above 40°F. It is very likely that dry winds at temperatures below 32°F have considerable influence on snow removal as well.

To effectively manage forests for water values we must know where and under what circumstances the major precipitation parameter, snow, is a manageable resource. This will allow concentration on those areas where the results of snowpack management for accumulation and melt rates will have a high probability of producing the desired changes in streamflow.

The probability is not very high of completely achieving Objective 2, although the probability is high of achieving a degree of success sufficient to satisfy the need for delineating areas where snowpack-management potential is high. To obtain data to construct isolines of evaporative potential by 10% intervals of probability of recurrence will require a much more intensive meteorological network than is likely in the next few years. Remote sensing information from ERTS will, it is hoped, provide much of the information that would be otherwise available only through an intensive meteorological network.

The results of this study will be pertinent to any forest-management prescription for water values. The probability is extremely high of the results of the study being put into practice. However, it will not be until forest-management schemes to regulate streamflow are put into practice.

A transect will be established from the lower foothills to 8,000-9,000 feet elevation to measure temperature, relative humidity, and evaporation. These data, along with data from existing meteorological stations will be used to determine the relation of chinook intensity, or evaporative potential, with elevation.

Remote sensing imagery in three spectral bands, 0.5-0.6 μ (blue-green), 0.6-0.7 μ (red), and 0.8-1.1 μ (near infrared), will be obtained from ERTS for a test area that includes Banff and KFES. This imagery will be obtained for the satellite passes during February and March, and will be used in conjunction with high-altitude aerial photography and ground photography to delineate areas of heavy snowpack ablation caused by chinooks. If the test of the satellite imagery proves its usefulness, the coverage obtained will be expanded.

9. Study Objectives:

1. To determine the amount of snowpack ablation during chinooks at selected points along the east slopes of the Alberta Rocky Mountains.

2. To construct isolines of evaporative potential by 10% intervals of probability of recurrence each winter.

10. Resources:

a. Starting date: 1969
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 1.3
d. Essential new major equipment items for 1975-76 with costs: Nil.

e. Essential new major equipment items beyond 1976 with costs: Nil

f. 1975-76 man-years

Prof.	0.2			
Supp.	0.1			
Casual	-			
Total	0.3		O & M funds req'd: $	970
			SR Cont.:	13,000

11. Progress to Date:

Tests were carried out to evaluate the use in this study of the Ogopogo evaporimeter and snow lysimeters. The former were of little use at sub-zero °F but could be used during chinooks to obtain a measure of evaporation. The latter could be used under ideal conditions to measure evaporation from snowpacks, but are impractical during general winter conditions.

Aerial reconnaissance of the east slopes was carried out to ascertain patterns of snow disappearance. Satellite imagery was studied to determine if present resolution and quality is sufficient for this study. Pre-ERTS imagery was not of high enough quality for the needs of the study. However, quality of ERTS imagery is much higher than that from previous satellites.

Compilation was made of location, elevation, and instrumentation of meteorological stations in Alberta. So few stations exist above 4,000 feet elevation that no attempt could be made to delineate areas of different evaporative potential at present.

A proposal was approved by the Remote Sensing Centre, Ottawa, to obtain ERTS imagery for an area of 2,000 square miles of the Bow River Valley, along with high-altitude aerial photography of the same area.

Imagery and photography were not obtained in 1972 due to postponement of ERTS launching and bad weather during the three weeks the aircraft was available. Ground photography was obtained before and after chinooks and will serve as control or comparison for the imagery and photography.

ERTS imagery was obtained for the test area along with high altitude photography for 1973. Both were interpreted with ground truth as basis.

ERTS imagery proved of little use in a study of this nature. The return period of 18 days by itself severely limited its use in studying transient phenomena of short return period. However, the infrequent ERTS passes during moderately cloudless periods provided the most severe limitation. The resolution of high altitude photography was much better than ERTS imagery, but here too the most severe limitation was availability of the aircraft and weather conditions. On this basis it was concluded that observational transects are necessary to supplement available data. Using the imagery, locations have been determined for two observational transects running from the foothills to 8,000-9,000 feet in elevation and for one transect running along the foothills.

12. Goals for 1974-75:

    1. By means of research contract have observational transects established during the summer of 1974 and serviced from January 1 to March 31, 1975.

    2. Analyze ERTS imagery for passes over the test area in January-March, 1974.

    3. Publish:

       Golding, D.L. 1974. Snow cover and melting snow from ERTS imagery. In: The Canadian Surveyor.

13. Accomplishments for 1974-75:

    1. Research contract was awarded Intera Environmental Consultants who established observational transects during fall of 1974 and serviced them from January 1 to March 31, 1975.

       Transect A - stations 1-5, on Barrier Mt. in Red Deer River Valley, elevation 5500-7700 ft.

       Transect B - stations 6-14, along Forestry Trunk road between Nordegg and Ghost River ranger station.

       Transect C - stations 15-19, on Pidgeon Mt. in the Bow River Valley, elevation 4600-7600 ft. All stations have a monthly-recording hygrothermograph, and odd-numbered stations also have a monthly-recording wind direction and intensity instrument.

    2. ERTS imagery for the test area for January-March 1974 was not analysed due to lack of time.

    3. Published:

       Golding, D.L. 1974. Snow cover and melting snow from ERTS imagery. The Canadian Surveyor 28(2): 128-134.

14. Goals for 1975-76:

    1. Have observational transects serviced under research contract for January 1 to March 31, 1976.

    2. Analyse ERTS imagery for the test area for the periods January-March 1974 and 1975.

    3. Abstract data from charts provided by research contract and analyse for temperature, humidity, and wind during chinook periods.

4. Prepare Study Progress Report.

15. Publications:

Up to 1974-75:

Golding, D.L. 1973. Satellites and snow melt. Can. Forest Serv., NFRC. Forestry Report 3(3): 10.

Golding, D.L. 1973. Chinooks may influence forest management. Can. Forest Serv., NFRC. Forestry Report 2(3): 3.

1974-75:

Golding, D.L. 1974. Snow cover and melting snow from ERTS imagery. The Canadian Surveyor 28(2): 128-134.

16. Signatures:

D L Golding
Investigator

R. E. Ackerman
Program Manager

GTSilver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality.

2. Title: Disposition of water in forest soils.

3. New: Cont.: X 4. No.: NOR 083

5. Study Leader: G.R. Hillman

6. Key Words: Unsaturated flow, evapotranspiration, infiltration, redistribution, modelling.

7. Location of Work: Southwestern and west central Alberta.

8. Problem:

Nature of study - this study is designed to evaluate saturated and/or unsaturated transient flow through nonhomogeneous, anisotropic porous media i.e., through typical forest soils, in response to the forces of drainage, transpiration and evaporation.

Benefits of the study - the results can be applied in the development of a watershed model based on physically derived, rather than on empirically derived relationships. Such a model can theoretically be applied to entire or parts of watersheds both before and after treatment. Thus where vegetation is manipulated for increasing water yield, the model can contribute significantly to determining which type of sites should be logged to obtain the best timing of the resulting increase in water yield as streamflow.

The results can be used in environmental quality studies to ascertain the rates at which biocides are transported by water through the soil system and into groundwater reservoirs and stream channels.

In forest management, the results will be of benefit in determining optimal stand densities when thinning is considered. They may also be useful for evaluating the regeneration potential of a site, and for consumptive use studies of forest tree species.

Probability of success - recent literature on the subject of saturated and unsaturated flow through porous media indicates that a physically-based mathematical model for three-dimensional, transient, saturated-unsaturated flow is now available (Freeze 1971, 1972). Solutions for the model have been found and a computer program for the model is available. Some progress has been made to incorporate this model into a physically-based synthesis of the hydrologic cycle.

Certain problems associated with soil freezing and with variability in both bedrock and surficial materials remain. However, the probability of completing the study successfully is high, particularly if the model is applied over small areas.

Freeze, R. Allan 1971. Three-dimensional, transient, saturated-unsaturated flow in a groundwater basin. Water Resources research 7(2): 347-366.

Freeze, R. Allan 1972. Role of subsurface flow in generating surface runoff. 1. Base flow contributions to channel flow. Water Resources Research 8(3): 609-623.

Probability of results being applied - the probability is very high that the results will be used in the hydrologic model for Marmot Creek Basin, and subsequently, for other watersheds as well.

In order for the results to be useful to forest management agencies directly, it would be necessary to carry out further research so that subsurface flow (saturated and unsaturated) patterns are correlated, for example, with stand vigor and densities, with and without thinning, with establishment and survival of regeneration and with consumptive use by different tree species.

Method used - the equation of flow developed for subsurface water movement requires measurement of pressure head (ψ), hydraulic conductivity (K), volumetric moisture content (θ), and porosity (n). These measurements are used to develop basic functional model inputs k (ψ), θ (ψ), and n (ψ), where k is the specific permeability derived from hydraulic conductivity (K).

Although the model accommodates three-dimensional flow, only two-dimensional flow will be considered initially. Measurements will be made on Cabin Creek Basin (sub-basin of Marmot Creek) along transects oriented downslope between the watershed divide and the stream channel, and also along transects that lie within, outside and across boundaries of blocks of timber earmarked for cutting.

Thermocouple psychrometers and tensiometers will be used to measure pressure heads less than atmospheric pressure. Pressure heads in the saturated zone will be measured with piezometers. Hydraulic conductivities and porosities will be determined by standard laboratory procedures, but attempts will be made to obtain *in situ* values also. Water table fluctuations will be monitored by means of water table observation wells and recorders.

Output from the model is in the form of the pressure head, total head, and moisture content fields at any time step. From the output it is possible to develop quantitative hydrographs of surface infiltration, groundwater recharge, water table depth and stream base flow. These hydrographs will be the main tools used to evaluate the effects of logging on infiltration and redistribution of water in the saturated-unsaturated flow system.

9. Study Objectives:

a. To develop from Darcy's Law and the continuity equation a mathematical model of two dimensional transient unsaturated and saturated flow through porous media applicable under natural conditions.

b. To incorporate the mathematical model as part of a physically-based synthesis of the hydrologic cycle.

10. Resources:

a. Starting date: 1968
b. Estimated year of completion: 1972 Revised: 1978
c. Estimated total Prof. man-years required: 3.5
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.6		
Supp.	0.2		
Casual	-		
Total	0.8	O & M funds req'd:	$2,680

11. Progress to Date:

The following studies have been completed.

1. Field investigations emphasizing soil water redistribution about a single tree and flow toward and adjacent to a portion of the root zone.

2. A preliminary study to determine the water-holding capacity and other characteristics of the forest floor.

Other work has progressed as follows:

Neutron probe access tubes were installed in each soil type, along two transects to obtain volumetric soil water content profiles on Cabin Creek Basin, a sub-basin of Marmot Creek Basin. The transects extended from the topographic divide to the stream channel. The first set of data was collected in October, 1972.

Four cased water table observation wells were installed adjacent to the new access road on Cabin Creek Basin, November 1972. Wells bottomed between 15 and 41 feet and indicated that water was present during periods of low stream flow in the fall.

Several watershed models were examined to determine which could be most realistically applied to Marmot Creek Basin. The model developed by Freeze (1971) was considered the best physically based subsurface flow model. Furthermore, it has been developed beyond this study's first objective.

The computer program for the Freeze subsurface flow model was obtained and studied carefully. Because the model is very complex, a three-dimensional physical representation of the mathematical model was constructed as an aid in interpretation.

Input data for the model was obtained during 1973 from Cabin Creek drainage. Neutron scatter and water table observation well data were collected two or three times a week during the snow melt period in May and June, and less frequently during the summer. Gravimetric soil samples were collected to obtain calibrations of neutron count ratio vs. volumetric soil water content.

The Mobile Minuteman drill together with its rigid platform and anchor chain assembly were tested on Marmot Creek Basin. Drilling was attempted in several soil and rock types, both on level ground and steep slopes. The drill worked satisfactorily in all soils and in soft shales. Under these conditions, holes eight or more feet deep could be drilled without difficulty. When harder rock e.g., sandstone, was encountered, drilling had to be terminated.

Drilling was also attempted in coarse glacial till, and a depth of 22 feet attained. However, when the auger train was withdrawn from the hole the sides collapsed, filling the hole. Some means must be found to case holes drilled in this type of material.

A portable refraction seismograph with manually operated hammer was made available for this study by the Great Lakes Forest Research Centre. This instrument was used in 1973 to obtain depth and geologic information i.e., profiles, on the soil and shallow rock layers of Cabin Creek sub-basin. This information is required as input for the subsurface flow model.

12. Goals for 1974-75:

1. To obtain facility with, "debug", and test the computer program for the subsurface flow model using either readily available or hypothetical data.

This objective can best be met through discussion between the study leader and Dr. Allan Freeze, developer of the subsurface flow model and author of the associated computer program. Dr. Freeze is now a member of the Geological Sciences Department at the University of British Columbia, and is an IHD Distinguished Lecturer for 1974-75.

2. Continue expanding the subsurface installations network on Cabin Creek sub-basin for the purpose of monitoring volumetric soil moisture content and pressure head fields in time and space, and for saturated and/or unsaturated conditions.

3. Continue seismic work as necessary to obtain more extensive information on the surficial geology of Cabin Creek sub-basin.

4. Use appropriate field and laboratory procedures to obtain functional relationships between specific permeability and pressure head, between volumetric moisture content and pressure head, and between porosity and pressure head, for the soils of Cabin Creek sub-basin.

5. Prepare study report for April 1975.

6. Obtain input data for the model by monitoring soil moisture content and groundwater table levels on Cabin Creek sub-basin.

13. <u>Accomplishments in 1974-75</u>:

1. The computer program for the Freeze subsurface flow model was tested on an IBM 360/67 computer. Computer storage was not great enough to satisfy a network of 100 X 100 X 100 nodes. A two-dimensional nodal grid (80 X 1 X 80) could be accommodated but time did not permit testing the program with data.

2,3,4, and 5. No progress was made in attaining these goals due to lack of time. (It was necessary to spend more time on NOR-14-121 than had been anticipated).

6. Soil moisture content was measured during May, June and July on Cabin Creek sub-basin. Ground water table levels were monitored periodically throughout the year.

14. <u>Goals for 1975-76</u>:

1. To progress towards development of a simplified and practical version of the Freeze subsurface flow model by:

   a) preparing a flow chart of the subsurface system and

   b) writing computer programs to model flow through the subsurface system.

2. Obtain input data for the model by monitoring soil moisture content and groundwater table levels on Cabin Creek sub-basin.

3. Prepare Study Progress Report.

15. Publications:

Up to 1974-75

Hillman, G.R. 1970. Soil moisture distribution about an isolated tree using potential flow theory. Unpublished M.S. thesis. Utah State University, Logan, Utah. pp. 105.

Hillman, G.R. 1972. Forest hydrology research. pp. 5. In: Soils Research, Northern Forest Research Centre. Forestry Report. Vol. 1, No. 6.

Hillman, G.R. 1972. Using potential flow theory to determine soil moisture distribution about an isolated tree. pp. 514-535. In: Proc. Second Symp. on Fundamentals of Transport Phenomena in Porous Media. University of Guelph, Guelph, Ontario. 1972. Vol. 2.

1974-75

Nil

16. Signature:

G. R. Hillman
Investigator

R. C. Coleman
Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality.

2. Title: Measuring transpiration of individual trees *in situ*.

3. New: Cont.: X 4. No.: NOR 084

5. Study Leader: R.H. Swanson, R. Rothwell

6. Key Words: Heat pulse velocity, conducting xylem, sap velocity, sap flow, moisture content, lodgepole pine, Radiata pine.

7. Location of Work: Kananaskis Forest Experimental Station; Marmot, Streeter, Deer Creek Experimental Basins; Purukohukohu Experimental Basin, Rotorua, New Zealand.

8. Problem:

Transpiration is the process whereby water is evaporated from the soil via a plant water conducting system. The amount of water thus vaporized is a considerable quantity, up to that which falls as annual precipitation. From the hydrologist's point of view such vaporization represents a loss in the water budget of a land area. No practical, reliable field method exists, for evaluating transpiration.

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. Nonetheless, the potential for water yield improvement through species conversion is a tantalizing 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. 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.

The method being used to estimate transpiration utilized the continuity equation Q = AV: where Q = transpiration; A = cross-section area of a tree stem involved in upward water movement; V = some function of the upward speed of sap movement. Both A and V are variable with time, space and species as are the functional relationships describing them.

"Area" in the sense used here is thought functionally related to sapwood area and sapwood moisture content - density. "Velocity" in the sense used here is thought related to heat pulse velocity, sapwood moisture content - density and measurement point position in the sapwood. Both theoretical and empirical methods of ascertaining these functional relationships are being explored.

Velocity is being estimated from the movement of a pulse of heat within the sapwood in response to upward water flow. The functional relationship between sap velocities (u) and heat pulse velocity (HPV) is: HPV = aupc where p, c are density and specific heat of the combined wood - water matrix. Practical field instrumentation has been developed by the authors for evaluating this parameter.

Area is being estimated from increment borings and non-destructively by the gamma attenuation technique. This involves passing a beam of monoenergetic gamma radiation of known intensity through a tree stem, and recording its attenuating characteristics of wood and water and tree thickness at the point of measurement. The assumption that all components of the system are constant with the exception of water, permits a direct measure of water content, and a calculation of its areal extent.

9. Study 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 measurement within a given tree is 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*.

10. Resources:

a. Starting date: 1969
b. Estimated year of completion: 1975 Revised: 1977
c. Estimated total Prof. man-years required: 2.5
d. Essential new major equipment items for 1975-76 with costs:
   Digital data logger $5,300.
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.4		(Swanson 0.2, Rothwell 0.2
Supp.	0.5		Pitt 0.4, Cumberland 0.1)
Casual	-		
Total	0.9	0 & M funds req'd: $1360	

11. Progress to Date:

a. Toward velocity function:

1. Twenty lodgepole pine were instrumented with one set each of heat pulse velocity measuring probes. Ten of these were placed at random depths in the first 4 cm of xylem, 10 at prescribed -1, 2 or 3 cm. Data from these points has been analyzed to determine sampling intensity necessary to describe the average heat pulse velocity of a group of trees. These data indicate that ten trees are an adequate sample if all sources of error are included. If error from either instrument placement or environmental effect on transpiration are stratified, then less than 5 trees are a suitable sample.

2. Sixteen lodgepole pine were instrumented with two groups of four sets of heat pulse velocity measuring probes placed at 1, 2, 3 and 4 cm depths. The eighty trees originally planned were not all instrumented due to time and personnel limitations. Data from these 32 groups of probes were taken in August 1969 and 1970. These data were fitted to a parabolic model and the resultant second degree equation was used to predict conducting xylem thickness. In 28 out of 32 cases, the depth predicted was equal or less than the thickness of "sapwood" as indicated by a sharp break in moisture content at the sapwood-heartwood interphase.

3. The physical parameters were described using conventional equipment. That is, dbh, height, age, moisture content and condition class were noted and recorded. The method used to obtain moisture content - increment cores - was found nonsensical as data obtained from hammered cores differed markedly from that of bored cores. This led to a study of the differences between these two methods and why it occurs. Also, a study to evaluate a non-destructive means of evaluating wet xylem moisture content and wet xylem area was started.

4. Parabolic model proposed for velocity-depth distribution was used to calculate transpiration, conducting basal-area cross-section and average heat pulse velocity. Results indicate the parabolic distribution is a good model for estimating sap conducting area from HPV data. A one-day energy budget and transpiration by the parabolic model were computed at the James River site. Quantitative agreement between the two was fair. The parabolic was also tested for precision by estimating volume flow in five vertical locations in study trees. The poorest volume estimates varied 8% of the mean daily value.

5. Transfer of work for theoretical considerations to New Zealand effected. Instrumentation of three species for study in New Zealand completed: lodgepole pine, Douglas-fir and Monterrey pine.

b. Toward development of a non-destructive method for determining the wet xylem moisture content and its areal distribution:

1. Laboratory development and testing of gamma radiation attenuation as a non-destructive method was completed. The method was tested by regressing of water contents obtained by gamma attenuation on equivalent oven-dry weight water contents. Regression results are: $\tilde{\theta}$ gamma = θ oven-dry 0.9860 + .0739, n = 47, r^2 x 100 = 92.7%, O.D.W. Based on these results gamma attenuation appears to be a reasonable method of wood water content determination.

2. A field application of gamma radiation attenuation and sampling for xylem moisture content at diameter breast height, in five mature lodgepole pine trees was initiated in summer 1971. Seasonal and diurnal patterns of xylem moisture content were studied. Concurrent oven-dry weight water contents, from increment borings were obtained from surrounding trees. The effects of soils water availability on xylem moisture were studied by isolating of a tree's root system by trenching. Results of the field test showed gamma water contents and bored water contents to have similar temporal variations. Gamma water contents, however, were 15-20% higher than bored values. On the trees with its root system isolated, gamma radiation attenuation methods detected a small but significant change in sapwood water content. Temperature effects on gamma radiation equipment corrected by installation of temperature sensor and development of temperature correction coefficient. Continued observations to study effects of soil water availability on xylem moisture content.

12. Goals for 1974-75:

1. To complete test of parabolic velocity distribution in lodgepole pine, Radiata pine and Douglas fir.

2. To verify accuracy of calculated transpiration rates using HPV techniques and to finalize and describe suitable sampling configuations for individual trees or plots.

3. If student help is avalable, to obtain one growing season's transpiration data from Marmot basin and to incorporate these data into the hydrologic simulation model for Twin sub-basin.

4. To complete field studies of heat pulse velocity and sapwood water content variation. To make two diurnal runs of concurrent observations of both variables in summer 1974.

5. Complete quantification of counting errors in sapwood water content measurements by gamma radiation attenuation.

6. To continue development of a technique to allow direct comparisons between gamma and bored water contents.

7. Complete PhD thesis "Sapwood water content of lodgepole pine".

13. Accomplishments 1974-75:

1. Study on these two goals conducted in R.H. Swanson's transfer of work to New Zealand for the period December 1973-April 1975. Simultaneous tests of transpiration evaluation by energy budgets and heat pulse methods in laboratory and field performed. Reporting of test results to be done on R.H. Swanson's return.

2. No progress to report on this goal. Student help necessary for work was not available.

3. Two diurnal observations of heat pulse velocities on sample trees obtained in August. Unable to obtain concurrent set of heat pulse velocity and sapwood water content measurements because of commitments in NOR 017, 121. Data tabulated for analyses.

4. No progress to report. Time not available, because of commitments in NOR 017, 121.

5. No progress to report. Time not available because of commitments in NOR 017, 121.

6. Publication: R.L. Rothwell, Ph.D. thesis "Sapwood water content of lodgepole pine" University of British Columbia, Faculty of Forestry, completed.

14. Goals for 1975-76:

    1. Testing and application of study results on transpiration in New Zealand to Canadian conditions and species.

    2. To obtain one growing season's transpiration data from Marmot basin and to incorporate these data in hydrologic simulation model for Twin sub-basin.

    3. Prepare paper on use of gamma radiation attenuation methods for in situ sapwood water content measurement for journal publication.

    4. Complete data analysis of heat pulse velocity and sapwood water content measurements.

    5. To prepare Study Progress Report.

15. Publications:

Up to 1974-75

Swanson, R.H. 1970. The tree as a dynamic system in forest-water resource research. In: Powell and Nolasco, editors, Proceeding, Third Forest Microclimate Symposium. Canadian Forestry Service. Prairies Regional Laboratory, Edmonton. pp. 34-39.

Swanson, R.H. 1970. Heat pulse velocity as an indicator of transpiration. In: Powell and Nolasco, editors, Proceeding, Third Forest Microclimate Symposium, Canadian Forestry Service, Prairies Regional Laboratory, Edmonton. pp. 85-86.

Swanson, R.H. 1970. Sampling for direct transpiration estimates. New Zealand Jour. of Hydrology. 9(2): 72-77.

Swanson, R.H. 1974. A thermal flow meter for estimating the role of xylem sap ascent in trees. In: Flow--Its Measurement and Control in Science and Industry, Vol. 1: R.B. Dowdell, editor. pp. 647-652.

Swanson, R.H. 1974. Velocity distribution patterns in ascending xylem sap during transpiration. In: Flow--Its Measurement and Control in Science and Industry, Vol. 1: R.B. Dowdell, editor. pp. 1425-1430.

Swanson, R.H. 1972. Water transpired by trees is indicated by heat pulse velocity. Ag. Met. 10: 277-281.

Swanson, R.H. 1975. Water use by mature lodgepole pine. In: Proceedings Management of Lodgepole Pine Ecosystems, Pullman Washington. D. Baumgartner, editor. pp. 264-277.

1974-75

Nil

16. **Signatures:**

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality.

2. Title: Runoff patterns resulting from differential snow accumulation and ablation as influenced by mass and energy relationships in small forest openings.

3. New: Cont.: X 4. No.: NOR 103

5. Study Leader: R.H. Swanson, D.L. Golding

6. Key Words: Snow melt, radiation, wind, lodgepole pine, aspen, Deer Creek, Marmot, Streeter Basin.

7. Location of Work: Alberta East Slopes.

8. Problem:

The hydrologic influence of large, clearcut blocks (10-100 acres), particularly with reference to snow accumulation and melt, is fairly well known. The leeward edge produces a sharp discontinuity in wind streamlines flowing over the forest, causing more snow to be deposited in the first 2-5H (tree height) distance within the opening, than under the treed edge or further out into the opening. Beyond 4-5H from the leeward edge, wind streamlines are again fairly uniform, often resulting in less snow than within the adjacent stand.

At the windward edge another discontinuity occurs. Streamlines may rise above the canopy or may penetrate 1-2H and dissipate their energy against the interior canopy. More snow is usually desposited under the canopy on the windward edge than in the open or the forested area. The development of the leeward eddy and windward penetration of streamlines depends on speed and structure of the wind, horizontal and vertical structure of the forest, and opening geometry.

In general, snow melts faster in large openings than under the canopy, resulting in greater streamflow occurring earlier than from areas of continuous forest. The volume of water in the rising limb of the snow melt hydrograph is always greater from areas harvested in large clearcut blocks than from uncut areas. This may create problems in Alberta where rivers flow east or north, because of ice breakup and snow melt occurring simultaneously.

No watershed studies have been conducted using small forest openings. Relevant runoff data is not available for snow accumulation and melt relationships in small openings. Very little real data exists on snow accumulation, melt, or wind-radiation patterns in small openings. What there is, is mainly observational and qualitative. However, observations do indicate that small openings contain more snow than surrounding forest, and melt rates are not dissimilar. These observations need quantitative statistical support to provide the basis for influencing snow accumulation, melt and associated runoff patterns.

The solution to this problem will permit forest logging patterns to be designed to regulate streamflow regime to influence such parameters as snow melt floods and low flows.

The probability of success in determining empirically the effect of forest opening size on snow accumulation and melt rates is very high. The probability of success is somewhat lower for objectives 2 and 3 (i.e., the theoretical process description of snow accumulation and ablation in forest openings). The first objective (i.e., development of a physically based conceptual model of the system) is even less likely of success, because it incorporates the difficulties of all other objectives. However, even here the probability must be considered as moderately high of developing the desired model within acceptable limits of precision.

The results of this study will provide the foundation on which any forest cover manipulation for water values will be based. The application of these results depends, as do many land use applications, on when the pressures for improving land use and environment become great enough.

The method to be used is as follows: A homogeneous stand of lodgepole pine has been chosen near Sundre, Alberta, where topography is extremely flat and there is reasonably uniform fetch for 4-6 miles in all directions. Ten replicates of 9 opening sizes, ¼, ½, 3/4, 1, 2, 3, 4, 5, 6 tree heights in diameter, plus control will be randomly located 10 chains apart along 10 lines also 10 chains apart.

Snow accumulation and melt will be measured throughout winter and spring. This will provide, empirically, cutting guidelines for snow management and input to the next step in the study. Instrumentation will be installed to measure the radiation regime, wind structure, temperature and humidity in the openings. From this will be derived the theoretical process description of snow accumulation and ablation.

A physically-based hydrologic model will be constructed to predict the effect of timber harvesting of the experimental watersheds on snowpack and the resultant outflow hydrographs.

9. Study Objectives:

To determine the influence of small forest openings on snow accumulation amounts, melt rates and snow melt runoff patterns through:

1. Development of a physically based conceptual hydrologic model incorporating differential areal precipitation input to predict the snow manipulative aspects of timber harvest schemes applied to experimental watersheds, on the resultant outflow hydrographs, and to test these models on experimental watersheds.

2. Quantitative determination and theoretical process description of differential snow accumulation amounts in a 10 treatment block of circular openings from ¼ to 6 tree heights in diameter.

3. Quantitative determination and theoretical process description of differential snow ablation rates within the above 10 treatment blocks.

4. Small scale pilot testing of proposed harvesting patterns to ascertain their general effect on snow melt runoff.

10. Resources:

a. Starting date: 1970
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 7.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.4 (Golding)		
Supp.	1.2		
Casual	0.3		
Total	1.9	O & M funds req'd:	$4,450

11. Progress to Date:

Ten replications of 10 opening sizes have been established and slash burned. Snow survey markers have been established and snow surveys carried out on three uncut areas to determine the homogeneity of snow accumulation across the study area. Five snow pillows were installed on Marmot basin to record snow accumulation and ablation throughout the snow season. Snow surveys have been carried out in the James area during early spring since 1973.

Four 100 foot towers have been erected and directional anemometers installed at the top. Four stations have been established at the tower sites, each instrumented for temperature, humidity, and precipitation. Data has been obtained since December, 1971.

Two 100 foot towers were erected in the uncut forest and instrumented at three levels. A one-day energy balance was conducted in 1973 using the newly-acquired data acquisition and analysis system. A second day was planned but bad weather forced cancellation. The data system worked reasonably well for a first run. One temperature problem was present in the 50-channel scanner that limited data collection runs to a 25% duty-cycle. This was subsequently corrected by the supplier under warranty. The data was analyzed and spatial deficiencies noted. Results were generally within the expected range. Similar daily energy balance data were collected in June 1974.

12. Goals for 1974-75:

1. Do daily energy balances for two periods - early season when growth rate and evapotranspiration are expected to be maximum, and late summer when such activity has tapered off.

2. Continue snow surveys in openings and uncut forest.

3. Continue the baseline data gathering from meteorological stations.

4. Publish in "Atmosphere" (Journal of the Canadian Meteorological Society) the paper: Golding, D.L. 1974. The correlation of snow-pack with topography and snowmelt runoff on Marmot Creek basin, Alberta.

5. Preparation of paper for either Can. J. For. Res. or For. Chron. entitled "Snow accumulation and melt in small forest openings."

6. Preparation of Study Progress Report.

7. Publish:

   Golding, D.L. 1974. Land-management practices that affect water yield (for Information Report).

13. Accomplishments in 1974-75:

1. Daily energy balance was carried out for only one of the two periods planned, early summer, for a one-week period. Time limitation (brought about by required supervision of Marmot cut - NOR 017) forced cancellation of the later summer balance.

2. Snow survey in openings and uncut forest was carried out March 14-18, April 9-12, and April 23-26, 1974. A total of 6,961 samples were taken.

3. Baseline data from meteorological stations was gathered, abstracted, and transferred to punch cards.

4. Published:

   Golding, D.L. 1974. The correlation of snowpack with topography and snowmelt runoff on Marmot Creek basin, Alberta. Atmosphere 12(1): 31-38.

5. Paper "Snow accumulation and melt in small forest openings" has not been written, although data has been analysed and results obtained. Time limitation responsible for not satisfying this goal.

6. Study progress report was not prepared.

7. Published:

   Golding, D.L. 1974. Land-management practices that affect water yield. In: Golding, D.L. (editor) Managing forest lands for water. Can. Forest. Serv. NFRC, Information Report NOR-X-13. p. 13-32.

14. Goals for 1975-76:

1. Install one 100-foot tower and three 30-foot towers in one 6H opening and instrument with wind direction and intensity sensors.

2. Obtain data for the summer months from the towers noted in 1 and continue gathering of baseline meteorological and snow accumulation data.

3. Prepare paper for either Can. J. Forest Res. or Forest. Chron. entitled "Snow accumulation and melt in small forest openings".

4. Prepare Study Progress Report for NOR 103.

15. Publications:

Up to 1974-75

Golding, D.L. 1968. Snow Measurement on Marmot Creek Experimental Watershed, Canada Department of Forestry and Rural Development, Forest Research Laboratory, Calgary. Information Report A-X-18. pp. 16.

Golding, D.L. 1969. Snow Relationships on Marmot Creek Experimental Watershed. Canada Department of Fisheries and Forestry, Forestry Branch, Bi-monthly Research Notes, 25(2): 12-13.

Golding, D.L. 1970. Computer mapping of the Marmot Creek snowpack and the influence of topographic and stand variables on the pack. Proc. 3rd Forest Microclimate Symp. Can. Forestry Serv., Calgary. pp. 76-83.

Golding, D.L. 1970. Research results from Marmot Creek Experimental Watershed, Alberta, Canada. In: Proceedings, Symposium on the results of research on representative and experimental basins. IASH publ. No. 96. Wellington, New Zealand. pp. 397-404.

Golding, D.L. 1972. Snowpack calibration on Marmot Creek to detect changes in accumulation pattern after forest-cover manipulation. Proc. UNESCO-WMO-IHD Internat. Symp. on the Role of Snow and Ice in Hydrology. Sept. 5-14, 1972, Banff, Canada.

Golding, D.L. 1972. Snow accumulation as influenced by topography and its correlation with annual and seasonal streamflow on Marmot basin, Alberta. NOR-Y-29. pp. 18.

Golding, D.L. and Harlan, R.L. 1972. Estimating snow-water equivalent from point-density measurements of forest stands. Ecology 53(4): 724-725,

Golding, D.L. 1973. Harvesting effects on snow pack detectable on Marmot experimental watershed. Can. Forest. Serv., Northern Forest Research Centre, Forestry Report 2(3): 7.

Golding, D.L. 1973. May-June streamflow can be reliably predicted from snow-course data. Can. Forest. Serv., Northern Forest Research Centre, Forestry Report 2(3): 4.

Storr, D. and Golding, D.L. 1973. A preliminary water balance evaluation of an intensive snow survey in a mountainous watershed. Proc. Inter-disciplinary Symp. on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, IHD, Monterey, California. Dec. 2-6, 1973.

1974-75

Golding, D.L. 1974. The correlation of snowpack with topography and snowmelt runoff on Marmot Creek Basin, Alberta. Atmosphere 12(10): 31-38.

Golding, D.L. 1974. Land-management practices that affect water yield. In: Golding, D.L. (editor) Managing forest lands for water. NFRC Information Report NOR-X-13. p. 13-32.

16. Signatures:

R.H. Swanson
Investigator
D.L. Golding

R.L. Ackerman
Program Manager

G.T. Silver
Director G.T. Silver

NOR 141

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality.

2. Title: Infiltration and erosion as influenced by land use.

3. New: Cont.: X 4. No.: NOR 141

5. Study Leader: T. Singh

6. Key Words: Pulpwood harvesting operations, oil and gas exploration, logging, improved management guidelines, watershed management.

7. Location of Work: Western Alberta

8. Problem:

   a. Project proposed by: Canadian Forestry Service and the Research Coordinating Committee, Alberta Watershed Research Program

   The hydrologic effects of large-scale clearcuts on infiltration and erosion remain relatively undetermined on most Alberta forest lands. To provide improved management guidelines it is imperative that the inherent vulnerability of forest areas be assessed properly for overland flow and consequent erosion.

   Infiltration, as an important integrator of many soil properties, can be measured directly and objectively. If other site influences could be superimposed on infiltration characteristics, a methodology could be developed for assessing the potential erosion hazards of different forest lands for pre-planning purposes.

   b. Nature of the study: The proposed methodology will provide an on-site evaluation of the infiltration and erosion potentials of forest areas in their natural condition and assist in predicting the hazards involved when such areas are to be subjected to various land use disturbances.

   c. Benefits from the solution: The assessment of the work area in terms of its inherent vulnerability to surface runoff and erosion will make the manager aware of the critical sites that should receive his special attention. By providing necessary information as to how some areas are rated more hazardous than others, the manager can be assisted in looking for similar causes elsewhere and take appropriate precautions accordingly.

d. Probability of success: The chances of successful development of the methodology are good. Consequently, it would be possible to identify areas which are inherently more vulnerable to overland flow and erosion than others.

e. Method to be used: The method to be used is based on a consideration of the essential processes involved in erosion on forest lands. Of these, infiltration is the key hydrologic process--it determines the disposition of water at the land surface. Soil porosity and depth to the least permeable horizon determine primarily the soil storage space available for the infiltrating water. When this storage is exhausted and the water is received at a rate greater than that at which the soil is being drained from the least permeable horizon, the excess water becomes available for overland flow. This overland flow, combined with the concentrated subsurface flow in places, determines primarily the rate at which erosion could occur on the sloping watersheds. The steepness of slope, and distance to a buffer strip where the water may infiltrate at a greater rate, are the other important considerations influencing erosion hazards.

The methodology is thus based on the use of the infiltration rated areas as indicators of potential overland flow. If the measured infiltration capacities show considerable excess over the amount of water likely to be received in long-duration rainstorms, there is no possibility of the overland flow occurring in such areas. An indication of high infiltration potential is therefore indicative of the sites that are likely to be the least erosive and vice versa. A ranking is thus possible for the different areas to be rated for their vulnerability to erosion on the basis of their infiltration potentials.

Previous work done in Streeter Basin has shown that it is easier to measure infiltration capacities directly than to estimate these from the many vegetative and edaphic factors influencing them. This work also suggested that vegetation stratifications can provide a convenient basis for indicating the inherent infiltration potentials of forest lands. Stratifications based on vegetation classification would therefore be used to provide general estimates of the infiltration capacities of the area to be subjected to a particular land use. However, as the forest lands are not uniformly vegetated there would be local areas with different runoff potentials as compared to the conditions represented by the overall vegetation. Vegetation stratifications therefore need to be supplemented with other site considerations in which slope characteristics would be particularly influential. Stratifications based on surficial materials would be used within an overall vegetation cover type in addition to topographic considerations. In view of the management oriented nature of the study these stratifications would be kept as simple as possible.

Experimental areas selected in each stratification would be used to determine the steady infiltration rates by double-ring infiltrometers. The information thus collected would provide a logical basis for ranking the stratifications for their vulnerability to overland flow and erosion according to the infiltration potentials. This would be supplemented with all other related information available in soil maps, topographic (contour) maps, bed-rock and surficial geology maps, and rainfall characteristics maps. All pertinent information would be put in an information report to explain the importance and relevance of each factor to the inherent erosion potential of the study area. The field observations, and the collected information mentioned above, would be used for providing management guidelines for safeguarding against the erosion hazards inherent in a given land use. The data will also find use in evaluating the constants on infiltration models (Philip, Singh, Holtan).

Although the above-mentioned approach would fulfill the objectives of the study on undisturbed forest lands, a different approach needs to be undertaken on the already cut areas. This phase of the study would require the use of a rainfall simulator to obtain actual measurements of overland flow and erosion in disturbed sites. The Rocky Mountain infiltrometer would be used for this purpose and would provide a comparative test on the severity of impact attributable to each land use practice at a given site. The compaction or exposure of the soil surface consequent to land use can thus be assessed directly in terms of the overland flow and sediment produced on such sites. The rainfall simulator will also serve as a test of the methodology developed from the double-ring infiltrometer approach.

9. <u>Study Objectives</u>:

a. To develop and test methodology for on-site evaluation and assessment of infiltration and overland flow potentials of forest lands and to relate these assessments to soil erosion hazards inherent in pulpwood harvesting operations, oil and gas exploration, and related land use disturbances.

b. To provide management guidelines based on such assessments for pre-planning purposes.

10. Resources:

a. Starting date: summer 1973
b. Estimated year of completion: 1976 Revised: 1977
c. Estimated total Prof. man-years required: 1.4
d. Essential new major equipment items for 1975-76 with costs: Infiltrometers, metallic rings, pressure head regulators = Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.6	
Supp.	.2	
Casual	.3	
Total	1.1	O & M funds req'd: $3,120

11. Progress to Date:

Stratifications based on forest cover and surficial materials were used for infiltration determinations. Six such stratifications studied within the lodgepole pine forest were: till materials (Marlboro, Obed, Robb), aeolian sandy materials (Hinton), water-laid sandy materials (Blackmud), and thin superimposed deposits overlying lacustrine materials (Lodge). These associations showed highly significant difference on the basis of steady infiltration rates. The initial assessment thus made showed that a ranking of these stratifications was possible to determine their erosion potentials for pre-planning purposes.

12. Goals for 1974-75:

1. Completion of the remaining surficial material stratifications within lodgepole pine cover.

2. Starting of infiltration runs in spruce cover types stratified according to surficial materials.

3. Preliminary work on ranking of the studied stratifications in order to obtain initial assessments for providing pre-planning management guidelines.

13. Accomplishments in 1974-75:

1. Infiltration determinations on the remaining stratifications within lodgepole pine forest were completed. The steady infiltration rates of these associations differed highly significantly. Individual comparisons on all the associations within lodgepole pine forest were also made.

2. Site locations within the spruce forests of the lease area were identified on spot as a preliminary to starting infiltration runs.

3. The lodgepole pine associations were ranked on the basis of their steady infiltration rates. Five groups were identified as regards their infiltration and erosion potentials. A preliminary approach to be used for this purpose was presented at the National Fall Meeting of AGU.

14. Goals for 1975-76:

1. To determine infiltration potential of stratifications within spruce forests of the lease area.

2. Select infiltration sites in aspen forest cover type.

3. Preliminary work on the erosion potentials of spruce forests and ranking of various stratifications as to their vulnerability for erosion.

4. Prepare an Information Report on the infiltration and erosion potential of lodgepole pine forests in the Hinton lease area.

5. Prepare Study Progress Report.

15. Publications:

Up to 1974-75

Singh, T. 1973. Simple empirical equations to predict infiltration on a range watershed. Paper presented at the 26th Annual Meeting, Society for Range Management, Boise, Idaho, February 4-9, 1973.

Singh, T. 1973. Simple empirical equations to predict infiltration on a range watershed. Environ. Can., Northern Forest Research Centre, Edmonton, File Report NOR-Y-71.

1974-75

Singh, T. 1974. Infiltration and erosion potential of lodgepole pine forests in a pulp lease area, Alberta, Canada. Paper No. H41 presented at the Fall Annual Meeting of the American Geophysical Union, San Francisco, California, December 12-17, 1974.

16. Signatures:

Teji Singh

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 13, 1975

1. Project: Maintenance and improvement of water yield and quality

2. Title: Water quality and road-side soil erosion and sedimentation at logging road-stream intersections.

3. New: Cont.: 4. No.: NOR 987

5. Study Leader: R.L. Rothwell

6. Key Words: Logging roads, stream crossing, erosion, sedimentation, fish, aquatic invertebrates

7. Location of Work: Hinton-Edson area, Alberta

8. Problem:

Natury of study - this study is designed to compare and demonstrate the effects of erosion sedimentation controls at logging - road stream intersections. The study originated from a request for assistance in study design by the Environmental Research Secretariat, Alberta Department of Environment, Edmonton and North Western Pulp and Power Ltd., Hinton, Alberta.

The need for this study is supported by recent investigations (NOR 121; Schultz 1973) which identify forest roads as major sources or erosion, especially at road-stream intersections where ditch runoff empties directly into streams causing unnecessary stream degradation. Erosion from roads and subsequent sedimentation can cause water quality deterioration and destruction of aquatic habitats and resident fish populations. Most serious erosion and sedimentation occur on road cuts, fills, ditches and at road-stream intersections.

The Alberta Forest Service requires revegetation where soil is exposed and subject to erosion. This requirement is relatively new, and has not been strongly enforced. Because of this, erosion control methods among forest industries are still indevelopmental stages. Furthermore, erosion control is hindered by a government imposed road construction standard which requires the ground surface, "be cleared to mineral soil, 25 feet on each side of the running surface, measured from the outside edge of the shoulder. (The) balance of the right-of-way (is) to be cleared of all woody debris, except stumps left in the ground." Confusion in the application of this standard has resulted in poor revegetation of roadsides and unnecessary erosion.

The benefits from this study could be an improvement in erosion control and reduction in soil erosion and its' attendant effects on water quality aquatic habitats and fish populations. Furthermore, road construction cost could be reduced. The methods proposed for study could be easily incorporated into existing road construction practices. The probability of results from this study being applied are good, because forest industry and provincial agencies are interested and active cooperators in the study.

Cooperating agencies in the study are: Environmental Research Secretariat, Alberta Department of Environment; Alberta Forest Service, and Alberta Fish and Wildlife Division, Department of Lands and Forest; North Western Pulp and Power Ltd.; Water Management Services and Canadian Forestry Service, Environment Canada.

The erosion control methods selected for testing are:
no. 1 - hydroseeding a grass-seed-fertilizer mixture on backslopes, ditches shoulder and fills at road-stream intersections; and
no. 2 - the application of a "brush mulch" to backslopes, ditches, shoulders and fills at road-stream intersections, followed by hydroseeding as in method no. 1.

Method no. 1 is representative of current erosion control practices used in the area. Because of this, it was selected for testing and comparison to a new method. The hydroseeding of grass seed and fertilizer has not been effective in preventing erosion on steep slopes such as backslopes, fill sections and at road-stream intersections. At such locations rill erosion followed by gully development and subsequent sediment discharge into streams occurs, because grass seed is washed away before it can establish.

Method no. 2 was selected because it has been successfully used in the Swan Hills' oil fields to control erosion on drilling sites and roadways. It has also been recommended by others as a practical and efficient erosion control method. The "brush mulch" consists of placing logging debris, (logs, tree tops, branches) on road shoulders, fills, backslopes and ditches to slow the velocity of surface runoff and to trap sediment. The logging debris is anchored in place by driving tracked or wheeled vehicles over it; after which a grass seed-fertilizer mixture is hydroseeded over the area. Besides reducing erosive forces the "mulch" also favors revegetation by preventing seed from being washed away and by providing favorable seedbed conditions (shade and moisture).

The two methods are to be tested at stream crossings on newly constructed roads. The treated areas will extend from the running surface of roads to the outer edges of right-of-way clearings; and from streambanks upslope to either topographic divides or the first major change in slope steepness.

Study sites are to be selected and treated in April-May as soon as ground conditions are favorable. Criteria for selection are: newly constructed road crossings; intersecting stream perennial in flow and of sufficient size and character to support invertebrate and fish populations; slope approaches and treatment areas of each crossing to be approximately equal. A range of different soil erodibilities is desireable, but may not be possible as location of sites are controlled by occurrence of new road construction. The study design calls for each method to be replicated 6 times, or a total of 12 road-stream intersections.

The methods of evaluation consist of - measurement of erosion-sedimentation and water quality in terms of suspended sediment production; and sampling of aquatic habitats and fish populations.

Agency responsibilities are: (1) Canadian Forestry Service - evaluation of treatments in terms of erosion and sediment production at stream crossings. (2) Alberta Fish and Wildlife Division and Alberta Forest Service - evaluation of treatments in terms of effects on aquatic invertebrates and resident fish populations. (3) Environmental Research Secretariat - funding for hiring and supporting field crews for treatment implementation and data collection and laboratory analyses. (4) North Western Pulp and Power Ltd. - provision of manpower, materials, and equipment for treatment implementation. (5) Water Management Services - loan of sediment sample bottles and current meters.

Aquatic invertebrates are to be studied by Suber samples obtained upstream and downstream from road-stream crossings. Specimens collected will be identified to genus and their numbers and volumes determined. It is hypothesized that differences in the number and/or composition of invertebrates exist between upstream and downstream samples, because of sediment deposition resulting from intervening roads. The quality and composition of fish populations are to be determined by electro-fishing techniques.

Suspended sediment production is determined by taking the difference in sediment concentrations between samples taken upstream and downstream from road-stream crossings. The basic assumption of the method is that downstream concentrations exceed upstream values because of sediment discharge from an intervening road. Sediment samples are taken daily through the work week. During storm periods sampling frequency is intensified to one sample per four hours until recession flows are apparent. Samples are collected in one pint glass bottles using a U.S.G.S. DH48A hand sediment sampler. Samples are transported weekly to Edmonton and suspended sediment concentrations in mg/liter determined by filtration.

9. <u>Study Objectives</u>:

To determine and demonstrate the effects of erosion-sedimentation controls at logging road-stream intersections in terms of:

a. suspended sediment concentrations and discharge determined upstream and downstream from road-stream crossings;

b. the number, volumes and composition of aquatic invertebrates and fish upstream and downstream from roadstream crossings.

10. Resources:

a. Starting date: 1974
b. Estimated year completion: 1977
c. Estimated total Prof. man-years required: 0.8
d. Essential new major equipment items for 1975-76: Nil
e. Essential new major equipment items beyond 1976: Nil
f. 1975-76 Man years

Prof.	0.2			
Supp.	-			
Casual	-			
Total	0.2		O & M funds req'd:	$500.00

11. Progress to date:

Request for study design assistance received from Environmental Research Secretariat and North Western Pulp and Power Ltd. in fall of 1973. Initial study plan formulated by C.F.S. and circulated to other study participants for comments and evaluation. Spring of 1974 final draft of study plan approved by all study participants.

Study was initiated in summer of 1974. Five road-stream intersections were selected for treatment application. Unable to obtain 12 sites desired, because in a given year there is not enough new road construction to provide the type of road-stream crossings necessary.

The five sites selected were treated, three receiving a brush mulch and two receiving a grass seed-fertilizer mixture. Suspended sediment was sampled daily, and during storm periods every four hours. Preliminary results shows that during storm periods, suspended sediment from grassed sites (Method no. 1) was 2-4 times more than that from brush mulch sites (Method no. 2).

Invertebrates and fish populations were studied at each road-stream crossing. However, at two of the five sites the upstream channel sections were unsuitable for sampling of invertebrates or fish populations. Stream channels were too small and littered with debris for effective sample. Results show a trend of fewer aquatic invertebrates downstream from roads than upstream. Electro fishing identified small but measureable populations of Dolly Varden trout, rainbow trout and rocky mountain whitefish in all streams.

A first year progress report on the erosion-sedimentation part of the study was prepared and distributed to cooperators. Paper submitted as a file report.

12. Goals for 1974-75:

(See section 11).

13. Accomplishments 1974-75:

(See section 11).

14. Goals for 1975-76:

1. To select 6-8 sites for implementation of new study design. Criteria for selection of sites has been modified. Instead of relying on new road construction; existing, stabilized road-stream intersections will be located and scarified to represent new road construction. This approach will make selection of sites easier and more efficient.
2. To apply treatments to new sites, and to continue sediment sampling and invertebrate and fish population studies as in 1974-75.
3. Prepare progress report of 1975 field season data.

15. Publications:

Up to 1974-75

Nil

1974-75

Rothwell, R.L. 1974. Progress Report: Road-Bank Stabilization in the Hinton-Edson Area, Alberta, File Report NOR 017.

16. Signatures:

R L Rothwell
Investigator

R. E. Ackerman
Program Manager

G T Silver
Director G.T. Silver

PROJECT NOR - 14

Impact of Clearcutting on the Forest Environment

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 14, 1975

1. Project: Impact of clearcutting on the forest environment.

2. Title: Changes in chemical and physical water quality following forest harvesting and related land disturbances.

3. New: Cont: X 4. No.: NOR 104

5. Study Leader: T. Singh

6. Key Words: Environmental quality, land use, clearcutting, nutrients in natural water, erosion.

7. Location of Work: Rocky Mountain front ranges and foothills, Alberta.

8. Problem:

   a. Project proposed by: Canadian Forestry Service and the Research Coordinating Committee, Alberta Watershed Research Program.

   b. Nature of the study: Land surface disturbances from different resource uses are on the increase along the eastern slopes of the Rocky Mountains and foothills. The detrimental effects of such disturbances on the chemical quality of water remain largely undetermined in Alberta.

      Large clearcuts result in reduced transpiration and interception losses. The consequent increased leaching and high streamflow can cause increased export of nutrients from the disturbed sites. The change in concentration of solutes directly affects the chemical quality of natural waters and thus influences the quality of habitat associated with such waters. Loss of nutrients at a rate greater than their replenishment can cause deterioration in site quality especially in areas where soil mantle is thin.

      The reduction in protective forest cover has resulted in increased fluctuations in stream temperatures in many headwater streams.

Similar changes in physical water quality are the other resultants of surface land disturbances of which little is presently known in Alberta. As the quality of water is at least as important as the quantity of water affected by the resource use practices, it is essential that the impact of such land disturbances on water quality be assessed quantitatively.

c. Benefits from the solution: The quantitative assessment of the effects of surface land disturbances on the chemical quality of natural waters will provide a rational basis for suggesting improvements in the methods adopted by the resource users in forest areas. Such improved methods will be especially useful when new areas are subjected to the same land use disturbances in other parts of Alberta.

The study would also provide an objective assessment of how the large clearcutting harvesting practices affect nutrient export as compared to the properly managed and undisturbed forests.

d. Probability of success: The probability of successful evaluation of the current surface land disturbances on the chemical and physical water quality of natural waters during the spring snowmelt and low flow periods is very high. The samples collected and analyzed for this purpose would also provide accurate estimates of total solute loads of streams on a monthly, seasonal and annual basis. The probability of successful assessment of nutrient losses from a forest catchment as result of treatment, and the consequent enrichment of streams, is high.

e. Method to be used: Water samples from the streams draining undisturbed and disturbed watersheds will be collected for analysis. Streamflow at the time of sampling will be determined from the stream gauges established at the sampling sites. The concentration of solutes and the total flow in the stream will provide estimates of the solute loads for the high and low flow periods.

The samples to be collected are from the main streams of 6 to 11 treated catchments and a similar total of untreated catchments. Emphasis will be placed on pairing the untreated and treated watersheds wherever possible; group comparisons would be made where direct pairs are difficult to obtain. In order to achieve comparable results, such groups would be formed on basis of geographical similarities, e.g. within the same working circle in the Hinton lease area.

Sampling would be distributed over the high and low flow periods. This is essential for providing an assessment of the seasonal patterns and dilution effects. The study will be conducted in the North Western Pulp and Power lease lands near Hinton.

9. Study Objectives:

   a. To determine the quantitative changes in chemical and physical water quality as a result of forest harvesting and related land disturbances.

   b. To develop statistical models for prediction purposes when similar forest areas are disturbed elsewhere in Alberta.

10. Resources:

   a. Starting date: 1971
   b. Estimated year of completion: 1976 Revised: 1977
   c. Estimated total man-years required: 1.0
   d. Essential new major equipment items for 1975-76 with costs: Nil
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years

Prof.	0.2	
Supp.	.2	
Casual	-	
Total	0.4	O & M funds req'd: $1,000 SR Cont.

11. Progress to Date:

   1. Selected parameters of chemical and physical water quality were sampled in previous work (Foothills Water Quality Study). The study provided an estimate of the variability encountered in water quality parameters. Although preliminary assessments were possible, more samples need to be collected to permit detailed conclusions.

   2. Data on streamflow and ionic concentration (mg/l) of calcium, magnesium, sodium and potassium were collected on the Hinton lease area during the spring and early summer of 1973.

12. Goals for 1974-75:

   1. Determine the spring melt, summer and early autumn concentrations of nutrients (N, P, Ca, Mg, Na, K, SO_4, Cl, HCO_3, CO_3) in the stream waters of the clearcut and undisturbed catchments of the Hinton pulp lease area.

   2. Make test of the water quality sampler for taking an integrated sample in remote sites.

   3. Tabulation, extraction and key punching of collected data.

   4. Prepare a paper entitled, "Specific conductance method for *in situ* estimation of total dissolved solids" for publishing in the Journal of American Water Works Association.

5. Write a paper on the "Nutrient status of small streams draining partially clearcut and undisturbed forest watersheds" for publication in the Pulp and Paper Magazine of Canada.

6. Present a paper at the Paris Symposium of IHD.

13. Accomplishments in 1974-75:

1. A total of 117 samples were collected from May 7 to June 19 representing the spring snowmelt and peak streamflow conditions. Another 104 samples were obtained from July 11 to August 29 for the mid-summer months. A total of 18 catchments were sampled although the intensity of sampling in the Athabasca working circle (5 catchments) was minimal because of lack of adequate controls due to late establishment of untreated gauging sites and difficult access. The chemical constituents analyzed were nitrogen, phosphorus, calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate and carbonate. The nitrogen determinations included nitrite and nitrate nitrogen, ammonia nitrogen and total Kjeldahl nitrogen. The streamflow at the time of sampling was also measured to provide estimates on the export of nutrients from the logged catchments as compared to the unlogged catchments. All analyses were done at NFRC laboratory.

2. A test was made and gave satisfactory results.

3. The analyzed data were tabulated and are being put on HP data cassette files.

4. The paper was prepared and is published in the February issue of the Journal of American Water Works Association.

5. Not completed; all the required data not yet available.

6. A paper was prepared and submitted to the Paris Symposium of IHD on the "Effects of man on the interface of the hydrological cycle with the physical environment", held during September, 1974. IASH Pub. 113: 21-27.

14. Goals for 1975-76:

1. Determine the important constituents of natural waters in 8 logged and unlogged catchments of the McLeod and Berland Working Circles.

2. Sample intensively for main storm events that add unknown amounts of particulate matter to the streams and cause export of nutrients from catchments.

3. Prepare a paper entitled, "A least squares method for estimating yield of dissolved constituents" for publishing in the Journal of American Water Works Association.

4. Prepare and publish a journal paper on the total dissolved solids and main constituents present in the stream waters of aspen-grassland and spruce-fir vegetation.

5. Complete Study Progress Report.

15. Publications:

Up to 1974-75

Singh, T. and Y.P. Kalra. 1972. Water quality of an experimental watershed during the calibration period. Paper presented at the Nineteenth Pacific Northwest Regional Meeting of the American Geophysical Union, University of British Columbia, October 16-17, 1972. (Also Environ. Can., Northern Forest Research Centre, Edmonton, File Report NOR-Y-28.)

Singh, T. 1973. Harvesting effects on stream temperature detectable. Environ. Can., Northern Forest Research Centre, Edmonton, Forestry Report Vol. 2:8.

1974-75

Singh, T. and Y.P. Kalra. Specific conductance method for *in situ* estimation of total dissolved solids. J. Amer. Water Works Assoc., February 1975.

Singh, T. 1974. A simplified procedure for detecting changes of specified magnitude on paired plots and watersheds. Environ. Can., Northern Forest Research Centre, Edmonton, Information Report NOR-X-47.

Singh, T. 1974. Land Management practices that affect physical and chemical water quality. Proc. 1970 Symposium on Managing Forest Lands for Water, Environ. Can., Northern Forest Research Centre, Edmonton, Information Report NOR-X-13, p. 49-72.

Singh, T., Y.P. Kalra and G.R. Hillman. 1974. Effects of pulpwood harvesting on the quality of stream waters of forest catchments representing a large area in western Alberta, Canada. Proc. of the Paris Symposium on the Effects of Man on the Interface of the Hydrological Cycle with the Physical Environment, International Association of Hydrological Sciences Pub. No. 113, p. 21-27.

16. Signatures:

Teja Singh
Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 14, 1975

1. Project: Impact of clearcutting on forest environment.

2. Title: Quantitative evaluation of the effects of pulpwood harvesting in western Alberta on water yield, physical water quality and streamflow regime.

3. New: Cont.: X   4. No.: NOR 121

5. Study Leader: G.R. Hillman, R.L. Rothwell

6. Key Words: Streamflow, sedimentation, logging, watershed management.

7. Location of Work: Western Alberta

8. Problem:

Nature of study - this study is designed to evaluate the magnitude of several specified hydrologic variables as influenced by forest harvesting and road construction practices, and also to evaluate the potential for damage that these variables will have if such practices were to continue. The major variables of interest are water and sediment yields, and sediment sources.

Benefits from the solution - the results will give a measure of the impact of clearcutting on streamflow, and sediment sources and yields on North Western Pulp and Power Co.'s lease area. The information will be useful in assessing the effects of sediment from roads and seismic lines on aquatic habitats and downstream water use. The results will provide a basis for constructing guidelines for land managers with the object of minimizing damage by water and sediment, where this is a problem. They will also provide a framework for any future research into the problem of managing forests for increasing water yields.

Probability of success - the probability of quantitatively evaluating the effects of clearcutting on water yield, physical water quality, and streamflow regime is high if the spring runoff period only is considered. For other times of the year, the chances of identifying sediment sources and detecting relative differences in the amount of sediment remain high but it is more difficult to detect differences between water yields from logged and from untreated areas.

Probability of results being applied - if results indicate that problems pertaining to changes in water yield, sediment sources, and sediment yield exist, there is a high probability that guidelines will be constructed with the object of minimizing these problems. The guidelines would contain recommendations relating to road and seismic line construction, in addition to forest cutting practices. Whether these guidelines are followed or not will depend upon the land management agency concerned with such problems.

Method used - a simple statistical analysis uses the null hypothesis to compare the mean values of a) water yield at specified times from treated and untreated groups of catchments, and b) sediment production from groups of a particular source type i.e., road and/or seismic lines.

The method requires streamflow measurements from 6 to 10 treated catchments, and from 6 to 10 untreated catchments. Catchments, the outlets of which must be accessible at all times, are selected so that several physiographic and climatic regions of the lease area are sampled. No artificial structures are used to control streamflow; the flow is measured along natural control sections with current meters or Rhodamine WT dye. Changes in water elevation are monitored by recorders or noted from staff gauges, and a correlation (rating curve) is obtained between water elevation and streamflow for both high and low flows.

Initial efforts to detect differences between streamflow from the two types of catchments will be confined to the spring runoff period, when differences are expected to be at a maximum.

Sediment production from a given source is to be determined by taking the difference in sediment concentrations between samples taken upstream and downstream from a sediment source. The basic assumption of the method is that downstream concentrations exceed upstream values because of sediment discharge from the source area. This technique has been successfully used elsewhere.

The initial sample design included forty sites, evenly divided among road-stream and seismic trail-stream intersections, less than two years old from the time of disturbance, and stratified by till types.

Sediment samples were obtained in one-pint glass bottles either as grab samples or with a DH48 hand sediment sampler. Rating curves and measures of streamflow were obtained in conjunction with sediment to allow sediment discharge to be calculated in terms of streamflow.

Water yield from catchments is governed to a large degree by precipitation on the catchments. It is necessary therefore to establish a climatic zonation of the lease area. For this purpose climatic data, including daily air temperature and precipitation data collected for study NOR 138 will be utilized.

9. Study Objectives:

   a. To quantitatively determine the impact of present and past timber harvesting operations on channelized streamflow, regime and physical water quality.

   b. To identify sources of sediment.

   c. To assist in the evaluation of the effect of such impact on downstream water users to foresee and forestall future problems.

10. Resources:

    a. Starting date: 1972
    b. Estimated year of completion: 1975 Revised: 1977
    c. Estimated total Prof. man-years required: 4
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years

Prof.	0.7 (Hillman 0.4, Rothwell 0.3)		
Supp.	0.2		
Casual	0.3		
Total	1.2	O & M funds req'd:	$3,000.00

11. Progress to date:

During 1971 preliminary work was undertaken to determine the feasibility of the study. Maps and overlays were assembled, and on-site reconnaissance by Canadian Forestry Service personnel was conducted to select 18 catchments for study from over 100 catchments.

Support for the study was obtained from Water Survey of Canada, Atmospheric Environment Service, North Western Pulp and Power Ltd., Alberta Forest Service, and the Fish and Wildlife Division of the Alberta Department of Lands and Forests.

Six questions were posed that required statistically designed sampling programs to achieve relevant answers. They were submitted to the Alberta Watershed Research Coordinating Committee for consideration in December 1971. The Committee agreed that efforts should be concentrated on obtaining answers to the two most important questions before proceeding to find answers to the other four.

The questions accorded primary consideration are:

1. How much higher are the instantaneous or total flows during snow melt from clearcut and/or incompletely cut catchments than from each other or those uncut?

2. What are the principal sources of sediment in the study area?

Progress has been made towards obtaining statistical sampling programs designed to answer these questions. Preliminary analysis of 1971 Tri-

Creeks (a highly-instrumented catchment near Hinton) data indicates that if the variance among harvested and non-harvested catchments are assumed equal, in order to obtain an 80 percent chance of detecting flow differences of 25 percent, a minimum of four harvested and four non-harvested catchments are required. When a similar analysis was carried out for total flows from catchments located all over the world, it was found that a minimum sample of six harvested and six non-harvested catchments are required for the present study. Therefore answers to question 1 will be based on data obtained from a minimum of six harvested and six non-harvested catchments.

To answer question 2, it was decided that initial studies should examine the relative importance of road-stream and seismic trail-stream intersections as sediment sources in the study area.

Results from earlier work indicated that 16 to 20 sampling sites must be used to detect sediment differences of 100% during reasonably homogeneous storm events. Therefore the initial study design included 40 sites evenly divided among roads and seismic trails.

During 1972-73 daily temperature (maximum and minimum) and precipitation data for the period 1961-70 for 31 climatological stations on and adjacent to the North Western Pulp and Power lease area were acquired, together with data from Tri-Creeks and Cache Percotte watersheds, for analysis.

Climatological data collected during the summer of 1972 was used to produce detailed isopleth maps of total precipitation for the period May to Septemaber, for the second half of July and for the storm period, June 8-12.

Water level recorders were installed on one undisturbed and five harvested catchments during 1972. Stream discharge measurements were obtained for the period mid-June to the end of August, and used to construct stage-discharge rating curves.

Some progress was made in summarizing the characteristics and condition of each catchment using information from topographic, surficial geology, bedrock geology, vegetation and forest management maps.

A sediment sampling network of 38 sites (22 road-stream and 16 seismic trail-stream intersections) was established and described during 1972. The network was instrumented with 38 staff gauges, 38 crest gauges, 29 MSC rain gauges and one recording precipitation gauge. Weekly sediment samples, upstream and downstream were obtained and analysed for suspended sediment concentration (units, mg/l), conductivity (units, micromhos/cm), turbidity (units, f.t.u.). Streamflow, stage, maximum stage and precipitation were obtained for each sample site.

Preliminary results of the sediment study indicated that the sampling method is satisfactory for evaluating sediment discharge from specific points. Downstream sediment samples, 75% of the time are higher than upstream samples. A one-way analysis of variance showed that during non-storm and low flows sediment discharges from road-stream and seismic trail-stream intersections are not significantly different.

In 1973, a preliminary summer climatic zonation map of the Hinton lease area using climatological data from over 30 stations for the period 1961-1970 was prepared.

Data was collected from a network of 143 precipitation stations in and adjacent to North Western Pulp and Power Co's lease area for the period May to September. They were used to produce isopleth maps of precipitation during the storm periods May 24 to 28, and June 23-26, 1973.

Water level recorders were installed on 9 catchments during 1973 bringing the total number of catchments so equipped to 15. Streamflow data were collected from a total of 16 catchments (nine logged and seven undisturbed) during the snowmelt runoff period.

Composite hydrographs were developed to represent the average flows from the logged and from the undisturbed catchments. Results indicated that during high flow conditions, greater water yields can be expected from logged areas.

From May 1 - June 29, 1973 daily sediment samples, current meter observations, and precipitation measurements were obtained at each of the 38 sediment sampling sites. Average sediment production from roads and seismic lines was 816 lbs/day and 413 lbs/day. The difference was found to be significant at the 80% level of probability. No significant differences were detected during non-storm conditions. Average sediment production for roads and seismic lines during non-storm conditions was 62 lbs/day and 54 lbs/day.

Eight recording precipitation gauges were installed in the Marlboro, McLeod, Athabasca and Berland working circles and serviced along with three others through the winter. Snow courses were also run at the eleven locations during each monthly visit. Snow courses were marked out on a number of the logged and undisturbed gauged catchments and measured during January, March and April, 1973. A preliminary snow survey undertaken April 10 to 12, 1973, indicated that an average of slightly over 5 inches of water was stored in the snowpack prior to spring breakup.

Preliminary results of the study were presented at meetings, e.g. Alberta Watershed Research Coordinating Committee, and seminars.

12. Goals for 1974-75:

1. Install water level recorder systems on the three catchments not yet equipped with recorders.

2. Repeat the data collection program initiated during 1973 in order to substantiate the results obtained during the May-June, 1973 snow melt runoff period. Continuous streamflow records, as opposed to discrete data, should be available from all catchments in the

network during 1974. Thus the problem of missing data frequently encountered during the analyses of the 1973 record should be largely eliminated.

3. Abstract and analyze streamflow data to: 1. evaluate the magnitude of the difference between water yield from logged and water yield from undisturbed catchments, 2. determine whether this difference is significant and, 3. use together with precipitation data from study NOR 138 to determine precipitation runoff relationships.

4. Test of a discriminant function as a method to classify catchment areas for high and low sediment production; and preparation of a report entitled, "Evaluation of Erosion-Sediment Potential for Watersheds by a Discriminant Function".

5. Field test an automatic sediment sampler by establishing a network of 10 sampling sites in the Hinton area. The samples will be used in evaluating sediment production from logged and undisturbed catchments.

6. If necessary, modify automatic sediment sampler; and construct 20 samplers.

7. Continue to collect climatic data from existing stations. Add additional rain gauges on some of the study catchments so that a minimum of three rain gauges per catchment is present to provide average values for each catchment. Maintain recording precipitation gauges during the winter, and take monthly measurements of water equivalent on snow courses running adjacent to each precipitation station.

8. Prepare an Information Report entitled, "The effects of pulpwood harvesting on water yield, water quality and streamflow regime;" and/or File Report on the study for April, 1975.

9. Prepare publication describing erosion-sedimentation from logging roads and seismic lines.

10. Prepare written description of North Western Pulp and Power Ltd's forest management plan and the stream gauging network situated on the lease area, for inclusion in a paper on chemical water quality to be presented at an IHD Symposium in Paris (see study NOR-14-104).

13. Accomplishments for 1974-75:

1. Stilling well/water-level recorder systems were installed on three catchments established earlier, but not previously equipped with water-level recorders. Continuous gauging commenced on these sites during June and July, 1974.

2. The streamflow data collection program commenced at the end of April, 1974 and was continued until mid-September, 1974 when all 18 stream gauging stations were shut down.

3. All the streamflow data has been abstracted and is now being analysed. Results to date indicate that logging has a significant impact on snowmelt runoff. The mean flow resulting from snowmelt (April 25 to May 23) was 3.8 inches for logged catchments, and 2.5 inches for undisturbed catchments. The difference of 1.3 inches (52%) was significant at the 90% confidence level. Differences in the timing of peak flows for logged and undisturbed catchments were not evident. Significant differences between flows from the two types of catchments were established for certain rain storm events in August and September, with the logged catchments sustaining higher flows. Total runoff volumes resulting from these storms, however, were small.

4. Test of discriminant function as a method to classify catchment areas for high and low sediment production completed. Of the physiographic and land use parameters tested, the number of road-stream, seismic line-stream crossings and catchment area were best indicators of land disturbance and erosion-sedimentation. Results are currently being prepared for a report.

5. Field test of automatic sediment sampler completed. However, because of shipping delays in materials for manufacture of samplers, they were not ready for testing in Hinton area. Accordingly, test program was shifted to Marmot Creek experimental watershed. Results show that integrated sediment samples for time periods of 1-8 days can be obtained.

6. Modifications to automatic sediment samplers involving pumping times and physical arrangement in field set up were made. Ten samplers constructed during the winter months.

7. During the winter of 1973/74 recording precipitation gauges were maintained at 11 locations on a monthly basis by contract. Snow course measurements were obtained at each of these stations on the monthly visits, and again in April when 10 additional locations were surveyed. Preliminary analysis of the 1972/73 and 1973/74 snow survey data was accomplished and reported to the Alberta Watershed Research Committee (Annual Report IV-5-6) along with other aspects of the study. Data from 36 standard rain gauges and 8 recording gauges were obtained on or in the immediate vicinity of the study watersheds. These formed part of a larger precipitation network of 145 standard gauges and 24 recording gauges associated with study NOR 138. Daily data from May to September has been extracted and tabulated from all but a few recording gauges. Twelve recording gauges are being maintained to obtain winter precipitation measurements.

8. Progress has been made in preparing the information report. The report will present processed hydrometeorological data obtained in the Hinton-Edson region during 1972-74, displayed in a form convenient for potential users of such information eg. land managers, road engineers, fisheries biologists, etc.

   Note: The streamflow data will also appear in tabular form in Water Survey of Canada's "Surface Water Data - 1974".

9. Preparation of publication describing erosion-sedimentation from logging roads and seismic lines started. Currently in second rewriting. Authored by R. Rothwell, R.H. Swanson.

10. The following paper was published in 1974:-

    Singh, T., Y.P. Kalra and G.R. Hillman. 1974. Effects of pulpwood harvesting on the quality of stream waters of forest catchments representing a large area in western Alberta, Canada. Proc. of the Symposium on the Effects of Man on the Interface of the Hydrological Cycle with the Physical Environment, International Association of Hydrological Sciences Pub. No. 113, p. 21-27.

14. Goals for 1975-76

   a. Provide support for study NOR-14-104 by monitoring streamflows from 8 catchments in the Berland and McLeod working circles during the period mid-May to mid-August, and by processing the field data so obtained into useable form.

   b. Prepare a paper on the successful testing of a here-to-fore untried statistical technique for quantifying the effects of large scale timber harvesting on ensuing streamflow. Authors: R.H. Swanson and G.R. Hillman.

   c. Prepare a report on the results of the study and their implications regarding the effects of pulpwood harvesting on water yield and streamflow regime. Authors: G.R. Hillman and R.H. Swanson.

   d. Complete information report on Hydrometeorological Information for the Hinton-Edson region, 1972-74. Authors: G.R. Hillman, J. Powell and R.L. Rothwell.

   e. Complete report on use of discriminant function for classifying high and low sediment production. Author: R.L. Rothwell.

   f. Complete testing of automatic sediment sampler on the Marmot Creek evaluation (NOR-13-017) and prepare a report.

   g. Complete report describing erosion-sedimentation from roads and seismic lines. Authors: R.L. Rothwell, R.H. Swanson.

   h. In early April run snow surveys at 12 to 18 locations for comparison with other years. Maintain a full network of precipitation gauges from May to September in the Berland, Athabasca and McLeod working circles to obtain background precipitation data for the present goals of this study and for NOR 104, 138 and 139.

i. Prepare study progress report.

15. Publications:

Up to 1974-75

Alberta Watershed Research Program. 1972. Annual Report, March 1971 - January 1972. Research Coordinating Committee. pp. VI 2-12.

Alberta Watershed Research Program. 1973. Annual Report, January 1972 - December 1972. Research Coordinating Committee. pp. III 3-5; IV 4-6.

Hillman, G.R. 1971. Probable hydrological effects of clear-cutting large blocks in Alberta. pp. 44-74. In: H.J. Johnson et al. Some implications of large-scale clearcutting in Alberta - a literature review. Northern Forest Research Centre Info. Rept. NOR-X-6.

Hillman, G.R. 1972. Determination of discharge and mean velocity of several Alberta streams using Rhodamine WT dye. - A report submitted to the Director of the Division of Pollution Control, Alberta Department of the Environment. December. pp. 11.

Alberta Watershed Research Program. 1973. Annual Report, January 1973 - December 1973. Research Coordinating Committee. pp. III 2-4; IV 1-4.

Hillman, G.R. 1974. Logged areas produce more water than not logged during spring storms. Canadian Forestry Service, Northern Forest Research Centre. Forestry Report 3(4).

Rothwell, R.L. 1973. How to design logging road drainage systems. Canadian Forest Industries 93(3):39-43.

Rothwell, R.L. 1974. Roads - Major Sediment Source. Canadian Forestry Service, Northern Forest Research Centre. Forestry Report 3(4).

1974-75

Alberta Watershed Research Program 1974. Annual Report. January 1974 - December 1974. Research Coordinating Committee. pp.III 3-6; IV 1-6.

Singh, T., Y.P. Kalra and G.R. Hillman, 1974. Effects of pulpwood harvesting on the quality of stream waters of forest catchments representing a large area in western Alberta, Canada. Proc. Symposium on the effects of man on the interface of the hydrological cycle with the physical environment. Int. Assoc. of Hydrological Publ. No. 113, p. 21-27.

16. Signatures:

G. R. Hillman
R. L. Rothwell
Investigator

P. L. Aackerman
Program Manager

G. Silver
Director

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 14, 1975

1. Project: Impact of clearcutting on forest environment

2. Title: The climate of clearcut forested areas.

3. New: Cont.: X 4. No.: NOR 138

5. Study Leader: J.M. Powell

6. Key Words: Forest climatology, macroclimatology, mesoclimatology, microclimatology, clearcut size, mobile and airborne sensing, SA1, SA2, M4, B19a, B19c.

7. Location of Work: North Western Pulp and Power Ltd. lease area at Hinton, Alberta and Edmonton Laboratory. Data will be obtained from the Prince George, B.C. area on a cooperative basis with Climatology Section, CLI, Victoria, B.C.

8. Problem:

A literature review indicated that there is a paucity of data relating to climatic environmental changes brought about by large-scale logging operations. Background information of the interrelationships of macro-, meso- and microclimate in clearcut areas is required for other forestry studies. Information on the effects of different types and sizes of cutting patterns is particularly lacking. What changes in the various climatic parameters important for forest regrowth can be expected following the removal of the tree cover, and how far does the ameliorating influence of the stand border extend? Can any adverse changes be physically adjusted by modifying cutting patterns to improve the ground-level factors?

A detailed analysis of the problem can be found in the study statement for the year 1974-75.

9. Study Objectives:

   a. To determine the effect of clearcutting of different sizes on the various climatic parameters.

   b. To identify the zones of stand border influence for each climatic parameter and to relate this to size and orientation of cut.

   c. To assess the use of fixed ground based climatic stations, with ground level mobile sensors and airborne sensors, for obtaining climatic data for forestry purposes.

10. Resources:

    a. Starting date: 1971
    b. Estimated year of completion: 1978
    c. Estimated total Prof. man-years required: 3.1
    d. Essential new major equipment items for 1975-76 with costs: NIl
       Minor equipment - Soil probes (6) 750.00
       2 Field Recording Wind sets $1,800.00
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years

Prof.	0.5	
Supp.	0.9	
Casual	0.3	
Total	1.7	O & M funds req'd: $4,000.00

11. Progress to Date:

A preliminary survey was undertaken in 1971 and five cutting compartments were selected for the initial study. Sites for the base and satellite stations were selected in these areas and the stations equipped with instruments then available. Only three compartments were adequately instrumented. At the peak period some 21 stations were operated, and a total of 53 locations were sampled. Sixteen to 20 stations were run throughout the winter of 1971-72 and detailed measurements of snow were taken.

The five study compartments instrumented in 1971 were again sampled in 1972, although one area was only used to a very limited extent. Stations were set up in three new compartments in the predominantly spruce area, to supplement the five stations operated by Lesko (NOR 016). Altogether 58 locations were sampled, including 22 on a continuous basis from May to early October. In addition to the instrumentation employed in 1971, two stations in each of five compartments were equipped with Gen atmometers for gaining information on evaporation rates. An additional three base stations were equipped with recording rain gauges and wind speed recorders. Access tubes for a soil moisture neutron probe were installed at 27 stations, and air and soil temperature profiles were installed at 28 stations. At each base station two access tubes and temperature profiles were installed. Periodic readings of soil moisture and soil and air temperatures were obtained at the stations (usually weekly) but not for as long a period as desired because of instrument failure or lack of manpower. Gravimetric soil moisture sampling was obtained once at 15 stations as a check against the neutron probe readings. Spring snow courses were run in April in four of the areas. Only one station, with a monthly recorder, was operated in the winter.

In 1973 the mesoclimatic networks established in 1971 or 1972 were continued, in some cases with a reduced number of stations, in others an increased number. Forty-five weekly climate stations were run from mid-April or early May until the beginning of October. Two monthly stations were run in one more inaccessible area of a compartment. One monthly climate station was maintained through the winter. Snow courses were measured in 10 locations in early April. During May and June most of the stations were visited each working day, providing daily temperature and precipitation readings, in addition to those of recording instruments. Climate and precipitation stations were established on most of the gauged watersheds and sediment sampling areas (NOR 121). The two operational areas of the silvicultural study (NOR 139) were included in the microclimatic network; one of the 1974 areas was instrumented as a climate station with the addition of a recording rain gauge and a pyrheliograph. No evaporation measuring instruments were operated at the stations in 1973. Also no mobile thermo-dew point traverses or soil moisture neutron probe readings were obtained. Station site descriptions were made of all climate and precipitation stations, but not the individual stations of the microclimate networks. The description included reference to aspect, site history, slope, microrelief, view factor, slash residue, forms and abundance of vegetation, and important species. An infrared field thermometer and a telethermometer were used for short periods to help check the representativeness of some of the recording sites.

In 1972 six areas, two strip cuts, two block cuts and two large irregular cuts were selected for microclimatic studies. In each of these areas 6 to 16 stations were established, each with a soil moisture neutron probe access tube and a soil and air temperature profile. Transects for measuring precipitation were established on two areas, and transects for wind and radiation on one area. Each area also included a station where other parameters were measured or recorded. Some of the soil temperature data was analyzed for a short Conference paper.

In 1973, soil temperature measurements were made at approximately weekly intervals from mid-May to late September on four microclimate networks established in 1972. Most soil thermocouples installed in 1972 had to be replaced (depths 5, 10, 20, 30, 50 and 70 cm). On one of the cuts two of the transects of the network were extended 25 feet into the adjacent forest stands. The networks of air temperature profiles were taken on two occasions and some information on distribution of precipitation on two of the cuts was obtained. Irregular soil and air temperature readings were also obtained from one large clearcut network instrumented in 1972. No neutron probe measurements were taken on the networks.

Two climate stations were established on the cut, and one in the adjacent stand of each silvicultural study area (NOR 139). Incoming solar radiation measurements, with pyrheliographs were obtained at the stations in the open, and radiation was also measured with a net radiometer for short periods on each area. Wind measurements were taken at one site on each cut. Two transects of five Gen atomometers were installed adjacent to each plot and measurements made from mid-June to early September. Two transects of 8 rain gauges, from the stand edge to the plot 600 feet into the clearcut were read at weekly or more frequent intervals from June to mid-September. Soil thermocouples were installed at 0.1, 5, 7.5, 10, 15, 20, 30 and 50 cm at 24 locations on one cut and at 26 locations on the other, and read weekly from mid-July to late September. Thermocouples were also installed at +15, 0, -7.5 and -15 cm on each plot and measurements obtained at 20-minute intervals on 24-point chart recorders from late July to mid-September. Continuous soil (5 and 7.5 cm) and air temperatures (0.1, 5, 10, 40, 70 and 150 cm) were obtained for short periods in the second half of August with a 10-point temperature system. One transect of five air temperature profiles (0.1, 5, 15, 75, 140 and 300 cm) were installed on each area, and measured on one occasion in August. Thermocouple psychrometers were installed at 7.5 and 15 cm in the soil, and tensiometers at 15 cm, on each plot to measure weekly soil water potential. A plane table survey was carried out on each area to establish location of plots, instruments and other features.

All temperature, radiation, precipitation and wind data has been extracted from charts and put on punch cards for all mesoclimatic stations up to October 1972. Data for these parameters has also been extracted for the April to late May, 1973 period but has not been put on punch cards. Humidity data for 6 stations has been extracted and put on cards for 1971 and 1972. The summaries of weekly climate data from all mesoclimate stations in 1971 and 1972 has also been extracted and put on cards. Temperature data for 27 stations for the 1973 season has been extracted.

Maps were prepared of the total precipitation for the period May to September 1974, second half of July and the storm of June 8-12, obtained from a total of 120 sampling points. In 1973, isopleth maps of precipitation during two storm periods, May 24-28 and June 23-26, were produced using data from 143 precipitation stations. This included data from 24 regular climatological stations, 9 stations in Jasper National Park, 15 stations on the Cache Percotte watershed and 2 stations in the Tri-Creeks Watershed Basins. The remaining 93 stations were operated under NOR 121 and this study. Daily measurements were taken at over 90 stations and 20 stations had recording precipitation gauges including 11 stations which also had standard gauges. Precipitation stations on each of the logged and unlogged watersheds of NOR 121 have been grouped and an average precipitation value for each catchment for each storm or period obtained. Eleven recording precipitation gauges and five thermographs were maintained through the winter, and snow courses were taken each month.

A description of the study and some preliminary results of soil temperature variations and precipitation patterns was presented as part of a paper given to the Alberta Centre of the Canadian Meteorological Society in April. Details of the precipitation aspects of the study were reported for 1972 and 1973 to the Alberta Watershed Research Program.

In 1971 and 1972 a dozen mobile temperature traverses, most at dawn, were run through and between four of the study compartments.

The thermal infrared line scan images taken in 1971 were used by Mr. Lubitz, a University of Alberta graduate student, to develop a computer technique for presentation of the data. A report describing this study is presently under local review. Generally the technique of thermal infrared line scanning and the computerization of the data has little value for general climate surveys, but could prove useful for detailed analysis in problem areas where a knowledge of the thermal regime is required.

Agreement was reached with the B.C. Climatology Section of CLI that pairs of stations would be set up in the Prince George area. In August, 1972, one pair was set up near the Bowron River to record air and soil temperatures, air humidity and precipitation and run through the winter until mid-October, 1973. Totalizing anemometers were installed at both stations and evaporimeters at the clearcut station in the summer of 1973. A new pair of stations were installed in May on Gregg Creek, southwest of Prince George. The forest station was operated until early November, but the clearcut station, which had also been in operation in the summer of 1972, was operated in the 1973 winter. Soil temperature and moisture readings were obtained at 5, 20 and 50 cms. Hygrothermographs, air and ground extreme temperatures and precipitation were read at these stations. In addition 5 thermograph stations were operated in the winter of 1972-73 at 50 and 250 feet into a stand, at the forest edge and at 50 and 250 feet into a cut. The pair of stations at the 250 foot distances were operated in the summer of 1973. Data from an earlier pair of stations near Naver River, B.C. has been received from the B.C. Climatology Section (CLI) and the daily maximum and minimum temperatures for the years 1968 to 1970 have been extracted.

12. Goals for 1974-75:

1. Continue the monitoring of the mesoclimate networks on the seven cutting compartments instrumented in 1972. There will probably be a reduction in the overall instrumentation to allow some to be used to satisfy other goals. It seems unlikely that manpower will be available to reestablish and measure the soil moisture neutron probe network, or to undertake mobile thermo-dew-point traverses.

2. Two further microclimate networks will be established in connection with NOR 139, employing similar instrumentation to those used this year on the two other areas. It is hoped that a longer period of recording will be possible during the growing season, if more manpower is made available.

3. Weekly reading of soil temperatures will be continued on three of the other microclimate networks for comparison with those used in the silvicultural study. It is doubtful that the other networks can be read in 1974 except on one or two occasions.

4. Some additional rain gauges will be installed in connection with NOR 121, especially on the unlogged catchments. Eleven recording precipitation gauges are being maintained through the winter and snow survey measurements will be taken at each location each month through to April. Daily precipitation readings will be obtained through May and June, with weekly values from then until early October.

5. The extraction and key punching of collected data will be continued to facilitate future analysis.

6. An Information Report on "Some computer techniques for presentation of thermal infrared line scan data" will be published.

7. The analysis and results of the May-June, 1973 precipitation data will form part of an Information Report on the effects of pulpwood harvesting on water yield, physical water quality and streamflow regime.

8. Prepare a draft report on the summer macroclimate zonation of the Hinton lease and adjacent area, including maps of individual climatic parameters.

9. A file Study Progress Report will be prepared by March 31, 1975.

10. Undertake preliminary analysis of the climatic data collected in Compartment XV of McLeod Working Circle in 1971 and 1972 and discuss with N.W.P.P. Ltd.

11. Continuation of the analysis of data from the first 17 months (two summers and one winter) of the study, by D.C. MacIver, to constitute the basis for a Ph. D. thesis.

12. With the cooperation of the B.C. Climatology (CLI), 1974 data from "paired" stations set up near Prince George will be provided for comparison purposes.

13. <u>Accomplishments in 1974-75</u>:

1. Monitoring of the mesoclimate networks on seven cutting compartments was undertaken from late April until early October. Four stations are now established on an eighth compartment, because of expansion of NOR 139 to this compartment. Climatic stations were run at a

total of 50 locations, 11 of these were directly associated with NOR 139. At all of these stations the following parameters were measured; temperature, including maximum and minimum thermometers; standard rain gauge and humidity. Recording rain-gauges were maintained at 17 locations, 8 of which are running through the winter. Radiation was measured at 13 stations, wind at 12 stations and soil moisture at 2 stations.

Soil temperatures at depths of 5 and 20 cm were measured weekly at 28 stations, and soil temperature profiles to 70 cm or 1 m at 19 stations. Soil moisture neutron measurements were not made. The mobile thermo-dew point equipment was not available.

2. Two further microclimate networks were established in the Athabasca Working Circle in connection with NOR 139 with similar instrumentation to the two networks in Compartment II of the McLeod Working Circle. A full season's measurements were obtained on the McLeod two networks, but measurements were sporadic on the Athabasca networks.

3. Reading of soil temperatures on the four networks associated with NOR 139 and three other networks in Compartment II, McLeod W.C. were taken most weeks from the end of May until the end of August, except for the two networks in the Athabasca which were only measured twice in August. An additional network in Compartment I, McLeod W.C. was measured on six occasions.

4. Precipitation stations were operated at an additional 26 locations in conjunction with study NOR 121 from early May to early October, this included 5 recording gauges which are being maintained through the winter to give totals of winter precipitation. Snow survey data was collected at 11 locations by contract on a monthly basis last winter. In April,9 of these were resurveyed and surveys undertaken at 10 other locations. The 1972/73 and 1973/74 snow survey data were analyzed and a preliminary report given. (Alberta Watershed Research Program, Annual Report III 5, IV 4-6, 1975). Precipitation was also obtained from 30 regular climatological stations in the general lease area and in Jasper National Park, and from 33 special hydrological study stations, giving a network of 145 precipitation stations for the area. All the precipitation data except for 6 recording gauge stations has been extracted and tabulated, and monthly totals obtained. Mention of aspects of this study were given in the report mentioned above.

5. Extraction and key punching of most data up to October 1973 is complete for most climatic parameters. All 1974 temperature data has been extracted and is presently being put on punch cards. Most of the precipitation data has been extracted (see c above) and some is ready for key-punching. Some soil temperature data is ready for key-punching.

6. The Information Report, NOR-X-79 "Some computer techniques for presentation of thermal infrared line scan data" by E.D. Lubitz and J.M. Powell, was published.

7. The 1972, 1973 and 1974 precipitation data from the whole network has been tabulated and summarized, and totals for individual storms calculated in preparation for an Information Report on the Hydrometeorological data, 1972-74, in connection with NOR 121.

8. Preliminary analysis for the report on the summer macroclimatic zonation of the Hinton lease and adjacent area has been completed, based on technique and data used in NOR 115.

9. Preparation of a Study Progress Report is underway. Tables showing stations operated in the years 1971 to 1974 and the parameters observed and periods of recording are complete. Other tables in various stages of completeness give full station descriptions; status of extraction, tabulation, punch cards and analysis of data; microclimate networks; dates and routes of mobile temperature traverses; descriptions of punch card data and coding system.

10. Preliminary analysis of the climate data collected in Compartment XV, McLeod W.C. was completed and discussed with the Chief Forester, N.W.P.P. Ltd. A proposal for a future study of frost problems in the area was discussed but is not included in goals for 1975 as budget is not adequate.

11. Continued progress was made with the analysis of the first 17 months data of the study by MacIver. Approximately a half of the draft of the thesis has been completed.

12. The two paris of stations were put back in operation in May, but no further information or data was received from the Climate and Data Services Resource Analysis Unit, Environment and Land Use Committee Secretariat (B.C.), Prince George.

14. <u>Goals for 1975-76</u>:

1. Continue the climatic monitoring of the mesoclimate networks on six cutting compartments, four in the Athabasca W.C. and two in the McLeod W.C. to provide adequate background information for studies NOR-104, 121 and 139, as well as to satisfy the objectives of this study.

2. Maintain precipitation gauges at additional locations in connection with studies NOR 104 and 121 from May through to September. Snow survey measurements will be taken at 12-18 locations, second week of April, to establish the winter snowpack and to compare with winter precipitation totals from recording gauges, and snow surveys of previous years.

3. Input will be provided to complete the precipitation section of the proposed Information Report on Hydrometeorological information for the Hinton-Edson Region, Alberta 1972-74.

4. The four microclimate networks associated with NOR 139 will be maintained from early May to late September. Hopefully the soil temperature profile network at each location, and at three other locations in McLeod W.C., Compartment II can be measured at weekly intervals.

5. The extraction and key punching of collected data will be continued to facilitate future analysis.

6. A report will be prepared on the summer macroclimate zonation of the Hinton lease and adjacent area based on climate stations with records for the 1961-1970 period.

7. A file Study Progress Report will be completed giving status of the Study up to March 31, 1975.

8. The draft of the Ph. D. thesis based on the first 17 months data from the study will be completed by D.C. MacIver.

15. Publications:

Up to 1974-75

Powell, J.M. 1971. Environmental factors affected by clearcutting pp. 4-18. In: Johnson, H.J., H.F. Cerezke, F. Endean, G.R. Hillman, A.D. Kiil, J.C. Lees, A.A. Loman and J.M. Powell. Some implications of large-scale clearcutting in Alberta, a literature review. Can. Dept. Environment, Can. Forestry Serv., Edmonton. Information Report NOR-X-6. pp. 114.

MacIver, D.C. and Powell, J.M. 1973. Thermal soil variations as a function of clearcut size: preliminary analysis. Paper presented at the Eleventh Conference on Agricultural and Forest Meteorology, American Meteorological Society, Durham, N.C. January 9, 1973. (Also Environ. Can., Northern Forest Research Centre, Edmonton, File Report NOR-Y-53. pp. 10).

Alberta Watershed Research Program 1973. Impact of existing timber harvest on water yield, physical quality and micro climate. pp. IV, 4-6. Annual Report January 1972-December 1972. January 3, 1973.

Powell, J.M. 1973. Forest Climatology in Alberta. Paper presented to the Canadian Meteorological Society (Alberta Centre), Edmonton, April 3.

Powell, J.M. 1973. Climatic data input for quantitative evaluation of the effects of pulpwood harvesting on water yield, physical water quality and streamflow regime, pp. III-3. Climate of clear harvested areas, pp. IV 3-4. In: Annual report January, 1973-December 1973. Alberta Watershed Research Program. December 7, 1973

1974-75

E.D. Lubitz and J.M. Powell, 1974. Some computer techniques for presentation of thermal infrared line scan data. N.F.R.C. Information Report NOR-X-79. January, 21 pp.

Powell, J.M. 1975. Climate of clear-harvested areas. pp. IV 4-6 III 5. In: Annual Report January-December 1974. Alberta Watershed Research Program. January 7, 1975.

16. Signatures:

J. M. Powell
Investigator

L. R. Ackerman
Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 14, 1975

1. Project: Impact of clearcutting on forest environment

2. Title: The effect of the microclimate of clearcut areas on vegetation encroachment and survival and growth of conifer regeneration.

3. New: Cont.: X 4. No.: NOR 139

5. Study Leader: H.P. Sims

6. Key Words: *Pinus contorta*, *Picea glauca*, seeding, planting, establishment, growth, survival, microclimate, aspect, vegetation.

7. Location of Work: North Western Pulp and Power Ltd. lease area at Hinton, and Edmonton laboratory.

8. Problem:

In recent years some forest management practices, notably clearcutting have become a focus of public controversy. Present management of our forests is by guidelines implemented and enforced by our provincial governments. A recent literature review (Johnson *et al.* 1971) of the implications of large-scale clearcutting in Alberta, undertaken at the request of the Alberta Forest Service, indicated that there is a paucity of data relating to climatic environmental changes brought about by large-scale logging operations. Some information is available, from other areas, for small blocks or strip cuttings, but virtually nothing for large clearcuts where the favorable influence of the stand border on environmental parameters only affects a minute area of the cut. New regulations in Alberta require that cuts in spruce and spruce/fir forests should not be larger than 40 acres and in pine forests 60 acres. However, large scale operators are now in the position of removing large blocks of reserve forest left at the time of the initial cut, hence cut areas covering hundreds of acres are being created. In a similar lodgepole pine type in Wyoming, a 35-acre maximum size limit is in force on new scales, although existing timber scale contracts call for larger clear-cut blocks (USDA, 1971). Regeneration of clearcut blocks of pine forest does not appear to be a problem in Alberta or Wyoming, as this harvesting method fits the silvical and ecological requirements of lodgepole pine, but this does not appear to be the case in spruce/fir areas (Johnson *et al.* 1971; USDA, 1971). The use of clearcut harvesting methods in spruce/fir areas often leads to problems of regeneration and seedling growth and needs further research.

North Western Pulp and Power Co. have expressed a need for correlation of regeneration stem analysis with air and soil temperature and soil moisture in clearcut blocks.

Questions have also arisen publicly re erosion following clearcutting, and the suitability of clearcut areas for wildlife. Vegetation cover is an important factor involved in both these problem areas and is also an important factor operationally, with regard to competition to conifer regeneration. In this respect the interests of the public and the timber manager may be antagonistic to some degree. Vegetation encroachment on the clearcut areas should be assessed in order to provide a reasonable solution to these problems, if they do indeed exist.

The study has been developed in collaboration with work by J.M. Powell to establish the effect of clearcutting on macro-, meso- and microclimate (NOR 138 - The climate of clearcut forested areas). The microclimate measurements proposed are an integral part of that study.

9. Study Objectives:

a. To determine the significance of microclimatic regimes created by clearcutting in terms relevant to growth and survival of planted spruce and pine.

b. To determine the effect of clearcutting on vegetation development and assess results in terms of competition to coniferous regeneration and use to wildlife.

10. Resources:

a. Starting date: 1973
b. Estimated year of completion: 1977
c. Estimated total Prof. man-years required: 2.4
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.8	
Supp.	0.9	
Casual	0.6	
Total	2.3	O & M funds req'd: $7,000

11. Progress to Date:

Aspects in the upper foothills areas of the Hinton limits are predominantly NW or NE and SW or SE. Soil series in the same area of the limits are dominated by Coalspur-Mercoal and Wildhay-Hanlan in the

McLeod working circle and by Wildhay-Hanlan and McPherson-Hardisty in the Athabasca working circle. All are developed on Marlboro till and belong to the Biseque or Orthic Gray Wooded soil subgroup.

Two areas were selected south of the town of Hinton on the Warden Creek road (10, 15-49-25-5). The sites were SW and SE aspects, situated on the Coalspur-Mercoal soil series.

Two transects of five sample plots were located outward from the stand edge at 50, 150, 300, 450 and 600 foot distance. Sample plots were ≃ 40 X 175 feet with the long axis parallel to the stand edge. White spruce and lodgepole pine container stock (Hillson container - 10 cu in) were planted at 3-foot spacing in 6 rows each of 50 trees. The plots were divided into five subplots (40 X 35 feet) to ensure adequate coverage of the plot with each sample. Seedlings were planted during the period June 18-26. After planting each seedling was marked with a metal pin and each subplot row was numbered.

Before planting, 200 seedlings of each species were sampled for shoot length and root and shoot dry weight. Root length was not measured since roots sometimes grew up and down the container walls several times so that root lengths would be misleading.

Shoot length of each seedling was measured in the field in early July. In late August a sample was collected from each plot (four shoots, one root of each species from each subplot), shoot length recorded and the seedlings stored in cold rooms in the Edmonton laboratory for drying and weighing. On October 1 and 2 a root sample (one root of each species from each subplot) was taken.

Instrumentation for microclimatic sampling was begun in early June. However, because of late delivery of some equipment and malfunctioning of some, the total sample for the area was incomplete.

Precipitation was sampled using standard met. gauges plus one recording gauge on each area. Precipitation was measured from late May; however, proper transects were not laid out until sufficient gauges were available in early August. Records were terminated September 18.

Evaporation was measured using Gen atmometers, beginning June 7. However, several of the instruments malfunctioned periodically over the season. Records were terminated September 11.

A temperature profile (10, 0, -7.5, -15 cm) was measured on each plot using thermocouples and a potentiometric strip chart recorded powered by a propane fuelled generator. Late delivery of generators resulted in delay of recording until August 14. Records terminated September 17. Two transects of profiles (-1, -5, -7.5, -10, -15, -20, -30, -50 cm) on each area were also measured once per week, when possible, using a portable potentiometer. Points included each plot, one half-way between each plot, the stand edge and 50 feet into the stand. Records terminated September 13.

Water potential was measured at -7.5 and -15 cm on each plot using thermocouple psychrometers. Records began July 5 and ended September 14.

Additional microclimatic measurement was carried out by Dr. J.M. Powell (Study NOR 138).

Two areas were selected for study in 1974-75 (NE and NW aspect) north of the town of Hinton (33-53-24-5 and 10-54-24-5) on the Wildhay-Hanlan soil series. Plot locations on these areas were cleared of slash and scarified through the co-operation of North Western Pulp and Power.

12. Goals for 1974-75:

1. The study will be replicated on the two new areas located in the fall of 1973. All instrumentation will be as in 1973. Seedlings will be sampled before planting and heights of all seedlings measured immediately after planting. If, as in 1973, there is no shoot growth during the first season a root sample will be collected in August and October.

2. The 1973 areas will be instrumented again as in 1973. A total survival count of seedlings will be carried out in June. Twenty seedlings will be sampled from each plot (four from each subplot) beginning approximately June 30, July 30, August 30 and September 30, with modifications according to the progression of the growing season. Measurements will include top length and top weight and root weight. The final sample will be limited to root weight.

3. Vegetation will be rated by species and cover on each plot, using either the point frame or line intercept method. In addition species and cover will be measured on a number of clearcut areas according to site, aspect, distance from stand edge, and time since scarification. Detail and extent of vegetation sampling will be governed by the time and manpower situation as it develops.

4. A study progress report will be prepared for this study before March 31, 1975.

5. As much data as possible will be summarized for analysis.

13. Accomplishments for 1974-75:

1. The study was replicated on the two areas located north of the town of Hinton (33-53-24-5 and 10-54-24-5). Seedlings were sampled before planting and heights of all seedlings measured immediately after planting. A root sample was collected in late September, 1974. The area was instrumented for precipitation measurement but because no growth occurred in 1974, equipment delivery was not on schedule, and money and manpower was limited no other instrumentation of the area was done. However, thermocouples were installed in readiness for the 1975 field season.

2. The 1973 area was instrumented beginning early June. Temperature, moisture, evaporation, precipitation was recorded. Atmometers did not function properly and the records are incomplete. Atmometers are being modified to correct faults. Seedlings were sampled for top and root growth June 30, July 15, Aug. 5 and late September (roots only). The sampling schedule proved inadequate and will be revised in 1975.

3. Budget and manpower did not allow any detailed vegetation measurements. Several areas were selected from compartment maps for possible study in 1975.

4. Not completed at this time.

5. Approximately 50% of temperature data has been transformed to computer sheets.

14. <u>Goals for 1975-76</u>:

1. The four areas will be fully instrumented in 1975. A total survival count of seedlings will be carried out in late May or early June. A revised sampling schedule will be carried out in 1975, based on observations from 1974. Roots of both pine and spruce will be sampled June 1, 1975; roots and tops of pine June 15; roots and tops of pine and spruce July 1, July 15; roots and tops of spruce Aug. 1; roots of both species Sept. 1 and Oct. 1. Measurements will include top length and weight and root weight.

2. Vegetation will be rated by species and cover on each plot using the line intercept method. In addition species and cover will be measured on a number of clear-cut areas according to site, aspect, distance from stand edge, and time since scarification. Detail and extent of vegetation sampling will be governed by budget and manpower.

3. Complete study progress report.

15. <u>Publications</u>:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

H. P. Sims
Investigator

R. L. Clapleman
Program Manager

G. T. Silver
Director G.T. Silver

PROJECT NOR - 15

Establishment and Maintenance of Forest Ecosystems for

Amenity and Recreation Use

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 21, 1975

1. Project: Establishment and maintenance of forest ecosystems for amenity and recreation use.

2. Title: Evaluation of post-planting maintenance techniques and soil moisture in recreational plantations in southern Saskatchewan.

3. New: Cont.: X   4. No.: NOR 140

5. Study Leader: G. L. Lesko

6. Key Words: Soil moisture, microclimate, weeding.

7. Location of Work: Danielson Park, Saskatchewan Landing and Rowan's Ravine, Saskatchewan.

8. Problem:

The Saskatchewan Department of Natural Resources has established several thousand acres of plantations in the past decade for recreational purposes, near lakes, rivers and highways in southern Saskatchewan. The aim of this large scale afforestation was to provide areas for camping, picnicking and other recreational activities in the semi-arid land of southern Saskatchewan, where no natural tree cover was present.

It is mandatory in this region that successfully established plantations will be subjected to some form of post-planting maintenance to protect the multi-million dollar investment. It is also necessary to identify species which are not suitable for recreational planting because of their low drought resistance, in order to eliminate further failures and expenditures.

The Saskatchewan Department of Natural Resources have requested that this study will be undertaken by the Canadian Forestry Service, because no expertise is available from other agencies in the province. The probability of success of this study is high, and there are strong indications already that the results of study will be put into practice.

9. Study Objectives:

a. To select and recommend post-planting maintenance technique(s) for established recreational plantings, which will satisfy both ecological and economical aspects.

b. To provide recommendations regarding species performance for thinning in established plantations and for future afforestation projects.

10. Resources:

a. Starting data: 1973
b. Estimated year of completion: 1975 Revised: 1976
c. Estimated total Prof. man-years required: 0.2
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.2	
Supp.	0.2	
Casual	-	
Total	0.4	O & M funds req'd: $100

11. Progress to Date:

A total of six post-planting maintenance techniques were conducted and evaluated since 1970 in a Wheeler poplar plantation at Danielson Park. The most promising maintenance technique appears to be cultivation in the first year after planting, and low mowing in subsequent years. The results are evaluated as mortality rates, and height, diameter, and crown measurements.

A problem assessment report was prepared in 1972 and sites were selected for the monitoring of soil moisture and for microclimate measurements at Danielson Park, Saskatchewan Landing and Rowan's Ravine. Measurements were made through 1973.

12. Goals for 1974-75:

1. Termination of all field observations.

2. Evaluation of all collected data.

13. Accomplishments in 1974-75:

1. All field observations were completed and terminated.

2. The collected data were compiled and statistically analysed.

14. Goals for 1975-76:

1. Preparation of the following report:

Lesko, G. and J. Soos. Post-planting maintenance techniques and soil moisture conservation in amenity plantations in southern Saskatchewan.

2. Terminate study.

15. Publications:

Up to 1974-75

Lesko, C.L. 1972. Report on the 1971 survey of recreational plantings in southern Saskatchewan. Environment Canada, Can. For. Serv., Northern Forest Research Centre, File Report NOR-Y-36.

Lesko, G.L. 1973. Condition of recreational plantations in Danielson Park and Saskatchewan Landing, Saskatchewan. Environment Canada, Can. For. Serv., Northern Forest Research Centre, File Report NOR-Y-65.

1974-75 Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 963

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 25, 1975

1. Project: Establishment and maintenance of forest ecosystems for amenity and recreation use.

2. Title: Background study of regional amenity and aesthetic forestry in urban and rural settings.

3. New: Cont.: X 4. No.: NOR 963

5. Study Leader: R. M. Waldron

6. Key Words: Environmental quality, pollution, shelterbelts, ornamentals, recreation, tree establishment and maintenance, problems, opportunities, scenario.

7. Location of Work: Manitoba, Saskatchewan, Alberta.

8. Problem:

Urban areas in the prairies are growing rapidly and by the year 2000 the major centres will have doubled their population; it is estimated that by the same year 70% of the people will live in Edmonton, Calgary, Saskatoon, Region or Winnipeg. Treed landscapes - for recreation or visual amenity - will be required in increasing acreages within the city itself or nearby. Street plantings and individual trees in backyards are also required in order to improve environmental quality by reducing noise, providing screens for unsightly buildings, utility lines, etc., purifying polluted air, providing some measure of oxygen production and habitat for birds and small animals. A growing affluence has resulted in increased spending by civic administrations, industry and individuals on tree establishment and maintenance; professional landscapes are being used more now than ever before. Citizens are also showing a strong interest in the maintenance of natural landscapes, and are making efforts to protect them from roads, storm sewers, housing, industry and other types of development.

In the rural areas populations are declining; farms and farm shelterbelts are being abandoned at a rapid rate (50% decline in the last 10 years in Saskatchewan). However, the farms that remain are presently landscaped with mature and overmature shelterbelts; hence replacement will probably be the major problem. Small towns and villages are currently showing a strong interest in the use of trees and shrubs as a means of improving the quality of life in rural areas; establishment and maintenance programmes are still significant preoccupations on the prairies.

However, before CFS embarks on an elaborate and perhaps misguided RD programme in amenity forestry, it is essential that the field of work be fully and clearly defined, given economic dimensions, and background information on technical and social problems and opportunities be collected, analyzed and evaluated.

9. Study Objectives:

a. To determine the existence of, and adequately define problems and opportunities in amenity and aesthetic forestry in urban and rural settings.

b. To determine the role, if any, of the CFS in solving problems or capitalizing on opportunities in cooperation with responsible municipal, provincial and federal agencies.

10. Resources:

a. Starting date: 1973
b. Estimated year of completion: 1974 Revised: 1975
c. Estimated total Prof. man-years required: 0.0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	-		
Supp.	-		
Casual	-		
Total	-	O & M funds req'd:	Nil
		SR Cont.:	Nil

11. Progress to Date:

Data from 1969 field survey designed to appraise the current condition and problems associated with shelterbelts in southwestern Saskatchewan was summarized and an initial draft publication prepared.

As one part of a proposed survey program designed to collect background information on urban forestry problems, a tree and shrub survey was carried out in Edmonton in September 1973. Results of this survey have been analyzed. Further imput into this study was terminated when the study leader was transferred to the Information Project in November 1973.

12. Goals for 1974-75:

    1. Publication entitled "Impact of farmstead abandonment and lack of cultural management on shelterbelts and related amenity values in Saskatchewan" with V. Hildahl. Proposed for Forestry Chronicle, manuscript has been reviewed and submitted for final typing.

    2. Publication entitled "Inputs into the establishment and maintenance, and replacement value, of trees and shrubs on residential lots in Edmonton, 1973". Proposed as the closing out study publication in the Information Report series.

    3. Close study.

13. Accomplishments in 1974-75:

    1. Completed. However publication was not acceptable to the Forestry Chronicle and was released as an information report. Waldron, R.M. and V. Hildahl. 1974. Deterioration of shelterbelts in southwestern Saskatchewan. Environment Canada, Can. For. Serv., Northern For. Res. Centre, Edmonton, Alberta, Inf. Rept. NOR-X-127.

    2. Publication in preparation and will be released as information report by the end of April 1975. Title revised to "Trees and shrubs on residential lots, Edmonton 1973".

    3. Study closed.

14. Goals for 1975-76:

    Nil. Study terminated.

15. Publications:

    Up to 1974-75

Waldron, R.M. 1973. Direct seeding in Canada, 1900-1972. In: Proceedings of a Direct Seeding Symposium held at Timmins, Ontario in September, 1973. Environment Canada, Can. For. Serv., Dept. Publ. No. 1339.

1974-75

Waldron, R.M. and V. Hildahl. 1974. Deterioration of shelterbelts in southwestern Saskatchewan. N.F.R.C. Information Report NOR-X-127.

Waldron, R.M. 1975. Trees and shrubs on residential lots, Edmonton 1973. N.F.R.C. Information Report (*In Press*)

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 975

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 21, 1975

1. Project: Establishment and maintenance of forest ecosystem for amenity and recreation use.

2. Title: Land use impact assessment - Banff National Park.

3. New: X Cont.: 4. No.: NOR 975

5. Study Leader: G. L. Lesko

6. Key Words: Carrying capacity, subalpine and alpine ecosystems.

7. Location of Work: Banff National Park, Alberta

8. Problem:

Trails and campgrounds in the study area show some signs of damage from over use and/or misuse. Park officials wish to promote conservation of the ecosystem in the camp and trail areas by locating these facilities in ecosystems of higher carrying capacity and by regulating their use and management.

9. Study Objectives:

a. To assess the impact of recreactional use on existing campgrounds in the Sunshine-Egypt Lake area.

b. To suggest relocation of existing campgrounds into ecosystems of higher carrying capacity if possible.

c. To select suitable locations for new campgrounds.

d. To suggest levels of use of all campgrounds in balance with their carrying capacity.

e. To suggest management systems for the maintenance of the campgrounds.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: 1975
c. Estimated total Prof. man-years required: -
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man years Prof. -
Supp. -
Casual -
Total - O & M funds req'd: -
SR Cont: -

11. Progress to Date:

N/A

12. Goals for 1974-75:

To complete all field work, analysis and reporting.

13. Accomplishments in 1974-75:

All field work, data analysis and reporting are completed. The following report is presently *In Press*:

Lesko, G.L. and E.B. Robson. 1975. Impact study and management recommendations for primitive campgrounds in the Sunshine-Egypt Lake area, Banff National Park.

14. Goals for 1975-76:

None. Study terminated.

15. Publications:

Up to 1974-75 Nil

1974-75

Lesko, G.L. and E.B. Robson. 1975. Impact study and management recommendations for primitive campgrounds in the Sunshine-Egypt Lake area, Banff National Park. N.F.R.C. Information Report NOR-X-132, 95 pp.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

PROJECT NOR - 17

Liaison and Technical Advisory Services in Forest Management

STUDY STATEMENT

1975-1976

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE Date:Mar.19/75

1. Project: Liaison and Technical Advisory Services in Forest Management.

2. Title: Technical and Advisory Services re Insect Pests and Diseases of Forests, Parks, Shelterbelts and Plantations.

3. New: Cont.: X 4. No.: NOR-068

5. Study Leader: V. Hildahl

6. Key Words: Tree biology, entomology, pathology, detection, insects, diseases, appraisals, protection, pesticides, chemical control, spraying, demonstrations

7. Location of Work: Manitoba

8. Problem:

   1) User agencies (provincial, federal, industrial, municipal, universities) must derive maximum benefits from results of research and development programs pertaining to tree protection, maintenance and establishment; and 2) research managers need feedback on the requirements and views of user agencies for the initiation of research and demonstrations aimed at resolving major insect and disease problems associated with forest, park and planted trees.

9. Study Objectives:

   Provide technical guidance and assistance to resource managers of the province in developing tree protection and maintenance programs aimed at keeping tree losses due to insect and disease outbreaks within acceptable limits.

   This is accomplished by: 1) interpreting and disseminating (in the form of bulletins, special reports and personal contact) results of scientific research that have practical application in dealing with insect and disease problems; 2) evaluating current insect and disease outbreaks with respect to impact on forest stands, and on park, shelterbelt and amenity plantings; and 3) advising and assisting with operational insect and disease control programs.

10. Resources:

a) Starting date: 1966
b) Estimated year of completion: Continuing
c) Estimated Prof. man-years required:
d) Essential new major equipment items for 1975-76: None
e) Essential new major equipment items beyond 1976: None
f) 1975-76 man-years: V. Hildahl 0.7

11. Progress to date:

Since 1966, when the study was initiated, liaison has been developed and maintained with authorities of government and industry associated with forest utilization, reforestation and amenity programs in the Region, and a technical advisory service has been established to provide advice on tree problems, especially as they relate to insects and diseases. To date, the study has been highlighted by: 1) demonstrating and evaluating aerial applications of chemical insecticides for suppressing outbreaks of the jack pine budworm, spruce budworm and forest tent caterpillar in forest and park areas; 2) developing chemical control programs for ground and aerial application against cankerworms and other defoliating insects in urban centres such as Winnipeg; 3) demonstrating and developing application techniques with ground spray equipment suitable for use in suppressing local outbreaks of the spruce and jack pine budworms in park and resort areas; 4) evaluating the effectiveness of recommended insecticides under field operational conditions (especially for control of the jack pine and spruce budworms, cankerworms, poplar bud-gall mite and spruce sawflies); 5) developing 10-year jack pine-mistletoe eradication programs in the Belair Provincial Forest and Western District of Manitoba, based on market demands for jack pine; and 6) preparing technical information brochures designed primarily for resource managers.

12. Goals for 1974-75:

1. Continue to maintain a high standard of liaison with resource managers throughout the province, and to provide a technical advisory service with regard to insect and disease problems in forest, urban and rural environments.

2. Conduct appraisals of insect and disease outbreaks as requested by resource managers, and provide appropriate reports on current conditions. Facilities of the Forest Insect and Disease Survey will be fully utilized in attaining this goal.

3. Continue evaluations of operational spray programs carried out by government agencies (at their request) against the spruce budworm, jack pine budworm, fall and spring cankerworms and yellow-headed spruce sawfly.

4. Publish scientific paper entitled "Evaluation of Insecticides for Control of Cankerworms in Manitoba" (with Dr. R.F. DeBoo, Chemical Control Research Institute, Ottawa).

5. Publish results of Spruce Woods spray program with Dr. R.F.DeBoo, Chemical Control Research Institute. Proposed title of publication: "Evaluation of Aerial Spray Applications of Insecticides Against Spruce Budworm in the Spruce Woods Provincial Park and Forest, Manitoba".

6. Complete brochure entitled "Cankeworms in the Prairie Provinces".

7. Complete journal publication entitled "Impact of Farmstead Abandonment and Lack of Cultural Management on Shelterbelts and Related Amenity Values in Saskatchewan".

8. Publish scientific paper entitled "Control of Poplar-Bud Gall Mite With Insecticides" (with Dr. R.F. DeBoo, Chemical Control Research Institute, Ottawa).

13. <u>Accomplishments in 1974-75</u>:

1. Contacts and liaison with resource managers were maintained and technical advisory services provided, especially on current insect and disease problems. Regular contact was also maintained with Forest Insect and Disease Survey personnel assigned to Manitoba for the field season, and information of mutual concern exchanged.

2. Outbreaks of the spruce and jack pine budworms in the Spruce Woods Provincial Forest and Park, forest tent caterpillar in Manipogo Recreational Area and cankerworms in the City of Winnipeg, were monitored. Results were provided to resource managers for the development of appropriate control programs.

   In addition, a forest tent caterpillar egg-band survey to predict probable outbreak intensity in 1975 was developed and carried out jointly with the Manitoba Departments of Agriculture, Tourism, Recreation and Cultural Affairs.

3. Evaluation of the effectiveness of operational spray programs as requested by provincial agencies was continued. Studies in 1974 involved aerial applications of fenitrothion for the control of spruce and jack pine budworms and malathion for the control of the forest tent caterpillar, and ground applications of methoxychlor for the control of cankerworm. Because of low populations, studies pertaining to the yellow-headed spruce sawfly were postponed.

4. The report "Evaluation of Insecticides for Control of Cankerworms in Manitoba" was not published in 1974--insufficient data available to determine the effectiveness of methoxychlor.

5. Results of the 1973 aerial spray program to control outbreaks of the spruce budworm in the Spruce Wooas Provincial Forest and Park were published.

6. The brochure "Cankerworms in the Prairie Provinces" was completed and printed for distribution to resource managers and other interested clients.

7. The proposed publication "Impact of Farmstead Abandonment and Lack of Cultural Management on Shelterbelts and Related Amenity Values in Saskatchewan" was published as an Information Report.

8. Proposed journal publication "Control of Poplar Bud-Gall Mite with Insecticides" is in preparation. Preliminary analysis of data completed to date.

Accomplishments not in 1974-75 goals:

The following reports were prepared:

1. Campbell, A.E. and R.H.M. Pratt. 1974. Bibliography of North American Shelterbelt Research. NOR-X-92. 52 p.

2. Hildahl, V. and R.F. DeBoo. 1974. Spruce Budworm Control, Manitoba 1973. In: Forest Protection in Canada Through Aerial Applications of Insecticides by M.L. Prebble. In Press.

14. Goals for 1975-76:

1. Continue liaison with resource managers throughout the province, and provide technical advisory services, especially with regard to insect and disease problems in forest, urban and rural environments. Close contact will be maintained with the Forest Insect and Disease Survey and their facilities fully utilized in achieving this goal.

2. Continue to evaluate the effectiveness of operational spray programs at the request of resource managers--fall cankerworm in southern Manitoba, spruce and jack pine budworms in Spruce Woods area, forest tent caterpillar in central Manitoba--and publish pertinent results.

3. Complete scientific publication "Control of Poplar Bud-Gall Mite With Insecticides" (Jointly with R.F. DeBoo, Chemical Control Research Institute).

4. Publish brochure entitled "Forest Tent Caterpillar in the Prairie Provinces".

5. Publish brochure entitled "Poplar Bud-Gall Mite in the Prairie Provinces" (Jointly with R.F. DeBoo, Chemical Control Research Institute) if Furadan registration is completed.

6. Publish results of 1974 spray program to control spruce budworm in the Spruce Woods Provincial Park and Forest of Manitoba.

15. Publications:

1. Hildahl, V. and R.F. DeBoo. 1973. Aerial Applications of Chemical Insecticides Against the Spruce Budworm in Manitoba, 1973. Man. Ent. 7:6-14.

2. Hildahl, V. and L.O.T. Peterson. 1974. Fall and Spring Cankerworms in the Prairie Provinces. Env. Can., Nor. For. Res. Cen., Inf. Rep. NOR-X-100. 10 p.

3. Waldron, R.M. and V. Hildahl. 1974. Deterioration of Shelterbelts in Southwestern Saskatchewan. Env. Can., Nor. For. Res. Cen., Inf. Rep. NOR-X-127. 17 p.

4. Hildahl, V. and R.F. DeBoo. 1974. Spruce Budworm Control, Manitoba, 1973. In: Forest Protection in Canada Through Aerial Applications of Insecticides by M.L. Prebble. In Press.

5. Campbell, A.E. and R.H.M. Pratt. 1974. Bibliography of North American Shelterbelt Research. Env. Can., Nor. For. Res. Cen., Inf. Rep. NOR-X-92. 52 p.

16. Signatures:

V. Hildahl
Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: Northern Forest Research Centre Date: March 20/75

1. Project: Liaison and Technical Advisory Services in Forest Management NOR-17.

2. Title: Liaison and Technical Advisory Services - Winnipeg Sub Office

3. New: Cont.: X 4. No.: NOR-071

5. Study Leaders: G. A. Steneker, L. D. Nairn

6. Key Words: Tree nutrition, reforestation, planting, seeding, regeneration, appraisals, *Picea glauca*, *Pinus banksiana*, *Populus tremuloides*, thinning, clones, scarification, suckering, poplar hybrids, fertilization, containers, demonstrations

7. Location of Work: Manitoba

8. Problem:

Forest resource managers in Manitoba have been required over the years to manage their forests more intensively. The manager must remain aware therefore of research findings which are relevant for meeting his management objectives. In many instances existing knowledge can be applied but in other cases new investigations are required to solve current problems. A line of communication between CFS research staff and the resource managers is essential for an exchange of information, discussion and examination of problems.

9. Study Objectives:

   1. To establish a working rapport with administrative, operational and research personnel in the renewable resource field in order that resource managers can obtain the benefit of research on the one hand and on the other that research personnel may conduct studies of value to the resource managers.

   2. To provide a technical advisory service to resource managers and the general public.

3. To survey or appraise forest operations in order to suggest means of improving techniques and methods and also as a means of determining research needs.

4. To demonstrate promising research findings to resource managers.

10. Resources:

a. Starting date: 1966
b. Estimated year of completion: Continuing
c. Estimated total man-years required: N/A
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years required:

Prof.	G. Steneker	1.0	Supp.	(M. Pratt)	1.0	Casual 0.3
	L. Nairn	1.0		(N.Schultz)	1.0	
		2.0			2.0	

Total 4.3

11. Progress to date:

Liaison has been maintained with provincial and industrial resource managers and an understanding has been gained of the broad spectrum of forest management practices and problems. The technical advisory service has made resource managers aware of research findings relevant to their problems and has provided expertise advice. Demonstrations and appraisals have been initiated to meet the requests of resource managers in the field.

12. Goals for 1974-75:

1. The regeneration survey on Manitoba Forestry Resources limits at The Pas has indicated that spruce regeneration is not satisfactory but generally good stocking has been obtained on jack pine sites. During the summer of 1974 it is planned to examine the relationship between the proximity of residual mature spruce and the distribution of regeneration on the cutovers. Also, in cooperation with the province, a start will be made in 1974 to scarify jack pine cutovers at different intensities. Areas of sufficient size will be left for controls. The survey has indicated that regeneration to jack pine in some instances is more than adequate. It is anticipated that under certain site conditions (e.g. drier sites with less duff) less intensive scarification will be sufficient.

2. Work on the aspen management demonstration area will be continued. A suitable portion of the area will be selected and clones will be mapped to demonstrate clonal differences particularly in quality and form. An additional area will be cleared of all trees and in subsequent years will be used for stand density control work such as strip and spaced thinning. In the fall of 1974 sucker regrowth

will be examined on the areas cleared in 1973.

3. Maintenance work will be carried out on the hybrid poplar plantation. Specifically, poplars at the Rosedale (=Polonia) farm will be pruned to facilitate access to cultivation equipment. A short information report will be prepared on the hybrid performance - "Performance of poplar hybrids in Manitoba" (Steneker).

4. A short note for the Forestry Chronicle will be prepared to give results of the 1964 2,4-D spraying at Riding Mountain - "Effect of 2,4-D spraying of aspen on residual white spruce" (Steneker).

5. An information report "Thinning of trembling aspen" (Steneker), originally planned for 1973-74 will be prepared on the 1971 and 1972 remeasurements of two trembling aspen thinning trials which are continued under NOR-075.

6. Separate statements will be prepared for all regeneration work and liaison and advisory services work for the Winnipeg Sub Office.

7. Fourth-year remeasurement of jack pine fertilization plots in the Belair Forest Reserve will be completed.

8. Publication for the Forestry Chronicle on the Wanless and Sipiwesk fertilization trials will be completed - "Economic feasibility of fertilizer application to upland black spruce stands " (Nairn).

9. Poor germination in the jack pine seeding trials (particularly in 1973 with ideal moisture conditions) over two years should be sufficiently indicative to make recommendations to the province in regard to this method of regeneration. However, seed losses to rodents may be a prime factor in the poor results. With the strong possibility that new acceptable seed coating rodent repellents (R-55?) may become available in the near future, it is proposed to assess the degree of seed losses to rodents. Dr. Buckner of the Chemical Control Research Institute is being consulted as to specific methods for these rodent exclusion seed tests. Prepare information report - "Germination of spot seeded jack pine on scarified sites in southeastern Manitoba" (Nairn).

10. A publication "Phytotoxicity of pentachlorophenol and captan on containerized red pine and jack pine seedlings by Carlson and Nairn will be prepared for submission to the Tree Planters' Notes.

11. Container planting trials will be continued as in 1973 with the addition of the #308 paperpot. All seedlings will be reared at the Manitoba Provincial Nursery. Survival will be assessed together with growth and survival of the 1972 and 1973 plantings.

13. Accomplished in 1974-75:

1. In 1974 a number of cutovers on Manitoba Forestry Resources Limited limits at The Pas were surveyed to examine the relationship between proximity of residual mature spruce and the distribution of regeneration on the cutovers. A total of 7 cutovers were examined with time since cutting ranging from 4 to 6 years. The areas had been scarified either by barrels or chains. A survey of spruce regeneration along transects at right angles to the residual stand indicated an influence of the residual stand upon spruce stocking over a distance of up to 2 chains (40 m). No differences in spruce stocking were detected along residual stand edges that could be attributed to aspect. Results further suggested that on the spruce cutovers, scarification by barrels had resulted in more abundant regeneration than scarification by chains. A brief report on the findings was submitted to the Manitoba Department of Mines, Resources and Environmental Management.

   Based on findings by CFS personnel which showed that jack pine regeneration in most instances is more than adequate, the Northern Region of the Department of Mines, Resources and Environmental Management made a start in 1974 with modifying their scarification technique. On a few jack pine areas intensity of scarification by chains was reduced. In addition, starting in 1974 representative portions of cutovers are being left unscarified to serve as controls.

2. Work on the aspen management demonstration area continued. Clones in a small portion (1/10 acre) of a mature stand were identified and tagged. A tally of sucker regeneration on the completely cleared area was carried out, together with a tally of regeneration on the commercially cut area. No further areas were cleared in 1974.

3. No maintenance work was carried out on the Rosedale hybrid poplar plantations. A first draft of the 1973 assessment of all hybrid poplar plantations established in Manitoba by the CFS since 1965 was prepared. Initial reviews indicated that some additional observations should be carried out in the field in 1975 before the preparation of a final draft.

4. A report on the 1964 2,4-D spraying at Riding Mountain National Park "Effect of 2,4-D spraying of aspen on the growth of residual white spruce," based on the 1973 assessment, has not been prepared. The compilation has been completed.

5. The information report "Thinning of trembling aspen in Manitoba," has been published (NOR-X-122). In addition, a first draft of "Multiple thinning in 14-year-old trembling aspen, Porcupine Forest Reserve, Saskatchewan," has been prepared and submitted for review.

6. In view of the size and short term duration of studies in regeneration, it was impractical to identify any of the studies by separate study statements.

7. Fourth-year remeasurement of jack pine (60-70 years) fertilization plots in the Belair Forest Reserve has been completed and data compiled. The per cent net gain of treatments compared to controls (100%) in basal area 1971-74 (4 growing seasons) was as follows:

Control	=	0.0
150 N	=	+ 4.2%
250 N	=	+ 3.4
200 N	=	+ 2.9
100 N + 44 P	=	+ 2.6
150 N + 44 P	=	+ 2.4
100 N	=	+ 1.9
75 N + 44 P	=	+ 1.5
44 P	=	+ 1.4
75 N	=	- 4.2

8. A publication is being prepared on Wanless and Sipiwesk fertilization trials and will include the above jack pine fertilization trials - "Economic feasibility of fertilizer application to mature jack pine and upland black spruce stands."

9. Preliminary tests to assess the degree of jack pine spot seed losses to rodents in the field were carried out using wire cages for rodent exclusion. On the two areas tested, one area had germination on 75% of the caged seed spots compared to 13% of the uncaged spots; the second area had no germination on both the caged and uncaged spots. The second area was subject to severe drought conditions.

10. Publication "Phytotoxicity of pentachlorophenol and captan on containerized red pine and jack pine seedlings" by Carlson and Nairn is now in press.

11. Outplanting trials of container-grown jack pine and white spruce seedlings were continued in Manitoba in 1974. The seedlings were reared at the Manitoba Provincial Nursery and included four sizes of paperpots (#213, #313, 1/2 of #313, and #308) and BCFS/CFS plugs. Severe damage by grasshoppers and drought occurred to the 1974 jack pine trials in southeastern Manitoba. In one area of high grasshopper populations, mortality ranged from 75% to 91%. In two other areas, where drought was the major factor, mortality ranged from 58% to 100%. No particular significance could be assigned to the size or type of container in relation to this mortality. On August 22 three test plots were planted in areas of high grasshopper populations with 18 week-old #313 container jack pine seedlings. By October 10 grasshoppers had killed 28% of these plants.

Jack pine container trials established in 1972 and 1973 showed no apparent grasshopper damage in 1974. Due to drought, 1973 plantings suffered mortality of 40 to 65% and the 1972 plantings had losses of 15 to 30%. Here the BCFS/CFS plugs and #408 paperpots had 10 to 15% better survival than the #213 and #313 paperpots. Mortality was less than 5% for all containers in two areas with adequate moisture.

White spruce container stock was planted in only one area of bull-dozed strips in the Interlake area due to spring floods, and these plantings were a complete failure due to severe drought in July and August. The 1973 plantings in the same area had mortalities of 44, 22, 18 and 9 per cent for BCFS/CFS, #313, #213 and #408, respectively. For the 1972 plantings mortality was 5% for both the BCFS/CFS plug and the #408 plots in this area. In two other drought-free areas 1972 and 1973 plantings had less than 5% mortality for all containers.

(Goals Added 1974-75)

12. As part of the Freshwater Institute program a small forestry exhibit was prepared at the Institute during the International Limnology Conference (SIL), August, 1974, at the University of Manitoba for the benefit of attending delegates. Again, on March 9, 1975, as part of the University of Manitoba's "open house," a forestry exhibit was prepared at the Freshwater Institute.

13. An edition of Forestry Report, dealing with "Poplars on the Prairies," was edited by G.A. Steneker.

14. Three submissions were made to a "silviculture" edition of the Forestry Report.

15. Assistance was given to provincial personnel in the ground truthing and assessment of large-scale aerial photography on Abitibi (Pine Falls) cutovers. Objective of the photography was to assess its usefulness in the surveying of regeneration.

16. Considerable damage occurred on provincial and federal first-year container planting stock in 1974 in southeastern Manitoba. Grasshopper infestation in the affected areas was high. Collection of representative grasshopper species and controlled feeding in the laboratory on first-year seedlings produced identical tree damage as that observed in the field, and it was concluded that grasshoppers were the damaging agent.

14. <u>Goals for 1975-76</u>:

1. Work on the aspen management demonstration area will be continued. The clones, identified in 1974, will be permanently marked. On a portion of the cleared area suckers will be thinned out to a spacing of about 3 m x 3 m. On part of this, ground vegetation will be cut

back regularly and sucker regrowth will be cut back to maintain the initial spacing. Subsequent increment and form of the thinned suckers will be monitored to demonstrate the effect of increased growing space and control of ground vegetation on individual tree performance. Proper signs will be installed in 1975 at the location to designate it as a demonstration area.

2. A combined thinning and pruning experiment in natural trembling aspen stands was started in 1964/65 along the south boundary of the Porcupine Forest Reserve. The objective of the study was to determine whether pruning in combination with thinning would reduce the incidence of stem decay, by reducing the possibilities of entrance of decay through branch stubs. First 5-year results were published (NOR-X-37, 1972). The remaining sample plots will be examined in 1975 and if warranted, tree performance in relation to thinning and pruning will be measured. It is anticipated that the 1975 observations will close out this experiment.

3. Some additional field data will be collected on the poplar cultivars which were planted in various locations in Manitoba since 1965 and which were remeasured in 1974. In particular, individual trees will be classified to form and suitability for fibre or amenity purposes. The additional information will be incorporated into the first draft of the report on the 1974 remeasurement. The report "Performance of poplar cultivars in Manitoba," should be completed in 1975.

4. A short note, possibly for the Forestry Chronicle, should be completed on the 10-year results of the 2,4-D spraying at Riding Mountain National Park.

5. Cooperation with the province is expected with their assessment of past seeding trials in the Western Region.

   It is anticipated that the scarification program, particularly that in the Northern Region, will be monitored. No survey or overall assessment is planned. However, during the past season the CFS in Winnipeg has suggested that some operational scarification trials on upland spruce sites be laid out, comparing chains with barrels and other available scarification equipment. If these operations have been carried out, it is planned to make some observations on site conditions and treatment intensity.

6. As a follow-up on the seeding trials it is planned to carry out some observations on the effectiveness of R-55 (Tertiary-butylsulfenyl-dimethyldithiocarbamate) a rodent repellent showing good promise. Currently, some germination tests are being run in the laboratory to determine the effect (if any) of R-55 on germination of conifer seed. Apparently, toxic effects on lodgepole pine seed have been indicated. If the germination tests give promising results, a spot seeding trial will be laid out in southeastern Manitoba, with the objective to demonstrate the usefulness of R-55 as a rodent repellent.

7. Complete publication for Forestry Chronicle "Economic feasibility of fertilizer application to mature jack pine and upland black spruce stands." (Nairn)

8. Assess 1973 broadcast seeding trials and prepare information report on "Germination of spot and broadcast seeded jack pine on scarified sites in southeastern Manitoba." (Nairn)

9. Container planting trials will be continued as in 1974 with particular attention being paid to grasshopper activity on these plantings. Plots will be established in provincial plantations where overwintered container stock will be planted in the spring of 1975. Survival will be assessed together with growth and survival of the 1972, 1973, and 1974 plantings.

10. As a follow-up on the severe grasshopper damage that occurred to provincial container plantations in 1974, laboratory and greenhouse tests will be carried out in order to establish the relationship between seedling age and feeding damage by grasshoppers during its various stages of development. Repellents and systemicides will be tested for effectiveness. Field trials will be carried out to test the effectiveness of the recommended chemical Dimethoate in protecting newly established container plantations. Tests will be carried out to qualify previous observations that overwintered container stock is not susceptible to grasshopper feeding. Mr. W. Romanow of Canada Agriculture is cooperating in this work.

15. Publications:

Carlson, L.W. and L.D. Nairn. Phytotoxic action of pentachlorophenol and captan on containerized red pine and jack pine seedlings. Tree Planters' Notes. In Press.

16. Signatures:

G.A. Steneker
Investigator

Program Manager

L.D. Nairn
Investigator

G.T. Silver
Director

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 19, 1975

1. Project: Liaison and Technical Advisory Services in forest management.

2. Title: Liaison and Technical Advisory Services in Saskatchewan.

3. New: Cont.: X No.: NOR 113

5. Study Leader: K. Froning and J. Ball

6. Key Words: Contact, dissemination research, lectures, public relation, trials, demonstrations, shade tree maintenance.

7. Location of Work: Saskatchewan.

8. Problem:

The primary role of Prince Albert Sub-office is to establish and maintain strong lines of communication with various forest management agencies, to ensure that the results of departmental research are known and utilized, keeping well informed on forest management problems in the province, and to acquaint the regional director and program managers with forest management problems in Saskatchewan by advising on opportunities and priorities for research. It is necessary to maintain close contact with other federal departments, universities, technical schools and general public to promote CFS activities in the province. The execution and maintenance of various trials and demonstrations requiring less than 0.2 professional man-year are also included in this study.

9. Study Objectives:

1. To provide advisory and consultative services in forest management to provincial and industrial forest managers and general public.

2. To provide advisory and consultative services to federal, provincial and municipal park personnel in shade tree maintenance.

3. To provide general liaison between provincial forestry agencies and staff members of Northern Forest Research Centre.

4. To conduct and maintain various demonstrations which normally require less than 0.2 man-year professional input.

10. Resources:

a) Starting date: 1970
b) Estimated year of completion: Indefinite
c) Estimated total Prof. man-years required: N/A
d) Essential new major equipment items for 1975/76 with costs: Nil
e) Essential new major equipment items beyond 1976 with costs: Nil
f) 1975/76 man-years

Prof.	(Froning	Ball	
Supp.	(Bohning	Kolabinski	
Casual			
Total			

11. Progress to date:

Effective working relationship was established and maintained with federal, provincial and municipal governments and general public in the field of forest management and shade tree management. Special attention was given to universities and technical schools where lectures were presented on forestry and park management problems. Liaison was provided between provincial and private forestry agencies and members of CFS personnel located in Edmonton and, as a result, several studies were initiated to improve the level of forest management in Saskatchewan. Several demonstrations e.g. interprovincial forest fertilization trials, post planting maintenance of hybrid poplars and reforestation demonstrations requiring less than 0.2 man-year input are included in this study.

12. Goals for 1974-75:

1. To provide continuous advisory and consultative services in forest management to provincial and industrial forest managers and general public.

2. To provide advisory and consultative services to federal, provincial and municipal park personnel in shade tree maintenance.

3. To provide general liaison between provincial agencies and staff members of Northern Forest Research Centre.

4. To conduct and maintain various silvicultural demonstrations requiring less than 0.2 man-year professional input.

   a) To conduct 5-year measurement for Candle Lake installation established in 1970.

   b) To complete experimental planting of conventional white spruce and jack pine seedlings and plugs on prescribed burn areas and continue mortality and height growth assessments.

c) To establish stooling bed in Prince Albert Nursery from selected Sargent poplar clones with high rooting ability.

d) To establish a small scale plantation at Hudson Bay with rooted triploid aspen.

13. <u>Accomplishments in 1974-75</u>:

1. Advisory and consultative services were provided to provincial and industrial forest managers on reforestation forest fertilization and other forest management topics.

2. Advisory and consultative services on shade tree maintenance were provided to mostly individuals from various agencies. Two one hour lectures on the topic of Shelterbelts and shade tree maintenance were given at the Saskatoon Technical School, K.I.A.A.S. to about 80 students. During the Melfort agricultural field days and during the Prince Albert Exhibition, an information desk was manned with excellent public response. Also attended a three day shelterbelt workshop at Brandon as representative of the Northern Forest Research Centre.

3. Numerous meetings were arranged with provincial and industrial forest managers for visiting CFS staff members from Edmonton. Arrangements were made for accommodations for visiting staff members in Prince Albert or at Candle Lake.

4. a) The 5-year measurements for Candle Lake installation of the Interprovincial Forest Fertilization Trials were completed and data sent to P.P.R.I.C.

b) The experimental planting of conventional white spruce and jack pine seedlings and plugs on prescribed burn areas was completed and data were collected to assess mortality and height growth of trial stock planted in previous years.

c) Stooling beds of Sargent poplar clones which proved to have superior rooting ability were established.

d) Two small plantations, each consisting of 40 rooted and potted triploid aspen, were established near Hudson Bay and Candle Lake.

14. <u>Goals for 1975-76</u>:

1. To provide continuous advisory and consultative services in forest management to provincial and industrial forest managers and general public.

a) To introduce sequential sampling to assist the Simpson Timber Company to evaluate the success of regeneration following cutting operations near Flin Flon. (1970: 200 acres; 1971: 1,000 acres).

2. To provide advisory and consultative services to federal, provincial and municipal park personnel on shade tree maintenance in response to requests.

3. To provide general liaison between provincial agencies and staff members of the Northern Forest Research Centre.

4. To conduct and maintain various silvicultural demonstrations requiring less than 0.2 man-year professional input.

   a) To establish trial plots on Finn ploughed areas in the Chitek and Tobin Lake region to investigate the potential usefulness of that tool in the rehabilitation of high quality sites.

   b) Maintain and establish various nursery plots and trials and demonstrate the effectiveness of 'Roundup' herbicide for nursery or amenity plantation in cooperation with nursery management.

   c) To test new herbicides 'KRENITE' and 'VELPAR' for effectiveness in brush control on high quality sites.

   d) To collect for propagation, material from exceptional aspen clones and superior black spruce stands, and to monitor performance of established triploid aspen plantations.

   e) To assess damage to various density classes of spruce following removal of aspen overstory through harvest, as a background for a study proposal for 1976-77.

15. Publications: Nil

16. Signatures:

H. Froning
Investigator

J. D. Johnson
Program Manager

G. T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 31, 1974

1. Project: Liaison and technical advisory services in forest management.

2. Title: Liaison and technical advisory services in Alberta/Territories.

3. New: Cont.: X 4. No.: NOR 118

5. Study Leader: H. Johnson, R.E. Stevenson

6. Key Words: Silviculture, appraisals, demonstrations, photogrammetry, mensuration, insects, disease.

7. Location of Work:

8. Problem:

The solution to many forest management problems in Alberta, the Northwest Territories and the Yukon do not require long term research. Often the answer lies in the application of existing knowledge. In some cases it is necessary for the Canadian Forestry Service to assist in putting dimensions on problems. By working closely with provincial and industrial forest management agencies in the determination of problems and recommending and testing promising forest management techniques it is possible to rapidly upgrade forestry practices in the region. This can be done by appraisal of existing practices, trials and demonstrations of various techniques, the preparation of practical reports and brochures, workshops, seminars and good contact.

9. Study Objectives:

To establish strong lines of communication with various forest management agencies, to ensure that the results of departmental research are known and utilized, and to advise the Program Management Committee on forest management problems.

10. Resources:

    a. Starting date: 1965
    b. Estimated year of completion: 1980
    c. Estimated total Prof. man-years required: 11.2
    d. Essential new major equipment items for 1975-76 with costs: Nil
    e. Essential new major equipment items beyond 1976 with costs: Nil
    f. 1975-76 man-years

	Prof.	1.6
	Supp.	4.5
	Casual	.9
	Total	7.0

11. Progress to Date:

    1. Established co-operative reforestation demonstrations of container planting (Ontario tubes), seeding and conventional planting - Alberta Department Lands and Forests and CFS (Soos, Johnson).

    2. Establishment and maintenance of inter-provincial forest fertilizer trials in Slave Lake Forest (three installations) (Soos, Johnson).

    3. Co-ordination and preparation of a literature review and interpretation of the effects of large scale clearcutting in Alberta (Johnson, *et al.*).

    4. Evaluation of reforestation practices in Alberta, Saskatchewan and Manitoba. Two Information Reports prepared (Froning, Johnson, appraisal crew).

    5. Co-ordination, preparation and presentation of technical lectures, workshops and seminars on forestry subjects - national parks, provincial parks, technical schools and University of Alberta (Stevenson).

    6. Silvicultural advisory services in Alberta and the Territories (Johnson, Stevenson).

12. Goals for 1974-75:

    1. Provision of advisory services in silviculture (Johnson, Stevenson).

    2. Establishment of additional plots (100 seedlings) to randomly sample 1974 planting of Spencer-Lemair plugs, North Western Pulp and Power Co. Ltd. (Johnson).

    3. To assist watershed research group in field work related to spring runoff studies, North Western Pulp and Power lease (appraisal crew).

    4. To assess reforestation program, KFES.

5. To assess reforestation results Prince Albert Pulp Co. limits. Introduction of sequential sampling method and performance of anchor chain scarification.

6. To assist genetics program in a measurement of provenance trials, Manitoba and Saskatchewan (appraisal crew).

7. To participate in the preparation of an "Eco-tour" pamphlet between Regina and Calgary. (Stevenson).

8. To conduct, co-ordinate and expedite a series of lectures, seminars and workshops on forestry subjects for clients such as, Parks Canada, University of Alberta, Forest Technology School, Community colleges, Provincial Parks. (Stevenson).

9. Mr. Stevenson prepared a report on technical information services of NFRC. 1972-74.

   Stevenson R.E. 1974. Technical Information Services 1972-74. Unpublished Report.

10. Mr. Stevenson was requested to prepare a statement on "leave-strips" on lakes, streams and rivers. This statement is based on existing practice across Canada and the thinking of various forestry agencies on this subject. The information is required as a background statement for a research request made by the Sask. DNR. A report is near completion.

11. A report was prepared on the three-year survival and growth results of the first styroplug plantings conducted on a trial basis in this region.

    N.R. Walker and H.J. Johnson. 1974. Field Performance of pine and spruce reared in the BC/CFS Styroblock - Alberta. Information Report NOR-X-84.

13. Accomplishments in 1974-75:

1. Several advisory services in Silviculture provided on request (Johnson, Stevenson).

2. Establishment of 10 plots of 100 Spencer-Lemaire seedlings in co-operation with North Western Pulp and Power Ltd. to randomly sample 1974 planting. First-year remeasurement of 10 plots established in 1973. (Johnson).

3. Appraisal crew assisted watershed research group in field studies of spring-runoff. NOR-14-121.

4. All cut over blocks at KFES were assessed for regeneration (appraisal crew). Results indicate approximately 60% success. In some cases unsuccessful areas were sampled too soon after treatment to accept results. Results provided to Mr. Brace.

5. In co-operation with J. Ball the appraisal crew conducted a survey of cut and treated blocks to determine status of regeneration. Mr. Ball has prepared an information report on the results which is presently under review.

6. The appraisal crew assisted J. Klein in a measurement of provenance trials in Manitoba and Saskatchewan (NOR-12-050).

7. Mr. R. Stevenson prepared the region's first "Eco-tour" between Calgary and Golden. The section between Regina and Calgary was contracted this year and Mr. Stevenson has participated in an advisory role in its preparation.

8. Mr. Stevenson co-ordinated and participated in a series of lectures, seminars and workshops on forestry subjects for clients such as Parks Canada, University of Alberta, Forest Technology School, Community Colleges and Provincial Parks.

14. Goals for 1975-76:

1. Provision of advisory services in Silviculture. (Johnson and Stevenson).

2. Establishment of approximately 10 plots of 100 seedlings each in the 1975 Spencer-Lemaire plantings on NWP & P. Co. Limited. This will complete plot establishment to monitor plantings. First-year survival and growth measurements will be made of plots established in 1974.

3. To assist Dr. W. Johnstone and Dr. I. Bella in studies to assess regeneration stocking standards, juvenile growth and the release of advance growth after logging. Approximately 8 more months of the appraisal crew's time will be allocated to this study.

4. Approximately 12 man-months time will be spent by the appraisal crew in an assessment of the status of high-site forest in Saskatchewan. This study leader is Mr. J. Ball of the Prince Albert sub-office.

5. Approximately 4 man-months of the appraisal crew's time will be assigned to assisting Mr. G. Fahnestock in a survey of forest fuels in Jasper National Park.

6. To prepare an information report on the five-year survival and growth results at the first styroplug seedlings to be introducted in Alberta. (Johnson & Walker).

7. To conduct, co-ordinate and expedite a series of lectures, seminars and workshops on forestry subjects for clients such as Parks Canada, University of Alberta, Forest Technology School, Community Colleges, Provincial Parks. (Stevenson).

15. Publications:

Up to 1974-75:

Johnson, *et al.* 1971. Some implications of large scale clearcutting in Alberta. A literature review. Information Report NOR-X-6.

Froning, K. 1972. An appraisal of recent plantations in forests of the prairie provinces. Information Report NOR-X-31.

Johnson, H.J. 1973. An evaluation of scarification and direct seeding in Alberta. Information Report NOR-X-71.

1974-75

Walker N.R. and J.H. Johnson. 1974. Field performance of pine and spruce reared in the BC/CFS styroblock - Alberta. Information Report NOR-X-84.

16. Signatures:

Investigator

Program Manager

Investigator

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 17, 1975

1. Project: Liaison and technical advisory services in forest management.

2. Title: Remote sensing and technical advisory services.

3. New: X Cont.: 4. No.: NOR 142

5. Study Leader: C.L. Kirby, P.I. Van Eck

6. Key Words: Assessment, environment, forest regeneration, forest growth and yield, inventory, aerial photography, satellite imagery, interpretation.

7. Location of Work: Alberta, Saskatchewan, Manitoba and Northwest Territories.

8. Problem:

Rapid developments in remote sensing and increased concern with the environment have increased the demand for baseline information. New sensors in aircrafts and satellites require development of applications, and education of users on new technology.

9. Study Objectives:

a. To apply new remote sensing techniques to forest inventories and environmental assessments in cooperation with industry, provincial and territorial governments.

b. To educate users by conducting seminars, workshops and participating in training sessions.

c. To provide aerial photography and interpretation services to regional agencies for timely assessment.

d. To maintain a regional aerial photo and satellite image library.

e. To coordinate remote sensing activities within NFRC through project CFS-1 and a remote sensing committee.

f. To advise program management at Northern Forest Research Centre on appropriate development program for remote sensing.

10. Resources:

a. Starting date: 1973
b. Estimated year of completion: Continuing
c. Estimated total Prof. man-years required: 0.5
d. Essential new major equipment items for 1975-76 with costs: 70 mm Vinten camera body with secondary optics and recording of time of photography - $3,500
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1975-76 man-years

	Prof.	0.5	
	Supp.	0.5	
	Casual	0.3	(photo librarian and field assistance)
	Total	1.3	

11. Progress to Date:

Completion of requests for airborne remote sensing in 1972 and 1973. See project CFS-1.

Forest inventory of Sunchild and O'Chiese Indian Reserves in Alberta, 1972-73.

Co-ordination of remote sensing in Northern Forest Research Centre.

A vegetation map and illustrated letter report of the Wilson Creek watershed in Manitoba completed, December 1, 1973.

A Northern Forest Research Centre Forest Report, Vol. 3, No. 3 on remote sensing was published in October, 1973.

A two-day workshop with forty delegates from various industrial and government agencies was held at Northern Forest Research Centre, September 27 and 28, 1973.

Advice to National Parks on inventory procedures for Banff and Jasper was given in August, 1973.

Advice to the Yukon Forest Service on inventory procedures suitable for Yukon was given at a meeting, Whitehorse in September, 1973.

Assisted in Remote Sensing one day remote sensing field trip at Annual C.I.F. meeting in Prince Albert in October, 1974.

Aerial photography was obtained using our own equipment for:

- Wilson Creek, Manitoba for forest inventory.

- Red River south of Winnipeg to survey area for potential mortality from Dutch elm disease, in co-operation with V. Hildahl, Northern Forest Research Centre.

- Kananaskis Forest Experiment Station for forest inventory updating.
- Cadomin-Luscar for red belt damage assessment, J. Robins, Northern Forest Research Centre.
- Hinton forest fertilization plots for Wayne Johnstone, Northern Forest Research Centre.
- Hinton forest regeneration in co-operation with North Western Pulp and Power.
- Swan Hills damage appraisal from SO_2 and salt sprays, R. Blauel, Northern Forest Research Centre.
- Nipisi assessment of damage from oil spills in co-operation with Alberta Forest Service.
- Manitoba for assessment of forest regeneration on Abitibi limits in co-operation with Manitoba Forest Service.
- Tar sand area near Fort McMurray to provide aerial photography of plots to determine effects of tar sand development on forest vegetation, R. Blauel, Northern Forest Research Centre.
- Smoke impingement area near the Aquitaine Racenus gas plant, D. Hocking, Northern Forest Research Centre.
- Sunshine, Baker, Skoki areas to assist in mapping of alpine meadows and trail impact study. In co-operation with National Parks and the Canadian Wildlife Service, D. Day and Dr. G. Scotter.

Maintained contact with the CCRS re airborne remote sensing and satellite programs (see file, 116-J-58 and Project CFS-1-144).

Maintained aerial photo library.

12. Goals for 1974-75:

1. To continue acquisition of aerial photography for various projects. Nahanni, Banff and Jasper National Parks.
2. To provide interpretative services.
3. To maintain an aerial photo library.
4. To maintain contact with the CCRS re airborne remote sensing and satellite programs, file 116-J-58.
5. To provide assistance and conduct a field tour for IUFRO photogrammetry meeting in Banff, October, 1974.

6. To co-ordinate remote sensing activities within Northern Forest Research Centre by chairing a remote sensing committee and advising program management.

7. Publication:

   Kirby, C.L. and P.I. Van Eck. 1974. Forest regeneration sampling using large-scale aerial photography. Journal publication.

   Van Eck, P.I. 1974. Forest inventory of the Wilson Creek Watershed. Information Report.

13. Accomplishments in 1974-75:

1. Aerial photography for Parks Canada was obtained in Nahanni,Banff, Jasper and Wood Buffalo National Parks.

2. Interpretative Services were extended to assist Northwest Territories obtain a small timber inventory near Fort Smith. Also with Banff-Jasper Biophysical Survey.

3. Maintained aerial photo and satellite library.

4. Aerial photo contract with CCRS for Banff-Jasper National Park Inventory was completed.

5. A field tour of the Kananaskis Forest Experiment Station and Marmot Basin was arranged for Commission VII of the International Society of Photogrammetry (IUFRO). Over 200 delegates from 27 countries took part.

6. Co-ordination of remote sensing activities was given by discussions with program managers.

7. A publication on Forest regeneration sampling using large-scale photography was prepared and will appear in NFRC Forestry Report.

8. No report for the Wilson Creek Inventory will be prepared as it was adequately covered under a file report.

9. Accompanied Messrs. D. Day and G. Wickware of Parks Canada to Ottawa to advise them on applications of satellite imagery for park management of Banff Park and Wood Buffalo-Peace Athabasca delta. Images selected were interpreted from the computer compatable tapes in cooperation with Dr. Goodenough

10. An illustrated talk on the use of satellite imagery and aerial photography was given to Park managers in Jasper.

11. Six seminars on remote sensing were presented to U of A classes in Geography, Forestry and Engineering.

12. Member of the Alberta Remote Sensing Advisory Committee, which presented its third week long remote sensing training course through the Dept. of Continuing Education of the University of Alberta.

14. Goals for 1975-76:

1. Publication of report in "Large-scale photo sampling of Regeneration", in Forestry Chronicle.

2. Cooperation with Parks Canada in providing assistance in developing inventory sampling designs and aerial photography for surveys in Prince Albert and Wood Buffalo National Parks.

3. Cooperation with N.F.R.C. staff regarding aerial photography and sampling design assessment of forest conditions in Saskatchewan.

4. Modification of Vinten Camera system to include two cameras and electronic clock to provide accurate air base.

15. Publications:

Up to 1974-75

Nil

1974-75

Regeneration Sampling from the Air. Forestry Report (*In Press*).

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

PROJECT NOR - 19

Mackenzie Valley Terrain Sensitivity Project

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March, 1975

1. Project: Mackenzie Valley terrain sensitivity evaluation.

2. Title: Landform - vegetation - permafrost relationships.

3. New: Cont.: Term: X 4. No.: NOR 119

5. Study Leader: S.C. Zoltai

6. Key Words: Subsidence, thermal erosion, pipeline, land use.

7. Location of Work: Mackenzie Valley, northern Yukon Territory.

8. Problem:

Large scale development of forested and permafrost affected lands is imminent in the Mackenzie River Valley. Very little is known on the effects of disturbances of the vegetative cover or of the land surface on the stability of permafrost affected land. Identification of potentially difficult areas is essential in the planning, construction and operational stages of transportation development.

Vegetation and landform determine the near-surface permafrost conditions and consequently the reaction of the surface to a disturbance. A rating of the susceptibility of the land to surface disturbances can be developed which has a predictive value.

There is a high probability that a generalized surface susceptibility rating of landform - vegetation complexes will be successfully developed.

With continuing development of the Canadian North, this information is likely to be used both at the planning and field levels in the area investigated.

9. Study Objectives:

   a. To determine the relationships between landform, vegetation cover, and permafrost in sub-arctic, arctic and alpine zones, to be used as mapping criteria for terrain sensitivity of land.

b. To map landform - potential vegetation types.

c. To integrate this work with results emerging from studies by the Geological Survey of Canada, Canadian Forestry Service, Canadian Wildlife Service, ALUR projects and others to devise a terrain sensitivity classification for land use regulations as they pertain to pipeline construction and operation.

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: 1975
c. Estimated total Prof. man-years required: -
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years Prof. -
Supp. -
Casual -
Total - O & M funds req'd: -

11. Progress to Date:

Reconnaissance survey of the Mackenzie River Valley and Delta, and northern Yukon was completed on a 130,000 square mile area. Landscape maps were produced for the southern half, and derivative surface susceptibility maps for the northern half. Relationships between near-surface ice-content, ground heaving and vegetation cover were determined the entire length of the area. Reports were published, dealing with the findings.

Detailed studies and intensive sampling were carried out in four clusters, distributed across the entire study area. Reconnaissance was carried out in the far northern portion of the area not previously covered. Reports on peatland dynamics and forest succession on highly cryotrubated terrain are published.

12. Goals for 1974-75:

1. To examine in detail the vegetation-landform-permafrost conditions in areas where pipelines and highway right-of-way are crowded together. To examine problems related to vegetation-landform-permafrost on the pipeline right-of-way as they become known and report to the team assessing the pipeline application.

2. To co-operate with other agencies in developing a terrain sensitivity classification for the entire Mackenzie Valley.

3. To integrate Study NOR 120 with this study.

4. To report the results of the above studies to the Northern Pipelines Task Force and publish the following reports:

a. Zoltai, S.C. and W.W. Pettapiece. *In Press.* Tree distribution on perennially frozen earth hummocks. Arctic and Alpine Research.

b. Zoltai, S.C. Draft. Structure of subarctic forests in northwestern Canada. Proposed Journal paper.

c. Zoltai, S.C. and Tarnocai, C. Draft. Properties and development Perennially frozen peatlands in the western arctic and subarctic of Canada. Proposed Journal paper.

d. Zoltai, S.C. and Tranocai, C. Draft. Soils and vegetation of hummocky terrain. Report to Environmental-Social Program.

e. Zoltai, S.C. Outline. Dendrochronology and soil heaving in permafrost areas.

f. Tarnocai, C. and S.C. Zoltai. Outline. Peat landforms of the Mackenzie Valley. Report to Environmental-Social Program.

Note: *In Press* - paper written and accepted by Journal.

Draft - draft copy written; in various stages of review.

Outline - outline of paper written, but no text yet.

13. Accomplishments in 1974-75:

1. Spot checks were completed and the results reported to the team assessing the pipeline application.
2. The terrain sensitivity classification for the Mackenzie Valley was completed and is now in press.
3. Study NOR 120 was integrated with NOR 119.
4. (a) to (e). Reports published. (see Section 15). (f) This report was not initiated. The information was reported elsewhere.
5. Study terminated.

14. Goals for 1975-76:

None. Study terminated. Further work on reports and on assessments related to pipeline application will be undertaken on an informal basis, as the need arises.

15. Publications:

Up to 1974-75

Crampton, C.B. 1973. The distribution and possible genesis of some organic terrain patterns in the southern Mackenzie River Valley. Can. J. Earth Sci. 10: 432-438.

Crampton, C.B. Studies of vegetation, landform and permafrost in the Mackenzie River Valley; Landscape survey in the southern Mackenzie River Valley. Submitted to Environmental-Social Program, Northern Pipelines, Task Force on Northern Oil Development. Rept. No. 73-8. pp. 67.

Crampton, C.B. Overlays and legend; vegetation-landform relationships to go with GSC Open Files. NTS maps 85D, 95A, 95B, 83E, 95H, 95G, 95I, 95J, 95K, 95O, 95N.

Zoltai, S.C. Legend: vegetation-landform relationships, NTS maps 106I, 106J, 106K, 106M, 106N, 106O. Geol. Surv. Can., Open Files 97, 109.

Zoltai, S.C. and W.W. Pettapiece. Studies of vegetation, landform and permafrost in the Mackenzie River Valley Terrain, vegetation and permafrost relationships in the northern part of the Mackenzie Valley and northern Yukon. Submitted to the Environmental-Social Program, Northern Pipelines, Task Force on Northern Oil Development. Rept. No. 73-4, pp. 105.

Crampton, C.B., R.M. Strang and S.C. Zoltai. The Mackenzie River Valley. Forestry Report, Northern Forest Research Centre, Vol. 1, No. 6. pp. 2-3.

Crampton, C.B. 1972. A reconnaissance landscape survey in the southern Mackenzie River Valley. Int. Rept. NOR-12, Northern Forest Research Centre, Edmonton.

Zoltai, S.C. 1973. The range of tamarack (*Larix laricina* (Du Roi) K. Koch) in northern Yukon Territory. Can. J. For. Res., 3: 461-464.

Zoltai, S.C. and W.W .Pettapiece. 1973. Surface susceptibility maps. Mapsheets 106J, 106I, 106K, 106M, 106N, 106O, 116O, 116N, 116P. Environmental-Social Program, Northern Pipelines Task Force, Open File No. 120.

1974-75

Zoltai, S.C. and W.W. Pettapiece. 1974. Tree distribution on perennially frozen earth hummocks. Arctic and Alpine Res. Vol. 6, No. 4. pp. 403-411.

Pettapiece, W.W. and S.C. Zoltai. 1974. Soil environments in the western Canadian Subarctic. In: Quaternary Environments, Proc. Symp., W.C. Mahaney, Ed., York Univ. Geogr. Monogr. No. 5, p. 279-292.

Zoltai, S.C. 1975. Structure of subarctic forests permafrost on hummocky terrain in Northwestern Canada. Can. J. For. Res., Vol. 5, pp. 1-9.

Zoltai, S.C. and C. Tarnocai. 1975. Perennially frozen peatlands in the western arctic and subarctic of Canada. J. Can. Earth Sci. Vol. 12, No. 1. pp. 28-43.

Zoltai, S.C. and C. Tarnocai. 1974. Soils and vegetation of hummocky terrain. Environmental-Social Committee, Northern Pipelines Task Force on Northern Oil Development, Report No. 74-5.

Zoltai, S.C. 1975. Tree ring record of soil movements on permafrost. Arctic and Alpine Research (*In Press*).

Van Eyk, D.W. and S.C. Zoltai. 1975. Terrain sensitivity. In: Mackenzie Valley and northern Yukon pipelines: regional analysis. Envir. - Soc. Comm., North. Pipelines, Task Force North. Oil Dev., Open File No. ESP-106, 14 p, 6 maps.

16. Signatures:

S.C. Zoltai

Investigator

Program Manager

G.T. Silver

Director G.T. Silver

PROJECT NOR - 20

Public Awareness Program

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 24, 1975

1. Project: Public Awareness Program

2. Title: Working plan, Kananaskis Forest Experiment Station

3. New: Cont.: X 4. No.: NOR 043

5. Study Leader: L.G. Brace

6. Key Words: Management, development, subalpine, SA_1, public awareness, land use.

7. Location of Work: Kananaskis

8. Problem:

The Kananaskis Research Forest has in the past been exclusively managed to serve forest research needs. The development included the construction of essential roads, stand improvements by thinning and the gathering of inventory information for research and operational purposes.

A management plan was initiated in 1967. The major objective of that plan was the diversification of age classes in the classical forest management concept. Shortly after beginning to implement the plan, it became necessary to abandon it. In view of changing demands by research personnel and public land managers and users, cutting patterns and cut block sizes were altered from the rigid strip system originally planned and more flexible planning and management procedures were adopted.

Continuing study and revision will ensure that the management of the Kananaskis Research Forest will remain flexible.

A demonstration of integrated land use could be one valuable current use of the property. If demonstrations are developed and carried out with some input from provincial agencies, they promise to be highly successful. Results may be taken by the Province and applied under similar conditions throughout the area of the East Slopes. National Parks managers and planners have expressed interest in demonstrations of integrated land use, and there is a good possibility that in the near future demonstrations provided under a management plan, may be useful to parks managers.

Initial steps will involve re-examination of management philosophy and priorities and re-zoning of the Research Forest. Once these decisions have been made, detailed planning for each of these zones can proceed.

9. Study Objectives:

a. To maintain and improve the Research Forest to serve research needs and forest management demonstrations in the context of integrated land use.

b. To accommodate and facilitate a public awareness program which will capitalize on the location, natural features, facilities and research and demonstration information at the Station, in order to promote public understanding of forest land and resources and management alternatives (NOR 971).

10. Resources:

a. Starting date: 1937
b. Estimating year of completion: Continuing
c. Estimated total Prof. man-years required: 0.3
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

	Prof.	0.3
	Supp.	2.0
	Casual	0.8
	Total	3.1

11. Progress to Date:

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 clearcutting 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 operation.

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 (1,200 acres), and logging operations commenced in 1968. The engagement of small operators resulted in undercutting and need for clean-up work.

Acceleration of the logging program combined with greatly improved logging standards was achieved in 1970. Along with intensified logging, a regeneration program was launched which is considered successful in reforesting all cutovers immediately. Scarification and hand planting of container grown "plug" seedlings were the primary techniques used. Some 40,000 seedlings were planted on different sites and a provenance trial with over 2,000 seedlings of Scots pine and Norway spruce from 22 Scandinavian sources was established on a 5 acre cut block.

No new research or demonstration initiation were undertaken in 1974 but all facility development for the Public Awareness Program was completed in preparation for a 1975 opening.

12. Goals for 1974-75:

1. Initiate management and operation of the Station under the new management plan. This will include:

   a. Regular maintenance and operation of building and forest property, including the road system.

   b. New minor construction and landscaping, exclusive of requirements for the public awareness program.

   c. Construction, landscaping and trail clearings for the public awareness program, exclusive of that done by contract.

2. The appraisal of success of reforestation efforts on all recent cut blocks.

3. The growing of 12,000 container seedlings, 8,000 for fill-in operations and 4,000 for a cooperative project on highway beautification with the Alberta Department of Highways and Transport.

13. Accomplishments in 1974-75:

1. Achieved. This included a survey of building maintenance requirements and of road maintenance requirements under management plan specifications. Work also included re-location and servicing of the Lac La Biche cabin for summer staff use and landscaping of the main residences. Fire stores re-organization was started and the new G.P. hut erected for that purpose.

   Regular food and dormitory services to C.F.S. and Water Survey personnel were provided.

Construction, landscaping and trail clearing for the Public Awareness Program was done as required by Station personnel.

2. Achieved. Reforestation results are to be reported by Froning in his follow-up report on planting operations and scarification results prior to 1974.

Landings requiring reforestation were surveyed separately and special treatment recommended.

3. Achieved. All seedlings dispersed.

14. Goals for 1975-76:

1. Continue to maintain and operate the Station on a regular basis according to plans. This will include:

   a) organization of fire stores in G.P. hut.

   b) grade and repair fire access roads as budget allows.

   c) do building maintenance and repair, particularly external painting and re-finishing as budget allows.

   d) install 14 access control gates.

   e) install 3 large property identification signs to be produced by Information Canada.

2. Scarify 11.4 acres of landings on logged areas and plant with 25,000 seedlings.

3. Plan rehabilitation of 7.5 acres of denuded ground, mainly in vicinity of sewage lagoons.

4. Provide necessary support for Public Awareness Program, including construction and landscaping assistance in Visitors' Centre and bridge area.

5. Prepare background information for silvicultural operations as part of an annual operating plan.

15. Publications:

Up to 1974-75

Krewaz, J. 1966. The operational organization of the Kananaskis Research Forest. Internal Report A-4.

Krewaz, J. 1967. Management Plan Kananaskis Research Forest. Internal Report A-10.

1974-75

Brace, L.G. and K. Froning. 1974. Management guidelines, Kananaskis Forest Experiment Station. Information Report NOR-X-

16. Signatures:

L.G. Brace
Investigator

D. Johnson
Program Manager

G.T. Silver
Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 24, 1975

1. Project: Public Awareness Program
2. Title: Public Awareness Program, Kananaskis Forest Experiment Station.
3. New: X Cont.: 4. No.: NOR 149
5. Study Leader: L.G. Brace
6. Key Words: Public awareness, information, demonstrations, visitors' centre, self-guiding trails, integrated resource use.
7. Location of Work: Kananaskis
8. Problem:

The general public, and many leaders in government, industry and education lack basic knowledge about Canada's natural resources and the social, economic and environmental consequences of different resource exploitation and development alternatives. The result is often ill-conceived and unsound natural resource policies, allocation decisions and management practices, leading to environmental degradation.

The opportunity for improving natural resource policies, resource allocation decisions and management practices through a public awareness program would appear to be particularly great in the Region, where many previously untouched natural resources are being rapidly exploited and "developed".

9. Study Objectives:

   a. Assess and revise management policies, priorities and land zoning at the Kananaskis Forest Experiment Station, and prepare a new management plan in cooperation with Mr. K. Froning (NOR 043).

   b. Initiate a modest public awareness program at KFES within the context of the new management plan, using self-guiding trails in the initial phase. The primary objective of this program is to promote public understanding of forest land resources and the consequences of alternative resource management policies. Open facilities in July, 1975.

c. Enlarge the public awareness program in the future to go beyond self-guiding trails and include seminars and formal courses, supported by audio-visual facilities, lectures and field tours.

d. Encourage the development of and participate in research projects related to integrated resource use, public information, and environmental impact of public use of forest land. This includes cooperative work with the University of Calgary, Environmental Sciences Centre.

10. Resources:

a. Starting date: August 1, 1973
b. Estimated year of completion: -
c. Estimated total Prof. man-years required: 0.8
d. Essential new major equipmetn items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	0.9
Supp.	1.0
Casual	0.3
Total	2.2

SR Contracts:

1.	Contract to operate Visitors' Centre	$ 10,200
2.	Budget Submission (future develop.)	127,000
	TOTAL	$137,200

11. Progress to Date:

In general the study is progressing on schedule. All of the construction is complete except for some inside finishing of the Visitors' Centre. The opening of facilities to the public should proceed on schedule.

12. Goals for 1974-75:

1. Proceed with public awareness program, with a work schedule aimed at opening facilities to the public in July, 1975.

2. Supervise Alberta Department of Highways and Transport work on parking lot.

3. Negotiate and supervise contracts for the parking lot, visitors' centre and trail construction work.

4. Supervise facilities construction and landscaping done by KFES staff on parking lot, visitors' centre and Resource Management Trail.

5. Develop displays in cooperation with NFRC staff and supervise display installation in visitors' centre.

6. Prepare sign and brochure information in cooperation with NFRC staff in preparation for sign and brochure production.

7. Negotiate and supervise contracts for sign and brochure production.

8. Initiate a research project for an information survey to measure the effects of the 1975 program, as a measure of pay-off.

9. Organize an opening ceremony for 1975.

13. Accomplishments in 1974-75:

1. Achieved. Program developed to schedule with respect to facilities.

2. Achieved. Parking lot plan somewhat modified from architects drawing, but completed as modified.

3. Achieved. The five main contracts, totalling $24,442 - were completed as scheduled or are pending completion by March 31. This completes all basic facilities (Visitors' Centre, parking area, trail, toilet) and sign and pamphlet production.

4. Achieved except for final hydroseeding which Alberta Highways and Transport is expected to do in the spring.

5. Not achieved yet. Displays are being developed and should be in place by the end of May, 1975.

6. Achieved. All work on texts and all necessary translation on signs is complete. (Pamphlet translation and production was not achieved as it was not scheduled).

7. Achieved. (see (3)).

8. Being submitted as a study proposal.

9. Not yet achieved. Opening ceremony is currently being planned.

14. Goals for 1975-76:

1. Open and operate the public awareness program as scheduled.

2. Complete preliminary surveys of the interpretive potential of the Lusk Creek site for a further stage of the program.

3. Measure visitor response to the self-guiding interpretive trail program and Visitors' Centre displays at Kananaskis, using traffic counts and questionnaire techniques[1], and prepare a report.

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[1] Using questionnaires designed for Petawawa Forest Experiment Station as guidelines.

4. Assure durability of trail and signs using permanent camera points and descriptive notes and prepare a report which includes all data for facilities(Technique described in: Magill, A.R. and R.H. Twiss. 1965. A guide for recording aesthetic biologic changes with photography. PSW F.R. Expt. Sta. Res. Note 77.).

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

PROJECT NOR - 21

Scientific, Technical and Public Information

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 6, 1975

1. Project: Scientific, technical and public information.

2. Title: Technical information.

3. New: Cont.: X   4. No: NOR-21-145

5. Study Leader: R.M. Waldron

6. Key Words: Displays, seminars, workshops, audio-visual, resource managers, industrial managers.

7. Location of Work: Region wide.

8. Problem:

The problem of communicating the results of research and development programs to the forest resource and industrial managers has been well documented in recent issues of professional and trade journals and in reports issued by the Science Council of Canada and by the Senate Committee on Science Policy. A recent study of CFS publications led a task force of the Department's Management Consulting Service to recommend and, at a recently held meeting, the CFS Program Committee to conclude, that there is a real need to undertake the production of technically oriented publications specifically aimed at forest resource and industrial managers. Part of the evidence which led to the above conclusion was the fact that of a total of approximately 600 articles published annually by the CFS, 80% are written for our scientific audiences and only 20% for our technical audiences; this allocation is based on definitions of our four principal audiences as contained in a policy statement prepared by Dr. N.L. Prebble on October 11, 1970. The need to increase our use of other forms of communications such as seminars, workshops, and audio-visual presentations is also recognized. It is anticipated that with more frequent and more effective use of these media the NFRC can enhance its probability of successfully communicating the results of our RD programme to clients and client agencies.

The role of the project leader is strictly that of providing 'functional guidance'. He has no administrative nor organizational responsibility.

The information program has been divided into scientific, technical and public headed up by the scientific editor, project leader and information officer respectively. Three study statements have been prepared and outline the program for 1975-76.

9. Study Objectives:

To initiate, develop and implement, with the co-operation and active participation of the research staff, a technical information program designed to encourage the application of research findings by forest resource and industrial managers.

10. Resources:

a. Starting date: 1973
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required: 1.0 annually
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1975-76 with costs: Nil
f. 1975-76 man-years

Prof.	1.0
Supp.	-
Casual	-
Total	1.0

O & M funds req'd:

11. Progress to Date:

Two technical publications specifically designed for forest managers have been prepared.

One issue of Forestry Report on Poplars was distributed.

12. Goals for 1974-75:

1. Initiate a series of one page summaries of significant information reports and journal articles for use by our technical audiences.

2. Prepare information reports specifically designed to serve our technical audiences. The following will be published in 1974-75:

   a. Cankerworms - V. Hildahl.

   b. Control of the white-spotted sawyer beetle in logs - H. Cerezke.

   c. Red Belt in Alberta - J. Robins and J. Susut.

   d. Issue 4-5 Forestry Report covering appropriate programs at NFRC. A special 75th Anniversary issue will be prepared.

   e. Carry out a survey of technical client response to the Forestry Report and obtain suggestions for improving content.

f. Arrange, as appropriate, to hold a number of seminars or workshops of interest and value to our technical clientele principally in areas of mutual concern.

g. In co-operation with the Information Officer and Public Awareness Program a start will be made on the production of short (15-20 minutes) audio-visual presentations on subjects suitable for technical and public audiences.

Goals added in 1974-75:

h. Ecotour Calgary-Regina. (Contract)

i. Publication "Trees and Forests of Jasper National Park: R.E. Stevenson.

j. Contribute to the Public Awareness Program (NOR-20)

k. Prepare an article for the Ottawa Fact Sheet series. Forest and Water. (D. Golding).

13. Accomplishments in 1974-75:

1. The one-page summaries of significant N.F.R.C. publications was not initiated as planned due principly to the lack of time. Current abstracts in the information report series are much improved and are effectively summarizing the value of the report contents to the practicing forester.

2. Two, of the proposed three, technical publications are published.

a. Hildahl, V. and L.O.T. Peterson, 1974. Fall and spring cankerworms in the prairie provinces. Environment Canada, Can. For. Serv. Northern For. Res. Centre, Edmonton, Alberta. Info. Rept. NOR-X-100.

b. Robins, J.K. and J.P. Susut. 1974. Red belt in Alberta. Environment Canada, Can. For. Serv. Northern For. Res. Centre, Edmonton, Alberta. Info. Rept. NOR-X-99.

The third report has been approved for publication and is in the final preparation stage.

c. Cerezke, H.F. 1975. White spotted sawyer beetle in logs. Environment Canada. Can. For. Serv. Northern For. Res. Centre, Edmonton, Alberta. Info. Rept. NOR-X-127.

d. One issue of the Forestry report has been published - 'Poplars'. A second on 'Environmental stresses in the Forest' has gone to press. A silviculture issue is in the final preparation stage. As a result of a management decision, the special 75th Anniversary issue was not prepared.

e. The survey of technical client response to the Forestry Report was not carried out due to the fact that the first issue of the year was so late in being published.

f. Seminars and workshops of interest to our technical clientele carried out in 1974-75 were organized and conducted by our research staff, e.g. Dr. D. Hocking on SO_2 pollution and reclamation, Mr. C.L. Kirby on remote sensing. No additional subjects of mutual interest to N.F.R.C. and forest managers were apparent and therefore no workshops or seminars organized.

g. A start was made on the audio-visual presentation of the watershed research program at Marmot Creek. Script, graphics, slides and sound requirements have been completed. All equipment except the dissolve unit is on hand. The final audio-visual program on Marmot Creek Basin will be shown on March 21 at an in-house seminar.

h. Dr. E. Peterson was contracted to prepare the text, to provide illustrations and participate in the production of the Calgary, Regina Ecotour. Final draft of the text will be on hand at the end of February. The next stage is to contract the preparation of a panorama view of the 450 miles together with 100 sketches trees, animals, etc. Ottawa is responsible for funding.

i. Mr. R.E. Stevenson is preparing this publication. A first draft text has been written, photographs are on hand and a proposed layout prepared.

j. Up to three weeks have been spent contributing to the Public Awareness program. Contributions have been in the form of serving on the 'Resource Management Trail Committee', reviewing text for trail signs, brochures and providing information on the research program carried out at the K.F.E.S. in the past.

k. Dr. D.L. Golding's paper on 'Forests and Water' was accepted by Ottawa for inclusion in the Fact Sheet series.

14. <u>Goals for 1975-76</u>:

1. Prepare reports specifically designed to serve our technical audiences. The following will be prepared in 1975-76:

   a) Forest tent caterpillar - V. Hildahl.

   b) Management of aspen - G.A. Steneker or
   Management of jack pine - I.E. Bella

   c) Trees and Forests of Jasper National Park - R.E. Stevenson

   d) Watershed Management guidelines for logging and road construction. (A-X-42) - R.L. Rothwell

2. Issue 3-4 Forestry Reports covering appropriate programs at N.F.R.C.

3. Carry out a survey of technical client response to the Forestry Report.

4. Arrange, as appropriate, to hold a number of seminars or workshops of interest and value to our technical clientele in areas of mutual interest.

5. In conjunction with our Information Officer and the Public Awareness Program, complete the audio-visual program on Marmot Creek Basin and begin the preparation of a presentation covering ALL N.F.R.C. forestry programs within the region.

6. Work on the Calgary-Regina Ecotour.

7. Contribute to the Public Awareness Program.

8. Prepare tree brochure on lodgepole pine (Waldron).

15. Publications:

Up to 1974-75

Nil

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR 21-146

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 6, 1975

1. Project: Scientific, technical and public information

2. Title: Scientific information

3. New: Cont.: X 4. No.: NOR 21-146

5. Study Leader: P. Logan

6. Key Words: Journal articles, information reports, editing

7. Location of Work: Region-wide

8. Problem:

This is an editing service designed to assist the scientist in the preparation of publications.

9. Study Objectives:

To assist, principally by providing editorial services, the research staff in the preparation and dissemination of scientific information through the media of journals and information reports.

10. Resources:

a. Starting data: 1974
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required: 0
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	
Supp.	1.0
Casual	
Total	1.0

11. Progress to Date:

Fifty information reports and 35 journal articles were published in 1974-75.

12. Goals for 1974-75:

To assist, by the provision of editing services, the research staff in preparing and publishing approximately 30 reports and an equal number of journal articles.

13. Accomplishments ir 1974-75:

Assisted staff in the publication of 50 information reports and 35 journal articles. A list of reports and articles published in 1974-75 is appended.

14. Goals for 1975-76:

To assist the research staff, through the provision of editing services, in the preparation and publication of approximately 50 information reports and an equal number of journal articles.

15. Publications:

Up to 1975-75: N/A

1974-75: N/A

16. Signatures:

Patricia Logan
Investigator

[illegible]
Program Manager

GTSilver
Director G.T. Silver

INFORMATION REPORTS PUBLISHED 1974-75

Bella, I.E. Growth-density relations in young aspen sucker stands. NOR-X-124.

Bella, I.E. Growth response of young jack pine to mechanical strip thinning, Manitoba. NOR-X-102.

Bella, I.E. and J.P. De Franceschi. Commercial thinning improves growth of jack pine. NOR-X-112.

Bella, I.E. and J.P. De Franceschi. Early results of spacing studies of three indigenous conifers in Manitoba. NOR-X-113.

Blauel, R.A. and D. Hocking. Air pollution and forest decline near a nickel smelter: the Thompson, Manitoba smoke easement survey, 1972-74. NOR-X-115.

Caltrell, R.M. and J.C.E. Melvin. Forest insects collected in Elk Island National Park, 1948-71. NOR-X-111.

Campbell, A.E. and R.H. Pratt. Bibliography of North American shelterbelt research. NOR-X-92.

Douglas, G.W. Ecological impact of chemical fire retardants: a review. NOR-X-109.

Drouin, J.A. and D.S. Kusch. Insecticide field trials on shade and shelterbelt trees in Alberta and Saskatchewan, 1973. NOR-X-81.

Drouin, J.A. and D.S. Kusch. Pesticide field trials on shade and shelterbelt trees in Alberta and Saskatchewan, 1974. NOR-X-131.

Edwards, I.K., W.D. Holland, and L.W. Carlson. Assessment of potential tree nursery sites near Hudson Bay, Saskatchewan. NOR-X-119.

Emond, F.J. and G.N. Still. Forest insect and disease conditions in Manitoba provincial parks, 1973. NOR-X-91.

Emond, F.J. et al. Forest insects and diseases in eight western Canadian national parks, 1973. NOR-X-90.

Endean, F. and W.D. Johnstone. Prescribed fire and regeneration on clearcut spruce-fire sites in the foothills of Alberta. NOR-X-126.

Endean, F. and W.D. Johnstone. Prescribed fire to regenerate subalpine lodgepole pine. NOR-X-114.

Gautreau, E.J. and J.C.E. Melvin. Forest insects collected in Kananaskis Forest Experiment Station, 1948-1971. NOR-X-88.

Gautreau, E.J. and J.C.E. Melvin. Forest insects collected in Waterton National Park, 1948-1971. NOR-X-120.

Golding, D.L. (ed). Managing forest lands for water: proceedings of research-management seminar held at Edmonton, Alberta, January 1970. NOR-X-13.

Grigel, J. Role of the helitanker in forest fire control. NOR-X-123.

Grigel, J., R.J. Lieskovsky, and R.G. Newstead. Air drop tests with helitankers. NOR-X-77.

Hildahl, V. and L.O.T. Peterson. Fall and spring cankerworms in the prairie provinces. NOR-X-100.

Hocking, D. and W.R. MacDonald. Proceedings of a workshop on reclamation of disturbed lands in Alberta. NOR-X-116.

Ives, W.G.H. Weather and outbreaks of the spruce budworm, *Choristoneura fumiferana*. NOR-X-118.

Lesko, G.L. Preliminary revegetation trials on tar sand tailings at Fort McMurray, Alberta. NOR-X-103.

Lesko, G.L. Species suitability for sand dune reclamation at Lesser Slave Lake, Alberta. NOR-X-86.

Lesko, G.L. and E.B. Robson. Impact study and management recommendations for primitive campgrounds in the Sunshine-Egypt Lake area, Banff National Park. NOR-X-132.

Lieskovsky, R.J., R. Kruger, and R.G. Newstead. Problems in mixing and storage of long term fire retardants in Alberta. NOR-X 94.

Mortenson, K., F.J. Emond, and J.C.E. Melvin. Forest insects collected in Prince Albert National Park, 1948-1971. NOR-X-108.

Patterson, V.B. *et al.* Annual district reports: Forest insect and disease survey, Prairies region, 1974. NOR-X-125.

Patterson, V.B. *et al.* Forest insect and disease conditions in Alberta provincial parks, 1973. NOR-X-93.

Petty, J., E.J. Gautreau, and R.C. Tidsbury. Forest insect and disease conditions in Saskatchewan provincial parks, regional parks, and Trans-Canada Highway campgrounds, 1973. NOR-X-95.

Powell, J.M. and L.S. Skaley. Arthropods from forest litter under lodgepole pine infected with Comandra blister rust. NOR-X-130.

Robins, J.K. and J.P. Susut. Red belt in Alberta. NOR-X-99.

Robins, J.K. *et al.* Annual district reports: Forest Insect and Disease Survey, Prairie Region, 1973. NOR-X-73.

Singh, T. A simplified procedure for detecting changes of specified magnitude on paired plots and watersheds. NOR-X-47.

Sims, H.P. Evaluation of seedbeds for jack pine regeneration in Southeastern Manitoba. NOR-X-87.

Smith, G.J. and J.C.E. Melvin. Forest insects collected in Kootenay National Park, 1948-1971. NOR-X-110.

Smith, G.J. and J.C.E. Melvin. Forest insects collected in Yoho National Park, 1948-1971. NOR-X-105.

Soos, J. and V.S. Kolabinski. Site preparation of jack pine cutovers with shark-finned barrels in Saskatchewan. NOR-X-89.

Steneker, G.A. Selective cutting to release white spruce in 75 to 100-year-old white spruce-trembling aspen stands, Saskatchewan. NOR-X-121.

Steneker, G.A. Thinning of trembling aspen in Manitoba. NOR-X-122.

Still, G.N., V.B. Patterson, and J.C.E. Melvin. Forest insects collected in Banff National Park, 1948-1971. NOR-X-104.

Still, G.N., ..C. Tidsbury, and J.C.E. Melvin. Forest insects collected in Riding Mountain National Park, 1948-1971. NOR-X-106.

Susut, J.P. and J.C.E. Melvin. Forest insects collected in Jasper National Park, 1948-1971. NOR-X-107.

Teskey, A.G. and J.H. Smyth. A directory of primary wood-using industries in west-central Canada, 1973. NOR-X-83.

Waldron, R.M. and V. Hildahl. Deterioration of shelterbelts in southwestern Saskatchewan. NOR-X-127.

Walker, N.R. and H.J. Johnson. Field performance of pine and spruce reared in the BC/CFS styroblock - Alberta. NOR-X-84.

Wong, H.R. and J.C.E. Melvin. Insects of aspen catkins in the Canadian prairies. NOR-X-76.

Zoltai, S.C. Southern limit of coniferous trees on the Canadian prairies. NOR-X-128.

JOURNAL ARTICLES PUBLISHED 1974-75

Ali, M.W. and Y.P. Kalra. 1974. Sodium contamination by filter paper. J. Ass. Offic. Anal. Chem.

Bella, I.E. 1974. Thinning young lodgepole pine is faster with a brush saw. For. Chron.

Bella, I.E. and J.P. De Franceschi. 1974. Analysis of jack pine thinning experiments, Manitoba and Saskatchewan. Dep. Publ.

Carlson, L.W. 1974. Fungicidal control of poplar leaf spots. Can. Plant Dis. Surv. 54: 81-85.

Carlson, L.W. and L.D. Nairn. Phytotoxic action of PCP and captan on containerized red pine and jack pine seedlings. Tree Planters' Notes. *In Press*.

Cerezke, H.F. 1974. Effects of partial girdling on growth of lodgepole pine with application to damage by the weevil *Hylobius warreni* Wood. Can. J. For. Res. 4: 312-320.

Chrosciewicz, Z. 1974. Evaluation of fire-produced seedbeds for jack pine regeneration. Can. J. For. Res. 4: 455-457.

Denyer, W.B.G. 1974. Composting. Alberta Hort. Guide.

Endean, F. and L.W. Carlson. Effect of rooting volume on the early growth of lodgepole pine seedlings. Can. J. For. Res. *In Press*.

Golding, D.L. 1974. Correlation of snowpack with topography and snowmelt runoff on Marmot Creek Basin, Alberta. Atmosphere, 12: 31-37.

Golding, D.L. 1974. Snow cover determination from ERTS imagery. Can. Surv.

Golding, D.L. 1974. Snowpack calibration on Marmot Creek to detect changes in accumulation pattern after forest-cover manipulation. Proc. Banff Symp. Role of Snow and Ice in Hydrology. Paris.

Henderson, D.M. and Y. Hiratsuka. 1974. Ontogeny of spore markings on aeciospores of *Cronartium comandrae* and peridermioid teliospores of *Endocronartium harknessii*. Can. J. Bot. 52: 1919-1921.

Hildahl, V. and R.F. DeBoo. Aerial applications of chemical insecticide against the spruce budworm in Manitoba. Manitoba Entomol. *In Press*.

Hiratsuka, Y. 1974. Proposal to conserve the generic name Periderium (Link) Schmidt & Kunze with a conserved type species, *Aecidium elatinum* Alb. & Schw. (Fungi imperfecti uredinearum). Taxon, 23: 428-429.

Hiratsuka, Y. and P.J. Maruyama. 1974. A modified critical point drying to study germ tubes of rust fungi under scanning electron microscope. Bi-mon Res. Notes 30: 5-6.

Hiratsuka, Y. and J.M. Powell. Pine stem rusts of Canada. Dep. Publ. *In Press*.

Hocking, D. and F. Endean. 1974. Performance after planting of four types of container-grown white spruce seedlings. Can. J. For. Res. 4: 238-245.

Kalra, Y.P. and I.K. Edwards. 1974. Possible sources of error in IUFRO plant samples. IUFRO News. No. 7: 10-11.

Kalra, Y.P. and F.G. Radford. 1975. Suitability of ammonium EDTA extraction procedure for determining calcium in tree foliage. Commun. Soil Sci. Plant Anal. Jan-Feb issue.

Kirby, C.L. 1974. Temporal analysis of ERTS imagery in the boreal forest region. Can. Surv.

Powell, J.M. 1974. Environmental factors affecting germination and germ tube growth of *Cronartium comandrae* aeciospores Can. J. Bot. 52: 659-667.

Powell, J.M. 1974. The role of natural biological agents in controlling a pine stem rust. Blue Jay, 32: 75-79.

Powell, J.M. 1975. Additional note on the incidence of *Cronartium coleosporioides* f. *album*. Plant Dis. Rep.

Powell, J.M. and D.C. MacIver. Climatic classification of the prairie provinces: a new classification for the forested area. Occas. Pap. Geogr. *In Press*.

Raske, A.G. Cold hardiness of first instar larvae of the forest tent caterpillar. Can. Entomol. *In Press*.

Raske, A.G. 1974. Hatching rate of forest tent caterpillar in the laboratory. Bi-mon. Res. Notes.

Singh, T. and Y.P. Kalra. 1975. Specific conductance method for in situ estimation of total dissolved solids. J. Amer. Water Works Assoc. Feb.: 99-100,

Singh, T., Y.P. Kalra and G.R. Hillman. 1974. Effects of pulpwood harvesting on the quality of stream waters of a forest catchment representing a large area in western Alberta, Canada. Proc. Symp. Effects of Man on the Interface of the Hydrological Cycle with the Physical Environment. Paris. pp 21-27.

Wong, H.R. 1974. The identification and origin of the strains of the larch sawfly, *Pristiphora erichsonii* (Hymenoptera: Tenthredinidae), in North America. Can. Entomol. 106: 1121-1131.

Wong, H.R. The abietina group of *Pristiphora*. Can. Entomol. *In Press*.

Zalasky, H. Cell deformities in bark and sapwood caused by *Rhytidiella moriformis* and *Keissleriella emergens* infections in poplar. Can. J. Bot. *In Press*.

Zoltai, S.C. Structure of subarctic forests in northwestern Canada. Can. J. For. Res. *In Press*.

Zoltai, S.C. and W.W. Pettapiece. 1974. Tree distribution on perennially frozen earth hummocks. Arct. Alp. Res. 6: 403-411.

Zoltai, S.C. and C. Tarnocai. 1975. Perennially frozen peatlands in the western arctic and subarctic of Canada. Can. J. Earth Sci. 12: 28-43.

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 6, 1975

1. Project: Scientific, technical and public information.

2. Title: Public information

3. New: X Cont.: 4. No.: NOR 21-147

5. Study Leader: B.R. Hill

6. Key Words: Pest leaflets, news releases, radio, television and displays.

7. Location of Work: Region wide

8. Problem:

The general public and special interest groups (i.e., Fish and Game Association, Boy Scouts, Naturalists etc.) are not fully or correctly informed about the forest, forestry, land management, related resource and amenity uses nor the RD program of the Northern Forest Research Centre. There is some urgency in keeping the public better informed, particularly in those areas of open conflict such as (1) the allocation of forest land for consumptive and non-consumptive uses and (2) the effects of current forest management practices and forest products manufacturing on environmental quality. In addition the RD programs of the CFS and in particular of the NFRC have yielded information of interest or use by the general public such as (1) the control of tree and shrub pests, (2) techniques for preserving fence posts and (3) ecological interpretations of forest landscapes. It is essential that this type of information be readily available to the general public.

9. Study Objectives:

To initiate, develop and implement an information program designed to inform the public about CFS research and development programs, about forestry and forests as they relate to the economics and social well-being of Canadians and to encourage the application of RD findings by the public sector.

10. Resources:

a. Starting date: 1974
b. Estimated year of completion: continuing
c. Estimated total Prof. man-years required: 0
d. Essential new major equipment items for 1975-76 with costs:
audio-visual equipment: Nil
e. Essential new major equipment items beyond 1975 with costs: Nil
f. 1975-76 man-years

Prof.	-
Supp.	1.0
Casual	0.2
Total	1.2

11. Program to Date:

The pest leaflet series was initiated with the publication of the Birch Leaf Miner. Tree pests of the prairies was reprinted for 1975. A series of in-house seminars was carried out, media release prepared, participated in in-house tours, career days, etc.

12. Goals for 1974-75:

1. Initiate a pest leaflet series on major insects, diseases and climatic problems for our public audience (Hill). Proposed titles of publications to be prepared during 1975-76 are:

   a. Winterbrowning
   b. Pear slug
   c. Lilac leaf roller
   d. Fireblight
   e. Yellow-headed spruce sawfly
   f. Tent caterpillar

2. Reprint an updated edition of "Tree pests of the prairies"- N.W. Wilkinson.

3. Prepare a proposal relating to an improved and expanded public information program in the region for implementation in 1975-76. (Hill, Waldron).

4. Prepare news releases, newspaper articles, TV and radio announcements, arrange for participation in local "talk shows" etc. as appropriate (Hill).

5. Participate or organize in-house tours by students, participate in career days, give lectures or talks to public audiences including Rotary Club etc. as appropriate (Hill).

6. Organize in-house seminars and prepare a staff newsletter as two means of improving internal communication and developing an 'esprit de corp' (Hill).

7. Initiate an audio-visual information program designed to explain our RD program to our technical and public audiences in co-operation with the Public Awareness Program at K.F.E.S. (Brace, Waldron, Hill, Debnam).

8. Initiate a revision of the Field Guide to Native Trees of Manitoba to cover the whole region. New title "Field Guide to Native Trees of the Prairies."

9. Distribute publications prepared by the staff of NFRC.

13. Accomplishments for 1974-75:

1. The pest leaflet series was initiated. The following is the status of the individual subjects:

   a. Winterbrowning - not done
   b. Pear slug - in press
   c. Lilac leaf roller - in preparation
   d. Fireblight - not done
   e. Yellow-headed spruce sawfly - in preparation
   f. Tent caterpillar - will not be done
   g. Fall cankerworm - in press
   h. Yellow bellied sapsucker - in preparation
   i. To spray or not to spray - in preparation
   j. Birch leaf miner - published

2. N.W. Wilkinson's "Tree pests of the prairies" is in press.

3. The proposal was not prepared due to lack of time and apparent future shortage of funds.

4. Approximately 10 new releases and newspaper articles were prepared. Subjects covered included: larch sawfly (Muldrew), forest fires (Fahnestock), oil sands (Lesko), remote sensing (Kirby), stand deteriorating at Pine Point and Rocky Mountain House (Hocking), announcements of staff additions and changes and on explanation of the role of the Environmental Management Services.

5. Approximately 1,000 individuals participated in 30 in-house tours during 1974-75--a 25% increase over last year. November and March through early June were the busiest months. Visitors included elementary, junior high, high school, and collegiate students, guides, scouts, junior forest wardens and ranger groups. Northern Forest Research Centre participated in the federal government's 'Salute to Aviation' Flare Square, Calgary Stampede 1974, and in the International Remote Sensing Convention at Banff where a display was erected. Displays were also set up at the Edmonton City's main library and 3 sub-libraries, and at the new Edmonton Centre.

6. An inhouse series of seminars was organized as follows:

January 10	G.R. Fahnestock. The Darwin Lake burn.
January 24	L.G. Brace. C.F.S. resource management trails, Kananaskis.

February 7 G.R. Hillman and R.L. Rothwell. Water yield and quality; Hinton pulpwood harvesting study.

February 28 S.S. Malhotra. The effect of SO_2 on plant metabolism.

March 7 J.A. Drouin. Field trials for registration of insecticides for use on ornamental and shade trees.

March 21 R.M. Waldron. The preparation of an audio-visual program on Marmot Creek Basin.

April 18 R.H. Swanson. An hydrologist's view of forestry in New Zealand and Australia.

April 25 W.D. Holland. Soil and vegetation inventory of Banff and Jasper National Parks.

Five issues of the staff newsletter ECO were prepared and covered items of interest to the staff with particular emphasis on technical contributions to forest management, education, public hearings and international symposiums.

7. A start was made on the Marmot Creek Basin audio-visual program. The presentation will be available for viewing on March 21.

8. A revision of Field Guide to Native Trees of Manitoba was not undertaken. Instead Trees and Forests of Jasper National Park was initiated. (Stevenson).

9. Approximately 3,000 requests for publications were received--a 20% increase over last year. The increase seems to be from individuals and business organizations with University and school libraries clost behind. The added publicity from the departmental list of available publications has had a noticeable effect on the number of requests - a factor to be considered in ordering supplies of reports etc. There seems to be no recognizable pattern to follow as a guide to ordering - popular subjects were the SO_2 and Fort MacMurray reports... Alberta Reclamation Workshop and (explain this?) The List of Insects Collected in thė National Park.

   In addition popular items prepared in Ottawa such as Fact Sheets, Forest Enemies, Forestry Lessons, and Careers in Forestry were distributed.

14. Goals for 1975-76:

   1. Continue the preparation of articles for release in the Pest Leaflet series. Titles of publications to be published during 1975-76 are:

      a. Lilac leaf roller - Wilkinson

b. Yellow headed spruce sawfly - Kusch
c. Dutch elm disease - Hildahl
d. Yellow bellied sapsucker - Hildahl
e. Spruce spider mite.

2. Reprint N.W. Wilkinson's "Tree pests in the prairies"

3. Prepare news releases, newspaper articles, TV and radio announcements, arrange for participation on local "talk shows" etc. as appropriate.

4. Participate or organize in-house tours by students, participate in career days, give lectures or talks to public audiences including Rotary Club etc. as appropriate.

5. Organize in-house seminars and prepare staff newsletter as two means of improving internal communication and developing an 'esprit de corp'.

6. Assist in the preparation of an audio-visual program on the entire N.F.R.C. Research and Development program.

7. Distribute publications prepared by N.F.R.C. and Ottawa as required and including maintenance of mailing lists, inventory and distribution records.

15. Publications:

Up to 1974-75

Environment Canada, Canadian Forestry Service 1974. Poplars in the prairie provinces. Northern Forest Research Centre, Edmonton, Alberta. 8 p.

1974-75

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

PROJECT NOR - 22

C.F.S. - 1

Evaluation of Earth Resources Technology Satellite

CFS-1-NOR-22-976

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: March 4, 1975

1. Project: Evaluation of Earth Resources Technology Satellite (LANDSTAT).

2. Title: Evaluation of ERTS for resource inventory, damage assessment and land-use planning in the Northern Region.

3. New: X Cont.: 4. No.: CFS 1 NOR-22-144

5. Study Leader: C.L. Kirby

6. Key Words: Forest, land inventory, multispectral, multidate, multiscale, multiple land use, aerial photography, spectral signatures, information systems, remote sensing.

7. Location of Work: Regional with focus of attention on Banff-Jasper-Kananaskis-Hinton test site.

8. Problem:

To show the capability of ERTS in forest-land management for mapping of cut-overs, burnovers, generalized covertypes, and succession after various disturbances; its application by provincial forest services, environmental management agencies and industry; and its future development.

In a region where resource development is proceeding quickly, it is important to have up-to-date and economical inventory techniques along with environmental monitoring capability that is timely.

Interest in remote sensing, especially ERTS applications is so great that in Alberta a one-week remote sensing course limited to 40 students and costing $150 per student has been oversubscribed for the past two years. The Province of Saskatchewan has contracted a private agency to map burnovers from ERTS and the Province of Manitoba has its own remote sensing centre. In the Yukon and Northwest Territories considerable interest has been expressed in the use of ERTS for: location of timber stands, route location and terrain analysis. The success of applications depends on adequate research and development work.

9. Study Objectives:

   a. To provide well documented test sites with descriptions of vegetation, geomorphology and soils, where remote-sensing research and development may be focused.

   b. To prepare an ERTS satellite mosaic of the Banff-Jasper-Kananaskis-Hinton test site.

   c. To provide assistance in the analysis of ERTS for the mapping of snow melt, red belt and SO_2.

10. Resources:

   a. Starting date: 1974
   b. Estimated year of completion: Indefinite
   c. Estimated total Prof. man-years required: 3.0
   d. Essential new major equipment items for 1975-76 with costs: Digitizer $20,000.
   e. Essential new major equipment items beyond 1976 with costs: Nil
   f. 1975-76 man-years Prof. 0.5
      Supp. 0.5
      Casual -
      Total 1.0 O & M funds req'd: $2,000

11. Progress to Date:

   a. Aerial photography was obtained from the CCRS jet program for the following test sites:

Test Site	Investigators	Problem	CCRS Task No.
Swan Hills, Nipisi, Alta	R. Blauel	SO_2 damage, oil spills	73-50
Flin Flon, Manitoba	R. Blauel	SO_2 damage	(73-47 (72-88
K F.E.S., Banff, Alta	D. Golding	Snow melt	73-61
K.F.E.S. Banff and Yoho National Parks	C. Kirby P. Van Eck A. Legge	Subalpine forest mapping of vegetation and environmental impact in Bow Corridor & K F.E.S.	73-62
Slave Lake, Alta.	J. Niederleitner	Mapping of forest fires (burn-overs)	72-57
Cadomin, Luscar, Alta.	J. Robins	Mapping of "red-belt" climatic damage to lodgepole pine	73-50
Peace River (P-6), Alta.	C. Kirby P. Van Eck	Mapping of boreal forest vegetation, cut-overs and forest fires	72-49

b. Ground truth for the P-6 test site was obtained.

c. High flight aerial photography and ground truth was obtained for the Banff-Kananaskis test site. In addition aerial photography for Yoho National Park, Swan Hills, Cadomin and Luscar was obtained.

Swan Hills, Nipisi, Alta.	R. Blauel	SO_2 damage, oil spills	73-50
K.F.E.S., Banff, Alta.	D. Golding	Snow melt	73-61
K.F.E.S. Banff and Yoho National Parks	C. Kirby P. Van Eck A. Legge	Subalpine forest mapping of vegetation and environmental impact in Bow Corridor & K.F.E.S.	73-62
Cadomin, Luscar, Alta.	J. Robins	Mapping of "red belt" climatic damage to lodgepole pine	73-50

d. Development of methods for ERTS analysis using time sequential imagery was started and a paper presenting results prepared. Canadian Institute of Surveying Journal.

e. Contract NOR-730-715 "Spectral reflectance of selected targets at the Kananaskis Forest Experiment Station", by Drs. P. Crown and S. Pawluk was completed.

f. Contract NOR-730-701 "Development and application of an ecological based remote sensing legend system in the Kananaskis, Alberta test corridor was completed, (Subalpine Test Site).

12. Goals for 1974-75:

1. Preparation of satellite mosaic for Banff-Jasper-Kananaskis-Hinton test site with interpretation of broad covertypes.

2. Detailed study of ERTS magnetic tapes in cooperation with CCRS to determine vegetation patterns and damage in subalpine forest region.

3. Completion of projects by cooperators for mapping of red belt burn-overs and SO_2 damage.

4. Complete a paper "Temporal analysis of ERTS imagery in the Boreal Forest Region".

13. Accomplishments in 1974-75:

    1. Satellite mosaic for Banff-Jasper-Kananaskis-Hinton site with interpretation of broad covertype using a computer (Image 100 system at CCRS) was completed on two Landstat (ERTS) images.

    2. Evaluation of the interpretation by aerial photography obtained by NFRC and ground sampling was initiated.

    3. The mapping of red-belt from Landstat images for damage occurring in 1972,73,74 was accomplished using magnetic tapes and the image 100 in Ottawa.

    4. Completed a paper:

    Kirby, C.L. 1974. Temporal analysis of ERTS imagery in the boreal forest region. The Cdn. Surveyor. Vol. 28. No. 2.

14. Goals for 1975-76:

    1. Completion of the evaluation of the Banff-Jasper map from satellite image interpretation.

    2. Preparation of a joint paper with CCRS and Parks Canada on the Banff-Jasper Satellite Map for presentation at Third Canadian Remote Sensing Symposium in Sept., 1975 (Edmonton).

    3. Act as Chairman of Natural Resource Exploration and Management Session of 3rd Canadian Remote Sensing Symposium.

15. Publications:

Up to 1974-75

Kirby, C.L. 1973. Preliminary results of earth resources technology satellite investigations on the Peace River test site for the Boreal Forest Region. Paper to Canadian Aerospace and Space Inst. Feb. 5, 1973

Kirby, C.L. 1973. Remote sensing. N.F.R.C. For. rept. Vol. 3(3).

Crown, P. and S. Pawluk. 1973. Spectral signatures at the Kananaskis Forest Experiment Station. File Report.

Kirby, C.L. 1973. Forest and land inventory using ERTS imagery and aerial photography in the Boreal Forest Region of Alberta. Paper to Principle ERTS Investigators. Washington, Dec. 10, 1973.

1974-75

Legge, A., C.E. Poulton, C.L. Kirby and P. Van Eck. 1974. Development and application of an ecological based remote sensing legend system in the Kananaskis, Alberta test corridor. (Published by University of Calgary).

Kirby, C.L. 1974. Temporal Analysis of ERTS Imagery in the boreal forest region. The Canadian Surveyor, Vol. 28, No. 2.

16. Signatures:

Cd Kirby
Investigator

Program Manager

GT Silver
Director G.T. Silver

PROJECT NOR - 23

Land and Vegetation Resource Inventory

of

Banff and Jasper National Parks

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April, 1975

1. Project: Land and vegetation resource inventory of Banff and Jasper National Parks.

2. Title: Land and vegetation resource inventory of Banff and Jasper National Parks.

3. New: X   Cont.:   4. No.: NOR 148

5. Study Leader: W.D. Holland S. Kojima

6. Key Words: Resource inventory, land inventory, biophysical mapping, vegetation inventory, land use interpretation guides.

7. Location of Work: Banff and Jasper National Parks and Northern Forest Research Centre, Edmonton.

8. Problem:

The National Parks Service have requested assistance to meet a number of objectives of the National Parks Inventory Program. The request indicates a need for knowledge of the kinds of soil and vegetation and their distribution in the National Parks system. The knowledge will be used for such purposes as:

1. determining soil limitations for certain land uses, e.g. soils subject to flooding, landslides, droughtiness; load bearing ability for access roads, trails, buildings; slope, drainage, permeability; soil depth, texture, stoniness; productivity for vegetation of different kinds, fertility levels, etc.;

2. providing background information for impact assessments and environmental monitoring;

3. providing the Parks' personnel, wardens, planners, and managers with interpretative guidelines for use of land for various purposes. Knowledge pertaining to soil characteristics and how they affect soil quality will assist in evaluation of the degree and kind of risk or hazard (soil limitations) that a certain soil may have for specific, selected National Park uses;

4. provision of information on forest cover and vegetative communities. Such knowledge assists in fuel-type mapping, establishment of fragility ratings, determining productivity of alpine and winter ranges, successional stages and advance growth, and understory components;

5. assisting, if necessary, with interpretation of the information for Parks personnel preparing master plans of the Parks.

Further, the knowledge gained will permit consultation and the possibility of critical review of resource management recommendations, either with individual Parks personnel or through the establishment of a liaison committee. It also permits participation in seminars with Parks personnel and students.

Priority areas for initial work in Banff and Jasper are currently recognized to be the Athabasca valley around the townsite of Jasper and Maligne Canyon; the south area of Banff National Park near the Spray Lakes, the transportation corridors; the Siffleur area; and the Athabasca Glacier area.

The approach to this inventory will use the Guidelines for Biophysical Land Classification (Lacate, 1969). It will, however, include interpretative guides, and methodology similar to that developed for Waterton Lakes National Park (Holland and Coen, 1973) but adapted to the biophysical guidelines. The scale to be used is assumed to be to the Level 4, or landtype category, using the 1:50,000 National Topographic Series for base maps. These can readily be reproduced by a 2 colour offset printing. The map legend will, by the nature of biophysical mapping, be more complex than that used in Waterton and may approach the complexity of legend used by Poulton (1973).

Experience since 1970 indicates that a number of the Parks' problems appear to be one of a lack of knowledge on how to manage specific areas of land. Research projects could be initiated, using the inventory data for guidance, to determine how such areas can best be managed. Such research may be concurrent with the survey or post-survey. Preparation of a field guide to solve problems in applied management is suggested.

An assessment of land use problems encountered in Banff and Jasper National Parks could do much to improve the data collected by the inventory and the subsequent resource interpretations. Especially pertinent is the experience of field personnel from Banff and Jasper.

9. Study Objectives:

To provide a land, soil, and vegetation inventory of Banff and Jasper National Parks, including maps and report, and research studies, plus interpretation of data for land use planning and management within the Parks.

10. Resources:

a. Starting date: April, 1974
b. Estimated year of completion: March, 1979
c. Estimated total Prof. man-years required: 30-40
d. Essential new major equipment for 1975-76 with costs: Nil
e. Essential new major equipment beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	2.0	
Supp.	2.0	
Casual	-	
Total	4.0	(C.F.S.)

O & M funds req'd:

C.F.S. $ 3,500.00
N.P.S. 120,000.00
SR Cont.: Nil

11. Progress to Date:

Progress in the current year included receipt of the "Terms of Reference" Day, Zinkan, and Wickware. Field work was begun in 1974 in the Mt. Eisenhower - Lake Louise area, and a report of the first year's progress is being prepared.

Project methodology is established as that used in bio-physical land classification work - Lacate, Jurdant, and Sprout. This methodology included the development of computer cards and coding for input into the Soil Research Institutes' data bank (canSIS and vegetation file currently being developed), Ottawa.

Photo-geology interpretation was made of all of Banff and part of Jasper and was completed via a separate contract.

Numerous meetings and seminars have been held with Parks Canada Regional Office (Calgary), Park's personnel in Banff and Jasper, and with other cooperating agencies such as the Canadian Wildlife Service (Edmonton) and the Soil Research Institute (Edmonton and Ottawa) to develop methodology, set priorities, and complete logistics planning.

12. Goals for 1974-75:

1. Complete project planning and staffing.

2. Continue literature survey for Banff and Jasper Parks.

3. Initiate air photo interpretation preliminary map preparation, and desegration of mapping units.

4. Commence inventory in priority areas as designated by National Parks Service.

5. Provide National Parks Service with interim reports, as required.

6. Initiation of photo-geology study of Banff and Jasper National Parks.

7. Development of computer cards and coding for input into the Soil Research Institute data bank (canSIS and vegetation file), Ottawa.

13. Accomplishments in 1974-75:

1. This goal is completed to the extent that budgetary restraints permit and logistics planning is possible at this time. Scale of mapping is finalized and methodology is chosen. The new air photography was not obtained in 1974 and has been requested in 1975. Priority areas established for 1975 are the southwest portion of Banff National Park (Bow valley and Lake Louise) and the intensively used area around the townsite of Jasper and the Maligne River.

The following team members have been assembled via arrangements with the Alberta Institute of Pedology, the University of Alberta, and the Soil Research Institute.

Dr. G.M. Coen - Pedologist
Dr. Russ Wells - "
Mr. Bruce Walker - "
Mr. Phil Epp - " (Part time; Epp is on M. Sc. program)

Mr. Ian Corns - Vegetation Scientist

Mr. Joe Tajek - Soil laboratory.

5 summer students.

Canadian Forestry Service team members:

W.D. Holland - Pedologist
S. Kojima - Vegetation scientist
Doug Allan - technician
Jake Dyck - technician

It is felt that the Banff-Jasper project has a well qualified roster of personnel. It may be necessary to provide additional personnel for the vegetation scientists next year, budget permitting.

Because of space limitations at the U of A, N.P.S. budgetary restraints, and the necessity of daily consultation, the team headquarters has been centred at the N.F.R.C. Rules, policies, and responsibilities will be presented to the entire B.-J. inventory team on April 7. Dr. Silver and A.M. Mont have agreed to address the team.

2. The literature review for B.-J. is a continual necessity. Literature has been selected for the new team members arriving April 1.

3. Air photo interpretation was initiated by the Banff inventory team that worked between Mt. Eisenhower and Lake Louise in 1974. The map preparation of this field work is nearly complete.

   The inventory team will continue with air photo interpretation throughout the term of the project.

4. The inventory was begun in the Mt. Eisenhower - Lake Louise area as stated above, including some work in tributary valleys such as Johnstone Creek, Moraine Creek, Larch Valley, Consolation Lakes, and Paradise Valley.

5. The interim report is in progress and will be completed in April.

6. The initial photo-geology work by Bayrock and Reimchen Surficial Geology Ltd., North Vancouver was delivered to Dave Day on January 30, 1975. The area investigated includes all of Banff and part of Jasper between Mt. Edith Cavell and Miette. Two copies of the report and maps were provided to us by National Parks.

   Maps and report received:

   Reimchen, T.H.F. and L.A. Bayrock. 1975. Terrain analysis of Banff and Jasper National Parks. For Parks Canada, Western Region. Bayrock and Reimchen Surficial Geology Limited, North Vancouver.

7. Computer card and coding work has developed to the point of submission of work to Dr. Julian Dumanski for input into a data bank (canSIS) in Ottawa. Three data files are being developed, as follows:

   I Soil data file:

   Daily field sheet - 1 computer card
   Semi-detailed sheet - 9 computer cards
   Detailed - 20 computer cards.

   II Vegetation file:

   Currently being developed in cooperation with S. Kojima

   Site and vegetation sheet - 2 computer cards
   Species listing - 8 computer cards.

   III Wildlife file:

   Currently being developed by John Stelfox and C.S.W. personnel.

14. Goals for 1975-76:

1. Completion of the Banff-Jasper Bio-physical Inventory Progress Report No. 1, 1974-75 by April 30, 1975.

2. Orientation of new members to the inventory team.

3. Continuation of soil and vegetation inventory in the southwest portion of Banff National Park, in accordance with established Park priorities; specifically:

82 N/9 west	82 0/5 west
82 N/9 east	82 0/4 west
82 N/8 east	82 0/4 east

These priorities are established in concert with the individual Park and Parks Canada Western Region. They include area priorities, advice, sampling, logistics, herbarium, and data bank (canSIS and vegetation file).

4. Establishment of a field camp at the old fish hatchery about 7 miles from Jasper townsite, and commencement of fieldwork in the priority areas around the townsite and Maligne River area.

5. Continuation of committee meetings, seminars, workshops, etc. as requested by National Parks, or others.

6. Preparation of Progress Report No.2, 1975-76.

15. Publications:

Up to 1974-75

Nil

1974-75

Day, D., C. Zinkan and G. Wickware. 1975. A multidisciplinary approach to resource inventory in National Parks. Indian and Northern Affairs, Parks Canada. 600 pp. and Appendices.

Reimchen, T.H.F. and L.A. Bayrock, 1975. Terrain analysis of Banff and Jasper National Parks. Bayrock and Reimchen Surficial Ecology Ltd., North Vancouver.

16. Signatures:

W. D. Holland

Investigators

S. Kojima

P. Ackerman

Program Manager

G.T. Silver

Director G.T. Silver

PROJECT NOR - 24

AOSERP: Effects of SO_2 on Vegetation

ALBERTA OIL SANDS ENVIRONMENTAL

RESEARCH PROGRAM

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April 1, 1975

1. Project: AOSERP: Effects of SO_2 on vegetation.

2. Sub-Project Title: Symptomology of SO_2 injury to vegetation.

3. New: X Cont.: 4. Sub-Project No.: NOR-24-990 (AOSERP No. V16)

5. Study Leader: D. Hocking,

6. Key Words: sulfur dioxide, plants, symptomology

7. Location of Work: Athabasca Oil Sands area and Northern Forest Research Centre.

8. Problem:

Delineation of SO_2 effects on vegetation in the field requires rapid diagnosis of symptoms of injury that may be due to any of a variety of causes. Since symptom expression is affected by many plant and environmental factors, carefully controlled experimentation is needed to determine contributions of various factors.

9. Study Objectives:

   1. Describe visible and microscopic effects of various levels of SO_2 fumigation on selected vegetation occurring in vicinity of oil sand leases.

   2. Develop diagnostic techniques for identifying and assessing impact of SO_2 fumigation on vegetation.

10. Resource Implication:

   a. Starting date: 1975
   b. Estimated year of completion: 1980
   c. Estimated total Prof. man-years required: 5.5
   d. Essential new major equipment for 1975-76 with costs: \$40,000 fumigation chamber (also required for Study V 17).
   e. Essential new major equipment beyond 1976 with costs: \$15,000. SO_2 monitor (also required for Study V 17).
   f. 1975-76 man-years

	Prof.	1.1	(term)	\$18,000
	Supp.	1.0	(term)	\$12,000
	Total	2.1		\$30,000 wages

   g. O & M \$5,000.

11. Progress to Date:

    Extensive collections have been assembled of herbarium specimens and photographs of SO_2-injured vegetation, with notes on probable conditions of exposure. Conditions of time and concentration of SO_2 are rarely if ever available. For further progress, control of these two factors is essential.

    Engineering drawings and estimates for construction of a suitable fumigation chamber have been prepared.

12. Goals for 1974-75: Nil - new study.

13. Goals for 1975-76:

    1. Let contract and supervise construction of fumigation chamber.

    2. Make preliminary experimental fumigations using an available micro-chamber, with suitable adaptations.

14. Study Reports and Publications: Nil - new study.

15. Signatures:

Program Manager

Study Leader

Director G. T. Silver

ALBERTA OIL SANDS ENVIRONMENTAL

RESEARCH PROGRAM

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April 1, 1975

1. Project: AOSERP: Effects of SO_2 on vegetation.
2. Sub-Project Title: Threshold levels of SO_2 injury and species tolerances.
3. New: X Cont.: 4. Sub-Project No.: NOR-24-991 (AOSERP No. V17a)
5. Study Leader: D. Hocking,
6. Key Words: sulfur dioxide, vegetation, plants, injury thresholds, tolerance
7. Location of Work: Alberta oil sands area and Northern Forest Research Centre
8. Problem:

   At present, air quality standards and objectives are based on data from other places and plants. A clear knowledge of species-specific injury thresholds is needed to rationalize such standards for Alberta species and climate.

9. Study Objectives:

   1. Determine threshold levels of injury to vegetation species occurring in the Alberta Oil Sands area.
   2. Screen candidate revegetation species for SO_2 tolerance under climatic stresses.

10. Resources:

    a. Starting date: 1975
    b. Estimated year of completion: 1980
    c. Estimated total Prof. man-years required: 3.0
    d. Essential new major equipment items for 1975-76 with costs: (fumigation chamber as identified under V 16)
    e. Essential new major equipment items beyond 1976 with costs: (SO_2 monitor as identified under V 16)

f. 1975-76 man-years

Prof.	0.6	(.1 Hocking,	.5 term)	$10,000
Supp.	1.0	(term)		$12,000
Total	1.6			

g. O & M $10,000

11. Progress to Date:

Objectives of this study clearly require the most careful control of exposure conditions. For this, a suitable fumigation chamber has been designed and estimates obtained for its construction.

12. Goals for 1974-75: Nil - new study

13. Goals for 1975-76: Congruent with those of Study V 16.

14. Study Reports and Publications: Nil - new study.

15. Signatures:

Program Manager

Drake Hocking

Study Leader

GTSilver

Director G. T. Silver

ALBERTA OIL SANDS ENVIRONMENTAL

RESEARCH PROGRAM

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April 1, 1975

1. Project: AOSERP: Effects of SO_2 on vegetation.

2. Sub-Project Title: Physiology and mechanisms of SO_2 injury.

3. New: X Cont. 4. Sub-Project No.: NOR-24-992 (AOSERP No. V17b)

5. Study Leader: S. S. Malhotra

6. Key Words: sulfur dioxide, plants, injury mechanisms, physiology

7. Location of Work: Alberta oil sands area, Northern Forest Research Centre, Whitecourt area (Legge)

8. Problem:

   Full understanding of plant injury thresholds requires a knowledge of the types of injury to be expected at different exposures and conditions, because injury development is a continuum, not a "yes or no" situation.

9. Study Objectives:

   1. Determine effects of SO_2 on central biochemical processes in forest species.

   2. Determine effects of SO_2 on subcellular organization and relate these results to Objective 1.

10. Resources:

    a. Starting date: 1975
    b. Estimated year of completion: 1980
    c. Estimated total Prof. man-years required: 5.0
    d. Essential new major equipment items for 1975-76 with costs: (fumigation chamber as identified under V 16)
    e. Essential new major equipment beyond 1976 with costs:

CO_2 analyzer	$8,000
Gas chromatogaphy accessories	3,000
Ultra centrifuge	16,000

f. 1975-76 man-years

Prof.	1.0	(.5 Malhotra, .5 term)	$10,000
Supp.	1.0	(term)	$12,000
Casual	--		
Total	2.0		

g. O & M $30,000 (includes 20,000 R & D Contract: A. Legge)

11. Progress to Date:

Available literature has been assembled and reviewed. Substantial experimentation has been carried out with pine needles exposed to SO_2 in aqueous solution, with results showing effects on photosynthetic pigments, enzyme activity, subcellular particle structures, and hill reaction of isolated chloroplasts.

Also, substantial preliminary data have been gathered on needle function in the field during late growing season conditions in the Whitecourt area (A. Legge).

12. Goals for 1974-75: Nil - new study.

13. Goals for 1975-76:

1. Examine photosynthetic efficiency following exposure to SO_2, using radioactive carbon tracers.

2. Examine the effects of exposure to SO_2 on whole tissue respiration and on amino acid metabolism.

3. Expand field studies of needle function under clean air and SO_2 fumigation conditions (A. Legge).

14. Study Reports and Publications: Nil - new study. (Several in preparation.)

15. Signatures:

Program Manager

S. Malhotra
Study Leader

G. Silver
Director G. T. Silver

ALBERTA OIL SANDS ENVIRONMENTAL

RESEARCH PROGRAM

1975 - 76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: April 1, 1975

1. Project: AOSERP: Effects of SO_2 on vegetation.

2. Sub-Project Title: Ecological benchmarking and biomonitoring for detection of SO_2 effects on vegetation.

3. New: X Cont.: 4. Sub-Project No.: NOR-24-993 (AOSERP No. V18)

5. Study Leader: D. Hocking,

6. Key Words: sulfur dioxide, plants, long-term ecological effects, biomonitoring

7. Location of Work: Alberta oil sands area.

8. Problem:

   Long-term exposure to SO_2, even at sub-symptomatic levels, may exert influences on the composition of plant communities. Early detection of such influences, if any, is desirable as a basis for review of emission standards and controls.

9. Study Objectives:

   1. Develops species sensitivity index for different environmental conditions and sequences (by determining SO_2 injury thresholds).

   2. Locate and inventory suitable vegetation reserve areas in vicinity of oil sands leases; establish permanent benchmark plots.

   3. Establish a biomonitoring network.

10. Resources:

   a. Starting date: 1975
   b. Estimated year of completion: 1980
   c. Estimated total Prof. man-years required: 6.0
   d. Essential new major equipment items for 1975-76: Photographic equipment $600.
   e. Essential new major equipment items beyond 1976 with costs: Nil

   f. 1975-76 man-years

Prof.	1.2	(D. Hocking, 1.0 term)	$18,000
Supp.	1.6	(1 term, .6 casual)	18,000
Total	2.8		$36.000

g. O & M $35,000

11. Progress to Date:

Permanent field plots have been established in 8 selected ecotones in the Fort McMurray area. Photographic documentation of vegetative cover has been collected for 1973 (3 plots) and 1974 (8 plots). Preliminary species inventories and herbarium collections have been made.

12. Goals for 1974-75: Nil - new study.

13. Goals for 1975-76:

    1. Intensify the level of data collection on established sites, to include species densities, numbers and distributions.

    2. In consultation with other AOSERP committees, select further common sites for collection of all data parameters.

14. Study Reports and Publications: Nil - new study.

15. Signatures:

Ron Reid
Program Manager

Drake Hocking
Study Leader

G.T. Silver
Director G. T. Silver

PROJECT NOR - 25

Arctic Islands Terrestrial Environment Project

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1975-76

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 25, 1975

1. Project: Arctic Islands Terrestrial Environment Project.

2. Title: Landform, vegetation and permafrost relationships.

3. New: X Cont.: 4. No.: NOR 989

5. Study Leader: S.C. Zoltai

6. Key Words: Arctic, land use, permafrost, thermal erosion.

7. Location of Work: E. Arctic, Arctic Islands.

8. Problem:

Large scale intensive exploration and development of hydrocarbon resources is currently under way in the Arctic Islands. A large diameter pipeline to deliver these resources to southern markets is being designed by a consortium, the Polar Gas Project. Although the projected pipeline would cross a variety of terrain and vegetation zones from polar deserts to well vegetated tundra, very little is known about the effects of disturbances on the vegetation and permafrost terrain and about the effects of construction across isolated vegetated oases on the wildlife.

In anticipation of development in the Arctic Islands and eastern Arctic mainland, there is a need to develop government expertise in order to evaluate the environmental impact of any proposals. The C.F.S. became involved in the Arctic Islands Project because of the research expertise gained in the western Arctic. Although terrain and climatic conditions are different in the eastern Arctic from the west, the relationships between terrain, vegetation and permafrost remain similar.

The Arctic Island Program is a multidisciplinary study. The C.F.S. component of the program is to identify the relationships between landform, vegetation and permafrost; to identify vegetated areas utilized by wildlife, and to contribute to the evaluation of the sensitivity of terrain to disturbance. Collaborating agencies include Geological Survey of Canada (determining and mapping landforms and geotechnical characteristics of the land); Canadian Wildlife Service (determining important wildlife habitat areas); Soil Survey of Canada (determining near-surface permafrost characteristics).

9. Study Objectives:

a. To determine the relationships between landform, vegetation cover and permafrost, and characterize natural terrain units in terms of vegetation and permafrost characteristics.

b. To contribute to terrain performance evaluation by characterizing natural terrain units in terms of susceptibility to disturbance

c. To identify vegetated areas capable of providing sustenance to wildlife.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1977
c. Estimated total Prof. man-years required: 2
d. Essential new major equipment items for 1975-76 with costs: Nil
e. Essential new major equipment items beyond 1976 with costs: Nil
f. 1975-76 man-years

Prof.	1.0	
Supp.	1.0	
Casual	-	
Total	2.0	O & M funds req'd: $1,500 (C.F.S.)

11. Progress to Date:

The study leader participated in identification of research requirements in the Arctic Islands Program. C.F.S. participation will be Terrestrial Environment Project (TEP-1 and TEP-3), with Ecological Survey as lead agency. The C.F.S. contribution to TEP-4, with Canadian Wildlife Service as lead agency, was also defined.

12. Goals for 1974-75:

N.A. New study.

13. Accomplishments in 1974-75:

N.A. New study.

14. Goals for 1975-76:

1. Initiate and complete field work on Somerset, Prince of Wales and Russel Islands.

2. Prepare interim reports and maps.

3. Contribute to assessment of pipeline proposal, as required.

15. Publications:

N.A. New study.

16. Signatures:

S. C. Zoltai

Investigator

A. L. Ackerman

Program Manager

G.T. Silver

Director G.T. Silver