S T U D Y S T A T E M E N T S

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NORTHERN FOREST RESEARCH CENTRE

CANADIAN FORESTRY SERVICE

MAY, 1975

NOR 026

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 Mortality 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, Yellowknife 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

NOR 058

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.

Wong, H. R. and R. B. Benson. 1965. A new species of *Pristiphora* from Brazil (Tenthredinidae:Hymenoptera). Can. Ent. 97(7):779-782.

Wong, H. R. 1966. A new species of *Allantus* Panzer on birch (Hymenoptera:Tenthredinidae) Can. Ent. 98(8):852-854.

Wong, H. R. 1967. The Nematine genera *Eitelius* and *Micronematus* in North America (Hymenoptera:Tenthredinidae). Can. Ent. 99:1101-1104.

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

Program Manager

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. Signatures:

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:

Investigator
for V. Hildahl

Program Manager

Director G.T. Silver

NOR 114

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:

Investigator

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 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. Study Objectives:

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. Resources:

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. Progress to Date:

See accomplishments for 1974-75.

12. Goals for 1974-75:

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 O_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

Program Manager

G T 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 -
Total 1.7
O & M funds req'd:

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

G. T. Silver
Director G. T. Silver

NOR 978

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 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

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:

Investigator

Program Manager

Director G. T. Silver

NOR 044

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^{o} to 35^{o} 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

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: 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 Galasky
Investigator

R. Reid
Program Manager

G. T. Silver
Director G. T. Silver

NOR 023

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:

Investigator

Program Manager

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. Accomplishments in 1974-75:

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. Goals for 1975-76:

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. Leugers
Investigator

R W Reid
Program Manager

Director

NOR 025

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:

Herbert F Cerezke
Investigator

Program Manager

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.

Goals added in 1974-75

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. Accomplishments in 1974-75:

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. Goals for 1975-76:

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.

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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.

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16. Signatures:

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: 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

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Buckner, C. H. 1964. Metabolism, food capacity and feeding behaviour in four species of shrews. Can. J. Zool. 42:259-279.

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Ives, W.G.H. 1960. Developmental rates of larch sawfly (*Pristiphora erichsonii* (Htg.)). Larvae in an insectary and in field shelters. Can. Ent. 92:668-674.

Ives, W.G.H. 1962. Population and mortality assessment during the egg and larval stages of the larch sawfly, *Pristiphora erichsonii* (Htg.) Can. Ent. 94:256-268.

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Heron, R. J. and J. A. Drouin. 1969. Methods of collecting, rearing and handling the larch sawfly for experimental studies. Information Report MS-X-15 Forest Research Laboratory, Winnipeg, Manitoba.

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Drouin, J. A., D.G.H. Ray and R. Smith. 1965. Annual report of forest research technicians: larch sawfly population dynamics studies, 1964. Interim Research Report, Forest Research Laboratory, Winnipeg, Manitoba.

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1973-74

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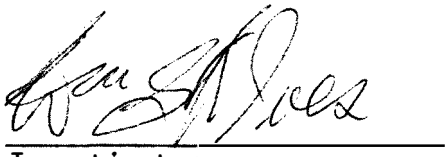
1974-75

Ives, W.G.H. and R. M. Smith. 1975. Larch sawfly population dynamics: Data summaries I Larch sawfly population and mortality estimates and related information. File Report Jan. 1975. 237 pp.

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.

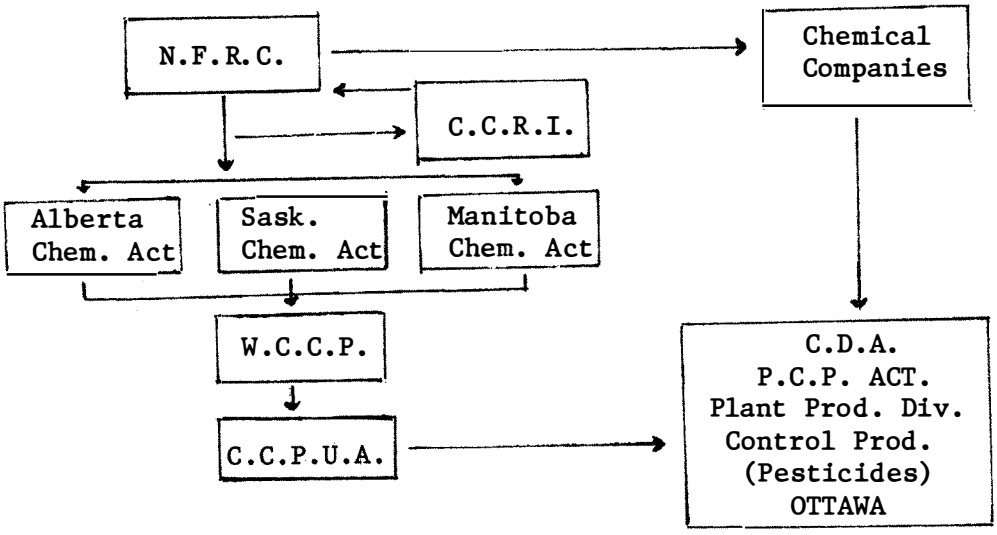
Where controls are not feasible, or economically or biologically justified, such will be reported and included in Canadian Forestry Service control recommendations to the chemical firms.

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	O & 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. Goals for 1975-76:

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:

Investigator

Program Manager

Director G. T. Silver

1974 Field Trials

Drouin - Kusch..MOR132

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	(a) Rt.	(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. alaskansis	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
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

Resmethrin 0.69%				Tetrachlorvinphos 2.5%			
No	Pest	Rt.	%	No	Pest	Rt.	%
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.

No.	Chemicals	Type	%
Malacosoma disstria Hbn			
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

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

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 the 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

G. T. Silver
Director G. T. Silver

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. Accomplishments in 1974-75:

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 Woods 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

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

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: 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

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: 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:

Program Manager

Study Leader

Director G. T. Silver