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

1 9 7 7 - 7 8

NORTHERN FOREST RESEARCH CENTRE

CANADIAN FORESTRY SERVICE

MAY, 1977

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

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-1-026

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 fir, 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 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 1977-78 with costs: Ultra-microtome
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.5	(Y. Hiratsuka)
Supp.	0.7	(P.J. Maruyama)
Casual	-	
Total	1.2	

11. Progress to Date:

1. Distribution, damage, and life cycle of pine stem rusts of the region were investigated and reported in three journal publications.

2. Comprehensive studies of cytology and morphology of pine stem rusts in the region resulted in new method of determining the type of life cycles of pine stem rusts by simple germination technique. This new method has been successfully applied not only in North America but also in Europe and Asia. Thirteen journal publications have been prepared on the related subjects.

3. White spored variety of *Cronartium coleosporioides* was discovered in 1960 in a small area in Banff National Park and annual observations were commenced in 1963. Occurrence of this form and results of the annual observations of canker growth and tree mortality were published in two journal publications.

4. Morphology and life cycle of several conifer needle rusts including *Pucciniastrum sparsum*, *P. goeppertianum* and *P. epilobii* have been studied and results have been reported in six journal publications.

5. Significant amount of information on hyperparasitic fungi and insects on pine stem rusts have been obtained. Five journal publications have been published on the subject.

6. A major publication entitled "Pine stem rusts of Canada" was published. This fully illustrated publication discusses aspects of identification, hosts, distribution, morphology, life cycle, cytology, damage, epidemiology, and control of all pine stem rusts which occur in Canada.

7. Based on the studies of forest tree rusts of the region, terminology of spore states of rust fungi were discussed in two journal publications.

12. Goals for 1976-77:

1. Arrange a rust taxonomy symposium at the Second International Mycological Congress in 1977.

2. Continue morphological and inoculation studies of pine stem rusts especially of *Cronartium ribicola*.

3. Prepare the first draft of the "Check list of Uredinales in Alberta".

4. Give advice to and consult with specialists on taxonomy, nomenclature and cytology of rust fungi especially of forest tree rusts.

5. Cooperate with Dr. S. Sato (Tokyo) to complete morphological and taxonomical study of *Pucciniastrum vaccinii* and *P. goeppertianum*.

6. Try to obtain information of tree rusts in continental China and Siberian region of U.S.S.R., especially of pine stem rusts.

7. Re-survey pine stem rusts plots established by Mr. Baranyay in 1965-68.

13. Accomplishments in 1976-77:

1. Organized a symposium on rust fungus taxonomy for the Second International Mycological Congress to be held in Florida in August 1977. Seven speakers representing six countries have been arranged.

2. Positive infections of *Cronartium ribicola* on previously unknown alternate hosts *Castilleja* and *Pedicularis* have been reconfirmed by inoculation experiments. The results will be important in the revision of taxonomy of pine stem rusts in intercontinental basis.

3. Index cards for all species of rusts reported in Alberta have been prepared for proposed "Check list of Uredinales in Alberta".

4. Gave advise and/or identified rust speciments for scientists including, Kaneko (Japan), Ramachar (India), Hennen (U.S.A.), Davidson (Canada), Mims (U.S.A.), Buristica (Columbia), Sato (Japan), La (Korea), and Savile (Canada).

5. Discussed with Dr. Sato (Tokyo) on the possible journal publication regarding taxonomy of several species of *Pucciniastrum* (see 8).

6. Made contact with Dr. Agbukina (U.S.S.R.) and received some information on the rust fungi of Siberian region of U.S.S.R. Communicated with Mr. Prentice (Ottawa) regarding possible exchange of information on forest diseases expecially on pine stem rusts between Canada and the People's Republic of China as a part of the ongoing scientific exchange program between the two countries.

7. Coordinated and conducted field surveys of pine stem rust study plots which were established by the late Joe Baranyay around 1965. Final re-surveys were made of plots in five different locations in Alberta and N.W.T. Dr. Van Sickle (PFRC) and Dr. Powell (NFRC) also participated in surveys of a few plots. Data has been analyzed by a computer at PFRC and joint publication with Van Sickle and Powell is being planned. Few plots may be considered for future observation.

8. Added Goal: Invited to the 20th Anniversary Meeting of the Mycological Society of Japan and presented a paper entitled "Two species of *Thejiosora* on *Tsuga*" with Dr. S. Sato (Tokyo Univ. of Education, former visiting scientist at NFRC) at the special symposium on species concepts of rust fungi.

9. Added Goal: Contributed significantly to the revision of a mycology textbook entitled "Introductory Mycology" by Alexopoulos and Mims by supplying illustrations and making comments on the text especially on a chapter dealing with the rust fungi.

14. Goals for 1977-78:

1. Present a paper entitled "Morphology of spermogonia and taxonomy of rust fungi" at a symposium on taxonomy and phylogeny of rust fungi at Second International Mycological Congress in Florida in August 1977. Prepare a MS for journal publication on the same subject based on the paper presented at the symposium.

2. Continue inoculation experiments with *Cronartium ribicola* on different alternate hosts.

3. Prepare "Check list of Uredinales in Alberta".

4. Analyse and examine data from inoculation experiments of *Endocronartium harknessii* on five different pine species for for a possible journal publication.

5. Cooperate with Dr. Sato (Tokyo) to organize a journal publication on taxonomy and morphology of several species of *Pucciniastrum*.

6. Try to obtain information and specimens of tree rusts in continental China and Siberian region of U.S.S.R., especially on pine stem rusts.

15. Publications:

Up to 1976-77

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. Rep. 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. 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 fo alpine fir, *Pucciniastrum geoppertianum* and *P. epilobii* in Alberta. Can. J. Bot. 45:1913-1915.

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

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, Alstracts: 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. 1974. 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.

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

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

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

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

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

Hiratsuka, Y. 1975. Recent controversies on the terminology of rust fungi. Rep. Tottari Mycol. Inst. 12:99-104.

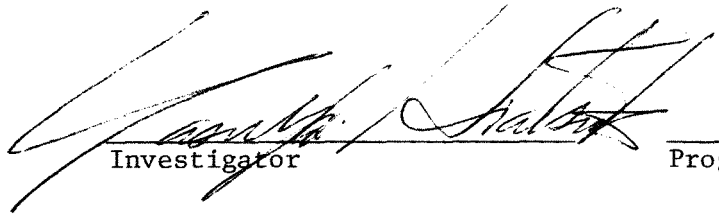
1976-77

Hiratsuka, Y. and J.M. Powell. 1976. Pine stem rusts of Canada. Department of the Environment, Canadian Forestry Service, Forestry Technical Report 4. 106 p.

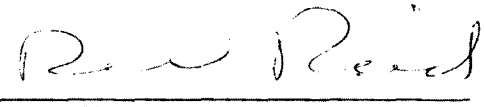
Hiratsuka, Y. and P.J. Maruyama. 1976. *Castilleja miniato*, a new alternate host of *Cronartium riticola*. Pl. Dis. Reptr. 60:241.

Hiratsuka, Y. and S. Sato. 1976. Two species of *Thekopsora* on *Tsuga*. Proceedings of 20th Anniversary Meeting, Mycological Society of Japan, 10-12.

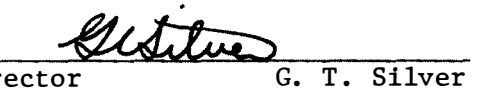
16. Signatures:



Investigator



Program Manager



Director G. T. Silver

NOR-1-033

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

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-1-033

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. 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.

9. Study Objectives:

1. 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.

2. 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 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.3	(W.G.H. Ives)
	0.1	(Y. Hiratsuka)
	0.3	(R.A. Blauel)
Supp.	1.0	(J. Petty)
	1.0	(V.B. Patterson)
	1.0	(F.J. Emond)
	1.0	(R.M. Caltrell)
	1.0	(A.E. Campbell)
	1.0	(G.N. Still)
	1.0	(R.C. Tidsbury)
Casual	-	
Total	7.7	

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.

12. Goals for 1976-77:

1. In the summer of 1976, 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. Two men will be stationed in Edmonton, and will engage in similar activities in Alberta. Two men will be assigned to special tasks as the needs arise, and will assist Prince Albert and Edmonton extension officers during peak work loads.

2. Provide a field diagnostic and pest extension service to client agencies and the public concerning the cause and control of problems of trees and shrubs attributable to insects, diseases and pollutants. When positive identification of the cause is impossible in the field, specimens will be referred to specialists--Study NOR-1-154 for insects, NOR-1-153 for diseases and other specialists as required.

3. Monitor known outbreaks of defoliating insects as required: forest tent caterpillar in the three Prairie Provinces; eastern spruce budworm in Manitoba and northern Alberta; jack pine budworm in southeastern Manitoba; and fall cankerworm along the Red and Assiniboine rivers in Manitoba.

4. Limited detection surveys will be conducted in Manitoba, particularly in parks and high-value fibre producing areas.

5. Training seminars or courses will continue to 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.

6. Available information on insect and disease pests will be collated into an annual report outlining known pest problems in the region.

7. A limited number of photographs of insect and disease pests will be taken, to complete the illustrations for the brochures being prepared. Assistance will also be given in searching the literature when required.

8. A pre-season forecast of anticipated insect and disease problems for the summer of 1976 will be made.

9. Conduct limited detection surveys of *Scleroderris* canker and Dutch elm disease in Saskatchewan, Alberta and adjacent areas of B.C. A note will be prepared for publication on the added distribution of *Scleroderris* canker in Alberta and B.C. with Dr. Funk (PFRC). (Hiratsuka).

10. Limited evaluations of suspect pollution damage will be made when the situation warrants such action.

    Possible areas are: Flin Flon and Prince Albert.

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

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

    Survey of a Forest Community near a Cement Production Industry.

12. An advisory service concerning the impact of air and landspill pollutants on forest ecosystems will be provided (Blauel).

13. Accomplishments in 1976-77:

    1 & 2. Extension work was conducted out of Winnipeg, Prince Albert and Edmonton. About 255 calls were handled in Winnipeg, 628 in Prince Albert and 1240 in Edmonton. Some of these inquiries could be answered on the basis of submitted samples, but many required on site inspections to determine the nature of the problem.

    3. A number of surveys to monitor known outbreaks were conducted in 1976:

        a) Forest tent caterpillar - Aerial and ground surveys were carried out in Manitoba, Saskatchewan and Alberta to monitor extent and severity;

        b) Jack pine budworm - Aerial and ground surveys were conducted in Manitoba, ground surveys in Saskatchewan.

c) Spruce budworm - Ground and aerial surveys were conducted in Manitoba. H. Cerezke conducted surveys in the Ft. McMurray area of Alberta.

d) Fall canker worm - Limited ground surveys were conducted in Manitoba and Saskatchewan.

4. General detection surveys in Manitoba were less extensive than in 1975, due to the pressure of other work. An aerial survey along the Manitoba-Ontario border was made at the request of Sault Ste. Marie (mostly for spruce budworm and forest tent caterpillar) and a report submitted.

5. A number of training seminars were given to staff of other agencies as follows: Alberta 15; Saskatchewan 1, Manitoba 2.

6. Available information on known pest conditions in 1976 is currently being collated.

7. Additional photos of insect and disease organisms were obtained.

8. A pre-season forecast of anticipated insect and disease problems was prepared.

9. Surveys of *Scleroderris* canker have been conducted at several locations in Jasper National Park, Hinton area and adjacent parts of B.C. but the disease was not found in new locations except wider areas in the original site in Jasper National Park. Together with information on two isolated incidences in B.C., a note has been published with Dr. Funk (PFRC). Dutch elm surveys have been conducted on three different occasions in Saskatchewan with negative results.

10. Several limited evaluations were made of suspect pollutant damage situations. These evaluations benefited the agencies making the inquiry but also served to broaden the knowledge of NFRC staff. Among these were:

a) Establishment of five permanent vegetative response and soil plots around the Prince Albert Pulp Mill to allow continued evaluation of the forest condition.

b) A follow up field evaluation of the catalyst disposal method at the Hudson Bay Brazeau Gas plant. Soil toxicity and tree foliar accumulation aspects were examined.

c) Examination of vegetative impacts resultant from an anhydrous amonia release near Milk River, Alberta.

d) Field evaluation of vegetation and soils subjected to salt water releases in the Medicine Hate and Silver Creek areas of Alberta.

e) Field survey of forest impacts resultant from a sour gas well blowout and fire near Windfall Alberta.

f) Evaluation of four sites in the vicinity of the Exshaw cement plant to determine possible soil contaminations.

Other short examination were made of limited stress situations including small oil and gas release incidents, salt water spills and residential ornamental tree and soil contamination problems. Brief file reports on the field aspects of these evaluations are completed.

Regarding the review of the Environmental Code for the proposed Mackenzie Valley Gas Pipeline the following were conducted and completed:

A general review of fourteen relevant documents and reports providing background to the environmental code development; Detailed review and written comment on two initial draft copies of the environmental code; Participation in the Mackenzie Valley Environmental Code workshop where each section of the document was examined and discussed on a line review basis and where review comments were consolidated and integrated into draft copy; and finally a review was made of the complete draft consolidation.

11. The reports entitled "Forest Conditions as Benchmarked in the Alberta Oil Sands Area prior to 1976 by Northern Forest Research Centre" and "Survey of a forest community near a cement production industry" were completed.

12. An advisory Service concerning the impact of air and landspill pollutants on forest ecosystems was provided.

During 1976-77 the following advisory services were provided:

a) The planning of a forest environmental impact assessment of a crude oil spray incident near Sturgeon Lake, Alberta - for Alberta Forest Service.

b) Review and discussion of forest impact assessment relevant to the natural gas processing industry in Alberta - for Alberta Energy Resources Conservation Board.

c) Advice concerning the evaluation and reclamation of salt spill and condensate release effected forest areas - for Environment coordinators of Amoco Canada Ltd. and Alberta Gas Trunk Pipeline Co. Ltd.

d) Provision of forest impact assessment procedures and possible amelioration processes regarding oil and gas well blowouts and flow backs - for Shultz International Ltd. and Epec Consulting Western Ltd.

e) Organization and provision of materials on forest pollutant problems for use in the Advanced Land Use Course at the Hinton Forest Training School (Alberta Forest Service).

14. Goals for 1977-78

1. In 1977, two men will be stationed in Winnipeg (one for summer months only) to handle extension calls and to conduct special 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. Two men will be stationed in Edmonton, and will engage in similar activities in Alberta. One man will be assigned to special tasks as the needs arise, and will assist Prince Albert and Edmonton extension officers during peak work loads.

2. Provide a field diagnostic and pest extension service to client agencies and the public concerning the cause and control of problems of trees and shrubs attributable to insects, diseases and pollutants. When positive identification of the cause is impossible in the field, specimens will be referred to specialists --Study NOR-1-154 for insects, NOR-1-153 for diseases and other specialists as required.

3. Monitor known outbreaks of defoliating insects as required: Forest tent caterpillar in the three Prairie Provinces; eastern spruce budworm in Manitoba and northern Alberta; jack pine budworm in southeastern Manitoba and central Saskatchewan; and fall cankerworm along the Red and Assiniboine rivers in Manitoba and in eastern Saskatchewan.

4. Limited detection surveys will be conducted in Manitoba and Alberta, particularly in parks and high-value fibre producing areas.

5. Training seminars or courses will continue to 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.

6. Available information on insect and disease pests will be collated into an annual report outlining known pest problems in the region.

7. Conduct limited survyes of *Scleroderris* canker in Alberta and adjacent areas of B.C. (Hiratsuka).

8. Conduct limited surveys of Dutch elm disease in Saskatchewan and Alberta. Coordinate and contribute to DED advisory committee in Saskatchewan which is headed by Dr. Duczek (Saskatchewan Agriculture). (Hiratsuka).

9. Limited evaluations of suspect pollution damage will be made when the situation warrants such action (Blauel).

10. An advisory service concerning the impact of air and landspill pollutants on forest ecosystems will be provided (Blauel).

15. Publications:

Up to 1976-77

Anon. 1975. Guidelines for the environmental assessment of the proposed Mackenzie Delta development. File report by the Mackenzie Delta Working Group.

Blauel, R.A. 1974. Survey field problem definition regarding forest pollutant occurrences. File Report.

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

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.

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

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

Blauel, R.A. 1975. Guildelines for the Mackenzie Delta gas development system. A first draft. File Report.

Blauel, R.A. and G.L. Lesko. 1975. Condensate release impacts on a forest area. *In:* Proceedings on "conference on the environmental effects of oil and salt water spills on land". November 1975. 229-239 pp.

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

Drouin, J.A. and H.R. Wong. 1975. Biology, damage and chemical control of the poplar borer (*Saperda calcarata*) in the junction of the root and stem of balsam poplar in western Canada. Can. J. For. Res. 5:433-439.

Edwards, I.K. and R.A. Blauel. 1975. Effects of salt water spills on forested land. *In:* Proceedings on the "conference on the environmental effects of oil and salt water spills on land". November, 1975. 38-80 pp.

Edmond, F.J. *et al.* 1974. Forest insects and diseases in eight western Canadian parks, 1973. 17 p. NOR-X-90.

Edmond, F.J. and G.N. Still. 1974. Forest insect and disease conditions in Manitoba provincial parks, 1973. 17 p. NOR-X-91.

Gautreau, E.J. and J.C.E. Melvin. 1974. Forest insects collected in Waterton National Park, 1948-1971. NOR-X-120.

Gautreau, E.J. and J.C.E. Melvin. 1974. Forest insects collected in Kananaskis Forest Experiment Area, 1948-1971. NOR-X-88.

Hocking, D. 1974. Preliminary survey of the forest condition near the Transmountain Pipeline Pumping Station. File Report.

Hocking, D. 1974. Effects on the forest of sulphur dioxide from a sulphur fire near Edson, Alberta. NOR-X-139.

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. File Report.

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

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. Appendix to NOR-X-115.

Ives, W.G.H., J.J. Lawrence and J.K. Robins. 1974. Important forest insects and diseases (in the) Prairies Region. *In:* Forest insect and disease survey annual report, 1973. 70-77 pp.

Ives, W.G.H., J.J. Lawrence, J. Petty and J.K. Robins. 1975. Important forest insects and diseases in the Prairies Region. *In:* Forest insect and disease survey annual report, 1974. Forestry Service, Environment Canada. 75-81 pp.

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

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

Patterson, V.B. *et al.* 1974. Forest insect and disease conditions in Alberta Provincial Parks, 1973. 14 pp. NOR-X-93.

Patterson, V.B. *et al.* 1975. Annual district reports: Forest insect and disease survey, Prairies Region, 1974. NOR-X-125.

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.

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

Robins, J.K. *et al.* 1974. Annual district reports: Forest insect and disease survey, Prairie Region, 1973. 55 pp. NOR-X-73.

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

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

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 M.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.

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.

1976-77

Anon. 1976. Draft of an Environmental Code for the proposed Mackenzie Valley Pipeline. September, 1976. File Report. Environment Canada Working Group.

Blauel, R.A. 1976. Review of the initial drafts of the proposed Mackenzie Valley Pipeline Environment Code. June, 1976. File Report.

Blauel, R.A. 1976. Appendum: Comments on the revised draft of the proposed Mackenzie Valley Pipeline Environ. Code. August, 1976. File Report.

Blauel, R.A. 1976. Examination of forest vegetation for impacts from emergency flaring procedures. File Report.

Blauel, R.A. 1976. Forest vegetation and soil survey Flin Flon, Manitoba. File Report.

Blauel, R.A. and D. Hocking. 1977. Forest conditions as benchmarked in the Alberta Oil Sands Area prior to 1976 by Northern Forest Research Centre. File Report.

Blauel, R.A. 1977. Survey of a forest community near a cement production industry. File Report.

Hiratsuka, Y. and A. Funk. 1976. Additional records of *Gremmeniella abietina* in western Canada. Pl. Dis. Reptr. 60:631.

Hocking, D. and R.A. Blauel. 1976. Progressive heavy metal accumulation associated with forest decline near the nickel smelter at Thompson, Manitoba. Information Report. NOR-X-160.

Ives, W.G.H., and J. Petty. Important forest insect and diseases (in the) Prairies Region. *In:* Forest insect and disease survey annual report, 1975. Forestry Service, Environment Canada (In press).

Petty, J. *et al.* 1975. Annual district reports, forest insect and disease survey, Prairies Region, 1975. NOR-X-154. 30 pp.

16. Signatures:

Investigator

Investigator

Investigator

Program Manager

Investigator

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977-78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

1. Project: Detection and appraisal of tree pests.

2. Title: Sawfly systematics

3. New: Cont.: X 4. No.: NOR-1-058

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:

Sawflies cause destructive damage to forest and shade trees in 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 only one of two people 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:

1. 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.

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

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

4. 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 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.5
Supp.	0.0
Casual	0.0
Total	0.5

11. Progress to Date:

Twenty seven scientific papers have been published in this study. The subject matter and the species or genera treated are indicated in the list of publications.

12. Goals for 1976-77:

1. Publish: American species of *Pristiphora* south of the United States. Journal. *Pristiphora* species of southeast Asia (Hymenoptera: Tenthredinidae). Journal.

2. Determine the life history of a willow shoot-boring sawfly, *Euura atra* (Jurine) in Alberta.

3. Identify sawflies for research personnel, institutions, laboratories and the Canadian National Collection.

13. Accomplishments in 1976-77:

1. 1. Results published in Ann. Ent. Soc. Am.
   2. Results in press in Can. Ent.

2. Results in press in Tree Plant Notes.

3. Identified nearly 400 sawflies for the Forest Insect and Disease Survey of the Northern Forest Research Centre, Canadian National Collection, U.S. National Museum, Ishikawa Agricultural College, Japan and California Academy of Sciences.

14. Goals for 1977-78:

1. Publish: *Fallocampus*:A new sawfly genus for the Nearctic species of *Platycampus* Schiødte(Hymenoptera: Tenthredinidae). Journal.

2. Determine the distribution and parasites of a willow shoot-boring sawfly in Alberta through field collection and rearings.

3. Identify sawflies for research personnel, institutions, laboratories and the Canadian National Collection.

15. Publications:

Up to 1976-77

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* Schiødte 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): 193-198.

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 (Hymenoptera: 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.

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.

Wong, H.R. 1975. The *abietina* group of *Pristiphora* (Hymenoptera: Tenthredinidae. Can. Ent. 107:451-463.

Wong, H.R. 1976. American species of *Pristiphora* south of the United States. Ann. Ent. Soc. Am. 69(3):525-526.

Wong, H.R. 1976. Chinese species of *Pristiphora* and their relationship to Palaearctic and Nearctic species (Hymenoptera: Tenthredinidae). Can. Ent. 109: (101-106)

Wong, H.R., J.C.E. Melvin and J.A. Drouin. 1976. Damage by a willow shoot-boring sawfly in Alberta. Tree Plant Notes 27: (In press)

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

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-1-089

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: 1978
c. Estimated total Prof. man-years required:
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years Prof. 0.3 (W.G.H. Ives).
Supp. -
Casual -
Total 0.3

11. Progress to Date:

Data have been placed on magnetic tape, edited and upgraded where necessary. These data include the FIDS historic file (for Manitoba and Saskatchewan) and ancillary data on weather, and infestation records and percentage parasitism for major defoliators.

A program has been developed by programmers in Ottawa that will provide preliminary data summaries for all variables. A test run has been made and this is currently being checked for accuracy.

12. Goals for 1976-77:

1. Complete the checking of test data, and have necessary corrections made to any errors in the program.

2. Obtain printouts of appropriate data summaries for 12 of the more common insects (there are 25 in all).

3. If Ottawa's funding permits, obtain additional printouts summarizing available data for the other 13 species.

4. Begin preliminary examination of the data to determine if any meaningful interrelationships can be detected.

13. Accomplishments in 1976-77:

1. Test data were checked and necessary changes in programs were made.

2 & 3. Data for all 25 species were summarized, except for 1948-50, which require a separate listing, currently underway.

4. Examination of the data is underway, but it is too soon to determine if any trends are evident.

14. Goals for 1977-78:

1. Continue examination of the data to determine if any meaningful interrelationships can be detected.

2. Moisture deficiencies and/or fire hazard ratings for a number of selected stations will be examined to determine if there are any relationships between drought conditions (or the lack of them) and insect population trends.

15. Publications:

Up to 1976-77:

Ives, W.G.H. 1973. Heat units and outbreaks of the forest tent caterpillar, *Malacosoma disstria (Lepidoptera:Lasiocampidae)*. Can. Ent. 105:529-543.

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

1976-77

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

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

2. Title: Dutch Elm disease detection and diagnosis.

3. New: Cont.: X 4. No.: NOR-1-110

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:

The Dutch elm disease is a fatal disease of native and planted American elm. It is transmitted from diseased to healthy trees mainly by bark beetles. The causal fungus (*Ceratocystis ulmi*) was first found in North America in Ohio in 1930. Since then it has spread north and eastward into Canada from Ontario to the Maritime Provinces and westward in the United States to Idaho, Washington and California. During the past 45 years, the disease has affected more than 80 per cent of the natural range of American elm in North America and has spread to parts of the continent where the host tree occurs only as ornamental or shelterbelt plantings.

In 1975, the pathogen was isolated from American elm at three locations in Manitoba, namely Winnipeg, Selkirk and Brandon. The expansion of the disease to Manitoba is of great importance, espeically to many urban centres in southern part of the Prairie Provinces where American elm has been used extensively (and in some cases almost exclusively) for boulevard and ornamental purposes.

Benefits of Study:

Major benefits of the study will be to reduce the impact of the disease in outbreak areas, thus maintaining the aesthetic values and pleasant environments associated with natural stands and plantings of American elms. In many urban centres and park areas throughout the prairie region American elm represents up to 80 per cent of the tree cover.

Probability of Success:

Now that the disease is present, the probability exists that within the next few years it may spread to most parts of the southern prairie regions where elms occur. Early detection and diagnosis followed by proper recommended sanitation procedures are important factors in controlling Dutch elm disease. In areas where these practices have been emphasized elm losses have been reduced by 1-5 per cent per year as compared to 16-60 per cent where sanitation measures have not been carried out.

9. Study Objectives:

The objectives of the study are primarily: 1) to carry out systematic detection and diagnostic services leading to early discovery of diseased trees or localized outbreaks of the Dutch elm disease in the Manitoba region; and 2) to provide technical advice, guidance and assistance to provincial, municipal and urban governments with respect to sanitation and chemical control procedures.

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 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years:

Prof.	-
Supp.	-
Casual	-
Total	-

11. Progress to Date:

Since 1970, elm disease investigations in Manitoba have involved ground and aerial reconnaissance. Detection surveys have been concentrated along river valleys, and in urban centres and rural areas where major concentrations of American elm occur. Since the study was initiated more than 9,000 suspect elms (trees with

characteristic external symptoms--flagging, dead branches or dieback in the crown) have been sampled. Laboratory diagnosis of material from the sample trees has indicated widespread but fluctuating infections of Fusarium, Verticillium and cephalosporium wilts.

Aerial photography using infrared and color films was carried out in 1973 along the Red River as an aid to early detection of elm disease, 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 a 12" lens. The aerial photography was carried out by the Remote Sensing Group, Northern Forest Research Centre.

12. Goals for 1976-77:

1. Continue detection (aerial and ground) surveys throughout areas of concern in southern Manitoba, and provide diagnostic services to 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.

13. Accomplishments in 1976-77:

1. Dutch elm disease detection and diagnostic services were intensified. Twelve summer students (8 by the Manitoba Department of Agriculture, 2 by the Manitoba Parks Branch and 2 by the City of Winnipeg involving 167 man-weeks) were provided to supplement the previous year's program. Direction and supervision of the students was provided by the Canadian Forestry Service.

   Field investigations indicated a significant increase in the incidence of Dutch elm disease in the previously recorded outbreaks at Selkirk, Brandon and in Winnipeg. In addition new localized outbreaks were recorded along the Brokenhead River, along the southeastern and southwestern shores of Lake Winnipeg, and west of Winnipeg in the Headingley Jail Forest. Approximately 2,500 suspect trees were sampled in these areas, of which 885 or 35% showed evidence of Dutch disease infection.

2. Technical advisory services to cooperating agencies, especially the Manitoba Department of Agriculture and the City of Winnipeg, were continued.

3. The proposed Information Report "Elm Diseases in Manitoba" was not completed.

4. Added accomplishment in 1976: A one-day workshop on Dutch Elm Disease sponsored by the Canadian Forestry Service was held in Winnipeg on March 3, 1976. The workshop was attended by close to 100 delegates from Manitoba, Saskatchewan and Alberta.

14. Goals for 1977-78:

1. The work in this study has been transferred to NOR-17-068.

2. Study NOR-1-110 is terminated.

15. Publications:

Steneker, G. A. et al. 1976. Summary of Papers Presented at Workshop on Dutch Elm Disease. Nor. For. Res. Cen., Env. Can., Edmonton, Alta.

16. Signatures:

W. Johnson for V. Heldebrik
Investigator

W. Johnson
Program Manager

Regional Director

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977-78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

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

2. Title: Forest diseases: Diagnostic and taxonomic services.

3. New: X 4. No.: NOR-1-153

5. Study Leader: Y. Hiratsuka

6. Key words: mycology, herbarium, culture collection, nomenclature identification,

7. Location of work:

8. Problem:

Accurate and prompt diagnosis of tree diseases and identification of causal organisms are essential to the pest extension services, damage appraisal studies, environmental assessment studies, and consideration of possible control measures of tree diseases. Besides, non pathogenic fungi in forest ecosystems also play important roles in nature. Proper identifications of mycorrhizal fungi, decomposing fungi and hyperparasitic fungi in the forest are important to many research studies and provide better understanding of forest ecosystems.

Taxonomy and nomenclature of fungi are constantly being revised. Changes in the concepts and limits of species and application of new or different names for the same organisms often cause confusion. Proper applications of up-to-date information of taxonomy and nomenclature are necessary whenever names of the organisms are used in reports or publications. To provide satisfactory taxonomic and nomenclatural service, a highly trained technical and professional. staff is required.

To maintain and improve diagnostic and taxonomic service capabilities, it is necessary to maintain a high quality disease reference collection, a fungus culture collection and a reference literature collection. The disease reference collection of the centre contains more than 20,000 catalogued specimens of forest fungi and it is the

biggest collection of forest fungi in the prairie provinces. The fungus culture collection includes more than 500 live cultures of major forest fungi. The centre maintains all major taxonomic literatures of the fungi.

9. Study Objectives:

1. To provide diagnostic and taxonomic service of tree diseases and other forest fungi.

2. To maintain and improve diagnostic and taxonomic service capabilities of tree disease pathogens and other forest fungi in the region.

3. To prepare check lists of forest fungi of important areas (e.g. national parks, provincial parks, etc.), diagnostic keys for identification, and other related publications.

10. Resources:

a. Study date: 1976 (Included as a part of NOR-1-033 until 1975-76).
b. Estimated year of completion: Continuous.
c. Estimated total Prof. man years required:
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.4
Supp.	0.3
Casual	Nil
Total	0.7

11. Progress to Date:

Reported as a part of NOR-1-033.

12. Goals for 1976-77:

1. Provide tree disease diagnostic and identification service. Diagnostic and identification service will be provided mainly for the general public and outside agencies through pest extension service.

2. Maintain and upgrade the Mycological Herbarium. Exchange of specimens will be arranged with several institutions.

3. Complete the reorganization of fungus culture collection.

4. Make taxonomic investigation of a possible new fungus (*Marssonina* sp.) on balsam poplar. A short journal publication describing the fungus will be prepared if the fungus is new.

5. Complete check lists of forest fungi collected in Prince Albert and Elk Island National Parks.

6. "Annotated check list of diseases of trees and shrubs of the prairie provinces" will be completed for information report.

7. Make significant progress towards the publication of an information publication on diseases of trees and shrubs of the prairie provinces.

13. Accomplishements in 1976-77:

1. Diagnostic and identification service of forest tree diseases was provided to outside agencies and to the general public through pest extension service. About 200 samples were identified by microscopic examinations and by cultural isolation technique.

2. About 100 new specimens have been added to the Mycological Herbarium and disease specimens were exchanged with several institutions including, Biosystematics Research Institute, Ottawa; Tottori Mycological Institute, Japan; Purdue University, Indiana; and Tokyo University of Education, Japan.

3. Reorganization of fungus culture collection is completed and several new cultures were added to the collection.

4. First draft of a journal publication entitled "A new leaf spot fungus *Marssonina balsamiferae* n. sp. on *Populus balsamiferae*" is prepared.

5. Due to prolonged illness of the senior mycological technician, check lists of forest fungi collected in Prince Albert and Elk Island National Parks were not prepared.

6. An information report "Annotated check list of diseases of trees and shrubs of the prairie provinces" is in theprocess of review.

7. Prepared a significant amount of plates of illustrations and wrote rough drafts of text of about 30 of 53 selected diseases or disease groups for the proposed major information publication on the diseases of trees and shrubs of the prairie region.

Accomplishements not in Goals in 1976-77:

8. Served as a member of the study committee of the International Mycological Association on fungus nomenclature and contributed to the revision of a section of the "International Code of Botanical Nomenclature".

9. Cooperated with Dr. S. Takai (G.L.F.R.C.) to study morphology and morphogenesis of synnemata of *Ceratocystis ulmi* using scanning electron microscope. Many excellent electron micrographs were obtained and several journal publications have been planned.

14. Goals for 1977-78:

1. Tree disease diagnostic and identification service will be provided for the outside agencies and for general public through pest extension service.

2. Maintain and upgrade the Mycological Herbarium and the Fungus Culture Collection.

3. Publish a journal publication "A new leaf spot fungus *Marssonina balsamiferae* n. sp. on *Populus balsamiferae* in Manitoba and Ontario.

4. Publish an information report "Annotated check list of diseases of trees and shrubs of the prairie provinces".

5. First draft of an information publication on diseases of trees and shrubs of the prairie provinces will be completed. Photographs will be taken to complete plates of illustrations for the publication.

6. Cooperate with Drs. Ayer and Browne (Chemistry Department, University of Alberta) for the study of fungus metabolites (antibiotics, toxins, etc.) by providing cultures of selected forest fungi from the culture collection and doing some biological assays.

15. Publication:

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977-78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 25, 1977

1. Project: Detection and appraisal of tree pests.

2. Title: Forest Insect Diagnostic and Biosystematic Services

3. New: Cont.: X 4. No.: NOR-1-154

5. Study Leader: H.R. Wong

6. Key Words: Insects, larvae, damage, hosts, parasites, biological control, galls, seasonal occurrence, distribution, nomenclature, taxonomy, identification, reference collection, insectary, life history.

7. Location of Work: Edmonton, Alberta

8. Problem:

Insects play a very important role in the forest ecosystem. They attack every part and stage of living and harvested trees. Prompt and accurate identification of the adult and larval stages is necessary to determine the economic status of the different species, kind and type of chemical or biological control necessary to combat them and the best time of application. A reference collection of mature and immature insects, which is an essential prerequisite to diagnostic and biosystematic work, must be maintained and upgraded each year.

Since most of the damage is caused by the immature stages and insect identification is based mainly on the adult stage, a rearing program is a necessity. The rearing program not only provides adults for the identification of the larvae, but also information on seasonal occurrence, hosts, parasites and diseases. It also supplies material for the adult and larval reference collections.

Difficulties are often encountered in diagnosing sibling species or those closely resembling one another either in the adult or larval stages. Life history studies are initiated when the

opportunity arise to gain biological information, which will assist in separating these and other species in Central Canada. The success of the diagnostic and biosystematic services are excellent provided experienced personnel, good insect reference collections (adults, larvae and damage) and major taxonomic literature are available. Considerable time must be devoted to keeping abreast of the latest entomological literature and changes in nomenclature. To facilitate prompt and accurate diagnosis, keys must be devised not only to the adult and immature forms, but also to insect damage in the Canadian Prairies.

The material is provided by personnel of the Forest Insect and Disease Survey and by the investigator. The immature insects are reared in the laboratory at Edmonton and in the field. The adults obtained are submitted to specialists in Ottawa or elsewhere in North America or Europe for identification and the latest nomenclature. All adults identified by specialists and larvae and damage associated with these adults are placed in the reference collection.

9. Study Objectives:

1. Provide diagnostic and biosystematic services to clients, in-service personnel, outside agencies and scientists engaged in biological and taxonomic research on insects.

2. Maintain and improve the regional collection of insects and mites.

3. When the opportunity arise, initiate biological and ethological studies to improve the diagnostic and biosystematic services.

10. Resources:

a. Starting date: 1976
b. Estimated year of completion: A continuing project. Revised.
c. Estimated total Prof. man-years required: Indefinite.
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.5	
Supp.	1.0	J.C. Melvin
Casual	0.0	
Total	1.5	

11. Progress to date:

Recorded formerly in NOR-1-033

12. Goals for 1976-77:

1. Provide diagnostic and biosystematic services.

2. Maintain and improve regional reference collection of insects and mites.

3. Provide information and specimens to scientists engaged in taxonomic and biological studies.

4. Publish: Biological observations and larval descriptions of *Enargia decolor* on trembling aspen in northern Alberta (Lepidoptera: Noctuidae). Journal.

13. Accomplishments in 1976-77:

1. 1. Diagnostic and biosystematic services made several thousand determinations and handled over 1000 inquiries for in-service personnel, clients, outside agencies, scientists and Dr. J.E. Guthrie, Whiteshell Nuclear Research Establishment, Pinawa, Man. (110 samples)

2. About 150 dead immature insects were examined to determine infectious diseases, and about 20 samples sent to specialists at Sault Ste Marie, Ontario for study.

2. 1. Amalgamated the insect orders, Coleoptera, Hymenoptera and Hemiptera from the old Winnipeg and Calgary collections.

2. Nearly 2000 insects were added to the reference collection. Most of these were identified by specialists in Ottawa, Ontario.

3. Over 500 insect samples were reared and 300 overwintered to obtain biological information and specimens for the reference collection.

4. Over 2000 insect specimens were pinned, spread, labelled or preserved for the reference or store collections.

3. Biological information and (or) specimens were provided to the following:

Dr. William Miller, U.S.D.A. St. Paul, Minnesota
Mr. M. Ivanochko, C.N.C. Ottawa, Ontario
Dr. David R. Smith, U.S. Nat. Museum, Washington, D.C.
Mr. P.J. Martinat, Michigan State University E. Lansings, Michigan.
Dr. H.H. Neunzig, North Carolina State Uni., Raleigh, N.C.
Mr. M.W. MacGowan, Mississippi State Uni., Starkville, Miss.
Dr. M.W. Hauseweart, Uni. of Minnesota, St. Paul, Minnesota

4. Published: Wong, H.R. and J.C.E. Melvin. 1976. Biological observations and larval descriptions of *Enargia decolor* (Lepidoptera: Noctuidae) on trembling aspen in Northern Alberta. Can. Ent. 108:1213-1220

14. Goals for 1977-78:

1. Provide diagnostic and biosystematic services for the more difficult determinations on mature and immature insects damaging forest and shade trees.

2. Maintain and improve regional reference collection of insects and mites.

3. Provide information and specimens to scientists engaged in taxonomic and biological studies.

4. Complete revision of the Information Report: some of the more common galls and abnormal plant growths caused by insects and mites in the forested areas of Manitoba and Saskatchewan in collaboration with Dr. A.M. Harper, Agriculture Canada, Research Branch, Lethbridge Alberta.

15. Publications:

Up to 1976-77

Recorded formerly in NOR-1-033

1976-77

Wong, H.R. and J.C.E. Melvin. 1976. Biological observations and larval descriptions of *Enargia decolor* (Lepidoptera: Noctuidae) on trembling aspen in northern Alberta. Can. Ent. 108:1213-1220.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-7-114

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 21, 1977

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-7-114

5. Study Leader: R. A. Blauel, S. S. Malhotra, and J. Baker

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:

1. Develop and apply methods for measurement of air-borne pollutants released from various sources as they are removed from the atmosphere by settlement, by precipitation and by assimilation. (Blauel, Baker).

2. Describe vegetative sympton development resulting from known amounts of single and combined atmospheric industrial effluents, the sequence in which they are produced and develop diagnostic techniques based on these findings. (Malhotra)

3. Discern air pollutant injury thresholds and develop a species sensitivity index for different environmental conditions. (Blauel)

4. Test the Federal Air Quality objectives for air quality under defined environmental conditions. (Blauel)

10. Resources:

a. Starting date: 1971
b. Estimated year of completion: Revised: 1980
c. Estimated total Prof. man-years required: 2.8
d. Essential new major equipment items for 1977-78 with costs:
Ultraviolet Dual Wavelength Flow through photometer - $3,000
Analytical balance (semi-micro and micro) - $4,000
Fumigation chamber (also required for Studies NOR-24-990, 991, 992 and 993)
e. Essential new major equipment items beyond 1978 with costs: Nil

f. 1977-78 man-years

Prof.	0.2	(S. Malhotra)
	0.2	(P. Addison
	0.5	(R. Blauel)
	0.2	(J. Baker)
Supp.	0.3	(J. Shuya)
	0.2	(J. Ridgway)
	0.4	(O. Fenn)
Total	2.0	

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.

Industry-government workshops have been sponsored.

Permanent sample plots have been located and vegetation described in vicinity of gas processing plants and oil sands processing plants; including plume impingement areas.

Survey on the effect of air pollutants from industrial operations (Thompson, Man.; Flin Flon, Man. and Prince Albert, Sask.) on forest vegetation and soils were conducted in response to requests from various Provincial Government Agencies.

Reference collections of slides, photographs and specimens have been sorted and catalogued.

12. Goals for 1976-77:

1. Set up and calibrate the siemens microchamber and run preliminary fumigation trials (Co-ordinated with Study 990). (Blauel and Malhotra)

2. Set up and calibrate the "pollution fumigation chamber". (Blauel and Malhotra)

3. Clear backlog of soil and vegetation samples collected from Thompson, Flin Flon, Hinton and Prince Albert areas and report the findings (Co-ordinated with Study 990). (Blauel, Baker and Malhotra)

4. Complete the color handbooks on symptomology for regional forest species exposed to air pollutants designed for use in the field. (Blauel)

13. Accomplishments in 1976-77:

1. The microchamber and preliminary fumigation trial runs were completed. Procedures and techniques were developed to document the type and sequence of visual symptoms produced by jack pine and white birch in response to sulphur dioxide fumigations.

2. Due to the non-delivery of the "pollution fumigation chamber" these goals are moved to 1977-78.

3. The backlog of soil and vegetation samples collected from the Thompson, Flin Flon, Hinton and Prince Albert areas were analysed and reports were written on the findings.

   Re Thompson: Reports and other documentations were submitted, and verbal presentations were made in the Manitoba Municipal Board Hearings regarding International Nickel Co. - Thompson Smelter aerial emissions. Also, a review was conducted of the International Nickel Co. (F.F. Slaney) Environmental Design proposal concerning ecosystem evaluation around the Thompson Smelter operations. A workshop on the proposal was attended and recommendations were made.

Re Flin Flon: The preliminary field survey and laboratory analysis of samples was conducted to benchmark forest soil and vegetation conditions in the Flin Flon area. An inverse gradient of zinc, copper and other heavy metal accumulations in soil and vegetation occurred distally from the smelter site. High accumulations were found on soil surface and vegetation targets to some 10 km distance from the smelter. High levels of heavy metal contaminates were found in the mineral soil at 5 km and closer distances. The native vegetation within most of the area 5 km from the smelter has suffered severe deterioration. Lichen and bryophyte depletions occur to 10 km distance.

These results were reported at the Federal, Provincial, Mining Co. triparty meeting concerning the smelter pollution abatement program at Flin Flon.

Re Hinton and Prince Albert: Field and laboratory data indicate a build up of sulphur in soil and vegetation in the forested areas in the vicinity of Hinton. The amount of sulphur was found to diminish with distance from the town. There were no indications found of damage to the soil or vegetation.

Analysis of samples obtained from the Prince Albert area were completed. Results were compared with those from the Hinton area.

4. Assembly of the color handbook on symptomology for regional forest species exposed to pollutants is currently in progress. Recent assessment of audience and field use practicalities has resulted in a requirement for extensive condensation of the topic material into a more compact format. This is now underway.

5. Other accomplishments - as an advisory service, meetings and discussions concerning ongoing environmental assessment programs were conducted with various provincial agencies. Documentations were provided for a hearing on problems associated in the well site aerial pollutant releases and vegetation toxicity. Also, a brief review of the "proposed Environment Impact Guidelines for Saskatchewan" was carried out.

6. Trials of bioassay techniques to test the influences of pollutant contaminated soils on germination and growth were conducted in the N.F.R.C. greenhouse facilities. Small pilot scale bioassays were carried out on a) the germination and growth influences of smelter deposited heavy metal soil contaminates on a few forest tree species; and b) the influence of crude oil - methanol mixtures spilled on soil as a tree toxicity factor.

14. Goals for 1977-78:

1. Dependent upon the delivery of the fumigation chamber, it will be assembled, installed, calibrated, electronically debugged and used for SO_2 fumigation purposes this year.

2. To complete preparation of the color handbook on symptomology for regional forest species to pollutants in the revised condensed format. (Blauel and Malhotra)

3. In order to determine the impact of air-borne pollutants on forest areas around Thompson Smelter, conduct a study program in co-operation with the Manitoba Dept. of Mines, Resources and Environmental Management. The study will include:

    1. heavy metal and total sulphur analysis on selected vegetation and soils (LFH only). This information will indicate the rate of build-up of air borne pollutants at various distances from the semlter (field and lab). (Blauel & Baker)

    2. use of indicator species such as existing or transplant lichens for air pollution biomonitoring purposes (field and lab). (Blauel)

    3. histological examination of vegetation suspected of air pollutant injury (lab). (Blauel)

    4. the fractionation of soil (LFH and the mineral horizons) to follow the movement and migration of indicator ions, i.e. - those from the smelter operation and other, throughout the solum. This work will help relate the presence of these ions in various fractions to vegetation uptake. (Baker)

15. Publications:

Up to 1976-77

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.

Blauel, R.A., 1975. Summary of Possible Impacts on Forests from Sulphur Dioxide and Other Air Pollutants. File Report NOR-114.

Blauel, R.A., 1975. Plant selection for reclamation purposes. File Report NOR-114.

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.

Hocking, D., 1974. Effects on the forest of sulphur dioxide from a sulphur fire near Edson, Alberta. File Report.

Hocking, D., 1974. Preliminary survey of the forest condition near the Transmountain Pipeline Co. Ltd. pumping station at Jasper, Alberta. File Report.

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

Hocking, D., S.S. Malhotra and R. Blauel, 1975. Environmental Stress in the Forest. Forestry Report Vol. 4, #2.

Rowe, R.D., 1974. Delineation of Plume and Impingement areas from a Sour gas Processing Plant.

1976-77

Hocking D. and R.A. Blauel, 1977. Progressive Heavy Metal Accumulation Associated with Forest Decline near the Nickel Smelter at Thompson, Manitoba. NOR-X-169.

Blauel, R.A., 1976. Forest Vegetation and Soil Survey Flin Flon, Manitoba (Preliminary Survey) File Report NOR-114.

Blauel, R.A., 1976. Review of International Nickel Co. (F.F. Slaney) Study design Proposal Concerning Environmental Impact Assessment around the Thompson Smelter. File Report NOR-114.

Blauel, R.A., 1976. Comments on the Proposed Environmental Impact Guidelines for Saskatchewan. File Report. NOR-114.

Baker, J., 1976. Accumulation and Impact of Air-borne Sulphur Compounds on Soil and Vegetation in the Vicinity of Hinton, Alberta. File Report 162.

Skorepa, A.C. and D.H. V.H., 1976. A quantitative study of epiphytic lichen vegetation in relation to SO_2 pollution in Western Alberta. NOR-X-161.

16. Signatures:

R.A. Blauel.
Investigator

Program Manager

P.A. Maddin

J. Baker

Director G. T. Silver

NOR-7-162

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 21, 1977

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents on forest soils.

3. New: Cont.: X 4. No.: NOR-7-162 (Formerly NOR-7-970)

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:

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 on sulphur emissions from the Aquitaine Gas Plant and Northwest Pulp & Power Plant. Both direct and indirect effects of sulphur and their reaction products in soils will be studied. Short as well as long term effects will be given consideration.

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.

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.

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: 1980
c. Estimated total Prof. man-years required: 1.6
d. Essential new major equipment items for 1977-78 with costs:

Double beam scanning spectrophotometer	- $7,000.00
Recorder	- $1,500.00
Dilutor	- $ 550.00

e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.5	(J. Baker)
Supp.	0.5	(D.G. Caldwell)
Casual	-	
Total	1.0	

11. Progress to Date:

Six sampling sites in the Strachan area were set up in the spring of 1976. In selecting sites use was made of the information obtained from the Loman-Hocking work of 1974-75. The area west of Idlewilde Mountain to Ram Fall was considered a region of light to minimal SO_2 impingement. Areas north, south, west, east and between the two sulphur extraction plants (Gulf & Aquitaine) were considered as impingement zones of varying intensities.

Precipitation, foliage and soil samples were taken from each site and analysed for S, P, N, Ca, Mg, K, Al and Fe. The sites were:

Radiant Ck. - Ram Falls - Control
Aquitaine N - SO_2 impinged
Aquitaine NE (between the two plants) - SO_2 impinged
Gulf plant - SO_2 impinged
Power Line (between and south of the two plants) - SO_2 impinged
Strachan Ranger Station (N.W. of Gulf) - SO_2 impinged

12. Goals for 1976-77:

1. Soil micro-flora studies will continue but the extent and detail will depend on suitable support help.

2. Sampling units similar to those used in Hinton (some modification) will be placed throughout the Aquitaine area.

3. A report of the results of the Hinton and Aquitaine results is planned. No field work for the Hinton area is planned for this year.

13. Accomplishments in 1976-77:

1. Soil samples were taken at various locations throughout the Strachan area to estimate any influence of atmospheric SO_2, to date, on the numbers and kinds of soil organisms. Particular reference was made to sulphur and nitrogen soil organisms. Except in the vicinities of sulphur piles and in drain ways from sulphur piles, there was little evidence of a build-up of sulphur oxidizers in the soil. There was no measurable effect of atmospheric SO_2 on nitrogen organisms. To date, it would appear that any reduction in soil pH, increase in exchangeable acidity, and water extractable constituents appears to be the result of acid precipitation.

   Two individual reports submitted as file reports were completed:

   1. Microbiological investigation of soils in selected areas west of Rocky Mountain House: Two Dam Creek, Radiant Creek, Gulf Sulphur Plant.

   2a. Identification of heterotrophic bacterial isolates from soils contaminated and uncontaminated with sulphur dioxide: investigation into the sulphur metabolizing capabilities of the organisms.

   2b. Effect of sulphur dioxide on numbers of thiosulfate-oxidizing and denitrifying organisms in soil.

2. Six sets of precipitation collecting apparatus were established within and outside the main SO_2 impingement areas throughout the Strachan area. Sulphur contents of rainfall vary accordingly to site location. The "control area" was consistently the site with least sulphur detected.

   Sulphur contents of rainfall sampled within the zone of SO_2 impingement differed from location to location. Other ions Ca, Mg, K. Na were also found in rainfall.

   Foliar samples taken within the SO_2 impinged lodgepole pine stands contained, on the average, more sulphur and aluminum but less calcium, magnesium and phosphorus than those from the control area.

   Soil samples from the SO_2 impinged areas showed lower pH, soluble and exchangeable cations (except for aluminum) but higher exchangeable acidity than samples from the control area.

3. A detailed report on the rainfall foliar and soils data from the Strachan area is presently under review. A tentative title is, "Observations on nutrient levels in rainfall, lodgepole pine foliage and soils surrounding two sulphur gas extraction plants in Strachan, Alberta".

14. Goals for 1977-78:

1. Because of the trends noted in the field work, two laboratory studies are planned for this year.

    a) effect of aqueous - SO_2 on nitrification in soils,

    b) effect of aqueous - SO_2 on nutrient levels in soil and lodgepole pine foliage.

15. Publications:

Up to 1976-77

Baker, J., D. Hocking and M. Nyborg. 1975. Acidity of open and intercepted precipitation in forests and effects on forest soils, in Alberta, Canada. Reidel Publishing Company, Holland. Published also by U.S.D.A. as Technical Report NE-23.

1976-77

Baker, J. 1976. Observations on nutrient levels in rainfall, lodgepole pine foliage and soils surrounding two sulphur gas extraction plants in Strachan, Alberta. Info. Rep. Dept. of Environ. C.F.S., Edmonton, Alberta.

Baker, J. 1976. Highlights of reports on the effects of emission pollutants on soil micro-flora under field and laboratory conditions (Joanne Danforth) File Rep., Dept. Of Environ. C.F.S., Edmonton, Alberta.

16. Signatures:

J Baker.

Investigator

Program Manager

Director G. T. Silver

NOR-7-170

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date:

1. Project: Reduction of damage from pollutants in the atmosphere.

2. Title: Effects of atmospheric effluents from mining and smelting industries on forest vegetation and soils.

3. New: X Cont.: 4. No.: NOR-7-170

5. Study Leader: G. Hogan

6. Key Words: Heavy metals, sulphur gases, mining and smelting industries, forest vegetation and soils.

7. Location of Work: Thompson--Flin Flon, Manitoba and Northern Forest Research Centre, Edmonton, Alberta.

8. Problem:

Air-borne pollutants such as heavy metals and sulphur gases emitted by the mining and smelting industries in northern Manitoba have a real, imagined, and/or potentially deleterious effect on the forest vegetation and soils. Government agencies and the general public at all levels are expressing concern. Little is known of the real impact. The industry is apprehensive of the environmental restrictions that may be applied. The major problem is lack of scientific information for (a) early detection of air pollutant injury to vegetation, (b) prediction of long-term effects of air pollutants on forest vegetation and soils, and (c) establishing fair and effective ambient air quality standards. In order to obtain such information, the provincial government agencies, industry and the public request participation of the Canadian Forestry Service in the form of co-operative research and survey programs. The Province of Manitoba is providing operating funds not to exceed 15 k for studies within Manitoba.

9. Study Objectives:

1. To carry out site specific vegetation inventory in suitable forested areas around smelter operation (base line information).

2. To establish bench mark and air pollution bio-monitoring system utilizing selected vegetation within the forested communities.

3. To determine the impact of air-borne pollutants (heavy metals and sulphur gases) on forest soil chemistry.

4. To develop diagnostic techniques based on specific symptoms under controlled environmental conditions. This information will be utilized to confirm the existing ambient air quality standards or to establish new and more effective ones.

10. Resources:

a. Starting date: 1977
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 3.0
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1977-78 with costs: Nil
f. 1977-78 man-years:

Prof.	1.0
Supp.	Nil
Total	1.0

11. Progress to Date:

Nil--New Study

12. Goals for 1976-77:

Nil--New Study

13. Accomplishment in 1976-77:

Nil--New Study

14. Goals for 1977-78:

1. Establish 8 bench mark and air pollution bio-monitoring sites in the forest area around Thompson smelter operation.

2. Conduct heavy metal and total sulphur analyses on selected forest vegetation and soils.

3. Conduct histological examination of vegetation suspected of air pollutant injury.

4. Establish precipitation traps in study plots and analyze the collected material for pollutant content and distribution.

5. Conduct a lichen study (existing and/or transplant lichens) for air pollution bio-monitoring purposes.

6. Initiate heavy metal study program around Hudson Bay mining and Smelting operation at Flin Flon.

7. Develop diagnostic technique to detect symptoms of air pollution injury to vegetation.

8. Study the impact of air pollutant contaminated soils on the germination and growth of various vegetation species (Bio-assay techniques--Lab.)

15. Publications:

Nil--New Study

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-8-044

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 21, 1977

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-8-044

5. Study Leader: H. Zalasky

6. Key Words: Frost burl, frost canker and dieback, bark pitch pocket, low temperature, hyper-and hypoplasia, interlocking and spiral grain, brachiate tracheids, sclereid-like cells, scabby bark, conifers, hardwoods.

7. Location of Work: Region-wide.

8. Problem:

Studies of distribution of hosts and geographic distribution and the histology of the bark and wood damage by low temperature was undertaken in 1971 to define the impact and symptoms on trees of different species. Investigations included annual rejuvenating capability, development and maturation of still-living woody tissues in annual growth rings around the frost-canker, and freeze-killing of new abnormal tissues. In frost hollows and frost risk localities, frost cankers are perennial because of the annual monthly or seasonal pattern of freeze-thaw conditions. Freeze-thaw is defined as a drastic variation between the high temperature during the day, the low of the night and the high of the next day regardless of season or month of the year. The range in which diurnal temperatures are required to drop from a high to a low and rise again to effect damage in plant tissues is known from field observations and from cell biology experiments. In nature wind-chill may bring on a risk of frost even if the temperature is slightly above freezing such as 33° to 35°F.

Physiographically our land mass, bordered by the cold pre-Cambrian Shield in the east and the Rockies in the west, rises sharply westward from the Manitoba escarpment. It is influenced by a cold Continental air mass pressure system from the Arctic and by a warm

air mass from the Pacific. The two systems bring about rapid diurnal freeze-thaws so common during the winter months along the eastern slopes of the Rockies with greatest turbulence and gusty winds. Risk of frost is also increased by radiation diurnal cooling in broad valleys throughout the region. Disked surfaces tend to be cold and raised surfaces warm; but on long slopes night frost settles at the bottom and top of the slopes, and the warm layer is sandwiched in between. Risk of frost injuries increases from east to west and the eastern slopes of the Rockies have the greatest instability of temperature.

In reforestation, frost risk areas should be designated for wild-life use rather than timber because of stand openings and successions of herbaceous ground cover suitable for grazing. Such designations may be permanent, or temporary if a complete canopy cover is established. But trees with deformed crowns make a useful habitat for larger nesting birds rather than timber for fiber use.

Low temperature damage may have some impact on redirection of disease appraisal, research on regeneration by natural or artificial means, and on some of the cultural practices such as hardening-off of seedlings, pruning, thinning and selection of adaptable species.

9. Study Objectives:

1. To assess variability of hardiness of poplar to frost canker and dieback for clones under field conditions.

2. To provide advisory services to outside agencies on establishment and maintenance of planted poplars.

3. To compile manuscript on role of winter injury and process of dieback and target canker formation.

4. 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: 1976.
c. Estimated total Prof. man-years required: 3
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years Prof. Nil.

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 chemiral 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 of 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 structure are due to failure of cell plate formation during cell division.

12. Goals for 1976-77:

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:

   1. Zalasky, H. Low temperature induced cankers and burls in test conifers and hardwoods. Can. J. Botany.

   2. Zalasky, H. Cell and tissue deformities in burl and canker induced experimentally by low temperature. Can. J. Botany.

   3. Zalasky, H. Septoria canker and leaf spot in test seedlings of native species of poplar. Can. J. Botany.

   4. Zalasky, H. Frost damage in poplar. Forestry Chron.

   5. Zalasky, H. Structure of burl tissues in frost canker of poplar. Can. J. Botany.

   6. Zalasky, H. Hyperplastic and hypoplastic tissues evaluated by aberration and diversity in nucleation and cell groupings. Can. J. Botany.

   7. Zalasky, H. Frost malformation in woody tissues of *Malus* following experimental frost injury. Plant Sci.

   8. Zalasky, H. Frost injury in Caragana. Plant Sci.

   9. Zalasky, H. Chimeral xylem in galls of lodgepole pine caused by western gall rust, *Endocronartium harknessii*.

   10. Zalasky, H. Abscission tissues in twigs affected by early autumn frost.

13. Accomplishments in 1976-77:

Goals 1 to 4 deleted after statement prepared.

5. 1. Published.
   2. Data combined with (a) in final draft.
   3. With the author.
   4. Published.
   5. Completed as File report NOR-8-044.
   6. Published.
   7. Accepted for publication with minor revision.
   8. Accepted for publication.
   9. Accepted for publication.
   10. Published.

14. Goals for 1977-78:

Study terminated. Transfer goals to study 155.

15. Publications:

Up to 1975-76

Zalasky, H. 1972. Ukrainian-English Translation OOENV TR159 Ottawa. Winter injuries to woody species in the process of acclimatization. Ms. 14 pages. Ukrainskyi Botanichnyi Zhurnal Vol. 22, No. 5, 1965. Co-authored by Borzakivska, I.V. and T.K. Maiko. 1965.

Zalasky, H. 1973. Brachiate tracheids in deformed wood of *Abies*. Bi-Mon. Res. Notes 29, 23.

Environment Canada, Can. For. Serv. 1973. Septoria canker and leaf spot. Northern Forest Research Centre. Forestry Report 3:3-4.

Zalasky, H. 1973. Isolation and characteristics of sclereid-like cells in sapwood of *Pinus Populus*. Information Report NOR-X-48. 14 pp. Northern Forest Research Centre, Edmonton, Alberta.

Environment Canada, Can. For. Serv. 1974. Defect in poplar. Northern Forest Research Centre. Forestry Report 4:5.

1975-76

Zalasky, H. 1975. Chimeras, hyperplasia and hypoplasia in frost burls induced by low temperature. Can. J. Bot. 53, 1888-1898.

Zalasky, H. 1975. Low-temperature-induced cankers and burls in test conifers and hardwoods. Can. J. Bot. 53, 2526-2535.

Zalasky, H. 1975. Frost damage in poplar. Forestry Chronicle. 52: 61-64.

Zalasky, H. 1976. Cytohistology of chimeral frost rib tissues in apple and mountain ash. Can. J. Plant Sci. 56: 501-504.

Zalasky, H. 1976. Phragmoid cells from Northwest poplar. Bi-Mon. Research Notes 32(5): 25-25.

Zalasky, H. 1976. Frost damage of poplar. Environment Canada, For. Serv. N.F.R.C. Edmonton, Alberta. NFRC PL15-76.

16. Signatures:

Harry Galasky
Investigator

Program Manager

G.T. Silver
Director G.T. Silver

NOR-9-061

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 19, 1977

1. Project: Reduction of damage from insects.

2. Title: Larch sawfly biological control

3. New: Cont.: X 4. No.: NOR-9-061

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:

1. To achieve biological control of the larch sawfly.

2. To contribute to the population dynamics study of the larch sawfly by determining the factors affecting parasite effectiveness, abundance and impact.

3. To monitor the spread of *Olesicampe benefactor* from release points in Manitoba, Saskatchewan, Alberta and the Northwest Territories.

4. 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: 1977
c. Estimated total Prof. man-years required: 0.2
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.2 (J.A. Muldrew)
Casual	-
Total	0.2

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, has been recovered from most release points in Canada. Studies in cooperation with the Entomology Research Institute, Ottawa, revealed that the hyperparasite had a holarctic distribution before *O. benefactor* was released in America.

Maximum detected dispersal from the Pine Falls release point was 1.8 miles in 1967, 8.3 miles in 1968, 45 miles in 1969 and 65 miles in 1970. In 1971 a spectacular apparent increase in dispersal was found: *O. benefactor* being recovered at Ignace, Ontario 225 miles from the release point. In 1972 an extension of 50 miles beyond this was detected. A survey made in 1974 indicated that dispersal had not increased greatly over that of 1972. Possible explanations were low host densities resulting in low parasite densities, adverse effects of the hyperparasite *M. dimidiatus* and absence of weather conditions required for long distance dispersal. A marked decrease in larch sawfly populations occurred throughout southeast Manitoba and northwest Ontario beginning in 1972. At the Pine Falls release point populations decreased progressively from over 500,000 per acre in 1964 to 871 in 1972 to 0 in 1973 and 1974. The decrease in sawfly populations in southeastern Manitoba occurred in spite of high rates of attack by *M. dimidiatus* on *O. benefactor* eg. 94% at Elma in 1974; 51% at South Junction and 96% at McMunn. Encapsulated *O. benefactor* larvae were found in 60% of 38 larch sawfly larvae from McMunn that had been attacked by this parasite in 1975.

Dispersal of *O. benefactor* from a release made near The Pas, Manitoba, in 1968 was given special attention since it may prove to be a suitable location for future mass collections of *O. benefactor*. A heavy sawfly infestation has occurred 40 miles south of the release point for several years. By 1975 *O. benefactor* had dispersed 35 miles south of the release point. Parasitism was 39% 13 miles south of the release point but dropped off rapidly south of this point.

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 1976-77:

1. Completion of the paper "Dispersal and impact of the introduced larch sawfly parasites, *Olesicampe benefactor* and *Mesoleius tenthredinis* from 1966 to 1974 in Central Canada".

2. To survey the McMunn location and locations approximately five miles to the east and to the west to determine if the encapsulation of *O. benefactor* larvae found there was anomolous or characteristic of this population.

13. Accomplishments in 1976-77:

1. Progress was made in collation and summarization of data but paper not yet completed.

2. Larch sawfly populations remained low in areas where *O. benefactor* is well established, presumably largely due to control exerted by this parasite. A special collection was made near McMunn, Manitoba

of 1155 larch sawflies. Parasitism by *O. benefactor* was low in this collection, only 19%; possibly partly due to the encapsulation rate of 60% recorded in 1975. Dissection of a sample of 58 hosts that contained *O. benefactor* revealed an encapsulation rate of 12%. This represents a considerable drop from 1975 but is still large in relation to other locations where encapsulation was encountered only rarely. There was some indication that encapsulation was related to excessive attack by the hyperparasite *Mesochorus dimidiatus*. The presence of the latter could not be determined in the dead encapsulated *O. benefactor* larvae due to decomposition, but in the unencapsulated parasites the attack rate had dropped from 96% to 76%.

14. Goals for 1977-78:

1. Completion of the paper "Dispersal and impact of the introduced larch sawfly parasites *Olesicampe benefactor* and *Mesoleius tenthredinis* from 1966 to 1974 in Central Canada".

2. To examine larch sawflies collected at McMunn, Manitoba and, if possible, an adjacent location for a further check on the encapsulation of *O. benefactor* larvae in relation to attack on the parasite by *M. dimidiatus*.

15. Publications:

Up to 1975-76

Muldrew, J.A. 1950. *Mesoleius aulicus*, a parasite of the larch sawfly. Bi-Mon. Prog. Rep., 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. Rep., Can. Dep. 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. Rep., Can. Dep. For. 20(2):3.

Muldrew, J.A. 1964. The biological control program against the larch sawfly. Proc. Ent. Soc. Man. 20:63.

Muldrew, J.A. 1965. The biological control program against the larch sawfly. Proc. North Cent. Br. Ent. Soc. Amer. 20:157.

Muldrew, J.A. 1967. Biology and initial dispersal of *Olesicampe* (*Holocremnus*) sp. nr. *nematorum* (Hymenoptera:ichnenmonidae), a parasite of the larch sawfly recently established in Manitoba. Can. Ent. 99:312-321.

Elliott, K.R. and J.A. Muldrew. 1967. A knockdown metal cage for rearing larch sawfly larvae. Can. Ent. 99(3):321-323.

Hinks, J.D. and J.A. Muldrew. 1968. Clearing and staining insect larvae to detect internal parasites. Manitoba Ent. 2:81-84.

Turnock, W.J. and J.A. Muldrew. 1971. *Pristiphora erichsonii* (Hartig), larch sawfly (Hymenoptera:Tenthredinidae). In: Biological control programmes against insects and weeds in Canada 1959-1968. Commonw. Inst. Biol. Contr. Tech. Commun. 4:175-194.

Turnock, W.J. and J.A. Muldrew. 1971. Parasites. In: Toward Integrated Control. Proceedings of the Third Annual Northeastern Forest Insect Work Conference, New Haven, Connecticut. February 17-19, 1970. 59-87.

Turnock, W.J. and J.A. Muldrew. 1973. Characteristics of *Bessa harveyi* (Diptera:Tachinidae) suggesting the historic introduction of the larch sawfly to North America. Manitoba Ent. 6:49-53.

Muldrew, J.A. 1973. Larch sawfly, a biological control success story. Forestry Report, Can. For. Serv., Edmonton. 3(2):1-2.

Reports

Muldrew, J.A. 1953. Population studies on *Bessa harveyi*. Bi-Mon. Prog. Rep., Dep. of Agric. 9(3):2.

Muldrew, J.A. 1959. Studies on the distribution and inheritance of the resistance of the larch sawfly to *Mesoleius tenthredinis* Morley. Interim Rept., For. Biol. Lab., Winnipeg. pp. 52.

Turnock, W.J. and J.A. Muldrew. 1964. Biological control attempts against the larch sawfly, *Pristiphora erichsonii* (Htg.) in Manitoba, 1961-1963. Inf. Rep., For. Ent. Lab., Winnipeg. pp. 40.

Muldrew, J.A. and W.J. Turnock. 1965. Biological control attempts against the larch sawfly, *Pristiphora erichsonii* (Htg.), 1964. Interim Res. Rep., Forest Ent. Lab., Winnipeg. pp. 35.

Muldrew, J.A. 1965. Biological control against the larch sawfly *Pristiphora erichsonii* (Htg.) in Canada. Interim Res. Rep., Forest Ent. Lab., Winnipeg. pp. 73.

1976-77

Nil

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-9-132

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977-78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 19, 1977

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-9-132

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 courterparts 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.

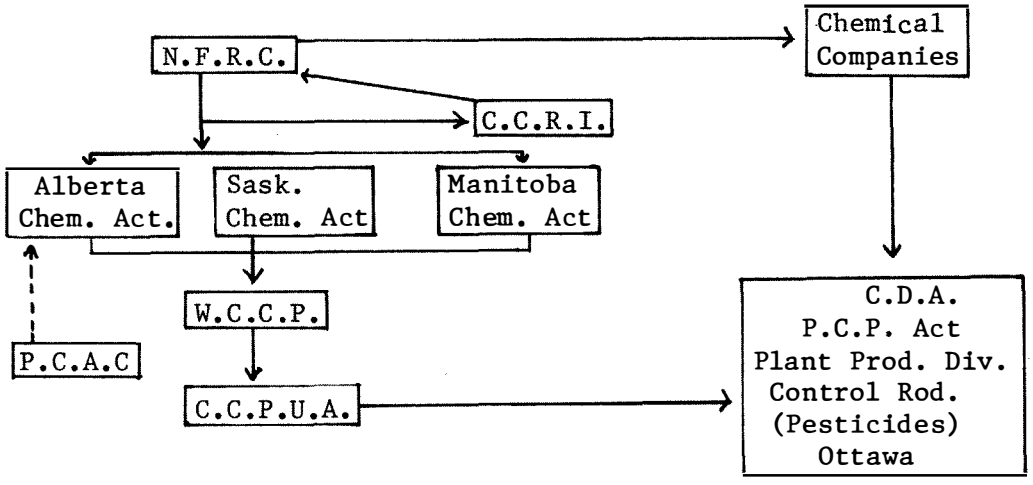
Where controls are not feasible, or economically or biologically justified, such will be reported and included in Canadian Forestry Service control recommendations to the chemical firms.

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 trials 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 timing and to determine percent mortality of target species and phytoxicity.

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 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man years Prof. -
Supp. 1.9 (J. Drouin 1.0, D. Kusch 0.9)
Casual -
Total 1.9

11. Progress to Date:

Implemented a viable 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. In 1972, conducted 59 efficacy tests consisting of mist blower, soil drench and bark paint applications. Analyzed the data, summarized the results and submitted performance reports to 9 chemical firms, a report of treatments and conclusions to the Western Committee on Crop Pesticides and prepared a file report NOR-Y-66. In 1973, 25 insecticides were tested on 99 field treatments on 20 insect species using hydraulic mist blower, Ultra low volume, soil drench and bark paint applications. Collaborated with C.C.R.I., C.W.S. and Fisheries Research (Manitoba) on large scale spruce budworm aerial and ground sprays with insecticides and microbials and evaluation of air-emulsion spray adjuvants and song/game birds and small mammals censusing. Analyzed the data, submitted performance reports to 14 chemical firms, report of tests, conclusions and recommendations to W.C.C.P., report on insecticide field development to joint Can. Ent./Alta. Ent. Societies at Banff, input into technical sessions on Biocides for the Alta. Environmental Conservation Board. Prepared Information Report NOR-X-81 and special report to C.C.R.I. on Furadan

(Carbofuran) tests for proposed registrations. During 1974, 6 insecticides were being considered for registration as a result of 77 efficacy tests of 26 pesticides.
Analyzed the data and submitted performance reports to 14 chemical firms, submitted a summary of pesticide efficacy tests from 1972-74 (230 treatments) to the Pesticide Research Report (C.C.P.U.A.), a report to the American Phytophathological Society for publication in the Fungicide & Nematocide Tests for 1974 and a report of these tests with conclusions and recommendations to the Western Crop Committee on Pesticides. In 1975, completed 2nd year data requirements on 17 insecticides to support their legislation on a result of 95 evaluations with 37 insecticides & 1 fungicide on 14 insect species and 1 fungal species at 12 sites in Alberta.
Commenced trials with foaming and spray adjuvants and deciduous foliage with systemic insecticides. Completed first year treatments & life history studies on the chokecherry midge (request from W.C.C.P.), completed soil drench and foliar spray tests on the yellow-headed spruce sawfly.
Analyzed data & submitted performance reports to 14 chemical firms, summary of 75 evaluations to the Pesticide Research Report (C.C.P.U.A.) Ottawa, prepared Information Report, CC-X-150, submitted manuscript for publication on the poplar borer, presented a seminar on registration at the N.F.R.C., a report on the biology and control of a willow stem sawfly to the Oliver Nursery and control of the pitch nodule maker to a private nursery, reviewed, edited, 6 pest leaflets and gave lectures on chemical control to school, college teachers and students.

12. Goals for 1976-77:

1. Continue evaluation of pesticides previously tested and showing promise with a view to completing 2-3 year data required for registration. These are: Basudin, Baygon, Carzol, Cygon, Dutox, Fundal, Furadam. Gardona, Galecron, Kelthane, K-840, Lannate L, Lorsban, Malathion, Metasystox-R, Omite, Orthene, Pirimor, R 28627, Sevin, Supracide, Temik, Vydate, and U.L.V.A.--see attached registration recommendations/chemicals requiring more data.

2. Continue boxelder twig borer control studies re: foliar spray controls.

3. Continue chemical control studies, biology of chokecherry midge. *(C. virginianiae)* and an associated seed boring sawfly.

4. Continue chemical controls on the pitch nodule maker in nurseries. Prepare report for submission to bi-monthly as "Chemical control of the pitch nodule maker (*P. albicapitana)* in Alberta".

5. Continue chemical control, biology of a willow stem sawfly, *Euura atra* and publish as an information report, "Damage by a shoot boring sawfly in Alberta" by Wong, Melvin, Drouin.

6. Continue chemical and efficacy tests on the root collar weevil, if time permits.

7. Consult with W. G. Ives, L. Carlson prior to trials at 4, 5, 6 re statistical analysis of data.

13. Accomplishments in 1976-77:

1. Completed 2nd or 3rd year data requirements for registration or label expansion of the following chemicals: Basudin, Baygon, Dylox, Dipel, (b.t.), Dutox, Gardona, Furadan, Galecron, Lannate, Malathion, Metasystox-R, Orthene, Pirimor, Supracide, Vydate, Temik, Thiodan... Since there is a reluctance on the part of most chemical firms to seek label expansion and/or registration because of the great expenses involved we are now sending (on their recommmendations) all efficacy data directly to the Control Products Section, Plant Products Division in Ottawa. This section has the responsibility to ensure that pesticides available to the public are properly manufactured, correctly labelled, effective and safe when used as directed. Hence, the most important part of the process of registration of a pesticide is the review and approval of this information which will eventually appear on a product label. It is on this information that a "Compendium on Pesticides Registered for use in Canada" is based. As a result of 2 or 3 year data accumulation, 23 insecticides should soon be registered on 21 specific insect species. See summary attached for results. (Goal 1)

2. Continued foliar spray control applications on the Boxelder Twig borer. (Goal 2) with excellent results.

3. Completed biology and 2nd year chemical control studies of a midge, *Contarinia virginianiae* Felt. and a seed boring sawfly *Hoplocampa lacteipennis* Rowher, with excellent results (100%). (Goal 3). Prepared report for submission to bi-monthly as "Chemical Control of a Midge, *C. virginianiae* Felt. and a seed boring sawfly, *H. lacteipennis* Rowher, in Alberta".

4. Continued controls on the pitch nodule maker in nurseries with consistent results. (67 & 71% respectively.) (Goal 4) Submission of the report "Chemical control of the pitch nodule maker in Alberta" to be held in abeyance for one more year until irrigation tests with the more promising insecticides are completed.

5. Completed chemical controls and biology of a willow stem sawfly *Euura atra* (Jurine) on willow stool beds in nurseries. Report submitted to Tree Planters Notes, U.S.D.A. (Goal 5)

6. No chemical efficacy treatments carried out on the root collar weevil due to low priority, continued mortality tallies and established 2 new plots of 10 units. (Goal 6)

7. Consultations, submissions re: 4 7 5 above with Mssrs. Ives and Carlson as attached. (Goal 7)

8. Added accomplishment - Nuclear ployhedra virus spray treatments with Ives/Muldrew assigned after project reviews. Spray treatments were very successful at 3 areas on a 2 acre site treated with Dipel (b.t.) and sub-lethal doses of Sevin (carbaryl) against the Forest tent caterpillar.

9. Submitted summary of 1976 field evaluation for publication in the Pesticide Research Report (C.C.P.U.A.) Canada, Agriculture.

10. Presented paper to Alta. Ent. Soc. on chemical control of a midge and a seed boring sawfly on chokecherry. Kananaskis, Oct. 15th/76.

11. Reviewed, edited, illustrated front cover art work for 9 pest leaflets and prepared one on poplar bud gall mite, the other 8 are:

forest tent caterpillar	frost damage on poplar
lilac leaf miner	spruce needle miner
cooley spruce gall aphid	aphids galore
spruce spider mite	ugly nest caterpillar

12. Submitted reports of results on control of a willow stem sawfly to the Oliver Nurseries and to the Devon Nurseries on controls of the pitch nodule maker and to the Plant Products Div. in Ottawa for registration and/or expansion (label) a summary of chemicals recommended for consideration with all the necessary data.

14. Goals for 1977-78:

1. Continue evaluations for pesticides previously tested and showing promise with a view to completing 2-3 year data required for label expansion or registration, Basudin, Baygon, Cygon, Dimecron, Dimilin, Dylox, Malathion, Metasystox-R, NRDC 143, Orthene, Shell W43775, and ULVA...see attached recommendations for chemicals showing promise and requiring more data.

2. Continue nuclear polyhedral virus spray treatments with Ives/ Muldrew and an ovicide spray treatment on a 2-acre plot.

3. Complete chemical control studies on a midge and a seed boring sawfly on chokecherry, follow up on phytotoxicity with adjuvants on *Prunus & Amalanchier* spp. and biology & control of a *lepidoptera* sp. feeding on the pulp of fruit.

4. Re-evaluate present insecticidal controls for the birch leaf miner with efficacy tests of foliar sprays, bark paints or soil drench applications.

5. Expand the knowledge, biology and chemical controls of insects attacking Saskatoon fruit & foliage. (Requested by Brooks Hort. Stm. Alta. Agric. & Stoneycroft Wines Calgary).

6. Complete chemical controls with irrigation assist on the pitch nodule maker in nurseries. Report to be updated and submitted to Tree Planters Notes as "Chemical controls of the pitch nodule maker, *Petrova albicapitana* Busck., in Alberta".

7. Complete chemical control studies on a willow stem sawfly attacking acute/golden willow including phytotoxicity.

8. Complete foliar applications to boxelder twig borer. Update and submit report "Chemical control of the boxelder twig borer, *P. willingana* Kft. in Alberta" to Tree Planters Notes, USDA.

9. Continue efficacy tests on the root collar weevil, *H. warreni* if time permits.

10. Consult with Messrs. Ives and Carlson prior to treatments at 4, 5, 6 and 7 re statistical analysis.

15. Publications:

Up to 1976-77

Drouin, J. A. and D. S. Kusch. 1973. Summary of Insecticide Field Trials on Shade and Shelterbelt Trees in Alberta, 1972. Can. Dep. of Environment, N.F.R.C., Edmonton, Alberta. 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. Environ. Can., Can. For. Serv., N.F.R.C., Edmonton, Alberta. Inf. Rep. NOR-X-81.

Drouin, J. A. and D. S. Kusch. 1974. Controls of Poplar Leaf Spots, *Septoria musiva* Pk. and *Marssonina populi* L. Fungicide and Nematicide Tests, Vol. 30. Am. Phyto. Soc. 1974. Raleigh, N. C.

Drouin, J. A. and D. S. Kusch. 1974. Pesticide Field Trials on Shade and Shelterbelt Trees in Alberta and Saskatchewan, 1974. Environ. Can., Can. For. Serv., N.F.R.C., Edmonton, Alberta Inf. Rep. NOR-X-131.

Drouin, J. A. and D. S. Kusch. 1975. Chemical Control of the Spruce Needle Miner in Alberta. Bi-monthly. Vol. 31, No. 2, May-June 1975.

Drouin, J. A. and H. R. Wong. 1975. Biology, Damage, and Chemical Control of the poplar borer, *Saperda calcarata* Say. in the Junction of the Root and Stem of Balsam Poplar in Western Canada. Nat. Res. Council, Canada, Can. Jour. of For. Res. Vol. 5, No. 3, 1975.

Drouin, J. A. and D. S. Kusch. 1975. Pest Leaflet series, Pear Slug, *Caliroa cerasi* L. Yellow headed spruce sawfly, *Pikonema alaskensis* Roh. and To Spray or Not to Spray, Environment Canada, For. Serv., N.F.R.C., Edmonton, Alta.

Drouin, J. A. and D. S. Kusch. 1975. Summary of field tests 1975, Pesticide Research Report. Can. Agric. Canada Committee on Pesticide Use in Agriculture, Ottawa, Ont.

1976-77

Drouin, J. A. and D. S. Kusch. 1976. Pesticide Field Trials on Shade and Shelterbelt Trees in Alberta, 1975. Environment Canada, For. Serv., N.F.R.C., Edmonton, Alta. Information Report NOR-X-150.

Wong, H. R. , J. C. E. Melvin and J. A. Drouin. 1976 Damage by Willow Shoot-Boring Sawfly in Alberta. Tree Planters Notes (in press).

Drouin, J. A. and D. S. Kusch. 1976. Summary of Field Tests, 1976. Pesticide Research Report. Can. Agric., Canada Committee on Pesticide Use in Agriculture, Ottawa, Ont.

Drouin, J. A. 1976. Pest Leaflet Series, Poplar bud gall mite.

Kusch, D. S. 1976. Pest Leaflet Series, Spruce Needle Miner, Lilac Leaf Miner, and Aphids Galore.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

PITCH PINE NODULE MAKER CONTROL PROGRAM 1976

PETROVA ALBICAPITANA BUSCK.

Part 1: Soil Treatment Program

Location: Devon area

Host: Lodgepole pine

Objectives: Soil treatment tests will serve three main pruposes:

a) to continue efficacy studies on the various systemic insecticides

b) obtain timing of soil drench application for optimum control of second year larvae early feeding prior to pupation

c) determine through previous and current soil treatments: 1 - control level and 2 - optimum period of treatment and phytotoxicity to the host.

NOTE: No input on nesting birds, small mammals, etc. since treatment area in nursery holding block.

Experimental Design

A. Replicated Tests: Devon Nursery - series of two replicates (5 trees per relicate) for each of the eight systemic chemicals under tests.

Materials and Dosages:

1. Cygon 4E @ 1 oz/in dbh, 2 x 5 trees
2. Furadan 10G @ 4 oz/in dbh, 2 x 5 trees
3. Meta-Systox-R 25% @ 2oz/in dbh, 2 x 5 trees

4. Baygon 1.5EC @ 3 oz/in dbh, 2 x 5 trees
5. Temik 10G @ 4 oz/in dbh, 2 x 5 trees
6. Vydate 10G @ 4 oz/in dbh, 2 x 5 trees
7. Orthene
- Check plots, 2 x 5 trees.

All rates given are imperial measure in ounces of product. Insecticides are dug in around the perimeter of the tree within the dripline and watered at time of application to dilute and hasten chemical action of the systemics in use.

Time: Apparently critical and soil treatments should be made as soon as frost leaves the ground, taking advantage of spring moisture to control second-year early feeding larvae prior to pupation. Irrigate where possible.

Application Procedures: Soil treatment application during last week of April. Standard soil treatment methods. Chemicals dug in at base, then watered.

Pre-Spray Plot Assessment: In late april on all trees selected, examine and record all old or new nodules, first and second year nodules on PNM form.

Part 2: Spray Assessment

Sampling to determine population reduction due to soil treatment with systemics will be carried out in mid-June. Sampling will consist of repeating the examination of the tagged trees in all replicated and check plots, dissecting all first and second year nodules and recording living, dead, parasitized, empty and emerged.

BOXELDER TWIG BORER* CONTROL ON THE PRAIRIES, 1976. (*Proteoteras willingana Kft.)

Part 1: Larvel Spray Program

Locations: Stettler (solonetzic soil), Erskine (sandy), Bashaw (solonetzic), Devon (sandy-loan). All areas within half day travel time.

Objectives: The spray program in 1976 with respect to boxelder twig borer control on manitoba maple will serve three main objectives:

a) to continue efficacy studies on various insecticides

b) to obtain additional timing of spray application (egg to III instar) development

c) to determine through previous and current spray operations, the level of control and optimum period between treatment.

NOTE: No input expected with respect to birds (nesting/game). Nesting complete and fledglings are in flight.

Experimental Design

A. Replicated Tests

Stettler shelterbelt: series of two replicates (5 trees per replicate) for insecticide under test - Basudin (diazinon).

Erskine block: series of four replicates (5 trees/replicate) for 2 insecticides under test Cygon (dimethoate) & Malathion.

Bashaw shelterbelt: series of four replicates (5 trees) for 2 insecticides, Dutox (trichlorfon + meta-systox-R) and Sevin 50 WP (carbaryl).

Devon shelterbelt: series of four replicates (5 trees/replicate) for Orthene (acephate).

Program will involve spraying test plots (see plot layouts) in 1976 as follows:

Stettler plots B-1, B-2 with Basudin 50 EC @ 8 oz/50 gal., Erskine block, C-1, C-2, C-3, C-4 with Cygon 4E @ 8 oz/50 gal., M-1, M-2, M-3, M-4 with Malathion 50 EC @ 8 oz/50 gal., Bashaw shelterbelt, D-1, D-2, D-3, D-4, and S-1, S-2, S-3, S-4 and at Devon on O-1, O-2, O-3, O-4.

All rates given are imperial measure in ounces of product. Insecticides to be applied at full coverage with recommended spreader-sticker adjuvant with hydraulic sprayer @ 750 p.s.i. applying approx. one gal. spray mix per 30 ft. tree.

Time: Critical, approx. last week in July. Optimum time is post eclosion in I to III instar - particularly for contact insecticide (Sevin, Orthene). Check periodically in late July for state of eggs.

Application Procedures: Spray applications during period last week of July to first week in August. Apply spray mixture when winds less than 8 mph and mid-day temperatures near or greater than 16°C (20°C for Malathion). Spraying may have to be in early morning or late evening to take advantage of the calm conditions. Mix chemicals in 25 gal. batches. Apply spray mixtures until tree starts to drip. Locate sprayer on upwind side of treatment block.

Part 2: Spray Assessment

Sampling to determine population reduction due to application of pesticide will be carried out 24 hours after spray application. The sample unit will consist of four 36 inch branches (measured from the crown periphery towards the trunk) from the N, S.E., W. sides of the tree from 5 trees in each treated and untreated test plot; sample branches being selected at random from the lower portion of the tree crown. Test plots to be sampled will be located as follows:

1) Stettler = 2 plots of 5 trees each
   2 check plots additional 2 x 5 = 10
   Total 80 individual samples 20 x 4 = 80

2) Erskine = 8 plots of 5 trees each
   2 check plots additional 2 x 5 = 10
   Total of 200 individual samples 50 x 4 = 200

3) Bashaw = 8 plots of 5 trees each
   2 check plots additional
   Total of 200 individual samples

4) Devon = 4 plots of 5 trees each
   2 check plots additional
   Total of 120 individual samples

NOR-9-143

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 19, 1977

1. Project: Reduction of damage from insects

2. Title: Control and damage impact of insects injurious to trees and shrubs.

3. New: Cont.: X 4. No.: NOR-9-143

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: 1973
b. Estimated year of completion: Indefinite
c. Estimated total Prof. man-years required: Ongoing
d. Essential new major equipment items for 1977-78 with costs:
e. Essential new major equipment beyond 1978:
f. 1977-78 man-years

Prof.	1.0	(H. Cerezke)
Supp.	0.9	(H. Gates)
Casual	-	
Total	1.9	

11. Progress to date:

Reporting and CFS representation were provided at (a) Western Committee on Crop Pests (Saskatoon), (b) Alberta Pest Control Advisory Committee (Edmonton), (c) Saskatchewan Advisory Council of Insect Control (Saskatoon), and (d) Shelterbelt Sub-Committee of Western Committee Shelterbelt and Horticulture. Planning and developmental work was continued on proposed information publication "Common Insects of Trees and Shrubs in

the Prairies". A variety of consultory and extension services provided to various clients and agencies on several insect problems of forest and shade trees.

12. Goals for 1976-77:

1. Complete the processing of the following manuscripts:

    1. Population and damage relationships of *Monochamus scutellatus* in tree-length white spruce logs in northern Alberta. (Proposed journal publ.)

    2. Sampling the woodborer, *Monochamus* in white spruce logs. (Proposed Bi-Monthly publ.)

2. Prepare manuscripts on:

    1. The spacial and temporal patterns of distribution of the weevil, *Hylobius warreni* Wood in lodgepole pine stands in Alberta. (Proposed journal publ.)

    2. (If time permits)--The root weevil, *H. warreni*, in the prairie provinces in relation to forest management. (Proposed technical report)

3. Complete the reports:

    1. Spruce budworm impact studies in spruce forests of northern Alberta. (Proposed Information Report)

    2. Spruce budworm development in northern Alberta in relation to spruce phenology and heat units. (Proposed Bi-Monthly publ.)

    3. (New goal)--Paper titled, "Variation in shoot and needle growth patterns on 46-cm branch tips of healthy white spruce" prepared and submitted to Bi-Mon. Res. Notes.

4. Complete the compilation of photographs and prepare first draft copy of "Common Insects of Trees and Shrubs of the Prairie Provinces of Canada". (Proposed Information publ.)

5. Provide Canadian Forestry Service representation on:

    1. Western Committee Crop Pests
    2. Alberta Pest Control Advisory Committee
    3. Saskatchewan Advisory Council on Insect Control
    4. Shelterbelt Sub-Committee of Western Committee of Shelterbelt and Horticulture
    5. C.F.S. contact officer for Pest Control Products Act

6. Provide information and consulting services to other scientists and to clients seeking information on forest insect problems, especially related to spruce budworms, root weevil and woodborers.

13. Accomplishments in 1976-77:

1. 1. "Population and damage relationships of *Monochamus scutellatus* in tree-length white spruce logs in northern Alberta". This paper was submitted to Can. J. For. Res., returned for journal reviewers comments and now re-submitted to journal.

   2. This paper was withdrawn since some information in it was incorporated into (1) above.

2. No progress

3. 1. "Spruce budworm impact studies in spruce forests of northern Alberta". The report was revised and designated a File Rep.

   2. Goal 3 (2) satisfied in a manuscript titled: "Notes on the biology and development of the spruce budworm in northern Alberta and Northwest Territories. Typed ms, 21 pp.

   3. (Goal added)
   Manuscript titled as follows was prepared, reviewed locally and submitted to Bi-Mon. Res. Notes:

   Cerezke, H.F. 1976. Variation in shoot and needle growth patterns on 46-cm branch tips of healthy white spruce. Typed ms, 7 pp.

4. Many new photographs of insect material were compiled through F.I.D.S. staff and from my own collections. Files were prepared on all insects to be included in the proposed information publication. Bibliography and reference material were accumulated for most files, and distributions of pest species are being summarized from past collections. Reports on the insects included in two chapter headings of the above publication (i.e. "Seed and Cone Insects" and "Bud and Shoot Insects") have been written and a start was made on the third chapter ("Leaf Eating Insects").

5. Reporting and C.F.S. representation were provided at:

   1. Western Committee on Crop Pests (Saskatoon)
   2. Alberta Pest control Advisory Committee (Edmonton)
   3. Saskatchewan Advisory Council on Insect Control (Saskatoon)
   4. Shelterbelt Sub-Committee on Western Committee of Shelterbelt and Horticulture (Regina)
   5. C.F.S. contact officer for Pest Control Products Act, Trade Memorandum 104.

6. 1. Several requests on spruce budworm problems were handled, including information on current outbreaks, aerial photography of damaged forests, aerial and ground surveys, damage impact, and control. Reports prepared included the following:

   a) Spruce budworm survey, Athabasca Forest, 1976. File Rep., 2 pp.

   b) Results of spruce budworm pheromone traps in Mayfair Golf Club, Edmonton. File Rep., 1 p.

   c) Spruce budworm conditions in Alberta. Taped interview, CBS radio.

   2. Requests for information on woodborers included information on insecticides, hazards of fire-killed infested logs and problems related to air-drying infested lumber and export. Contributed oral presentation at C.I.F. panel discussion on "Entomological problems and possible solutions" related to theme "Disaster in the Forest--The Judy Creek Fire of 1974".

   3. Conducted survey in lodgepole pine for Alberta Forest Service and prepared report: "Report on conditions of lodgepole pine regeneration near Water Valley, Alberta". File Rep., 1 p.

   4. Numerous other client requests handled by letter, phone, and visits.

   5. Preliminary studies were made on birch leaf miner and associated leaf miner species in Edmonton and vicinity, since this insect has continued to be a major pest on birch ornamentals. Review of literature was made and report prepared: "Birch leaf-mining insects in the prairie provinces--a literature review and present status"., 8 pp. This exploratory work was conducted with view of expanded program in 1977 to examine the possibility of biological control.

14. Goals for 1977-78:

   1. Prepare an information report on spruce budworm species with particular emphasis on Alberta-N.W.T. region, summarizing cumulated information on history of outbreaks, damage impact, budworm life history, and seasonal development.

   2. Prepare a proposed journal publication: "The spatial and temporal patterns of distribution of the weevil, *Hylobius warreni*, in lodgepole pine stands in Alberta".

   3. Complete the compilation of colored photographs necessary for first draft of information publication on "Common Insects of Trees and Shrubs of the Prairies".

4. Complete first draft of "Common Insects of Trees and Shrubs of the Prairies".

5. Provide C.F.S. representation on various regional and provincial shelterbelt, pest control, and regulatory committees including the following:

    1. Western Committee on Crop Pests
    2. Alberta Pest Control Advisory Committee
    3. Saskatchewan Advisory Council on Insect Control
    4. Shelterbelt Sub-Committee of Western Committee Shelberbelt and Horticulture
    5. Contact officer for federal Pest Control Products Act, Trade Memorandum 104.
    6. D.F.E. Regional Biocide Committee.

6. Provide information and consulting services to other scientists and to various clients in response to their requests on insect identifications, abundance, hazard, damage impact, and control. Short-term field studies may be necessary on such forest insect problems as spruce budworm, root weevils, and woodborers.

7. Initiate life history and ecological studies of birch leaf-mining species in urban areas of the prairies to examine the possibility for biological control.

15. Publications:

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. 1971. Spruce budworm. Forestry Report, Environment Canada, Edmonton. 1(4):7.

Cerezke, H.F. 1972. 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 associated 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.

Cerezke, H.F. 1977. Characteristics of damage in tree-length white spruce logs caused by the white-spotted sawyer, *Monochamus scutellatus*. Can. J. For. Res. (In press)

Sanders, C.J., G.R. Daterman, R.F. Shepherd and H.F. Cerezke. 1974. Sex attractants for two species of western spruce budworm, *Choristoneura biennis* and *C. viridis* (Lepidoptera:Tortricidae). Can. Ent. 106:157-159.

16. Signatures:

Herbert F. Cerezke
Investigator

Program Manager

G.T. Silver
Director G.T. Silver

NOR-9-150

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 19, 1977

1. Project: Reduction of damage from insects.

2. Title: Integrated control of the forest tent caterpillar.

3. New: X Cont: 4. No.: NOR-9-150

5. Study Leader: W.G.H. Ives, J.A. Muldrew

6. Key Words: *Malacosoma disstria*, *Sarcophaga aldrichi*, *Populus tremuloides*, nuclear-polyhedrosis virus, integrated control, *Bacillus thuringiensis*, chemical control, parasites.

7. Location of Work: Prairie Provinces and Edmonton.

8. Problem:

The forest tent caterpillar, *Malacosoma disstria* (Hubner), attacks a wide range of hosts, and periodically occurs in outbreak numbers in all Canadian provinces and in most states in the U.S.A. In the Prairie Provinces its principal host is trembling aspen, *Populus tremuloides* Michx. Outbreaks on this host usually occur somewhere in the Prairie Provinces each year. In any given locality the interval between the start of outbreak varies from 6 to 16 years. During these outbreaks, populations of the forest tent caterpillar typically increase in numbers until limited by the amount of food available, and complete stripping of the foliage then occurs for a period of 3 to 5 years. Populations then often collapse to a level where it is difficult or impossible to find any larvae, even during extensive sampling.

The defoliation caused by the forest tent caterpillar causes a reduction in growth but relatively little immediate mortality, as the trees are able to refoliate and produce sufficient new foliage to minimize the effect of defoliation. However, there may be a delayed effect upon subsequent survival.

Since little, if any, tree mortality occurs as a result of forest tent caterpillar outbreaks, the pest is of relatively little concern to informed forest managers. Rural residents, however, are subjected to crawling masses of caterpillars and find this experience extremely annoying. Tourist operators, in particular, are very vocal in demanding government agencies to take remedial actions. Although Malathion (and other insecticides) can provice satisfactory control, such chemical application is often difficult to justify when one considers the problem objectively.

In Canada, most outbreaks appear to be terminated by unfavorable weather conditions, high levels of dipterous parasitism (primarily *Sarcophaga aldrichi* Parker), or epizootics of virus, particularly a nuclear polyhedrosis virus. These factors may operate alone or in combination. Unfortunately, both the diperous parasites and the virus usually reach extemely low levels during endemic periods between outbreaks, simply because the host insect is so rare that there is little to sustain them. Consequently, both these factors usually require several years to increase in abundance before they become effective control agents.

This problem presents a unique opportunity in biological (or possibly integrated) control. If the sarcophagids and virus could be introduced into localities with incipient outbreaks, it might be possible to avert major outbreaks in these areas. This idea is not new, having been suggested by Tothill in 1918, but as far as we know has not been tried with the forest tent caterpillar, although a similar approach has been used successfully with one or two other insects. *S. aldrichi* is admirably suited to experimental manipulation of its numbers, as it can be reared successfully and easily on artificial media. Similarly, it is probable that the virus can eventually be propagated on tissue cultures. This has been done with other viruses, without loss of virulence, but has not yet (as far as we know) been done with the forest tent caterpillar, although tissue cultures of this insect have been established. It therefore seems probable that stock cultures of both the parasites and virus could eventually be maintained for use in applied biological control as needed. Before such a program is initiated, or advocated, it is essential that preliminary studies be undertaken to determine whether or not the required densities of parasites and virus can be produced and manipulated advantageously. For example, it will be necessary to determine the dispersal of released parasites under field conditions.

9. Study Objectives:

To determine whether or not localized incipient outbreaks of forest tent caterpillar can be prevented or their severity minimized by maniuplation of natural biotic control factors, particularly *Sarcophaga aldrichi* and nuclear polyhedrosis virus, augemented where necessary by chemical or bacteriological control measures.

10. Resources:

a. Starting date: New
b. Estimated year of completion: 1980
c. Estimated total prof. man years required: 6.5
d. Essential new major equipment items for 1977-78 with costs: Nil
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	0.8	(J.A. Muldrew)
	0.4	(W.G.H. Ives)
Supp.	1.0	(R.M. Smith)
	0.1	(D.S. Kusch)
	0.1	(H. Gates)
Casual	0.6	
Total	3.0	

12. Goals for 1976-77:

1. The review of pertinent literature will be completed.

2. To determine whether or not virus and *B. thuringiensis* can be introduced into field populations and produce demonstrable mortality in current and/or subsequent generations. Two techniques will be evaluated:

    1. Ground applications of high concentrations of virus will be made to small plots of aspen as soon as the foliage flushes.

        Similar group applications of *B. thuringiensis*, enchanced by sub-lethal doses of insecticide, will also be made.

    2. Egg bands of forest tent caterpillar will be dipped in a high concentration of virus particles, then tied adjacent to natural egg bands in an area of forest tent caterpillar infestation on regeneration aspen.

3. Techniques for propagating and storing the virus will be evaluated and adapted to suit our conditions.

4. Similar adaptations for rearing and storing the sarcophagid parasites will also be made.

5. Dispersal of marked *S. aldrichi* adults upon release under field conditions will be studied to determine if enough remain in the vicinity to create an impact on local forest tent caterpillar populations.

13. Accomplishments in 1976-77:

1. Review of pertinent literature was completed.

2. 1. High mortality of forest tent caterpillar larvae resulted from edge-spraying of two plots. Mortality in one plot approached 100% and exceeded 95% in the other, compared to a total mortality of about 33% in the check plots.

   Dipel, supplemented by 0.5 and 1.0 oz of Sevin per 50 gals. of spray caused an estimated 85 and 75% mortality in two 1-acre plots when applied as a larval spray.

   2. Two methods for treating egg bands were tested: 1) bands dipped in a virus suspension; and 2) bands were sprayed to the drip point with a high concentration of virus. (Approximately 10^8 polyhedral bodies per ml. were used in both tests). Both methods gave high mortality (nearly 100%) indicating that treating egg bands is a feasible method for introducing virus into tent caterpillar populations.

3. Dr. Cunningham in Sault Ste. Marie has agreed to produce a limited amount of virus for 1977 trials.

4. Limited rearings of sarcophagids on an artificial diet consisting of milk and egg yolks in an agar medium seem promising, but the results so far are inconclusive. About 4,000 sarcophagid puparia for 1977 tests were collected in the field, and from these some diapause - free adults were obtained. However, none lived long enough to produce progeny.

5. Not enough flies were caught, so results of the dispersal study were inconclusive.

Accomplishments not listed in goals for 1976-77:

1. Areas for larval spray and fly releases were located.

2. An area suitable for testing virus as a spray on egg bands was also located.

3. Devices for attracting wild flies and contaminating them with virus were designed and partially tested.

14. Goals for 1977-78:

1. To collect as many sarcophagid parasites as possible from the same area of the Interlake as in 1976 to provide a source of future releases and breeding stock to try to develop a diapause-free strain. This material will be supplemented by locally-collected parasites if necessary. -Ives

2. To subject sarcophagid parasites to artifically manipulated temperatures and day lengths to try to enhance the amount of diapause-free emergence and thus develop the means for producing stock cultures of flies that can be maintained on a year-round basis. -Muldrew

3. To conduct further tests of artificial diets to determine the type most suitable for maintaining healthy stocks of sarcophagids on a year-round basis. -Muldrew

4. To conduct field tests of virus sprays as a biological insecticide on egg bands prior to larval hatch utilizing a mist-blower. -Ives

5. If enough virus is available, conduct additional tests to virus as a larval spray, using a hydraulic sprayer. -Ives

6. To test the feeding stations to determine if wild flies can be used to introduce virus into field population of tent caterpillars. -Ives

7. To sample tent caterpillar populations in the Joussard area to determine if there was a demonstrable carry-over of virus from the 1976 trials. Rates of mortality will be compared during the early, mid, and late larval stages, but no attempt will be made to assess total mortality during the larval stage. -Muldrew

8. Wild flies will be trapped in the Lake Wabamum area for marking and release in the Joussard area. -Ives

9. The flies trapped in 8 will be marked, released and recaptured in the Joussard area, to determine if enough remain in the area to create an impact on local forest tent caterpillar populations. -Muldrew

10. An attempt will be made to obtain virus-infected material for 1978 field testing, in case Sault Ste. Marie is unable to provide this material for us. -Ives and Muldrew

15. Publications:

Nil

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-17-068

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: January 26, 1977

1. Project: Liaison and technical advisory services in forest management.

2. Title: Technical and advisory services re insect pests and diseases.

3. New: Cont.: X 4. No.: NOR-17-068

5. Study Leader: V. Hildahl

6. Key Words: Tree biology, entomology, pathology, detection, insects, diseases, appraisals, protection, pesticides, chemical control, spraying, demonstrations, Dutch elm disease.

7. Location of Work: Manitoba

8. Problem:

Provincial, municipal and industrial resource managers are responsible for forest, park and amenity tree programs in Manitoba. Therefore, they must derive maximum benefits from results of research pertaining to tree protection, maintenance and establishment. Research managers also need feedback on the requirements and views of the user agencies in order to initiate research and demonstrations aimed at resolving problems associated with effective and intensive forest management.

9. Study Objectives:

1. To provide technical advice and guidance to resource managers of the province in developing and implementing forest protection programs aimed at keeping tree losses due to insect and disease outbreaks within acceptable limits.

2. To provide a technical advisory service to provincial and municipal government agencies and the general public with regard to appropriate detection, diagnostic and control procedures for Dutch elm disease in the Manitoba region.

10. Resources:

a. Starting date: 1966
b. Estimated year of completion: Continuing
c. Estimated Prof. man-years required: N/A
d. Essential new major equipment items for 1977-78 with costs:

An automatic agar sterilizer at approximately $1,900 for preparation of culture media used in Dutch elm disease diagnosis. (In 1976 about 7,000 plates were cultured manually.)

e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	1.0	(V. Hildahl)
Supp.	-	
Casual	-	
Total	1.0	

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 expert advice on insect pest and disease problems. To date, the study has been highlighted by: 1) interpreting and disseminating (in the form of brochures, special reports and personal contacts) results of scientific research that have practical application in dealing with resource management problems; 2) evaluating current insect and disease outbreaks with respect to impact on forest stands, and on park, shelterbelt and amenity plantings; 3) developing, demonstrating and evaluating ground and aerial techniques and procedures for applying chemical insecticides used in suppressing outbreaks of the jack pine budworm, spruce budworm, forest tent caterpillar, cankerworms, and poplar bud-gall mite; 4) 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 5) directing provincial and municipal sponsored Dutch elm disease detection (including the use of infrared aerial photography for early recognition of diseased trees) and control programs in Manitoba.

12. Goals for 1976-77:

1. Continue liaison with resource managers throughout the province, and provide technical advisory services on insect pest 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 chemical spray programs against the spruce and jack pine budworms in the Spruce Woods of Manitoba, and provide results to resource managers for the development of future control programs.

3. Complete scientific publication "Control of poplar bud-gall mite with insecticides". (This publication to be prepared jointly with R.F. DeBoo, Chemical Control Research Institute.)

4. Complete preparation of report depicting results of the 1974 and 1975 spray programs against the spruce budworm in the Spruce Woods Provincial Park and Forest.

13. Accomplishments in 1976-77:

1. Contacts and liaison with resource managers were maintained and technical advisory services (including lectures and seminars) were provided, especially on current insect and disease problems in forest, urban and rural environments. Regular contact was also maintained with Forest Insect and Disease Survey personnel of the Northern Forest Research Centre in achieving this goal.

2. The operational aerial spray program against the jack pine budworm was monitored and evaluated as requested by officials of the Manitoba Parks Branch, Department of Tourism, Recreation and Cultural Affairs.

   The spray program covered approxaimtely 1,250 acres of pine plantations in the Spruce Woods Provincial Forest using the chemical Sumithion in one application at the rate of 4 oz. a.i. in 1 U.S. gal. water/acre. Preliminary analysis of data taken by field sampling during spray operations indicated that larval incidence was reduced about 70%.

3. The proposed scientific publication "Control pf poplar bud-gall mite with insecticides" was not published. Field work and analysis of data completed to date.

4. Proposed report depicting results of 1974 and 1975 operational spray programs against the spruce budworm outbreak in the Spruce Woods Provincial Forest and Park in Manitoba is still in early stages of preparation.

5. Added Accomplishment 1977: A research publication--Aerial control operations against the spruce budworm in Manitoba, and a pest leaflet--Forest tent caterpillar were published.

14. Goals for 1977-78:

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 utilized in achieving this goal.

2. Continue cooperative programs with provincial and municipal agencies regarding Dutch elm disease detection and diagnoses, and provide technical advisory services in relation to sanitation practices and control procedures.

3. Continue to evaluate the effectiveness of operational chemical spray programs against the spruce and jack pine budworms in the Spruce Woods area of Manitoba, and provide results to resource managers for the development of future control programs.

4. Complete scientific publication "Control of poplar bud-gall mite with insecticides". (This publication to be prepared jointly with R.F. DeBoo, Chemical Control Research Institute.)

5. Complete preparation of information report on results of the operational spray programs (1974-76) against the spruce budworm outbreak in the Spruce Woods Provincial Forest and Park in Manitoba.

6. Complete information report entitled "Elm diseases in Manitoba", including interpretation of aerial photography.

15. Publications:

Up to 1976-77

Hildahl, V. and A.E. Campbell. 1975. Forest tent caterpillar in the Prairie Provinces. Environ. Can., North. For. Res. Cent., Inf. Rep. NOR-X-135. 12 p.

Hildahl, V. 1975. Fall cankerworm. Environ. Can., North. For. Res. Cent., Pest Leaflet NFRC P. 3-75.

Hildahl, V. 1975. Yellow-bellied sapsucker. Environ. Can., North. For. Res. Cent., Pest Leaflet NFRC P. 7-75.

1976-77

Hildahl, V. and R.F. DeBoo. 1974. Aerial control operations against the spruce budworm in Manitoba. In: Aerial control of forest insects in Canada. M.L. Prebble, Editor. Can. Dep. Environ., Ottawa, Canada. 126-128.

Hildahl, V. 1977. Forest tent caterpillar. Environ. Can., North., For. Res. Cent., Pest Leaflet NFRC. (In press)

16. Signatures:

Investigator

Program Manager

Director G. T. Silver

NOR-24-157

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 21, 1977

1. Project: AOSERP: Effects of SO_2 on vegetation.

2. Title: Symptomology and threshold levels of air pollutant injury to vegetation.

3. New: Cont.: X 4. No.: NOR-24-157 (Formerly NOR-24-157 and NOR-24-158.)

5. Study Leaders: S.S. Malhotra, P.A. Addison

6. Key Words: sulfur dioxide, plants, symptomology, injury thresholds, tolerance.

7. Location of Work: Alberta 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 and threshold levels of pollutant injury to vegetation is dependent upon a number of plant and environmental factors, it is absolutely necessary that such studies be carried out under controlled fumigation and environmental conditions. The present air quality standards lack adequate experimental support. It is therefore highly desirable that in the light of Alberta species and climate, new air quality standards be established.

9. Study Objectives:

1. Describe visible and microscopic effects of air pollutants on selected vegetation from the oil sands area in order to develop techniques to identify and assess the impact of air pollutants on vegetation.

2. Determine in quantitative terms, the threshold levels of air pollutant injury to species native to the oil sands region.

3. Screen candidate revegetation species for tolerance to air-borne pollutants under climatic stress conditions.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 2.4
d. Essential new major equipment items for 1977-78 with costs:

Data Aquisition System	7,000
(Signal conditioner and data printer)	
Dew point Hygrometer	1,500
Storage Oscilloscope	4,000

e. Essential new major equipment items beyond 1977-78 with costs: Nil
f. 1977-78 man-years

Prof.	0.2	(Malhotra
	0.2	(Addison)
	0.2	(Blauel)
	0.6	Total NFRC
	+0.3	(Sarkar - AOSERP)
	0.9	
Suppl.	0.3	(Fenn)
	0.1	(Ridgway)
	0.4	Total NFRC
	+1.0	(Hurdle - AOSERP)
	+0.5	(Hargesheimer - AOSERP)
	1.9	
Total	2.8	

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. The lack of information on the environmental conditions and SO_2 fumigation rates makes it impossible to quantify or define these symptoms. The control of environmental conditions and SO_2 exposure rates is therefore of great importance. For this purpose, we have designed a fumigation chamber and the contract for its construction has been let. The delivery of the chamber is expected by March 10, 1977 after which it will be assembled, installed and used for SO_2 fumigation purposes this year.

The gas exchange cuvettes have been put into operation and are currently being used for preliminary fumigation trial runs.

12. Goals for 1976-77:

1. Dependent on release of and hiring for the instrument technologist position, the Siemen's micro-chamber will be set up, calibrated and preliminary fumigations will be carried out (coordinated with Study 114).

2. Dependent on fumigation chamber delivery and the hiring of the instrument technologist, the fumigation chamber will be set up, calibrated and electronically debugged. Preliminary test trials will be concommittantly conducted (coordinated with Study 114).

13. Accomplishments in 1976-77:

1. The instrument technologist was hired. The gas exchange cuvettes have been set up and calibrated for small-scale fumigation purposes. The preliminary pollutant symptomology and threshold trial runs are currently underway.

2. Due to certain design and engineering difficulties, the pollutant chamber delivery has been delayed. The delivery is now expected by March 10, 1977.

   The old Scherer walk-in-chamber was modified and set up for multi-cuvette (gas exchange microchambers) operation. The light balasts and lamps have been ordered to put it into operation for pollutant symptomology and threshold studies.

14. Goals for 1977-78:

1. Dependent upon the delivery of the fumigation chamber, it will be assembled, installed, calibrated, electronically debugged and used for SO_2 fumigation purposes this year (coordinated with Study 114). Addison, Malhotra, Blauel

2. The gas exchange cuvettes and the walk-in fumigation chambers will be used to initiate studies (a) to determine threshold levels of SO_2 injury to vegetation species occurring in the Alberta oil sands area (b) to describe visible effects of various levels of SO_2 fumigation on selected vegetation occurring in the vicinity of oil sands leases. Malhotra, Blauel, Addison, Sarkar

15. Publications:

1976-77

Malhotra, S.S., P. Addison, R. Blauel and S.K. Sarkar. 1977. Symptomology and threshold levels of air pollutant injury to vegetation and species tolerance. pp.1-2 *In:* Malhotra, S.S. (ed.) The effect of sulphur dioxide on forest vegetation and soils of Alberta Oil Sands area. Annual Report (1976-77), Vegetation Technical Research Committee, AOSERP, Edmonton. 46 pp.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-24-159

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date: February 21, 1977

1. Project: AOSERP: Effects of SO_2 on vegetation.

2. Title: Physiology and mechanisms of SO_2 injury.

3. New: Cont.: X 4. No.: NOR-24-159

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.

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: 3.3
d. Essential new major equipment items for 1977-78 with costs:

Spectrophotometer	5,000
Spectrofluorometer	5,000
Radiogaschromatography system	10,000
Sonicator	2,000

e. Essential new major equipment items beyond 1977 with costs:

Densitometer	10,000

f. 1977-78 man-years

Prof.	0.5	(Malhotra)
	0.5	Total NFRC
	+0.6	(Sarkar - AOSERP)
	1.1	
Supp.	0.7	(Shuya)
	0.7	Total NFRC
	+0.5	(Hargesheimer - AOSERP)
	1.2	
Total	2.3	

11. Progress to Date:

The literature on biochemical and physiological effects of SO_2 on vegetation has been reviewed and published . The effect of aqueous SO_2 on some central biochemical processes has been studied. The results have shown significant effects on (a) photosynthesis (b) energy metabolism (c) lipid metabolism and (d) amino acids. There is a strong indication that the primary site of SO_2 action is on the cellular and sub-cellular membranes (related to permeability properties). These membranes act as barriers that control the inward and outward movement of nutrients and cellular metabolites.

12. Goals for 1976-77:

In order to determine biochemical threshold levels of SO_2 injury to forest vegetation, the following studies will be carried out:

1. Gas chromatography studies on amino acids.

2. Gas chromatography studies on organic acids.

3. Effect of SO_2 on lipid biosynthesis (membrane permeability studies).

4. Write up and report the results obtained in 1975-76. Proposed titles:

    1. Effect of aqueous SO_2 on chlorophyll destruction in *Pinus contorta*.

    2. Effect of SO_2 on lipid composition of pine needle tissue. (Both to be published in journals.)

5. Goal added: Effect of SO_2 on the release of soluble sugars from pine needle tissue (membrane permeability studies).

6. Goal added: Effect of SO_2 on phosphatase and lipid autooxidation (membrane permeability studies).

13. Accomplishments in 1976-77:

1. The current literature does not have any accurate and reliable gas chromatographic method for amino acid analysis from pine needles. We have achieved considerable success in developing a gas chromatographic method that will enable us to study in detail the effects of SO_2 on different amino acids. The preliminary experiments have indicated a decline in amino acids (serine, valine, leucine, glutamic acid and lysine) that are very essential for some central biochemical processes.

2. Quantitative separation of 23 different organic acids (acids involved in respiration, photosynthesis and energy metabolism) was achieved on a single column by means of gas chromatography. Treatment of pine needles with aqueous SO_2 produced a significant decrease in organic acids such as isocitric acid and malic acid. These compounds are very important for proper energy balance of living plants.

3. These studies were designed to determine the effect of SO_2 on membrane permeability properties of pine needles. The chloroplast lipids (glycolipids) are known to be involved in the structure and function of chloroplast membranes. Aqueous SO_2 (10-100 ppm) caused a general reduction in the incorporation of [1-^{14}C] acetate into these lipids. Fumigation of plants with gaseous SO_2 at approximately 0.2, 0.4 and 0.6 ppm concentrations for 24 hours produced results similar to those produced by 10-100 ppm aqueous SO_2.

4. Both papers entitled "Effect of aqueous SO_2 on chlorophyll destruction in *Pinus contorta*" and "Effect of SO_2 on lipid composition of pine needle tissue" have been accepted for scientific journal publication and are currently in press.

5. The release of soluble sugars from pine needle tissue is indicative of changes in cellular and sub-cellular membrane permeability. SO_2 resulted in a significant increase in the release of soluble sugars from pine needle tissue. It is suggested that the loss of sugars was due to decreased membrane permeability brought about by a drop in glycolipid concentration.

6. The results indicated that changes in permeability properties of pine needle tissue brought about by SO_2 may also be due to a decrease in the activity of enzyme phosphatase and an increase in lipid auto-oxidation; such changes have been associated with the movement of metabolites across the cellular barriers and degradation of membrane lipids.

14. Goals for 1977-78:

The following studies will be undertaken to understand the mode of action of SO_2 on forest species. These studies will be designed to help establish the biochemical threshold levels of SO_2 injury to vegetation and to select candidate revegetation species on the basis of their true tolerance toward air pollutants. All biochemical work will be carried out on plants exposed to gaseous SO_2 (not aqueous SO_2).

1. Study the effects of gaseous SO_2 on organic acid and amino acid metabolism to confirm our previous results with aqueous SO_2. Malhotra, Sarkar

2. Study the effect of SO_2 on enzymes involved in energy metabolism. Malhotra, Sarkar

3. Continue the membrane permeability studies (membrane protein analysis by gel electrophoresis). Malhotra, Sarkar

4. Write up and report the work on amino acid and organic acid metabolism. The possible titles are (1) A gas chromatographic method for organic acid analysis. (2) Effect of SO_2 on organic acid metabolism in pine needles. (3) Effect of SO_2 on amino acid metabolism in pine needles. These papers will be published in scientific journals. Malhotra, Sarkar

15. Publications:

Up to 1976-77

Hocking, D., S.S. Malhotra and R. Blauel. 1975. Environmental stress in the forest. Environ. Can., North. For. Res. Cent. For. Rep. 4(2).

Malhotra, S.S. and D. Hocking. 1976. Biochemical and cytological effects of sulphur dioxide on plant metabolism. New Phytol. 76:227-237.

Malhotra, S.S. 1976. Effects of sulphur dioxide on biochemical activity and ultrastructural organization of pine needle chloroplasts. New Phytol. 76:239-245.

1976-77

Khan, A.A. and S.S. Malhotra. Effects of aqueous sulphur dioxide on pine needle glycolipids. Phytochemistry (In Press).

Malhotra, S.S. Effects of aqueous sulphur dioxide on chlorophyll destruction in *Pinus contorta*. New Phytol. (In Press).

Malhotra, S.S. 1976. Physiology and mechanisms of air pollutant injury to vegetation. Proceedings of the First Annual Workshop of the Vegetation Technical Research Committee, AOSERP, Oct. 14 and 15, 1976. pp. 19-30.

Malhotra, S.S. and S.K. Sarkar. 1977. Physiology and mechanism of air pollutant injury to vegetation. pp. 2-23. *In:* Malhotra, S.S. (ed.) The effect of sulphur dioxide on forest vegetation and soils of Alberta oil sands area. Annual Report (1976-77), Vegetation Technical Research Committee, AOSERP, Edmonton. 46 pp.

16. Signatures:

Investigator

Program Manager

Director G.T. Silver

NOR-24-160

CANADIAN FORESTRY SERVICE

STUDY STATEMENT

1977 - 78

Responsibility Centre: NORTHERN FOREST RESEARCH CENTRE

Date:

1. Project: AOSERP: Effects of air pollution on vegetation.

2. Title: Ecological benchmarking and biomonitoring for the detection of air pollution effects on vegetation and soils.

3. New: Cont.: X 4. No.: NOR-24-160

5. Study Leader: Addison, Baker

6. Key Words: sulphur dioxide, boreal forest, air pollution, biomonitoring, soil nutrition, lichen communities.

7. Location of Work: Athabasca oil sands area and Northern Forest Research Centre.

8. Problem:

Long-term exposure to air pollution (especially SO_2) at low concentrations may result in dramatic changes in composition of plant communities and soils leading to forest decline. Early detection of such decline is critical to maintain environmental quality and to provide a basis for emission standards and controls review.

9. Study Objectives:

1. Develop species sensitivity index for different environmental conditions and sequences (by determining SO_2 injury thresholds).

2. Locate and inventory suitable vegetation reserve areas in the vicinity of oil sands leases; establish permanent benchmark plots.

3. Establish a biomonitoring network through vegetation response units.

4. Under controlled environmental and field conditions, determine the influence of air pollutants characteristic of oil sands operations on soil chemistry.

10. Resources:

a. Starting date: 1975
b. Estimated year of completion: 1980
c. Estimated total Prof. man-years required: 3.3
d. Essential new major equipment items for 1977-78 with costs:
Automatic titrator $10,000 and dishwasher $6,000
e. Essential new major equipment items beyond 1978 with costs: Nil
f. 1977-78 man-years

Prof.	.6	(P.A. Addison)
	.3	(J Baker)
	.1	(S.S. Malhotra)
	.1	(S. Sarkar - AOSERP)
Supp.	.7	(J. Ridgway)
	.5	(D. Caldwell)
	.3	(O. Fenn)
Casual	-	
Total NFRC	2.5	

11. Progress to Date:

Permanent field plots have been established at 13 locations at various distances from the oil sands operations in the Ft. McMurray area. Sites were described with respect to vascular and cryptogam species present, stand age and density, cover and frequency of understory plant species, soil type and characteristics, and condition of vegetation (vascular plants, lichens and mosses). Vegetation samples were collected and are being analysed for sulphur and heavy metals and a lichen transplanted study was initiated.

12. Goals for 1976-77:

1. The number of biomonitoring plots will be increased based upon new site selection in consultation with AOSERP committees. (Addison)

2. To effectively identify the influence of pollutants on the forest ecosystem, the plot work will be expanded and upgraded to include:
    1. Soil profile description (Addison).
    2. Soil chemistry (Baker).
    3. Soil microbiology (Baker).
    4. Field exposure of indicator plants.
        1. Lichen transplant study in selected micro-environments at varying locations from the processing plant. (Addison)
        2. Description of lichen communities at established biomonitoring plots. (Addison)

3. A report with the proposed title: The forest condition and ecological benchmarking in the Athabasca Oil Sands area will be produced. (Blauel and Hocking)

4. Conduct aerial photography to determine the stand condition of various communities in the vicinity of oil sands operations.

13. Accomplishments in 1976-77:

1. Nine sites (20 x 20 m) were established in Jack Pine Stands in the Ft. McMurray area. These sites have been described in the following manner:
    1. Vascular plant species list
    2. Cryptogamic plant species list
    3. Stand density
    4. Stand age
    5. Soil type
    6. Soil profile description
    7. Cover and frequency of understory plants
    8. Cover and frequency of branch lichens
    9. Sulphur and heavy metal content of plant tissue (Addison, Malhotra, Sarkar)

2. 1. See #1, 5 and 6.

    2. Analyses of precipitation and water soluble, salt extractable and total ion content in soils were carried out at 8 sites in the oil sands area. Precipitation and soils were analysed for pH, Ca, Mg, Fe, Al, Na, K, S and P. (Baker, Addison)

    3. Influence of processing plant emissions on soil bacteriological populations was determined in the laboratory. (Baker)

    4. 1. Lichen transplants were installed in each of 5 micro-environments (open and under pine, aspen, black spruce and white spruce) at 4 locations (2.2, 5.6, 10.5 and 23.7 km from GCOS operations). Results are not available since method requires re-examination of material after 1 year.

        2. Lichen plots were established in naturally occurring lichen communities at 9 biomonitoring sites. Other biomonitoring techniques currently being tested at the sites included growth rate changes of vascular plants and chemical analysis of tissue for S, Fe, Al, N. (Addison, Malhotra, Sarkar)

    3. See Publications

    4. Approximately 60 miles of low level aerial photography (1:2000) was flown at the end of June, 1976. At the same time as the 60 x 0.6 mile transect was flown, stereo pairs at 1:500 were taken every 2000 m. (Blauel, Addison)

14. Goals for 1977-78:

1. Establishment and description of jack pine stands at 5 new sites to complete the network of biomonitoring and benchmarking sites. (Addison)

2. Establishment and description of plots in black spruce stands at each of the 14 permanent plots. (Addison)

3. Detailed description and analysis (S and heavy metals) of lichens and vascular plants in the vicinity of GCOS operations both through the use of naturally growing and transplanted specimens. (Addison, Malhotra, Sarkar)

4. Collection of selected plant species for sulphur and heavy metal content analysis. (Addison)

5. Collection of precipitation in the vicinity of GCOS operations and use of this material to determine the influence of polluted precipitation on the availability of soil nutrients in selected soils. (Baker, Addison)

15. Publications:

1975-76

Blauel, R.A. 1975. Inventory Design Comments (AOSERP Vegetation Committee). File Report.

1976-77

Addison, P.A. 1976. Ecological benchmarking and biomonitoring for detection of SO_2 effects on vegetation and soils. p. 31-37. In: Proceedings of the Vegetation Research and Technical Committee meeting, October, 1976. AOSERP, Edmonton. 182 pp.

Addison, P.A. 1976. Soils of the air pollution benchmark sites in the Athabasca Oil Sands Area. Canadian Forest Service. File Report NOR-7-160.

Blauel, R. and D. Hocking. 1976. Forest condition as benchmarked in the Alberta Oil Sands Area prior to 1976 by Northern Forest Research Centre. File Report NOR-7-160.

Addison, P.A. and J. Baker. 1977. Ecological benchmarking and biomonitoring for detection of SO_2 effects on vegetation and soils. p. 22-46. In: Malhotra, S.S. (ed.), The Effect of Sulphur Dioxide on Forest Vegetation and Soils of Alberta Oil Sands Area. Annual Report (1976/77), Vegetation Research and Technical Committee, AOSERP, Edmonton. 46 pp.

Two file reports by Joanne Danforth with covering resume by J. Baker were submitted:

1. Investigation into effect of oil sands extraction plant emissions on soil microflora.

2. Effects of vanadium levels on growth of isolates occurring naturally in oil sands and Strachan areas of Alberta.

16. Signatures:

Investigator

Program Manager

Director G. T. Silver