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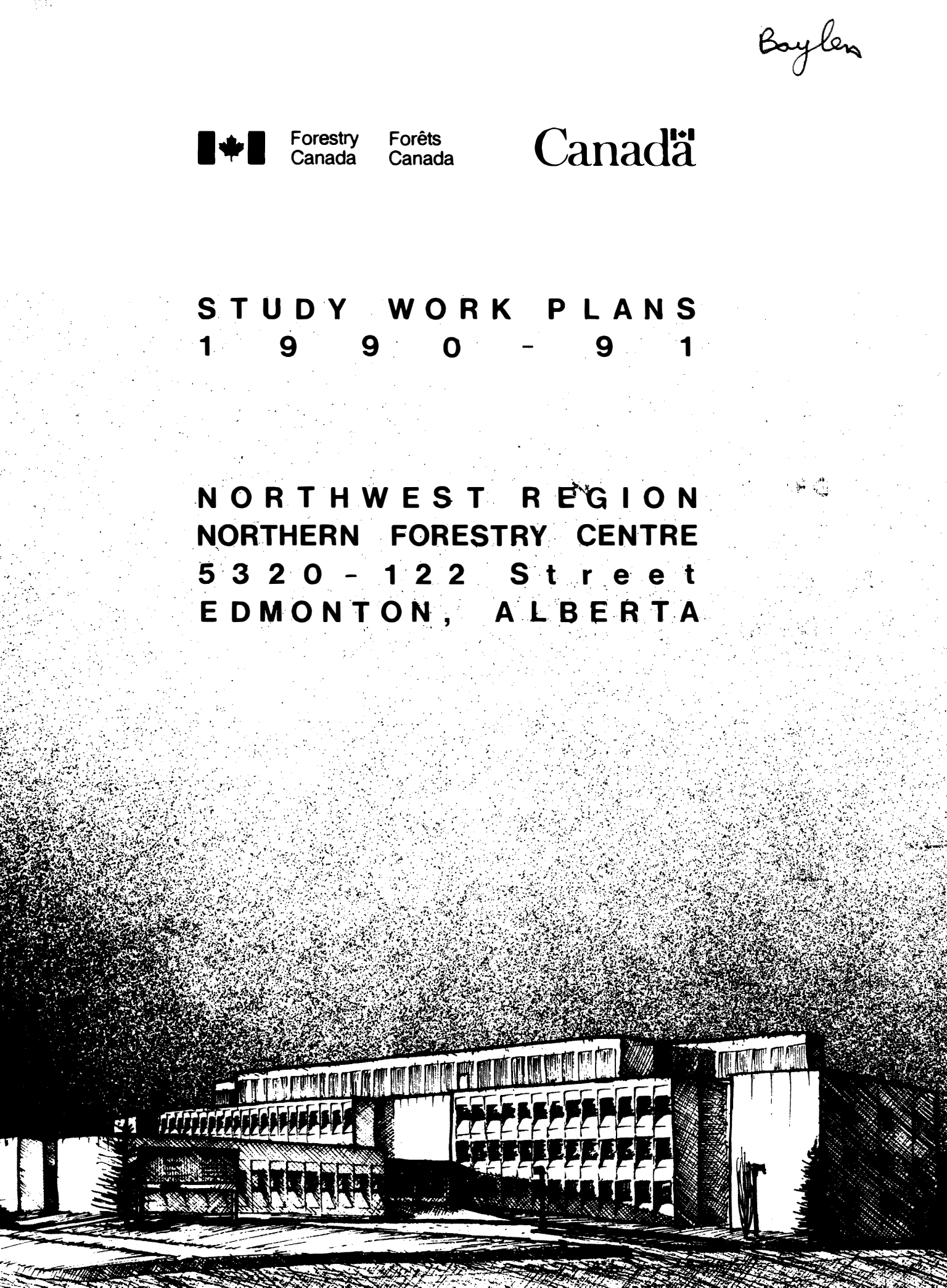
Forestry Canada Forêts Canada

Canada

STUDY WORK PLANS
1990-91

NORTHWEST REGION
NORTHERN FORESTRY CENTRE
5320-122 Street
EDMONTON, ALBERTA



STUDY WORK PLANS

1990-91

NORTHERN FORESTRY CENTRE

NORTHWEST REGION

FORESTRY CANADA

5320 - 122 STREET

EDMONTON, ALBERTA

T6H 3S5

MARCH 1990

NOR-7-01

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

March 7, 1990

1. Project: Environmental Effects of Chemical Substances and Vegetation Management

2. Title: Environmental impact assesment in relation to forest ecosystems

3. New: Cont.: X 4. No.: NOR-7-01

5. Study Leaders: D.G. Maynard, S.S. Sidhu, S.C. Zoltai, J.C. Feng

6. Key Words: Environmental impact assessment, advisory, AR-NEWS, ICP-AES

7. Location of Work: Region wide, emphasis on Alberta

8. Problem Analysis:

Industrial development and emissions have potentially deleterious effects on forest vegetation and soils. Several studies were completed within the Prairie region that looked at potential problems. Expert advice on the effects of air pollutants, northern development and forestry operations to forest ecosystems is required to answer specific concerns in relationship to potential environmental impacts within the region. In addition, potential effects of acid deposition on forest ecosystems could go unnoticed until considerable damage to the forest has occurred. Maintaining an advisory role and carrying out all aspects of the chemical analyses of soil and plant materials in the Acid Rain-National Early Warning System (AR-NEWS) is essential to assure that any possible effects of acid depostion on the forest are detected. High quality analysis in a reasonable time is often required for this study and other studies within NoFC. Therefore, it is important for ICP-AES to be maintained with a minimum of down time.

All Projects/studies associated with NoFC (including contracts and FRDA funded projects) must be reviewed for environmental implications by the NoFC - Environmental Screening Committee. The purpose of such screening is to ensure that environmental effects are considered during the planning stages before any commitments or irrevocable decisions are made.

9. Study Objectives:

1. Provide consultative and advisory services to government agencies, industry and the public on environmental concerns in relationship to acid deposition (air pollution), herbicides, and northern development.

2. Provide reviews of projects/studies for environmental implications through the Environmental Screening Committee.

3. Participate in the monitoring of AR-NEWS plots in collaboration with NOR-11 (FIDS).

10. Goals for 1989-90:

1. Publish an Information Report on the soil analysis and vegetation cover of the AR-NEWS plots of the prairie region. (Maynard, Fairbarns)

2. Publish an Information Report entitled "Biomonitoring forests near two sour gas processing plants: A 5-year study" by D.G. Maynard.

3. Provide consultative and advisory services and undertake studies to resolve problems related to industrial development in natural areasas needs and opportunities arise in consultation with the Program Director (includes involvement with the AR-NEWS sampling and analysis and the Quality Assurance working group). Attend workshops and symposia. (Maynard,Sidhu,Feng,Zoltai)

4. Maintain the inductively coupled plasma atomic emission spectrometer (ICP-AES) by preventative maintenance checks and replacement of worn parts. Upgrade the ICP-AES to reduce operating expenses and maintenance downtime and costs. (Radford)

5. Review of Projects/studies for environmental implications by the NoFC - Environmental Screening Committee. (Sidhu, Maynard, Feng, Zoltai, Brace)

11. Accomplishments in 1989-90:

1. The first draft of the Information Report on the baseline chemical and vegetation analysis will be completed early in the new fiscal year (May). It is anticipated that it will be sent out for review at that time. (Maynard, Fairbarns)

2. The Information Report entitled ""Biomonitoring forests near two sour gas processing plants: A 5-year study" by D.G. Maynard has been edited and is being typeset.

3. Consultative and advisory services were rendered to a variety of government (federal and provincial) agencies, industry (forestry, energy, and consulting companies) and university researchers. This included the review of 3 pulp mill proposals by Steve Zoltai for Environment Canada.

4. The ICP-AES has been maintained with very little down time. A general preventative maintenance was done by the company serviceman. Approximately 40 000 analysis will have been run on the ICP-AES during 1989-90 including 12 000 for the Analytical Services Laboratory. The majority of the samples were analyzed for NoFC associated

projects. A new ICP-AES has been purchased and is expected to arrive by the end of February. Installation and quality assurance tests will take approximately 2 weeks.

5. There were 6 studies reviewed by the environmental screening committee during 1989-90.

12. Present Status of Study:

The final report of the study carried out in west-central Alberta has been edited and is now being typeset. The consultative and advising services are-on going and requests have been dealt with as required. The first draft of the information report on the baseline ARNEWS chemical and vegetation analysis for Northwest region will be completed by May 1990. A complete resampling of the ARNEWS plots in the region is scheduled for the summer of 1990 as part of a resampling of the ARNEWS plots nation wide.

13. Goals for 1990-91:

1. Publish an Information Report on the soil analysis and vegetation cover of the AR-NEWS plots of the prairie region. (Maynard, Fairbarns, carried over from 1988-89)

2. Resample 10 ARNEWS plots in the Northwest region. This will include samples for soil and foliage analysis, vegetation analysis (e.g. plant cover estimates), and other measurements as outlined in the ARNEWS manual (Fairbarns, Maynard and in cooperation with NOR 11).

3. Provide consultative and advisory services and undertake studies to resolve problems related to industrial development in natural areas as needs and opportunities arise in consultation with the Program Director (includes involvement with the AR-NEWS sampling and analysis and the Quality Assurance working group). Attend workshops and symposia. (Maynard,Sidhu,Feng,Zoltai)

4. Complete quality assurance on newly installed ICP-AES. Acquire training on the operation of the new instrument and systems computer software. Maintain the inductively coupled plasma atomic emission spectrometer (ICP-AES) by preventative maintenance checks (Radford).

5. Review of Projects/Studies for environmental implications by the NoFC - Environmental Screening Committee. (Sidhu, Maynard, Feng, Zoltai, Brace)

6. Evaluate and reorganize 0701 in relationship to the other NOR 07 studies. (Maynard, Sidhu)

14. Publications 1989-90:

1. Maynard, D.G. 1990. Biomonitoring forests near two sour gas processing plants: For. Can., Northwest Reg., Nor. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-311.

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leaders, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Start: 1970 Completion: On-going

17. Resources 1990-91:

PYs:	Prof.:	Feng, J.	0.1
		Maynard	0.2
		Sidhu	0.2
		Zoltai	0.1
	Tech.:	Radford	0.5
		Fairbarns	0.3
Total:			1.4
Term/Student:			0.0
O & M		$7.8 K	
Capital:		Nil	

18. Signatures:

Investigator

Investigator

Investigator

Program Director, Protection

Investigator

Regional Director General

NOR-7-04

FORESTRY CANADA

STUDY WORKPLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 7, 1990

1. Project: Environmental Effects of Chemical Substances and Vegetation Management

2. Title: Environmental impact and residue chemistry of forestry herbicides

3. New: Cont.: X 4. No.: NOR-7-04

5. Study Leader: S.S. Sidhu, J. Feng, C. Feng

6. Key Words: Herbicides, forest system, persistence, degradation, adsorp-tion, desorption, environmental impact, residue chemistry

7. Location of Work: Northwest Region

8. Problem Analysis:

Herbicides, as well as nonchemical methods of weed control such as site scarification, prescribed burning, mechanical and manual treatments provide a wide range of options for forest weed management. Even though the effectiveness of herbicides for control of weed species in forestry has been recognized since the introduction of the phenoxy herbicides, their use in forestry has lagged far behind that of agriculture. At present, forestry use of herbicides in Canada is less than 0.5% of the total used in agriculture. The limitation in the use of herbicides as a silvicultural tool is to some extent a result of the lack of information available on the environmental effects of these compounds in the natural environment. While various herbicides have been tested by CFS over the last several decades, herbicide studies have never constituted a top priority in forest management research activities. In addition, the agrochemical industry has never had a research and development program of any duration for forestry use of herbicides in Canada.

Currently, the Forest Pest Management Institute (FPMI) of ForCan, as a National Institute, has the mandate to conduct herbicide research for forest resource management in Canada. The aims of FPMI's Herbicide Research Project are to accelerate the development of new herbicides, to refine and improve methods of utilizing existing products, and to improve application technology and formulation characteristics to enhance effectiveness of the herbicides while minimizing the impact on the forest ecosystem.

One of the major areas of concern, with significant data gaps, is the fate of herbicides entering the forest ecosystem. Available information on residue chemistry and environmental impact of forest herbicides under Canadian climatic conditions, particularly in the boreal forest, is very limited. Therefore, NoFC proposes to carry out research, relevant to the Western and Northern Region, on the persistence, mobility, degradation, and fate of forest herbicides and their metabolites in the terrestrial environment. In addition, attempts will be made to assess the impact of herbicide application on the plant community as a whole to evaluate the influence of this silvicultural practice on plant community structure and forest productivity. These studies are essential if sufficient information is to be generated to make informed decisions regarding the use of herbicides in this region.

In order to avoid fragmentation of environmental impact and residue research studies, NoFC will ensure that the data collected is available to FPMI, provincial governments, and the public. Also, the information obtained from this study will be integrated into vegetation management guidelines/prescriptions to be developed through a parallel study on "Field Testing and Evaluation of Forestry Herbicides" in NOR-10. Initially, three major herbicides, namely Roundup, Velpar, and Garlon, will be considered for study.

9. Study Objectives:

1. Determine the fate of herbicides in the forest ecosystems, by studying persistence, lateral and downward movement, degradation, and adsorption/desorption characteristics in regionally important forest soils under laboratory and field conditions.

2. Evaluate the impact of herbicides on the structure, composition, and dynamics of forest plant communities, including mycorrhizal aspects.

3. Provide federal, provincial, and industrial resource managers in the region with advice on the environmental effects of the use of herbicides in forestry applications.

10. Goals for 1989-90:

1. Complete analysis of all samples of vegetation, soils, water and soil leachate collected in 1988 from the Grande Prairie Study (Method-II) plots by September 1989. Synthesize vegetation and residue data and prepare the final research report for the Canada-Alberta FRDA. Alberta FRDA (Sidhu, J. Feng, C. Feng).

2. Design a monitoring system and collect samples to monitor PRONONE 10G deposition, off-site movement and hexazinone residues in soil and vegetation from Method-I herbicide plots scheduled for Spring 1989 application. Alberta FRDA (Sidhu, J. Feng).

3. Prepare soil samples collected in 1988 for bulk density determination. Perform residue analysis on field soil samples hand-planted with inoculated Pronone 10G granules. A-Base. (J. Feng, C. Feng)

4. Depending on the preliminary results (Method II) collect post-herbicide treatment field samples of soil leachate and surface water (in collaboration with Alberta Environ.), foliage and soils for herbicide residue analysis until residue level are reduced to non-detectable for two consecutive sampling periods. Alberta FRDA. (J. Feng, Sidhu)

5. Publish a paper "Deposition of hexazinone from a logarithmic sprayer" by J.C. Feng, G.B. Ehrentraut and T.J. Drew in J. Environ. Sci. Health. Alberta FRDA. (J. Feng)

6. Prepare and submit a paper on the soil sampling method for 0-time pesticide residues after field application, in collaboration with S. Navratil. A-Base. (J. Feng)

7. Complete the study and prepare a report on the hexazinone degradation in air-dried soil during cold storage. A-Base. (J. Feng)

8. Sample vegetation for cover and density on supplementary plots, biomass in 32 plots and cover in 360 selected plots of the herbicide and mechanically treated plots of the site preparation area (Method-II) of the Grande Prairie study. Alberta FRDA. (Sidhu)

9. Participate in the National Check Sample Program as the coordinator for forestry herbicides, conduct check sample studies, and publish results (J. Feng). Modify and streamline analytical methods for herbicide residues. Initiate and maintain laboratory Quality Assurance programs. A-Base. (J. Feng, C. Feng)

10. Provide information and advice to federal, provincial and industrial agencies in the region on environmental effects of the use of herbicides in forestry. Participate in various committees (ECW-Soil Residue Carry-over Committee, For. Can. Weed Management Working Group and other scientific committees). A-Base and Alberta FRDA. (Sidhu, J. Feng)

Additional Goals:

11. Prepare and submit research summaries to the ForCan Vegetation Management Working Group to up-date the compendium of Forestry Canada Summaries on Vegetation Management. The final document of this compendium will be published as an ForCan Information Report. A-base. (J. Feng, Sidhu)

12. Design a sampling and residue analytical protocol for NOR-10 on monitoring glyphosate residues in the wood of aspen after trunk injection and harvesting to evaluate impact to the health of wood handling workers (a potential collaborative study with Navratil). A-base. (J. Feng)

13. Collaborate with FPMI and the University of Toronto (via FPMI) on publishing two papers on the environmental impact of forestry herbicides (glyphosate and hexazinone). A-base. (J. Feng)

14. Collaborate with FPMI and PFC (via FPMI) on preparing and submitting three papers for journal publication on the environmental impact of forestry herbicides, hexazinone and glyphosate. A-base. (J. Feng)

15. Publish paper," Effect of selected forestry herbicides on ectomycorrhizal development and seedling growth of lodgepole pine and white spruce under controlled and field environment." in Eur. J. For. Path. (Sidhu)

11. Accomplishments in 1989-90:

1. All samples collected in 1988 were analyzed on schedule. Residue data were synthesized and reported at the Expert Committee on Weeds (ECW) meetings, including three platform presentations and two research reports (see section 14 -- other publications) for the purpose of "Technology Transfer" (TT). A final research report was prepared for the Canada-Alberta FRDA.

2. Due to the use of new equipment and field conditions, the original monitoring plan was expended to two studies: 1) to evaluate a new ground application systems and 2) to study hexazinone runoff and persistence in the low, wet and semi-water-logged areas within and outside the treatment area, respectively. Methods and work-plan were designed. Application was carried out by using the tractor-mounted Granul-Air® applicator in May, 1989 in the Method-I area, Grande Prairie. Samples for studying granule deposition and distribution were collected and analyzed. Results of the ground application were reported at ECW by platform presentation and ECW research report (see section 14) for TT purpose. Twenty soil sampling stations were established. A new method was used to collected both runoff and on-site soil samples at 2 depths from all stations and at 3 time-periods during the 1989 growing season. Soil samples were stored in -20°C cold room.

3. All 1988 samples were analyzed, and data calculated, synthesized, and evaluated. Averaged level of hexazinone residues reduced to 1% that the amount applied in the 0-10 cm soils, and 3-5% in the 0-40 cm soils. Results were reported at ECW by platform presentation and ECW research report for TT purpose.

4. Soil samples collected at the end of growing season in 1988 showed 1% hexazinone residues in the 0-10 cm soil layer and 4% in 0-40 cm layer. Two full scale sampling of soils were conducted and soil leachate sampling were continued between snow melt and ground freeze in 1989. Other types of sampling were discontinued.

5. The paper was published in J. Environ. Sci. Health B24(5):525-537.

6. A paper entitled "Sampling for zero-time hexazinone residues in forest soils for dissipation study" by J.C. Feng and S. Navratil was submitted to Can. J. For. Res. Results of this study were reported at ECW by platform presentation and ECW research report for TT purpose.

7. Postpone for 1 year due to other priorities (see additional goals). Samples of one more time period will be analyzed in 1990-91 to complete this study.

8. Sampled 360 vegetation plots for stem density and cover, and 32 plots for biomass. In addition 72 plots sampled for degree of disturbance in herbicide + mechanical treatment and Double-disced treatment plots.

9. The National Check Sample Program has been accepted by the Canadian Association of Pest Control Officials (CAPCO) to be the Program's sponsor organization. Routine tasks were carried out on an on-going basis.

10. Consultations were provided to various government agencies, industries and other herbicide users and researchers. Participated in committees identified in Goal 10.

    Data and information package generated on the Pronone 10G from the Grande Prairie studies were provided to FPMI for their needs to evaluate the information submitted for the registration of the compound. The FPMI commented that the information provided by NoFC (NOR-0704) was critical for the registration of the compound.

    Two accomplishments initiated under this goal were listed as additional goals 11 and 12 due to their significance in forestry research and the work involved.

11. Twenty two (22) research summaries were prepared for and submitted to the ForCan Vegetation Management Working Group towards the ForCan compendium and Inf. Rep. on vegetation management.

12. After initial discussions, a detailed protocol with diagrams was prepared for the future implementation of this study.

13. A paper entitled "Drift response of stream invertebrates to aerial applications of glyphosate" by Kreutzweiser, Kingsbury, and Feng was published in Bull. Environ. Contam. Toxicol. (see section 14)

    A paper entitled "Determination of persistence, movement, and degradation of hexazinone in selected Canadian boreal forest soils" by Roy, D.N., S.K. Konar, D.A. Charles, J.C. Feng, R. Prasad and R.A. Campbell was published in J. Agric. Food Chem. (see section 14)

14. A paper entitled "Red pine release and residue persistence after hexazinone spot gun treatment in northern Ontario" by Prasad and Feng was submitted to Weed Technol. for publication.

    A paper entitled "Fate of glyphosate in a Canadian forest watershed. Part 1: aquatic residues and off-target deposit assessment" by Feng, Thompson, and Reynolds was submitted to J. Agric. Food Chem. for publication.

    A paper entitled "Fate of glyphosate in a Canadian forest watershed. Part 2: persistence in foliage and soils" by Feng and Thompson was submitted to J. Agric. Food Chem. for publication.

15. Paper," Effect of selected forestry herbicides on ectomycorrhizal development and seedling growth of lodgepole pine and white spruce under controlled and field environment." (Accepted for publication in Eur. J. For. Path.; galley proofs received and sent back to the Journal.)

12. Present Status of Study:

The herbicide environmental Impact study has progressed well during the last 4 years. Several new herbicide application systems were evaluated for drift control or for reducing the amount of herbicide used in research trials. Vegetation, soil, soil leachate, water, and sediment samples have been collected for the last 3 years after the herbicide application in the fall, 1986.

Residues of hexazinone and its metabolites were analyzed for all samples collected during and before 1988. New methodologies for determining the hexazinone residues in soil and vegetation were developed.
A total of 7 journal papers, 2 government reports, and 14 Expert Committee on Weeds (ECW) research reports were published. In addition, a total of 9 journal and proceeding papers and information reports were published in collaboration with FPMI.

The journal papers were related to the effect of glyphosate, hexazinone (Velpar and PRONONE 10G), and triclopyr on the seedling growth and mycorrhizal fungi; the distribution pattern of PRONONE 10G granules from aerial and ground applicators; the release of hexazinone from PRONONE 10G granules under laboratory and field conditions; vertical movement of hexazinone residues in soil leachate; and the application of liquid hexazinone (Velpar L) by a logarithmic sprayer. A status report on the environmental impacts of the vegetation management project (Canada-Alberta FRDA) and a final research report for the Canada-Alberta FRDA project were prepared. The ECW research reports as well as platform presentations at its annual meetings were intended for the purpose of technology transfer to allow forester, forestry managers, forestry industries, chemical company, and regulatory agencies making decisions on the proper and responsible use of forestry herbicides. As the role of FPMI within ForCan in herbicide research is recognized as to accelerate the development of new herbicides, to refine and improve methods of utilizing existing products, to improve application technology, and to enhance effectiveness of the herbicides while minimizing the impact on the forest ecosystem, the continual collaboration with FPMI is therefore deemed to be essential, and 9 papers related to herbicide research were thus published.

In addition, 5 journal papers on the residue sampling technology, the environmental fate and impact of forestry herbicides (in collaboration with FPMI), and the effect of hexazinone on ectomycorrhizal development and seedling growth in lodgepole pine and white spruce under laboratory and field conditions were also prepared and submitted to scientific journals for publication. A permit application has been made to apply PRONONE 10G by using a newer tractor-mounted granule applicator to the crop release plots of the Grande Prairie study in spring 1989. The plots were monitored for the herbicide deposition rates and granule distribution pattern, as well as the off-site movement and persistence of herbicide residues in the low, wet areas where soil samples will be taken on an on-going bases for two years after application. The sampling of vegetation for stem density and cover (Method I) is scheduled for 1990/91. The final vegetation sampling of site preparation plots (Method II) is scheduled for 1991/92 (5th year); those of crop release plots (Method I) is scheduled for 1994/95 (5th year).

The wet chemistry laboratory (Room M109) was renovated to upgrade the ventilation system and to improve the safety of working environment. Two bench top fumehoods (Class A) and new exhaust pipes and fans were installed.

Consultation and advice were provided to various provincial, federal and industrial agencies on a continuing basis. Under technology transfer, available information was communicated in the form of published papers, reports and presentations at professional meetings. Acknowledgements were received from chemical industries who had been successfully registered their products by including research results of our studies as the support.

13. Goals for 1990-91:

1. Receive training on computer analysis from NOR-13 and process weather data collected hourly for 3 years since July, 1986, including air temperature, relative humidity, amount of rainfall, soil temperature and moisture at two different soil depths. (C. Feng)

2. Analyze samples of vegetation, soils, and soil leachate collected in the Method II areas in 1989; perform analysis of 1989 soils treated with hand-planted inoculated Pronone granules; and initiate analysis of run-off soils from the Method I areas (a new study initiated in 1989). (J. Feng, C. Feng)

3. Collect soil samples from the Method I area, Grande Prairie, for monitoring the off-site movement and persistence and leaching of hexazinone (applied as PRONONE 10G) in low, wet area. (Continuation of 1985-90 Canada-Alberta FRDA study) (J. Feng)

4. Collect soil samples from the Method II area, Grande Prairie, treated with spiked PRONONE granules in 1986, until residues reduced to non-detectable level as agreed by the coordinators of the Grande Prairie Vegetation Management Project, including NoFC, AFS, and Alberta Environment. (Continuation of 1985-90 Canada-Alberta FRDA study) (J. Feng, C. Feng)

5. Prepare a manuscript for a Journal publication on the persistence of hexazinone and its metabolites in vegetation. (Sidhu, J. Feng)

6. Prepare a manuscript for a Journal publication on the effects of hexazinone on nutrient status in foliage of boreal species. (Sidhu)

7. Publish a paper, "sampling for zero-time hexazinone residues in forest soils for dissipation study", in collaboration with S. Navratil. (J. Feng)

8. Publish three papers in collaboration with FPMI and PFC (via FPMI) on the environmental impact of forestry herbicides, hexazinone and glyphosate. (J. Feng)

9. Complete the study and prepare a report on the hexazinone degradation in air-dried soil during cold storage. (J. Feng)

10. Sample vegetation for hexazinone and brush-saw effect of treatments in the crop release area (Method I, Grande Prairie). (Sidhu)

11. Participate in the CAPCO-National Check Sample Program (CAPCO=Canadian Association of Pest Control Officials) as the coordinator for forestry herbicides, coordinate and conduct check sample studies, and publish results (J. Feng). Modify and streamline analytical methods for herbicide residues. Initiate and maintain laboratory Quality Assurance programs. A-Base. (J. Feng, C. Feng)

12. Provide information and advice and contribute to the report on the wildlife implications of the use of hexazinone as a forestry herbicide. (Sidhu, J. Feng)

13. Provide information and advice to federal, provincial and industrial agencies in the region on environmental effects of the use of herbicides in forestry. Participate in

various committees (ECW-Soil Residue Carry-over Committee, For. Can. Weed Management Working Group and other scientific committees). A-Base and Alberta FRDA. (Sidhu, J. Feng)

NOTE: THE FOLLOWING GOALS DEPEND ON THE APPROVAL OF NEW FRDA.

14. Initiate a new study on the modelling of temperature effect on hexazinone degradation in soils. Manitoba-FRDA. (J. Feng, C. Feng)

15. Initiate a new study on the modelling of hexazinone leaching in soils. Manitoba-FRDA. (J. Feng, C. Feng)

16. Initiate a new study on the effect of hexazinone on vegetation changes and residue persistence and movement in three different types of Manitoba soils. Manitoba-FRDA. (Sidhu, J. Feng)

14. Publications 1989-90:

Journal:

Feng, J.C.; Ehrentraut, G.B.; Drew, T.J. 1989. Deposition of hexazinone from a logarithmic sprayer. J. Environ. Sci. Health B24(5):525-537.

Feng, J.C.; Sidhu, S.S. 1989. Distribution of blank hexazinone granules from aerial and ground applicators. Weed Technol. 3:275-281.

Kreutzweiser, D.P.; Kingsbury, P.D.; Feng, J.C. 1989. Drift response of stream invertebrates to aerial applications of glyphosate. Bull. Environ. Contam. Toxicol. 42:331-338.

Roy, D.N.; Konar, S.K.; Charles, D.A.; Feng, J.C.; Prasad, R.; Campbell, R.A. 1989. Determination of persistence, movement, and degradation of hexazinone in selected Canadian boreal forest soils. J. Agric. Food Chem. 37:443-447.

Sidhu, S.S.; Chakravarty, P. 1990. Effect of selected forestry herbicides on ectomycorrhizal development and seedling growth of lodgepole pine and white spruce under controlled and field environment." Eur. J. For. Path. (in press)

Sidhu, S.S.; Feng, J. 1990. Final report Canada-Alberta Forest Resource Development Agreement (FRDA): Forest Vegetation Management R&D Program - Environmental Impacts and Residue Chemistry. March 1990.

Others:

Feng, J.C. 1989. Granular herbicide application by helicopter equipped with an bucket spreader. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:212.

Feng, J.C.; Ehrentraut, G.B.; Drew, T.J. 1989. Evaluation of a logarithmic sprayer for herbicide application in forestry research trial. Expert Comm. Weeds, East. Can. Sect. Res. Rep. 3:

Feng, J.C.; Feng, C.C. 1989. Persistence of hexazinone two years after application in silty clay soil. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:191.

Feng, J.C.; Navratil, S. 1989. Evaluation of a new soil sampling method for herbicide residues immediately after spraying. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:192.

Feng, J.C.; Sidhu, S.S.; Feng, C.C. 1989. Persistence and leachability of hexazinone in deep soils. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:193.

Feng, J.C.; Sidhu, S.S.; Feng, C.C. 1989. Performance of a commercial granular applicator in hexazinone application. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:211.

Payne, N.J.; Feng, J.; Reynolds, P.E. 1989. Off-target deposits and buffer zones required around water for various aerial silvicultural glyphosate applications. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:218.

Sidhu, S.S.; Feng, J.; Feng, C. 1989. Persistence and levels of hexazinone residues in some plant species. Expert Comm. Weeds, West. Can. Sect. Res. Rep. 3:221.

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment. (For Environmental Implications of herbicide application, also see NOR-10 & NOR-36-02-01).

16. Duration:

Start: 1985 Completion: 1992

17. Resources 1990-91:

PYs:	Prof.: Sidhu	0.7
	Feng, J.	0.9
	Feng, C.	1.0
	Tech.: Fairbarns	0.7
	Total:	3.3
	Student:	0.6

O & M: $ 14.0 K
Capital: $ 1.6 K

Alberta-FRDA (Canada Alberta Agreement)

O & M: $ Nil
$ Nil (service contract PY)

18. Signatures:

Investigator

Investigator

Program Director, Protection

Investigator

Regional Director General

NOR-7-05

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

March 7, 1990

1. Project: Environmental Effects of Chemical Substances and Vegetation Management

2. Title: Nutrient cycling and dynamics, in relation to chemical substances and silvicultural practices.

3. New: Cont.: X 4. No.: NOR-7-05

5. Study Leader: D.G. Maynard

6. Key Words: Nutrient cycling, nutrient uptake, herbicides, ecosystem stability, tree growth

7. Location of Work: Region wide, emphasis on Alberta

8. Problem Analysis:

Much of Canada's previously harvested forests are significantly understocked and the use of chemical control (eg herbicides) of weed species is seen as one of the major tools that can be used to establish a comercial forest. Environmental groups have expressed their concern about the spraying of herbicides and what effects may occur as a result. The forest industry and Provincial Regulatory Agencies would like to use this silivicultural tool but lack essential scientific information on either the direct effects on various ecosystem processes and components (e.g. decomposition of organic matter) or the long-term influence on fundamental ecosystem functioning (nutrient cycling and uptake). This information is essential if the forest resource is to be managed for sustained yields in an environmentally acceptable and ecologically stable manner.

Soil is fundamental to any forest management and productivity strategy. Present and future concerns will be the result of new technologies or of intensification of forest management in areas where relevant information is lacking. Management strategies such as whole tree harvesting, shorter rotations, and intense site preparation such as herbicide applications, are being proposed. Increased nutrient losses associated with harvest raises questions about adequate long-term soil supplies for future stands and hence productivity declines. At present we can not answer questions regarding long-term productivity of most sites. There are few appropriate analytical procedures, sampling is often inadequate and published estimates of soil supply are not always meaningful as the information has been determined on unmanipulated,

undisturbed stands. In addition, if the proposed scenario of increased temperatures within the next 50 to 100 years (climate change) occurs then many of our current management strategies with respect to nutrient dynamics will be inadequate. If the optimum management and protection of forest resources is to be assured, studies on the effects of climate change on nutrient cycles, especially their inorganic/organic transformations are required.

Soil factors may also play a role in the incidence of certain diseases particularly, root rots. Armillaria root rot is one of the most important diseases of coniferous regeneration in Canada. Different soils based on site productivity have been found to have variable incidence of Armillaria root rot; however, the soil properties (if any) associated with conduciveness or suppression of the disease have not been identified. It would be desirable from a forest management perspective to be able to hazard rate sites for Armillaria root rot before regeneration takes place.

9. Study Objectives:

1. Determine the influence of herbicide applications on the decomposition of organic matter and nutrient cycling within forest soils.

2. Determine the transformations and fractionation of nitrogen, phosphorus and sulfur in relation to the cycling of these elements in forested ecosystems as affected by herbicide applications.

3. To determine the relationship between nutrient stress and Armillaria root rot in lodgepole pine (in collaboration with Dr. Ken Mallett, NOR 11).

4. Provide federal, provincial, and industrial resource managers with advice on the environmental effects of the use of various silvicultural practices.

10. Goals for 1989-90:

1. Complete a report for publication as a journal article or Information Report on the impact of silviculture practices on nutrient cycling in mixed woods.(Maynard, carried over from 1988-89)

2. A journal article on the result of the hexazinone (Velpar) growth chamber study will be completed and submitted for publication. (Maynard)

3. Complete an interim report on the nutrient status of the soil before and after herbicide application in the operational plots. (Maynard)

4. Continue to monitor the soils, zero-tension lysimeters, and litter fall collectors in the nutrient cycling field site. Analysis of the litter bag samples, soils and foliage is on-going. (Maynard, Sidhu)

5. Complete the analysis of the soils collected from Block 2 of the operational field study and prepare an interim report. Further reporting will depend upon the results of this study plus information obtained in the growth chamber and smaller nutrient cycling field plots. (Maynard)

6. Prepare a file report on the results of the Philom Bios phosphorus biofertilizer study. (Maynard in cooperation with I. Edwards)

7. Review information available on soil management and nutrient supply with respect to long-term site productivity in a mixed- wood forest. (Maynard)

Added goal:

8. Conduct a preliminary survey on conifer stands in the Hinton and Whitecourt areas to determine if there is a relationship between soil nutrient status and the incidence of root rot. (Maynard, in cooperation with K. Mallett, NOR 11)

11. Accomplishments in 1989-90:

1. Most of the current literature has been collected. An outline on the main sections to be covered has been prepared. The report will focus on the information available on soil nutrient dynamics in the boreal mixedwood and indicate areas where more reseach is needed. It is expected that this report will be useful in developing the proposed new study for NOR 07. (Maynard)

2. The analysis of the soil and plant samples has been completed. Collation and statistical analysis of the data is being done. A title on the "Effect of hexazinone on nutrient dynamics in a postharvest aspen regeneration" has been submitted for prsentation at the Canadian Society of Soil Science Meetings in July, 1990. A journal manuscript on these results will be completed and submitted for review in the new fiscal year. The results of the study indicate that the microbial populations responsible for the transformations (mineralization and immobilization) of N, S, and P were not affected by Velpar. An interesting aspect of the study indicated that the aspen litter has the potential to release large amounts of mineral (NO_3 and NH_4) N under certain temperature and moisture conditions. (Maynard)

3. An interim report on the effects of Pronone on the nutrient balance in the LFH has been completed and included in the final FRDA report. This report is based on the preliminary finding from the operational plots (goal #5), nutrient cycling plots, and the growth chamber study. The results indicate that for at least two years post-herbicide application the nutrient regime of the LFH in the 4 kg ha^{-1} plots has been altered. Extractable nutrients and litter fall nutrient concentrations indicate the changes in the nutrient concentrations of the LFH are due to changes in the litter fall quality and quantity and decreased nutrient uptake (ie less vegetation less nutrient demand). (Maynard)

4. The smaller nutrient cycling plots were sampled twice, in June and September 1989. It was an extremely moist summer in the Grande Prairie area and there was some difficulty in getting representative samples. Analysis on the LFH samples for all years has been completed and work is continuing on the mineral soil samples. Results to date indicate an increase in mineral N concentrations of the LFH suggesting a reduced demand for N as a result of reduced vegetation cover. This has implications with respect to herbicide management (ie site preparation versus release) and also potential nutrient losses. (Maynard)

5. The LFH soil analysis for all years and the mineral soil analysis for 1986 and 1987 has been completed. Work is continuing on the analysis of the mineral soils sampled in 1988. The results from the operational plots were incorporated with the results of the smaller field study (goal #3) and included in the section on soil nutrients for the final FRDA report. (Maynard)

6. A report was prepared and submitted to Philom Bios on the results of the biofertilizer growth chamber study. The results found no postive effect of the biofertilizer (fungus) on the growth and P uptake of pine and spruce, or extractable soil P concentrations.

7. A review of the information on ecosystem productivity in mixed wood forests was carried out. The information collected formed the basis for the nutrient dynamic section of a new proposal for NOR 07 (in cooperation with S.S. Sidhu). In addition some of the information reviewed will be incorporated into the paper on nutrient cycling in mixed woods (goal 1, 1990-91).

8. A preliminary survey was set up to determine the possible link between Armillaria and nutrient status. Foliage and soil samples were collected from infected and uninfected trees on one site in the Hinton area and three sites in the Whitecourt area. Preliminary results found significantly lower concentrations of N, S, and Ca in the foliage of trees affected by Armillaria. A greenhouse study has been designed to look at the relationship between nutrient stress and Armillaria root rot.

12. Present Status of Study:

The operational herbicide study plots were not sampled in 1989. Analysis of the 1986 and 1987 samples and the 1988 surface organic horizons (LFH) are complete. Work is continuing on the 1988 mineral soil analysis. An interim report comparing pre- and post-herbicide nutrient concentrations on the operational plots has been completed and is included in the final FRDA report. The analysis of the soil from the growth chamber study was completed and analysis of the data is continuing. A journal article on the results of the growth chamber study is being prepared. Two soil samplings in June and September of 1989 were done on the smaller nutrient cycling field plots; however, 1989 was a very wet year and sampling of these plots was difficult. Analysis of the LFH samples for all years is completed and analysis of the mineral soils is continuing. In 1989 there was some recovery of the vegetation in both herbicide treatments although the understory cover was considerably less than in the control. Preliminary results of these studies indicate that the herbicide effects soil nutrients through changes to the litter fall quality and quantity and by reduced uptake of nutrients by vegetation. The growth chamber results indicate there were no effects either positive or negative on the mineralization of N, S, and P. Differences in the soil nutrients of the LFH were observed up to two years following the herbicide treatment on the operational plots; however, it is not known what the longterm implications on ecosystem productivity are.

13. Goals for 1990-91:

1. Prepare and submit for review by October, 1990 a journal review article on the impact of silviculture practices on nutrient cycling in mixed woods. (Maynard, carried over from 1989-90)

2. Prepare and submit for review by July 1990, a journal article entitled " The effect of hexazinone (Velpar) on the mineralization of N, P, and S from aspen litter". (Maynard, carried over from 1989-90)

3. Present a paper entitled "Effect of hexazinone on nutrient dynamics in a postharvest aspen regeneration" at the Canadian Society of Soil Science Meetings in Penticton, B.C. July 22-26, 1990. (Maynard)

4. Continue to monitor the soils, zero-tension lysimeters, and litter fall collectors in the nutrient cycling field site. Analysis of the litter fall, soils and foliage is on-going. (Maynard)

5. Complete the analysis of the soils collected from Block 2 of the operational field study. Prepare a journal article or report on the results of the operational plots study. (Maynard)

6. Initiate and complete a greenhouse experiment to determine the relationship between nutrient stress and Armillaria root rot in lodgepole pine. (Maynard, in cooperation with K. Mallet, NOR 11)

7. Depending upon approval of funding under a new Alberta FRDA, plan and design a new study on "Baseline ecological trends in vegetation and soils and changes a s a result of forestry practices" (in cooperation with S.S. Sidhu).

14. Publications:

Nil

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Start: 1986 Completion:1992

17. Resources 1990-91:

PYs:	Prof.:	Maynard	0.7
		Sidhu	0.1
	Tech.:	Radford	0.3
	Total:		1.1
	Term/Student:		0.0

O & M: $ 6.0 K
Capital: Nil

Capital: Nil

18. Signatures:

Investigator

Program Director, Protection

Regional Director General

NOR-11-01

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 23, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Forest Insect and Disease Surveys

3. New: Cont.: X 4. No.: NOR-11-01

5. Study Leaders: H.F. Cerezke and W.J.A. Volney

6. Key Words: Detection, parasites, predators, hosts, damage impact, biological control, tree damage agents, acid rain, tree pest extension, parks, Geographical Information System, pest depletion losses, FIDS/INFOBASE, plantations, nurseries, forest ecosystems, survey methods, plant quarantine, Pinewood namatode

7. Location of Work: Northwest Region

8. Problem:

Forest Insect and Disease Surveys (FIDS) and detection in Canada date back some 50 years. During this period of continuous operation, a wealth of information has accumulated that provides an historical record and knowledge base of native and introduced insect and disease species inhabiting forests and trees, their distributions, damage effects on trees, natural control agents, life cycle development and behavior within the Northwest Region. The data are gathered by a wide variety of established sampling, collecting and processing procedures that have been developed over a long period of time. Application of these procedures provides an efficient means of continually updating the knowledge of forest insect and disease infestations and other forest disturbances within the region, and to satisfy nationally directed surveys such as acid rain monitoring, pest outbreak prediction and plant quarantine concerns. The procedures also provide the basis for generating forest pest caused loss estimates, in pest risk analyses, in assessing pest controls, and in implementing integrated pest management strategies. During the period, 1976 to 1980, FIDS data helped identify annual tree mortality loss estimates in Canada from insects and diseases to be of the order of 77 mil. m^3 per year, and additional losses in growth reduction to be of a similar magnitude.

The survey, identification, reporting and prediction of losses due to insects, diseases and other damage agents forms an integral part of intensive forest management and other land use

interests, and must be maintained on an annual basis because of the dynamic nature of pest populations, forest growth and development. The combined objectives of the FIDS program are to assist in the overall wise use and management of forests within the region by providing basic on-going information for integrated pest management and protection of forests.

The encorporation of sound pest management strategies by regional clientele rely heavily upon an efficient and comprehensive FIDS operation. To meet this need the various functions of FIDS require a continual updating to encorporate new technologies such as insect pheromones, GIS systems applications, improved data recording and processing, and improved pest sampling/monitoring procedures.

9. Objectives:

1. To gain an improved and updated knowledge of forest insects and diseases in the region to help minimize their damage impact effects on trees and forests, provide an advisory service to regional and national management agencies and the public, contribute to FIDS national and provincial overviews of important pest conditions and FIDS/INFOBASE, and compile pest loss data to support FORSTATS.

2. To support research and plant quarantine activities with historical records, collections and observations.

3. To contribute to nationally directed surveys such as Acid Rain National Early Warning System (ARNEWS) and pinewood nematode.

4. To provide management agencies with pest identification, control and impact assessment services relating to effects of insects, diseases, climatic influences and pollutants on trees and other forest vegetation.

10. Goals for 1989-90:

1. Survey, map and report on major forest pests of the region:

   a. Mountain pine beetle in Saskatchewan, Alberta and the Rocky Mt. national parks;
   b. Spruce beetle, mostly in Alberta;
   c. Spruce budworm region wide;
   d. Jack pine budworm in the three prairie provinces;
   e. Forest tent caterpillar in the three prairie provinces;
   f. Other pest and damage agents as requested or identified. (FIDS Staff)

2. Conduct special surveys:

   a. Dutch elm disease and vectors in Alberta and Manitoba as required;
   b. Parks Canada; general surveys as in previous years;
   c. Selected provincial parks; surveys, collections, identifications and technology transfer as requested;
   d. Spruce budworm pheromone field trials (pending review of past several years data);
   e. Insect and disease concerns in provincial forest nurseries;

f. Other insect and disease problems as requested or identified. (FIDS Staff)

3. Publish 1987 and 1988 FIDS reports and submit to Editor the 1989 FIDS report. Urge publication of the 1986 FIDS report, now with Editor. (Emond, Cerezke, other FIDS Staff)

4. Continue training of FIDS staff on GIS system and map digitizing, and summarize data on regional pest depletion losses to 1989. Complete pest depletion loss exercise for period 1981-87. (Volney, Amirault, Cerezke, Mallett, FIDS Staff)

5. Provide pest extension services and technology transfer of information to regional clientele as requested, provide pest identification, diagnostic and advisory services on tree and shrub pests, and arrange for technology transfer workshops as required. (Staff of NOR-11)

6. Conduct pest surveys in designated genetic and tree improvement plantations and other high value stands as requested by client agencies and report. (FIDS Staff)

7. Represent Forestry Canada and NoFC on various national, regional and provincial forest pest and related insect and disease committees and advisory groups. (FIDS Staff)

8. Organize and conduct a Regional Insect and Disease Technical Advisory Committee meeting in Yellowknife, NWT, and prepare a report of recommendations for presentation to the Senior Regional Advisory Committee. (Volney, Cerezke, FIDS Staff)

9. Re-survey all ARNEWS plots in the region for presence of forest pests and tree damage. (FIDS Staff)

10. Serve as FIDS Head of NOR-11-01 (Cerezke), and provide functional guidance and supervision of studies initiated under the Federal-Provincial FRDA's in the Northwest Region. (Volney, Cerezke)

11. Complete any required editorial changes of two chapter contributions submitted to Dr. J.A. Armstrong for: "Aerial control of forest insects in Canada". (Cerezke, Volney, Pendrell-MFC)

12. Revise and submit for review for an Information Report: "The forest insect and disease survey sampling methods and survey techniques, prairie provinces and the Northwest Territories". (Moody, Emond).

13. Compile listing and stand inventory data on registered PSP's in Manitoba and identify which ones can be used for long term insect and disease monitoring and impact assessment. (Volney, Grandmaison)

14. Obtain from Alberta, in cooperation with Timber Management Branch, file data on all established provincial PSP's to identify selected locations for establishment of longterm insect and disease monitoring and impact plots. (Volney, Cerezke, FIDS Staff)

15. Conduct survey trials for pests in young high value conifer stands to test out a new survey sampling procedure now being developed under contract by Silvicom Consulting. (Amirault, FIDS staff)

16. Continue to develop an MOU with Manitoba and initiate similar MOU's with Saskatchewan, Alberta and the Northwest Territories. (Volney, Cerezke).

Added Goals:

17. Request by FORCAN, HQ, to provide information on wood borer/grubhole damage in Canadian softwood lumber for European export markets, and in relation to the pinewood nematode issue. Request also from Agriculture Canada, Plant Health Directorate, Ottawa, for attendance at technical sessions and to provide illustrative and text materials for training quarantine inspection staff. (Cerezke).

18. Request from Alberta Forest Service to participate in public information technical presentations on spruce budworm in northern Alberta. (Cerezke).

19. Undertake revisions and review of contract report by J.Petty ("Insect and Disease Infestations on Forest Lands in Alberta"), in cooperation with T. Singh (NOR-28-07 Study) for final report. (Cerezke).

20. Participate in peer review process of FIDS project at Great Lakes Forestry Centre. (Volney, Cerezke).

11. Accomplishments in 1989-90:

1. Surveys were completed region-wide for spruce budworm, jack pine budworm and aspen defoliators, and bark beetles were monitored in suspect locations. (FIDS Staff)

   a) surveys of mountain pine beetle were completed in the Rocky Mt. Nat'l Parks, southwestern Alberta and Cypress Hills.
   b) No active infestations of spruce beetle were reported.
   c) Infestations of spruce budworm increased in all jurisdictions. Assistance was provided to Alberta Forest Service in egg-mass and population census surveys, and in pre/post spray monitoring.
   d) Only a small infestation of the jack pine budworm was noted in central Alberta.
   e) The forest tent caterpillar defoliated an estimated 2.3 mil ha in the three prairie provinces, showing decreases in Alberta and Saskatchewan and increases in Manitoba.
   f) Infestations of Bruce spanworm, large aspen tortrix, aspen leaf beetles, Hypoxylon canker, Armillaria root rot and dwarf mistletoe necessitated additional surveys.

2. a) Assistance provided to Alberta Agriculture for surveys.
   b) General pest surveys were conducted in all 5 Rocky Mt Nat'l Parks. Bark beetle surveys were conducted in Jasper N. P. in areas of heavy pine and spruce blowdown, and to confirm negative invasion of mountain pine beetle.
   c) Selected provincial parks were surveyed for forest tent caterpillar, spruce beetles and tree decline.
   d) Spruce budworm pheromone traps were placed in about 20 locations to monitor moth populations; one group for the national pheromone tests, the other as a cooperative trial with Pacific Forestry Centre.

e) A seed orchard in Saskatchewan and the provincial tree nursery in Alberta were monitored for pests and reported on. (FIDS Staff)

3. The 1989 regional FIDS report was completed, reviewed and is now with Editor. A condensed version is in preparation for the national FIDS report. (Edmond, Cerezke)

4. Training of a FIDS Ranger on GIS technology and map digitizing was continued and is on-going. All FIDS historical maps from 1974 to 1989 have been digitized. Regional factors to be used in the pest depletion exercize for period 1981-1987 have been summarized and are being standardized nationally (re meeting in Ottawa Feb. 8-9, 1990). (Amirault, Volney, Cerexke, Mallett)

5. Tree pest extension information was provided in response to over 2000 client requests for insects, diseases and other tree damage agents in nurseries, shelterbelts, forests, mill yards, plantations and ornamental trees and shrubs. Other technology transfer contributions include the following: (FIDS Staff)

- several news media interviews (newspaper, radio) on forest tent caterpillar and spruce budworm.
- Two pruning course presentations for provincial training program.
- Seven public meeting presentations on forest tent caterpillar.
- Three general tree pest workshops, including herbicide use.
- Lectures on forest pests were given to forest entomolology students at Univ. Alta.
- Workshop on insect pests was presented to staff at Pine Ridge Forest Nursery, Alberta.
- Three-day workshop on forest pests and management presented to provincial/industry staff at Hinton Forestry School.
- Workshop on forest pests presented to staff at Alberta Forest Service, Timber Management Branch.
- Workshop on tree pests presented to students at Olds College, Alberta.
- Training session on spruce budworm sampling and damage estimation provided to Alta. Forest Service staff, Footner Lake Forest, Alberta.
- Two training sessions provided to provincial and industrial field staff on pest identification and sampling procedures in plantations.
- Workshop on tree/shrub pests and damage presented at Yellowknife, NWT.
- Coded lists of potential insect and disease pests in spruce and aspen plantations prepared for Manitoba Natural Resources.
- Public awareness information session on spruce budworm provided in Grande Prairie Forest, along with display materials.
- Texts of several NoFC Pest Leaflets revised: Spruce budworm, Forest tent caterpillar, Aphids, and spruce spider mite.
- Contributions made toward Forest Insect and Disease Notes (Tech. Transfer Note) issued in April, July and December, 1989.

6. Detailed pest surveys were conducted in 7 tree genetic plantations in Alberta and results were reported; two additional plantations were assessed for rootcollar weevil damage and control. One plantation in Saskatchewan was surveyed and pest conditions reported on. (FIDS Staff)

7. The following meetings and committees were attended and reported at:

   - Jack pine budworm support systems; Minneapolis, Minn. and texas College Station. (Volney)
   - Forest Pest Control Forum (plus FIDS Heads meeting, Pheromone Workshop, Pinewood nematode review) Ottawa.(Cerezke)
   - FIDS Heads Meeting, Sault Ste. Marie (Cerezke)
   - Four meetings (Edmonton and adjacent counties) on Forest Tent Caterpillar Advisory Group. (Emond, Gates)
   - Meeting with Muttart Conservatory staff, Edmonton. (Emond)
   - Alberta Pest Control Advisory Board, Edmonton. (Emond)
   - Four meetings on development of provincial (Alta.) pest emergency measures were attended, Edmonton. (Cerezke)
   - Attended meeting withm Alta. Agriculture to discuss provincial pest survey needs and methodology, Edmonton. (Cerezke)

   In addition, reports were prepared for the following, but meetings were not attended:

   - Western Committee on Crop Pests: updatings were provided for two chapters for 1990 control of tree/shrub insect pests, and for insects attacking seasoned wood. (Cerezke)
   - Report on 1989 status of forest insect and disease pests in Alberta to Alberta Horticultural Advisory Committee (Cerezke)
   - Saskatchewan Advisory Council on Pest Control (Still)

8. Organized, conducted and reported at Regional Forest Insect and Disease Technical Advisory meeting in Yellowknife, NWT., and a summary was prepared and presented at the Senior Regional Advisory Committee. (Volney, Cerezke, Mallett, Amirault, FIDS Technical Staff)

9. Eleven of the 12 regional ARNEWS plots (one lost in forest fire in 1989) were visited and surveyed for pests and damage; data sheets completed up to 1988 have been compiled and sent to PNFI for data entry/analyses. Base plot data were provided in early 1989 and were published in a PNFI Inf. Rep. (FIDS Staff)

10. Many duties were carried out as FIDS Head for Northwest Region. (Cerezke)

11. Two chapter contributions for Dr. J.A. Armstrong book "Forest Insects in Canada" were reviewed locally and submitted to Ottawa. (Cerezke, Volney)

12. The second draft of the manuscript "The forest insect and disease survey sampling methods - ----- Northwest Territories" was revised by B. Moody and J. Emond and reviewed locally.

13. Seventy five permanent sampling plots of Manitoba Natural Resources were monitored for pests and their damage, as part of cooperative program aimed at obtaining long-term pest-caused depletion losses. (Grandmaison, Volney)

14. This task was deferred, based on discussions with AFS, Timber Management Branch.

15. Detailed surveys were conducted in 3 young stands in Alberta, and one each in Saskatchewan and Manitoba to describe pest and damage conditions. The data were

provided to Silvicom Consulting as a contract for FC to design and develop statistically-based survey sampling procedures in young high-value stands. The final report is in preparation. (Amirault, Volney, FIDS Staff)

16. Four MOU's detailing forest pest survey responsibilities between provincial/Territories and FORCAN were completed for the Northwest Region, and have all been signed by the respective authorities. (Volney)

Added Accomplishments in 1989-90:

17. Three meetings were attended, two in Ottawa, one in Edmonton and technical presentations were made at all three, dealing with grubhole control in Canadian green coniferous lumber for export to European community markets. All were related to the Pinewood nematode issue and its vector relationships, primarily with Monochamus species of woodborers. Slide and corresponding text materials were loaned to Agriculture Canada, Plant Protection Directorate, for preparation of a video that is now being used by Plant Quarantine staff, Canadian exporters of coniferous wood and organizations such as the Alberta Forest Products Association. (Cerezke)

18. A week-long technical presentation session on the spruce budworm is planned for the first week of February for public information, in preparation for proposed aerial spray applications in the Footner Lake and Peace River forests in 1990. Scheduled meeting locations include High Level, Rainbow Lake, Chateh and Manning. (Cerezke)

19. Revisions and editorial review of contract report by J. Petty ("Insect and Disease Infestations on Forest Lands in Alberta") were undertaken in cooperation with T. Singh (NOR-28-07 Study) to prepare a more comprehensive document, probably as a FRDA document. A revised draft is nearing completion. (Cerezke)

20. Attended and participated as an external reviewers for peer review process of the Forest Insect and Disease Survey Project at Great Lake Forestry Centre. (Volney, Cerezke)

12. Present Status of Study:

1. Regional FIDS activities were focused on detecting, monitoring and mapping current infestations of the major pest species (spruce budworm, jack pine budworm, forest tent caterpillar, mountain pine beetle, etc.). This information is updated annually, summarized in regional and national reports, and reported at the annual Forest Pest Control Forum meeting in Ottawa. The annual summary of data adds to the knowledge base of regional outbreak patterns, provides a basis for developing predictive models, and provides immediated useful information for major client agencies in developing pest management strategies.

   Special surveys were undertaken in support of national, regional and provincial requests, and in response to a variety client agencies.

   All permanently located ARNEWS plots are being maintained for long term monitoring of the effects of acid rain, as part of a nationally directed program.

On an ongoing basis, FIDS regularly provides a vast array of information to regional client agencies in the form of extension calls, pest leaflets, lectures, field demonstrations, published information on life history, impact and control, pest identifications and recommendations on pest management.

13. Goals for 1990-91:

1. Survey, map and report on major forest pests of the region:
mountain pine beetle, spruce beetle, spruce budworm, forest tent caterpillar, jack pine budworm and others. (FIDS Staff)

2. Conduct special surveys as requested, including Dutch elm disease and its vectors, general and specific surveys in the national parks, surveys in selected provincial parks, spruce budworm pheromone trials if needed, and pest surveys in forest nurseries. (FIDS Staff)

3. Publish the 1989 FIDS regional report; prepare and submit to Editor the 1990 FIDS report; prepare a short version of 1989 FIDS report and submit to HQ for the national FIDS report; and finalize the 1986 FIDS report (unpublished) into a File Report. (Cerezke, Émond).

4. Complete the pest depletion loss exercize for period 1981-87 and summarize data results, maps, etc. for report(s). (Amirault)

5. Provide pest extension services and technology transfer of information to regional clientele as requested, provide pest identification, diagnostic and advisory services on tree and shrub pests, and arrange for technology transfer workshops as required. (Staff of NOR-11)

6. Conduct detailed pest surveys in 5 newly designated genetic and tree improvement plantations in Alberta, and resurvey Huallen Seed Orchard and Pine Ridge Forest Nursery (Smoky Lake, Alta.). (FIDS Staff)

7. Represent FORCAN and NoFC on various national, regional, provincial meetings, committees and advisory groups. (FIDS Staff)

8. Organize and conduct the Regional Insect and Disease Technical Advisory meeting in Edmonton; prepare recommendations and present to Senior RegionaL Advisory Committee. (Volney, Cerezke, FIDS Staff)

9. Conduct annual and first 5-year assessments of 10 ARNEWS plots; select two replacement sites for Suwannee and Rocky Mt. House plots. (FIDS Staff)

10. Serve as FIDS Head; provide functional guidance for anticipated studies to be developed under new FRDA projects in the Northwest Region. (Volney, Cerezke, Amirault)

11. Provide editorial change requirements and photos as required by HQ Editor for the two chapters for "Forest Insects of Canada" publ. (Cerezke, Volney, Pendrel)

12. Complete third-stage editorial requirements for "FIDS sampling methods --------" and finalize as a File Report. (Moody, Emond).

13. Prepare contributions toward a regional FIDS sampling and survey manual. (NOR-11 Staff).

14. Continue compilation and stand listing of stand inventory data on registered PSP's in Manitoba; report on project status. (Grandmaison)

15. Conduct test surveys of pests in young high-value conifer stands using Silvicom Consultant developed method. (Amirault, FIDS Staff)

16. Function as scientific advisors to Alberta Forest Service personnel conducting efficacy trials of Bt to be sprayed on spruce budworm in the Footner Lake and Peace River Forests, Alberta. (Volney, Cerezke, Amirault)

14. Publications 1989-90:

Other Reports:

Cerezke, H.F. 1989. Report to the Seventeenth Annual Meeting of the Forest Pest Control Forum, Ottawa, November, 1989.

Cerezke, H.F. 1989. Revised Chapter on insect pests affecting "Seasoned wood and timber structures", in Western Committee on Crop Pests report for 1990.

Cerezke, H.F. 1989. Pest and damage conditions in planted lodgepole pine, Huallen Seed Orchard near Grande Prairie, Alberta. File Report.

Cerezke, H.F. 1989. Sawyer beetles in softwood lumber. In: Tech. Trans. Note, FIDS Notes A-012, July, 1989.

Cerezke, H.F. 1989. Grubholes in softwood lumber products. Technical paper presented at Technical Committee on Grubhole Control for Softwood Lumber, April 20, 1989, Ottawa.

Cerezke, H.F. 1989. Revised Pest Leaflet on Forest Tent Caterpillar.

Cerezke, H.F. 1989. Revised Pest Leaflet on Spruce Budworm.

Cerezke, H.F. 1989. Revised Pest Leaflet on Aphids.

Cerezke, H.F. 1989. Grubhole control in Canadian green coniferous lumber for shipment to European Community markets including the United Kingdom. Tech. paper presented to Technical Committee on Grubhole Controls, May 11, 1989, Ottawa, and a similar presentation on June 21, 1989, Edmonton.

Emond, F.J. 1989. Report of insect and disease conditions in the Pine Ridge Forest Nursery, Alberta, in 1989. File Report.

Emond, F.J. 1989. Report of pest and damage conditions of planted trees in the Jumping Pound Demonstration Forest in 1989. File Report.

Emond, F.J. 1989. Report of insect and disease conditions in the Rocky Mountain National Parks in 1989. File Report.

Emond, F.J. 1989. Major forest insect pest conditions, 1989 predictions. In: Tech. Trans. Note, FIDS Notes, A-009, April, 1989.

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Gates, H.S. 1989. Insect and disease survey report for Alberta. File Report.

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Still, G.N. 1989. Report of pest conditions to the Saskatchewan Advisory Council on Crop Protection. File Report.

Tidsbury, C. 1989. Insect and disease pests and damage in genetic tree plantations in northwestern Alberta in 1989. File Report.

Tidsbury, C. 1989. Forest insect and disease surveys in Wood Buffalo National Park in 1989. File Report.

Tidsbury, C. 1989. Results of egg-band surveys of the forest tent caterpillar in northwestern Alberta in 1989. File Report.

Tidsbury, C. 1989. Surveys of the spruce budworm in the Northwest Territories in 1989. File Report.

Tidsbury, C. 1989. Forest insect and disease conditions in Blackstone Territorial Park, NWT. File Report.

Volney, W.J.A. 1989. Observations on the Smoothstone Lake white spruce plantaion. Northern Forestry Centre, Edmonton. File Report.

Volney, W.J.A. 1989. The aspen leaf beetle. In: Tech. Trans. Note, FIDS Notes A-013, December, 1989.

15. Environmental Implications:

The NoFC Environmental Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started: 1936 Estimated Completion: Continuing

17. Resources 1990-91:

PYs:	Prof.:	Cerezke	0.7
		Volney	0.2
	Tech.:	Emond	1.0
		Gates	1.0
		Still	1.0 (Summer season Saskatchewan Dist. Off.)
		Tidsbury	1.0
	Total		4.9 (Plus 1.0 PY for Manitoba Office - Grandmaison)
	Student		0.3

O & M: $40,000
Capital: $2,200

18. Signatures:

Investigator

Program Director, Protection

Investigator

Regional Director General

NOR-11-03

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 23, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Bionomics of important forest insects

3. New: Cont.: X 4. No.: NOR-11-03

5. Study Leader: H.F. Cerezke

6. Key Words: forest habitats, plantations, nurseries, damage impact, control, populations, behavior, bark beetles, woodborers, rootcollar weevils, regeneration pests, semiochemicals (pheromones)

7. Location of Work: Northwest Region

8. Problem:

The objectives of this study are closely aligned with those carried out under the Forest Insect and Disease Survey (NOR-11-01) study program, and in most cases, have been undertaken in response to problems arising out of the general surveys or from specific client requests. Usually, these problems have required short-term research goals within a time frame of 1 to 5 years. Over the years, this study has included investigations on woodborer hazard and impact in fire-killed timber; spruce bud midge impact; ecological studies and surveys of Warren's rootcollar weevil; control and impact studies of spruce seed and cone insects; biology, seasonal development and impact of spruce budworm; and damage impact characteristics of jack pine budworm defoliations. Because of the nature of the study to resolve regional client-driven needs, and often involving client input, it has maintained a strong element of technology transfer.

In 1980, following the development of a mountain pine beetle (MPB) outbreak in Alberta and Saskatchewan, intensive surveys were necessary to establish annual tree losses and risk assessments. Because large volumes of merchantable lodgepole pine were being killed, joint studies with federal and provincial agencies were undertaken to explore uses of aerial photography to map infestations, to estimate trees killed, and assess the beetle's potential for spread.

Provincial forestry and parks agencies commenced extensive programs to monitor and control the MPB and incorporated newly developed semiochemicals into the detection and control strategies in 1983. Coordination and complimentary field studies were provided to help optimize bait placement strategies and to interpret baiting results. Cooperative research studies were established with these provincial agencies, with Simon Fraser Univ. and the Univ. of Calgary to assess bait effectiveness, MPB behavior, and to conduct additional field bioassay studies to test new bait formulations.

Coordination of MPB/lodgepole pine management and research/surveys in western Canada and the U.S. was maintained through representation on an MPB Technical Committee and through the activities of an MOU for the CAN-US MPB Action Plan.

The spruce beetle, an endemic species throughout the region, caused over 80,000 m^3 mortality to mature white spruce in northern Alberta between 1982 and 1984. This outbreak prompted interest in the development of methods to detect population change and assess stand hazard. Developmental work on spruce beetle semiochemicals for commercial applications was subsequently initiated in cooperation with the Univ. Calgary, Alberta Forest Service, B.C. Ministry of Forests and Crestbrook Forest Industry in 1987 and has continued through 1989.

Increasing forest renewal emphasis in recent years has forced a closer examination of tree damage and survival in plantations and other high-value coniferous stands. Surveys across the region during 1987 to 1989 indicate that rootcollar weevils (Hylobius warreni and H. radicis) rank among the top 1 to 5 biotic agents causing tree mortality and growth reductions of mainly pine hosts. In addition, other regions (namely Maritimes and Pacific) have expressed similar concerns with H. warreni. There is a need therefore to examine site-specific problems and to develop new strategies for early detection, impact assessment and control of these weevil species.

9. Objectives:

1. Coordinate this sudy with NOR-11-01 and undertake bionomic studies of important forest insect pests (mountain pine beetle, spruce beetle, rootcollar weevils) that can provide management strategies for reducing their risk and the losses they cause.

2. Provide technology transfer of pest information to regional clientele.

3. Develop and field test new pheromone techniques and applications for the management of important forest insects.

10. Goals for 1989-90:

1. Prepare and submit to journal paper on "Attack pattern and brood productivity of the MPB on three pine hosts". Can. Ent.

2. Complete revisions and submit to journal paper on "Mountain pine beetle attack density pattern on semiochemical baited and unbaited lodgepole pine in southwestern Alberta". C.J. For. Res.

3. Analyse 1988 spruce beetle semiochemical data and contribute to two reports: a) Status report on spruce beetle semiochemical field studies during 1988, and b) "A successful pheromone blend for manipulating spruce beetles, (Dendroctonus rufipennis Kirby); (b) will be co-authored by MacKenzie, Wieser, Dixon, Cerezke, and Werner and presented at 72nd Can. Chem. Conf. and Exhibition, Victoria, B.C., June 1989.

4. Conduct a field-replicated experiment in central and northern Alberta to test the performance of best known spruce beetle semiochemical formulation and determine optimum release rates, in cooperation with chemists from the University of Calgary.

5. Conduct preliminary studies of the Warren rootcollar weevil in selected locations in western Alberta to establish experimental monitoring sites that can be used to identify:

   - methods for estimating populations of the weevil and their dispersal behavior;
   - pre- and post-harvest population sources;
   - distribution and attack pattern of the weevil in young planted or naturally stocked stands, and;
   - explore potential controlling agents and pest management strategies

6. Provide representation on MPB Technical Committee and CAN-US MPB Action Plan as required.

Added Goal:

7. Present workshop on the biology, damage and control of Warren's rootcollar weevil on invitation by the B.C. Ministry of Forests.

8. Contribute as co-author to a paper on mountain pine beetle pheromone studies.

9. Carry out duties as an Associate Editor for the Canadian Entomologist.

11. Accomplishments in 1989-90:

1. Little progress was made due to heavy commitments in NOR-11-01.

2. Little progress was made due to heavy commitments in NOR-11-01.

3. a) Spruce beetle capture data for 1988 were summarized in a status report under the FRD Agreement, prepared in conjunction with co-workers at the University of Calgary.

   b) A paper encorporating 1988 beetle capture data results was presented at the 72nd Can. Chem. Conf. and Exhibition in June, 1989, Victoria, B.C., with co-authorship by MacKenzie, Wieser, Dixon, Cerezke and Werner.

4. Three field experiments to test spruce beetle response to semiochemical-baited traps and to baited trees were conducted at five locations in central and northern Alberta. One of the experiments deployed 4 different bait formulations, all tested simultaneously at two locations in B.C. and in southern Alaska (cooperating agents included Drs. Wieser and Dixon and A. MacKenzie at Univ. Calgary; Dr. Borden, Simon Fraser Univ.and Dr. Lindgren, Phero Tech;

and Dr. Werner, USDA, Fairbanks, Alaska). All spruce beetles and larch beetles captured in the Alberta components of the experiments have been counted, sexed and measured. Results of the spruce beetle captures have been summarized and circulated to the cooperators for review and discussion.

5. Three sites were selected in west-central Alberta to initiate cooperative studies with Dr. Dixon and A. MacKenzie (Univ. Calgary) to test various trap designs and to screen various semiochemical baits as potential attractants for adult Hylobius warreni. A replicated experiment (in a 7 x 7 design) was established at one of the sites where different baits were deployed in a pit-fall type of trap. Two walk-in trap designs placed on tree stems were tested at the other two sites to explore their potential for future field bioassays. A report summarizing this work was prepared by MacKenzie, Dixon and Wieser to fulfill their commitment for funding obtained under the Alberta Forest Development Research Trust Fund. Assistance was also provided in conducting a survey in the first experimental site to estimate population abundance of H. warreni and for a collection of adults for behavioral, electroantennogram and chemical wash studies at the Univ. of Calgary.

6. The MPB Technical Committee and CAN-US MPB Action Plan were both inactive in 1989 and required no input.

Added accomplishment:

7. Presented a workshop on the biology, impact and control of Warren's rootcollar weevil (H. warreni) at Hazelton, Prince Rupert Forest Region to B.C. Forest Service, Industry and For. Can, staff. The workshop was by invitation and financed by B.C. Ministry of Forests.

8. Contributed co-authorship to a journal article on mountain pine beetle pheromone studies.

9. Reviewed and processed about 10 scientific papers submitted to the the Canadian Entomologist for publication.

12. Present Status (1988-89 Objectives):

In recent years this Study has focused on studies of the semiochemicals of the mountain pine beetle and the spruce beetle, to help develop and modify methodologies to improve detection, monitoring and control strategies. Much of this work has involved close cooperation with client agencies such as Parks Canada, Alberta Forest Service, Saskatchewan Parks, Recreation and Culture, Alberta Recreation and Parks, Simon Fraser Univ., Phero Tech and the University of Calgary. The studies have helped to develop practical applications for MPB and SB semiochemical use, identified new attractants and inhibitors, resolved some field behavioral questions in beetle attraction, attack pattern and distribution, and identified predator response to synthetic and natural attractants.

Studies in 1989 on the spruce beetle semiochemicals were broadened to include additional field test sites in B.C. and Alaska and an additional pheromone component was added to further develop a commercially acceptable bait and appropriate release devices.

Participation has been maintained on the MPB Technical Committee for western Canada and on the Canada-US MOU Mountain Pine Beetle Action PLan.

13. Goals for 1990-91:

1. Prepare and submit to journal a paper on "Attack pattern and brood productivity of the MPB on three pine hosts".

2. Complete revisions and submit to journal a paper on "MPB attack density pattern on semiochemical baited and unbaited lodgepole pine in southwestern Alberta".

3. Prepare, in consultation with cooperators, one or two reports summarizing 1987 to 1989 spruce beetle and larch beetle semiochemical field bioassay test data.

4. Cooperate with Univ. Calgary, Simon Fraser Univ., and Phero Tech in conducting field bioassays of semiochemicals and release devices toward development of a commercially acceptable pheromone bait for the spruce beetle.

5. Cooperate with Univ. Calgary in conducting field bioassays of semiochemicals and trap devices for Warren's rootcollar weevil.

6. Carry out duties as an Associate Editor for the Canadian Entomologist.

14. Publications 1989-90:

MacKenzie, A.; Wieser, H.; Dixon, E.; Cerezke, H.; Werner, R. 1989. A successful pheromone blend for manipulating spruce beetles (Dendroctonus rufipennis Kirby). Presented by MacKenzie at 72nd Can. Chem. Conf. and Exhibition. June, 1989, Victoria, B.C.

Unpublished Reports:

Dixon, E.A.; Whitehead, A.T.; Wieser, H.; Cerezke, H.F.; Scott, D.T. 1989. Electroantennograms of mountain pine beetles to structural analogs of exo-brevicomin and their enantiomers. 17 pp.

Wieser, H.; Dixon, L.A.; MacKenzie, A.A.; Cerezke, H.F. 1989. Development of strategies for spruce beetle management by means of pheromones; phase II-1988. Report prepared for Canada/Alberta Forest Resource Development Agreement, Forestry Canada, Northern Forestry Centre, Edmonton. 53 pp.

15. Environmental Implications:

The NoFC Environmental Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started: 1960 Estimated Completion: 1992 for MPB and SB studies; 1995 for rootweevil studies.

17. Resources 1990-91:

PYs: Prof.: Cerezke 0.3

Total: 0.3

Term/student 0.3

O & M: $4,000

Capital:

18. Signatures:

Investigator

Program Director, Protection

Regional Director General

NOR-11-05

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 3, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Damage appraisal of major forest pests

3. New: Cont.: X 4. No.: NOR-11-05

5. Study leader: W.J.A. Volney

6. Key Words: Damage, appraisal, impact, hosts, forest pests, management, mortality, risk, growth loss, stand dynamics, population dynamics, benefit/cost, pest management.

7. Location of Work: Northwest Region

8. Background:

Sound pest management systems require information on the resource values threatened by pests. This information can only be obtained from an understanding of pest epidemiology and their effects on host stands. Two different time horizons are considered in developing these pest management systems. These are the short-term and the long-term horizons. They are related to the need for treatments under current pest conditions, and forecasting pest impacts on the timber supply in the integrated resource management system respectively. The basic scientific information required to design pest management systems is therefore embodied in a description of the interactions among pest population dynamics, stand dynamics and control strategies. This description permits an evaluation of the socio-economic impact of pests on resource values and the benefit/cost integration required to embed pest management systems in the integrated resource management system.

This study aims to provide the descriptions of the physical pest impacts and the information on pest population dynamics to make long-term and short-term predictions of their effects on stand yield. An attempt is also to be made to identify critical sources of pest generation mortality and natality so as to be able to manipulate populations effectively.

9. Study Objectives:

1. To develop methods to evaluate the significance of specific forest pests in terms of measured damage to trees and forest stands.

2. To develop or modify appraisal methods for assessment of losses caused by forest pests.

3. Design forest pest management systems which optimize the return from stand management activities.

10 Goals for 1989-90:

1. Monitor Jack pine budworm impact plots in Manitoba and Saskatchewan.

2. Complete file report on "Studies on the impact of the 1985/86 jack pine budworm outbreak on stand development in the Torch River Forest".

3. Prepare draft of Information Report entitled "Characteristics of jack pine budworm life table plots in Manitoba And Saskatchewan".

4. Complete file report entitled "The interaction of jack pine budworm and lodgepole pine dwarf mistletoe with jack pine".

5. Complete file report on "The relationship between root condition and damage to trees following jack pine budworm outbreaks" with K. Mallett.

6. Complete file report on "Studies on stand deterioration following the 1980's jack pine budworm outbreak near Thompson, Manitoba" with K. Mallett and D. Langor.

7. Prepare final report on "The Status of Insect and Disease Studies Conducted Under the Canada-Saskatchewan Forest Resources Development Agreement".

8. Participate on Committee to plan and draft a proposal for a multi-disciplinary study on the management of mixedwood forests.

Added Goals:

9. Prepare and present a paper on expert systems for pest management at the Modeling Symposium, Saskatoon Saskatchewan.

10. Prepare and present a paper on managing pest of mixedwood forests at the Morthern Mixedwood Symposium, Fort St. John, B.C.

11. Prepare proposal to conduct studies on the effects of climate change on forest productivity.

12. Arange the hosting and Chair the annual North Central Forest Pest Work Conference in Winnipeg, Manitoba.

13. Participate and contribute to the North American Forestry Commission study to develop a decision support system to manage the jack pine budworm.

14. Prepare a contract and act as scientific authority to evaluate the optimum sampling strategies to assess pest conditions in young, high value stands.

15. Develop a systematic sampling procedure to evaluate the incidence of pest damage in high value genetics instalations.

16. Design and implement an impact assessment procedure to evaluate permanent sample plots used by provincial forestry agencies.

17. Prepare a contract and act as scientific authority to evaluate the impact of historic jack pine budworm outbreaks on stand productivity using provincial P.S.P. data.

18. Prepare and present an overview of information required to manage jack pine budworm outbreaks at the Northern Ontario Pest Review in Thunder Bay, Ontario.

19. Attend and participate in a scoping workshop to develop models on the impact of Canada's forests on the global carbon budget.

20. Visit and evaluate the Northwestern Ontario Forest Technology Development Unit in Thunder Bay, Ontario.

11. Accomplishments in 1989-90:

1. Jack pine budworm impact plots in Manitoba and Saskatchewan were monitored and the information collated into machine readable files.

2. A report incorporating inform,ation on the impact of the 1985/86 jack pine budworm outbreak on stand development in the Torch River Forest is being prepared as part of a F.R.D.A. report.

3. A report on the characteristics of jack pine budworm life table plots in Manitoba And Saskatchewan is being prepared as part of a F.R.D.A. report.

4. A documented data set on the interaction of jack pine budworm and lodgepole pine dwarf mistletoe with jack pine has been prepared.

5. A paper entitled "Relationship among jack pine budworm damage, selected tree characteristics, and Armillaria root rot in jack pine" has been submitted to the Canadian Journal of forest research. Authors: Mallett & Volney.

6. A report on stand deterioration following the 1980's jack pine budworm outbreak near Thompson, Manitoba is being prepared as part of a F.R.D.A. report with K. Mallett and D. Langor.

7. A final report on "The Status of Insect and Disease Studies Conducted Under both the Canada-Saskatchewan Forest Resources Development Agreement and the Canada-Manitoba Forest Resources Development Agreements" is being prepared.

8. Participated on Committee to plan and draft a proposal for a multi-disciplinary study on the management of mixedwood forests. A proposal to develop decision suport systems to manage pest of the mixed wood forests was prepared.

9. A paper entitled "Artificial Inteligence for Forest Pest Management" was prepared and presented at the Modeling Symposium, Saskatoon Saskatchewan. (In Press.)

10. Prepared, with G. A. Van Sickle, and presented a paper entitled "Pest Management Tools for Managing Pests of the Boreal Mixedwood Forest" at the Morthern Mixedwood Symposium, Fort St. John, B.C.

11. Prepared proposal, with J.R. Spence, to conduct studies on the effects of climate change on ecotonal aspen forest productivity.

12. Arranged the hosting, prepared the meeting agenda, and Chaired the annual North Central Forest Pest Work Conference in Winnipeg, Manitoba attended by 70 professionals from the U.S. and Canada.

13. Participated and contributed to the North American Forestry Commission study to develop a decision support system to manage the jack pine budworm by presenting information on the information available to develop such systems at workshops in St. Paul, MN and College Station, TX.

14. Prepared a contract and acted as scientific authority to evaluate the optimum sampling strategies to assess pest conditions in young, high value stands. The contract is now complete and a computerized report generator and data managing system has been developed.

15. Developed and implemented a systematic sampling procedure to evaluate the incidence of pest damage in high value genetics instalations. The procedure was tested on 6 plantations in the past year.

16. Designed and implemented an impact assessment procedure to evaluate permanent sample plots used by provincial forestry agencies. The system was assessed on 540 plots in Saskatchewan and 75 plots in Manitoba.

17. Prepared a contract and acting as scientific authority to evaluate the impact of historic jack pine budworm outbreaks on stand productivity using provincial P.S.P. data. This contract terminates on 31 March 1990.

18. Prepared and presented an overview of information required to manage jack pine budworm outbreaks at the Northern Ontario Pest Review in Thunder Bat, Ontario attended by 50 forestry practitioners.

19. Attended and participated in a scoping workshop to develop models on the impact of Canada's forests on the global carbon budget.

20. Visited and evaluated the Northwestern Ontario Forest Technology Development Unit in Thunder Bay, Ontario. Contributed to report submitted to the Management Committte of NoFC

12. Present Status of Study:

A network of permanent impact plots in stands of different ages, growing under different densities and site conditions have been established in jack pine forests of Manitoba (240 plots) and Saskatchewan (ca. 600 plots). A latitudinal analysis of damage in these stands together with an analysis of historical records will permit an initial description of
the impacts of jack pine budworm and other pest populations on these stands. The stands in Manitoba should be remeasured in the comming season for the first five year assessment.

A network of intensive study plots were established in Manitoba (9 plots) and Saskatchewan (9 plots) in which population and defoliation estimates were made. Studies conducted in these plots are aimed at developing efficient sampling techniques as well as descriptions of the dynamics of jack pine budworm populations. These should be monitoreds annually for eggmass populations and defoliation and be monitored intensively once populations appear to be on the rise.

1. The jack pine budworm has been selected as the pest on which to develop impact evaluation procedures. Techniques for assessing growth loss on individual trees, the incidence and amount of top kill in defoliated stands, and the incidence of mortality in affected stands are being developed and applied. Many of these techniques can be modified for defoliators attacking other hosts.

2. Appraisal methods are being developed for the losses caused by the jack pine budworm.

3. Observations on populations density and concomitant growth losses are being made on the jack pine budworm/host tree system. These studies will provide information for monitoring, treatment evaluation, and prediction technologies for managing jack pine budworm populations.

13. Goals for 1990-1991:

1. Complete the F.R.D.A. report and prepare portions for publication as scientific papers. Proposed titles are:

    a) Procedures to estimate jack pine budworm caused defoliation.
    b) Sampling jack pine budworm populations.
    c) The impact of jack pine budworm on individual tree growth.

2. Monitor the intensive study plots and extensive study plots in Manitoba nad Saskatchewn for increases in budworm populations.

3. Provide scientific leadership in developing a jack pine budworm support system.

4. Design and supervise the establishment of impact and population studies on the spruce budworm in mature white spruce stands in Alberta. This is to be a cooperative study with Alberta Forestry, Lands and Wildlife. (With Cerezke & Amirault.)

5. Initiate a review of aspen forest pest population biology and compile a bibliography.

6. Finalize plantation survey report and transmit the findings to client agencies.

14. Publications:

Volney, W.J.A. 1989. Biology and dynamics of North American coniferophagus Choristoneura populations. Agricult. Zool. Rev. 3: 133-156.

Volney, W.J.A. 1990. Artificial inteligence for forest pest management. Pages 50-54 in B.J. Boughton and J.K. Samoil, eds. Forest Modeling Symposium. Proc. Symp. March 13-15, 1989. Saskatoon, Saskatchewan, For. Can., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-308.

Volney, W.J.A.; Van Sickle, G.A. 1990. Pest Management Tools for managing the Boreal Mixedwood Forest. For. Can., Pac. For. Cent. Victoria, B.C. (In Press)

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started: 1986 Estimated Completion: Ongoing.

17. Resources 1990-91:

PYs:	Prof.:	Volney	0.8	
	Tech.:	Yohannes	1.0	
	Total:		1.8	
	Term/Student		0.3	
		A-Base	Sask. FRDA	Man. Prov. (Direct)
O & M:		$6,000	$ 0	$ 0
Capital:		Nil		

18. Signatures:

Investigator

Program Director, Protection

Regional Director General

NOR-11-06

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 23, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Research, diagnostic, and technical transfer services of forest tree rusts and other forest tree diseases

3. New: Cont: X 4. No.: NOR-11-06

5. Study Leader: Y. Hiratsuka

6. Key Words: Taxonomy, mycology, herbarium, culture collection, tree disease identification, Forest tree rusts, pine stem rusts, Cronartium, Endocronartium, western gall rust, biocontrol, mountain pine beetle, blue stain fungi, Ceratocystis spp.,

7. Location of Work: Edmonton (NoFC--mycological herbarium, culture collection, laboratory, and greenhouse facilities), various field locations in the region and occasionally in other areas of the world.

8. Background Statement:

A. Disease identification and taxonomic service

Accurate and prompt diagnosis of tree diseases and identification of causal agents are essential to the disease surveys, pest extension services, damage appraisal studies, environmental assessment services, and consideration of possible control measures for tree diseases. Many non-pathogenic fungi in forest ecosystems also play important roles. Proper identification of mycorrhizal fungi, decomposing fungi, and hyperparasitic fungi of forest tree pathogens is important to many research studies and provides better understanding of forest ecosystems. Taxonomy and nomenclature of fungi are constantly being revised. Proper application of up-to-date information on taxonomy and nomenclature are important whenever names of fungi are used in reports or journal publications. 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.

B. Western gall rust

Western gall rust has been identified as the most important disease in artificial regeneration and intensive management situations of lodgepole and jack pines in the region. It is essential that it be included in genetic improvement programs of hard pines.

C. Taxonomy, biology, and pathology of forest tree rusts

An estimate of the losses attributable to forest tree rusts in this region has not been obtained, but rusts have caused significant growth loss and mortality of major forest tree species of the region including lodgepole and jack pines, white and black spruces, aspen, balsam poplar, and alpine and balsam firs. In addition, several rust species endemic to the region have been recognized as serious pathogens or potentially dangerous pathogens in other areas where forestry practices are more intensive. It is important to clarify identity, life history, host range, cytology, damage potential, conditions of infection, and taxonomy of forest tree rusts of the region to cope with the present and future problems with this group of tree diseases.

D. Short-term investigation of selected forest tree diseases

Short-term research activities on selected tree diseases becomes necessary from time to time when diseases are identified as important in certain forest management practices in the region, recognized as important by the public or news media, or identified as suitable topics for joint research activities with outside agencies.

9. Study Objectives:

1. To conduct forest tree disease identification and taxonomic service, and to maintain and upgrade a disease reference collection (Mycological Herbarium) and a fungus culture collection.

2. To study biology, cytology, pathology, host-parasite relationship, inoculation techniques, and resistance screening methods of western gall rust to contribute to the genetic improvement programs and management of lodgepole and jack pines in the prairie provinces.

3. To study taxonomy, morphology, pathology, and life-cycle of forest tree rusts, especially those of pine stem rusts of Canada and related species elsewhere in the world, with the aim of compiling a definitive manual of forest tree rusts of Canada (or North America), and a monograph of pine stem rusts, and to contribute to the taxonomy, nomenclature, and terminology of rust fungi.

4. To conduct short-term investigations of selected forest tree diseases of the region such as Dutch elm disease, Armillaria root rot, and mortality caused by mountain pine beetle.

10. Goals for 1989-90:

A. Disease identification service and taxonomic service

1. Provide diagnostic and identification service for tree and shrub diseases.

2. Maintain and upgrade the disease reference collection (Mycological Herbarium), and a fungus culture collection.

3. Complete an information report entitled "Diagnosis and recognition of winter- and other climate- related damage of trees" with H. Zalasky and publish during 1989-90 fiscal year.

4. Act as one of the compilers of "Aspen-poplar decay identification and measurement manual" with AFS personnel.

5. Investigate etiology of aspen "black galls" in relation to decay caused by Phellinus tremulae.

B. Western Gall Rust study

6. Continue western gall rust investigation, in conjunction with ongoing jack pine genetics and tree improvement program with J. Klein, and Manitoba Department of Natural Resources.

   a) Examine and analyze results of inoculation experiments conducted in 1988 with 20 families resulting from crosses between 40 top performers in family planting experiments.

   b) Collect seeds(open pollinated) from selected families exhibiting resistance in family plantation surveys and conduct inoculation experiments.

   c) Survey family plantings in the western breeding district (Saskatchewan) for the incidence of western gall rust.

7. Complete an information report on western gall rust with Dr. P.V. Blenis of the University of Alberta and publish in 1989-90.

8. Prepare a journal paper on cytology and taxonomy of autoecious pine stem rusts.

9. Start co-operative work on western gall rust resistance evaluation of lodgepole pine in conjunction with tree genetics and improvement with AFS personel (Drs. Dhir and Sproule).

10. Serve as the scientific authority for a ForCan contract to Dr. P.V. Blenis (Univ. of Alberta) for the investigation of western gall rust control.

C. Taxonomy, biology, and pathology of forest tree rusts

11. Organize the 3rd International IUFRO "Rusts of Pine" Working Party Conference in Banff, Alberta (September 18-22).

12. Edit the proceedings of the IUFRO "Rusts of pine" conference with Dr. P. Blenis of the University of Alberta and publish in 1990-91 or 1991-92 fiscal year.

13. Re-submit a journal paper entitled "Auriculariaceous rusts" to Mycologia.

14. Investigate taxonomy and morphology of several groups of forest tree rusts with a group of Japanese scientists (Drs. S. Sato, K. Katsuya,and S. Kaneko) under a cooperative research project, and prepare two to three journal papers.

15. Continue to explore a new strategy of biological control of western gall rust using a rust feeding insect (Epuraea obliquus) and a mycoparasite (Scytalidium uredinicola) with J. Volney.

D. Microbiological and pathological investigation of trees attacked by mountain pine beetle

16. Publish a journal paper entitled "Inoculation of blue stain fungi associated with mountain pine beetle monitored with heat-pulse velocity equipment" with Y. Yamaoka and R. Swanson.

11. Accomplishments for 1989-90:

A. Disease identification and taxonomic service

1. Provided diagnostic and identification service of tree and shrub diseases.

2. Maintained and upgraded the disease reference collection (Mycological Herbarium) and fungus culture collection.

3. Draft of the information report entitled "Diagnosis and recognition of winter- and other climate-related damage of trees" with H. Zalasky has been prepared and ready to be submitted for internal review.

4. An information report entitled "Aspen decay and stain identification and measurement" has been prepared and expexted to be published within 1989-90 fiscal year.

5. Many fungi and bacteria have been isolated from aspen black gall tissue and in the process of identification and examination.

B. Western Gall Rust Study

6. Continued western gall rust investigation, in conjunction with ongoing jack pine genetics and tree improvement program with J. Klein, and Manitoba Department of Natural Resources.

a) Analysed the results of inoculation experiments conducted in 1988 with 20 full sib families and reported at the IUFRO "Rusts of Pine" Working Party Conference.

b) Inoculated about 3000 seedlings resulted from seeds collected from field resistant and field susceptible families; and parts of seeds used for original family plantings 17 years ago ,in the green house.

c) Jack pine family plantations in Saskatchewan (western breeding district) involving in two locations, 216 families, 12 replications, totalling about 9000 trees were examined for the presence and number of western gall rust. Results are tabulated and examined.

7. Completion of the information report on western gall rust with Dr. P. V. Blenis has been postponed till later date.

8. A paper entitled " Nuclear cycle, taxonomy, and nomenclature of western gall rust" was presented at the International IUFRO "Rusts of Pine" Working Party Conference and manuscript for the proceedings was prepared.

9. Inoculation experiments were conducted with 10 selected families of lodgepole pine (300 seedlings) provided by AFS (Drs. Dhir and Sproule).

10. Served as the scientific authority for a ForCan contract to Dr. P. V. Blenis (Univ. of Alberta) for the investigation of biocontrol of western gall rust.

C. Taxonomy, biology, and pathology of forest tree rusts

11. Organised and coordinated the 3rd International IUFRO "Rusts of Pine" Working Party Conference in Banff, Alberta from September 18 to 22. Sixty-five scientists from eight countries attended the conference.

12. Edited the proceedings of the "Rusts of Pine" Conference with J. Samiol (NoFC) and Dr. P. V. Blenis (University of Alberta) and to be published as an information report from NoFC.

13. A journal paper entitled "Auriculariaceous rusts" will be submitted to a differenct journal with style changes.

14. Cooperative investigation of forest tree rusts with Japanese scientists (Drs. S. Sato, K. Katsuya, S. Kaneko, and K. Kakishima) is under way. Invited to Japan for three weeks under the program with fund provided by Japanese government June 1989). Several joint journal papers are in preparation.

15. Continued the exploration of a new strategy of biological control of western gall rust using a rust feeding beetle (Epuraea obliquus) and mycoparasites with J. Volney. Many larvae of the insect were colleced and stored for observation.

D. Microbiological and pathological investigation of trees attacked by mountain pine beetle

16. A journal paper entitled "Inoculation of lodgepole pine with four blue stain fungi associated with mountain pine beetle, monitored by a heat pulse velocity instrument." with Y.Yamaoka (Visiting Scientist) and R. Swanson is in press (Can. J. For. Res.).

12. Present Status of Study:

A. Disease identification and taxonomic services

1. Tree disease diagnosis and identification service has been provided for FIDS activities since the 1950s.

2. Disease reference collection (Mycological Herbarium) has been maintained and upgraded for many years, and now contains more than 22,000 catalogued specimens.

3. Fungus culture collection was established in the 1950s, and has been maintained and upgraded. The collection now contains more than 1000 cultures, including important isolates of wood decay fungi, Scleroderris canker, Armillaria root rot, Dutch elm disease, mycoparasites of pine stem rusts, and fungi associated with mountain pine beetle.

4. "Annotated checklist of tree and shrub diseases in the Prairie Provinces" was published in 1977, and an information report entitled "Forest tree diseases of the Prairie Provinces" was published in 1987.

5. Several new forest fungi have been described and published.

6. Because disease detection survey activities are less intensive, the number of samples for identification has decreased to less than 100 per year for the last several years but more collections of fungi from specific studies such as Armillaria root rot study, fungi associated with mountain pine beetle, mycoparasites of pine stem rusts have been identified and filed in the disease reference collection and fungus culture collection.

7. An information report entitled "Diagnosis and recognition of winter- and other climate-related damage to trees" with H. Zalasky is in preparation.

B. Western gall rust investigation

1. Morphology, life cycle, nuclear cycle, and taxonomy of the pathogen have been investigated and reported. Comparative studies of cytology and morphology resulted in a new explanation and interpretation of the western gall rust life cycle and the establishment of a new genus, Endocronartium.

2. Three aggressive hyperparasites (Monocillium nordinii, Cladosporium gallicola, and Scytalidium uredinicola) were discovered and investigated with A. Tsuneda (NSERC Visiting Fellow, 1982-84). Mode of parasitism and production of bioactive metabolites produced by these fungi were investigated and documented in journal publications.

3. Active investigations of host-parasite interaction, resistance testing techniques, axenic culture of the pathogen, and epidemiology of the disease are underway with the

cooperation of P. Blenis (U of A), A. Hopkin (NSERC Visiting Fellow), E. Allen (Ph.D. student, U of A).

4. A new cooperative investigation with the province of Manitoba to test jack pine genetic improvement material has been started. Field surveys of genetic family plantations and inoculation experiments with selected full-sib families were conducted in 1988-89.

C. Taxonomy, biology, and pathology of forest tree rusts

1. Distribution, taxonomy, life cycle, morphology, cytology, damage, epidemiology, and control of pine stem rusts were compiled and published in a major, fully illustrated, publication entitled "Pine stem rusts of Canada" with J.M. Powell in 1977.

2. Incidence and identity of hyperparasitic fungi, rust-feeding insects, and animal damage to pine stem rusts have been recorded and published by J.M. Powell.

3. Organized and coordinated teh 3rd International IUFRO "Rusts of Pine" Working Party conference in 1989 in Banff, Alberta and published a proceedings of the conference as an information report from NoFC.

4. Information for the monograph on pine stem rusts is being compiled.

5. A new approach to biocontrol of pine stem rusts has been proposed and preliminary investigation of selecting candidate organisms was conducted.

6. An information report entitled "Impact of pine stem rusts of hard pines" with J.M. Powell (NoFC), G.A. Van Sickle (PFC) was published in 1988.

D. Short-term investigation of selected forest tree diseases

1. Together with S. Takai of GLFC, host-parasite interaction of Dutch elm disease was investigated and a specific toxin of the disease (cerato-ulmin) was discovered.

2. Bioactive metabolites of forest fungi such as Gremmeniella abietina, Ceratocystis spp. associated with mountain pine beetle, and Stereum purpureum were investigated with W. Ayer (U of A).

3. Pathological and chemical investigations of fungi associated with mountain pine beetle have been jointly conducted by W. Ayer (U of A), R. Swanson (NoFC), and Y. Yamaoka (NoFC), and a significant discovery was made. A fungus that is both an effective colonizer and an agent that stops water flow in MPB-attacked trees was identified. Further experiments are in progress.

4. Aspects of distribution, biological species identification, detection method, and pathogenicity tests of Armillaria root rot have been conducted by K. Mallett (NoFC), M. Mugala (U of A), and P. Blenis (U of A). The Armillaria root rot investigations are transferred to the new study with K. Mallett (NOR-11-09) in 1988.

13. Goals for 1990-1991:

A. Disease identification service and taxonomic service

1. Provide diagnostic and identification service for tree and shrub diseases.

2. Maintain and upgrade the disease reference collection (Mycological Herbarium), and a fungus culture collection.

3. Complete an information report entitled "Diagnosis and recognition of winter- and other climate- related damage of trees" with H. Zalasky and submit for internal review.

4. Prepare and publish provisional and draft edition of "Field Guide for Aspen decay identification and measurement" with AFS personnel.

5. Investigate etiology of aspen "black galls" in relation to decay caused by Phellinus tremulae.

B. Western Gall Rust study

6. Continue western gall rust investigation, in conjunction with ongoing jack pine genetics and tree improvement program with J. Klein, and Manitoba Department of Natural Resources.

   a) Examine and analyze results of inoculation experiments conducted in 1989.

   b) Collect seeds(open pollinated) from selected families exhibiting resistance in family plantation surveys and conduct inoculation experiments.

   c) Analize the results of sureys of family plantings in the western breeding district (Saskatchewan) for the incidence of western gall rust.

7. Continue to work on an information report on western gall rust with Dr. P.V. Blenis of the University of Alberta.

8. Continue co-operative work on western gall rust resistance evaluation of lodgepole pine in conjunction with tree genetics and improvement with AFS personel (Drs. Dhir and Sproule).

   a) Examine and analyze results of inoculation experiments conducted in 1989.

   b) Conduct green house inoculation experiments with 40 lodgepole families.

   c) Assist AFS personel to select areas in central Alberta to out plant resistant and susceptible lodgepole pines for long range field resistant trials.

9. Serve as the scientific authority for a ForCan contract to Dr. P.V. Blenis (Univ. of Alberta) for the investigation of western gall rust control.

10. Conduct ultrastructural investigation of the cytology of western gall rust with Dr. M Neuwirth and Arlene Oatway of Alberta Envirinmental Centre.

C. Taxonomy, biology, and pathology of forest tree rusts

11. Edit, publish and distribute the proceedings of the IUFRO "Rusts of pine" conference with J. Samoil and Dr. P. Blenis (University of Alberta).

12. Re-submit a journal paper entitled "Auriculariaceous rusts" to a journal other than Mycologia.

13. Investigate taxonomy and morphology of several groups of forest tree rusts with a group of Japanese scientists (Drs. S. Sato, K. Katsuya,and S. Kaneko) under a cooperative research project, and prepare two to three journal papers.

14. Attend the Fourth Internatioanal Mycological Congress in Germany (Regensburg) in August, serve as a chairman of a symposium session, and present two invited symposium papers.

14. Publications 1989-90:

Allen, E. A.; Blenis, P. V.; Hiratsuka, Y. 1990. Early symptom development in lodgepole pine seedlings infected with Endocronartium harknessii. Can. J. Bot. 68: (In press)

Blenis, P. V.; Mugala,M. S.; Hiratsuka,Y. 1990. Soil affects Armillaria root rot of lodgepole pine. Can. J. For, Res.(In press)

Hiratsuka, Y.; Gibbard, D.A.; Bakowsky, O.; Maier, G.B.; 1990. Classification and measurement of aspen decay and stain in Alberta. For. Can., Northwest Reg., North. For.Cent., Inf. Rep. NOR-X-314

Hopkin, A. A.; Blenis, P. V.; Hiratsuka, Y. 1989. Resistant responses in juvenile seedlings of Pinus densiflora (Japanese red pine) inoculated with Endocronartium harknessii. Can. J. Bot. 67:3545-3552.

Mugala, M. S.; Blenis, P. V.; Hiratsuka, Y.; Mallett, K. I. 1989. Infection of lodgepole pine and white spruce by Alberta isolates of the Armillaria . Can. J. For. Res. 19: 685-689.

Sigler. L.; Yamaoka, Y.; Hiratsuka, Y. 1990. Taxonomy and chemistry of a new fungus from beetle infested Pinus cintorta var. latifolia Part 1. Arthrographis pinicola sp. nov. Can. J. Microbiol. (In press)

Yamaoka,Y.: Hiratsuka,Y.: Swanson,R.H. 1990. Inoculation of blue stain fungi associated with mountain pine beetle monitored with heat-pulse velocity equipment. Can. J. For. Res. 20(1):31-36.

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started : 1970 Estimated Completion: Continuing

17. Resources 1990-91:

PYs: Prof.: Hiratsuka	0.3
Tech.: Maruyama	0.3
Total:	0.6
Term/Student	0.0

O & M: 9 K

Capital: Nil

18. Signatures:

Investigator

Program Director, Protection

Regional Director General

3. Continue studies on finding alternative fungicides for the control of damping-off in nurseries. Candidate fungicides will be evaluated for phytotoxicity and efficacy in controlling damping off.

4. Submit a journal paper entitled "The cultural characteristics of the A. mellea complex" for internal review.

5. An inoculation experiment with Armillaria mellea complex species and 5 conifer species will be evaluated.

6. Provide advice and technology transfer of information regarding forest diseases to NOR-11-01 personnel and client groups.

7. Produce 3 issues of "The Forest Insect and Disease Notes". (in cooperation with personnel from NOR-11).

Saskatchewan Agreement

8. Continue studies into the causes of mortality in pine stands that have been defoliated by the jack pine budworm, through excavation and dissection of the root systems, and stem analysis. In conjunction with NOR-11-05 (Mallett & Volney)

Manitoba Agreement

9. A report will be written on studies to determine volume loss and the cause of the elevated mortality rates in selected stands of severely defoliated jack pine stands in Thompson area. In conjunction with NOR-11-05 (Volney & Mallett).

Added goals - A-base:

10. Isolate and identify fungi from terminal weevils and their galleries in spruce and pine. In conjunction with NOR-11-10 (Mallett & Langor).

11. Collect and determine nutrient content of needles from field grown lodgepole pine trees affected and unaffected by Armillaria root rot. In conjunction with NOR-7-xx (Mallett & Maynard).

12. Participate in the development of the host rules for the National Insect and Disease Forest Pest Depletion Exercise.

13. Prepare an article entitled "Non-chemical controls of insect and diseases of trees and shrubs".

14. Prepare and present a paper at the International Society of Arboriculture (prairie chapter) meeting.

15. Isolate and identify conifer seedling pathogens from Pine Ridge Tree Nursery soil media.

11. Accomplishments for 1989-90:

1. Continued to develop early detection and survey techniques for Armillaria root rot. Traplog plots established in the Hinton and Lac la Biche area were evaluated. Isolates from cutblocks in the Swan Hills area were evaluated to determine clonal size.

2. Continued studies on the distribution and taxonomy of the NABS of the Armillaria mellea complex in the region. An information report on Armillaria root rot is in preparation. A journal article on the Armillaria mellea complex in the Prairie provinces is in preparation. A journal article entitled "Vegetative incompatibility in diploid isolates of North American Armillaria species I and V, was submitted to the Canadian Journal of Botany and published.

3. Continued studies on finding alternative fungicides for the control of damping-off in nurseries. Five fungicides were tested for phytotoxicity to conifer seedlings. A file report on experimental results was written.

4. A journal paper entitled "Pseudosclerotial type and rhizomorph branching pattern in relation to Armillaria taxonomy" was submitted to Mycologia for review.

5. An inoculation experiment with Armillaria mellea complex species and five conifer species was evaluated. Results were presented at the "North Central Forest Pest Workshop" in Winipeg.

6. Advice and diagnostic support was provided to NOR-11-01 personnel and client groups. Technology transfer of information was provided through 7 workshops, site visits, Advisory committees, and diagnostic service.

7. Three issues of "Forest Insect and Disease Notes" were edited and mailed out (in cooperation with NOR-11 personnel).

Saskatchewan Agreement

8. Continued studies into the cause of mortality in pine stands that have been defoliated by the jack pine budworm, through excavation and dissection of the root systems, and stem analysis. A paper entitled "Correlation of Armillaria root rot with damage to trees defoliated by the jack pine budworm" was presented at the American Phytopathological Society's Annual meeting. A journal article entitled "Relationships among jack pine budworm damage, selected tree characteristics, and Armillaria root rot" was submitted for review to the Canadian Journal of Forest Research. In conjunction with NOR-11-05 (Mallett & Volney)

Manitoba Agreement

9. A report was written on studies to determine volume loss and the cause of the elevated mortality rates in selected stands of severely defoliated jack pine in the Thompson area. In conjunction with NOR-11-05 (Mallett & Volney)

Added goals - A-base:

10. Fungi from terminal weevils were isolated and identified from pine and spruce. In conjunction with NOR-11-10 (Mallett & Langor).

11. Needles from field grown lodgepole pine trees, affected and unaffected by Armillaria root rot, were collected from the Hinton and the Swan Hills area and analyzed for nutrient content. In conjunction with NOR-07-05 (Mallett & Maynard).

12. Development of the host rules for the National Insect and Disease Forest Pest Depletion Exercise was begun.

13. An article entitled "Non-chemical controls of insect and diseases of trees and shrubs" was prepared for the Prairie Landscape Magazine.

14. A invited paper entitled "Pest of trees and shrubs: A different perspective" was presented at the International Society of Arboriculture (prairie chapter) meeting in Regina.

15. A file report on the identity of conifer seedling pathogens from Pine Ridge Tree Nursery growth media was prepared.

12. Present Status of Study

Research studies were conducted on the taxonomy and distribution of the Armillaria mellea complex in the region. Specimen collections were made and are being identified with the aim at developing a distribution map for these species according to geographical region and host species. Identification methods for identifying the various NABS are being developed. Techniques for identifying Armillaria root rot centers in cutover areas have been initiated. The A. mellea complex species present in the region are being tested for their ability to kill native conifer species.

A study to find alternative fungicides for the control of damping off of conifer seedlings was continued. Six fungicides have been screened for phytotoxicity.

Studies into the cause of mortality of jack pine budworm defoliated jack pine in Saskatchewan have shown that there is a relationship between Armillaria root rot and jack pine budworm damaged trees.

13. Goals for 1990-91:

1. Continue studies on the distribution and taxonomy of the NABS of the Armillaria mellea complex in the region. Prepare an information report on the Armillaria mellea complex in the region for internal review. Prepare a journal paper on The Armillaria mellea complex in the prairie provinces of Canada for journal review.

2. Continue studies on finding alternative fungicides for the control of damping-off in nurseries. Candidate fungicides will be evaluated for efficacy in controlling damping off.

3. Isolate and identify fungi from terminal weevils and their galleries in spruce and pine. In conjunction with NOR-11-10 (Mallett & Langor).

4. Collect and determine nutrient content of needles from field grown lodgepole pine trees affected and unaffected by Armillaria root rot. Initiate a greenhouse experiment to

determine the relationship between foliar nutrients and Armillaria root rot. In conjunction with NOR-07-05 (Mallett & Maynard).

5. Initiate a study on population structure of Phellinus tremulae in aspen poplar. Collect isolates and identify mating genes for genetic markers.

6. Continue studies to develop early detection and survey techniques for Armillaria root rot. Survey Aspen poplar stands for Armillaria root rot using traplog technique. Survey Aspen poplar stands to determine other root rotting fungi present. Prepare a Forest Management Note on Trap Log Technique.

7. Continue inoculation studies with Armillaria species. Investigate the relationship of water stress to pathogenicity.

8. Revise and submit a journal paper entitled "The cultural characteristics of the A. mellea complex" to Mycologia review.

9. Prepare a journal article on the affects of jack pine budworm and root rot on jack pine growth. Prepare a journal article on tree analysis of jack pine budworm defoliated trees. In conjunction with NOR-11-05 (Mallett & Volney)

10. Participate in the development of the host rules for the National Insect and Disease Forest Pest Depletion Exercise.

11. Provide advice and technology transfer of information regarding forest diseases to NOR-11-01 personnel and client groups. Contribute to the development of a FIDS Insect and Disease Survey Manual.

12. Produce 3 issues of "The Forest Insect and Disease Notes". (in cooperation with personnel from NOR-11).

14. Publications 1989-90:

Mallett, K.I. 1989. Non-chemical control of insects and diseases of trees and shrubs. Prairie Landscape Magazine. 12:(4):4.

Mallett, K.I. 1989. Pest of trees and shrubs: A different perspective. Proceedings of the International Society of Arboriculture, Prairie Chapter Conference, Regina, Saskatchewan, Sept. 10-13, 1989.

Mallett, K.I. (Compiler) 1989. Forest Insect and Disease Notes. Forestry Canada, Northern Forestry Centre, Edmonton, Alberta. Tech. transfer Note A-009, A-012, A-013.

Mallett, K.I.; Hopkin, A.A.; and Blenis, P.V. 1989. Vegetative incompatibility in diploid isolates of North American biological species I and V. Can. J. Bot. 67: 3083-3089.

Mallett, K.I.; Volney, W.J.A. 1989. Correlation of Armillaria root rot with damage to trees defoliated by the jack pine budworm. Phytopath. 71: 1166.

15. Environmental Implications:

The NoFC Environmental Committee has evaluated the proposed study activities. On the basis of the information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started: 1987 Completion: ongoing

17. Resources 1990-91:

PY'S: Prof.: Mallett 0.9
Tech.:

Total: 0.9
Term/student: 1.5

O & M: $ 6,000

Capital: $11 K

18. Signatures:

Investigator

Program Director, Protection

Regional Director General

NOR-11-10

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 2, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Forest insect biosystematics

3. New: Cont.: X 4. No.: NOR-11-10

5. Study Leader: D.W. Langor

6. Key Words: Insects, adults, larvae, damage, impact, hosts, predators, parasites, identification, taxonomy, reference collection, distribution, life history, terminal weevils, electrophoresis, forest tent caterpillar, aspen pests

7. Location of Work: Northwest Region

8. Background:

Insects constitute one of the most important biotic factors affecting forest ecosystems. Hundreds of insect species attack and damage every part and age class of the native and exotic tree species in this region. Prompt and accurate identification of mature and immature stages of insects is essential to insect surveys, pest extension services, damage appraisal studies, environmental assessment services and consideration of control measures for forest insect pests. Insect diagnostic and taxonomic services are important to many research studies and provide information which leads to a broader understanding of forest ecosystems. It is important to keep abreast of the taxonomy and nomenclature of insect taxa important to forestry so as to provide current scientific names for use in publications. To maintain and improve diagnostic and taxonomic service capabilities, it is necessary to maintain a reference collection of mature and immature insects as well as a reference literature collection.

Since the insect larval stage is the most destructive and insect identification is based mainly on the adult stage, a rearing program is a necessity to establish larval-adult association. The rearing program also provides information on phenology, parasites, predators, diseases and host associations as well as supplies material for the reference collection.

Some groups of insects of importance to forestry are closely related and resemble each other morphologically. Without adequate ways to discriminate among similar species this may lead to

some confusion in biological studies and in the implementation of management plans. Therefore, there is a need to understand the taxonomy of these species in order to determine species boundaries and to find characters to discriminate among similar species. Taxonomic studies are usually based on an examination of morphological characters. However, some species are poorly differentiated morphologically and biochemical methods (e.g., electrophoresis, RFLP, etc.) are required to discriminate among these species. Additionally, life history studies also provide important biological information which assists in separating such species.

9. Study Objectives:

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

2. Maintain and improve regional collections of insects and mites, photographic slides, insect taxonomic literature, and FIDSINFOBASE.

3. Undertake biosystematic and faunistic studies of Pissodes weevils and other selected important forest insect taxa.

10. Goals for 1989-90:

1. Continue to develop diagnostic skills for identification of the immature and mature stages of forest insects of the region.

2. Provide diagnostic and taxonomic services for determinations of mature and immature insects damaging forest and shade trees.

3. Maintain and improve reference collection of insects and mites by updating the current collection, adding new insect specimens and compiling a computerized catalogue for accessing the collection.

4. Provide maintenance and improvement of nursery stock for foliage and food materials for insect rearing.

5. Provide advice, information and specimens to scientists engaged in taxonomic and biological studies and to clients.

6. Enter, retrieve and process data from FIDSINFOBASE when necessary.

7. Continue organization of the FIDS photographic slide collection and compilation of a computerized catalogue for accessing the collection.

8. Continue biosystematic and ecological studies of the genus Pissodes of the region:

a) Complete assembly of an electrophoresis laboratory and develop electrophoretic protocols for Pissodes species in the region.

b) Initiate a genetic survey of the Pissodes species in the region.

c) Cross breed P. terminalis from jack pine and lodgepole pine to determine compatibility.

d) Set up permanent plots in the Whitecourt area of Alberta to monitor the effects of cutting the overstory on incidence of P. strobi attack on white spruce. [Mixedwood Project]

e) Search for populations of P. terminalis in boles of lodgepole pine and jack pine for comparison with populations in terminals.

f) Continue survey of predators and parasites of Pissodes.

g) Continue survey of fungi dessiminated by Pissodes.

h) Search for populations of Pissodes associated with witches broom on conifers.

i) Continue searching for morphological characters to discriminate among Pissodes species in the region.

j) Prepare a bibliography of Pissodes literature for publication as an information report.

9. Monitor the spread of introduced insects as well as their predators and parasites in the prairies.

10. Continue studies on insect communities associated with and contributing to the deterioration of jack pine killed by jack pine budworm in Manitoba (Volney, Langor).

Manitoba Agreement:

11. Initiate a study of P. strobi phenology in white spruce plantations in the Inter-lakes region of Manitoba.

12. Set up permanent plots in the Inter-lakes region of Manitoba to monitor the effects of cutting the overstory on incidence of P. strobi attack on white spruce.

11. Accomplishments in 1989-90:

1. About 200 hours were spent identifying mature and immature insects.

2. - Fifty-four collections were received from FIDS rangers for identification and 128 other collections were received from clients, NoFC personnel, and other sources (about 3100 specimens).
   - Sixty collections (about 800 specimens) of insects were reared for diagnostic purposes or to obtain parasites.
   - Fifteen collections were sent to the Biosystematics Research Centre for identification or confirmation.

3. - The museum and diagnostics lab has expanded to include room 2052.
   - The reference collection is still undergoing re-organization and expansion to incorporate the storage collections.

- About 900 specimens were added to the collection.
- Updating of the names of all species is continuing.
- A computer program for generating insect labels was developed and is now fully operational [in cooperation with D. Carrigan].

4. Nursery stock was watered, fertilized, and maintained in good condition.

5. - Advice and information was given to 48 clients, NoFC personnel, other agencies, and the public.
   - Acted as scientific advisor for a research project on the western ash bark beetle initiated by the Calgary Dept. Parks and Recreation.
   - Reviewed for authors or journals 7 papers and one book totalling about 700 manuscript pages.
   - Four requests for loans of insects were received from scientists and three were filled (1645 specimens). Five requests for gifts of insect specimens were received and three were filled (340 specimens).
   - Presentations were given to five groups (140 people) touring NoFC.
   - Two lectures were given to a forest entomology class at the University of Alberta and one seminar to NoFC personnel.

6. Three FIDSINFOBASE queries were made.

7. Approximately 900 slides were sorted and 100 identified. The storage facilities have been reorganized and improved and are located in room 2052.

8. a) A laboratory for starch and polyacrylamide gel electrophoresis has been set up. Forty-five enzyme systems were examined for Pissodes strobi. Electrphoretic protocols have been worked out for 13 enzyme systems representing 18 loci.

   b) A genetic survey of three populations of P. strobi and two of P. terminalis has commenced. Thus far 100 specimens have been examined electrophoretically.

   c) Seven hundred specimens of P. terminalis were reared from jack pine in Saskatchewan and stored at 2 C to be used in cross breeding studies in the spring of 1990. Unfortunately, a fungus killed all specimens.

   d) Four sites were chosen for future establishment of plots in the Drayton Valley [Mixedwood Project].

   e) Time was spent searching for populations of P. terminalis in boles (mainly in the Hinton area and near Prince Albert, Sask.) but no populations were found.

   f) About 300 specimens of Pissodes parasites were collected and most identified. Together with specimens collected previously, these parasites form a valuable reference collection which will be of great use in future studies on Pissodes (e.g. parasite impact, life tables, biocontrol).

   g) Fungal isolations were made from terminals infested with P. terminalis and P. strobi from 12 localities and from adult beetles. [In collaboration with K. Mallett, NOR-11-09]

h) No witches brooms collected.

i) About 150 specimens of Pissodes spp. from the region were examined. This preliminary research led to the conclusion that a generic revision of Pissodes is necessary to resolve taxonomic problems within regional representatives of this genus. About 120 museums were solicited for loan of Pissodes specimens to be used for this revision.

j) About 800-900 pieces of literature on Pissodes now been collected and abstracting has begun.

9. No specimens of introduced species were collected in Manitoba. The pine false webworm, Acantholyda erythrocephala, was discovered for the first time in this region (Edmonton). A brief survey was carried out to determine the distribution of this species in northern Edmonton.

10. Rearing of insects associated with boles of trees killed or weakened by jackpine budworm was completed and a final report submitted.

Manitoba Agreement:

11. Plots set up to initiate study were burned in forest fire.

12. ditto

Additional Accomplishments:

13. Revised two pest leaflets, White Pine Weevil and Birch Leafminers.

14. Presented a paper at the Entomological Society of America conference in San Antonio, TX.

15. Presented a poster at the Entomological Society of Canada meetings in St. John's, Nfld.

16. Collected some data on the life history of P. terminalis near Hinton, Alberta and tested a new trap design for monitoring weevil flight.

17. Prepared a forest management note titled: "The Lodgepole Terminal Weevil, Pissodes terminalis Hopping, in the Prairie Provinces" [in cooperation with H.R. Wong and J. Drouin].

12. Present Status of Study:

Development of diagnostic skills is continuing and diagnostic services are ongoing. The insect reference collection is undergoing reorganization, expansion, and scientific names of insects are being updated. Advice, information, and insect and mite specimens are provided to scientists, clients, and the public upon request.

The FIDSINFOBASE is continuing to be updated by addition of new records and correction of old records. The database is queried and reports generated upon need or request.

Organization of the FIDS photographic slide collection (ca. 10,000 slides) is continuing. About 50% of the approximately 5,000 unsorted slides have now been sorted and on most the

dentifications have been confirmed or updated. A new storage system has been created in room 2052.

A study of the systematics and ecology of Pissodes species in the region is continuing. An electrophoresis laboratory to study genetic variability of forest insects is fully operational and preliminary data on isozyme variation in Pissodes has been collected. A taxonomic revision of the genus has been started. A study of the fungi desseminated by P. strobi and P. terminalis is well under way and selected fungi are to be tested for their pathogenicity to trees. Predators and parasites of the Pissodes species in our region are currently being surveyed and a reference collection prepared. About 800-900 papers on Pissodes have been compiled and are being abstracted in preparation for an annotated bibliography.

Monitoring of the spread of several introduced forest insects (European spruce sawfly, introduced pine sawfly, larch casebearer, mountain ash sawfly, pine false webworm) and their parasites in the prairie provinces is continuing.

13. Goals for 1990-91:

A. Biosystematics and Ecology of Pissodes Weevils.

1. Continue a survey of isozyme variation of Pissodes in search of biochemical characters for use in a taxonomic revision of the genus and for diagnostic purposes.

2. Commence a taxonomic revision of Pissodes: assess variation of structural characters within and among currently recognized species, delimit genus and species boundaries, assess species evolutionary relationships, compile distribution and host records, and write keys to be used to separate species.

3. Continue survey of fungi associated with P. strobi and P. terminalis in the region and evaluate the pathogenicity of selected fungi to host trees. [In collaboration with K. Mallett, NOR-11-09]

4. Complete annotated bibliography of North American Pissodes literature for publication as a diskette.

5. Complete and publish a forest management note titled: "The Lodgepole Terminal Weevil, Pissodes terminalis Hopping, in the Prairie Provinces". [in cooperation with H.R. Wong and J. Drouin]

6. Attempt to cross breed P. terminalis from lodgepole pine and jack pine to study compatibility, fertility, and fecundity.

7. Commence preliminary research on cuticular hydrocarbons (CH) of Pissodes to determine if these characters have taxonomic importance. Initially geographic, sex, and host effects on the CH profile of P. strobi and P. nemorensis (two closely related species) will be assessed and the utility of CH for separating these two species will be evaluated. [In collaboration with Dr. M. Haverty (U.S. Forest Service, Berkeley, CA)]

8. Continue to survey predators and parasites of Pissodes and commence a study of their impact on P. strobi and P. terminalis populations in the region.

B. Diagnostic & Advisory Services and Collections Management

9. Provide diagnostic and taxonomic services for determinations of mature and immature insects damaging forest and shade trees.

10. Maintain, update, reorganize, and improve regional collections (insects and mites, photographic slides, FIDSINFOBASE).

11. Provide advice, information, and specimens to scientists engaged in taxonomic and biological studies and to clients.

12. Provide input (advice and data analysis) into a western ash bark beetle research program in Calgary. [In collaboration with C. Hergert, Calgary Parks and Recreation]

C. Other Faunistics and Taxonomic Studies

13. Commence survey of the parasites and predators of the forest tent caterpillar in Alberta. [In collaboration with Dr. J. Spence, University of Alberta]

14. Commence survey of insects and mites feeding on aspen in the region.

15. Continue to monitor the spread of introduced insects as well as their predators and parasites in the region as opportunity allows.

14. Publications 1989-90:

Langor, D. W. 1989. The western ash bark beetle, Pages 2-3. in K. I. Mallett (compiler), Forest Insect and Disease Notes, April, 1989. Forestry Canada, Northern For. Cent., Edmonton, Alta. Tech. Transfer Note A-009. [This article was reprinted twice (1) Prairie Landscape Magazine 12 (4):8. (2)

Langor, D.W.; Raske, A.G. 1989. A history of the eastern larch beetle, Dendroctonus simplex (Coleoptera: Scolytidae), in North America. Great Lakes Entomol. 22: 139-154.

Langor, D.W.; Spence, J.R.; Pohl, G.R. 1990. Host effects on the mountain pine beetle, Dendroctonus ponderosae Hopkins (Coleoptera: Scolytidae), in controlled breeding experiments. Evolution (in press).

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Start: 1988 Completion: Continuing

17. Resources 1990-91:

PYs: Prof.: Langor 0.9
Tech.:

Total ~~1.9~~ 0.9

Term/Student 0.4

O&M: $ 6.0 K

Capital: $ 3.6 K

Minor Construction: $15.0 K (insectary)

18. Signatures:

David W Langor
Investigator

Program Director, Protection

Regional Director General

NOR-11-11

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 23, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Biotechnological and pathological investigation of western gall rust of hard pines in the Northwest Region

3. New: X Cont: 4. No.: NOR-11-11

5. Study Leaders: O. M. Aguilar, Y. Hiratsuka

6. Key Words: Endocronartium, western gall rust, biocontrol, host-parasite interaction, molecular basis of cell prolification, ultrastructure, tissue culture, axenic culture, genetic transformation

7. Location of Work: NoFC, Plant Molecular Genetics and Plant Biotechnology Centre, University of Alberta, and Alberta Research Council.

8. Background Statement:

Jack pine is an important reforestation species in Manitoba and Saskatchewan. A breeding program for jack pine in these provinces has identified genetically superior trees which will be mass-produced to increase the productivity and economic attractiveness of jack pine plantation forestry. Realization of the potential benefits of planting genetically improved jack pine could be offset by an increase in the prevalence of western gall rust. This disease, which is caused by the fungus Endocronartium harknessii, is not recognized as a major threat to natural jack pine stands, but will probably increase in importance as the area occupied by planted jack pine increases. Development of a system for efficient control of western gall rust will allow realization of the potential benefits of genetic improvement.

As the result of a jack pine breeding program genetically superior jack pine families are available.

As a result of ongoing research work at the Northern Forestry Centre (NoFC) on morphology, life cycle, cytology, and distribution of western gall rust are well documented. Also a significant amount of knowledge has been accumulated on collection and preservation of spores, technique

and timing of artificial inoculation, infection process, and host parasite interaction of the disease. Axenic cultures of the fungus have been established.

During the past decade, significant progress has been achieved in genetic alterations of fungi. Recently, genes can be introduced into fungi with more complex life cycle like Neurospora sp. Aspergillus sp. Cochliobolus sp. Ustilago sp.

Similarly, great advances have been made towards the genetic transformation of trees. Several laboratories reported successful transformations and regeneration of transformed plants of poplar.

Both, fungal and plant genetic advances that are described above provide the scientific justification for immediate initiation of similar research for the pathogenic fungus E. harknessii as well as on the host plant jack pine. Our experiments are aimed to elucidate the mechanism of gall rust formation which undoubtedly will help in designing of novel plant protection approaches for conifers.

9. Study Objectives:

Long Term Objectives:

1. To create hard pine families immune to western gall rust with superior growth characteristics and wood quality with biotechnological and pathological methods.

2. To develop novel biological control method(s) to reduce loss caused by western gall rust and other pine stem rusts.

Short Term Objectives:

1. Establish and learn technique to enhance growth and sporulation of axenic cultures of western gall rust from various geographical locations and different hosts for in vitro resistance evaluation and molecular biological investigations. (1993-1994)

2. Achieve genetic transformation of lodgepole or jack pine, and western gall rust. (1994-1995)

3. Establish protocols for micropropagation, tissue culture, cell culture, and organ regeneration of logepole and jack pines. (1992-1993)

4. Develop a novel concept of biological control strategy for western gall rust and other pine stem rusts which uses free moving rust feeding insects as vectors of aggressive mycoparasite(s), and demonstrate the applicability with a selected system (Epuraea obliquus - Scytalidium uredinicola). (1993-1994)

10. Goals for 1989-90:

(New Study)

11. Accomplishments for 1989-90:

(New study)

12. Present Status of Study:

This study is initiated to respond to a new strategic thrust in biotechnology in this region, and with the appointment of a research scientist (M. Aguilar) in biotechnology.

13. Goals for 1990-91:

1. Review and update literature on plant (conifer)-fungi interaction. (Aguilar)
2. Set up laboratory facilities for molecular biology research in conifer and fungi. (Aguilar)
3. Optimize experimental procedures for extraction of macromolecules(Protein, DNA, RNA) from western gall rust infected and non-infected hard pines (Jack and lodgepole pines). (Aguilar)
4. Continue to explore a new biocontrol strategy of western gall rust involving insects and hyperparasited. (Hiratsuka, Volney)

14. Publications 1989-90:

(New Study)

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started : 1990 Estimated Completion: Continuing

17. Resources 1990-91:

PYs: Prof.	Aguilar	0.8
	Hiratsuka	0.4
	Volney	0.1
Tech.	Maruyama	0.4
Total:		1.7
	New	0.5 (share with NOR-11-12)
Visiting Scientist		2.0 (Dr. A. Stolart, Dr. Pei Minghao)
Technologist		1.0
Summer Student		0.3
O & M:	A-base	$ 8 K

FRDAs (three prov.)

Capital equipment: 10.6 K

Cooperators: Dr. T. Thorpe (University of Calgary), Dr. A. Szalay and Dr. W. Langridge (University of Alberta)

Related Studies: NOR-12-04 (J. Klein), NOR-11-06 (Y. Hiratsuka)

18. Signatures:

Investigator

Program Director, Protection

Investigator

Regional Director General

NOR-11-12

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 15, 1990

1. Project: Forest Insect and Disease Surveys and Management Systems

2. Title: Biotechnological, pathological, and entomological investigations of aspen in the Northwest Region (Aspen Bioinnovation Centre)

3. New: X Cont: 4. No.: NOR-11-12

5. Study Leaders: Y. Hiratsuka, M. Aguilar

6. Key Words: aspen, Populus tremuloides , biotechnology, insects, diseases, biocontrol, ultrastructure, molecular biology, forest tent caterpillar, Armillaria root rot, poplar leaf rusts, Hypoxylon canker

7. Location of Work: Northern Forestry Centre, Plant Molecular and Plant Biotechnological Centre, University of Alberta

8. Background Statement:

As mixedwood management becomes important, regeneration of aspen will be considered as important as conifer reforestation in our region. Aspen provides excellent possibilities of biotechnological work. Aspen became an important forest tree species in the region and the genus Populus is considered to be much easier to propagate and to tissue culture. Successful genetic transformation of Populus with Agrobacterium has been accomplished. At the present time, decay is the biggest concern in relation to the utilization of existing aspen resources. In the future when intensive management of aspen will be practised, such diseases as Armillaria root rot, leaf rusts and Hypoxylon canker and insect pests like forest tent catepillar will become important factors for successful cultivation, and need to be considered in aspen improvement work. However, big gaps exist in our knowledge of conventional biological information of aspen and molecular level work (biotechnological approaches). At this time very little basic biological and pathological information is available on aspen and no ongoing pathological or physiological studies of aspen is underway in NoFC.

9. Study Objectives:

Long Term Objectives:

1. To create aspen clones with superior growth characteristics, desirable wood quality, insect repellency, and disease resistance using biotechnological, pathological and entomological methods.

2. To find novel biological control method(s) of protecting aspen from decay and stain organisms.

Short Term Objectives:

1. Identify, collect, and maintain aspen clones with superior growth characteristics, superior wood quality, resistance to forest tent caterpillar feeding, and resistance to leaf rusts (Melampsora spp.) which occur naturally within the range of aspen in North America. (1992-93)

2. Achieve transformation of aspen and improve protocols for efficient gene transfer, tissue culture, and regeneration. (1993-94)

3. Investigate the material collected in 1 above and conduct biotechnological investigation of identifying genes, and create and regenerate new clones of aspen having more than one desirable genetic trait. (1994-95)

4. Determine the cause of "blackish gall" of aspen, discover the relationship of "blackish gall" and decay development, and propose a new strategy of biological protection of decay.(1993-94)

10. Goals for 1989-90:

(New Study)

11. Accomplishments for 1989-90:

(New Study)

12. Present Status of Study:

This study is initiated to respond to a new strategic thrust proposed in aspen biotechnology (Aspen Bioinnovation Centre) in this region, and with the appointment of a research scientist in biotechnology (M. Aguilar).

13. Goals for 1990-91:

1. Molecular biology and biotechnology

a) Survey available information on tissue culture, regeneration, and transformation of poplar (genus Populus) and plan possible application to aspen. (Aguilar)

b) Develop protocols for tissue culture and plant regeneration of aspen. (Aguilar)

2. Insect and disease resistant aspen

a) Establish methods of identification, collection, and preservation of insect and disease resistant clones of aspen in the region. (Hiratsuka, Cerezke, Langor, Mallett)

3. Biocontrol of aspen decay

a) Identify fungi and bacteria isolated from "black gall of aspen" and investigate anti fungal properies of major species. (Hiratuska)

b) Investigate metabolites produced by fungi from 3. a. above and assay their efficacy as antifungal agents. (Hiratsuka)

14. Publications 1989-90:

(New Study)

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started : 1990 Estimated Completion: Continuing

17. Resources 1990-91:

PYs Prof.:	Hiratsuka	0.3
	Aguilar	0.2
	Langor	0.1
	Mallett	0.1
	Cerezke	0.1
Tech.:	Maruyama	0.3
Total:		1.1
New		0.5* (share with NOR-11-11)

Visiting Scientist	1.0*
Technologist	1.0*

* Pending approval

O & M: $ 5 K A-base
Capital equipment: $ 6 K

Cooperators: Dr. F. Yeh (Dep. For. Sci., U. of Alberta) Drs. A. Szalay and W. Langridge (Plant Molecular Biol. and Biotechnol. Centre, U. of Alberta), Dr. T. Thorpe (U. of Calgary), Dr. W. A. Ayer (Dep. Chemistry, U. of Alberta)

Related studies: NOR-10-12 (S. Navratil), NOR-11-05 (J.Volney), NOR-11-09 (Mallett), NOR-11-10 (D.Langor), NOR-11-01 (H. Cerezke), NOR-11-06 (Hiratsuka)

18. Signatures:

Investigator

Program Director, Protection

Investigator

Regional Director General

NOR-36-01-1

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 23, 1990

1. Project: Development Agreements

2. Title: Forest pest management, surveys, and damage appraisal (Manitoba)

3. New: Cont.: X 4. No.: NOR-36-01-1

5. Study Leader: vacant

6. Key Words: Damage appraisal, impact, hosts, forest pests, sampling methods, management, mortality, growth loss, forest renewal, jack pine budworm, detection, distribution, parks, recreation, easement atmosphere, effluents.

7. Location of Work: Manitoba District Office, Manitoba wide

8. Study Objectives:

   1. To develop methods for predicting short and long term impact of pest(s) including damage appraisal on forest resources, values, management plans and operations.

   2. To determine how and to what extent pest damage affects forest resource users and management plans.

   3. To intensify and improve the general pest detection and damage surveys and to conduct special surveys of particular forest pests of designated areas.

   4. To evaluate or develop methods to manage pest-susceptible forest and pest populations, to limit forest damage to tolerable levels use of silvicultural, chemical and biological techniques.

   5. To provide management agencies, and the public with diagnostic impact and appraisal services relating to insects, diseases, climatic influences, and pollutants on trees, shrubs and other vegetation.

   6. To contribute to FIDS national overview of important pest conditions.

9. Goals for 1989-90:

1. Complete a final report on the jack pine budworm population, phenology, and defoliation studies.

2. Survey, map, and report on the major forest pests in Manitoba.

3. Conduct and prepare data on an intensive impact survey of the 5 ha plantations in Manitoba.

4. Conduct and prepare data files on tree assessments in 50 permanent forest inventory sample plots in Manitoba.

5. Conduct the annual assessments of the four permanent ARNEWS plots.

6. Compile a report on the forest pest situation in Manitoba for 1989 and pest prediction in 1990.

7. Provide a pest extension service and technology transfer to various client agencies.

8. Prepare material for presentation at the annual Regional Insect and Disease Technical Advisory Committee.

9. Represent ForCan on various forest pest committees and advisory groups.

10. Accomplishments in 1989-90:

The study leader was absent during the report year, however, most of the goals were completed by Grandmaison and other NOR-11 members.

1. The analysis and reporting responsibilities were assured by NOR-11-05; a draft of the final report is in preparation.

2. The major forest pests of Manitoba were surveyed and reported upon in the publication.

3. A detailed survey of a jack pine plantation was conducted.

4. Tree assessments were conducted on 100 permanent sample plots.

5. All ARNEWS plots were assessed and the data forwarded to Edmonton.

6. A file report on pest conditions 1989 with predictions for 1990 was prepared.

7. Pest extension and advisory services were provided to various client.

8. The necessary material was prepared and forwarded to regional headquarters for the annual Regional Insect & Disease Technology Advisory Committee.

9. Assisted in preparation for the North Central Forest Pest Workshop.

11. Goals for 1990-91:

Terminated.

12. Publications 1989-90:

Grandmaison, M. 1989. Forest insect and disease conditions in Manitoba in 1989. File Report. 32 pp.

13. Environmental Implications:

The agreement manager has been directed by management committee to include all pertinent environmental related information on the PAF associated with this project. The PAF will serve as the official document which the environmental screening committee will review.

14. Duration:

Start: 1984 Completion: 1990

15. Resources 1990-91:

Nil (Grandmaison's PY shown under NOR-11-01)

16. Signatures:

Investigator

District Manager

Technical Advisor

Program Director, Development

Program Director, Protection

Regional Director General

NOR-36-02-4

FORESTRY CANADA

STUDY WORK PLAN

1990-91

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 1, 1990

1. Project: Development Agreements

2. Title: Forest pest management and damage appraisal (Alberta)

3. New: Cont: X 4. No: NOR-36-02-4

5. Study Leader: P. Amirault

6. Key Words: Damage appraisal, diagnostic and advisory services, forest management, forest pests, forest pest surveys, geographic information systems, hazard rating, pest impact, technology transfer.

7. Location of Work: Northern Forestry Centre; Alberta-wide.

8. Background:

The Province of Alberta, like other jurisdictions in Canada, is adopting "intensive" forest management techniques. This has implications for all fields of forest research and planning, and implies that damage caused by forest insects and diseases will be minimized. This was recognized in the Canada-Alberta Forest Resource Development Agreement as funds were allotted for forest insect and disease studies. The proposal which governs the agreement is a comprehensive document which outlines a wide variety of potential areas of study. While varied, these areas of study are designed to compliment existing Forest Insect and Disease Survey (FIDS) programs. The studies initiated as a result of the Canada/Alberta Forest Resource Development Agreement are intended to provide information that will enhance and improve the survey and management of forest pests in Alberta.

9. Study Objectives:

1. To identify when and where damage by forest pests may occur, and to rank stands according to potential losses.

2. To determine how and to what extent pest damage affects forest resource users and management plans.

3. To provide technology transfer, training, and diagnostic and advisory services to AFS staff and other forestry personnel in th province.

4. To develop or improve existing methods to assess population and infestation levels of forest pests.

10. Goals for 1989-90:

1. Contribute to the initiative to use forest inventory permanent sample plots for insect and disease studies, as requested.

2. Act as scientific advisor (with J. Volney) for the contract to analyse data from pests surveys in young stands. Field test various methods of conducting pest surveys, as proposed by contractors (cross reference NOR-11-01).

3. Complete file report on the distribution and impact of dwarf mistletoe on jack pine in Alberta.

4. Continue incorporating historical FIDS data into the geographic information system (GIS) (cross reference NOR-11-01).

5. Complete depletion estimates for Northwest Region (cross reference NOR-11-01).

6. Assist in the completion of the information report on pest impact in the Northwest Region (cross reference NOR-11-05).

7. Continue to provide diagnostic and advisory services on pest problems as requested.

8. Complete reports/documentation requested as part of the FRDA final report process.

Added Goals:

9. Conduct root rot surveys in dwarf mistletoe infected jack pine stands (cross reference NOR-11-09).

10. Continue to work with AFS in monitoring spruce budworm conditions in Northern Alberta (cross reference NOR-11-01).

11. Complete first draft of an agreement report involving using GIS technology to apply a hazard-rating system to mountain pine beetle in Alberta.

12. Progress with developing GIS applications for the FIDS program (i.e. as a storage/retrieval facility for young stand data).

13. Receive one week of training in the Arc\Info GIS system from a representative of the Environmental Systems Research Institute.

14. Assist in the delivery of a Forest Insect and Disease Workshop to industry and provincial forestry personnel (June 5-8, Hinton).

15. Represent Forestry Canada on the Forest Protection Task Force.

11. Accomplishments 1989-1990:

1. Summarized information pertaining to the use of forest inventory permanent sample plots for insect and disease studies.

2. Contract was let to analyse data from previous young stand surveys and data from said surveys was made available. Additional field data was collected form three new study areas in Alberta using a combination of full-tree mapping and pest coding techniques (cross reference NOR-11-01).

3. File report on the distribution and impact of dwarf mistletoe in east-central Alberta was completed.

4. Historical FIDS data has continued to be incorporated into the geographic information system (cross reference NOR-11-01).

5. Progressed with preparing depletion estimates (from 1982-87) for the Northwest Region (cross reference NOR-11-01).

6. Progressed in the preparation of an information report on pest impact in the Northwest Region (cross reference NOR-11-05).

7. Continued to provide diagnostic and advisory services on pest problems as requested.

8. Completed a draft copy of the FRDA final report.

9. Conducted root rot surveys in dwarf mistletoe infected jack pine stands (cross reference NOR-11-09).

10. Continued to work with AFS in monitoring spruce budworm conditions in Northern Alberta (cross reference NOR-11-01).

11. Completed first draft of an agreement report involving using GIS technology to apply a hazard-rating system to mountain pine beetle in Alberta.

12. Progressed with developing GIS applications for the FIDS program (i.e. as a storage/retrieval facility for young stand data).

13. Received one week of training in the Arc\Info GIS system from a representative of the Environmental Systems Research Institute.

14. Assisted in the delivery of a Forest Insect and Disease Workshop to industry and provincial forestry personnel (June 5-8, Hinton).

15. Represented Forestry Canada on the Forest Protection Task Force.

12. Present Status of Study:

1. Information on the use of forest inventory permanent sample plots for insect and disease studies is available to potential users.

2. Awaiting final report on pest surveys in young stands from Sylvicom Ltd. Assumably the proposed methodology will be adopted by FIDS.

3. The distribution and impact of dwarf mistletoe on jack pine in east central Alberta could be further investigated pending further agreement funding.

4. Historical FIDS data continues to be incorporated into the Geographic Information System.

5. The pest depletion exercise has reached the point where regional exchanges of data are occurring. This will be followed by estimate development, provincial approval of figures, and the final report.

6. Information report on pest impact in the Northwest Region will be returned to reviewers after two chapters are re-written.

7. Diagnostic and advisory services will continue on request.

8. Completion of the FRDA Final Report is a short-term goal.

9. Root rot fungi collected during surveys in jack pine stands are being cultured for identification.

10. Monitoring of spruce budworm in Northern Alberta will continue as the population remains active.

11. Report on mountain pine beetle will be revised to incorporate reviewers comments

13. Goals for 1990-91:

1. Dwarf mistletoe impact plots will be remeasured.

2. Assistance in the study and monitoring of the spruce budworm in Northern Alberta will be provided as directed in the overall project plan (cross reference NOR 11-01).

3. Continue to incorporate historical FIDS data into the GIS (cross reference NOR 11-01).

4. Continue to provide regional input into the Pest Depletion Project (cross reference NOR 11-01).

5. Complete information report on pest impact in the Northwest Region (cross reference NOR 11-01).

6. Continue to provide diagnostic and advisory services on pest problems as requested.

7. Complete FRDA final report.

8. Complete report on mountain pine beetle hazard rating.

9. Assist FIDS personnel in adopting young stand pest survey procedure proposed by Sylvicom Ltd. (cross reference NOR 11-01).

10. Contribute to development of FIDS survey manual.

11. Continue to represent Forestry Canada on the Forest Protection Task Force.

12. Terminate the study.

14. Publications 1989-90:

Amirault, P. A.; Pope, B. 1989. Pest distribution and impact in young lodgepole pine stands in West-Central Alberta. For. Can, North. For. Cent., Edmonton, Alberta, Can.-Alta. For. Res. Development Agree. Rep. No. 1410-65. 37p.

Amirault, P.A. 1989. The cone and seed insects of tamarack in eastern North America. In. G.E. Millar (comp.). Proc. of the Cone and Seed Insects Working Party Conference, IUFRO Working Party S2.07-01, June 26-30, 1988, Victoria, B.C. For. Can., Pacific For. Cent., Victoria, B.C.

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of information provided by the study leader, the committee concludes that these activities are not potentially detrimental to the environment.

16. Duration:

Started: 1985 Estimated Completion: 1990

17. FRDA Resources 1990-91:

PYs: Prof.: Amirault 1.0

18. Signatures:

Apr 12/90

Investigator

Program Director, Development

Regional Director General