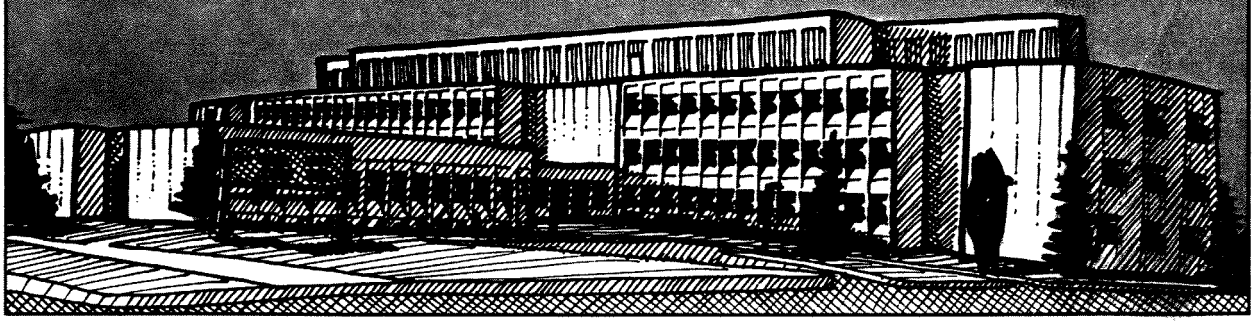
SASKATCHEWAN D.O.

# STUDY WORK PLANS

# 1991 - 92

## NORTHWEST REGION
## NORTHERN FORESTRY CENTRE
## 5320 - 122 STREET
## EDMONTON, ALBERTA



Forestry Canada Forêts Canada

Canada

# STUDY WORK PLANS

# 1991-92

NORTHERN FORESTRY CENTRE

NORTHWEST REGION

FORESTRY CANADA

5320 - 122 STREET

EDMONTON, ALBERTA

T6H 3S5

MARCH 1991

NOR-7-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Environmental Stresses on Forest Ecosystems

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

6. Key Words: acid deposition, 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.

Concerns have again been raised about the present and potential impacts on forest health due to sulfur emissions from sour gas processing plants in west central Alberta. These impacts include the direct effects of deposition in forest stands, including soils, and the predisposing effects these depositions may have on exacerbating latent forest insect and disease problems. A study, to be initiated in 1991-92, (in cooperation with the natural gas industry) will reexamine the existing sites sampled previously in 1981 and 1985, expand the network, and complete a forest health survey (in collaboration with NOR 11). This is a multidisciplinary

approach that will provide a more accurate assessment of sulfur emission impacts on the health of the forest ecosystem.

9. Study Objectives:

1. Determine the impact of sulfur deposition on the forest ecosystem near two sour gas processing plants in west central Alberta (in collaboration with J. Volney and K. Mallett, NOR 11).

2. 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.

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

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

10. Goals for 1990-91:

1. Publish an Information Report on the soil analysis and vegetation cover of the ARNEWS 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)

Added Goals:

7. Conduct a survey of the forests in the area of the Ram River sour gas processing plants, prepare a file report and present findings at the Energy Resource Conservation Board Hearing on the Caroline Sour Gas Development Project (Maynard, Mallett)

8. Carry out a survey, sample and analyze soils and foliage, and prepare a report on the results to assess the impact of $SO_2$ on the forests near the Giant Mine Yellowknife, NWT.

11. Accomplishments in 1990-91:

1. A first draft of the ARNEWS Information Report is completed. We are now reviewing and rewriting parts of the report. Several sections need shortening and reformating for consistency.

2. Ten ARNEWS plots in the Northwest region were resampled for soil and foliage analysis, vegetation analysis (e.g. plant cover estimates), and other measurements as outlined in the ARNEWS manual. Two sites, Hudson Bay, Saskatchewan and a new site to replace the Suwanee site, Leaf Rapids, Manitoba were sampled for foliar analysis and FIDS measurements. Soil samples and the vegetation analysis were not collected at these locations. The chemical analyses has been started for the soils and vegetation. The soil and most of the foliar analysis will be completed by the end of March.

3. Increased public awareness of environmental issues resulted in an increased number of requests for information and consultative services from private citizens and government agencies, particularly with respect to acid deposition. This included attending a workshop on a proposed Acid Deposition Program for Alberta (Maynard). Project staff participated in the public consultation meetings for the Green Plan (Zoltai, Fairbarns) and the public consultation meetings on a revised federal pest management regulatory system (J. Feng).

4. The new ICP-AES was installed in late February-early March. Quality assurance was completed in April. This included analysis of know standards and analysis of samples originally analyzed by the old ICP-AES. Radford attended a one week training course in the operation of the instrument and system computer software in June, 1990. The new ICP-AES is performing excellently with calibration and normalization very stable. Some problems still exist with the computer software. The program for print outs is not exactly as we want, however, our computer services section has now modified the program to meet our needs. Approximately 35 000 analysis will have been run on the ICP-AES during 1990-91 including 15 000 for the Anlaytical Services Laboratory and the ARNEWS program. The majority of the samples were analyzed for NoFC associated projects. Some outside analysis, at cost recovery, for the University of Alberta and Parks Canada was done.

5. There were 3 studies reviewed by the environmental screening committee during 1990-91.

6. Study 0701 was evaluated in relationship to other NOR 07 studies and organization changes for NoFC. The responsibility of chairing the Environmental Screening Committee has been assumed by J. Powell so the inclusion of the environmental screening committee should be deleted form NOR 0701. The recent involvement in several acid deposition-air pollution problems and renewal of our study near the sour gas processing plants of west central Alberta indicates that NOR 07 should remain as is.

7. The Energy Resource Conservation Board (ERCB) began hearings into the development of a huge sour gas find near Caroline, Alberta. The application involved $SO_2$ emissions from the Husky Ram River processing plant (where we conducted a 5 year monitoring study). It was alleged by environmentalists that severe forest decline had occurred as a result of $SO_2$ emissions from the sour gas processing plants. We were asked to respond to these allegations. It included a survey of the area in early April, preparation of a file report on our findings and appearing as expert witnesses at the ERCB hearings in Caroline, Alberta, April 18 and 19, 1990 (Maynard and Mallett). Our survey confirmed earlier findings that there was no regional impact of $SO_2$ emissions.

8. A monitoring study was done near the Giant Mine, Yellowknife, NWT at the request of the Renewable Resources Department of NWT in response to reports of widespread pollutant damage to trees. The study involved soil and foliar sampling, chemical analysis of the samples and preparation of a file report given to the Renewable Resources Dept. of NWT. Elevated S levels in the birch foliage along a gradient downwind of the stack suggested that some deposition and impact of $SO_2$ may have occurred. The widespread foliar sympotms observed, however, were probably related to the drought conditions in the area during 1989 and early part of the summer of 1990.

12. Present Status of Study:

Consultative and advising services are on going. Requests from private citizens have increased as a result of increasing environmental awareness. Several staff were involved in public consultation meetings for the Green Plan and federal pest management regulatory system.

The first draft of the information report on the baseline ARNEWS chemical and vegetation analysis for the Northwest region has been completed. A second draft, reformatted and shortened is near completion. Soil samples for chemical analysis and plant cover estimates were completed at 10 of the 12 ARNEWS sites. Foliar samples for chemical analysis were collected at all 12 sites. Analysis is on-going and should be completed early in the next fiscal year.

A new initiative has been proposed in cooperation with Husky Oil Ltd, and Gulf Canada Resources Limited. The study is for 3 years and will involve resampling of sites near the two sour gas processing plants of west central Alberta plus a detailed forest health survey (in cooperation with J. Volney and K. Mallett, NOR 11).

13. Goals for 1991-92:

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

2. Resample the soils and complete the vegetation analysis of Hudson Bay and Leaf Rapids ARNEWS plots. Collate data collected from the 1990 resampling of the ARNEWS plots in the NWR. (Fairbarns, Maynard)

3. Maintain and expand the existing plot-network near the Ram River and Strachan sour gas processing plants. Initiate resampling of the soils and vegetation of the existing plots. (in collaboration with J. Volney and K. Mallett, NOR 11)

4. Prepare and submit to Husky Oil Ltd. and Gulf Canada Resources Limited, an annual report describing the accomplishments in 1991-92. (in collaboration with J. Volney and K. Mallett, NOR 11)

5. Maintain the ICP-AES by preventative maintenance checks and quality control measures. (Radford)

6. 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. Attend workshops and symposia. (Maynard, Sidhu, Fairbarns)

14. Publications 1990-91:

1. Maynard, D.G.; Mallett, K.I. 1990. Health assessment of forests in the vicinity of the Husky Oil Ram River sour gas processing plant. ForCan, North. For. Cent. File Rep. NOR-0701.

2. Maynard, D.G.; Malhotra, S.S. 1990. Impact of $SO_2$ on the soils and vegetation near the Giant Mine, Yellowknife, NWT. ForCan., North. For. Cent. File Rep. NOR 0701.

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 1991-92:

| | | | |
|---|---|---|---|
| PYs: | Prof.: | | |
| | | Maynard | 0.4 |
| | | Sidhu | 0.1 |
| | Tech.: | Radford | 0.5 |
| | | Fairbarns | 0.2 |
| Total: | | | 1.2 |
| Students: | | | 0.6 (from industry $) |
| Term | | Lywak (Term) | 0.3 |

O&M: $ 7.0 K
Capital: Nil
Industry: $ 75.0 K

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-7-04

FORESTRY CANADA

STUDY WORKPLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Environmental Stresses on Forest Ecosystems

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, adsorption, 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 ForCan 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 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 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.

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

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

15. 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)

Added Goals:

16. Prepare a manuscript "Horizontal and vertical variation of Hexazinone in soils". (Sidhu & Feng)

17. Coauthor and publish a paper with N. Payne (FPMI) on the aerial application of glyphosate. (J. Feng)

18. Initiate and complete analysis of soil samples collected in the 1990 growing season from the Method II sites, Grande Prairie, treated with spiked PRONONE granules. (J. Feng, C. Feng)

19. Initiate analysis of soil samples collected in the 1990 growing season from the Method I sites, Grande Prairie, to study hexazinone run-off in the low, wet areas. (J. Feng)

11. Accomplishments in 1990-91:

1. Weather data have been sorted; raw data files cleaned, reorganized, and tabulated; summarized weather information package is now available for the users to select and abstract for specific purposes.

2. Sample processing, cleanup, and analysis by gas chromatograph is complete for all 1989 field samples collected in both Method I and II areas in Grande Prairie.

3. Two collections were completed in May and July, 1990 for monitoring the off-site movement of granular hexazinone in low, wet area (Method I, Grande Prairie).

4. Two collections were completed in May and July, 1990 for monitoring the persistence of hexazinone in the Method II area, Grande Prairie.

5. Draft manuscript is in preparation by S. Sidhu and J. Feng. Final draft of the paper intended for Weed Science will be completed before March 31 and submitted for internal review.

6. Additional literature search on foliar nutrients has been completed and draft of the paper intended for Forest Ecology and Management will be ready for internal review by the end of March, 1991.

7. The paper was published in Can. J. For. Sci. (see "Publication).

8. Three papers were published in Weed Technology and J. Agric. Food Chem. (see "Publication").

9. Sample analysis is complete; data processing and report preparation are postponed for 1 year due to other duties (see Additional goals and accomplishments).

10. In 3 replicate blocks of stem density counted in twenty 5 X 5 m plots in each of the control, double-disced, disk-trenched in combination with low and high herbicide and brush-cut treatments. Cover estimates were also performed in 10 (DT+LH, DT+HH, DT+BC; 3 microsites/quadrat) to 20 quadrats (controls and double disk). In addition limited number samples were collected for biomass of aspen stems and herbaceous species and leaf litter. The data is on the computer and will be analyzed for preparing publications in 1991/92.

11. A check sample study to evaluate a new analytical method developed by J. Feng was proposed. The initial response was very good. Fourteen analytical laboratories across Canada and from U.S.A. are willing to participate.

12. Hosted a ForCan Vegetation Working Group Meeting jointly with NOR-10. Presented a seminar and conducted a field trip to the Grande Prairie study site for the group (Sidhu). Hosted a laboratory tour to the NoFC herbicide chemistry research facilities in supporting the Canada Chemistry Week activities organized by the Canadian Institute of Chemistry (J. Feng, C. Feng). Consultations provided to D. Penner on the implications of forestry application of hexazinone to wildlife (Sidhu).

13, 14, and 15.
No progress was made as the new Canada-Manitoba PAIF has not been approved.

16. A manuscript entitled "Spatial distribution of hexazinone and metabolite residues in soils" was prepared jointly by J. Feng and S. Sidhu and is under review for submission to the Can. J. For. Res.

17. A paper coauthored with N. Payne (FPMI) was published. (see "Publication").

18. With additional laboratory assistance we were able to complete analysis of all soil samples collected in the 1990 growing season from the Method II sites, Grande Prairie, for the hexazinone persistence study.

19. We initiated and hopefully will complete by March 31 analysis of all soil samples collected in the 1990 growing season from the Method I sites, Grande Prairie, for monitoring the off-site movement of hexazinone.

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, forest litter, soil, soil leachate, water, and sediment samples have been collected for the last 4 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 and most samples collected in 1989 and 1990. New methodologies for determining the hexazinone residues in soil and vegetation were developed.

A total of 10 journal papers, 2 government reports, and 14 Expert Committee on Weeds (ECW) research reports resulted from the Grande Prairie study. 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; the application of liquid hexazinone (Velpar L) by a logarithmic sprayer; and the soil sampling method for zero-time residues. 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 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 continued collaboration with FPMI is essential. Collaboration with FPMI resulted in at least 9 journal and proceeding papers and Information Reports.

An application of PRONONE 10G has been made by using a newer tractor-mounted granule applicator to the crop release plots (Method I) of the Grande Prairie study in spring 1989. The plots are 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) was completed in 1990/91. The final vegetation sampling of site preparation plots (Method II) is scheduled for 1992/93 (5th year); those of crop release plots (Method I) is scheduled for 1994/95 (5th year).

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 successfully registered their products by including research results of our studies as the support.

The experimental plots of the Grande Prairie study should be maintained for further sampling for the detection of longer term (5, 8 or 10 years) impacts of site preparation and crop release methods on vegetation and soil. This would result in maximizing the scientific information returns from the high initial cost of the study.

13. Goals for 1991-92:

1. Prepare a summary report of all vegetation management studies under Alberta-FRDA jointly with L. Brace.

2. Collect soil samples from the Method I area, Grande Prairie, initiated in 1989 for monitoring the off-site movement, persistence, and leaching of hexazinone (applied as PRONONE 10G by tractor-mounted applicator) in low, wet area. (Continuation of 1985-90 Canada-Alberta FRDA study) (J. Feng)

3. Complete analysis of soil and vegetation samples collected from both Method I and II areas, Grande Prairie, in 1990, and initiate analysis for 1991 soil samples of Method I. (J. Feng, C. Feng)

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

5. Publish a journal paper, "Spatial distribution of hexazinone and metabolite residues in soils". (J. Feng, Sidhu)

6. Publish a journal paper on the persistence of hexazinone and metabolites in vegetation. (Sidhu, J. Feng)

7. Publish a journal paper on the effects of hexazinone on nutrient status in foliage of boreal species. (Sidhu)

8. Prepare a manuscript for a journal on the "early effect of vegetation management on species composition, cover and density in a cut-over". (Sidhu)

9. Prepare a manuscript for a journal on the analytical methods for hexazinone and metabolite residues in soil and vegetation. (J. Feng)

10. Maintain environmental assessment plots of the Grande Prairie Study. Sample limited number of plots for shrub and herb biomass and cover. (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. (J. Feng, C. Feng)

12. 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). (Sidhu, J. Feng, C. Feng)

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

13. Analyze vegetation data and identify level of sampling which is essential to sample the vegetation plots for the 5th and 8th year sampling for monitoring the impacts of the chemical and non-chemical methods of vegetation management. Sample selected plots for density and cover. Alberta-PAIF (Sidhu)

14. Continuation of soil sample collection from the Method II area, Grande Prairie, treated with PRONONE 10G 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. Alberta-PAIF. (J. Feng, C. Feng)

15. Initiate a new study on the metabolism of hexazinone in rat. Alberta-PAIF. (J. Feng)

14. Publications 1990-91:

Feng, J.C.; Navratil, S. 1990. Sampling for zero-time hexazinone residues in forest soil dissipation study. Can. J. For. Res. 20:1549-1552.

Feng, J.C.; Thompson, D.G. 1990. Fate of glyphosate in a Canadian forest watershed. 2. Persistence in foliage and soils. J. Agric. Food Chem. 38:1118-1125.

Feng, J.C.; Thompson, D.G.; Reynolds, P.E. 1990. Fate of glyphosate in a Canadian forest watershed. 1. Aquatic residues and off-target deposit assessment. J. Agric. Food Chem. 38:1110-1118.

Payne, N.J.; Feng, J.C.; Reynolds, P. 1990. Off-target deposits and buffer zones required around water for aerial glyphosate application. Pestic. Sci. 30:183-198.

Prasad, R.; Feng, J. 1990. Spotgun-applied hexazinone: Release of red pine (*Pinus resinosa*) from quaking aspen (*Populus tremuloides*) competition and residue persistence in soil. Weed Technol. 4:371-375.

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. 20(2):77-94.

Others:

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. 305 pp.

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. (for environmental implications of herbicide application, also see NOR-10 & NOR-36-02-01).

16. Duration:

Start: 1985 Completion: 1996

17. Resources 1991-92:

| | | |
|---|---|---|
| PYs: | Prof.: Sidhu | 0.7 |
| | Feng, J. | 0.6 |
| | Feng, C. | 0.7 |
| | Tech.: Fairbarns | 0.7 |
| | Total: | 2.7 |
| | Term/Student: | 0.6 |

O & M: $10.0 K Canada-Alberta PAIF funds pending
Capital: Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

Investigator

NOR-7-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

February 6, 1991

1. Project: Environmental Stresses on Forest Ecosystems

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 uptake, herbicides, ecosystem stability, tree growth, Armillaria

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 K. Mallett, NOR 11-09).

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

10. 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.

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".

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.

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.

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.

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 11-09)

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

11. Accomplishments in 1990-91:

1. Informal inquiries were made with associate editors of two journals. They felt that without an unique or different approach to the subject, a review article would be difficult to publish given the large number of review articles on various aspects of nutrient cycling. Much of the information collected has been used in preparing the proposal on the baseline ecological study and in the presentation of two seminars.

2. A journal article entitled "The effect of hexazinone (Velpar) on the mineralization of N,P, and S from aspen litter" is about 50% complete. The data was presented at a University of Alberta, Soil Science departmental seminar and the feedback was useful in preparing the article.

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

4. The smaller nutrient cycling plots were sampled twice, in June and August of 1990. The zero-tension lysimeters were maintained throughout the summer and then removed in September. The litterfall collectors were used for the fall-winter of 1989-90 but were no longer functional. Analysis of all the litterfall samples, surface organic material (LFH), and leachates have been analyzed with the exception of some repeats due to problems with the microwave digestion oven. Extractions of the mineral soils are continuing and will be completed next fiscal year. Increased nitrate levels in the LFH have persisted through the 1990 sampling season in the high herbicide treated plots. Increased nitrate levels were observed in the leachates from the lysimeters in the high herbicide plots suggesting increased N losses; however, no changes in the total N of the LFH were observed. Extractable potassium concentrations showed the largest change in the LFH of any element decreasing 20-25% in the herbicide treated plots. Potential impacts to site productivity will be assessed when the mineral soil analyses are completed to determine if N and K have been removed from the rooting zone.

5. The analysis of the operational plots has been completed except for some of the mineral samples from 1988. The data from the operational plots are too variable and do not warrant a journal article on their own. The results of the surface organic horizons were reported on in the FRDA report (Sidhu and Feng) and have been used to indicate that N is behaving in a similar fashion as has been observed in the microplots. The data will be used to support results found in the micro plots and the growth chamber study; however, the data is too variable to stand on its own as a journal article.

6. The greenhouse experiment was started and 3 of the 4 samplings have been completed. The last sampling will be done in March. There were problems with viability of the Armillaria inoculum; one strain did not remain that viable when put in the soil. It is likely that we will have to repeat at least a portion of the experiment. Preparation of the foliage material is continuing. Four additional field sites were sampled in the Hinton and Rocky Mountain House areas. (in collaboration with K Mallett)

7. No Alberta PAIF was approved in 1990-91; however, a revised proposal was prepared based on literature reviews and recent developments with respect to the Green Plan and climate change programs. The initial study will be limited to one stand type. (in collaboration with S.S. Sidhu)

12. Present Status of Study:

The sampling and most of the analysis of the operational herbicide plots has been completed. A report on the nutrient composition of the surface organic horizon (LFH) was included in the final FRDA report (Sidhu and Feng). Further publication of the operational plot results on their own is not warranted based on the large variability of the soil concentrations. The analysis of the growth chamber study has been completed, a seminar was presented at the University of Alberta and a journal article is about 50 % done.

The microplots were sampled twice in 1990 and the leachates collected. No sampling is planned for 1991, however, for the long-term impacts of the herbicide on site productivity a sampling in 1992 or 1993 would be useful. Analysis of the LFH material for all years is complete except for some repeat analysis of total concentrations from 1990 because of a problem with the microwave digestion oven. Work is continuing on the soil mineral horizons. Differences in soil nutrient concentrations of the LFH as a result of the herbicide application persisted in 1990. The most drastic change was with potassium; however, it is not known what are the long-term implications for site productivity. The data from the mineral horizons will provide some information whether the nutrients removed from the LFH have been retained within the rooting zone or lost from the system.

The greenhouse study on the relationsip between nutrient stress and Armillaria root rot was started. Three of the four samplings have been completed and preparation of the foliage for analysis is on-going. A second field survey of young stands to determine the possible link between Armillaria and nutrient status was done in September. Four additional sites, two in the Hinton area and two in the Rocky Mountain House area were sampled.

13. Goals for 1991-92:

1. Complete a paper entitled "The effect of hexazinone (Velpar) on the mineralization of N, P, and S from aspen litter" by June 1991.

2. Complete the analysis of the soils collected from the microplots and begin interpretation of the results. Prepare outline of a journal article(s) on the impact of the herbicide on soil nutrient dynamics by February 1992.

3. Complete the greenhouse study on the relationship between nutrient stress and Armillaria root rot in lodgepole pine. Repeat a portion of the greenhouse experiment because of poor inoculum viability with one strain of Armillaria. Analysis of the foliage and soils of the field and greenhouse studies will be on-going.

14. Publications:

Maynard, D.G. 1990. Herbicide (hexazinone) impacts on nutrient dynamics in a postharvest aspen regeneration Page 29 in Programs and Abstracts, Canadian Society of Soil Science, 36th Annual Meeting, July 23-26, 1990, Penticton, B.C. (Abstract only)

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:1993

17. Resources 1991-92:

| | | | |
|---|---|---|---|
| PYs: | Prof.: | Maynard | 0.3 |
| | Tech.: | Radford | 0.3 |
| | Total: | | 0.6 |
| | Term/Student: | | 0.0 |

O & M: $ 5.0 K
Capital: Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-7-07

FORESTRY CANADA

STUDY WORKPLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Environmental Stresses on Forest Ecosystems

2. Title: Baseline ecological studies of mature forest communities

3. New: X Cont.: 4. No.: NOR-7-07

5. Study Leader: D.G. Maynard, S.S. Sidhu, M.D. Fairbarns

6. Key Words: biodiversity, long-term, ecosystem variability, soils, vegetation, acid deposition, climate change

7. Location of Work: Northwest Region

8. Problem Analysis:

The stresses on forest ecosystems from forestry related activities, air pollution, climate change, recreational and other uses is increasing. Variations in and controls on ecosystem productivity are not well understood. Fundamental research on a long-term basis is required to understand the structure and function of the major forest ecosystems in the Northwest Region. Without a basic understanding of how these systems function and change over time and space, it will be difficult to assess the effects of stresses, such as forestry practices and climate change on sustained productivity of the ecosystem.

The National Strategic Plan of Forestry Canada recognizes forest environmental quality as one of the four areas of its strategic initiatives. Multiple-use forest management is one of five new initiatives identified in the Northwest Region strategic plan. Canada's Green Plan stresses the "sustainability" of our forest resources which includes the maintenance of their ecosystem productivity and biodiversity. An opportunity for studying the forest ecosystem and how various stresses impact on productivity could be provided through the Model forests program outlined in the Green Plan. The purpose of the proposed baseline study is to provide needed scientific information against which changes in forest ecosystems as a result of impacts such as forestry management practices, acid rain, and climate change can be compared.

9. Study Objectives:

   1. To determine the nature and causes of patterns of natural variation in an ecologically and silviculturally important forest community.

   2. To provide baseline information against which changes in similar but disturbed ecosystems (as a result of forestry practices, air pollutants or climate change) can be compared.

   3. To detect aberrations in natural ecosystems as a result of human activity (eg forestry practices, air pollutants or climate change).

10. Goals for 1990-91:

    N/A

11. Accomplishments in 1990-91:

    N/A

12. Present Status of Study:

    We have met as a group (study leaders) to develop a strategic plan for the study. To date we have outlined justification and general purposes for the study. Some time has been spent deciding on possible locations. The location(s) of the sites will depend upon several factors, the key parameter being protection from future development. Preliminary discussions have also considered integration of this study with other programs, primarily the Green Plan Model forests program, ARNEWS, and climate change.

13. Goals for 1991-92:

    1. Select site(s), in consultation with other related projects for the baseline ecological study.

    2. Conduct a literature review on forest ecosytems and long-term ecological studies. Analyze existing data related to study area (if available).

    3. Establish permanent plots (random and feature-oriented sampling design) if sites are decided on before September 1991.

14. Publications 1990-91:

    N/A

15. Environmental Implications:

    This is a new project and the study will be submitted to the NoFC Environmental Screening Committee for evaluation before the start of the project.

16. Duration:

Start: 1991 Completion: On-going

17. Resources 1991-92:

PYs: Prof.: Maynard 0.2
Sidhu 0.2

Tech.: Fairbarns 0.1

Total: 0.5

O & M: $ 6.0 K

Capital: Nil

(Funding has been applied for under the new Alberta PAIF and will be applied for under Canada's Green Plan).

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

Investigator

NOR-7-08

FORESTRY CANADA

STUDY WORKPLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 4, 1991

1. Project: Environmental Stresses on Forest Ecosystems

2. Title: Water quality and aquatic impact in the forest management agreement areas

3. New: X Cont.: 4. No.: NOR-7-08

5. Study Leader: J. Feng, C. Feng, Y. Kalra, T. Singh

6. Key Words: Dissolved organic carbon, nutrient flux, forest aquatic ecosystem.

7. Location of Work: Northwest Region

8. Problem Analysis:

Part of the complex relationship between forests and water lies in the contribution of 1) the **forest** in regulating soil moisture, water table, stream flow, and maintaining water quality and 2) the **water** as a vital transporting agent, chemical solvent, and catalyst. The complexity depends upon the type of forest, nature of precipitation; upon geology, topography and soils; and upon the interaction of physical and biochemical cycles within the aquatic ecosystem.

Adverse effects due to human activity, such as logging and forest site preparation (chemical or mechanical) for tree planting, will affect many components of the aquatic biota. Removal of the forest canopy following forest clearcutting and the subsequent disturbance by mechanical site preparation and prescribed burning have adverse impacts on overall microbial biomass and metabolism and soil erosion leading to movement of particulate and dissolved organic matter and nutrients through forested watersheds; and increased streamflow and concentration of suspended sediments and debris in streamwater.

Changes in aquatic concentrations of chemicals (dissolved organic matter, nutrients, and elements) due to logging and forest management practices have direct impact on the aquatic ecosystem by altering pH, dissolved oxygen, energy pool, and available food sources sustaining attached algae, phytoplankton, and zooplankton, and may lead to changes in the structure of the food-web.

Both particulate and dissolved organic matter are important food sources for fish and freshwater biota. Dissolved organic matter is also an important component of the organic energy budget of temperate stream ecosystems and is frequently measured as dissolved organic carbon (DOC) in fresh water quality studies. Increases in particulate organic matter and concentration of DOC may last for three years or more following forest clearcutting. Benthic algae, fungi, and bacteria are the organisms most likely to assimilate naturally occurring DOC from the water column.

In the Coweeta watershed study, Meyer *et al.* (1988) reported that the concentration of tannins, lignins, and sugars in streamwater accounted for less than 30% of total DOC and that a large fraction (70%) of DOC remained unidentified. They also suggested: 1) streamwater DOC changes with watershed disturbance and recovery, 2) the ultimate fate of DOC in the stream trophic structure is an important topic for future research, and 3) benthic meiofauna may prove to be an important link between DOC-utilizing bacteria and benthic macroinvertebrates.

A few forestry related DOC studies were reported in forest catchments in New Zealand, boreal watersheds in Quebec, and peatlands of the north central North America. Changes of naturally occurring DOC in headwaters associated with forest management practices in northern Alberta have not been studied previously. Because of the potential adverse impact on fresh water biota, a data base on DOC and their species in streamwater (associated with other water quality data, such as concentrations of nutrients and elements, pH, and dissolved oxygen, as well as impact on algae, and aquatic invertebrates) should be established before and after disturbance from logging and planting site preparation (mechanical and chemical) in the forest management agreement (FMA) areas of northern Alberta.

Dominant portions of northern Alberta are classified as wetlands. Vitt *et al.* (1990) reported that boreal wetlands are the major contributor of methane ($CH_4$) and carbon dioxide ($CO_2$) production and that over 99% of methane produced in boreal Alberta evolves from these areas. Although the mechanism of wetland processes associated with climatic warming is not fully understood, disturbance from wetland logging and road construction in FMA areas will alter the water table, the natural course of peat decomposition, the wetland type, and carbon sink that contributes to the climate changes. However, wetland fen may be an important buffer in maintaining water quality and fish habitat in the fish bearing lower streams (river and primary tributaries) from the disturbance in the headwater region. Hartland-Rowe (1973) tested the use of peatlands as natural sinks for receipt of sewage effluent. Sewage effluent from Hay River, NWT was released into a small stream which meandered through natural peatland before flowing into Great Slave Lake. He reported that the upper 2500 meters of the effluent creek showed evidence of damage by the sewage effluent, but at the next sampling site (4000 meters downstream), the biological and chemical characteristics of stream water were fully recovered in terms of biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen, total soluble phosphate, bacteria counts, and the concentration of dissolved oxygen. The retention capability for water soluble chemicals by wetland fen in relation to the disturbance by forest management practices in the headwater regions needs to be investigated.

At present, ALPAC-FMA (ALPAC = Alberta-Pacific Forest Industries) is identified by Fisheries and Oceans Canada as one of the two forest management areas selected for studies with regard to the potential impacts of forest harvesting practices on fish and fish habitat in

the Northwest Region. Studies of the long-term and cumulative environmental impacts along the Athabasca-Peace River Basin were recommended by the ALPAC-EIA Review Board (EIA = Environmental Impact Assessment) and are supported by the Government of Canada in its "Green Plan".

ALPAC-FMA consists of mostly wetlands and aspen forests which produce more biomass annually than coniferous forests. Therefore, the land-base disturbance is expected to induce greater response from and interaction with the aquatic ecosystem in these areas.

Initially, the most characteristic sites (both wetlands and well-drained aspen forest sites) in the ALPAC-FMA area will be selected to study the components and profile of chemical structures in the aquatic ecosystems as well as their land-based sources of input; the changes in physical characteristics of the aquatic ecosystem (including hydrological monitoring); and their impact on algae, and aquatic invertebrates before and after disturbance by harvesting and forest management practices; and the buffer capacity of wetland fen toward aquatic chemical changes caused by the land-base disturbance. Initial protocols for sampling and chemical analysis will be tested, evaluated, and further developed to enable a full understanding of the mechanism between land-base disturbance and aquatic impact. Sampling protocols and data collection for organic carbons, nutrients, elements, $CH_4$ and $CO_2$ production can be integrated with climate change studies to assess the carbon-pool in forest wetlands.

Results of the initial studies will provide a first-cut information package on forest land-water interaction and aquatic impact, and the potential of using wetland fen as natural and cost-effective buffer; and will enable the establishment of mitigation measures necessary to minimize aquatic impact resulting from logging and forest management practices. Subsequent experimental design and data collection, based on results of the initial studies, will be modified to facilitate the long-term monitoring and modelling of the forest-water interaction by using more sophisticated systems, such as the Hydrology Simulation Program-Fortran (HSPF) in conjunction with other hydrological and climatic data.

9. Study Objectives:

1. To sample, analyze, and determine the total concentration and species of naturally occurring dissolved organic carbon (DOC), nutrients, and elements in the tributaries and headwaters (including wetlands) of the Athabasca River watershed before and after forest management practices such as logging and forest site preparation.

2. To assess and correlate the effects of silvicultural activities on freshwater biota (algae, and aquatic invertebrates) with water quality parameters such as DOC, nutrients, elements, pH, dissolved oxygen, sediment, etc.

3. To monitor the hydrological changes and its impact on ecology and peat decomposition in wetlands before and after forest management and logging practices.

4. To assess the retention capacity for water soluble chemicals by the wetland fen and its potential of being the natural and cost-effective buffer for the land-base disturbance resulted from forest management and logging practices.

5. To establish methodologies and to provide baseline information for assessing the contribution of wetland carbon-pool to climatic changes.

6. To provide federal, provincial, and industrial resource managers in the region with advice on water quality changes and environmental effects associated with forest management practices.

10. Goals for 1990-91:

N/A

11. Accomplishments in 1990-91:

N/A

12. Present Status of Study:

Result of initial discussions (Swanson as the NoFC representative) indicated that the basic concept of this study is supported by the provincial and federal departments of forests, environment, and fisheries. Outside funding will be sought to support the proposed experimental work. The potential funding organizations and programs include Fisheries and Oceans Canada, Canada-Alberta Partnership Agreement in Forestry, and the Green Plan.

13. Goals for 1991-92:

1. Conduct literature search and review pertinent literature on DOC for information, knowledge, and methodologies (both field and analytical) developed up-to-date. (J. Feng, C. Feng, Kalra)

2. Conduct feasibility study and formulate experimental strategy jointly with other related Project/Study at NoFC and outside organizations. (J. Feng, C. Feng, Kalra, Singh)

3. Investigate potential experimental sites in the tributary and headwaters areas of the ALPAC-FMA; select from them the most suitable sampling sites; and prepare a general experimental plan. (J. Feng, C. Feng, Kalra, Singh)

4. Prepare detailed field workplan and acquire tools, sampling materials, temporary storage facilities, and sample shipping equipment. (J. Feng)

5. Set up laboratory protocol, acquire analytical instruments and materials. (J. Feng, C. Feng)

6. Establish field sampling stations and collect samples, if funding is secured. (outside funding) (J. Feng)

14. Publications 1990-91:

N/A

15. Environmental Implications:

The experimental plan will be submitted to the NoFC Environmental Screening Committee for evaluation and comments, when it is prepared.

16. Duration:

Start: 1991 Completion: 1996

17. Resources 1991-92:

| | | | |
|---|---|---|---|
| PYs: | Prof.: | Feng, J. | 0.4 |
| | | Feng, C. | 0.3 |
| | | Kalra, Y. | 0.2 |
| | | Singh, T. | 0.1 |
| | Total: | | 1.0 |
| | Term: | | |

O & M: $ 5 K
Capital: Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

Investigator

Investigator

NOR-11-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 1, 1991

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

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 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, Emond).

4. Complete the pest depletion loss exercize for period 1981-87 and summarize data results, maps, etc. for report(s). (Amirault, Study NOR-36-02-4).

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, Study NOR-36-02-4).

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, Study NOR-36-02-4; 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, Study NOR-1105; Cerezke; Amirault, Study NOR-36-02-4).

11. Accomplishments in 1990-91:

1. Surveys were completed region-wide for spruce budworm, jack pine budworm, and forest tent caterpillar. Other aspen defoliators (Bruce spanworm, large aspen tortrix and leaf beetles) were monitored and areas of infestation were mapped in Alberta and Manitoba. Mountain pine beetle infestations were mapped in Kootenay and Yoho national parks, southwestern Alberta, and in the Cypress Hills (Alta. & Sask.). A spruce beetle infestation in north-central Alberta was surveyed aerially and from the ground. Parks Canada, provincial/territorial and industrial agencies assisted FIDS with many of these surveys.

2. General pest surveys were conducted in most of the regions National parks; important tree damage agents are described in the regional annual report. Assistance was provided to Alberta Agriculture for Dutch elm disease surveys. Spruce budworm pheromone baits were deployed at 13 established sites in Manitoba and in 12 plots in the Hawk Hills, Alberta. A special survey was conducted in Weyburn, Saskatchewan for herbicide injury to urban trees.

3. The 1989 FIDS regional report (NOR-X-313) was published. A draft of the 1990 report was prepared, reviewed locally, and is now with the Editor for publication. The 1989 regional report served as the basis for the national report now in press. The 1986 report, to be finalized as a File Report, requires some editing and typing.

4. Volume loss estimates were compiled in tabular and report format, except for map overlays and some final estimates for some of the defoliators; these data are to come from PNFI. Final approval of the volume loss data must still be approved by each provincial and territorial agency. (Amirault, Study NOR-36-02-4).

5. Over 2500 tree pest enquiries from various clientele were handled by the Tree Pest Extension staff and other FIDS staff; this involved identification, diagnostic and advisory services on tree and shrub pests and technology transfer through training sessions and workshops, listed as follows:

   a) Lectures on forest pests to forestry students at Univ. Alberta;
   b) Field survey and pest recognition at Pine Ridge Forest Nursery;
   c) Field training session with Parks Canada for hazard rating of trees in campgrounds, Jasper National Park;
   d) Slide presentation on tree damage agents to Junior Forest Wardens;
   e) Workshop on cankerworms to city and parks staff in Saskatchewan;
   f) Lecture on forest pest management to students at Lethbridge Community College;
   g) Field training for recognition and recording of spruce pests in young stands following aspen cover removal and in mature spruce plantations in Manitoba;
   h) Workshop presentation on forest pest recognition and prescribed management options to Alberta Forestry technical staff;
   i) Workshop and field training presentation to Saskatchewan Forestry staff, industry, agriculture, and parks tree maintenance staff;
   j) In-house training and up-dating workshop for all Project NOR-11 staff;
   k) Four tree pruning workshops for insect and disease control were presented at Alta. Tree Nursery/Hort. Centre;

l) An insect and disease identification/control workshop was presented to Alberta Forest Service and Kananaskis area employees;
m) Two workshops on urban forest pests presented to Saskatchewan Parks and Recreation Association, Prince Albert;

6. Pest surveys were completed in 5 genetic tree plantations in Alberta; selected genetic sites at the Pine Ridge Forest Nursery and the Huallen Seed Orchard were also surveyed for pests. Eight reports of these surveys were prepared for the Alberta Forest Service.

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

a) Forest Pest Control Forum, Ottawa; (Cerezke)
b) FIDS Heads; two meetings, Ottawa and Newfoundland; (Cerezke)
c) LRTAP/ARNEWS meeting, Ottawa; (Cerezke)
d) Alberta Critical Plant Pest Infestation Task Force meetings, Edmonton; (Cerezke, Volney)
e) Pheromone Trapping Working Group meeting, Ottawa; (Cerezke)
f) Federal Emergency Preparedness Canada meeting, Edmonton; (Cerezke)
g) Pesticide Registration Review meeting, Edmonton; (Volney, Cerezke)
h) Green Plan information sessions; (Volney, Cerezke)
i) Saskatchewan Dutch Elm Disease committee meeting. (Still)

8. The Regional Insect and Disease Technical Advisory Committee meeting was held in Edmonton; recommendations were prepared for the Senior Regional Advisory Committee.

9. Surveys to update the annual and 5-year data assessments of all 11 regional ARNEWS plots were completed and the data prepared for PNFI.

10. No new PAIF projects were developed.

11. No requests for editorial change were received from HQ.

12. Final editorial work on the report "Sampling methods and survey techniques in the Prairie Provinces and the Northest Territories" was terminated, and a decision was made to prepare a more comprehensive survey manual using information in this report as a basis.

13. No progress was made toward assembling a new regional FIDS survey manual.

14. Several PSP's in Manitoba were surveyed for pest information to supplement stand inventory data and a summary statement prepared.

15. Some field test surveys were made in high-value conifer stands in Alberta to check out a survey method of pest assessment developed by Silvicom Consultant. (See also Amirault, Study NOR-36-02-4)

16. Two operational and one experimental aerial spray applications of Bt were conducted for control of spruce budworm by the Alberta Forest Service involving three forest

districts. This cooperative project required numerous planning and information meetings between Alberta Forest Service and Forestry Canada. Base camp facilities were established at Manning, Alberta to carry out the experimental spray trials, design of field experimental procedures, establishment of field plots for pre- and post-spray monitoring and data collection, field crew supervision and collection of budworm and host tree data, data analysis and reporting. (Reports prepared for this are listed under Volney, Study NOR-11-05; additional support reported under Amirault, Study NOR-36-02-4).

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 1991-92:

1. Survey, map and report on major forest pests of the region, including spruce budworm, jack pine budworm, forest tent caterpillar and other aspen defoliators, mountain pine beetle, spruce beetle, and some selected tree diseases. (FIDS Staff)

2. Conduct special surveys as requested, such as Dutch elm disease and its insect vectors, tree damaging agents affecting urban, shelterbelt, parks, tree nurseries and other high-value sites. (FIDS Staff)

3. Publish the 1990 FIDS regional report, prepare a condensed version of this regional report and submit to HQ for the National FIDS report, and prepare a 1991 regional report. (Cerezke, Emond, et al.)

4. Assemble data and overlay maps yet to come from PNFI and incorporate into pest depletion loss report; circulate for approval to provincial/territorial agencies and complete as regional report. (Amirault, see also Study NOR-36-02-4)

5. Provide tree pest extension service, pest diagnostics and identification, scientific and technical advisory service on pest management, and arrange for technology transfer workshops and information sessions as requested. (FIDS Staff)

6. Conduct detailed pest surveys in 5 or more designated genetic and tree improvement plantations in Alberta; re-survey the Huallen Seed Orchard near Grande Prairie and conduct pest surveys at the Pine Ridge Forest Nursery as requested. (FIDS Staff)

7. Represent Forestry Canada on various national, regional, provincial, and other local meetings, committees and advisory groups. (FIDS Staff)

8. Organize and conduct the Regional Insect and Disease Technical Advisory Committee meeting and prepare recommendations for the Senior Regional Advisory Committee. (Volney, Cerezke, FIDS Staff)

9. Conduct surveys of the 11 regional ARNEWS plots for an annual data set requirement; compile, summarize, interpret and report 1991 plot information and submit to HQ by February 1, 1992. Compile 1990 ARNEWS plot data (Forms 4 and 7) and prepare a published report with PNFI and HQ. Measure tree increment data from all plots for 1990 and submit to PNFI for processing along with other plot data. (Cerezke, FIDS Staff)

10. Provide functional guidance for anticipated studies to be developed under new Federal-Provincial Partnership Agreements in the Northwest Region. (Volney, Cerezke, Amirault, Study NOR-36-02-4)

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

12. Conduct surveys of pest conditions in PSP's registered in Manitoba and compile listing of these for supplementary stand inventory data; prepare a report. (Grandmaison)

13. Conduct surveys of pests in young high-value conifer stands in central and western Alberta. (Amirault, Study NOR-36-02-4; FIDS Staff)

14. Provide scientific advice to Alberta Forest Service personnel conducting commercial and experimental aerial spray applications against the spruce budworm in northern Alberta, supervise the data to be collected during pre- and post-spray operations and summarize, interpret, and report the results. (Volney, Study NOR-1105; Cerezke; Amirault, Study NOR-36-02-4; other NOR-11 Staff)

14. Publications 1990-91:

Emond, F.J.; Cerezke, H.F. 1990. Forest insect and disease conditions in Alberta, Saskatchewan, Manitoba, and the Northwest Territories in 1989 and predictions for 1990. For. Can., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-313.

Other Reports:

Cerezke, H.F. 1990. Report to the Eighteenth Annual Meeting of the Forest Pest Control Forum, Ottawa, November, 1990.

Cerezke, H.F. 1990. Reports prepared for North American Forestry Commission:

a) Highlights of forest insect-related research and development activities in the Northwest Region during 1989-90.

b) Contributions to: pest conditions report for North American Forestry Commission, Forest Insect and Disease Study Group.

Cerezke, H.F. 1990. Root- and stem-girdling weevils in the Genus Hylobius. In: Tech. Transfer Note, FIDS Notes A-014, April, 1990.

Cerezke, H.F. 1990. Bruce spanworm infestations in the prairie provinces. In: Tech. Transfer Note, FIDS Notes A-015, July, 1990.

Cerezke, H.F. 1991. Forest tent caterpillar. Final revised draft of Pest Leaflet.

Cerezke, H.F. 1991. Spruce budworm. Final revised draft of Pest Leaflet.

Cerezke, H.F. 1991. Aphids. Final revised draft of Pest Leaflet.

Cerezke, H.F. 1991. Survey of pests and damage in 1990 in the Huallen Seed Orchard near Grande Prairie, Alberta. File Report, 6 pp.

Cerezke, H.F. 1991. Report on pests, damage and tree condition in 1990 in the lodgepole pine plantations, G127A and G127B. File Report, 10 pp.

Cerezke, H.F.; Mallett, K.I. 1990. Survey report of pests in the Pine Ridge Forest Nursery near Smoky Lake, Alberta: prepared for Alberta Forestry, Lands and Wildlife. File Report NOR-11-01, 1990.

Cerezke, H.F.; Emond, F.J.; Gates, H.S. 1990. Forest insect and disease conditions in Alberta, Saskatchewan, Manitoba, and the Northwest Territories in 1990 and predictions for 1991. (Final draft with Editor).

Cerezke, H.F. 1990. Pests and damage conditions in genetics and tree improvement plantings in Alberta. Presented at Annual Tree Improvement Meeting, March, 1990. Edmonton.

Emond, F.J. 1990. Major forest pest conditions in 1989, predictions for 1990. In: Tech. Transfer Note, FIDS Notes A-014, April, 1990.

Emond, F.J.; Jacubec, K. 1990. Pest situation report. In: Tech. Transfer Note, FIDS Notes A-015, July, 1990.

Emond, F.J. 1990. Synopsis of major pests in the region - 1990. In: Forest Insect and Disease Notes. A-016, December, 1990.

Gates, H.S. 1991. Forest insect and disease survey, Elk Island National Park. File Report, 11pp.

Grandmaison, M. 1991. Forest insect and disease conditions in Manitoba in 1990. File Report. 31 pp. For. Can., Man. Dist. Office, Winnipeg, Man.

Tidsbury, C. 1990. Pest and damage conditions in planted lodgepole pine. Fox Creek Genetics Experimental Area; Lodgepole Pine Half-sib Family Testing: Region B1 Experiment G127A. File Report, 2pp.

Tidsbury, C. 1990. Pest and damage conditions in planted lodgepole pine. Nose Mountain Genetics Experimental Area Lodgepole Pine Half-sib Family Testing: Region B1 Experiment: G127B. File Report, 2pp.

Tidsbury, C, 1990. Pest and damage conditions in the Virginia Hills Genetics Experimental Area - Whitecourt Forest. File Report, 3 pp.

Volney, W.J.A. 1990. Pancake and Taggart lakes 1990 spruce budworm survey. Report prepared for Weyerhaeuser Canada Ltd., Saskatchewan Division. File Report.

Volney, W.J.A.; Amirault, P. 1990. Stands in the Swan Hills area affected by hail. Report prepared for Blue Ridge Lumber (1981) Ltd., Whitecourt, Alberta. File Report.

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 1991-92:

| | | | |
|---|---|---|---|
| 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: $41,000
Capital: $Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-11-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 1, 1991

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

2. Title: Pheromone applications and 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 have often been initiated in response to problems arising out of the general surveys or from specific client requests. 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.

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 improved methods to detect population change and to assess stand hazard. Studies of spruce beetle chemical ecology were undertaken in 1987 to develop improved semiochemicals for commercial application in beetle management. These studies were undertaken in cooperation with chemists at the Univ. Calgary, with support from the Alberta Forest Service, B.C. Ministry of Forests and Crestbrook Forest Industry. One of the pheromone compounds tested in 1988 showed superior attractancy to spruce beetle, compared to previously tested compounds. Further tests in 1989 and 1990 were directed toward development of this compound in a commercial bait formulation.

Increasing forest renewal emphasis in recent years has forced a closer examination of tree damage agents and tree survival in plantations and other high-value coniferous stands. Surveys across the region during 1987 to 1989 indicated that rootcollar weevils (Hylobius warreni and H. radicis) rank among the top 1 to 5 biotic agents causing tree mortality and growth reductions of pine hosts. Other regions (Maritimes and Pacific) have expressed similar concerns with H. warreni. There is a need therefore to examine site-specific problems and to develop strategies for early detection, impact assessment and control of these weevil species. Some preliminary cooperative studies of the chemical ecology of H. warreni have been undertaken with a chemist (Dr. E.A. Dixon) at the Univ. of Calgary to identify and test attractants and/or repellents that may ultimately have application in weevil management.

9. Objectives:

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

2. Undertake bionomic studies of important forest insect pests (mountain pine beetle, spruce beetle, woodborers, rootcollar weevils) that can provide management strategies for reducing their risk and the losses they cause.

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

10. Goals for 1990-91:

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

2. Complete revisions and submit journal 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.

Added Goals:

7. Attend Phero Tech. Ltd. sponsored meeting to review insect pheromone technology.

11. Accomplishments in 1990-91:

1. No progress could be made due to heavy commitments in NOR-11-01.

2. No progress could be made due to heavy commitments in NOR-11-01.

3. Completion of this goal depended upon measurement and sexing of Scolytid (especially the Douglas-fir and larch beetles) material other than the spruce beetle. All collections containing the Douglas fir beetle were sent to Univ. Calgary where these measurements are in progress, while the larch beetle samples are being processed at NoFC.

4. Three field experiments to examine pheromone response of spruce beetles in baited multiple funnel traps were undertaken in north central Alberta. These experiments were part of a larger field testing program replicated at three other locations and in cooperation with Phero Tech Ltd. (Vancouver), Simon Fraser Univ., U.S. Forest Service (Alaska), and Univ. Calgary. Data collected in the Alberta experiments have been processed and summarized.

5. No field involvement occurred in bioassay studies for Warren's rootcollar weevil in 1990; functioned as scientific advisor and attended several meetings with Univ. of Calgary co-workers.

6. Carried out duties as an Associate Editor for the Canadian Entomologist and processed 14 scientific papers.

7. Attended meeting to review insect pheromone technology and applications in forestry, sponsored by Phero Tech Ltd. in Vancouver, B.C.

12. Present Status:

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 insect predator response to synthetic and natural attractants.

Studies in 1989 and 1990 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 field test along with appropriate release devices. A new commercially usable bait has been developed for the spruce beetle that also shows potential as an attractant for the Douglas-fir and larch beetles. Some field tests are required to confirm geographical applicability of the bait and make final adjustments in release rates and release devices.

13. Goals for 1991-92:

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

2. Complete revisions and submit to journal by September 1 a paper on "MPB attack density pattern on semiochemical baited and unbaited lodgepole in southwestern Alberta".

3. Complete examination of 1987-89 larch beetle collections and prepare a journal paper with Univ. of Calgary co-workers.

4. Conduct field experiments to test spruce beetle response to semiochemicals as bait in multiple funnel traps and on trap trees.

5. Act as scientific advisor and participate with Dr. E. Dixon, Univ. Calgary, in carrying out a field bioassay test for H. warreni response to a selected list of semiochemical compounds.

6. Provide technology transfer of pest information as requested.

7. Continue as an Associate Editor for the Canadian Entomologist.

14. Publications 1990-91:

Cerezke, H.F. 1990. Status report of 1990 field results of spruce beetle pheromone tests. Presented at meeting in Vancouver, December, 1990 sponsored by Phero Tech Inc.

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 1991-92:

PYs: Prof.: Cerezke 0.3

Total: 0.3

Term/student 0.3

O & M: $4,000

Capital:

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-11-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 5, 1991

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

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 1990-91:

1. Complete the FRDA 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 and Saskatchewan 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.

Added Goals:

7. Prepare and present paper on the association of climate change and jack pine budworm outbreaks at the Population Dynamics Working Group session at the IUFRO Congress.

8. Assist in the organization of and hold a workshop on the effects of climate change on insects in Canada at the joint meetings of the Entomological Society of Canada and the Entomological Society of Alberta.

9. Prepare and present lectures for forestry students at the University of Alberta on the impact of insects on forest resources.

10. Prepare and make a presentation on management of spruce budworm populations in Alberta for the Fall Forest Protection Conference of the Alberta Forest Service.

11. Revise and submit for publication the manuscript entitled "Relationships among jack pine budworm damage, selected tree characteristics, and Armillaria root rot in jack pine budworm".

12. Attend and participate in impact science meeting Kamloops B.C., hosted by PFC.

11. Accomplishments in 1990-91:

1. Attempted to complete the FRDA report.

   a) A manuscript entitled "Distribution and estimation of jack pine budworm defoliation" was prepared and is being revised.
   b) Analysis for the paper entitled "Sampling jack pine budworm populations" is complete.
   c) A draft of a manuscript entitled "Light rings and the age of jack pine trees" was prepared.

2. The intensive study plots and extensive study plots in Manitoba and Saskatchewan were monitored for increases in budworm populations.

3. Participated in the planning and development of a jack pine budworm decision support system and served on the Steering Committee. Served as chairman of the population dynamics working group of the jack pine budworm decision support system development project. Prepared a report on the current knowledge relating to jack pine budworm population dynamics. Acquired and prepared the jack pine budworm population and weather data sets from Wisconsin for processing.

4. Designed and produced a procedures manual for assessing the establishment of impact and population studies on the spruce budworm in mature white spruce stands in Alberta. Conducted the field work and prepared the final report on the study entitled "Hawk Hills Spruce Budworm Project Report".

5. Initiated a review of aspen forest pest population biology and compiled a bibliography containing 89 references.

6. Finalized plantation survey report and transmitted the findings to client agencies. A diskette containing the surveys data summarization procedures has been forwarded to Manitoba Natural Resources.

7. Prepared and presented a paper on the association of climate change and jack pine budworm outbreaks at the Population Dynamics Working Group session at the IUFRO Congress.

8. Assisted in the organization of and held a workshop on the effects of climate change on insects in Canada at the joint meetings of the Entomological Society of Canada and the Entomological Society of Alberta. Presented a paper on the likely effects of climate change on forest insect populations.

9. Prepared and presented two lectures for forestry students at the University of Alberta on the impact of insects on forest resources.

10. Prepared and made a presentation on management of spruce budworm populations in Alberta for the Fall Forest Protection Conference of the Alberta Forest Service.

11. Published journal paper entitled "Relationships among jack pine budworm damage, selected tree characteristics, and Armillaria root rot in jack pine budworm".

12. Attended week-long session hosted by PFC and prepared draft proposal for formation of interested scientists group.

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 coming 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 monitored annually for egg mass 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.

4. A long-term predictor of outbreaks has been developed and methods to hazard rate stands for mortality is being improved.

The techniques and procedures to assess the impact of defoliators developed in this study were modified and applied to the assessment of spruce budworm populations on white spruce stands in northern Alberta.
The study also provides in-put to various graduate student committees in the departments of Forest Science and Entomology, University of Alberta, and lectures in the undergraduate Forest Entomology course. Research co-ordination is also provided by this project for contracts with out-side agencies and the Study Leader serves as scientific authority for contracts administered through Dept. of Supply & Services.

There is an expectation that the study will also co-operate with the climate change project and provide information on the reaction of forest insects to different climate change scenarios.

13. Goals for 1991-1992:

1. Revise as necessary the draft of the FRDA report for publication.

2. Revise as necessary the journal paper on distribution of jack pine budworm defoliation and submit for publication.

3. Revise as necessary the journal note on light rings in jack pine and submit for publication.

4. Complete journal paper on jack pine budworm population sampling and submit for internal review.

5. Prepare a report on the population dynamics of the jack pine budworm in Wisconsin.

6. Complete journal paper on phenology of spruce budworm on white spruce in Alberta and submit for publication.

7. Design and manage spruce budworm population suppression project in northern Alberta.

8. Maintain and monitor jack pine budworm plots in Manitoba and Saskatchewan.

9. Assist in the design and implementation of studies on the impact of gas plant emissions on individual tree growth.

10. Coordinate and lead project NOR-11 Forest Insect and Disease Management Systems and Surveys, and provide other advice as required.

14. Publications:

Mallett, K.I.; Volney, W.J.A. 1990. Relationships among jack pine budworm damage, selected tree characteristics, and Armillaria root rot in jack pine. Can. J. For Res. 20: 1791-1795.

Volney, W.J.A.; Van Sickle, G.A. 199?. Pest Management Tools for managing the Boreal Mixedwood Forest. For. Can., Pac. For. Cent., Victoria, B.C. (In press)

Other reports:

Volney, W.J.A. 1990. Hawk Hills spruce budworm project: instructions and procedures. Unpublished manual.

Volney, W.J.A. 1990. Hawk Hills spruce budworm project report. Unpublished report.

Volney, W.J.A. 1990. Population dynamics of three North American coniferophagous Choristoneura. Unpublished report prepared for the Jack Pine Decision Support System Development Group.

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 1991-92:

| | | | |
|---|---|---|---|
| PYs: | Prof.: | Volney | 0.8 |
| | | Amirault | 0.1 |
| | Tech.: | Yohannes | 1.0 |
| | Total: | | 2.3 |
| | Term/Student | | 0.3 |

| | A-Base | Sask. PAIF | Man. Prov. (Direct) |
|---|---|---|---|
| O & M: | $7,000 | $ 0 | $ 0 |
| Capital: | $12,000 | | |

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-11-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 1, 1991

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

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:

A. 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.

B. 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.

C. 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.

D. 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 1990-91:

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 surveys 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 greenhouse 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 International Mycological Congress in Germany (Regensburg) in August, serve as a chairman of a symposium session, and present two invited symposium papers.

Added goal:

15. Undertake, by invitation, a study tour to Brazil.

11. Accomplishments for 1990-91:

A. Disease identification service and taxonomic service

1. Provided diagnostic and identification service for tree and shrub diseases; processed about 300 samples for diagnosis and identification.

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

3. Considerable progress has been made to complete an information report entitled "Diagnosis and recognition of winter- and other climate- related damage of trees" with H. Zalasky for submission for internal review in 1991-92.

4. Published provisional and draft edition of "Field Guide for Aspen decay identification and measurement" with AFS personnel. The manual has been evaluated by field and management personnel in AFS as well as industries and their comments will be incorporated in final edition which will be published in 1991-92 or 1992-93.

5. Isolated about 20 fungi and bacteria from aspen "black galls" to investigate etiology of gall formation and their relationship to decay caused by Phellinus tremulae. Preliminary histological investigations of gall tissue have been made.

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) Analyzed results of inoculation experiments conducted in 1989 and identified extremely resistant and susceptible families for further studies.

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

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

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

8. Continued 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) Analyzed results of inoculation experiment conducted in 1989.

   b) Conducted greenhouse inoculation experiments with 40 selected lodgepole families provided by AFS.

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

9. Served 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. Conducted ultrastructural investigation of the cytology of western gall rust with Dr. M Neuwirth and Arlene Oatway of Alberta Environmental Centre and discovered interesting cytological events worthy to be published.

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

11. Edited the proceedings of the IUFRO "Rusts of pine" conference with J. Samoil and Dr. P. Blenis (University of Alberta) to be published before the end of 1991-92 fiscal year.

12. A journal paper entitled "Auriculariaceous rusts" was published in the Report of the Tottori Mycological Institute.

13. Investigated taxonomy and morphology of several groups of forest tree rusts with Japanese scientists (Drs. S. Sato, K. Katsuya,and S. Kaneko) under a cooperative research project, and prepared a paper entitled "Morphology, taxonomy and nomenclature of Tsuga - Ericaceae rusts".

14. Attended the Fourth International Mycological Congress in Germany (Regensburg) in August, served as a chairman of a symposium session, and presented two invited symposium papers and two presentations at the work shops.

15. Made a study tour to Brazil from November 23, 1990 to January 9, 1991 by the invitation of Dr. Mario Figueiredo of Instituto Biologico (Sao Paulo, Brazil) supported financially by the State of Sao Paulo government agency (FAPESP). Examined tropical and subtropical rusts which are deposited at the institute; made about 70 field collections of rust fungi in various locations; gave seminars at three institutions; visited eucalyptus cellulose companies in Bahia and Esprit Santo states to observe eucalyptus rust (Puccinia psidii) problem; and consulted on coffee rust (Hemileia vastatrix) epidemiology and control.

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 were undertaken with the cooperation of P. Blenis (U of Alberta), A. Hopkin (NSERC Visiting Fellow, now GLFC), 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 1976.

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

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 with K. Mallett were transferred to NOR-11-09 in 1988.

13. Goals for 1991-92:

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 in 1991-92 for publication in 1992-93.

4. Complete preparation of the "Field Guide for Aspen decay identification and measurement" with AFS personnel in 1991-92 for the publication in 1992-93.

B. Western gall rust study

5. 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 1990.

   b) Plan and conduct inoculation experiments based on the results of 1990 inoculation experiment results and field observations.

   c) Conduct field evaluation of jack pine family plantations in Saskatchewan-Manitoba border area (Central Breeding District, Klein 1982) involving more than 10,000 seedlings planted in four different sites 18 years ago.

6. Continue to work on an information report on western gall rust with Dr. P.V. Blenis of the University of Alberta. Aiming for publication in 1992-93 fiscal year.

7. 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 1990.

b) Plan and conduct green house inoculation experiments based on the results of 1990 inoculation experiments and field observations.

c) Plant seedlings of selected resistant families identified from 1990 inoculation experiments with AFS personel to select high rust incidence areas in central Alberta for field testing.

8. Results of ultrastructural investigation of the cytology of western gall rust with Dr. M Neuwirth and Arlene Oatway of Alberta Envirinmental Centre will be examined and considered for publication.

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

9. Examine several interesting rusts collected in Brazil during the study trip in 1990.

14. Publications 1990-91:

Allen, E. A.; Blenis, P. V.; Hiratsuka, Y. 1990. Histological evidence of resistance of Endocronartium harknessii in Pinus contorta var. latifolia. Can. J. Bot. 68: 1728-1737.

Hiratsuka,Y. 1990. Auriculariaceous "rusts". Rept.Tottori Mycol.Inst.28:31-36.

Hiratsuka, Y. 1991. Nuclear cycle, taxonomy, and nomenclature of western gall rust. In Y. Hiratsuka, J. Samoil, and P. V. Blenis eds. Rusts of Pine. Proceedings of the 4th International IUFRO "Rusts of Pine" Working Party Conference. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-317. (In Press)

Hiratsuka, Y. 1991. A new strategy for the biological control of pine stem rusts. In Y. Hiratsuka, J. Samoil, and P. V. Blenis eds. Rusts of Pine. Proceedings of the 4th International IUFRO "Rusts of Pine" Working Party Conference. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-317. (In Press)

Klein , J. I.; Hiratsuka, Y.; Vescio, S.: Maruyama, P. J. 1991. Disease resistance evaluation of jack pine for western gall rust. In Y. Hiratsuka, J. Samoil, and P. V. Blenis eds. Rusts of Pine. Proceedings of the 4th International IUFRO "Rusts of Pine" Working Party Conference. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-317. (In Press)

Klein-Gebbinck, H. W.; Blenis, P. V.; Hiratsuka, Y. 1991. Spread of Armillaria ostoyae in juvenile lodgepole pine stands in west central Alberta. Can J. For, Res. 21: (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:

Started : 1970 Estimated Completion: Continuing

17. Resources 1991-92:

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

O & M: $ 8 K

Capital: $ 5.5 K

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-11-09

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 01, 1991

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

2. Title: Operational research studies into economically important tree diseases.

3. New: Cont.: X 4. No.: NOR-11-09

5. Study Leader: K.I. Mallett

6. Key Words: Armillaria root rot, pine stem rusts, dwarf mistletoe, poplar diseases and decay, nursery diseases, seed and cone diseases, taxonomy, pathogenicity, control.

7. Location of Work: Northwest Region.

8. Background Statement:

For effective forest management, accurate and reliable methods of disease identification, damage, and loss assessment are necessary. As well, information on the biology of forest pathogens, and control measures must be available to the forest resource manager.

In the Northwest Region, the economically important tree diseases are Armillaria root rot, hard pine stem rusts, dwarf mistletoe, nursery diseases, poplar decay and deterioration, and seed and cone diseases.

Armillaria root rot, caused by the North American Biological Species (NABS) of the Armillaria mellea complex, has been identified as one of the most important disease problems in the region. Most recent work has centred on the identification of the NABS in the region, their distribution, and pathogenicity. Little is known about the impact of the disease on plantations or intensively managed conifer stands. Information regarding early detection and survey techniques are limited, and also information regarding the biology of the NABS in the region and control measures.

Pine stem rusts are thought to impact young conifer stands through mortality, growth and yield loss. Research to date has focused on biology of the hard pine rusts. Information on breeding for resistance, epidemiology, impact, and control measures needs to be developed.

Dwarf Mistletoe of jack and lodgepole pines is a highly destructive disease in region. Much information has been collected concerning the biology of dwarf mistletoe, but more information is required on impact and control, measures.

With the increase in Poplar utilization there is a greater demand for investigations into poplar diseases, and deterioration. Methodology is required to determine the amount of decay in poplar stands for inventory purposes. As old growth forests are used, and poplar regeneration and stand management become important, other poplar disease problems will arise. It is important that these problems be identified and the appropriate control measures be developed.

The use of planted stock is becoming increasingly important in intensive forest management. There is a need to study the diseases of conifer seedlings in forest nurseries in the region. Diseases, such as storage moulds of seedlings and damping-off, can cause large losses to nurseries. Little information is available to nursery personnel on the impact of these disease or their control.

Little is known about the seed and cone diseases of the region. More study is required to provide for nursery and breeding program personnel with accurate and reliable information on these diseases.

This study attempts to address the need to: develop impact information and survey techniques for the major disease causing agents for nurseries, plantations and natural stands; study the biology of the major disease causing agents and develop appropriate control strategies; advise forest managers and forest resource users on the major disease causing agents.

9. Study Objectives:

   1. To study the taxonomy, distribution, ecology, and pathogenicity of important disease causing agents in Northwest Region.

   2. To study the impact of disease causing agents in nurseries, plantations, and in natural stands.

   3. To develop early detection, survey techniques, and control strategies for disease causing agents in nurseries, plantations, and natural stands.

10. Goals for 1990-91

    1. a) Collect and identify isolates of Armillaria species from the Northwest region.

       b) Prepare an information report on the Armillaria mellea complex in the region for internal review.

       c) Prepare a journal paper on the Armillaria mellea complex in the prairie provinces of Canada for journal review.

    2. Four 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. Collect isolates of Phellinus tremulae and identify mating genes for genetic markers to help elucidate the population structure of P. tremulae in aspen poplar.

6. 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 the Trap Log Technique.

7. Investigate the relationship of water stress to pathogenicity of A. ostoyae. Lodgepole pine seedlings will be inoculated and grown under several different soil moisture regimes.

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).

Added goals:

13. Provide consultations to Energy Resources Conservation Board (ERCB) concerning forest tree disease impact on forest decline in west central Alberta

14. Survey Alberta Forest Service, Pine Ridge Forest Nursery, for tree disease problems and produce report.

15. Organize the Plant Pathology Society of Alberta annual meeting.

11. Accomplishments for 1990-91:

1. An information report on Armillaria root rot in the prairie provinces was prepared for internal review. A journal article entitled "Host range and distribution of Armillaria root rot pathogens in the prairie provinces of Canada was prepared, reviewed, and published.

2. A study on evaluating fungicides for the control of damping off of conifers was terminated. A file report was written.

3. Fungal isolations were made from terminal weevils and weevil galleries from 5 different locations and two species of trees. Some of the fungi that have been isolated have been identified.

4. Lodgepole pine needle samples and soils samples were collected from trees with and without Armillaria root rot on 4 sites in west central Alberta. Samples were prepared for nutrient analysis. A greenhouse experiment to determine the relationship between Armillaria root rot and foliar nutrients was initiated. In conjunction with NOR-07-05 (Mallett & Maynard).

5. A study on the population structure of Phellinus tremulae in aspen poplar was initiated. Fruiting bodies were collected from five different areas and single spore isolations made. Identification of mating genes was begun.

6. Study plots were established in a mixedwood stand that had undergone aspen removal. The plots were surveyed for Armillaria root rot by sampling aspen stumps, placing traplogs in the plot area, and examining spruce regeneration.

7. A greenhouse experiment to investigate the relationship between Armillaria root rot and water stress was initiated. Lodgepole pine seedlings were grown in saturated soil, 80% field capacity soil, and 50% field capacity soil. Some of the seedlings in the saturated and 50% field capacity treatments have started to die.

8. The article was reassessed by the author, K.I. Mallett. In light of some recent articles that have been published in this area this goal was dropped. Part of this study was published in the Proceedings of the 6th International Conference on Root and Butt Rots. IUFRO S2.06.01.

9. A journal article entitled "Relationships among jack pine budworm damage, selected tree characteristics, and Armillaria root rot" was published in the Canadian Journal of Forest Research. A note on tree analysis of jack pine budworm defoliated trees was prepared. In conjunction with NOR-11-05 (Mallett & Volney)

10. Participated in an advisory capacity to the development of the host rules for the National Insect and Disease Forest Pest Depletion Exercise.

11. Provided advice and technology transfer of information regarding forest diseases to NOR-11-01 personnel and client groups. Numerous consultations were made with Forest industry personnel, provincial government agencies and private citizens. Four workshops on tree disease problems were given to client groups. Information on tree disease survey methodology was collected for the preparation of FIDS survey manual.

12. Three issues of the "Forest Insect and Disease Notes" were produced in cooperation with personnel from NOR-11.

13. A disease survey of the forest surrounding the Husky Ram River sour gas plant was done to determine the cause of the alleged forest decline. An internal report was

written in conjunction with D. Maynard regarding the findings of the survey. Testimony regarding the findings of the report was given to the ERCB hearings on the Caroline sour gas field.

14. A disease survey was conducted at the Pine Ridge Forest Nursery and a file report written. In conjunction with H. Cerezke.

15. The annual meeting of "The Plant Pathology Society of Alberta" was organized, Nov. 5 - 7.

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 identified. Three species of Armillaria have been found in the Northwest region, A. ostoyae, A. sinapina, and A. calvescens. A host list for the species and a distribution map has been developed. Identification methods such as the L-DOPA technique for identifying the various species have been developed. Studies into the incompatibility system of some Armillaria species have revealed valuable information regarding intraspecific and interspecific incompatibility. Techniques for identifying Armillaria root rot centers in cutover areas have been initiated. A study into the effects of Armillaria root rot in mixedwood management systems has been initiated. The A. mellea complex species present in the region are being tested for their ability to kill native conifer species. Results to date suggest that both A. ostoyae and A. sinapina are pathogenic to native conifers.

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.

A study to find alternative fungicides for the control of damping off of conifer seedlings was conducted. Six fungicides were screened for phytotoxicity. None of the fungicides proved highly phytotoxic except for metaxyl on white and black spruce.

A study into the population structure of Phellinus tremulae was initiated. The genes controlling mating type have been identified.

13. Goals for 1991-92:

1. a) Submit for review an information report entitled "Armillaria root rot in the prairie provinces".

   b) Submit for review a forest management note entitled "Detection of Armillaria root rot pathogens in forest soils".

   c) Submit for internal review a journal article on Tree ring analysis of jack pine budworm defoliated trees (in conjunction with W.J.A. Volney.)

2. Isolate and identify fungi from terminal weevils and their galleries in spruce and pine.

3. Complete greenhouse experiment initiated in 1990 to determine the relationships between Armillaria root rot and foliar nutrients and analyze data. Repeat greenhouse experiment. Analyze soil and foliar nutrient data collected from lodgepole pine trees that were affected by Armillaria root rot. In conjunction with NOR-07-05 (Mallett and Maynard)

4. The relationship of soil moisture stress on Armillaria root rot will be investigated by inoculating white spruce and lodgepole pine seedlings grown under different soil moisture conditions. The effect of the soil moisture conditions on infection of the seedlings will be evaluated.

5. The population structure of Phellinus tremulae in aspen poplar will be studied by collecting conks from Manitoba, Saskatchewan, and other locations in Canada. Single spore isolates from these conks will be used to confirm the mating system that is proposed.

6. Plots established at Hinton in a mixedwood stand will be assessed to determine the affects of Armillaria root rot in young white spruce after aspen removal. Establish study plots in Whitecourt aspen removal area.

7. A three year forest health survey in the forest surrounding the Husky Ram river and Gulf Strachen sour gas processing plants will be initiated. Disease surveys in 10 stands near the processing plants will be conducted. An annual report describing the accomplishments for 1991 will be prepared and submitted to Husky Oil Ltd. and Gulf Canada Resources Ltd. In collaboration with D. Maynard and W.J.A. Volney.

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

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

14. Publications 1990-91:

Mallett, K.I. 1990. Host range and geographic distribution of Armillaria root rot pathogens in the Canadian prairie provinces. Can. J. For. Res. 20: 1859-1863.

Mallett, K.I. (Compiler) 1990. Forest Insect and Disease Notes. Forestry Canada, Northern Forestry Centre, Edmonton, Alberta. Tech. transfer Note A-014, A-015, A-016.

Mallett, K.I.; Volney, W.J.A. 1990. Relationships between jack pine budworm damage, selected tree characteristics, and Armillaria root rot. Can. J. For. Res. 20: 1791- 1795.

Maynard, D.G.; Mallett, K.I. 1990. Health assessment of forests in the vicinity of the Husky Oil Ram River sour gas processing plant. ForCan, North. For. Cent. File Report. NOR-0701.

Cerezke, H.F.; Mallett, K.I. 1990. Survey report of pests in the Pine Ridge Forest Nursery, near Smoky Lake, Alberta. ForCan, North. For. Cent. File Report NOR-11-01.

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 1991-92:

| | | |
|---|---|---|
| PY'S: | Prof.: Mallett | 0.9 |
| | Tech.: | 0.0 |
| | Total: | 0.9 |
| | Term/student: | 0.3 |

O & M: $ 6,000

Capital: Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-11-10

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 15, 1991

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

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, DNA sequencing, 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, DNA sequencing, 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. Undertake biosystematic and faunistic studies of Pissodes weevils and other selected important forest insect taxa.

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

3. Maintain and improve regional collections of insects and mites, collection of photographic slides, and FIDSINFOBASE.

10. 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. [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 FMN 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. [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 Colin 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. [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.

Added Goals:

16. Commence life history and life table studies of Pissodes terminalis and P. strobi.

17. Examine, for incidence of Pissodes strobi, plots near Hinton where aspen was selectively logged leaving the spruce understory.

18. Collect life history data on the bark beetle Pityophthorus pulchellus tuberculatus attacking young lodgepole pine in Alberta.

19. Rear spruce budworm larvae and pupae to obtain parasitoids.

20. Collect a second years data on the effects of clear-cutting on the ground fauna (predatory insects and spiders) in lodgepole forests near Hinton.

21. Prepare a poster titled "Effects of forestry practices on ground beetles" and present at two conferences.

22. Prepare a paper titled "Host effects on the mountain pine beetle in Alberta" to submit to the University of Alberta Agriculture and Forestry Bulletin.

23. Write paper titled "Taxonomic research on forest insects and diseases at the Northern Forestry Centre: part 1, Introduction to taxonomy" for publication in Forest Insect and Disease Notes.

11. Accomplishments for 1990-91:

A. **Biosystematics and Ecology of *Pissodes* Weevils**

1. Electrophoretic protocols were refined and electrophoretic data were collected for about 200 specimens of four species of Pissodes. Learned protocols for extracting DNA from Pissodes and for DNA digestion using restriction enzymes. About 600 specimens of Pissodes spp. were collected from several localities, sexed, and preserved in preparation for electrophoretic data analysis and DNA extraction.

2. About 14,000 specimens of Pissodes were received on loan from museums and were fitted with identification labels and curated. The taxonomic literature on Pissodes was reviewed to assess morphological character systems which might be of use for delimiting species boundaries. A survey of variation in two characters systems (antennae and genitalia) was begun.

3. Fungi were collected from Pissodes terminalis adults as well as frass and wood of infested terminals from 6 localities and two hosts. Identification of fungi from previous collections was commenced. [In collaboration with K. Mallett, NOR-11-09]

4. About 150 more publications on Pissodes were collected. Translation and abstracting of papers continued. About 500 papers were entered into the ProCite computer bibliographic database.

5. FMN on "the lodgepole terminal weevil" was completed and submitted for internal review.

6. About 800 adults of Pissodes terminalis and P. strobi were reared from infested terminals and overwintered in outdoor cages in preparation for cross breeding experiments in the spring of 1991.

7. Specimens of P. strobi and P. nemorensis were collected in preparation for cuticular hydrocarbon analyses. [In collaboration with Dr. M. Haverty, U.S. Forest Service, Berkeley, CA]

8. About 150 specimens of predators and parasitoids of Pissodes spp. were collected, pinned and identified. The impact of natural enemies on P. terminalis at three localities was assessed.

B. **Diagnostic & Advisory Services and Collections Management**

9. 156 collections (about 3500 specimens) were recieved for identification. Moved rearing equipment into new insectary. About 90 collections (10,000 specimens) of insects were reared for diagnostic purposes. Twenty collections were packaged and sent to the Biosystematics Research Centre, Ottawa for identification or confirmation.

10. About 700 specimens of insects were pinned, labelled, most identified, and incorporated into the reference collection. To date, about 200 photographic slides have been sorted and 900 identified, and filed. FIDSINFOBASE was queried twice. Enclosure slips from 1987-1989 were sent to PNFI for entering into database.

11. Advice, information, and lectures were given to 40 clients, NoFC personnel, other agencies, students, and the public. Acted as scientific advisor (biology) for a project on the pheromones of the western ash bark beetle initiated by Drs. H. Wieser and E. Dixon (Dept. Chemistry, Univ. of Calgary). Ten requests for loans or gifts of insects were received and filled. Made five collections of bark beetles on request for Dr. D. Wood (Univ. California, Berkeley).

12. Continued as a scientific advisor for a research project on the western ash bark beetle initiated by the Calgary Dept. of Parks and Recreation. A second years' data on life history was collected, data analysis was commenced in preparation for publication. [In collaboration with C. Hergert]

C. **Other Faunistics and Taxonomic Studies**

13. About 200 specimens of parasitoids were reared from Malacosoma spp. from the prairie provinces and N.W.T. All specimens in the collection at NoFC have now been identified and curated in preparation for construction of identification keys.

14. Twenty four collections of insects on aspen and poplar were made. Most were reared to associate larvae and adults and to obtain parasitoids. Photos were taken of some specimens.

15. Commenced compiling a list of pests of forest and shade trees introduced into Canada which have potential for economically important impact in the Northwest region.

Added Accomplishments

16. Commenced a study of the life history and life tables of P. terminalis in lodgepole pine. One years' data was collected at each of three localities in Alberta and is currently being analyzed. Collected some preliminary data for a study of the life history and life tables of P. strobi in white spruce.

17. Examined plots near Hinton but they were considered unsatisfactory for studying effects of removing hardwood overstory on incidence of P. strobi in spruce because of proximity to mountains, spruce size, and lack of nearby beetle source.

18. Collected life history and life table data on a bark beetle (Pityophthorus pulchellus tuberculatus) attacking young lodgepole pine stands in the Hinton area.

19. Reared 1800 specimens of spruce budworm larvae and pupae to obtain parasitoids. Data were collected, entered into computer files, and parasiotids were pinned, sorted and sent to BRC for identification. [In collaboration with J. Volney, NOR-11-05]

20. Collected second years' data on the effects of clear-cutting on the ground fauna in lodgepole pine forests near Hinton. Samples were all processed and data is being analyzed for publication. [In collaboration with Drs. J. Spence and J. Niemela, Univ. of Alberta]

21. Poster was prepared and presented at the Entomological Society of Canada Meetings in Banff in October and at the Entomological Society of America meeting in New Orleans in December.

22. Preparation of paper on "Host effects on the mountain pine beetle in Alberta" was completed.

23. Paper on "Introduction to taxonomy" was completed and published in the December 1990 issue of Forest Insect and Disease Notes.

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 slides have now been sorted and on most the identifications have been confirmed or updated.

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 laboratory to analyze DNA sequences and restriction sites is being set up and training in these techniques is continuing. A study of morphological variation in Pissodes, in search of character systems to help discriminate among species, is ongoing. 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 and entered into the ProCite database in preparation for an annotated bibliography.

13. Goals for 1991-92:

A. **Biosystematics and Ecology of Pissodes Weevils**

1. Continue a survey of isozyme variation in Pissodes: assess geographic variation of isozymes in P. strobi and P. terminalis.

2. Continue a morphological examination of Pissodes: assess variation in antennae and genitalia to find characters to discriminate among Pissodes species.

3. Extract DNA from Pissodes specimens in preparation for DNA sequencing or restriction site analyses.

4. Continue survey of fungi associated with P. strobi and P. terminalis and identify species collected to date. Commence data analyses in preparation for publication.

5. Complete abstracting papers on Pissodes and enter data into ProCite database.

6. Collect a second years' data on the life history and life tables of P. terminalis in lodgepole pine and initiate a similar study in jack pine.

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

8. Continue to survey the parasitoids and predators of Pissodes and studies of their impact on P. strobi and P. terminalis.

9. Examine plots near Whitecourt for suitability for study of effects of removal of aspen overstory on incidence of P. strobi in the spruce understory. If suitable, collect initial data and set up control plots.

10. Revise and publish FMN titled "The lodgepole terminal weevil, Pissodes terminalis Hopping, in the prairie provinces".

B. **Diagnostic and Advisory Services and Collections Management**

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

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

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

14. Provide input (advice and data analysis) into a western ash bark beetle research program in Calgary. Prepare a journal paper(s) on the life history and life tables of the western ash bark beetle in Alberta. [In collaboration with C. Hergert, Calgary Parks and Recreation and Drs. H. Wieser and E. Dixon, University of Calgary]

C. **Other Faunistics and Taxonomic Studies**

15. Continue survey of the parasites and predators of the forest tent caterpillar in Alberta. Commence construction of identification keys. [In collaboration with Dr. J. Spence, University of Alberta]

16. Continue survey of insects and mites feeding on aspen in the region.

17. Prepare a journal paper(s) on the life history and life tables of Pityophthorus pulchellus tuberculatus in Alberta.

18. Publish a paper titled "Host effects on the mountain pine beetle in Alberta" in the Agriculture and Forestry Bulletin. [In collaboration with Dr. J. Spence, Univ. of Alberta]

19. Prepare a journal paper titled "Effects of forestry practices on ground beetle (Coleoptera: Carabidae) communities in lodgepole pine forests in Alberta". Tend traps and sort samples to evaluate effects of forestry practices on ground-dwelling, predatory insects and spiders. [In collaboration with Drs. J. Spence and J. Niemela, University of Alberta]

20. Rear spruce budworm larvae and pupae for parasitoids, collect data, enter data into computer files, pin and curate parasitoids. [In collaboration with J. Volney, NOR-11-05]

14. Publications 1990-91:

Langor, D.W. 1990. Taxonomic research on forest insects and diseases at the Northern Forestry Centre: Part 1, Introduction to taxonomy, Pages 3-5. In K. I. Mallett (compiler), Forest Insect and Disease Notes, December, 1990 For. Can., North. For. Cent., Edmonton, Alta.

Langor, D.W. 1991. Arthropods and nematodes co-occurring with the eastern larch beetle, Dendroctonus simplex (Col.: Scolytidae), in Newfoundland. Entomophaga (in press)

Langor, D.W.; Spence, J.R. 1991. Host effects on allozyme and morphological variation of the mountain pine beetle, Dendroctonus ponderosae Hopkins (Coleoptera: Scolytidae). Can. Ent. 123: (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 1991-92:

| | | | |
|---|---|---|---|
| PYs: | Prof.: | Langor | 1.0 |
| | Tech.: | | 0.5 |
| | Total | | 1.5 |
| | Term/Student | | 0.3 |

O&M: $ 6.0 K

Capital: Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-11-11

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 1, 1991

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

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

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

5. Study Leader: 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.

For three breeding districts in Manitoba and Saskatchewan, family tests were planted from 1972 to 1976. Each family test consists of four replicated plantations containing more than 200 open-pollinated progenies of selected wild parent trees from the breeding district. All tests have been measured at five and ten years from planting. Results from analysis of measurement data from the eastern breeding district family test in southeastern Manitoba at ten years from planting were used to select the best 40 families and the five best trees in each of these 40 families. Controlled mating was performed with the selected trees to

produce progenies for a seed orchard. Surplus seedlings and seeds from the crosses were provided for assessment of response to artificial inoculation with western gall rust. Measurement of height and diameter, and scoring of stem quality and rust infection have been completed for two breeding districts at 15 to 16 years from planting.

As a result of ongoing research work at the Northern Forestry Centre (NoFC) for many years, 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. (N. Giles),Aspergillus sp. (W. E. Timberlake), Cochliobolus sp. (O. Yoder), Ustilago sp. (S. Leong).

Similarly, great advances have been made towards the genetic transformation of trees. Several laboratories reported successful transformations and regeneration of transformed plants of poplar (University of Iowa, University of Wisconsin), walnut and apple (Cornell University Experimental Station).

Genetic transformations and regeneration of conifers are actively pursued in Canada and elsewhere (W. Cheliak, Ottawa; B. Sutton, Vancouver; D, Dunstan, PBI-Saskatchewan), and University of Alberta - Plant Biotechnology Centre is actively collaborating with these laboratories. Further, Dr. Thorpe's laboratory at University of Calgary reported the recent findings concerning the regeneration of jack pine (personal communication).

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:

3. 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)

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

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

6. 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 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)

    Added goals:

    5. Attend Conifer Biotechnology meeting, July 1990.

    6. Participate in Plant Molecular Genetics and Biotechnology seminars at University of Alberta.

11. Accomplishments for 1990-91:

    1. Literature on plant (conifer)-fungi interaction have been collected and reviewed. Direct contacts with research scientists in laboratories involved in conifer research have been established. (Aguilar)

    2. Purchased equipment, and supplies to establish molecular biology research facilities at NoFC and conducted preliminary material processing of jack pine. (Aguilar)

    3. Macromolecules from woody tissues: Methods to extract proteins from gall tissue were assayed and found that few of them were suitable for the protein analysis in polyacriamide gel electrophoresis. The overall procedure was able to reveal different polypeptidic profiles in samples prepared from gall and normal stem tissues. Proteins were transfered onto membrane for the determination of the amino acid M-terminal sequences. A method for the extraction for RNA from woody tissues of jack pine (from gall and normal tissue) was established after several attempts in which different protocols were applied and plant material of different age after inoculation with the fungus were used. This protocol has been optimized in order to provide quantitative amounts of high quality RNA for further experiments such as construction of cDNA libraries. Extraction and purification of total

DNA from needles of jack pine and lodgepole pine have been performed and found suitable for enzymatic digestion. (Aguilar)

4. Because of other commitments and shortage of manpower resources, active field and laboratory investigations of the strategy of biocontrol of western gall rust involving a mycoparasite (Scytalidium uredinicola) and an insect (Epuraea obliquus) were not conducted but larvae of the beetle were collected and observed in the laboratory. (Hiratsuka, Volney)

5. Attended the Conifer Biotechnology Meeting in United Kingdom in July 1990. This provided an excellent opportunity to meet scientists involved in the field of conifer research and to share information that helped to make progress in our projects. (Aguilar)

6. Participated actively in the weekly series of research and literature seminars at the Plant Molecular Genetics and Biotechnology laboratory, University of Alberta. (Aguilar)

12. Present Status of Study:

Study initiated to respond to a new strategic thrust in biotechnology with the appointment of a research scientist (M. Aguilar) in biotechnology.

13. Goals for 1991-92:

1. Prepare polyA-RNA from total RNA extracted from gall and normal jack pine stem tissue to use in the construction of cDNA lobraries. (Aguilar)

2. Initiate construction of cDNA libraries of infected and normal jack pine tissues using RNA extracted as 1. above. (Aguilar)

3. Initiate the differential screening of the libraries to isolate cDNA clones that corespond to gene expressed specifically in the infected or non-infected tissue. (Aguilar)

4. Investigation of a biocontrol strategy of western gall rust using rust feeding beetle (Epuraea obliquus) and a mycoparasite (Scytalidium uredinicola) will be actively pursued if additional resources are available (ForCan S & T Opportunity Fund etc. (Hiratsuka, Volney)

14. Publications 1990-91:

Hiratsuka, Y. 1991. A new strategy for the biological control of pine stem rusts. In Y. Hiratsuka, J. Samoil, and P. V. Blenis eds. Rusts of Pine. Proceedings of the 4th International IUFRO "Rusts of Pine" Working Party Conference. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-317. (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:

Started: 1990 Estimated Completion: Continuing

17. Resources 1991-92:

| | | | |
|---|---|---|---|
| PYs: | Prof. | Aguilar | 0.8 |
| | | Hiratsuka | 0.4 |
| | | Volney | 0.1 |
| | Tech. | Maruyama | 0.4 |
| | | New | 0.5 |
| | Total: | | 2.2 |
| | | Technologist | 1.0 |
| | | Summer Student | 0.3 |

O & M: $ 6 K
Capital: $ 9.5 K

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-11-12

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 1, 1991

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

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

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

5. Study Leader: 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: NoFC, Plant Molecular and Plant Biotechnological Centre, University of Alberta

8. Background Statement:

As the mixedwood management become important and regeneration of aspen will be considered as important as conifer reforestation in our region, there will be excellent possibilities of biotechnological work on aspen. Aspen became an important forest tree species in the region and genus Populus is considered to be much easier material to propagate and to make tissue cultures. Sccussful genetic transformation of Populus with Agrobacterium has been accomplished (Fillatti et al. 1987). At the present time, decay is the biggest concern in relation to the utilization of existing aspen resources. In future when intensive management of aspen will be practised, such disease as Armillaria root rot, leaf rusts and Hypoxylon canker and insect pest like forest tent catepillar will become important factors for successful cultivation, and need to be considered in aspen improvement work. However, there are big gaps exist between 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 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

   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 antifungal properties of major species. (Hiratuska)

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

11. Accomplishments for 1990-91:

1. a) Conducted a survey of available information on tissue culture, regeneration, and transformation of poplar (genus Populus) and explored the possibilities of application to aspen. Isolations of polyA-RNA from several tissues of aspen such as xylem, roots, leaves were conducted and used to construct a cDNA library in expression vector plasmids. Analysis of the library to assess the ration of recombinant clones are under way. (Aguilar)

b) It was understood that Drs. A. Storaz and A. Szalay at the University of Alberta were going to undertake the topic of regeneration and tissue culture aspect of the project.

2. a) Collection and preservation of insect and disease resistant clones of aspen in the region were not actively conducted.

3. a) Many fungi and bacteria were isolated from black gall tissues and are undergoing identification and evaluation.

b) A fungus antagonistic to Phellinus tremulae (the main decay causing fungus of aspen) was discovered and metabolites produced by the fungus are under investigation with Dr. W. Ayer (University of Alberta, Dept. of Chemistry).

12. Present Status of Study:

Study 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). With the anticipated external funding opportunities re-grouping and planning of the future activities of the study is under way.

13. Goals for 1991-92:

1. Screen the cDNA library prepared from the xylem RNA of aspen in order to isolate clones specifically expressed in that tissue. (Aguilar)

2. Purify polyA-RNA from different tisues of aspen to use as probes in the screening. (Aguilar)

3. Investigations of black galls of aspen in conjunction with biocontrol of decay and stain will be stepped-up with the NSERC Strategic Grant support to Y. Hiratuska,W. Ayer (Univ. of Alberta, Chemistry) and L. Sigler (U of A Microfungi Collection). (Hiratsuka)

4. Efforts will be made through PAIF's to initiate a multiagency-multidiscipline project on aspen decay and stain. The proposal includes researchers from University of Alberta, University of Calgary, Pulp and Paper Research Institute of Canada, Alberta Forest Service and Forestry Canada. (Hiratsuka, Aguilar)

5. Participate in Biotechnology Network for Biorational Control of Forest Products (BCFP) initiated by Dr. J. Saddler, University of British Columbia. (Hiratsuka, Aguilar)

6. Clones of aspen with unusual field charaacteristics such as disease resistance, insect resistance etc. will be noted, reported and collected by insect and disease specialists, and propagated and retained for future investigations. (Langor, Mallett, Cerezke, and Hiratsuka)

14. Publications 1990-91:

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:

Started : 1990 Estimated Completion: Continuing

17. Resources 1991-92:

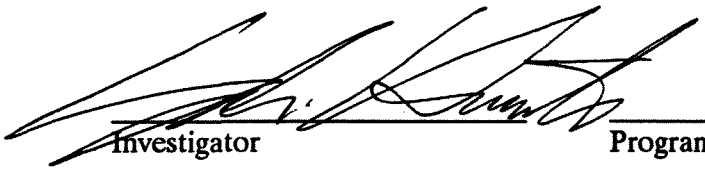
| | | |
|---|---|---|
| PYsProf.: | Hiratsuka | 0.3 |
| | Agilar | 0.2 |
| | Langor | 0.1 |
| | Mallett | 0.1 |
| | Cerezke | 0.1 |
| Tech.: | Maruyama | 0.3 |
| | New | 0.5 |
| Total: | | 1.6 |
| Visiting Scientist | | 1.0* |
| Technologist | | 1.0* |

*NERC Strategic Grant

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

NSERC Strategic Grant $ 10 K

18. Signatures:



Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-36-02-4

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 18, 1991

1. Project: Regional Development

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

3. New: Cont.: Term.: 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 the province.

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

10. 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.

11. Accomplishments 1990-91:

1. Dwarf mistletoe impact plots not remeasured.

2. Assisted with field requirements related to the study of the spruce budworm in northern Alberta (cross reference NOR 11-01).

3. Managed the incorporation of FIDS data into the GIS (cross reference NOR 11-01).

4. Pest depletion estimates for 1982-87 are in final stages of calculation at the regional level. Will require provincial territorial approval and the creation of a final report (cross reference NOR 11-01).
5. Report on pest impact in the Northwest Region was submitted for review, revised by authors, and has been resubmitted for review (cross reference NOR 11-01).

6. Provided diagnostic and advisory services on pest problems as requested.

7. Completed final FRDA report. (see publications)

8. Completed file report on mountain pine beetle hazard rating.

9. Continued conducting pest surveys in high value young conifer stands (with some AFS involvement).

10. No input into FIDS survey manual which was downgraded to file report.

11. Represented Forestry Canada on Forest Protection Task Force.

12. Study terminated.

Additional Accomplishments:

13. Acted as a resource person for FIDS GIS (4-5 weeks of work at the request of various personnel).

14. Summarized data from pest surveys in high value young coniferous stands.

15. Participated in FIDS in-service training (Hinton, May 28-31).

16. Provided advice to Weyerhaeuser personnel on sampling spruce budworm (cross reference NOR 11-05).

12. Present Status:

Study suspended pending implementation of a new Canada-Alberta Partnership Agreement.

13. Goals 1991-92:

Nil, study terminating.

14. Publications 1990-91:

Amirault, P.A. 1990. Forest pest management and damage appraisal final report. Canada-Alberta Forest Resource Development Agreement Report.

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: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

Program Director, Development

Regional Director General