STUDY WORK PLANS

1991-92

NORTHERN FORESTRY CENTRE

NORTHWEST REGION

FORESTRY CANADA

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MARCH 1991

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NORTHERN FORESTRY CENTRE

STUDY WORK PLANS, 1991-92

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FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 15, 1991

1. Project: Geographic Information Systems, Forest Inventory and Site

2. Title: Forest ecology and site productivity

3. New: Cont.: X 4. No.: NOR-02-01

5. Study Leader: I.G.W. Corns

6. Key Words: GIS, Forest ecology, site productivity, forest soils, site modification, succession, ecological classification

7. Location of Work: Northwest Region

8. Problem:

The recent developments in GIS and remote sensing have presented on opportunity to use new and powerful tools to extend the applications of many of our forest research findings and to compare results from diverse disciplines within a common geographic framework. The increasing realization that many forest management opportunities and constraints are related to site type presents the possibility of their prediction and analysis using a site classification within a GIS, and in conjunction with remote sensing methods. Several aspects will be addressed by this study.

1. Recent GIS technology presents an opportunity to exploit GIS as a tool to relate site classification and other information (e.g., inventory, growth and yield) in a pilot project with a forest industry cooperator.

2. There is need for information on factors influencing forest growth and for new methodology for site evaluation and classification of boreal forest ecosystems.

3. Large scale pulpwood clearcuttng operations in Alberta foothills have resulted in large areas of young (≤25 yr.) forest. The rate and extent to which the productivity, structure and species composition of these forests is proceeding toward that of mature forest on similar situations is not well documented. An opportunity is thus available to increase our understanding of forest dynamics in the foothills. Such information can be used to

interpret recently developed forest site classifications emphasizing mature forest vegetation.

4. Grass competition with white spruce seedlings in our region is recognized to be a major silvicultural problem. Mechanical site preparation is expensive and often not effective. Chemical methods have encountered resistance from environmental lobby groups. Reduction of grass competition by an alternative method may be attractive. (Carried over from NOR-10-06).

5. The importance of the major insect and disease agents upon lodgepole pine and jack pine survival and stand development on a variety of sites in western Alberta and southeastern Manitoba is becoming evident. The relationships between damage agents and site factors should prove very useful in the management of such stands originating after clearcutting operations.

9. Study Objectives:

1. Quantification of site forest productivity relationships through multivariate analysis and GIS application.

2. To evaluate synthetic aperture radar (SAR) as a means to estimate tree biomass and discriminate and map site types.

3. To characterize and analyze environmental influences upon tree growth on highly productive forest sites in our region, with the objective of learning potentially manageable chemical and physical factors responsible for growth. The role of some macronutrients, still unknown for our area, would be evaluated.

4. To further document plant succession and early tree growth in young (≤25 yr) lodgepole pine forests originating from pulpwood clearcutting in western Alberta.

5. To evaluate MEIS imagery as a means to discriminate and map site types.

6. To determine the effect of site upon major insect and disease agents upon lodgepole pine and jack pine survival in west-central Alberta and southeastern Manitoba respectively.

7. To initiate a GIS - site classification pilot project with a forest industry cooperator in the Northwest Region.

8. To carry out technology transfer in site classification as it relates to forest management.

9. To provide leadership to the NOR-02 (GIS-FIS) project.

10. Goals for 1990-91:

1. Prepare Forest Management Note on characterization of highly productive white spruce sites in the region.

2. Publish paper in Forestry Chronicle: "Forest Site Classification in Alberta - Its Evolution and Present Status" to be included in compendium compiled by For. Can. Site Classification Working Group. The possibility of publication separately from the now long overdue ForCan site classification working group compendium, will be investigated.

3. Contribute to Mixedwood Management Decision Support System team and coordinate the development of the basic conceptual model.

4. Revise and publish paper on plant succession 24 years after clearcutting in Alberta foothills as information report or journal article.

5. Continue as Scientific Authority on FRDA contract on Biogeoclimatic classification and field guide development for Bow Crow and Rocky-Clearwater forest districts. ForCan will attempt to secure publication funding under next FRDA agreement

6. Continue evaluation of remote sensing methods in site classification.

    a) Cooperative study with Canada Centre for Remote Sensing to use radar imagery to estimate stand biomass and discriminate site.

    b) Draft Forest Management Note on evaluation of MEIS imagery to discriminate site classes.

7. Continue monitoring and seedling growth measurements in study of synthetic mulches to control grass competition in Slave Lake forest.

8. Committee involvement:

    a) Chairmanship of national CIF Ecology Working Group and member of CIF Forest Science Technology Board.

    b) Chairmanship of RMS-CIF Committee to evaluate the desirability of initiating a benchmark sites project within RMS.

    c) Continue to act as regional Scientific Authority for revised "Trees in Canada" book.

    d) Continue to serve as member of Alberta-Saskatchewan National Vegetation Working Group of the Canada Ecological Land Classification Committee.

    e) Continue to serve on Saskatchewan GIS pilot project steering committee. Dr. D. Gauthier, University of Regina is the principal investigator.

    f) NAIT Biological Sciences (Renewable Resources Option) curriculum advisory committee.

    g) Member of Alberta Ecological Classification Task Force chaired by AFS to determine forest industry and government needs in site classification.

    h) Member west-central Alberta caribou technical working group.

i) Member CIF/RMS Executive council.

9. Initiate a predictive site classification mapping study in cooperation with Alberta forest industry and Alberta Research Council (Jones).

10. Provide leadership to NOR-02 project.

11. Draft paper on the economic benefits of site classification in cooperation with B. White (NoFC) and K. Jones (ARC).

12. Provide site classification input to NOR-10-03. (Rentz/Ives)

13. Prepare Torch River Forest (Sask.) site classification information for GIS entry and analysis in cooperation with R. Hall. (NOR-02-04)

14. Prepare and deliver a forest site classification workshop in cooperation with K. Jones (ARC).

Added Goals:

15. Participate in Green Plan information session, Regina May 1, 1990 and Green Plan Consultation session (Wildlife workshop), Calgary June 12-13.

16. Prepare poster at request of Dr. P. Hall, ForCan, HQ for XIX IUFRO Congress, Montreal on behalf of Working Party SI. 05-12, Northern Forestry Silviculture and Management.

17. Participate in Forest Science Technology Board and Ecology Working Group meetings at CIF - AGM Fredericton, N.B. August 20-23.

18. Participate in Regional Reforestation Technical Committee Workshop on Preharvest Silvicultural Prescriptions Sept. 6-7.

19. Present invited talk entitled "Do different sites require different standards?" to CIF/RMS meeting, Slave Lake, Alberta September 14-15.

20. Consultation with K. Branter, Forester in Charge, Reforestation, AFS Edmonton, September 24-25 in Forest Management Unit F8 re: site related causes for reforestation failure in the area.

21. Present invited lecture to Dr. E. MacDonald's U of Alberta Ecology class on site classification in Canada, October 31, 1990.

22. Assume duties related to management of the Forest Resources Research program:

a) Assume coordination of DSS - mixedwoods program, preparation of poster for Aspen Symposium November 20-21, and organization of February 1991 workshop.

b) Forest Resources representative on Space Committee.

c) Participate in preliminary negotiations of research component of the Canada-Manitoba and Saskatchewan forest partnership agreements.

d) Initiate staffing on Resources Program vacancies.

11. Accomplishments in 1990-91:

1. No progress.

2. The paper has been reviewed by members of the ForCan Site Classification Working Group. It is now with the author for revision and should be published during 1991.

3. Work focused on the development of predictive site classification mapping in cooperation with K. Jones of ARC and Naia Systems, Calgary. A basic conceptual model of the program was prepared in consultation with Forest Resources staff and submitted as a poster at the Aspen Symposium, November 20-21. A contract for a facilitated workshop in February 1991 to further develop the conceptual model, has been initiated.

4. No progress.

5. Final revisions to the south western Alberta field guide continue cooperatively between AFS and ForCan. At least a draft of the guide for users in the study area is planned for 1991.

6. Evaluation of remote sensing methods in site classification.

   a) Participated in the CCRS organized RADAR Data Development Program meeting at Gananoque, Ont. January 14-18 and reported on analogue interpretation of the test imagery for discriminating forest sites in the Whitecourt area.

   b) No progress.

7. Field work on the synthetic mulch study has been completed. Data synthesis are analysis are in progress.

8. Committee involvement:

   a) Entering second year of chairmanship of national CIF Ecology Working Group and working group and member of CIF Forest Science Technology Board. Participated in meetings at CIF AGM, Fredericton.

   b) Committee did not meet during 1990.

   c) Work on "Trees in Canada" is continuing with publication planned for 1991.

   d) The National Vegetation Working Group published a report on the Canadian Vegetation Classification System (see publication).

e) A report on the Saskatchewan GIS pilot project was completed and circulated to committee members for review.

f) Committee met January 22 to review the curriculum of the Biological Sciences Renewable Resources Option.

g) The Ecological Classification Task Force has met several times to draft a terms of reference for future site classification work in Alberta.

h) Attended meeting of caribou working group in Jasper January 12, 1990 and reported on the predictive site classification mapping initiative which is of interest to the committee from a caribou habitat perspective.

i) Accepted position an CIF/RMS Executive Council.

9. The predictive site classification mapping study has been pursued with the forest industry to solicit necessary funds CanFor (Grande Prairie) and Millar Western Industries (Whitecourt) provided room and board for a ForCan field crew to do work on two pilot areas as ground-truthing for the study.

10. Continued to coordinate NOR-02 activities and do necessary administrative work.

11. Some draft material on the economic benefits of site classification has been prepared but needs to be further developed.

12. Assistance in data analysis and same additional field checking was accomplished to help refine the site productivity classes.

13. The Torch River site maps and related information processing are awaiting the hiring of a GIS technician.

14. Site classification field workshops were prepared and delivered in cooperation with K. Jones, ARC for staff of Canfor (Grande Prairie) Millar Western Industries (Whitecourt) and Blue Ridge Lumber (Whitecourt).

15. Prepared poster "Canadas Northern Forests" in cooperation with D. Kuhnke and D. Allan. for XIX IUFRO congress on behalf of SI.05-12 working party.

16. Participated in Green Plan background - information session Regina and consultation a session (wildlife) in Calgary.

17. Participated in CIF - AGM Fredericton - FSTB and Ecology Working Group.

18. Participated in the RRTC, PHSP workshop at Whitecourt by selecting training site and serving as an instructor in classroom and field.

19. Presented invited talk to CIF/RMS Slave Lake meeting September 14.

20. Presented invited lecture to E. MacDonald's ecology class October 31, 1990.

21. Duties related to management of Forest Resources Program:

    a) A poster for the Aspen Symposium November 20-21 was prepared with input from Forest Resources staff. A contract for a facilitated workshop to move fully develop the Mixedwood Management Decision Support System has been initiated.

    b) Forest Resources representative on Space Committee.

    c) Participated in preliminary negotiations of research component of the Canada-Manitoba forest partnership agreement.

    d) Initiated staffing actions on Resources Program vacancies.

12. Present Status of Study:

The study is completing goals related to silviculture carried over from NOR-10 and is starting new initiatives related to GIS, remote sensing and decision support tools within the context of mixedwood management.

13. Goals for 1991-92:

1. Prepare Forest Management note on the characterization of highly productive white spruce sites in the region.

2. Publish paper in Forestry Chronicle: "Forest site Classification in Alberta - Its evolution and present status" to be included in a compendium compiled by the ForCan Site Classification working group.

3. Publish paper "Forest understory plants as predictors of lodgepole pine and white spruce site quality in west-central Alberta, Canada" by W.L. Strong, P.J. Pluth, G.M. LaRoi, I.G.W. Corns.

4. Coordinate Mixedwood Management Decision Support System team and development of a more fully developed conceptual model.

5. Revise and publish paper on plant succession 24 years after clearcutting in Alberta as information report or journal article.

6. See the publication of the Field Guide to Forest Ecosystem of South Western Alberta through to completion.

7. Prepare in cooperation with K. Jones, ARC a chapter "Site classification systems for predicting productivity decline" to be included in International Energy Agency Book" Impacts of harvesting on long-term productivity."

8. Continue evaluation of remote sensing methods in site classification:

a) Assist in logistics of winter/spring CCRS coordinated SAR slights for Whitecourt study area. Interpret multi-temporal RADAR images for utility in site classification mapping.

b) Draft Forest Management Note on evaluation of MEIS imagery to discriminate site classes.

9. Draft manuscript on the evaluation of synthetic mulches to control grass competition with planted white spruce.

10. Committee involvement:

a) Continue chairmanship of national CIF Ecology Working Group and member of CIF Forest Science Technology Board.

b) Continue to act as regional Scientific Authority for revised "Trees in Canada" book.

c) NAIT Biological Sciences (Renewable Resources Option) curriculum advisory committee.

d) Alberta Ecological Classification Task Force.

e) West central Alberta caribou technical working group.

f) Member CIF/RMS Executive Council.

g) Participate on AFS Regeneration Standards Task Force at request of AFS.

h) Participate on committee reviewing revised Ecoregions of Alberta map project at request of LISD.

11. Continue development of predictive site classification mapping project with forest industry in regions and incorporate it as an integral part of the mixedwood management DSS.

12. Provide leadership to NOR-02 project.

13. Continue with input and analysis of Torch River Forest (Saskatchewan) data for GIS input and analysis in cooperation with R. Hall.

14. Participate in Forest Science Technology Board and Ecology Working Group meetings at CIF/AGM Toronto.

Goals for Dr. I. Dymock carried from NOR-12-01 (terminated)

1. Complete publication of manuscript "Early accelerated growth in conifers: I. Supplemental light and photoperiod effects in lodgepole pine" currently under review by Can. J. For. Research.

2. Complete writing of manuscript "Early accelerated growth in conifers: II. Growth regulator effects in lodgepole pine" and submit for review in a refereed scientific journal.

3. Complete writing of manuscript "Influence of temperature and duration of exposure during rapid freezing of containerized lodgepole pine seedlings" and submit for review in a refereed scientific journal.

4. Complete writing of manuscript "Environmental factors affecting overwintering success of containerized lodgepole pine seedlings" and submit for review in a refereed scientific journal.

5. Supervise collection of growth, flowering and environmental data on 3140 accelerated growth study trees in NoFC nursery by NoFC staff/students.

6. Evaluate all remaining data on overwintering in white spruce, black spruce, jack pine, and red pine. Discuss publication options/strategies/goals with Project Leader and Program Director. Initiate writing of designated manuscript(s).

7. Evaluate all remaining data on accelerated growth in lodgepole pine, white spruce, jack pine and black spruce (both greenhouse and outplanting data). Discuss fate of nursery studies/publication options/strategies/goals with Project Leader and Program Director. Initiate writing of designated manuscript(s).

8. Provided consultative services in response to NoFC/FORCAN Northwest Region staff and client requests on matters concerning tree physiology and nursery management and tree improvement practices.

14. Publications 1990-91:

Kuhnke, D.; Corns, I.G.W.; Allan, D.T. 1990. Canada's Northern Forests. Poster presented at IUFRO XIX World Congress, Montreal on behalf of IUFRO Working Party SI.05-12 Northern forest silviculture and management.

Forest Resources Staff. 1990. Mixedwood management decision support systems. Poster presented at Aspen Symposium Edmonton November 20-21 and at ForCan Modelling/Climate change working group meeting, Kananaskis December 13-14, 1990.

Strong, W.L.; Oswald, E.T.; Downing, D.J. (editors). 1990. The Canadian Vegetation Classification System. Sustain Dev. Corp. Policy Group., Environ. Can., Ecol. Land Class. Series No. 25. (Corns credited as a contributor through National Vegetation Working Group).

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: 1984 Completion:

17. Resources 1991-92:

A-base

PYs:	Prof.:	Corns	1.0
		Dymock	0.3
		Knowl. Eng.	0.6 (vacant)
	Tech.:	Allan	1.0
	Total:		2.9
	Term Student:		0.3

O & M: $14,200
Capital: Nil

18. Signatures:

Investigator

A/ Program Director, Resources

Regional Director General

NOR-2-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 14, 1991

1. Project: GIS - Forest Inventory and Site

2. Title: Interpretation and Mapping

3. New: Cont.: Term: X 4. No.: NOR-2-03

5. Study Leader: W.C. Moore

6. Key Words: Inventory, ecosystem, remote sensing, mensuration, Alberta Forest Service (AFS), Memorandum of Understanding (MOU), Canada Centre for Remote Sensing (CCRS), Geographic Information System (GIS), transect, and permanent sample plot (PSP)

7. Location of Work: Northwest Region

8. Problem Analysis:

Forest demand, ecological concerns, remote sensing technologies, and GIS developments to support decision-making have all increased in importance in the past decade. Public concerns with the first two factors appear to have generated requirements for the latter two for the efficient management of forest lands in particular. Forestry Canada remote sensing applications research is particularly appropriate for determining optimum means of updating area information for GIS data bases, and for developing new information for the monitoring and appraisal of forest resources in cooperation with governments, industries and academic institutions.

9. Study Objectives:

1. To provide advice and prescriptions by analyzing, developing, coordinating and applying regionally unique forest interpretation and mapping methods for appraising and monitoring changes in the forest resource in an efficient manner with NoFC colleagues, federal agencies, provincial governments, educational institutions and industries.

2. To support GIS and Site, Forest Ecology and Soils, Silviculture and Environmental Impacts research and development, and the development of mixedwood management decision support systems.

10. Goals for 1990-91:

1. Publish paper on R&D accomplishment evaluation.

2. Publish paper on ER-2 high altitude reconnaissance in Alberta.

3. Coordinate and further develop regional ER-2 operations under the MOU between Forestry Canada and the U.S. Forest Service.

4. Help assess harvesting impacts on mixwood sites, and applications of blow-down risk criteria, using large-scale airphotos. (NOR-10-03)

5. Assist in the stratification of life-table transects into productivity classes for lodgepole pine using airphoto interpretation. (NOR-10-08)

6. Jointly present paper, with Tim Polzin of Alberta Forestry, Lands and Wildlife, on the cost-effectiveness of ER-2 survey for Alberta at the International Society of Photogrammetry and Remote Sensing, Commission VII, symposium in Vancouver, August 1990.

7. Present poster paper on ER-2 applications at the Aircraft in Agriculture and Forestry - Future Needs symposium and trade fair in Winnipeg, October 1990.

8. Examine digitized high resolution optical bar camera film for hardwood differentiation by digital image analysis for AFS.

9. Examine digitized high resolution optical bar camera film for ten-year regeneration appraisals with AFS.

10. Prepare for designated investigator participation in the European ERS-1 radar satellite program through documenting the Whitecourt test site with existing radar imagery in cooperation with AFS.

11. Accomplishments in 1990-91:

1. Paper, W. Moore and R. Newstead, "Evaluation of research and devleopment accomplishments: Northern Forestry Centre", in press for 1991 publication in the Canadian Journal of Program Evaluation.

2. Paper, W. Moore and T. Polzin, "ER-2 high altitude reconnaissance: a case study", published, Forestry Chronicle.

3. A second ER-2 demonstration flight, 12 Aug. 90, covered lines frmo the border, immediately west of 114° West Longitude, and to 56° 30' North Latitude under the Forestry Canada/U.S. Forest Service MOU. It passed over Calgary and the Slave Lake

FMA. It was a test of different cameras and film emulsions. Our Alberta Forestry, Lands and Wildlife clients, who paid for the flight, specifically declined digital imagery options. The Alberta ER-2 Committee is now examining the results.

4. preliminary harvesting impact assessment through large-scale airphoto interpretation, and through digitizing medium-scale ER-2 optical-bar camera airphotos for digital analyses, have been examined. A digital imagery analysis cnotractor from the west coast is devleoping similar techniques, and optical bar film of hte B.C. Flathead Provincial Park area has been loaned to EarthProbe Systems Limited for investigation. The most practical method examined to date is the video fire spread mapping system devleoped for NoFC Fire Management.

5. Working contacts with three survey contractors for development of cost-effective options with optical bar film are being discontinued.

6. Joint paper was cancelled by Alberta, and the principal concentration at the Symposium appeared to be the sophistication of expensive high technology rather than cost-effectiveness.

7. Paper was withdrawn from the Aircraft in Agriculture and Forestry -- Future Needs Symposium and Trade Fair in Winnipeg, October 1990.

8. Digitizing high resolution optical bar camera films for hardwood differentiation has been cancelled.

9. Preliminary examinations of digitizing high resolution optical bar camera films for digital image analyses for regeneration appraisals have indicated some potential, and this goal has been combined with harvesting impact assessments (goal 4) above.

10. Preparations for designated investigator particpation in the ERS-1 radar satellite program has been turned over to the Project Leader.

12. Present Status of Study:

1. Develop up-to-date, location-specific, and cost-effective inputs to GIS as management systems with particular emphasis on the proposed Boreal Forest Experiment in Wood Buffalo/Prince Albert National Parks.

   Start: 1990 Finish: 1991

2. Develop and transfer technology of NASA ER-2 aircraft operations for base map and natural resources (principally forest) inventory map updating as GIS inputs throughout the Region.

   Start: 1988 Finish: 1991

Progress to 1989:

1. Hardware and software of ENFOR GIS at NoFC has been operationally used to digitize example forestry maps from each of the political jurisdictions within the region;

appropriate stand and stock tables were entered for biomass computations; and, "Computer mapping for biomass inventories", presented at the 1983 Sixth International Symposium on Automated Cartography. Info. Rep. NOR-X-285 (1987), "A mapping and analysis of resources system application", applies.

2. Initiated a GIS information exchange meeting for regional forestry authorities in Prince Albert with Regional Development Program support, which enhanced provincial GIS implementation for forestry.

3. Served on the GIS R&D Sub-Committee to the Alberta Energy and Natural Resources Ministerial Advisory Committee, and participated in the preparation of recommendations for the Final Report.

4. Completed ENFOR contract supervision for non-inventoried forest land sampling across the Region, and proposed/completed supplementary work for prairie forest land area determinations from Landsat imagery.

5. Demonstrated change monitoring techniques of Procom-2 Landsat imagery interpretation and mapping equipment at Alberta and Saskatchewan workshops in Edmonton and Saskatoon, as well as presenting such techniques to international visitors at NoFC. Presentations in Winnipeg and Yellowknife followed (1987/88). Forest Management Note, No. 32, "Procom-2 mapping technique for monitoring forest depletion" applies.

6. Job creation through participation as a manager in the Environment 2000 Program provided a supervisor and eight assistants to reproduce Northwest Territories summary forest inventory maps and to provide manpower assistance for joint projects at AFS and NoFC.

7. Participated as an active member of both the CFS Working Group on Remote Sensing and the Alberta Advisory Committee on Remote Sensing, which included serving on the Organizing Committee for the Tenth Canadian Symposium on Remote Sensing.

8. Coordinated very successful ER-2 high altitude aircraft demonstration flight and training workshop by U.S. Forest Service experts for the AFS and others under the Canada-Alberta Forest Resources Development Agreement and the Canada-United States MOU for forestry.

13. Goals for 1991-92:

Nil

14. Publications 1990-91:

Moore, W.C.; Polzin, T. 1990. ER-2 high altitude reconaissance: a case study. Forestry Chronicle 66(5):481-486.

Moore, W.C.; Newstead, R.B. 1991. Evaluation of research and devleopment accomplishments: Northern Forestry Centre. Canadian Journal of Program Evaluation. (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: 1983 Estimated Completion: 1991

17. Resources 1991-92:

Terminated

18. Signatures:

Investigator

r/ Program Director, Resources

Regional Director General

NOR-02-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: GIS, Forest Inventory and Site

2. Title: Development and application of remote sensing and GIS analysis techniques to forest resource problems

3. New: Cont.: X 4. No.: NOR-02-04 (formerly NOR-4-07)

5. Study Leader: R.J. Hall

6. Key Words: inventory, mensuration, remote sensing, Geographic Information Systems (GIS), pest damage, vegetation damage, large-scale photography (LSP), aerial photography, photogrammetry, satellite imagery, digital image analysis, statistical analysis, technology transfer, microcomputers

7. Location of Work: Northwest Region and Yukon Territory

8. Problem Analysis:

Rising costs in acquiring inventory data for both mensuration and monitoring of pest damage, have resulted in a need to develop cost-effective systems or techniques, to replace or augment conventional ground surveys. This calls for the development, regional adaptation, and modification of systems, both hardware and software, to provide user agencies with the tools to more efficiently acquire and interpret resource inventory data. Remote sensing techniques, particularly the use of large-scale aerial photos and digital analyses, are playing increasing roles in inventory surveys. In addition, beyond investigations of image data from new resource satellites and airborne scanners, consideration needs to be given for possible integration into Geographic Information Systems (GIS). Challenges are in integrating systems design and adapting new techniques for regional inventory applications and technology transfer.

Progress and Achievements: Up to Prior Year

1. A computer-based, large-scale, aerial camera system has been developed. A second system was built for Yukon NAP and training & assistance was provided. A technology transfer agreement with the RCMP has been arranged to assist in the construction of their sytem.

2. LSP applications development work have included regeneration assessments, timber inventory, slash volumes on cutovers, log pile volumes on millyards, and comparison of existing models for estimating dbh. Regeneration assessment methodology was adapted for Sask/Weyerhaeuser project, work on optimizing exposure/processing parameters has been undertaken, and preparations begun for evaluation of jack pine budworm damage appraisal.

3. Computer-based photo measurement system constructed and much measurement/analysis software has been written. Several programs have been transferred to client agencies upon request and summary reports are being prepared for publication. IBM PC compatible has been integrated into the Project.

4. Both analogue and digital image analysis techniques have been developed or applied to regional projects: pest damage (tent caterpillar), clearcut mapping, and broad forest covertype mapping. Special image enhancements using MEIS data for covertype discrimination has been completed, with adaptation for bpop/taspen initiated. There is increasing activity and enquiries for applications as these high technology developments continue.

5. There has been participation in numerous seminars, workshops, courses, symposia, and committees. Examples of committee participation have included the Forestry Working Group of the Canadian Advisory Committee on Remote Sensing, ForCan Remote Sensing Working Group, Scientific & Technical Committee of 9th Cdn. Symposium on Remote Sensing, and Organizing Committee of 10th Cdn. Symposium on Remote Sensing. 20 reports have been published and 4 file reports written.

6. Contribution made to the 3rd editon of Forest Inventory Terminology which was published during 1989.

7. Comprehensive statistical evaluation of LANDSAT TM, MSS, airborne RADAR, SPOT PLA & MLA for forest cutover mapping has been completed for the AFS in cooperation with CCRS and Intera.

9. Study Objectives:

1. To assess, develop and apply new remote sensing & interpretation (digital image analysis, large-scale photo) techniques in the inventory and monitoring of forest resources in the region, with consideration for GIS integration.

2. To provide advisory and technology transfer services in the acquisition, uses, analyses of remote sensing imagery, mapping, survey design, GIS, microcomputers, and in the operation of interpretation equipment.

3. To enhance and maintain a comprehensive image acquisition, image analysis, and GIS laboratory for cooperative studies.

10. Goals for 1990-91:

1. Continue on PhD program and complete course requirements. Technical assistance will be used for data preparation from LSP and field data, processing site classsification work, interpreting photos, and using the GIS to produce digital damage maps. A fully detailed research plan to meet academic requirements will be prepared and both image and GIS processing will be initiated. Site classification maps will be produced for use by current study and 02-01. (Hall, Siltanen, Allan)

2. M/S reviews from:
Hall, R.J., R.V. Dams, and L.N. Lyseng. Forest cutover mapping from SPOT satellite data.

Dams, R.V., R.J. Hall, and F.J. Ahern. Forest cutover mapping from X-band SAR.

Hall, R.J., and L. Fent. Relating forestry interpreter preference to aerial film densitometric parameters.

Aldred, A.H. and R.J. Hall. Forest regeneration appraisal with large-scale photography.

Kruger, A.R. and R.J. Hall. PC system configurations and operations for GIS and image analysis. in prep for GIS '90.

3. LSP activity: Test sample rolls of NEW AGFA color films in cooperation with AFLW and Elk Island National Park. Aircraft cost is to be paid by Parks. This effort serves the purpose of both testing the new films and on-the-job training for Siltanen and Ogilvie on camera system installation and operation with very little hard expenditures. (Siltanen, Ogilvie, Hall)

4. Maintain NoFC camera system and maintain contact with the RCMP to assist them in their assembly of a camera system for aircraft accident investigation. Fully assess funding requirement and work with Yukon to pursue STA aeronautical approval. (Siltanen)

5. Maintain remote sensing/GIS laboratory and related computer equipment. Finalize FMN "Two-way ASCII file transfers between IBM and HP microcomputers", and complete HP software information report. Translate several HP programs to IBM: flight planning, sun angle table computations, and shim size due to client requests: Saskatchewan Forest Inventory Division, Yukon NAP, and RCMP. (Kruger)

6. Initiate preparations and develop research plan of applications for evaluation and analysis of ESA ERS-1 RADAR data for mapping forest cutovers in cooperation with the Alberta Forest Service, PNFI and CCRS. (Siltanen, Hall)

7. Provide advisory services in remote sensing, forest inventory, and GIS to NoFC clients and colleagues as required and particularly:

   a) assist NOR-02 project staff with GIS projects and programming needs (Kruger); TRANSFER 0.4 MAN/YEAR TO NOR-0201

   b) assist with NoFC Library Sydney information retrieval system and management (Kruger);

   c) assist with LSP of pre- and post-burn conditions in Timmins with NOR-0502 Ogilvie study. Equipment and film expenditures to be provided; (Siltanen, Ogilvie) SUBJECT TO FUNDING APPROVAL

   d) keep abreast of GPS technology and evaluate possible integration into NoFC and remote sensing/GIS programs through consultations, contacts; provide in-house workshop and an information report; (Siltanen)

   e) attend CFIC meeting in Whitehorse and provide LSP presentation & software demos. (Hall, Kruger)

   f) manage CCRS - RESORS on-line document retrieval system on behalf of NoFC (Siltanen)

11. Accomplishments in 1990-91:

1. PhD program: Course requirements completed December '90 and candidancy exams will be undertaken in February '91. Research work in progress.

2. Status of publications:

Hall, R.J.; Dams, R.J.; Lyseng, L.N. Forest cutover mapping from SPOT satellite data. Accepted for publication, in press.

Dams, R. V.; Hall, R.J.; Ahern, F.J. 1990. Forest cutover mapping from X-band SAR. Can. J. Remote Sensing. Published

Hall, R.J.; Fent, L. Relating forestry interpreter preference to aerial film densitometric parameters. Revised and resubmitted to journal

Aldred, A.H.; Hall, R.J. Forest regeneration appraisal with large-scale aerial photographs. Accepted pending minor revisions.

Kruger, A.R.; Hall, R.J. PC system configurations and operations for GIS and image analysis. Published.

3. In June, aerial photographs of an area in Elk Island National Park proposed for burning to control hardwood encroachment were obtained. The costs were largely borne by Parks Canada and AFLW. The flight had three objectives and the project was very successful:

   1. test two new Agfa 70-mm aerial color films (Avicolor 200, Avichrome 200- provided gratis from Agfa-Gaevert);

   2. provide pre-burn photography at four scales for determining the most suitable scale for interpreting pre-burn vegetation; and

   3. provide a forum for M. Siltanen's inaugural flight and on-the-job training in operating the LSP camera system.

4. Minimal work on maintenance of NoFC camera system and maintenance of contact with RCMP in their assembly of a camera system due to departure of technician to another project. Drawings and advice has been provided in response to a request by CCRS who are building an airborne radiometer system for a helicopter.

5. FMN published as FMN #49. HP software information report and several HP-IBM program translations will not be completed due to departure of Kruger to another project.

6. Participation in ESA ERS-1 RADAR study with PNFI and CCRS withdrawn at present due to departure of technician and efforts on PHD.

7. Advice and assistance provided to clients and colleagues as required, and two manuscripts (Arctic, Canadian Journal of Remote Sensing) were reviewed. Significant activities included:

   - Fire project (NOR-0502) Ogilvie utilized the camera pod and radar altimeter for a second season in Ontario. Also, photography of logging residues were obtained by Siltanen for assisting them in evaluating alternative ways of quantifying fuel loadings on the ground. Current limitations of time and money do not permit adequate assessment to desired precision limits. Current efforts for digital and analogue assessment of the photography are limited due to lack of staff. Alternatives are being explored since considerable aircraft and film processing expenditures were undertaken by GLFC (~$9000).
   - Assistance in configuring PC's for GIS using a memory manager was provided to the University of Manitoba.
   - Background statistical material and data for a lab exercise using discriminant analysis was provided to UBC forestry in their planning of a new graduate multivariate statistics course.
   - Assisted in preparation of lecture materials for lectures in photogrammetry (Forest Engineering 201) and Intro to GIS (Forestry 310).
   - Contributing considerable statistical design advice to two aerial photo interpretation and usage studies being conducted by L. Fent, AFLW.

12. Present Status of Study:

Several papers listed in the publications section were either completed, published, or revised and resubmitted to the journal. Due to departure of two staff, existing projects that they were participating in have been terminated or temporarily put on hold. Further progress on the PhD program was made including completion of course work and candidancy exams set for February '91. Much of the research work will be undertaken during 1991. The m/s presented at GIS '90 has made a moderate impact to the GIS -PC user market. Due to its significance, it has been selected for publication in a report of the best papers from all the GIS Symposia series.

13. Goals for 1991-92:

1. Continue PhD program with emphasis on the research work pertaining to the dissertation. Make a trip to Prince Albert to conduct fire history study of both Torch River and Fort a la Corne Provincial Forests relevant to the thesis. (~10 days). Further field work to check forest stand descriptions relative to the forest cover map is possible in order to derive map accuracy estimates.

2. M/S reviews from:

   Hall, R.J.; Dams, R.V.; Lyseng, L.N. Forest cutover mapping from SPOT satellite data. Int. J. Remote Sensing. in press.

   Hall, R.J.; Fent, L. Relating forestry interpreter preference to aerial film densitometric parameters.

   Aldred, A.H.; Hall, R.J. Forest regeneration appraisal with large-scale aerial photographs.

3. Provide advisory services in remote sensing, forest inventory, and GIS to NoFC clients and colleagues as required and particularly:

   a) assist NOR-0502 (Ogilvie) as needed in the use of the camera pod and radar altimeter in the Ontario fire behavior study.

4. Initiate study with Alberta Forestry on resolution of the hardwood discrimination problem. Conduct problem analysis, experimental design, and determine spectral/densitometric analysis requirements.

14. Publications 1990-91:

Dams, R.V.; Hall, R.J.; Ahern, F.J. 1990. Forest cutover mapping from X-band SAR. Can. J. Remote Sensing 16(2): 2-7.

Hall, R.J.; Dams, R.V.; Lyseng, L.N. Forest cutover mapping from SPOT satellite data. Int. J. Remote Sensing. in press

Hall, R.J.; Hiscocks, P. 1990. A microcomputer-based camera control system. Photogramm. Eng. Remote Sensing. 56(5): 443-446.

Hall, R.J.; Kruger, A.R. 1990. Two-way ASCII file transfers between IBM and HP microcomputers. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Forest Management Note No. 49.

Kruger, A.R.; Hall, R.J. 1990. PC system configurations and operations for GIS and image analysis. Pages 319-326 in Proc. GIS '90, Making it Work. For. Can., Pac. For. Cent., Victoria, B.C. FRDA Report 107.

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: 1981 Estimated Completion: 1995

17. Resources 1991-92:

PYs:	Prof.:	Hall	1.0 (LTT at Univ. of Alberta)
	Tech.:		
	Total:		1.0
	Term/Student:		0.3

O & M: $ 10,000

Capital: $ 1400 (tape drive controller cards)

18. Signatures:

Ron Hall
Investigator

A/ Program Director, Resources

Regional Director General

NOR-2-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Geographic Information Systems, Forest Inventory and site

2. Title: Ecological and site processes: modelling site productivity and the effects of different forest management alternatives.

3. New: Cont.: Term: X 4.No.: NOR-02-05

5. Study Leader: M.J. Apps, H. Grewal

6. Key Words: Ecosystem modelling, resource management modelling, nutrient cycling, nutrient dynamics, mixedwood, aspen, artificial intelligence, AI, GIS, biogeoclimatic, site productivity, site classification, climate change, Greenhouse effect, FORCYTE, STEMS

7. Location of Work: Northwest Region

8. Statement of Problem:

This study incorporates many of the goals of NOR 12-07 (Ecosystem and nutrient cycling modelling) as well as some of NOR 04-02. While the former study was primarily focussed on the FORCYTE-11 model and the ecological factors included in that model, the current study more specifically addresses resource management questions based on these and other ecological factors within the framework of the new project of GIS: forest inventory and site productivity.

In the late summer of 1990, this study was terminated due to a change in the structure of the Resources Program and shifts in regional and national priorities. The objectives of the study were subsumed within those of the new climate change study (objectives 1 and 2) and the restructured Resources program (objective 3). Ten of the 11 specific 1990-91 goals were met under NOR-2-05 or within the aegis of the studies NOR-28-07 or NOR-[16-] into which they were transfered. Only one goal was dropped due to its deemed reduced relevance to the new priorities.

9. Study Objectives:

   1. To develop methods of integrating existing ecosystem knowledge to forcast changes in growth determining variables (nutrients, light, moisture, temperature, and others) which are caused by resource management and natural environmental changes.

   2. To develop methods of relating the response of the forest ecosystem to changes in these variables, with particular emphasis on forest site productivity.

   3. To assemble user friendly tools which translate these predictions into readily interpreted results for use in forest resource management decisions, by developing and maintaining expertise in the latest modelling technologies (including GIS and artificial intelligence systems).

10. Goals for 1990-91:

    1. Develop expertise in new modelling technologies (AI systems, GIS, OOPS and other new computer languages) by attending workshops, symposia and self-directed tutorials as available. Participate in developing applications to mixedwood managment (e.g. adaptation of Rauscher's RP-FMAS and AS-FMAS expert systems for red pine and aspen management respectively).

    2. Provide national leadership for the orderly termination of the FORCYTE-11 project by providing national coordination and leadership to ensure:

       a. publication of the "FORCYTE-11 User's Manual" and "The scientific foundations .." between Forestry Canada covers (ENFOR)

       b. publication of Forestry Canada's technical and scientific evaluation of FORCYTE-11, and by organising a final FORCYTE-11 User's group workshop (April) at Kananaskis(?) in April. (Apps, ENFOR funds)

    3. Participate in the IUFRO Congress 1990 at Montreal and prepare the following presentations:

       a. "Evaluation of benchmark FORCYTE-11 ecosystem simulation model." (Apps)

       b. "Using FORCYTE-11 to examine the medium- and long-term effects of mixedwood management in western Canada." (Grewal, Apps, MacIsaac)

       c. "Forest ecosystems in Canada: a net source or a net sink of carbon?" (Apps, Kurz)

    4. Continue the development of DSS tools and utilities (including releasing a generic version of PROBE) for the use with simulation models for mixedwood forest management applications. (Apps, Grewal)

    5. Participate in the National conference "Canada's forests: growth, depletion, balance" at Victoria in June 1990 by preparing a poster paper on FORCYTE-11 and its application to mixedwood forest management. (Grewal, Apps, MacIsaac)

6. Participate in Forestry Canada Modelling Working Group (Forest Mangement Systems Working Group?). Organise the next meeting and workshop at Edmonton in Fall 1990 or Spring 1991. (Apps)

7. Publish the information report on STEMS as it related to stand tending of jack pine and aspen.(Grewal)

8. Update the assessment of biomass productivity in 6-year-old aspen cutovers near Calling Lake and Slave Lake. Prepare manuscript for publication of results. (Grewal - ENFOR funds)

9. Participate as a Canadian representative on the international Science Steering Committee for the NASA-CANADA Boreal Forest Experiment BFE Science Steering Committee.

10. Participate in and act as scientific authority for phases 2 and 3 of the "Annual Carbon Budget of the Canadian Forest Sector". Develop a simulation model to evaluate the effect of alternative forest management strategies and for different postulated changed climatic conditions. (Apps, ENFOR Funding)

11. Act as member (or alternate to Steve Zoltai) on the new Forestry Canada Climate Change Working Group. Act as liaison with the ForCan Modelling Working Group. (Apps)

11. Accomplishments in 1990-91:

1. Prior to termination of this study, initial work on this goal included participation in a workshop on a workshop on adaptation of preliminary framework for an NWR AI framework. Self-directed acquisition of new computer language skills (AI, object -oriented programming, etc.) contiuned as time permitted. (Grewal, Apps)

2. This goal was fully met:

   "FORCYTE-11 User's Manual for the benchmark version", was completed, reveiewed, printed and given limited distribution (upon request). Authors: Kimmins, Scoullar and Apps.

   "The Scientific Foundations of FORCYTE-11" has been prepared, undergone scientific review and is awaiting editing for publication as an ENFOR funded Information Report. Author: Kimmins.

   A FORCYTE-11 User's meeting was organised by M. Apps and held in Kananaskis in April 1990.

3. Both Apps and Grewal attended the XIXth IUFRO World Congress in Montreal and presented 3 poster displays which were well received:

   a. Apps: "Evaluation of benchmark FORCYTE-11 ecosystem simulation model."

   b. Grewal and Apps: "Using FORCYTE-11 to examine the medium- and long-term effects of mixedwood management in western Canada."

c. Kurz, Apps, Webb and MacNamee: "Forest ecosystems in Canada: a net source or a net sink of carbon?"

4. Completed the PROBE software and preparation of a User's Manual to be reviewed for publication as an ENFOR funded Information Report (Apps, Kurz and MacIsaac)

5. Grewal participated in the National conference "Canada's forests: growth, depletion, balance" at Victoria in June 1990. A poster paper on FORCYTE-11 and its application to mixedwood forest management was prepared and presented (Authors: Grewal and Apps).

6. Grewal and Apps organised and participated in the Forestry Canada Modelling Working Group Workshop at Kananaskis in December, 1990.

7. Goal dropped upon termination of the study. A draft manuscript on STEMS as it relates to stand tending of jack pine and aspen was prepared by Grewal, but the subject matter was determined to be of lower priority than the challenges of the new study when NOR-2-05 was terminated due to changes in priorities.

8. Goal completed; reported under NOR-28-07 (ENFOR).

9. Goal transferred to NOR-16 where it is more fully documented.

10. Goal transferred to NOR-16 where it is more fully documented.

11. Goal transferred to NOR-16.

12. Present Status of Study:

Study terminated in summer of 1990 and objectives incorporated within the other studies in NOR-2 and NOR-16 (see Statement of Problem above).

13. Goals for 1991-92:

Study Terminated and remaining incomplete goals and unfulfilled objectives transferered to NOR-16 and other studies within NOR 02.

14. Publications 1990-91:

These are reported in NOR-28-07 (ENFOR) and NOR-16.

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:

Starting Date: Completion date: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

A/Program Director, Resources

Investigator

Regional Director General

NOR-02-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Geographic Information Systems, Forest Inventory and Site

2. Title: Provenance tests for coniferous species

   Experiment a. (Formerly MS187, PNFI 93-I) Provenance experiments with the white spruce of Manitoba and Saskatchewan.

   Experiment b. (Formerly MS089, PNFI 96-J) Red pine (Pinus resinosa) provenance experiment.

   Experiment c. (Formerly MS088, PNFI 201-F/G/H) Scots pine (Pinus sylvestris) provenance experiment.

   Experiment d. (Formerly MS234, PNFI 200) A test of twelve Norway spruce provenances from northern Europe and Siberia --Riding Mountain Research Area.

   Experiment e. (Formerly MS019) All-range jack pine provenance experiment, Manitoba-Saskatchewan sub-experiment.

   Experiment f. (new) Geographic variation in black spruce, Northern Region component.

3. New: Cont.: X 4. No.: NOR-02-06 (formerly NOR-12-02)

5. Study Leader: J.I. Klein

6. Key Words: Geographic variation, seed sources, seed zones, Alberta, Manitoba, Saskatchewan, exotic species, Picea abies, Picea glauca, Picea mariana, Pinus banksiana, Pinus resinosa, Pinus sylvestris

7. Location of Work: Wasagaming, Vassar, Piney, Mafeking, Lonesand, and Carberry, Manitoba; Holbein, Indian Head, and P.A. Pulp Camp 6, Saskatchewan; Reno, Alberta

8. Problem:

This study comprises provenance experiments with six conifer species. Five are sub-experiments of cooperative investigations initiated by Petawawa Forest Experiment Station. The white spruce experiment was initiated by the District Forest Officer in Winnipeg.

Each experiment consists of one or more plantations containing populations of one species but of varying geographic origin, arranged in a replicated design. Populations are compared within experiments on the basis of mean performance at periodic observations, usually on survival and growth plus other traits deemed appropriate for a particular experiment. The outcomes of the comparisons are used to draw inferences about (1) the productivity of the tested populations for planting in similar environments, (2) the usefulness of further provenance testing with the same species, (3) patterns of geographic variation, or (4) the value of the tested populations for breeding.

9. Study Objectives:

1. To screen populations of conifer species for possible usefulness for planting in various areas within the Northern Region.

2. To obtain an indication of the probable usefulness of further provenance testing or similar research with the species under trial and to guide the planning of such research.

3. To obtain information on patterns of geographic variation in the species under trial.

4. To identify adapted genotypes among the introduced populations for further breeding use.

10. Goals for 1990-91:

Jack Pine:

1. Publish the Forest Management Note entitled "Survival and growth of jack pine provenances in Manitoba".

Black Spruce:

1. Tend the Manitoba plantation, and the other plantations as required.

2. Verify and document location, layout, and stocking in all plantations.

3. Measure height and diameter and score condition in all plantations after the 16th growing season from planting.

11. Accomplishments in 1990-91:

Jack Pine:

1. Forest Management Note No. 50 entitled "Survival and growth of jack pine provenances in Manitoba" has been published. This experiment is now completed.

Black Spruce:

1. Funding and technical support were not available, and no work was done on the three goals of tending, layout verification, and measurement.

12. Present Status of Study:

All objectives have been achieved as far as is possible for the red pine, Scots pine, Norway spruce, and jack pine experiments. Completion of objectives will not be feasible for the white spruce experiment. Objectives remain to be completed for the black spruce experiment. Study location will transfer to Manitoba District Office in summer of 1991.

13. Goals for 1991-92:

Black Spruce:

1. Tend the Manitoba plantation, and the other plantations as required.

2. Verify and document location, layout, and stocking in all plantations.

3. Measure height and diameter and score condition in all plantations after the 17th growing season from planting.

14. Publications 1990-91:

Klein, J.I. 1990. Survival and growth of jack pine provenances in Manitoba. For. Can., Northw. Reg. Edmonton, Alberta. For. Manage. Note 50.

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: 1955 Completion: 2000

17. Resources 1991-92:

PYs:	Prof:	Klein	0.2
	Tech:	Chapman	0.3
	Total:		0.5

O & M: $ 1,000 Additional funding from Manitoba PAIF
Capital: Nil

18. Signatures:

Investigator

A/Program Director, Resources

Regional Director General

NOR-02-07

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 8, 1991

1. Project: Geographic Information Systems, Forest Inventory and Site

2. Title: Breeding jack pine for the Northern Region

3. New: Cont.: X 4. No.: NOR-02-07 (formerly NOR-12-03)

5. Study Leader: J.I. Klein

6. Key Words: Pinus banksiana, progeny test, family test, seed orchard, forest genetics, tree breeding, artificial selection, grafting, clone bank, Manitoba, Saskatchewan, Alberta.

7. Location of Work: Lonesand, Marchand, Stead, Oakbank, and Boggy Creek, Manitoba; Smeaton, Meadow Lake, and Hudson Bay, Saskatchewan; Wildwood, Alberta.

8. Problem:

This study is the first step in an applied breeding program, intended to identify superior genotypes in base breeding populations which are samples of wild populations. These superior genotypes will be propagated for establishment of seed orchards, not necessarily within this study. Future plantations planted with the output from those seed orchards will have enhanced profitability in consequence of the genetic gain achieved under this study.

The sampling and assessment strategy chosen for this study ensures efficient use of whatever genetic variation exists in the sampled populations. No evidence was available as to the magnitude of this variation prior to study initiation.

Breeding districts were delineated in eastern Manitoba, western Manitoba to eastern Saskatchewan, and central Saskatchewan to eastern Alberta. In each breeding district, family tests were established on representative sites, using open-pollinated progenies of parent trees selected primarily within each district. Each family test includes more than 200 progenies in replicated test plantations.

The tests are measured and data analyzed periodically for elucidation of genetic variation patterns within populations, selection of superior genotypes, and estimation of genetic gain from selection. When appropriate, new trees are produced from selected trees in the test plantations or the clone bank, by grafting or controlled breeding, for establishment of seed orchards. Test results can also be applied by designating superior source locations for seed collections.

9. Study Objectives:

1. To identify wild jack pine genotypes that are genetically superior in terms of economic yield for areas of major jack pine planting activity in the Northwest Region.

2. To produce scions or control-pollinated seed of the superior genotypes for propagation of seed orchard trees.

3. To identify genetically superior source areas for seed collection.

10. Goals for 1990-91:

1. Complete service as Chairman of the Canadian Tree Improvement Association by closing financial accounts, assisting with editing of symposium papers, and disposing of meeting files.

2. Select trees in the eastern breeding district family test plantations, based on analysis of 15-year results (including the report from the 1988-89 contract as appropriate) for use as parents for controlled breeding to complete the pedigreed seed orchard and to initiate second generation breeding.

3. Produce a mating plan and plan controlled breeding among selected trees in the eastern breeding district family test plantations to produce seed orchard and breeding population progenies.

4. Collect cones and process seed from 1989 controlled breeding of superior eastern breeding district parent clones in the clone bank.

5. Select trees in the western breeding district first generation breeding population based on analysis of 15-year results for use as parents for controlled breeding to establish a pedigreed seed orchard.

6. Produce a mating plan, and plan, organize, and implement controlled breeding among selected trees in the western breeding district first generation breeding population to produce seed orchard progenies.

7. Select trees, produce a mating plan, and plan, organize, and implement controlled breeding to produce progenies for research on inheritance of response to infection by the western gall rust fungus. Provide technical advice on jack pine genetics as required for studies on western gall rust on jack pine.

8. Provide technical advice to client agencies on maintenance of jack pine family test plantations and seed orchards.

9. Draft a Forest Management Note on estimation of wood density in jack pine at 16 years from planting using the Forest Model 6-joule Pilodyn.

10. Determine the scope and authorship of the next journal publication from the family test data and begin drafting a manuscript.

11. Draft plans for second generation breeding of jack pine, for implementation by client agencies, and for publication.

11. Accomplishments in 1990-91:

1. Completed service as Chairman of the Canadian Tree Improvement Association by closing financial accounts, assisting with editing of symposium papers, and forwarding meeting files to new Chairman.

2. Selected trees in the Stead plantation of the eastern breeding district family test for use as parents for controlled breeding to complete the pedigreed seed orchard and to initiate second generation breeding. Selection was based on scoring done by Dr. F.C. Yeh (University of Alberta) using 15-year data.

3. Produced a mating plan, and planned, organized, and implemented controlled breeding among selected trees in the eastern breeding district family test plantations to produce seed orchard and breeding population progenies, in collaboration with the Tree Improvement Specialist, Manitoba District Office, and Manitoba Forestry Branch. Poor flowering and bag failures were experienced, requiring repetition of the breeding.

4. Collected cones and processed seed from 1989 controlled breeding of superior eastern breeding district parent clones in the clone bank.

5. Selected trees in the western breeding district first generation breeding population, for use as parents for controlled breeding to establish a pedigreed seed orchard, based on analysis of 15-year data.

6. Produced a mating plan, and planned, organized, and implemented controlled breeding among selected trees in the western breeding district first generation breeding population to produce seed orchard progenies, in collaboration with Saskatchewan Forestry Branch. All crosses were accomplished, expected selection gain was reported to the clients, and a computer-organized seed orchard layout was produced.

7. Selected parent trees, produced a mating plan, and planned, organized, and implemented controlled breeding to produce progenies for research on inheritance of response to infection by the western gall rust fungus. Owing to poor flowering, further controlled breeding will be required. There was no requirement for technical advice on jack pine genetics for studies on western gall rust on jack pine.

8. Provided technical advice to client agencies on maintenance of jack pine family test plantations and seed orchards.

9. Funds were not available to inspect western breeding district family test plantations to diagnose causes of poor growth of individual trees and to record actual spacing between trees.

10. A draft of a Forest Management Note on estimation of wood density in jack pine at 16 years from planting using the Forest Model 6-joule Pilodyn, is under review.

11. There is preliminary agreement on the scope of a paper on 15-year results of the eastern breeding district family test to be co-authored with Dr. F.C. Yeh. Drafting of a manuscript will commence after further progress on data analysis. Dr. S. Magnussen of PNFI was approached as a possible additional collaborator. He expressed interest, but his time is fully committed until spring 1992.

12. Funds were not available to measure the central breeding district family test at 15 years from planting.

13. A draft plan for second generation breeding of jack pine for Manitoba was submitted to Manitoba Forestry Branch for review in July, with an explicit request for review. No written response has been received. Planning for second generation breeding in Saskatchewan appears less urgent than other goals.

12. Present Status of Study:

There has been preliminary identification of superior genotypes based on 10-year performance in family tests, for all three breeding districts. Scions or control-pollinated seeds have been produced for seed orchards in every breeding district. Superior source areas have been identified in the eastern and western breeding districts.

It is likely that selection decisions based on 15-year performance will require only minor modification in light of subsequent performance. Maintenance (by client agencies) and measurement of existing family tests to 25 years is proposed in order to determine early-late correlations. Superior source areas can be identified for the central breeding district using data on hand.

Publication of the scientific findings obtained the course of the breeding work is considered to be an implicit objective which has been only partly achieved.

13. Goals for 1991-92:

1. Publish the Forest Management Note on estimation of wood density using the 6-joule Forest model Pilodyn.

2. Draft a joint publication with Dr. F.C. Yeh on 15-year results in the eastern breeding district family test. Follow up on Dr. Magnussen's availability early in 1992 and seek other potential collaborators proficient in analysis of family test data.

3. Select parent trees for 1991 pair-mating in one eastern breeding district location to produce seed orchard progenies, using the improved combined multi-trait scoring system currently under development, and assist as required in planning and implementing of mating.

4. Revise the second-generation breeding plan for Manitoba as required, including detailed planning of selection and mating of parents of second-generation progenies. Pursue publication of final plan.

5. Draft a report for publication on selection of parents and breeding of seed orchard progenies in 1990 for the western breeding district.

6. Measure the eastern breeding district family test at 20 years from planting, with collaboration from the Stand Productivity project in deriving stand productivity from individual trees arranged in small plots. Manitoba Forestry Branch have agreed to provide staff and funds.

7. Measure the central breeding district family test at 16 years from planting, if time and funds are available.

8. Attend the meeting of IUFRO working parties on "Biological Systems in Tree Breeding" in Finland in September, and if possible, the Western Forest Genetics Association meeting in Vernon, B.C. (August), and the Canadian Tree Improvement Association meeting in Ottawa (August).

9. Select trees, produce a mating plan, and plan, organize, and implement controlled breeding to produce progenies for research on inheritance of response to infection by the western gall rust fungus. Provide technical advice on jack pine genetics as required for studies on western gall rust on jack pine.

10. Grow and measure selected fast-growing, slow-growing, and average progenies (based on eastern family test results) for cooperative research on early testing.

11. Compile a database of forest genetics literature using the software product Pro-Cite.

12. Plan and initiate research on rooting stem cuttings of jack pine seedlings.

14. Publications 1990-91:

Klein, J.I. 1989. Tree improvement at the Northern Forestry Centre, 1985-1989. Proc. 22nd Meetg. Can. Tree Improv. Assoc., Edmonton, Alta., August 1989. Part 1: 126-128.

Klein, J.I.; Hiratsuka, Y.; Vescio, S.; Maruyama, P.J. 1990. Disease resistance evaluation of jack pine for western gall rust. Proc. IUFRO Conf. on Rusts of Pines, Banff, Alberta, September 1989. (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: 1967 Completion: 2001

17. Resources 1991-92:

PYs:	Prof:	Klein	0.6
	Tech:	Chapman	0.7
	Total:		1.3

O & M: $1,000 (other funding pending from Can.-Man. PAIF)

Capital:

18. Signatures:

Investigator

A/ Program Director, Resources

Regional Director General

NOR-3-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 31, 1991

1. Project: Forest Policy, Plannning and Resource Data

2. Title: Policy, planning and statistics

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

5. Study Leader: D.M. Boylen

6. Key Words: Forest resource policy; planning; integrated resource management;marketing systems, forest industry, employment/economic impacts; forest statistics, NFEP, FORSTATS

7. Location of Work: Northwest Region

8. Study Objectives:

   1. To provide socio-economic and statistical data, analyses and documentation for policy and program development of regional and national forestry research, development and technology transfer programs.

   2. To provide evaluations of the costs of integrated forest management practices, the socio-economic benefits and impact of forest sector activities in the region, to be used for development and programs such as job creation and federal-provincial Agreements.

9. Goals for 1990-91:

   Scientific/Project Authority for Contract Research

   1. Complete activities associated with FRDA research contracts.

   Regional Development analysis, Policy and Planning, Evaluation Documentation

   2. Provide socio-economic and statistical data, analysis and documentation for policy and program development for new forestry agreements in Manitoba, Saskatchewan, Alberta and NWT.

3. Co-ordinate input for development of socio-economic profiles for Agreement schedules.

4. Negotiate economic research proposals with appropriate provincial representatives for consideration of FRDA funding by developing, co-ordinating, assessing and planning various collaborative projects.

5. Develop interdisciplinary forest economics project for evaluation and management of non-timber values.

6. Continue work, as required, on Northwest Region Regional Strategic Plan.

Economics Research

7. Serve as a member on the National Task Force Review of the Economics Program

Reviews,Comments,Briefings

8. Continue to provide peer reviews/comments of journal articles, reports proposals as well as to provide briefing notes, as required.

Project Coordination

9. Continue to act as Project Leader, NOR-03.

10. Continue to serve on Senior Economists' National Forest Economics Project.

11. Complete 5 year regional strategic plans for economics program, and statistics and data analyses program.

12. Continue to represent the Program Director on the national FORSTATS Committee.

13. Coordinate regional responses to national programs such as new National Forest Data Base, national forest inventory, Annual Report to Parliament.

Added Goals

14. Assist in Green Plan and Arctic Environmental Strategy information sessions and consultation workshop as FORCAN management representative in Northwest Territories.

15. Develop a Memorandum of Understanding/Cooperation with the Department of Rural Economy, University of Alberta.

16. Develop a departmental perspective and program initiative for FORCAN as well as Northwest Region on multiple-use (integrated) resource management.

10. Accomplishments for 1990-91:

Scientific/Project Authority for Contract Research

1. Project Report #90-07 "An Economic Analysis of Wood Production on Private Forest Land in West Central Alberta" by M. Messmer, M. Percy, W. Phillips, and D. Boylen was published by the Department of Rural Economy, University of Alberta.

   G. Armstrong completed a MSc. thesis and project report " A Forest Planning Simulation Model: Integration of Transportation and Silviculture Decisions" by Glen W. Armstrong, William E. Phillips, James A. Beck,Jr., and Luis F. Constantino for the Canada-Saskatchewan FRDA. D. Boylen was the Scientific Authority.

   Reviewed and critiqued first complete draft of D. James MSc. thesis, "Socio-economic and attitudinal survey of Alberta bushowners"(Boylen)

   Reviewed final report for FERIC project #20205 "Phase II. Size, distribution and composition of process flows. Chemical Pulping Trials". (Bohning)

   Reviewed three forestry proposals from Western Diversification Office.(Bohning)
   Attended two meetings in Edmonton where results of study "Current Private Land Forestry Infrastructure in Province of Alberta" were discussed, as part of a program to develop private woodlots in the province. (Boylen)

Regional Development Analysis, Policy and Planning, Evaluation Documentation

2. Provided assistance for policy and program development and attended various meetings for new forestry agreement in NWT (and other provinces, as requested). (Boylen, Bohning)

   Represented the Regional Director-General at Canada-GNWT Economic Development Agreement policy (program) meetings. (Boylen)

3. Analyzed structure and content of other provincial PAIFs. (Boylen, Bohning)

   Wrote complete first draft of NWT Schedule A for new PAIF agreement. (Boylen)

   Wrote partial first draft of Alberta Schedule A for new PAIF agreement. (Boylen)

   Wrote partial first draft of Manitoba Schedule A for new PAIF agreement. (Bohning)

   Wrote partial first draft of Saskatchewan Schedule A for new PAIF agreement. (Bohning)

4. Collated a set of economic research proposals, proposed by all members of NOR-03 and discussed with provincial representative (G. Ardron, Manitoba Natural Resources) for consideration of Manitoba PAIF funding. (Boylen)

   Presently collating and proposing economic research proposals for Saskatchewan PAIF. (Boylen)

5. Developed objectives and work plans for Long Term 20 year integrated forest resource management plans with provincial IRM Working Groups in Saskatchewan and Manitoba. (Boylen)

Represented Forestry Canda at meetings with secondary wood-using industry to ascertain possibilities for a conference on "Value-added Forest Products Opportunities".(Bohning)

Attended initial planning meeting for an Alberta forest educational program "Focus on Forests". (Bohning)

6. Prepared final version of Regional Strategic Plan for Northwest Region, FORCAN entitled "Toward the 21st century forest" with Regional Director- General.(Boylen)

Assisted in writing a brochure for the general public on the Regional Strategic Plan. (Boylen)

Assisted with the development of a "focussed" mailing list from current NoFC lists. (Boylen)

Assisted with the translation and publication processes, generallly. (Boylen)

Economics Research, Reports and Publications

7. Served as a member on the National Task Force Review of the Economics Program. (Boylen)

Wrote Section II "Identification of Program Issues" and critiqued drafts of the report.(Boylen)

Attended conferences,workshops,seminars,courses:
- Aspen Symposium - Edmonton (Boylen, Bohning)
- RISI- The Global Democratic Revolution. Challenges and Opportunities for the Forest Products Industry - Boston. (Boylen)
- Papricourse '90 - Vancouver (Bohning)
- Environment Canada Hearings.Proposed pulp and paper regulations - Yellowknife,Edmonton, Saskatoon (Bohning)
- Waste Paper Symposium - Montreal (Bohning)
- FORINTEK. Program Update - Edmonton (Bohning)
- CIF-RMS. Free-to-Grow standards - Slave Lake (Bohning)
- 2nd International Forestry Show - Edmonton (Bohning)
- 1st Pacific Paper Expo - Vancouver (Bohning)
- Finnish Logging Seminar - Jasper (Bohning)

Organized and manned FORCAN displays:
- 2nd International Forestry Show - Edmonton (Bohning)
- 1st Pacific Paper Expo - Vancouver (Bohning)

Reviews,Comments,Briefings

8. Prepared several report and paper reviews/comments/requests for information for senior FORCAN officials (such as Minister,Deputy, ADMs,RDGs).(Boylen)

Three referred journal papers and one S&T research proposal were reviewed.(Boylen)

Supplied information on forest products industry in Northwest Region in terms of aspen use to Poplar Council for use in their Poplar Directory. (Bohning)

Read numerous trade and technical publications to increase knowledge and understanding of the forest products industry. (Bohning)

Project Co-ordination

9. Continued to act as Project Leader, NOR-03.

10. Continued to serve on Senior Economists' and National Forest Economics Project Committee.

Served on NoFC Science Committee.

11. Regional strategic plans for economics, statistics and data analysis programs were not completed due to incompletion of plans for the national economics and national forest data programs, and now, pending new project developments.

12. National FORSTATS committee was replaced by a national advisory committee.

13. Reviewed Annual Report to Parliament and provided information, as requested.

Added Accomplishments

14. Transported, set-up and manned FORCAN display booth at Green Plan and Arctic Environmental Strategy information sessions held in Inuvik and Yellowknife.

Assisted in preparation and contact of interested personnel to attend consultation workshops.

Participated in consultation workshop in Yellowknife.

Prepared summary briefing notes of information sessions and consultation workshop.

15. Held consultations with staff of Departments of Rural Economy and Forest Science, and other regioanl/HQ FORCAN staff on purpose of a Memorandum of Understanding/ Cooperation.

Held consultations with finance officers of FORCAN and U of Alberta over different funding and transfer mechanisms/options.

Drafted a Memorandum of Cooperation between Northern Forestry Centre, Forestry Canada and the Department of Rural Economy, University of Alberta, which was signed.

Drafted a contribution agreement for consideration of PAIF funding.

16. Reviewed literature on sustainable development, environmental planning, ecology, conservation and integrated resource management (IRM) programming.

Held consultations with various personnel in several university departments, government scientists and managers in FORCAN and other federal/provincial departments, industry, non-government environmental groups.

Made presentation to SRAC on need for IRM Working Group.

Developed Terms of Reference for IRM Working Group.

Prepared draft of report on IRM in FORCAN for Operations Committee presentation.

11. Goals for 1991-92:

Scientific/Project Authority for Contract Research

1. Develop and implement various interdisciplinary integrated forest resource management contract studies for Manitoba and Saskatchewan PAIFs, as agreed to by IRM Working Groups. (Boylen)

2. Develop research strategy for primary and secondary wood-users directories, forest sector industry profiles and associated publications for Northwest region. (Bohning, Boylen)

   Develop and manage PAIF contracts for these projects. (Bohning)

3. Develop and manage forest product and marketing opportunities contracts under the Saskatchewan and Manitoba PAIFs. (Bohning).

Regional Development Policy and Planning Analyses

4. Lead and implement work plan of IRM Working Groups in Manitoba and Saskatchewan for production of LT. 20 yr integrated forest resource management plans and production of general public documents on same. (Boylen)

5. Establish federal-provincial task forces for evaluation of PAIFs and negotiate terms of reference and objectives.(Boylen)

   Develop strategy for (and manage contracts, if necessary) for new evaluation frameworks of the PAIFs. (Boylen)

6. Continue to provide socio-economic and statistical data analysis and documentation for Regional Development program and PAIFs, Green Plan initiatives and other policies and programs, as required. (Boylen, Bohning)

Policy and Planning Research and Development

7. Develop and document the progress of the Northwest Region Regional Strategic Plan towards its goals and implementation of new thrusts, as well as linkage to the National Strategic Plan of FORCAN. (Boylen)

8. Continue to plan and participate in implementation of Regional Strategic Plan thrust in integrated forest resource management. (Boylen)

9. Continue to provide policy and planning analysis and documentation for Regional Development program and PAIFs, Green Plan initiatives and other new initiatives, as requested. (Boylen)

Reviews,Comments, Briefings

10. Continue to provide reviews/comments of journal articles, reports, research proposals as well as briefings.(Boylen, Bohning)

Project Coordination,Committees

11. Continue to act as Project Leader for NOR-03. (Boylen)

Develop a new project for Policy,Planning and Resource Data. (Boylen)

Continue to serve on various departmental Committees and Task Forces, as required. (Boylen)

Continue to serve on NoFC Science Committee. (Boylen)

Represent NoFC on new Integrated Resource Management Working Group that will be advisory to Senior Regional Advisory Committee. (Boylen)

12. Present Status of Study

Objective 1: The Regional Strategic Plan for Northwest Region was finalized and published. Prepared material for Schedule A for the new legal agreements of the PAIFs and participated in negotiations, meetings, as requested. Represented Forestry Canada at a large number of conferences, workshops, displays and the Green Plan activities.

Objective 2: Served on the National Task Force Review of the Economics Program, and wrote part of the report. Prepared report on integrated resource management research in Forestry Canada. Participated in planning committees for IRM 20 yr. provincial plans and projects.

13. Publications 1990-91:

Forestry Canada. 1990. Toward the 21st century forest: the Northwest Region's strategic plan. 1990-95. For. Can., Northwest Reg., North. For. Cent. Edmonton, Alberta.

Messmer, M.; Percy, M.; Phillips, W.; Boylen, D. 1990. An Economic Analysis of Wood Production on Private Land in West Central Alberta. Proj. Rep. #90-07. Can.-Alta. FRDA. For.Can., North. For. Cent. Edmonton, Alberta.

Armstrong, G.W.; Phillips, W.E.; Beck, J.A. Jr.; Constantino, L.F. 1990. A Forest Planning Simulation Model: Integration of Transportation and Silvicultural Decisions. Can.-Sask. FRDA. For. Can., Prince Albert, Saskatchewan.

14. Environmental Implications:

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

15. Duration:

Started: 1980 Completion: continuing

16. Resources 1991-92:

PYs:	Prof:	Boylen	1.0
	Tech:	Bohning	1.0
	Total:		2.0
	Term/student:		0.6

O&M: A-base : $5,000
PAIFs :
Green Plan:

Capital:

17. Signatures:

Investigator

Program Director, Development

Regional Director-General

NOR-3-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 21, 1991

1. Project: Forest Policy, Planning and Resource Data

2. Title: Forestry and socio-economic statistics and analysis

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

5. Study Leader: D.H. Kuhnke

6. Key words: Provincial, regional and national forest statistics (e.g.silviculture, growth and yield, depletion, accrual and inventory), socio-economic statistics, database management, evaluation frameworks, DEVMIS

7. Location of Work: Prairie Provinces and NWT, Petawawa NFI

8. Study Objectives:

   1. To develop and interpret forestry and socio-economic statistics at the stand, provincial, regional and national levels to further and improve forest management decision-making by resource managers and researchers.

   2. To assist in the development and implementation of project proposals, management information systems and evaluation frameworks for partnership agreements in forestry.

9. Goals for 1990-91:

   1. Complete planning and preparation of a second annual combined silviculture statistics and forest management expenditures report.

   2. Publish a technical supplement to "Forest Management Statistics in Canada, 1977-88" containing more detailed information than could be presented in the abbreviated format of the latter report. Data would be presented in a largely tabular format.

3. Initiate and manage a project to investigate the potential gains of using a stand diameter distribution model to determine the product that can be most economically produced from a given stand. Piece size, not the traditional volume per hectare, is the crucial factor in determining profitability. This project is dependent on the availability of agreement funding.

4. Continue to develop the Regional Statistics Strategic Plan. Possible elements of the strategic plan are collection of forest management expenditure data for non-CPPA forest products companies, development of a production cost data set for silviculture, a publication of regional forest sector statistics, and the 1991 national inventory.

5. Undertake a collaborative project with CPPA personnel and provincial staff from New Brunswick and Alberta to update and define the success rates of natural and artificial regeneration stated in the national silviculture reports. Recent concerns about the state of forest regeneration in Canada have raised questions concerning silvicultural success rates. The results of this pilot will determine whether the project can be extended over all provinces.

6. Conduct planning, liaison, and conversion activities for the 1991 national inventory.

7. Manage the update of information in the Forest Industry Data Management Data System, the Microcomputer PSP Catalogue (in cooperation with WESBOGY),and other databases like the Tree Detail Growth and Yield Database.

Added goals:

8. Prepare two posters for presentation at major conferences.

9. Participate in the federal Indian lands program.

10. Fulfil a variety of special requests concerning forest management statistics and practices.

10. Accomplishments in 1990-91:

1. Planning and preparation of the second forest management statistics report, titled "Forest management statistics for Canada, 1979-89", was performed. This involved a) addressing criticisms over the first forest management statistics report; b) design and distribution of new questionnaires; c) design and layout of the report and; d) preparation of production schedules; e) preparing support documents and coordinating their progression through Forestry Canada Headquarters in Ottawa.

2. The technical supplement titled " Silviculture statistics for Canada, 1977-88 - Technical supplement" was completed and is currently before NoFC editors. Publication will occur in 1991-92. This Information Report contains the sort of detailed information presented in "Silviculture statistics for Canada: An 11-year summary".

3. The investigation into the use of a stand diameter distribution model did not proceed due to a lack of agreement funding. It may be conducted as part of a larger project proposal that explores combinations of sampling design and plot allocation for forest

inventory that minimizes the cost/benefit ratio of acquired inventory data and merchandises forest stands (determines product breakdowns by species and size class).

4. Development of a regional statistics strategic plan is ongoing for completion of a first draft in 1990-91. The plan embodies many of the objectives of the National Forestry Database Program and addresses deficiencies in current forest management statistics.

5. The update and refinement of the success rates of natural and artificial regeneration stated in the national forest management statistics reports now involves every province because of the urgency and importance surrounding the presentation of reforestation statistics based on the best information available. These statistics will be incorporated into the second forest management statistics report.

6. Performed planning and liaison activities for the 1991 national forest inventory. This involved discussion and planning of strategies with provincial government officials for correcting deficiencies in the 1986 national forest inventory, and delivery mechanisms.

7. The update of information in the Forest Industry Data Management Data System (FIDMS) and other databases like the Tree Detail Growth and Yield Database was conducted,in part through direction of support personnel.

8. Prepared two posters for presentation at major conferences. One related to the deficiencies of national forest management statistics in Canada and the other to the nature of the boreal forest in Canada.

9. Participated in the federal Indian lands program through assisting the development of the ILAND management information software system. The ILAND system borrows heavily from experience gained in the development of the Microcomputer Permanent Sample Plot Catalogue (MPC).

10. Fulfilled a variety of special requests including an inquiry into thinning practices by thinning type and land tenure, areas treated and monies spent under all FRDAs for use in a ForCan headquarters Information Report, review of a draft booklet/report on silviculture terminology in Canada and National Forestry Database Program study proposals.

11. Goals for 1991-92:

1. Publish the second annual forest management statistics report.

2. Publish the silviculture statistics technical supplement titled "Forest management statistics for Canada, 1977-88: Silviculture statistics supplement."

3. Conduct planning and preparation of a third annual forest management statistics report in cooperation with the Canadian Pulp and Paper Association and Forestry Canada - Ontario Region.

4. Implement the regional statistics strategic plan in conjunction with the Northwest Region's Strategic Plan and the National Forestry Database Program.

5. Conduct planning, liaison and conversion activities for the 1991 national forest inventory.

6. Manage the update of information in the Forest Industry Data Management Data System and other databases like the Tree Detail Growth and Yield Database.

7. Act as project authority for study contracts conducted under the new Partnership Agreements in Forestry (PAIF). These contracts may include the stand merchandising forest inventory design study, and projects involving work identified under the Regional Forest Statistics Regional Plan and the federal government's Green Plan.

12. Present Status of Study:

1. Publication of the second forest management statistics report has been deferred to May 1991 due to incomplete data. Preparation of the third forest management statistics report will commence following the NFDP Steering Committee meeting in April 1991.

2. The technical supplement has also been deferred to 1991-92 due to NoFC editorial staff workload.

3. Preparation of the regional statistics strategic plan is ongoing.

4. Discussions with provincial government officials for correcting deficiencies in the 1986 national forest inventory and re-examining conversion criteria are ongoing. In Alberta, development of conversion criteria for the Continuous Vegetation Inventory (CVI) and the transfer arrangements for funding have been the focus of effort. Delays in the delivery of provincial data seem inevitable due to personnel shortages and other priorities within the provincial governments, especially Alberta's.

5. Work on FIDMS, MPC and Tree Detail Database are ongoing. Expansion of the MPC to accommodate the data requirements of the Forest Resources Group may be undertaken.

13. Publications 1990-91:

Kuhnke, D.H. 1990. What's needed to improve reforestation statistics for Canada. Poster presented at the Canada's Timber Resources Conference, June 1990, Victoria, BC.

Kuhnke, D.H. 1990. Canada's northern forests. Poster presented at IUFRO XIX World Congress, August 1990, Montreal, QU.

14. Environmental Implications:

The NoFC Environmental Screening 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.

15. Duration:

Start: 1984 Completion: Continuing

16. Resources 1991-92:

PY's: Prof: Kuhnke 1.0
Tech:

Total: 1.0

Term/Student: 0.0

O&M: $5,000 (A-base)
PAIFs:
Green Plan:
Capital

17. Signatures:

Investigator

Program Director, Development

Regional Director General

NOR-3-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 15, 1991

1. Project: Forest Resource Economics and Statistics

2. Title: Forestry development and economics research

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

5. Study Leader: W.A. White

6. Key Words: Forest economics, interdisciplinary research, socioeconomic impact evaluation, decision support systems, operations research, risk analysis, forest industry, regional perspectives development, economics of sustainable development, cost effectiveness, financial analysis.

7. Location of Work: Northwest Region

8. Study objectives:

   1. To provide high quality economics research through individual studies as well as joint interdisciplinary studies with NoFC scientists, industrial, government and academic clients.

   2. To provide data and analytical support for policy and program development of regional and national forestry research and development programs and policies.

9. Goals for 1990-91:

   Scientific/Project Authority for Contract Research

   1. Provide input to and/or act as project authority for FRDA and other projects.

   Regional Development Analysis, Policy and Planning, Evaluation and Documentation

   2. Continue to provide socioeconomic and other data, analysis and documentation for policy and program development for new FRDAs with Manitoba, Saskatchewan, Alberta and the NWT.

Economic Research, Reports, and Publications

3. Develop prioritized list of joint projects with NoFC scientists.

4. Commence work on joint studies with scientists involved in pest control, peatland drainage, vegetation management, site classification and other areas as interest (see 3) and priorities warrant.

5. Continue to meet with scientists and other clients to establish areas where joint research would be appropriate.

6. Publish dynamic programming paper currently in final editorial review at PFC.

7. With C.E. Love and T. Heaps of Simon Fraser University complete paper on stand optimization under a budget constraint.

Reviews, Comments, Briefings

8. Continue to provide peer reviews and comments on journal articles, FORCAN reports, contract proposals and to provide briefing notes as required.

9. Continue to respond to requests for information from the public and to maintain the Regional Development reference library.

10. Continue to develop, assemble and man displays which inform clients of NoFC and FORCAN programs.

Added Goals

11. Represent Forestry Canada and participate in a panel discussion at an "Ecological Economics Workshop" in Minneapolis.

12. Publish a report on "Economics and Sustainable Development: The Case of Soil Degradation".

13. Present a paper at the "Soil Degradation Workshop" in Penticton.

14. Present a paper at the "Workshop on Computer Based Models for the Allocation of Resources to Silviculture" in Vancouver.

15. Develop close working relationship with U of Alberta Department of Rural Economy.

16. Prepare a major study on "Forest Sector Dependency in the Prairie Provinces."

17. Begin preparations for an international "Conference on Environmental and Economic Issues in Forestry".

10. Accomplishments 1990-91:

Scientific/Project Authority for Contract Research

1. Numerous project proposals were developed internally, with the U of Alberta and with industry. No funding was available to begin new projects.

Regional Development Analysis, Policy and Planning, Evaluation and Documentation

2. This task was removed from NOR-3-03 early in fiscal 1990-91.

Economic Research, Reports and Publications

3. Projects were developed with scientists in pest control, peatland drainage, vegetation management and site classification.

4. Study plans were developed and data collection commenced for studies in peatland drainage, pest control and vegetation management. Input was provide on the economics of site classification for a proposal involving NoFC staff. Other project proposals for funding were developed.

5. Meetings were held with industry representatives and the U of Alberta and project proposals were developed to obtain funding for research projects.

6. The dynamic programming paper entered an unexpected further review process. This has been completed and the paper is with the author for further revision.

7. Further work was completed on this study which is still in progress.

Reviews, Comments, Briefings

8. Chaired the review committee for proposed information report on the economics of jack pine thinning completed in NOR-4. Provided reviews to headquarters and Macmillan Bloedel on a wilderness allocation paper. The study leader was named an associate editor of the Forestry Chronicle and arranged for reviews and reviewed numerous papers in that position.

9. Responded to requests from the public re conversion of log weights to volume measurements. Reorganized the development library and created a directory of holdings.

10. Participated at the FORCAN booth at the Alberta Forestry Show

11. At the request of headquarters, represented Forestry Canada at an "Ecological Economics Workshop" in Minneapolis and participated in a panel discussion in the workshop's closing session.

12. The paper "Economics of sustainable forest development: The case of soil degradation" was published in the February issue of the Forestry Chronicle.

13. With D. Peterson of PFC co-authored the paper "Economic implications of site degradation" which was presented at the "Soil Degradation Workshop" in Penticton. The paper will appear in the forthcoming proceedings of the workshop.

14. An invited paper, "Application of dynamic programming to stand level decisions" was presented at the "Workshop on Computer Based Models for the Allocation of resources to Silviculture" in Vancouver.

15. The study leader has been appointed as an adjunct professor in the Department of Rural Economy, University of Alberta. Numerous study proposals have been developed and submitted for funding. The study leader is serving on two graduate thesis committees. Teaching activities have included substituting for the professor of the 365 Resource economics course for 3 1/2 weeks and team teaching the combined 445/465 Forest economics and Resource Economics class.

16. A graduate thesis is near completion. The study leader and S. Fletcher presented a paper at the Western Regional Science Association Meetings in Monterey, California and a paper has been accepted for the "Innovative Rural Communities" conference in Prince Edward Island in June 1992.

17. Planning meetings have been held, the Jasper Park Lodge has been booked, keynote speakers have been approached and a call for papers has been issued.

11. Goals for 1991-92:

Study discontinued. See NOR-06.

12. Present Status of Study:

This study has been discontinued and replaced by NOR-06 which combines the forest resource economics research thrust which was the principal study objective of NOR-3-03 with the forest resource economics research coordination objective of NOR-03-01.

13. Publications 1990-91

White, William A. 1991. Economics and sustainable forest development: The case of soil degradation. For. Chron. 67(1):19-22.

14. Environmental Implications:

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

15. Duration:

Started: 1980 Completion: 1991

16. Resources 1991-1992:

Study discontinued; see NOR-06.

17. Signatures:

Investigator

A/Program Director, Development

Regional Director General

NOR-3-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28,1991.

1. Project: Forest Resource Economics and Statistics

2. Title: Economic analyses of forest management practices.

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

5. Study Leader: J De Franceschi

6. Key words: Economics, interdisciplinary forest management, cost-effectiveness, risk:benefit, decision-making models, production costs, employment/economic impacts, silviculture.

7. Location of the work: Prairie provinces, NWT, Ottawa.

8. Study objectives:

   1. To provide socio-economic and statistical data analyses and documentation for interdisciplinary studies in forest management.

   2. To determine costs of silvicultural treatments in the region for a range of site or stand conditions. These costs to be determined through time studies of silvicultural operations.

   3. Based on cost information derived from this study, provide economic evaluation of silvicultural treatments to assist forest managers in allocating funds among competing treatments.

9. Goals for 1990-91:

   Economics research, reports and publications

   1. Prepare an establishment report describing plot locations and data summaries of field survey of white spruce release area in Manitoba. The report will provide the necessary documentation to facilitate future remeasurements.

2. Prepare a brief journal article describing condition of released spruce and of the emerging aspen sucker stand two years following removal of the aspen overstory.

3. Analyse labor production data for manual tree planting and precommercial thinning and complete first draft of a report on production and costs of these treatments.

4. Provide economic analyses for interdisciplinary studies with research scientists at NoFC in conjunction with NOR-03-03.

5. Oversee the completion of ENFOR project P-370, "Economic feasibility of utilizing logging slash and fire-killed timber for energy in Manitoba and Saskatchewan", including the preparation of consultant's final report (cross-reference NOR-28-06).

6. Develop terms of reference and contract specifications for expansion of the existing ENFOR project to include publication of interim results and additional survey of domestic wood users. Collaborate with ENFOR consultant to publish preliminary results of slash survey information collected from Manitoba and Saskatchewan (cross-reference NOR-28-06, project P-379)

Reviews, comments and briefings

7. Prepare background documentation as required in support of negotiations for new federal-provincial agreements.

8. Continue to provide socio-economic and statistical data, analyses and documentation for policy and program development as required. Continue to provide reviews/comments on reports, proposals, briefings, etc.

Added Goal

9. Conduct field survey of white spruce release study in Duck Mountain, Manitoba to assess treatment effects on insect and disease populations. This data will provide preliminary assessment of risks for similar types of investments.

10. Accomplishments in 1990-91:

The study leader was assigned to acting positions administering forestry agreements. Accomplishments presented here therefore represent activities from April 1 to August 1, 1990.

Economics research, reports and publications

1. Some data summaries have been prepared as preliminary tables for an establishment report describing the study area and data collection.

2. Report writing was initiated but considerable work remains before a first draft is completed.

3. No progress was made towards this goal.

4. No further progress was made towards this goal. Activity for this goal is concentrated in NOR-03-03.

5. ENFOR project P-379 is on schedule. During the year, two interim reports were produced which will form the basis of the final report. The final report will be completed by March 31/91 (cross-reference NOR-28-06).

6. Two contract extensions to ENFOR project P-379 were developed and contract work on these was completed. A brochure was published which reported waste wood volumes available in Manitoba and Saskatchewan (extension 1). The brochure was to alert potential wood users to the availability of the resource. A survey to describe the fuel wood industry and fuel wood users was conducted and preliminary data summarizes have been prepared (extension 2). Results will be incorporated in the final report (cross-reference NOR-28-06).

Reviews, comments and briefings

7. All necessary agreement documentations were prepared as required.

8. Provided as required.

Added accomplishment

9. The study area was surveyed in July, 1990. Expertise and assistance was provided by H. Cerezke, M. Grandmaison, N. Walker, and one person from Manitoba Forestry Branch. The survey suggested the treatment may have stimulated terminal weevil populations in the younger stand.

11. Goals for 1991-92:

Nil Goals transferred to NOR 28-06 and NOR-36-02.

12. Present status of the study:

Study terminated; some goals transferred to NOR-28-06 and NOR-36-02.

13. Publications 1990-91:

Reports listed under NOR-28-06.

14. 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.

15. Duration:

Start: 1985 Estimated completion: 1991

16. Resources 1991-92:

Nil

17. Signatures:

Investigator

Program Director, Development

Regional Director General

NOR-4-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Stand Productivity

2. Title: Analysis of growth and yield of important tree species in the prairie provinces (revised).

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

5. Study Leader: I.E. Bella

6. Key Words: Tree and stand growth and development, yield, thinning, tending.

7. Location of Work: Data originates from various locations in Alberta, Saskatchewan, and Manitoba

8. Problem:

As forestry activity and demand for wood fibre increases in the region, so does demand for information on growth and yield of the major commercial tree species, whether they are growing in old growth, fire origin stands or in second growth stands following harvesting. The most important problems include: predicting growth and yield in natural, unmanaged stands; predicting growth and yield of managed, planted, seeded stands that were spaced, thinned and possibly fertilized; the effect of insects, diseases and other agents on growth and yield; species selection for optimum growth and development on a given site; and synthesizing tree and stand growth information into suitable predicting models to be used for estimating Annual Allowable Cut (AAC).

Progress to 1988:

1. A series of PSPs were established to monitor growth and development of old growth stands of lP, jP, wS, and tA. Some of these plots date back to 30 years or more (see summary table in NOR-4-02). Many of these plots--most of them lP--are still intact, periodically remeasured and provide useful information. Data were analysed as became available, and yield tables published for jP, lP, wS and tA.

2. Thinning experiments and some growth monitoring plots in operational thinning trials, have been established in jP, lP, tA, and wS. Results are published as became available,

and the studies provide important information on managed stand yield. Thinning equipment performance trials were also conducted, analysed and published.

3. Spacing experiments have been established in jP, rP, lP, and wS. Results are published as became available, and the studies provide important information on managed stand yield.

4. At the request of the Alberta Government, intensive short term studies were conducted on regeneration standards, and tree growth response along seismic lines. Results were analysed and published.

5. Studies have been initiated to determine the impact of insects, diseases and other agents on growth and yield, particularly in stands following harvest. Preliminary results and recommendations have been presented at symposiums and/or published.

6. Over 20 reports and journal articles have been published on growth and yield, on thinning and spacing response and on related problems referred to above for jP, lP, rP, sP, and wS by Bella, I.E. and DeFranceschi, J.P.; Cayford, J.H. Jameson, J.S., Johnstone, W.D., Steneker, G.A., and Wilson, G.M. between 1950 and 1986.

9. Study Objectives:

1. Provide project leadership, advice and technical transfer to project and regional development staff, clients and the Growth and Yield Cooperative in growth and yield R & D activities.

2. Develop and evaluate yield models for natural and managed stands of the major commercial tree species in the region. Obtain managed stand growth and yield information from related spacing, thinning and fertilization experiments.

3. Prepare treatment prescriptions for different species for use by the forest manager.

4. Conduct intensive short-term studies on urgent problems as required by clients.

10. Goals for 1990-91:

1. Provide project leadership functions to NOR-04 staff and functional guidance to Regional Development staff in Manitoba and Saskatchewan District Offices and to the Alberta and Saskatchewan Agreements' mensurationist; provide advice to collegues and clients on mensurational problems and carry out technology transfer in thinning, growth and yield and stand modelling; yield forecasting; act as a scientific authority on related contracts as required.

2. Provide technical input in the regional Growth and Yield Coop.

3. Cooperate with C. Cieszewski on goals listed in NOR 04-10, viz., goals 2, 3, 4, 5, 6, and 7.

4. Cooperate with V. Zakrzewski in preparing a final manuscript on a G & Y predicting system for updating inventory. This system also requires further testing for the major, especially mixed covertypes; and possibly an evaluation on a pilot study area. Satisfactory completion of this goal requires full time involvement for up to a year of a PDF specializing in G & Y modelling with strong nonlinear curve fitting and computer programming skills.

5. Contribute as required in the Mixedwood MD initiative, particularly to the development of a regional DSS for forest management, and provide leadership/organizational functions to the development and testing of a knowledge base system for aspen management.

6. Prepare a prescription for thinning IP.

Added Goals:

7. Coauthor a poster (Ondro and Bella) on "Thinning lodgepole pine for profit in Alberta" for Canada's Timber Resources Conference, June 3-6, 1990, Victoria, B.C.

8. Participate in the Steering and Program Committees in organizing the Aspen Symposium, Edmonton.

9. Prepare and present a joint paper (Bella and Yang) on "Should we thin young aspen stands?" at the Aspen Symposium, Edmonton.

10. Coauthor a paper (Cieszewski, Bella and Perala) on "Predicting growth and yield of aspen in Western Canada" for the Aspen Symposium, Edmonton.

11. Coauthor a poster (Bella, Ejsmont, Navratil, Yang) on "Developing a decision support system for aspen stand management in Western Canada" for the Aspen Symposium, Edmonton.

12. Coauthor a poster (Ondro and Bella) on "Financial implications of some harvesting options in overmature aspen stands in Alberta" for the Aspen Symposium, Edmonton.

11. Accomplishments 1990-91:

1. Provided project leadership functions to NOR-04 staff and functional guidance to Regional Development staff in Manitoba and Saskatchewan District Offices and to the Alberta and Saskatchewan Agreements' mensurationist; provide advice to colleges and clients on mensurational problems and carry out technology transfer in thinning, growth and yield and stand modeling; yield forecasting; act as a scientific authority on related contracts as required.

2. Provided technical input and leadership as required in the WESBOGY Co-op.

3. Cooperated with C. Cieszerski on accomplishments in NOR-04-10 (under 2, 3, 4, 5, 6 and 7). Completion of these goals and publications arising from them has been seriously hindered and delayed by insufficient technical support in data processing, statistical

analysis and mathematrical modelling; all of those requiring superior skills in computer use.

4. Continued to work with V. Zakarzewski to complete the analysis and prepare a final draft on a Growth and Yield predicting system for updating inventory. Progress has been slow and the final draft is still some way off. As V. Zakarzewski has other, more pressing work priorities in his new job at the OMNR in Sault Ste. Marie, this activity is on the back burner, and completion time is rather uncertain.

5. Contributed as a team member to the mixedwood MD initiative. Organized a seminar/workshop in Edmonton-Kananaskis to provide introduction to forest stand management DSS and to initiate the development of conceptual framework for aspen and for mixedwood stand management advisory systems. Developed a proposal and acted as scientific authority for a contract to develop a new prototype stand management advisory system for apsen. The structure and some of the main modules have been developed and implemented in Q.PROLOG. The system was demonstrated at the Aspen Symposium, Edmonton, November 22, 1990.

6. Prescription for lodgepole pine thinning was postponed.

7. Coauthored a poster (Ondro and Bella) on "Thinning lodgepole pine for profit in Alberta" for Canada's Timber Resources Conference, June 3-6, 1990, Victoria, B.C.

8. Participated in the Steering and Program Committees in organizing the Aspen Symposium, Edmonton.

9. Prepared and presented a joint paper (Bella and Yang) on "Should we thin young aspen stands?" at the Aspen Symposium, Edmonton.

10. Coauthored a paper (Cieszewski, Bella and Perala) on "Predicting growth and yield of aspen in Western Canada" for the Aspen Symposium, Edmonton.

11. Coauthored a poster (Bella, Ejsmont, Navratil, Yang) on "Developing a Decision Support System for aspen stand management in Western Canada" for the Aspen Symposium, Edmonton.

12. Coauthored a poster (Ondro and Bella) on "Financial implications of some harvesting options in overmature aspen stands in Alberta" for the Aspen Symposium, Edmonton.

12. Present Status of Study:

1. Leadership function and technical transfer are important and continuing activities under this study, with an added new trust through the Regional Growth and Yield Cooperative.

2. Most work in growth and yield model evaluation and development is currently centred on our effort to complete the development of managed stand yield tables (models) for lP and wS initially funded under Can.-Alta. agreement, and to develop a comprehensive system of models for updating forest inventories and calculating AAC's across the region (Alta., Sask., Man.).

3. Treatment prescriptions, particularly for spacing and thinning, are developed as data becomes available and are passed to the user through workshops, field tours and printed form.

4. All treatment response and prescription information together with Growth and Yield forcasting models will be integral part of stand and forest level decision support systems being developed by a MD team, with significant input from this study and project (NOR-4).

13. Goals for 1991-92:

1. Provide project leadership functions to NOR-04 staff and functional guidance to Regional Development staff in Manitoba and Saskatchewan District Offices and to the Alberta and Saskatchewan Agreements' mensurationist; provide advice to collegues and clients on mensurational problems and carry out technology transfer in thinning, growth and yield and stand modelling; yield forecasting; act as a scientific authority on related contracts as required.

2. Provide technical input in the regional Growth and Yield Coop.

3. Cooperate with C. Cieszewski on completing goals listed in NOR 04-10, viz., goals 2, 3, 4, 5, 6, and 7.

4. Make a final push with V. Zakrzewski (now with the OMNR in Sault Ste. Marie) to complete the analysis and a final draft on a Growth and Yield predicting system for updating inventory. The next step is to test and evaluate the accuracy of this new system on a pilot study area. To complete this later goal would require the assistance of a programmer/analyst, or PDF for up to a year.

5. Continue design and development work on the aspen stand management DSS. By year-end 1991, we should have available a working prototype for demonstration. Participate in discussions and workshops to further define concepts and framework both for aspen and mixedwood stand management DSS, as well as for the forest level DSS.

14. Publications 1990-91:

Bella, I.E. 1990. Thinning lodgepole pine by brute force: Three implements in a decade's perspective. For. Chron. 66:611-615.

Bella, I.E.; Ejsmont, M.; Navratil, S.; Yang, R.C. 1990. Developing a decision support system for aspen stand management in western Canada. A poster presented at the "Aspen Symposium", Edmonton, Nov. 20-21, 1990.

Bella, I.E.; Yang, R.C. 1990. Should we thin young aspen stands? In "Aspen Symposium" Edmonton, Nov. 20-21, 1990. 12 p.

Cieszewski, C.C.; Bella, I.E.; Perala, D.A. 1990. Predicting growth and yield of aspen in western Canada. In "Aspen Symposium", Edmonton, November 20-21, 1990.

Ondro, W.; Bella, I.E. 1990. Thinning lodgepole pine for profit in Alberta. A poster presented at "Canada's Timber Resources" Conference, Victoria, B.C., June 3-6, 1990.

Ondro, W.; Bella, I.E. 1990. Financial implications of some harvesting options in overmature aspen stands in Alberta. A poster presented at the "Aspen Symposium", Edmonton, Nov. 21, 1990.

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: 1991

17. Resources 1991-92:

PYs:	Prof.:	Bella	0.5
	Total		0.5
	Student		

O&M:	$ 12.0 K
Contract:	$
Capital:	$ 5.0 K (Scanner)

18. Signatures:

Investigator

Program Director, Resources

Regional Director General

NOR-4-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Stand Productivity

2. Title: Data base development for growth and yield of important forest types in the Prairie Provinces.

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

5. Study Leader: S. Lux

6. Key Words: Computerized database, tree and stand growth, treated and untreated stands, thinning, spacing, site yields, stocking, models, aspen, jack pine, black and white spruce, red pine, lodgepole pine.

7. Location of Work: Alberta, Saskatchewan and Manitoba

8. Problem Analysis:

Growth and yield information is required for the efficient management of forest resources in the Prairie Provinces. Such information is needed for both treated and untreated stands. Silvicultural options and treatments can be evaluated by establishing and periodically re-examining permanent sample plots in the important forest types in the region. Growth and yield information thus obtained will form the basis of developing and improving growth and yield forecasting models both for old growth and managed stands. Computerizing such data bases increases their usefulnessin-house and to clients.

9. Study Objectives:

1. Continue to monitor existing permanent sample plots as well as to establish new ones where necessary for studying the effect of stand treatments in the important forest types in the prairie provinces.

2. Develop and maintain a computerized database of regional forest productivity data.

3. Analyze and interpret growth and yield data and to publish appropriate information reports and forest management notes.

10. Goals for 1990-91:

1. Publish information report entitled "Early stand development of 7-year-old lodgepole pine following spacing in West Central Alberta" (Yang).

2. Publish the journal article "Thinning lodgepole pine on the cheap" (Bella).

3. Complete ms review and submit the article "Growth of fourteen-year-old aspen repeatedly thinned to constant stand density" (Yang) to a journal for publication.

4. Remeasure the red pine plantation plots in the Sandilands and the jack pine thinning plots in Hadashville and Belair Manitoba (Lux).

5. Complete data analysis of Teepee Pole Creek thinning trial and prepare ms for review (Yang).

6. Complete data analysis of mechanical strip thinning trial of jack pine in the Sandilands Forest Reserve and draft a report (Lux).

7. Complete data analysis of jack pine multiple thinning in the Sandilands Forest Reserve (MS154) and draft a report (Lux).

Goals added:

8. Present a paper on aspen thinning at the Aspen Symposium.

11. Accomplishments for 1990-91:

1. Publication of the information report entitled "Early stand development of 7-year-old lodgepole pine following spacing in West Central Alberta" was postponed due to the low priority.

2. The journal article "Thinning lodgepole pine by brute force: three implements in a decades perspective" was published in the Forestry Chronicle.

3. A review on the first draft of the article "growth of 14-year-old aspen repeatedly thinned to constant stand density" was unfavorable; a revision is in progress.

4. The remeasurements of the red pine plantation plots in the Sandilands and the jack pine thinning plots in Hadashville and Belair, Manitoba were postponed to the spring of 1991.

5. Data analysis of the Teepee Pole Creek thinning trial was postponed as emphasis was diverted to goals on developing decision support systems.

6. Data analysis of the jack pine mechanical strip thinning in the Sandilands Forest Reserve, Manitoba was postponed.

7. Data analysis of jack pine multiple thinning in the Sandilands Forest Reserve (MS154) was postponed.

8. A paper entitled "Should we thin young aspen stands?" was prepared and presented at the Aspen Symposium held in Edmonton on Nov. 20-22, 1990.

12. Current Status of Study:

1. A series of permanent sample plots were established of monitoring old growth stands in lP, jP, wS, and tA. Many of these plots, some date back more than 40 years - are still periodically remeasured and provide useful information. Thinning (in jP, lP, tA, and wS) and spacing (in jP, lP, rP, and wS) experiments were established and these studies provide useful information on managed stands (see summary table).

2. A regional PSP catalogue containing ForCan as well as provincial and industrial PSPs has been developed and distributed to cliental by D. Kuhnke (NOR 03-02). In addition individual tree and plot information has been computerized to ensure effective utilization by CFS staff and clients.

3. Appropriate reports - both Information Reports and Forest Management Notes - are published as information relating to additional remeasurements becomes available or new analytical techniques come on stream.

13. Goals for 1991-92:

1. Publish information report entitled "Early stand development of 7-year-old lodgepole pine following spacing in West Central Alberta (Yang).

2. Revise and re-submit the proposed journal article on thinning aspen for peer review (Yang).

3. Remeasure the Gregg Burn spacing trial plots in Hinton, Alberta (Lux) (Fall).

4. Maintain and remeasure the red pine plantation plots in the Sandilands and the jack pine thinning plots in Hadashville and Belair, Manitoba (Lux)(Spring).

5. Maintain and remeasure the Turtle Mountain aspen thinning (MS 133) and the Riding Mountain aspen thinning plots (MS 146) (LUX)(Fall).

6. Complete data analysis of Teepee Pole Creek thinning trial and prepare ms for review (Yang).

14. Publications 1990-91:

Bella, I.E. 1990. Thinning lodgepole pine by brute force: Three implements in a decade's perperctive. For. Chron. 66(6): 611-615.

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: 1948 Completion: Ongoing

17. Resources 1991-92

PYs Prof: Yang 0.2
Tech: Lux 0.4
Total: 0.6

O&M: $2,200

Capital: Nil

18. Signatures:

Investigator for S. Lux

A/ Program Director, Resources

Regional Director General

NOR-4-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Stand Productivity

2. Title: Fertilization and thinning of semi-mature lodgepole pine stands

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

5. Study leader: R. C. Yang

6. Key words: Nutrition, fertilizer, thinning, growth

7. Location of Work: Hinton, Alberta; Saskatchewan, Manitoba

8. Problem Analysis:

Although fertilizing has been found to improve lodgepole pine productivity, information on nutrient requirements of this species remains sparse. Knowledge on the mechanism of the species responding to thinning and fertilization treatments is especially limited. A correct diagnosis of nutrient requirements is often cited as a pre-requisite to effective fertilization along with the density control of the stand. The latter is particularly important in young lodgepole pine, which often grows in over-dense stands. Previous study results (NOR-4-04) showed improved diameter and volume growth of two 30-year-old stands after fertilization; stand growth response, however, was obscured by high and variable mortality associated with excessive stand density. This suggests that fertilizer should be applied in combination with thinning to improve stand productivity.

9. Study Objectives:

1. To assess the effect of thinning and N fertilization on growth of semi-mature lodgepole pine.

2. To quantify the effect of thinning, fertilization and their combined effects on nutritional status in trees and soils and to establish relationships between tree growth response and nutrient status.

3. To develop a diagnostic technique for fertilizer prescription of lodgepole pine from the above relationships.

4. To obtain growth response information to fertilization for other regional commercial tree species as warranted by available data sources.

10. Goals for 1990-91:

1. Complete remeasurement of the fertilization and thinning plots to assess growth response to fertilization and thinning. The remeasurement includes diameter tally for all plot trees, sufficient height samples from each treatment combination, and increment cores from each plots to correlate annual dbh growth to nutrient status in soils and foliage.

2. Draft a management note on response of aspen growth to fertilization.

3. Complete nutrient determinations for all soil and foliage samples, complete data analysis and prepare a manuscript on soil and foliar nutritional changes following fertilization and thinning.

4. Provide advice and carry out technology transfer on mensurational problems relating to forest fertilization.

11. Accomplishments in 1990-91:

1. A total of 72 fertilization and thinning plots were remeasured in September; all trees on plots were dbh tallied and 10 trees for height; increment cores from 4 dominant trees on plots were also sampled to assess correlation of dbh growth response to nutrient status in foliage and soils.

2. Preparation of a draft on response of aspen growth to fertilization is in progress and will be available for review shortly.

3. Chemical determinations of foliar and soil samples from fertilization and thinning plots were completed; data analysis was postponed as emphasis was diverted to goals on developing DSS.

4. Provided advice on forest fertilization to a private company in Camrose, Alberta and advice on mensurational problems related to forest fertilization to colleagues as requested.

12. Present Status:

This study was initiated in 1984. Seventy-two 0.03-ha circular plots were established and half of plots were thinned; all plot trees were tagged and tallied at establishment. Nitrogen at four levels (0, 180, 360 and 540 kg/ha) along with 40 kg/ha each of P, and S were applied in the fall, 1985. Foliar, ground vegetation, and soils were sampled in 1985 prior to fertilization and 1986, 1987, 1988 for nutrient analyses. Laboratory analyses of pre-fertilization and 1987 samples have been completed and determinations of 1988 samples are in progress.

Dimensional changes in current needles in thinned and fertilized plots become noticeable two years after treatment. The information on needle length and weight in combination with nutrient status in soil and foliages following treatment provide needed data for predicting growth response and diagnosing nutrient requirement of lodgepole pine.

13. Goals for 1991-92:

1. Complete data analysis on five-year growth response of lodgepole pine following fertilization and thinning.

2. Prepare the manuscript on response of aspen growth to fertilization and submit for peer review.

3. Complete data analysis on nutrient status on foliage and soils following fertilization and thinning in lodgepole stands and prepare a manuscript for publication if time permits.

4. Provide advice and carry out technology transfer on mensurational problems relating to forest fertilization.

14. Publications:

Nil

15. Environment Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of the following clarifications provided by the study leaders, the committee concludes that no further action is required:

1. The treated area is only 1.5 ha.

2. The terrain is flat and there are no creeks in the area. As a result there is no possibility of the fertilizer moving off-sites into nearby water bodies.

3. The fertilizer is applied by manually-operated cyclone spreaders.

16. Duration:

Started: 1984 Estimated Completion: 1996

17. Resources 1991-92:

PYs:	Prof.: Yang	0.3
	Tech.:	0.0
	Total:	0.3
	Term/Student:	0.0

O & M: $5,000

Capital: $3,400 (workstation peripherals)

18. Signatures:

Investigator

Program Director, Resources

Regional Director General

NOR-4-08

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Stand Productivity

2. Title: Financial and economic evaluation of intensive forest management practices

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

5. Study Leader: W. Ondro

6. Key Words: Financial and economic returns, financial, economic and marginal evaluation and analyses, costs, benefits, financing, investment, decisions, cost effectiveness, pruning, spacing, conifer release, tree improvement, thinning, fertilization

7. Location of Work: Northwest Region

8. Problem Analysis:

Biological responses to intensive forest management practices are fairly well documented and understood, but we are lagging behind in financial and economic analyses of such treatments. This study is to fill that gap.

9. Study Objectives:

1. Determine financial and economic returns from increased growth after spacing, release, fertilization and other intensive management practices.

2. Evaluate cost-effectiveness of different intensity, mix and sequence of forest management treatments.

3. Evaluate the economics, utilization and market potential of poplars.

10. Goals for 1990-91:

1. Publish an information report on cost/benefits of thinning naturally regenerated lodgepole pine.

2. Publish an information report on costs/benefits of thinning naturally regenerated jack pine.

3. Prepare a final draft of an information report on cost/benefits of white spruce release from aspen. Using the same material prepare and present a paper on profitability of white spruce release from aspen in Saskatchewan and Manitoba at Midwest Economists Meeting in Madison, Wisconsin, August 22-24, 1990.

4. Publish a journal article on present trends and future prospects for poplar utilization in Alberta.

Added Goals:

5. Develop a computer software for financial evaluation of forest management practices.

6. Prepare and present a poster on profitability of lP thinning in Alberta at National Timber Conference in Victoria.

7. Prepare and present a poster on financial implications of some harvesting options in overmature aspen stands in Alberta at Aspen Symposium in Edmonton.

11. Accomplishments in 1990-91:

1. A draft report on cost/benefits of thinning dense naturally regenerated lP was reviewed and comments incorporated in the MS.

2. A draft report on costs/benefits of thinning naturally regenerated jack pine was reviewed by the review committee.

3. A draft report on cost/benefits of white spruce release from aspen was prepared. and presentation given on profitability of white spruce release from aspen at Midwest Economists Meeting in Madison, Wisconsin, August 22-24, 1990.

4. A journal article on present trends and future prospects for poplar utilization in Alberta was accepted for publication in the Forestry Chronicle.

5. Together, with student assistant R. Mair, developed a micro-computer software, called TIMRET, TIMber RETurns for financial evaluation of forest management practices.

6. Jointly with I.E. Bella presented a poster on profitablility of lP thinning in Alberta at Canada's Timber Resources Conference, Victoria, B.C.

7. Jointly with I.E. Bella, presented a poster on financial implications of some harvesting options in overmature aspen stands in Alberta at the Aspen Symposium, Edmonton.

12. Present Status of Study:

1. Completed analysis of financial returns from fertilization in mature lP stand and spacing lP and jP. Evaluation of returns from increased growth after spruce release from aspen is in progress.

2. Evaluated cost-effectiveness of different fertilization treatments in lP and spacing of lP and jP. Assessment of cost-effectiveness of white spruce release from aspen is in progress.

13. Goals for 1991-92:

1. Publish a forest management note on cost/benefits of thinning naturally regenerated lodgepole pine.

2. Publish a forest management note on costs/benefits of thinning naturally regenerated jack pine.

3. Publish a journal article or forest management note on cost/benefits of white spruce release from aspen.

4. Prepare user's manual and a journal article or a forest management note on applications of TIMRET, micro-computer software on financial evaluation of forest management treatments.

5. Complete cooperative research on economics of poplar utilization and write report (thesis).

14. Publications 1990-91:

Ondro, W.J. 1991. Present trends and future prospects for poplar utilization in Alberta. For. Chron. (in press).

Ondro, W.J.; Bella, I.E. 1990. Thinning lodgepole pine for profit in Alberta. A poster presented at "Canada's Timber Resources Conference, Victoria, B.C. June 3-6, 1990.

Ondro, W.J.; Bella, I.E. 1990. Financial implications of some harvesting options in overmature aspen stands in Alberta. A poster presented at "Aspen Symposium", Edmonton, Alberta. November 21, 1990.

Ondro, W.J.; Constantino, L.F. 1990. Financial returns from fertilizing 70-year-old lodgepole pine near Hinton, Alberta. For. Chron. 66:287-297.

Ondro, W.J.; Yang, R.C. 1991. Fertilizing preharvest lodgepole pine in Alberta: cost revenues and returns. Page 291 *in* Proceedings from "Forest Fertilization Workshop. Ministry of Forests, Research Branch, Victoria, B.C.

15. Environmental Implications:

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

16. Duration:

Start: 1985 Completion: continuing

17. Resources 1991-92:

PYs: Prof.:	Ondro	1.0
	Tech.:	0.0
	Total:	1.0

Term/Student:

O & M: $ 3 K

Capital: $

18. Signatures:

Investigator

Program Director, Resources

Regional Director General

NOR-4-09

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Stand Productivity

2. Title: Stand tending techniques in the Mixedwood Forest Section

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

5. Study Leader: R. C. Yang

6. Keywords: Stand tending, stand development, yield, growth models

7. Location of Work: Manitoba, Saskatchewan and Alberta

8. Problem Analysis:

Spruce-aspen is one of the most important cover types in the Mixedwood Forest Section (B.18a) of the Boreal Forest Region. Aspen, a vigorous pioneer species, usually forms the upper canopy for at least the first 50 to 60 years of the life of the stand. Often the spruce in the understorey is subjected to severe suppression, and mechanical injury from the dominating aspen. The aspen competition results in reduction of height and diameter growths of the white spruce and losses in volume production.

Foresters have long realized the impact of aspen on white spruce growth. Experimental improvement cuttings to favor the white spruce in mixedwood stands in Manitoba were first carried out in 1936 (Duck Mountain). A series of experimental release cuttings were made in 1951- 54 in 15- to 60-year-old stands in Manitoba and Saskatchewan (MS-153), to determine the effects of partial and complete removal of aspen upon the development of white spruce. A similar experiment was also carried out in Slave Lake area, Alberta (A-13).

9. Study Objectives:

1. To prepare silvicultural prescriptions for releasing white spruce from trembling aspen in mixedwood stands based on ecological factors and mensurational growth responses derived from experiments and operational trials carried out in this region.

2. To assess the impact of white spruce release in terms of potential increase in wood production in mixedwood forests in the region.

3. To assess growth and yield of spruce-aspen mixedwood stands following stand tending treatments and to develop tending techniques to improve productivity of the cover type.

10. Goals for 1990-91:

1. Publish the journal artile "Growth of white spruce following release from aspen competition: 35-year results" (A-13).

2. Conduct field work to assess white spruce regeneration on individual spruce release plot following removal of aspen (A-13).

3. Design and develop, in co-operation with researchers of the Forest Resource Program, a prototype decision support system for aspen management.

Goals added:

4. Analyze potential for utilizing aspen stem wood from release cutting in spruce-aspen mixedwood stands.

5. Prepare a poster on developing aspen forest management decision support system for the Aspen Symposium.

11. Accomplishments in 1990-91:

1. The journal article "Growth of white spruce following release from aspen competion: 35-year results" has been accepted by Forestry Canada for publication.

2. The field work to assess white spruce regeneration on individual spruce release plots following removal of aspen was completed; data analysis in progress.

3. Debugged the Aspen Forest Management Advisory System developed by Dr. R.M. Rauscher of USFS, Grand Rapids, Minn. and demonstrated at the Aspen Symposium.

4. Analyses of potential aspen volume gains from release cutting in spruce at various ages was completed; a manuscript for a management note has been prepared and will be submitted for review shortly.

5. A poster entitled "Developing a decision support system for aspen stand management" was prepared and presented at the Aspen Symposium, Edmonton Nov. 20-22, 1990.

12. Present Status:

This study is based on data from experiments on releasing white spruce from aspen competition established in early 1950's in Manitoba and Saskatchewan (MS-153) and Alberta (A-13). Plots were remeasured 5 and 10 years following release. Five reports were published.

Another remeasurement of release response has been initialized in 1985, 35 years after establishment. Data analysis on individual tree release in Slave Lake, Alberta (A-13) has been complete. Three reports will provide needed information set forth in the study objectives.

Recent advances in applying artificial intelligence (AI) techniques to natural resource management prompted changes in study objectives towards developing decision support systems (DSS) for boreal mixedwood management. A prototype DSS for aspen stand management has been developed and a system encompassing harvesting, regeneration, and tending are under developing.

13. Goals for 1990-91:

1. Publish the journal article "Growth of white spruce following release from aspen competition: 35-year results" (A-13).

2. Analyze results on spruce regeneration on individual release plots following removal of aspen and prepare a management note if results warrant publication.

3. Submit for review and revise a management note on potential for utilizing aspen stem wood from release cutting in spruce-aspen mixedwood stands in the boreal mixedwood forests.

4. Complete the design and development of a decision support system prototype for aspen stand management.

14. Publications in 1990-91:

Yang, R.C. 1990. Growth response of white spruce to release from trembling aspen. For. Can., North For. Centre, Edmonton, Alta. Inf. Rep. NOR-X-302.

15. Environment Implications:

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

16. Duration:

Started: 1985 Estimated Completion: 1991 Revised: 1995

17. Resources 1991-92:

PYs:	Prof.:	Yang	0.5
		Bella	0.2
		Hans	1.0
	Tech.:	Lux	0.0
	Total:		1.7

Term/Student:

O & M: $6,000

Capital: $20,000

18. Signatures:

Investigator

A/Program Director, Resources

Regional Director General

NOR-4-10

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Stand Productivity

2. Title: Managed stand yield tables for lodgepole pine and white spruce

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

5. Study Leader: C.J. Cieszewski

6. Keywords: Seeded or planted stands, second growth, site framework, AAC calculations

7. Location of Work: Alberta

8. Problem Analysis:

With the continued and accelerating forest harvest in Alberta, there are ever increasing areas of second growth coniferous stands that are established through either natural regeneration or by planting. Even casual observations reveal substantial differences between various characteristics of this regeneration--especially in stocking density--compared to regeneration of fire origin. these differences cause related differences in tree growth and stand development, and thus in the length of time required to grow the next merchantable crop, i.e., rotation. Yield tables are available to forecast yields of old growth stands, but no yield tables are available for second growth stands. For these, any quantitative information is rather scarce and even potential data for Alberta is limited to the first 30 years of growth. therefore, related mensurational research is urgently needed to remedy this situation by developing suitable yield predicting systems for second growth lodgepole pine and white spruce stands.

9. Study Objectives:

To develop a growth and yield prediction system for second growth lodgepole pine and white spruce--i.e., new stands that follow harvest and are being established through either natural regeneration or planting-- within an appropriate and available site classification framework. Yield estimates thus obtained should be suitable input for timber management system models (e.g., TIMPLAN) for AAC calculations.

10. Goals for 1990-91:

1. Continue the Ph.D program at U. of A. and prepare for and take the candidacy exam.

2. Revise and publish the Forest Science paper on height growth models using direct height age measurements instead of a fixed age site index - a new technology for development of height/SI curves.

3. Revise and publish as a FMN, a manuscript on height/SI curves for the major tree species in Alberta.

4. Prepare a manuscript on the methodology of height/SI curves development and their applications based on the work involved in developing the new set of Alberta height/SI curves for the major commercial tree species in the provence.

5. To enhance the utility of the lP managed stand growth model, develop and install a new improved diameter growth function, and refit all model parameters on the corrected AFS PSP data and the CFS spacing/thinning data (previous version of the model was fitted exclusively to old growth data). As part of this analysis, work out a single, practical rule for density and elevation correction in lP stands, as requested by the AFS and Weldwood.

    a) As a part of this work a new goal had to be added to develope individual crown classes height growth models for all Alberta tree species.

6. Complete testing of the lP model and publish an Information Report as a user's guide.

7. Complete and publish a paper on improvements in nonlinear regression analysis techniques, i.e., a paper on technical aspects of the modeling work that has been initiated in previous years.

8. Initiate the development of a system to predict G&Y of natural and managed aspen stands in the region based on the approach derived for lP managed stands, i.e., the logarithmic density-size limiting relations. This goal was extended to accommodate two additional targets:

    a) Coauthor a paper on the results of aspen growth data analysis for the Aspen Symposium, Edmonton; and
    b) Collaborate with other scientists in Canada and USA on the conceptual formulation of the aspen growth and yield models and work towards coauthored report.

9. Contribute to the development of a DSS for forest management in the region as required.

10. Give talks and demonstrations on growth and yield modeling as required.

Added Goals:

11. Search for data from available sources, conduct analysis towards developing a growth and yield predicting system for aspen.

12. Analyze the Weldwood Canada Ltd. lP stem analysis data and test for consistency with the AFS data.

13. Respond to Weldwood's request, conduct analysis of compatibility between their present SI and height models and develop another set of models if needed to overcome incompatibilities.

14. In response to AFS requests initiate a development of a user friendly human interface for the lP stand model.

15. Provide prototype models of height and diameter growth and survival for the aspen stand management DSS.

16. Develop a new technology for fitting self-referencing functions to assure base-age invariance in developing height site index models.

17. Use the new technology (goal 16) for base-age invariant fitting of self-referencing functions to recalibrates all of the height site index models for the major Alberta tree species. Use the results to update the manuscript in goal 3.

11. Accomplishments in 1990-91:

1. Completed all course work and passed the candidacy exam for the Ph.D. study.

2. The paper on height growth models using direct height age measurements instead of a fixed age site index has been revised and resubmitted for publication to Forest Science.

3. The paper on height/SI curves for the major Alberta tree species has been revised and submitted for publication as a FMN.

4. A first draft of the manuscript on the methodology of height/SI curves development and their applications based on the work involved in developing a new set of Alberta height/SI curves for the major commercial tree species has been prepared.

5. The AFS and FORCAN thinning data has been processed for refitting of the lP stand model. Some initial analysis were started but could not be finished due to unforseen loss of technical support. Working out a single, practical rule for density correction in lP stands, as requested by the AFS and Weldwood, has been accomplished (manuscript in review). Analysis of available data showed that when height growth variation is partially explained by site index, elevation practically does not contribute to any further explanation.

   a) Individual crown classes height growth models have been developed for all Alberta tree species.

6. Extracted and processed the corrected AFS data for testing the lP stand model with respect to new stand height. Processed also FORCAN data from thinning and spacing trials (including some recently collected control measurements) for testing the model performance in young ages with respect to height-density growth suppression. Tested the newly developed height/density model for compatibility with the published CJFR lP variable age SI height model. Loosing technical support prevented completion of this goal.

7. Due to lack of technical support this goal has been postponed.

8. Initiated the development of a system to predict G&Y of natural and managed aspen stands based on the approach derived for lP managed stands, i.e., the logarithmic density-size limiting relationship. The other goals developed from extension of this goal:

   a) Coauthored a paper with I.E. Bella and D. A. Perala on the results of aspen growth data analysis and stand model development.

   b) Collaborated with D. A. Perala on the development of an integral diameter growth and mortality model for aspen---a manuscript on the results for submission to CJFR is nearly completed.

9. Contributed to the development of DSS for forest management in the region as required.

10. Gave talks and demonstrations on growth and yield modeling as required.

11. Obtained and analyzed aspen growth and yield data from the USFS, NCFES, formulated a new framework for aspen growth and yield system based on the previous experience with lP stand model.

12. Analyzed the Weldwood Canada Ltd. stem analysis data; used the data in the development of the provincial curves and developed a separate height model for Weldwood.

13. Conducted analysis on the incompatibility of the Weldwood SI and height model, and developed a new fully compatible height SI model.

14. The development of a user friendly human interface has been initiated and is showing excellent progress.

15. Provided prototype models of height and diameter growth and survival for the aspen stand management DSS implemented and presented as a poster during the Aspen Management Symposium (Bella, Ejsmond, Navratil, Yang).

16. Developed a new technology for fitting self-referencing functions to assure base-age invariant in developing height site index models.

17. Used the new technology (goal 16) for base-age invariant fitting of self-referencing functions to recalibrates all of the height site index models for the major commercial tree species in Alberta. Updated the publication in goal 3 accordingly.

12. Present Status of Study:

The development of height curves is finished. Analysis of density effect on the lP height growth are finished and report writing remains. LP stand model development is disrupted by the loss of technical support. Aspen model development begun and shows good progress. The Ph.D. program is progressing well.

13. Goals for 1991-92:

1. Continue thesis preparation for the Ph.D program at U. of Alberta.

2. Publish the paper on height/SI curves for the major Alberta tree species as a FMN (Cieszewski, Bella).

3. In response to AFS requests complete the development of a user friendly human interface for the IP stand model (Cieszewski, Wawrykowicz).

4. Publish the paper on predicting density related reduced height growth of lodgepole pine in Alberta (Cieszewski, Bella).

5. Publish the paper on modeling aspen G&Y from the presentation given in the 1990 aspen symposium (Cieszewski, Bella, Perala).

6. Coauthor a poster on the model of aspen radial growth and survival at a Decision Support System Conference (Perala, Cieszewski, Host)

7. Finish developing and installing a new improved diameter growth function, and refitting all IP stand model parameters on the corrected AFS PSP data and the FORCAN spacing/ thinning data (previous version of the model was fitted exclusively to old growth data).

8. Complete testing of the above IP model, and publish an Information Report as a user's guide (Cieszewski, Bella, Wawrykowicz)

9. Revise and publish a paper on the methodology of height/SI curves development and their applications, based on the work of developing a new set of height/SI curves for the major commercial tree species in Alberta (Cieszewski, Bella)

10. Complete the development of a system to predict growth and survival of natural and managed aspen stands in the region based on the approach derived for IP managed stands, i.e., the logarithmic size-density limiting relationship.

11. Publish the results of goal 10. (Perala, Cieszewski)

12. Prepare a draft of a manuscript on the new technology of base-age invariant fitting of self-referencing functions (last year's goal 16)

13. Contribute to the development of a DSS for forest management in the region as required.

14. Give talks and demonstrations on growth and yield modeling as required.

15. Prepare a draft of a FMN on the development of height/SI curves for different crown classes of all Alberta commercial tree species.

16. Publish a guide to a new methodology of height/SI curves development (Cieszewski, Titus).

17. Complete and publish a paper on improvements in nonlinear regression analysis techniques, i.e., a paper on technical aspects of the modeling work that has been initiated in previous years (Cieszewski, Bella)

14. Publications 1990-91:

Nil

15. Environment Implication:

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

16. Duration:

Start: 1986 Completion: 1992

17. Resources 1991-92:

PYs:	Prof.:	Cieszewski	1.0
		Bella	0.3
	Tech.:		1.0
	Total:		2.3
	Term/Student:		0.3

O & M: $2,000
Capital: $1,500 (Laser printer)

18. Signatures:

Investigator

A/ Program Director, Resources

Regional Director General

NOR-5-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 4, 1991

1. Project: Fire Management Research

2. Title: Fire behavior in boreal forest fuels

3. New: Cont.: Term: X 4. No.: NOR-5-01

5. Study Leader: Z. Chrosciewicz

6. Key Words: Canadian Forest Fire Weather Index, fire behavior, fire use, fire effects, danger rating

7. Location of Work: Northwest Region

8. Problem:

Intensive fire management requires improved methods of assessing and forecasting fire danger for all major fuel types over a wide range of weather and site conditions. A good start in the development of such methods was made with the introduction of the new Canadian Forest Fire Weather Index tables in 1970. The main index as well as the component codes are designed to summarize and rate the important weather variables that affect the ignition and spread of forest fires. In its daily rating of fire danger, the system uses primarily weather-dependent scales, and so it does not really provide means for rating fire behavior and effects in specific fuels. A thorough knowledge of fuel types, their characteristics and their ultimate interactions with fire is, therefore, essential for both proper control and proper use of fire on problem areas.

Specifically, the research in this study is aimed at (a) developing suitable techniques for assessing spatial distribution and loading of dimensionally categorized total biomass in any forest ecosystem, (b) delineating basic relationships between weather, moisture codes, and actual moisture contents of various dead components of that biomass, (c) documenting seasonal changes in moisture content, dry-weight content, chemical content, and heat content of some more important living biomass components present, (d) determining microclimatic differences between major forest ecosystems and the open in terms of solar radiation, temperature, relative

humidity, wind speed, and rainfall, (e) measuring and analyzing various fire-behaviour parameters, and fire effects, over a range of diverse forest weather, fuel, and landform conditions, (f) devising seasonally differentiated fire-hazard rating for major forest ecosystems in the region, and (g) testing and formulating ecologically sound and economically feasible methods for securing adequate postcut forest reproduction by the use of controlled burning and various supplementary treatments including seed-tree systems, direct seeding and planting. The work is of both fundamental and practical nature.

9. Study Objectives:

   1. To determine fire spread and intensity for major fuel complexes under various weather combinations.

   2. To assess fire effects in terms of fuel reduction and plant succession over a range of burning conditions.

   3. To establish guidelines for rational uses of fire in manipulation of various fuel combinations.

   4. To assist fire control agencies in application of the resulting guidelines.

10. Goals for 1990-91:

   1. Conclude publication of a journal article on "Site conditions for jack pine seeding."

   2. Complete and submit for publication a journal article on "Prediction of fire-produced seedbeds on jack pine-black spruce cutovers".

   3. Complete and submit for publication a management note with "Tables for silvicultural burning prescriptions on jack pine-black spruce cutovers".

   4. Conclude preparation of a journal article on "Metric roundwood classification and jack pine forest biomass studies."

   5. Carry out a followup regeneration and growth survey on spot seeded in 1960-63 upland jack pine cutovers and burns, central Ontario.

      The incumbent intends to retire at the end of June 1990, and will seek a part-time status in order to complete a number of publications including those under items 1-4 above. Data analysis and report writing for item 5 will be done in 1991-92.

11. Accomplishments in 1990-91:

   1. Published a journal article on "Site conditions for jack pine seeding."

   2. Advanced preparation of a journal article on "Prediction of fire-produced seedbeds on jack pine cutovers."

   3. Advanced preparation of a management note with "Tables for silvicultural burning prescriptions on jack pine-black spruce cutovers."

4. Commenced a journal article on "Metric roundwood classificaton and jack pine forest biomass studies."

5. Conducted a follow-up regeneration and growth survey on spot seeded in 1960-63 jack pine cutovers and burns, central Ontario.

Added Accomplishments:

6. On request from the agencies involved, conducted comprehensive seminars on the various uses of fire in postcut regeneration of conifers, notably jack pine and black spruce. This was done for:
   a) the Forestry Canada Prescribed Fire Working Group meeting at Hinton, Alberta, May 30, 1990... and
   b) the Ontario Ministry of Natural Resources Forest and Fire Managers Group meeting at Kenora, Ontario, October 10, 1990.

   Papers under items 2-4 could not be completed in 1990-91 because, so far, the incumbent was unable to resume his duties on a part-time basis.

12. Present Status of Study:

The new Canadian Fire Weather Index was introduced to the Region in 1970 through a series of training sessions for the user agencies. Since then, fire behavior and fire effects were studied by means of experimental burning on a number of cutover sites and in uncut stands.

Varying in area from 0.09 to 33.35 ha, the tests included: 2 burns of black spruce slash, plus 17 burns of jack pine slash in Manitoba; 31 burns of jack pine slash in Saskatchewan; and 22 burns of lodgepole pine slash, 2 burns of undisturbed black spruce stands, plus 20 burns of undisturbed jack pine stands in Alberta.

While this work was nearing completion, variations in moisture content, dry-weight content, chemical content, and heat content of green conifer foliage (jack pine, black spruce, white spruce and balsam fir) were studied in Alberta to determine their seasonal lows and highs that may contribute substantially to the incidence and the spread of crown fires.

Postburn treatments such as seed-tree systems, direct seeding, and planting were routinely tested in conjunction with all experimental fires on cutover areas to provide authentic prescription data for silvicultural purposes.

Other work included development of methods for fuel classification, stand biomass assessments, stand fire hazard ratings, and microclimate studies in diverse forest ecosystems.

In all this, results are being published as they become available. Over 40 journal articles, in-house reports, and notes have been published on the basis of this study. The specific contributions by the objectives listed can be summarized as follows:

Objective #1. Fire spread and intensity values were determined for (a) lodgepole slash (22 burns), (b) undisturbed black spruce stands (2 burns), and (c) undisturbed old jack pine stands (8 burns). Further fire spread and intensity values will be forthcoming for (d) undisturbed semimature jack pine stands (12 burns).

Objective #2. Fuel reduction values and information on plant succession, including forest regeneration, were provided for (a) black spruce slash (2 burns) and (b) jack pine slash (48 burns). In addition, fuel reduction values alone were provided for (c) lodgepole pine slash (22 burns), (d) undisturbed black spruce stands (2 burns), and (e) undisturbed old jack pine stands (8 burns). Further fuel reduction values will be forthcoming for (f) undisturbed semimature jack pine stands (12 burns).

Objective #3. Explicit guidelines were published for postcut disposal of fuels as well as for formulation of specific prescriptions in preparation of favorable seeding and planting sites by fire. Further 24 regressions and readout tables will be forthcoming for more precise setting up of silvicultural burning prescriptions over a wide range of jack pine-black spruce cutover sites.

Objective #4. Fire control agencies, silviculturist, educators, and all those willing to listen were instructed on the use of available guidelines. This was done by means of personal contacts, through various handouts, and through a series of some 20 more or less formalized, often illustrated lectures, seminars, and workshops. The process of instruction will continue.

13. Goals for 1991-92:

Nil. Study terminated with resignation of Study Leader. Any further completed publications will be reported under another fire study.

14. Publications in 1990-91:

Chrosciewicz, Z. 1990. Postcut burning and black spruce regeneration. Pages 35-44 in B.D. Titus, M.B. Lavigne, P.F. Newton and W.J. Meades, editors. The silvics and ecology of boreal spruces. IUFRO Working Party S1.05-12 Symp. Proc., Newfoundland, 12-17 Aug. 1989. For. Can., Newf. & Labrador Reg., St. John's, Newfoundland. Inf. Rep. N-X-271.

Chrosciewicz, Z. 1990. Site conditions for jack pine seeding. For. Chron. 66(6):579-584.

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: 1970 Completion: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Bryan S. Lee
FOR Z. CHROSCIEWICZ
Investigator

Program Director, Protection & Environment

Regional Director General

NOR-5-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 4, 1991

1. Project: Fire Management Research

2. Title: Evaluation and development of fire detection-suppression technology

3. New: Cont.: X 4. No.: NOR-5-02

5. Study Leader: C.J. Ogilvie

6. Key Words: Aerial patrols, lookouts, detection, storm tracking, wildfire mapping, remote sensing, retardants, combustion lab, air tankers, suppression, fire control, fire planning, foam

7. Location of Work: Northwest Region

8. Problem:

Each year fire starts number at least 2000 in the prairie provinces and Northwest Territories. Many of these fires become unmanageable resulting in costly suppression and mop-up activities. The objective of this study is to improve fire detection, surveillance and suppression methods. It is oriented towards the immediate needs and requests of the client agencies and so provides an excellent opportunity to improve operations which will reduce total fire losses and minimize fire suppression costs.

Many of the results achieved in this study have already been implemented, and the prospects of further findings being put to practical use are excellent.

The following general course of action is being followed:

1. Discussion with respective user agencies to define and outline the problems to be solved.

2. On-site evaluations of existing installations and analysis of available data.

3. Formulation of objectives to be met by new systems or equipment.

4. Design of new systems or modification of existing systems in order to achieve optimum returns under given local conditions and accepted restraints.

5. Assistance to user agencies during implementation including solving day-to-day problems that have a bearing on systems design and operation.

9. Study Objectives:

1. Develop techniques and equipment for wildfire surveillance and mapping.

2. Identify the most advantageous primary detection medium for given conditions.

3. Develop techniques to evaluate fire retardants and determine the optimum application required to inhibit fire spread in different fuels under varying burning conditions.

4. Develop fire suppression production information for a variety of methods and conditions.

5. To analyze and disseminate information to fire management agencies through technical assistance, consultation, and training.

10. Goals for 1990-91:

1. Continue forest fire foam evaluations in cooperation with the AFS, GNWT, Sask. DPRR and Chemonics Canada Ltd.

2. Take delivery, install and test the video down link as a part of the AIDMAS.

3. Take part in the Mass Fire study in Ontario by providing the AIDMAS service and participating in the use of the NoFC, LSP camera system to obtain pre and postburn fuel data. (R. Hall NOR-02-04)

4. Provide the analysis of the IR and visible light imagery using the NoFC digital video analysis system, to the various organizations involved in the Mass Fire study.

5. Act as chairman for the International Ground Suppression Foam Workshop to be held April 24-26, 1990 in Cranbrook, BC. The workshop is co-sponsored by FFES and FEWT.

6. Submit the article on the application of the US Operational Retardant Evaluation study to Canadian conditions to "Foam Applications for Wildland and Urban Fire Management".

7. Initiate an investigation regarding seen area mapping using GIS. (B. Lee NOR-05-04)

8. Provide technical services and liaison to client agencies.

11. Accomplishments in 1990-91:

1. Foam drop evaluation procedures were finalized and tested in northern Alberta in cooperation with the Alberta Forest Service, Chemonics Canada Ltd. and Turbowest Helicopters. Ground data and FLIR imagery were collected on a number of CL215 drops made on a fire near Lac La Biche.

2. A video down link supplied by Compuheat Canada Ltd. was received and tested. The testing proved the equipment to be unacceptable and it was returned. The components for a second system using a different concept have been purchased and are being integrated by B.R. Enterprises.

3. Two prescribed fires in the Timmons, Ontario area were imaged using the AIDMAS. The NoFC LSP camera system was used to obtain large scale preburn imagery of the fuels on the Mass Fire study sites. These fires are part of a Canada-US cooperative study involving Forestry Canada, Ontario Ministry of Natural Resources, U.S. Forest Service, NASA, NIST and SAC. The AIDMAS is the primary source of IR data for this study.

4. The analysis of the IR imagery is ongoing. To assit in the analysis a system to enable a video picture to be transmitted over a telephone line is being developed.

5. The International Ground Suppression Foam Workshop was attended by some 80 people from as far as Maine and California in the U.S. and New Brunswick in Canada.

6. The article on applicaton of the US Operational Retardant Evaluation study to Canadian conditions was submitted to "Foam Applications for Wildland and Urban Fire Management."

7. The investigation regarding seen area mapping using GIS was initiated but was limited due to the inability to run the needed GIS program (PAMAP).

8. Provided technical services and liaison to client agencies as follows:

   a) Presented a poster and demonstrations on the AIDMAS at the Associate Committee on Agriculture and Forestry Aviation Symposium and Trade Show in Winnipeg October 8-12, 1990.

   b) Presented a poster and demonstrations on the AIDMAS at the Industrial Trade Show and Hi-Technology Exhibition in Calgary Sept. 5-6, 1990.

   c) Conducted demonstratoins on the video image analysis system to the following:
   - Fire Danger working group
   - representatives of the Sask. Dept. of Parks and Renewable Resources.
   - Alberta Forest Service Inventory representatives
   - Members of NoFC resources group and FIDS

   d) Provided engineering drawings and advice regarding the NoFC portable fire finder to the Manitoba Dept. of Natural Resources.

e) Conducted IR scanning and video analysis of spruce budworm infested trees in cooperation with FIDS and the AFS.

f) Provided assistance to the Alberta Fish and Wildlife during a prescribed burn in the East Slopes.

g) Initiated the installation of a FLIR scanner on air attack aircraft to enhance air tanker efficiency. This was done in cooperation with AFS, Airspray, FLIR Systems, and Cessna.

12. Present Status of Study:

1. The use of hand-held infrared scanners for forest fire mop-up was initiated and methods developed for their use.

A "scan-extender" designed to expand the capabilities of hand-held infrared scanners was conceived, built and tested.

An "area estimator" designed to measure ground distances from the air was developed and built.

A large capacity battery and charging system capable of powering various instruments for long periods was developed.

An inexpensive portable lookout fire finder was developed.

Equipment for gathering and analyzing infrared imagery of large prescribed burns has been identified, modified and tested.

Development is ongoing and the Aerial Infrared Data Management and Analysis System (AIDMAS) has proven to be an essential part of the fire behavior analysis of large prescribed fires.

2. Detection appraisal studies have been completed for Manitoba (1987), Riding Mountain National Park, (1981), Saskatchewan (1978), Prince Albert National Park (1978), Wood Buffalo National Park (1978), Northwest Territories (1975), and Yukon (1974).

An attempt was made to integrate the LLP system and the For Can scan extender to improve the ability to locate holdover fires. This met with limited success due to inaccuracies in the LLP system at that time and the lack of a reliable lightning fire prediction model.

Data was collected at the source of lightning ignitions in support of a lightning fire prediction model.

Nine detection tower sites have been evaluated for effectiveness, following recommendations made in the detection appraisal studies in Saskatchewan.

Extensive tests were conducted to determine the suitability of the Daedalus 1260-1268 line scanner for detecting holdover fires.

Tests were also conducted to compare the For Can scan extender AGA scanner combination, The Barr and Stroud scanner and the Daedalus line scanner.

3. The apparatus and methods were developed for doing comparative evaluations of retardants in the combustion laboratory.

   An orientation trip were made to California to become familiar with the retardant evaluation program.

   Preliminary trials have been made to develop methods of guiding the air tanker operation and evaluating drops using infrared technology.

4. The University of Alberta has been conducting fireline production work which started in 1986 with a PRUF grant. The work continued in 1987, 1988 and 1989 under a Canada-Alberta FRDA contract. Several papers have been published or are in progress covering production rates for both crews and equipment. A Bulldozer Use Manual was published.

5. Information dissemination takes up an estimated 25% of the PY time in this study and is ongoing.

13. Goals for 1991-92:

1. Participate as a cooperative researcher in the international mass fire study being conducted in Ontario by obtaining and analyzing IR and visible light imagery using the AIDMAS, LSP system and the video analyzer. The resulting data will be used to develop a prescribed fire ignition model and new methods of measuring fuel loading from large scale photographs. (CJO, GLFC, PNFI, NOR-02-04, OMNR, USFS) [NSP-20,15; RSP II, III, 3]

2. Continue forest fire foam delivery efficiency evaluations in cooperation with the AFS, Turbowest, and Chemonics. Part of this work may be conducted in conjunction with wildlife related burns planned by the AFS in the East Slopes. (CJO, KGH, AFS Chemonics, Turbowest) [RSP III V, 5]

3. Develop methods of utlizing IR in the air attack aircraft to enhance air tanker efficiency and provide IR intelligence to the ground attack. (CJO, AFS, Airspray, FLIR Systems) [NSP-23; RSP-III]

4. Develop a radio frequency video transmission capability for enhanced intelligence dissemination (CJO, AFS, B.R. Enterprises, OMNR) [RSP-III].

5. Supply the detection component to the preparedness planning integrated study. (NOR-05-07, CJO) [NSP-20, 23; RSP-III, 1, 5].

6. Contribute to the Fire Research Project Strategic Plan. (NOR-05-07, CJO) [NSP-24; RSP-VI].

7. Complete a problem analysis on fire suppression research in the Northwest Region. Produce an internal report and a published futuring paper. (KGH, CJO) [NSP-20; RSP-III, VI].

8. Provide technical services and liaison to client agencies.

14. Publications 1990-91:

Ogilvie, C.J. 1990. A Canadian Foam Effective Study. NWCG Foam Applications for Wildland and Urban Fire Management. Vol. 3, No. 2. (In press.)

Ogilvie, C.J. 1990. IR scanning of spruce budworm. In Hawk Hills Spruce Budworm Project Report. For. Can. NoFC December 24, 1990.

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: 1971. Completion: 1996

17. Resources 1991-92:

PYs:	Prof.	Hirsch	0.1
	Tech.	Ogilvie	0.9
	Total:		1.0
	Term/Student:		0.0

O & M: $ 7,000

Capital: $ 1,500

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-5-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 19, 1991

1. Project: Fire Management Research

2. Title: Fire management systems and modelling

3. New: Cont.: X 4. No: NOR-5-04

5. Study Leaders: B.S. Lee, K.R. Anderson

6. Key Words: Fire physics, fuels, fire line production, fire statistics, fire effects, decision models, fire management, computer systems, geographic information systems.

7. Location of Work: Regional

8. Problem:

Fire management is becoming more complex every day. Increasing costs, changing values, higher risk, as well as hosts of other factors make any fire management decision difficult at best. At the same time we are entering into the age of "high technologies" which offer new opportunities for fire management decision support. Hence, it is becoming increasingly more important that Forestry Canada investigate the application of these "high technologies" to forest fire management problems. A significant research, development, and technology transfer role exists to develop new processes, conduct applications research, and provide support for the integration of the new technology into day-to-day forest fire management.

The application and integration of management science techniques such as numerical models (i.e., simulation and gaming), expert systems, and artificial intelligence into forest fire management emphasizes the development and technology transfer components of the innovation (research) process. Fire management needs computerized decision-aids, database management structures and/or systems, and associated technology transfer documents to operate effectively in today's environment. This role is well within the mandate of Forestry Canada and the capability of NoFC.

The maturing computer applications area of expert systems provides a new opportunity area for Forestry Canada. Such systems have the potential to provide enhanced day-to-day decision making for fire and natural resource managers. In future these systems will integrate factual information now being derived from numerical models like the FWI and FBP systems with the knowledge and "expertise" of fire managers. They will add a new layer of information into the

computer-assisted decision process and will provide better human - machine interfaces. Future expert systems will also automate the learning process, however such systems are probably 10 years away at this time.

9. Study Objectives:

1. To identify the key factors relating to the occurrence, behaviour, and effect of wildfires on the cost-effectiveness of fire control decisions.

2. To build, test, and operate relevant decision-aid models designed to assist fire management agencies in optimizing the allocation and use of available resources during demanding or multiple fire occurrence situations.

3. To develop and maintain regional data bases on fire weather, fire occurrence, fire environments, and fire management activities for use in fire research and fire management activities.

10. Goals for 1990-91:

1. Submit a M.Sc. thesis entitled "An evaluation of the application of expert systems for dispatching initial attack resources to wildfires" for committee approval during the 1990 fall quarter. (B.L.)

2. Submit a M.Sc. thesis entitled "Techniques to forecast lightning" for committee approval during the 1990 fall quarter. (K.A.)

3. Present a paper entitled "The Intelligent Fire Management Information System - decision support for forest fire preparedness planning and initial attack dispatching" at the International Forest Fire Research conference, to be held Nov 19-22, 1990 at Coimbra, Portugal. (B.L.)

4. Present an interactive presentation entitled "Predicting lightning occurrence and frequency from upper air soundings over Stony Plain, Alberta" at the Conference on Atmospheric Electricity, to be held October 22-26, 1990 in Kananaskis, Alberta. (K.A.)

5. Complete the contract to implement a forest fire preparedness expert system for Kootenay National Park for the 1991 fire season. (B.L., K.A., R.S.)

6. Continue development and technology transfer of the Intelligent Fire Management Information System (IFMIS) through:

   a. continued software support of current IFMIS installations. (K.A., R.S.)

   b. installation of IFMIS software in the Lac La Biche, Slave Lake, and Bow Crow Forests in Alberta, and Hudson Bay and Meadow Lake Districts in Saskatchewan. (K.A., R.S.)

   c. complete the development of the basic system with new user interface, multi-tasking capability and communications. (PC-2 Term, Contract Programmer, K.A., B.L.)

d. research and development of new features such as optimal resource deployment, GIS interface, automatic vehicle location, surface wind modelling, lightning location and fire occurrence prediction. (B.L., K.A., PC-2 Term)

7. Continue evaluation of potential applications of GIS for fire behavior and management through:

   a. scene area mapping through GIS. (C.O., B.L.)

   b. incorporation of advanced elliptical fire growth models into a GIS rasterized (cell) environment. (B.L., K.A.)

   c. prepare a journal report on potential applications of GIS for fire management. (B.L., R.S., C.O.)

8. Prepare a file report on the application of the WNDCOM surface wind model in mountainous terrain. (B.L., K.A.)

9. Consider incorporation of lightning research into a Canadian Forest Fire Occurrence Prediction (FOP) System. (K.A.)

10. Develop the fire weather data library into a fire environment library for the Western and Northern Region. The library would include forest inventory and terrain data, along with the fire weather currently available. (R.S.)

11. Continue to provide advisory services to client agencies, universities, and others as required. (B.L., K.A., R.S.)

Added Goal:

12. Install IFMIS for a number of agencies.

11. Accomplishments for 1990-91:

1. Continued thesis work on the application of artificial intelligence and expert systems for forest fire preparedness and initial attack dipatching (B.L.).

2. Continued thesis work on lightning forecasting techniques (K.A.).

3. Poster presentation and paper was given at the International Forest Fire Research Conference, Nov 19-22, 1990 at Coimbra, Portugal (B.L.).

4. Poster presentation and paper was given at the Conference on Atmospheric Electricity, Oct 22-26, 1990 at Kananaskis, Alberta (K.A.).

5. Contract for a fire preparedness expert system for Kootenay National Park is near completion and will be ready for the 1991 fire season. (B.L., K.A., R.S.).

6. Development of the Intelligent Fire Management Information System continued.

a. Versions 1.5 and 2.0 of the software were released. Visits to the AFS provincial headquarters and trips to Whitecourt and Prince Albert were made to provide personal assistance and version upgrades (K.A.).

b. IFMIS was installed in the Lac La Biche, Slave Lake, Bow Crow, and Athabasca forest regions. IFMIS was not installed in Saskatchewan regional offices due to networking problems within the agency (B.L., K.A.).

c. The development of the new user interface was temporarily suspended pending the release of version 3.0 of the Microsoft Windows Software Development Kit. Upon its release in September 1990, development was resumed, and has continued to this date. Since September, the Mapper module has been redesigned in such a manner as to facilitate the easy addition of new mapping capabilities. This redesigning involved splitting the Mapper into two modules, the most extensive of which should be completed shortly. In addition to the ability to easily expand the Mapper, the Mapper has been designed so as to make it useful to projects other than Fire Management Research (PC-2).

d. A number of advance features for IFMIS were tested and developed. These include

- two linear programming routines to solve for the optimal deployment of suppression resources (K.A., B.L.).

- a test of the automatic vehicle location system. This successfully showed that AVL technology could be incorporated into the IFMIS system, although no plans by the protection agencies to place these systems on aircraft have been made. (PC-2, B.L.)

- the display of LLP lightning location data with IFMIS. Communications links to down-load the data have not yet been established. (K.A.)

- procedures to export GIS information from SPANS. No interface has been developed. (R.S., K.A., B.L.)

7. GIS applications for fire behavior and fire managament was initiated but was limited due to problems with the PAMAP GIS software.

8. File report on WNDCOM was not written. The intent was to work WNDCOM into the IFMIS software but data requirements, such as the geostrophic wind, were too demanding to incorporate.

9. Incorporation of lightning research into a Canadian Forest Fire Occurrence Prediction (FOP) System was discussed with members of the Canadian Fire Danger Group but was agreed that this should be pursued when interest is higher among protection agencies. (K.A., B.L.)

10. The fire weather data library for the Northwest Region has continued to grow. Approximately 800 station-years have been accumulated some stations starting as early as 1952. The data library has been expanded into a fire environment role with the collection of forest inventory, airtanker and initial attack base databases for agencies within the region. (R.S.)

11. Advisory services and technology transfer provided this year include:

a. Client Agencies
   - an overview presentation of the IFMIS software was given at a Parks Canada Fire Management meeting. (K.A.)

b. Universities
   - a presentation on fire management and the IFMIS software was given at the University of Alberta. (B.L.)

c. Other
   - overview presentations of the IFMIS software were given at the Central Region Fire Weather Committee and the Western Region Fire Weather Committee meetings. A paper for the former is currently in preparation (K.A.).

12. a. An IFMIS system has been installed for Manitoba for the 1991 fire season. This includes a forest inventory database interpreted from satellite imagery using the SPANS GIS software.

b. An IFMIS system has been installed for the Northwest Territories for the 1991 fire season. A forest inventory database was built from a CWS ecosystems map and advice from R. Lanoville of GNWT (B.L.).

c. An IFMIS system was used by the Alaskan Forest Service for the 1990 fire season. The system was taken to Fairbanks by T. Van Nest, Alberta Forest Service. No forest inventory database was built (B.L.).

12. Present Status of Study:

Fire Management in the Northwest Region is becoming increasingly more sophisticated. All clients in the region have deployed microcomputers at their HQ and forest level operations, with minicomputers being considered. Similarly, with the advent of this computing capability, there is a new and budding demand for the so-called "high technologies". These technologies include mathematical programming, artificial intelligence, expert systems, computer graphics and GIS, along with others too numerous to mention. It would appear that the timing is right for this study to capitalize on applications research opportunities in these new technology areas.

Specific contributions by study objectives listed can be summarized as follows:

1. The Intelligent Fire Management Information System (IFMIS) has been very successful in Alberta and Saskatchewan. Preliminary studies conducted by the Alberta Forest Service have suggested by using IFMIS, the province can save in the order of two to five million dollars a year in presuppression costs. Thus the service has decided to adopt the coverage assessment concept put forward in IFMIS as the new method for presuppression planning.

2. Knowledge engineering and systems analysis approaches with client agencies have served to identify key factors related to fire management as well as to develop conceptual models of fire management systems, both existing and in the future.

3. Computer-based decision aid models developed at NoFC such as the Intelligent Fire Management Information System (IFMIS), the Initial Attack Planning Model, FWI/PC, and the Appropriate Suppression Response Expert System are being used by client agencies.

Future initiatives in GIS along with new mathematical models for expert systems for deployment planning and fire effects will also contribute to fire management within the region, as well as nationally.

4. A large historical fire weather/fire environment data library has been developed for clients of the Northwest Region. This data library has assisted clients in developing the data bases required to evaluate fire management effectiveness and will provide the data bases essential for future fire occurrence prediction models.

13. Goals for 1991-92:

1. Conduct a program of strategic planning for the fire management research project that takes into account the advice and consultation of client agencies and research cooperators. This goal includes the following outputs and milestones:

   a. Conduct a client research needs questionnaire and prepare a report summarizing the results of the survey by September 15, 1991. (BSL, KGH) [NSP-923; RSP-VI]

   b. Hold a fire management research and technology transfer needs priorization workshop in conjunction with the Regional Technical Sub-Committee (RTSC) on forest fire research by October 15, 1991. (BSL, KGH, and others) [NSP-923; RSP-VI]

   c. Present questionnaire and RTSC workshop results to the Senior Regional Advisory Committee by November 21, 1991. (BSL) [NSP-923; RSP-VI]

   d. Complete a Strategic Plan for Fire Management Research for Forestry Canada Northwest Region by March 15, 1992. (BSL) [NSP-920,923; RSP-VI]

2. Initiate an integrated research study on forest fire preparedness planning. This study will include the preparation of a literature review, a fire suppression containment model, and development of a working computer model. Outputs and milestones for this goal include:

   a. Hold a scoping session to determine the nature of the problem, the potential products/outputs, and prepare a detailed action plan by May 30, 1991. (BSL, KGH, WJD, CJO) [NSP-920, 923; RSP-III]

   b. Prepare a literature review on forest fire preparedness planning by March 15, 1991. (KGH, WJD, CJO) [NSP-920, 923; RSP-III]

   c. Develop a prototype computer model for forest fire preparedness planning by March 15, 1991. (KRA, BSL) [NSP-920, 923; RSP-III,1]

3. Develop a project communication package to include a new third floor wall display, a new publication display, a portable public info display, a Fire Management Research Project brochure, and a slide presentation. (BSL, WJD, MEM, KGH, RMS) [NSP-923]

4. Initiate cooperative research and technology transfer programs under the Partnerships Agreements in Forestry and the Green Plan. (BSL) [NSP-923; RSP-VI]

5. Re-write the vice Lee PAS to a CS, systems analyst, and fill the vacant position. (BSL) [NSP-924; RSP-VI]

6. Supervise and coordinate the regional fire management research program, including providing assistance to the district offices. The latter could include staffing of fire management specialist positions for one or both of the district offices. (BSL) [NSP-924; RSP-VI]

7. Provide liaison and technology transfer through attendance at national and regional fire research meetings (ie; CCFFM, RTSC-FMR), Forestry Canada fire research meetings (ie; FDRWG, PFWG), and participation on committees and task forces (ie; AFS Preparedness Planning Committee). (BSL) [NSP-923; RSP-VI]

8. Maintain cooperative relationships and studies with the University of Alberta and other centres including presentations at academic institutions as appropriate. In conjunction with the University of Alberta, this will include the establishment and supervision of a coop graduate student position in forest fire science, located at NoFC. (BSL and U of A) [NSP-924; RSP III]

9. Continue the development of the Forest Fire Reprint Collection by

   a. entering 3000 additional records into the Pro-Cite data base

   b. relocating and organizing the collection for ease of use by Project staff and clients

   c. preparing accession listings, user guide, and demonstrations to Project staff on the use of the Pro-Cite data base. (MEM and term/student) [NSP-923; RSP-VI]

10. Submit a M.Sc. thesis entitled "An evaluation of the application of expert systems for dispatching initial attack resources to wildfires" for committee approval. (B.L.). [NSP-915, 924; RSP-III].

11. Submit a M.Sc. thesis entitled "Techniques to forecast lightning" for committee approval. (K.A.) [NSP-915, 924; RSP-III].

12. Present an interactive presentation entitled "Linear programming techniques for initial attack resource deployment" at the 11th Conference of Fire and Forest Meteorology, April 16-19, Missoula, Montana. (K.A., B.L.) [NSP-915; RSP-III].

13. Provide support for the completion of the Canadian Forest Fire Behavior Prediction (FBP) System technology transfer/training package. (K.A.) [NSP-923; RSP-III,4].

14. Continue development and technology transfer of the Intelligent Fire Management Information System (IFMIS) through:

   a. continued software support of current IFMIS installations. (K.A., B.L., S.H., R.S.) [NSP-923; RSP-III].

   b. assist Manitoba and the Northwest Territories as they begin using IFMIS for their first fire season. (K.A., B.L., R.S.) [NSP-923; RSP-III,IV].

c. provide IFMIS systems to Ontario and British Columbia for trial use and evaluation. (B.L., K.A.) [NSP-923; RSP-III].

d. continue developement of the DOS and the Windows versions of the IFMIS software. Consider possible development of a UNIX version. (S.H., K.A.) [NSP-923; RSP-III,1].

e. IFMIS overview documentation.

15. Complete a literature review of fire occurrence prediction models. (K.A.) [NSP-915; RSP-III].

16. Continue developing expert systems and operations research applications for fire management. (B.L., K.A., S.H.) [NSP-915; RSP-III,1].

17. Continue development of the fire environment data library for the Northwest Region. (R.S.) [NSP-902; RSP-III,5].

18. Continue to provide advisory services to client agencies, universities, and others as required. (B.L., K.A., S.H., R.S.) [NSP-923; RSP-III,4].

14. Publications 1990-91:

Anderson, K.R.; Charlton, R.B. 1990. Predicting lightning occurrence and frequency from upper air soundings over Stony Plain, Alberta. Pages J40-J45 in Preprints of the 16th Conference on Severe Local Storms/Conference on Atmospheric Electricity, Oct 22-26, 1990, Kananaskis, Alta. Amer. Meteorol. Soc., Boston.

Lee, B.S.; Anderson, K.R. 1990. An Overview of IFMIS: the Intelligent Fire Management Information System. In Proceedings of the International Conference on Forest Fire Research, Nov 19-21, 1990, Coimbra, Portugal. (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: 1984. Completion: 1994.

17. Resources 1991-92:

PYs:	Prof:	Lee	0.5
		Anderson	1.0
		CS-2	1.0
	Tech:	Smith	1.0
		Maffey	0.2
Total			3.7
	Student		0.3

O&M: $18,000
Capital: $20,000
Other: $10,000 (Sask.)

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-5-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 7, 1991

1. Project: Fire Management Research

2. Title: Fire danger and behavior rating in forest and rangeland environments

3. New: Cont.: X 4. No.: NOR-5-05

5. Study Leaders: M.E. Alexander

6. Key Words: Canadian Forest Fire Danger Rating System, wildfire case histories and studies, fire behavior estimation, fire environment

7. Location of Work: Northwest Region

8. Problem:

Embedded in nearly every fire management decision is the need to accurately evaluate fire danger and/or predict fire behavior for a variety of fuel types/topographic situations over a range of possible fire weather conditions. The goal of fire danger/fire behavior research should be to provide fire managers with simple, timely answers to the following questions given an actual or potential wildfire occurrence:

What will be the head fire rate of spread? What will be the area, perimeter length, and forward spread distance at 1 hour, 2 hours, 3 hours and so no after it starts?

Will it be a high-intensity or low-intensity fire? Will it be a crown fire or a surface fire? How difficult will it be to control? Will mechanical equipment and/or airtankers be required or can it be handled by a suppression crew?

Is there a possibility of it "blowing-up"? If so, will it produce a towering convection column or have a wind-driven smoke plume? What will be the spotting potential? -- short- or long-range? Are fire whirls likely to develop? If so, when and where?

The Canadian Forest Fire Danger Rating System (CFFDRS) represents the practical output of the continuing Forestry Canada (ForCan) fire behavior research programme (i.e., experimental burning projects and wildfire investigations).

The CFFDRS is the national system of rating fire danger in Canada. The CFFDRS includes all guides to the evaluation of fire danger and the prediction of fire behavior such as the Canadian Forest Fire Weather Index (FWI) System and Canadian Forest Fire Behavior Prediction (FBP) System. This study formalizes the need for the continuing development, evaluation, interpretation, and application of the CFFDRS in the region serviced by the Northern Forestry Centre (NoFC) in order to further extend its usefulness in fire management planning and operational decision-making. Secondly, it recognizes the opportunity to formulate improved methods for the assessment and prediction of wildfire behavior in terms which are useful to fire management agencies by regional adaptation of existing and new knowledge, techniques, etc. The principal aim or thrust of Study NOR-5-05 is to develop practical systems or schemes for evaluating fire danger and predicting fire behavior for use in fire management and fire suppression programs. Note that this study is designed to compliment rather than duplicate some of the RD&A efforts covered under studies NOR-5-01 and NOR-5-04.

9. Study Objectives:

   1. To develop, evaluate, interpret, and apply the Canadian Forest Fire Danger Rating System.

   2. To improve the assessment and prediction of wildfire behavior in terms and by methods which are useful to fire management agencies.

10. Goals for 1990-91:

    1. Continue longer term training (LTT) towards the completion of a Ph.D. degree at the Australian National University while occupying a Visiting Fire Researcher position with the CSIRO National Bushfire Research Unit, Canberra, A.C.T., Australia. (M.E.A.)

    2. Attend to any manuscripts currently in the "system" which may be returned by the NoFC editorial group (e.g., Porter L. Inf. Rep., Interior West Fire Council proceedings, annotated bibliography on fire research, spring fires in an aspen stand). (M.E.A.)

    3. Continue to participate in cooperative activities of the ForCan Fire Danger Group as necessary (e.g., finalizing draft FTR on FBP System). (M.E.A.)

    4. Continue to provide advice and services with respect to fire danger rating and fire behavior as required (e.g., manuscript reviews). (M.E.A.)

    5. Continue to support M. Alexander in Australia as requested. (M.E.M.)

    6. Support other members of the Fire Research Group as requested (i.e., help C. Ogilvie with the International Foam Workshop, Cranbrook, BC, April 24-27, 1990.) (M.E.M.)

    7. To carry out the necessary work required to produce the final edited versions of the Porter Lake and Big Fish Lake experimental burning study videos as the opportunity arises. (M.E.M.)

11. Accomplishments in 1990-1991:

1. Completed very successful year as Ph.D. Scholar, Department of Forestry, Australian National University (ANU) and Visiting Fire Researcher, Bushfire Research Unit, CSIRO Division of Forestry, while on longer-term training (LTT) in Canberra, Australia:

a) Meetings were held with Ph.D. Supervisory Committee on June 19, August 20, and December 10. The major thrust of the Ph.D. investigation, dealing with "fire behavior in exotic pine plantations of Australasia, with particular emphasis on the requirements for crown fire development, has become well-established. An outline of the project is documented in a memo entitled "Fire Behaviour in Exotic Pine Plantations" prepared for the CSIRO Division of Forestry's Research Liaison Committee-Softwood Plantation Program meeting at Mount Gambier, South Australia, November 1, 1990 and a supplement to the Australian Fire Research-In Progress-Register No. 1. A draft table of contents for the Ph.D. thesis was tabled at the August 20 meeting. The approach taken to the thesis research involves a judicious use of mathematical modelling, physical insight and relevant field experiments. (MEA).

b) Reconnaissance trips were made to Australian Capital Territory (ACT), South Australia, Western Australia, Victoria, Fiji and New Zealand for the purpose of discussions with key fire research and fire management personnel relevant to Ph.D. research project and to examine pine plantation fuel complexes in these areas. (MEA)

c) Fieldwork was undertaken in Western Australia (investigation of a medium-intensity wildfire in a P. pinaster plantation; experimental study of intermittent crown fires in P. pinaster plantation stands), ACT (temperature & radiation above surface fires in P. ponderosa; experimental study of intermittent crown fires in P. radiata), and Queensland (crown fuel weight sampling of P. elliotti and P. caribaea). Established methodology for foliar moisture content (FMC) sampling and developed network of "cooperators" in western Australia (3 sites), South Australia (2 sites), Victoria (4 sites), New South Wales (4 sites), Northern Territory (1 site), Queensland (2 sites), and New Zealand (2 sites), to sample FMC in P. radiata, P. pinaster, P. elliottii, and P. caribaea. (MEA)

d) Acquire and organized weather data associated with experimental fires and well-documented wildfires in Canadian pine fuel types for analysis of forward rate of spread in relation to Australian fire danger indexes, as well as data on height to live crown base in relation to stand structure for P. radiata, P. pinaster, P. elliottii, and P. caribaea. (MEA)

e) Lead author on a chapter dealing with crown fire initiation and spread for a book on crown fire ecosystems (edited by R.D. Laven and P.N. Omi, Colo. State Univ.) to be published by Princeton University Press. Co-authors include B.J. Stocks (GLFC), B.D. Lawson (PFC), and R.S. McAlpine (PNFI). (MEA)

f) Invited presentation (& handout prepared) on "Crown Fire Initiation and Spread: Experience in Canadian Forests and Relevance to Australian Exotic Pine Plantations" made at workshop on Plantation Fire Management: Opportunities

for Research held in conjunction with the 11th meeting of the Australian Forestry Council Research Working Group No. 6-Fire Management, July 3-4, Victor Harbor, South Australia. (MEA)

g) Invited presentation on "Fire Research in Support of Fire Management in Canada" at the Seventh National Conference of the Australian Association of Rural Fire Authorities, May 14-16, Canberra, ACT. (MEA)

h) Invited presentation on "Fire Behaviour Research in Western and Northern Canada" to Fire Protection Branch, Department of Conservation and Environment, September 24, Melbourne, Victoria. (MEA)

i) Invited presentation on "Forest Fire Behavior Research in Canada" in ADFA Bushfire Seminar series, University College, University of New South Wales, Australian Defence Force Academy (ADFA), May 23, Canberra, ACT. (MEA)

j) At the request and sponsorship of the New Zealand Fire Service and forest industry in New Zealand, delivered seminars on the Canadian Forest Fire Danger Rating System at seven locations (Auckland, Rotorua, Palmerston North, Dunedin, Christchurch, Nelson and Wellington) between October 28 and November 20. Prepared and delivered a summary of 10 major recommendations on forest and rural fire danger rating in New Zealand to the New Zealand Rural Fire Advisory Committee as a result of the 3½ week tour of the North and South Islands of New Zealand. (MEA)

k) In cooperation with Dr. E.A. Catchpole (ADFA) and Dr. A.M. Gill (CSIRO Division of Plant Industry, Canberra, ACT) developed methodology for determining elliptical fire area and perimeter intensity for steady-state conditions and acceleration phase deemed most applicable to homogenous fuel complexes (e.g., industrial pine plantations). (MEA)

l) Short article entitled "Computer Calculation of the Keetch-Byram Drought Index--Programmers Beware!" accepted for publication in Volume 51, Issue 3 or 4 (1990) of Fire Management Notes. (MEA)

2. a) Spent 5 days proofreading the final draft of the Proceedings of the First Interior West Fire Council Annual Meeting and Workshop. A further 5 days was expended on reviewing/editing three papers and on a variety of miscellaneous tasks related to the proceedings (e.g., correspondence, announcements; etc.). (MEA)

b) The finalized review draft of Inf. Rep. on "Fire Behaviour in Black Spruce-Lichen Woodland: the Porter Lake Project" originally submitted to NoFC editor in August 1988 was finally returned (received January 2, 1991) (MEA)

c) No action to report on finalized review draft of Inf. Rep. on "Spring Fires in Semi-mature Trembling Aspen Stand, Central Alberta" which was submitted to the NoFC editor in April 1989. (MEA)

d) The finalized review draft of Inf. Rep. on "Forest Fire Research in Western and Northern Canada, 1962-1987: An Annotated Bibliography" was submitted to the NoFC editor in November 1988. Because of the lack of action and the time elapsed, its been now decided to update the manuscript to publications produced up to March 1991. (MEA)

3. a) Contributed extensive written comments on numerous occasions in 1990 (& late 1989) towards the finalizing of the first edition of the Canadian Forest Fire Behaviour Prediction System. (MEA)

b) Prepared an unattended poster paper on the 1985 Butte Fire for an international fire symposium held in the U.S.A. based on training material developed for the annual Advanced Fire Behavior Courses held at FTS Hinton. (MEA)

c) Co-authored a paper with other Fire Danger Group members on the Canadian approach to fire behavior research for the proceedings of an international fire symposium held in Portugal. (MEA)

d) Facilitated the development of a memorandum of understanding and exchange of data related to a grassland fire behavior study in the Northern Territory of Australia between the Bushfire Research Unit, CSIRO Division of Forestry, and the Forestry Canada Fire Danger Group. (MEA)

4. a) Reviewed two manuscripts: i) Estimating Rate of Fire Spread in Banksia Low Woodlands by W.L. McCaw and N.D. Burrows and ii) a Simple and Inexpensive Method of Estimating the Moisture Content of Dead Pinus pinaster needle litter by N.D. Burrows (Can. J. For. Res.). (MEA)

b) Presented two poster papers (complete with handouts) entitled "Predicting Fire Behaviour in Canada's Aspen Forests" and "Quantifying the Physical Aspects and Impacts of Fire in Aspen Ecosystems" at the Aspen Management for the 21st Century Symposium, November 20-21, Edmonton, Alta.

c) Distributed the first supplemental materials pertaining to the CFFDRS Users' Guide in May. 1990. This involved distribution to more than 225 "subscribers". (MEA & MEM)

5. Provided support to M. Alexander while on LTT assignment in Australia as follows:

a) sorted and forwarded work-related mail, correspondence, etc. (MEM)

b) mailing or faxing files, publications and other articles in support of his LLT project. (MEM)

c) co-authoring and presenting a poster paper, "Predicting Fire Behaviour in Canada's Aspen Forest" at Aspen Management for the 21st Century Symposium, Edmonton, Alberta, November 20-21, 1990. (MEM)

6. Supported as required other members of the Fire Management Research Project as requested:

a) worked at and attended with C. Ogilvie the International Foam Workshop, Cranbrook, B.C., April 24-27, 1990. (MEM)

b) Carried out various assignments as requested by B. Lee. (MEM)

7. Due to time constraints and the unavailability of some information editing was not completed but the burns are in chronological sequence on VHS video tape. (MEM)

12. Present Status of Study:

The present project was initiated in early 1981 by M.E. Alexander who was joined in mid 1985 by R.S. McAlpine, on a part-time basis (0.5 PY at present), as a co-study leader (R.S. McAlpine transfered to PNFI in April 1989). M.E. Alexander is on longer term training (LTT) until at least September 1991 (and possibly March 1992). M.E. Maffey serves as the study technician. Both study leaders are currently members of the ForCan Fire Danger Group. This group maintains liaison with regional, national, and international fire organizations, committees and agencies to ensure research, development and applications of the CFFDRS continues in a timely and relevant manner. The major accomplishments of the Group since 1981 have been:

- Production of an updated edition of the FWI System in 1984 (i.e., ForCan Forestry Technical Reports dealing with Tables and Equation/FORTRAN Program).

- Distribution of an interim edition of a user guide to the rate of spread component of the Canadian Forest Fire Behavior Prediction (FBP) System in 1984 which also includes a simple elliptical fire growth model.

- Development of a CFFDRS Users' Guide (i.e., a three-ring binder designed to house all national publications and associated material documenting the technical aspects of the (CFFDRS).

The study leaders have been involved directly or indirectly in the application of the CFFDRS in the "system" of several user agencies in the region (e.g., AFS, Alberta Parks, GNWT).

A point worth emphasizing is the fact that the data base used in the development of the FBP System does include the various experimental fires documented by NoFC staff between 1965-1978. The principal field research activities since 1981 have been concerned with two experimental burning projects coordinated by NoFC but involving fire staff from the other ForCan research establishments:

i) 1982: Porter Lake, Caribou Range, N.W.T. - upland black spruce- lichen woodland (FBP System Fuel Type C-1); a cooperative project with Indian and Northern Affairs Canada (INAC).

ii) 1985-89: Big Fish Lake, Footner Lake Forest, Alta. -black spruce-Labrador tea-Cladonia fuel complex (FBP System Fuel Type C-2); a cooperative project with Alberta Forest Service (AFS).

Other notable achievements during the period 1981-91 include:

- Assistance with the regional implementation of spring Drought Code (DC) starting value determinations on a regular, yearly basis in 1981-82.

- Development of a 4-day advanced fire behavior course in cooperation with Alberta Forest Technology School and AFS Forest Protection Branch in 1982 (sustained participation has continued up to and including 1989). Fire management personnel from N.W.T., Manitoba and Parks Canada have also attended the course.

- Coordinated the development of a scientific and technical seminar series under the auspices of the Western and Central Region Fire Weather Committees beginning in 1983.

- Initiated and solicited support for a 3-yr. CFS-HQ sponsored PRUF (Program of Research University Forestry) by University of Alberta Meteorology Division entitled "Climatology of Atmospheric Conditions Related to Extreme Forest Fire Behavior in West-Central and Northern Canada" in 1984. This work is related to the prediction of blowup fire occurrences.

- Preparation of several user-oriented aids which have been immediately utilized by AFS and INAC. (e.g., procedures and an adiabatic chart for plotting helicopter soundings of temperature, dew-point (DP) tables for fire weather stations with ventilated thermometers, prototype chart/table for the fire intensity component of the FBP System); an excellent example of this is the AFS "Fire Behavior Officer Reference - 1986". The concepts currently incorporated into the WM-680 Wind Monitor produced by Forest Technology Systems Ltd. represents another practical example of an original study initiative.

- Production of a slide-rule device incorporating the existing information on the FBP System. The "Fire Growth Calculator" or FGC simply represents an alternative methods of calculating area, perimeter length, etc. in lieu of manual, table or computer calculation.

- A variety of fire-related programs (e.g., RH and DP computations from dry-and wet-bulb temperatures, spring DC starting value) written in BASIC have been prepared including present versions of the FWI and FBP Systems. The current application involves the NEC PC-8201A portable computer which is ideally suited to district level use and by a fire behavior officer on campaign fires.

- Increased the interest and set standard for wildfire case histories or studies in the Northwest Region of ForCan.

- Development of a propane ignition torch using off the shelf components which eliminates the need for complicated pressure torches using a liquid fuel.

13. Goals for 1991-92:

1. Continue longer term training (LTT) towards the completion of a Ph.D. degree at the Australian National University while occupying a Visiting Fire Researcher position with the CSIRO National Bushfire Research Unit, Canberra, A.C.T., Australia. (M.E.A.)

2. Attend to any manuscripts currently in the "system" which may be returned by the NoFC editorial group. (M.E.A.)

3. Continue to participate in cooperative activities of the ForCan Fire Danger Group as necessary (e.g., finalizing draft FTR on FBP System). (M.E.A.)

4. Continue to provide advice and services with respect to fire danger rating and fire behavior as required (e.g., manuscript reviews). (M.E.A.)

5. Continue to support M. Alexander in Australia as requested. (M.E.M.)

6. Support other members of the Fire Research Group as requested. (M.E.M.)

7. Carry out the necessary work required to produce the final edited versions of the Porter Lake and Big Fish Lake experimental burning study videos as the opportunity arises. (M.E.M.)

8. Prepare, as time permits, the poster paper handout "Predicting Fire Behavior in Canada's Aspen Forests" as a Forest Management Note. (M.E.M.)

14. Publications 1990-91:

Alexander, M.E. 1989. Australian workshop on bushfire meteorology and dynamics. Climatol. Bull. 23(3):135-136. [Also published in: International Forest Fire News No. 3:10. 1990].

Alexander, M.E. 1990. The 1985 Butte Fire in central Idaho: a Canadian perspective on the associated burning conditions [Abst.]. Page 17 in Program & Abstracts, Fire and The Environment: Ecological & Cultural Perspectives--An International Symposium (May 20-24, 1990, Knoxville, Tenn.). Univ. Tenn., Knoxville, Tenn.

Alexander, M.E.; Andrews, P.L. 1989. Wildland fire occurrence and behavior analysis in the year 2000 and beyond. Fire Manage. Notes 50(4):35-37.

Alexander, M.E.; Bisgrove, G.F. (technical coordinators). 1990. The Art and Science of Fire Management Proceedings of the First Interior West Fire Council Annual Meeting and Workshop (October 24-27, 1988, Kananaskis Village, Alta.) For. Can., Northwest Reg., North. For. Cent., Edmonton, Alta. Inf. Rep. NOR-X-309. 333 pp.

Alexander, M.E.; De Groot, W.J.; Hirsch, K.G.; Lanoville, R.A. 1989. Wall posters as interpretive aids of fire behavior/danger research and development [Abstr.]. Page 67 in Abstracts: Research Posters, Workshops and Commercial Exhibits--Forestry Research Marketplace: Results in Action (Nov. 21-23, 1989, Toronto, Ont.). For. Can., Ont. Reg., Sault Ste. Marie, Ontario. OFRC Symp. Proc. O-P-18.

Alexander, M.E.; Maffey, M.E. 1990. Predicting fire behavior in Canada's aspen forests. Page 131 in Program & Abstracts Aspen Management for the 21st Century Symposim (Nov. 20-21, 1990, Edmonton, Alta.). Sponsored by the Poplar Council of Canada Forestry Canada, and Alberta Forestry, Lands and Wildlife.

Alexander, M.E.; Quintilio, D. 1990. Perspectives on experimental fires in Canadian forestry research. Mathl. Comput. Modelling 13:(12)17-26.

Alexander, M.E.; Sando, R.W. 1989. Fire behavior and effects in aspen-northern hardwood stands. Pages 263-274 in Proc. Tenth Conf. on Fire and For. Meteorol. (Apr. 17-21, 1989, Ottawa, Ont.). For. Can. and Environ. Can., Ottawa, Ont.

Ascher, A.C.; Alexander, M.E. 1990. Mounting the attack on wildfire: The video. Page 92 in The Art and Science of Fire Management. Proc. First Interior West Fire Coun. Annu. Meeting and Workshop (Oct. 24-27, 1988, Kananaskis Village, Alta.). For. Can. Northwest Reg., North. For. Cent., Edmonton, Alta. Inf. Rep. NOR-X-309.

Delisle, G.P.; Alexander, M.E.; Maffey, M.E. 1990. Cartographic history of forest fires in Alberta: 1931-1983. Pages 90-91 in The Art and Science of Fire Management. Proc. First Interior West Fire Coun. Annu. Meeting and Workshop (Oct. 24-27, 1988, Kananaskis Village, Alta.). For. Can., Northwest Reg., North. For. Cent., Edmonton, Alta. Inf. Rep. NOR-X-309.

Forestry Canada Fire Danger Group. 1991. Development and structure of the Canadian Forest Fire Behavior Prediction System. For. Can., Ottawa, Ont. For. Tech. Rep. [in prep. for publ.].

McAlpine, R.S.; Stocks, B.J.; Van Wagner, C.E.; Lawson, B.D.; Alexander, M.E.; Lynham, T.J. 1990. Forest fire behavior research in Canada. Pages A. 02.1-12 in Proc. Interl. Conf. on Forest Fire Research (Nov. 19-22, 1990. Coimbra, Portugal). Univ. Coimbra, Coimbra, Portugal.

McAlpine, R.S.; Wakimoto, R.H. 1991. The acceleration of point source fire to equilibrium spread. For. Sci. 37:(in press).

McAlpine, R.S.; Xanthopoulos, G. 1989. Predicted vs. observed fire spread rates in ponderosa pine fuel beds: a test of American and Canadian systems. Pages 287-294 in Proc. 10th Conf. on Fire and For. Meteorol. (Apr. 17-21, 1989, Ottawa, Ont.). For. Can., Ottawa, Ontario.

Ogilvie, C.J.; Alexander, M.E.; Lieskovsky, R.J.; Bird, J. 1989. Interim guidelines for aerial application of foam on forest fires. Foam Applications for Wildland & Urban Fire Management [newsletter published by National Wildfire Coordinating Group] 2(3):5.

Sando, R.W.; Alexander, M.E. 1990. Quantifying the physical aspects and impact of fire in aspen ecosystems. Pages 321-322 in Proc. Aspen Symposium '89 (July 23-25, 1989, Duluth, Minn.), proceedings. USDA For. Serv., North. Cent., For. Exp. Stn., St. Paul, Minn. Gen. Tech. Rep. NC-140.

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: 1982 Estimated Completion: 1992

17. Resources 1991-92:

PYs:	Prof.:	Alexander	1.0 (LTT in Australia)
	Tech.:	Maffey	0.1
	Total:		1.1
	Term/Student:		
O&M:			$ 2,000
Capital:			$ 500

18. Signatures:

Bryan S. Lee
FOR M.E. ALEXANDER
Investigator

Program Director, Protection & Environment

Regional Director General

NOR-5-07

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 30, 1991

1. Project: Fire Management Research

2. Title: NoFC Forest Fire Research Coordination

3. New: Cont.: Term: X 4. No.: NOR-5-07

5. Study Leader: B.S. Lee

6. Key Words: Fire Research, Fire Programs, Research Management, Fire Research coordination

7. Location of Work: Northwest Region

8. Problem:

The widespread nature of the fire research program at NoFC requires considerable effort in coordination and management. The problems, the size of the area which includes, Alberta, Saskatchewan, Manitoba and the NWT in itself presents severe coordination challenges, especially with the provincial/federal agreement program activities. The diverse nature of the fire problems, research program and wide variety of user needs all make for an extremely complex management task. The need to use existing funding, secure outside funding, extensive support and agency cooperation adds to the complex dimensions already encountered. There is a need for coordination to maximize productivity and wise use of all resources within the fire research project.

9. Study Objectives:

1. To coordinate NoFC fire research activities as an essential element of the overall forest fire management programs in the prairie provinces and NWT.

2. To enhance the regional, national and international perspectives of the Forestry Canada fire research program through participation on committees, task forces, review boards and other service activities aimed at improving the protection of Canada's forestry.

3. To promote the fire research program within the prairie provinces and NWT as well as nationally.

4. To develop support and cooperation for fire research programs through a wide array of activities, processes and action.

10. Goals for 1990-91:

1. Fill the Project Leader position and realign the project as required, including assisting with filling of other vacant positions.

2. Supervise and coordinate the regional fire research program, including providing technical guidance for the Fire Specialists in the District Office.

3. Continue to provide technology transfer through, participation on committees, task forces, etc. aimed at improving the protection and use of Canada's forests through efficient fire management.

4. Conduct regional fire research technical subcommittee meeting and hold other special workshops as required including further follow up to the "Foam as a Fire Retardant" workshop. (P.L. and others)

5. Maintain cooperative relationships and studies with Universities of Alberta and other centres including presentations at academic institutions as appropriate. (P.L. and others)

6. Provide technical and advisory services and training to client agencies with emphasis on fire management guidelines (P.L. and others)

7. Provide guidance and assistance to forest economist for studies in fire management economics if applicable (see NOR-3). (P.L. and others)

8. Plan and initiate research activities in area of fire management science expertise.

9. Reorganize the Fire Research Group Library. Carry out the reorganization, shift the library location if funds are available and enter the library publication lists in the card catalogue on to a library software package known as Pro-Cite to enable data searches to be carried out by computer. This goal will largely be performed with the help of a term employee, if made available. (M.M.)

10. Carry out evaluations on two pieces of fire equipment:

a) use of the Echo backpack mister/blower to dispense foam and create a temporary fire line on small rapidly spreading ground fires.

b) to work in cooperation with the AFS on the use of a standard 5/8 inch garden soaker hose to replace bulky fire line sprinkler systems under certain fire line conditions. Also to look into using the standard 42 mm (1 1/2 inch) fire hose as a soaker hose if it can be adapted as such. (M.M.)

11. Prepare a study work plan for the balance of year and future goals when the position of Fire Suppression Systems is filled.

11. Accomplishments in 1990-91:

1. The vacant position of Project Leader was filled by B.S. Lee in July. Two new positions were also staffed during the year. These included K.G. Hirsch and W.J. De Groot in the positions of Fire Suppression Research Officer and Fire Environmental Research Officer, respectively (BSL).

2. Initial strategic planning sessions were held with all project members in attendance. An approach to fire management research planning has been adopted to assess client needs with the goal of preparing a five year program of fire management research and technology transfer (BSL & Others).

3. Technology transfer was provided for through meetings by all staff with client agencies. The Project Leader made the following presentations during the year:

   a) An overview of IFMIS at the FAO, North American Forestry Commission, Fire Management Study Group annual meeting, Sept. 24-28, 1990, Kananaskis, Alberta.

   b) An overview of IFMIS at the annual director's meeting of the Canadian Interagency Forest Fire Centre, November 1990, Hinton, Alberta.

   c) An overview of the NoFC Fire Management Research Project at the annual meeting of the Canadian Committee on Forest Fire Management, Jan. 21-25, 1991, Victoria, B.C.

   d) A presentation on Decision Support Systems for forest fire management, University of Alberta Seminar Series, Feb 20, 1991.

   In addition to the above presentations, the following meetings were attended:

   a) Forestry Canada's Prescribed Fire Working Group meeting, May 29 - June 1, Hinton, Alberta.

   b) Forestry Canada's Fire Danger Working Group meeting, September, 1990, Edmonton, Alberta.

4. No regional fire research technical subcommittee meeting was held this year. In its place K.G. Hirsch presented an overview of the Fire Management Research Project to the Senior Regional Advisory Committee.

5. Cooperative activities were continued with the University of Alberta. Discussions on a fire research cooperative, a joint NoFC and UofA fire research poster day, coop students, and FRDA II and Green Plan cooperative research programs were held (BSL).

6. Technical and advisory services were provided to client agencies on a wide range of technical matters (BSL and others).

7. Advice was provided to NOR-3 on the potential research in the areas of fire damage appraisal system and integrated resource management. (BSL).

8. Budget-year and multi-year operational plans were prepared for the project and new directions for the project staff developed. Two new type positions have been described and one (vice McAlpine) is in staffing action (BSL).

9. The months of a Library filing clerk was made available and good progress was made in entering new publications on cards and into the Pro-Cite package. System was effectively used to obtain retrieval of information for industry clients (MEM).

10. This goal was terminated in September due to a lack of interest by the client cooperators (MEM).

11. A study work plan for the last half of FY 90-91 was prepared for the position of Fire Suppression Research Officer (KGH, BSL).

12. Present Status of Study:

The study has been terminated and the relevant objectives and goals are transferred to NOR-5-04.

13. Goals for 1991-92:

Nil

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:

Start: 1987 Terminated: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-05-08

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 4, 1991

1. Project: Fire Management Research

2. Title: Fire suppression systems and strategies

3. New: X Cont: 4. No.: NOR-05-08

5. Study Leader: K. Hirsch

6. Key Words: fire suppression - strategies, systems, effectiveness, efficiency, productivity; fire suppression systems; fuel management; forest management; technology transfer; fire environment.

7. Location of work: Northwest Region

8. Problem:

The suppression of wildfires has been and will continue to be one of the primary objectives of the fire management agencies in northern and western Canada. This is especially true in areas where wildfires may have a negative impact on the social or economic value of a given resource. The general goal of research in the field of fire suppression systems is therefore, to develop new strategies and approaches to fire suppression that will reduce resource losses resulting from unwanted wildfires.

The importance of fire suppression has increased in recent years for two primary reasons. First, public demand on both industry and government for sustainable forest development has been growing. An important aspect of this demand is the desire for a continuous resource supply to be available from a given area which has caused a greater reliance on fire suppression to eliminate major resource losses. Second, as overall funding for government programs becomes more difficult to obtain it is important that new, more cost-effective and environmentally acceptable approaches to fire management are developed.

The fire suppression systems study investigates the *process* of suppressing wildfires. This includes the methods, tactics and strategies used in preparing for and conducting fire suppression activities as well as the impact and benefits obtained from fire suppression. This study is very operationally oriented and is closely linked to other areas of fire research at the Northern Forestry Centre. For example, as new technology and equipment is developed for use in fire suppression, systems for

its most effective application can be determined along with an assessment of its benefits. Also, since fire suppression activities are highly dependent on the conditions of the fire environment, the two fields of study can be directly linked to ensure optimum operational efficiency is achieved. Finally, quantitative information on the effectiveness of various fire suppression systems is of great value to the fire manager and can easily be incorporated into a fire management decision support systems for operational use in presuppression and suppression planning.

9. Study Objectives:

   1. To identify and develop forest fire suppression knowledge and strategies that will enhance forest resource management and improve the efficiency and cost-effectiveness of fire management programs in Canada.

   2. To develop systematic, quantitatively-based fire suppression practices, guidelines and models that are linked to fire behavior parameters and fire management decision-support systems.

   3. To conduct technology transfer activities in the area of forest fire management in order to facilitate the development and application of forest fire research results and products.

10. Goals for 1990-91:

    1. Conduct a survey of client agencies in the Northwest Region to determine their fire suppression systems research priorities. (KGH)

    2. Initiate the development of a comprehensive strategy and/or problem analysis for fire suppression research in the Northwest Region and identify how it can be integrated into other types of fire management and forest management research. (KGH, CJO).

    3. Develop an extensive technology transfer and operational training package for the Canadian Forest Fire Behavior Prediction System. Note: this work is being conducted at the request of the Forestry Canada Fire Danger Group who are providing some technical direction and assistance. (KGH, WJD)

    4. Provide technology transfer services to fire management agencies by:

       (a) providing advice and services on topics related to forest fire suppression and management,
       (b) participating in and/or conducting meetings, workshops, seminars, and demonstrations,
       (c) maintaining liaison with operational staff and fire management researchers.

    5. Complete two publications. A conference paper (International conference on Forest Fire Research, Coimbra, Portugal, Nov. 1990) and journal article (Forestry Chronicle) on the 1989 fire season in Manitoba.

    6. Produce a conference paper and poster (11th Forest and Fire Meteorology Conference, Missoula, Montana April 1991) on the Development of An Initial Attack Preparedness System for Manitoba.

11. Accomplishments in 1990-91:

    1. Completed an in-person survey of the major fire management agencies in the Northwest Region. An internal report summarizing their comments with respect to fire suppression systems research priorities is in preparation (Study NOR-05-08, File Rep. No. 2).

    2. A problem analysis on fire suppression research in the Northwest Region has been initiated. This includes a draft of a futuring paper (CJO) and the above survey report. This project will be completed in 1991-92.

    3. The development of a technology transfer/training package for the Canadian Forest Fire Behavior Prediction (FBP) System is in preparation. The target date for completion is April 1991. This project is being conducted jointly with PNFI and GLFC.

    4. Provided technical services and liaison as follows:

        - attended the Interior West Fire Council Meeting in Kalispell, Montana,
        - provided advice to Banff National Park concerning a fuels management proposal near the Banff townsite,
        - provided assistance to the Canadian Parks Service and Alberta Fish and Wildlife during prescribed burns at Elk Island Park and in the East Slopes,
        - worked with Manitoba Natural Resources staff to review their Initial Attack Preparedness System,
        - developed a slide presentation on the Fire Management Research Project at NoFC (Study NOR-05-08, File Rep. No. 1),
        - produced a draft document to be used for a comprehensive survey of fire management agencies to determine their fire research needs, and
        - reviewed three manuscripts upon requests from W.J. De Groot (NoFC), B.M. Wotton (PNFI), and R.A. Lanoville (GNWT).

    5. Completed a journal article and conference paper on the 1989 fire season in Manitoba (see publications).

    6. Prepared a conference paper and poster presentation on the Development of an Initial Attack System for Manitoba.

12. Present Status:

    This is new study in the Fire Management Systems project that will focus on fire suppression related questions. The results of this research will be integrated into various fire and forest management practices. The study will attempt to develop the knowledge and systems demanded by fire management agencies in order to improve the effectiveness of their fire management organizations.

13. Goals for 1991-92:

    1. Complete a problem analysis on fire suppression research in the Northwest Region. Produce an internal report and a futuring paper to be published in an appropriate journal. (KGH, CJO). [NSP-920; RSP-III,VI].

2. Complete a technology transfer/training package on the FBP System. Produce a binder style workbook and conduct 3 workshops at various locations across Canada. Note that funding for the binders and workshops is to be provided through the Forestry Canada Fire Danger Group. (KGH, WJD, KRA, PNFI, GLFC). [NSP-923; RSP-III,4].

3. Contribute to the integrated fire research study on preparedness planning by initiating work on an initial attack containment model. Available literature will be reviewed and a prototype model will be developed. (KGH, KRA, SRH). [NSP-920,923; RSP-III,1,5].

4. Contribute to the Fire Research Project strategic plan by producing a client survey form, analyzing its results and producing a report (internal or information report) on the survey. (KGH, BSL). [NSP-924;RSP-VI].

5. Publish a conference paper and produce a poster (11th Forest and Fire Meteorology Conference, Missoula, Montana April 1991) on the Development of An Initial Attack Preparedness System for Manitoba.

6. Provide technology transfer and liaison services to fire management agencies by (KGH) [NSP-923;RSP-III,4):

   (a) providing advice and services on topics related to forest fire suppression and management,
   (b) participating in and/or conducting meetings, workshops, seminars, and demonstrations,
   (c) maintaining liaison with operational staff and fire management researchers, and
   (d) providing input and assistance into the NoFC Fire Research Project's communications effort.

14. Publications 1990-91:

Hirsch, K.G. (Compiler and Editor). 1990. Proceedings of the Sixth Central Region Fire Weather Committee Scientific and Technical Seminar, Winnipeg, Manitoba, April 6, 1989). For. Can., Man. Dist. Office, Study NOR-36-03-1, File Rep. No. 5). 54 p.

Hirsch, K.G. 1991. A chronological overview of the 1989 fire season in Manitoba. Forestry Chronicle 67(x) xxx-xxx. [in press].

Hirsch, K.G. 1991. A summary of fire suppression systems research needs in the Northwest Region. For. Can., North. For. Cent., Study NOR-05-08, File Rep. No. 2. [in preparation].

Hirsch, K.G.; Flannigan, M.D. 1990. Meteorological and fire behavior characteristics of the 1989 fire season in Manitoba, Canada. In Proceedings of the International Conference on Forest Fire Research, Nov. 19-22, 1990, Coimbra, Portugal.

Hirsch, K.G.; Lee, B.S. 1990. A slide presentation on the fire management research project at the Northern Forestry Centre. For. can., North. For. Cent., Study NOR-05-08, File Rep. No. 1. (text and slides).

Raddatz, R.L.; Kluth, G.S.; Hirsch, K.G. 1991. Mid-level stability and moisture index: likelihood of extreme fire behavior. In Proceedings of the Seventh Central Region Fire Weather Committee Scientific and Technical Seminar (W.J. De Groot - compiler), April 4 1990,

Winnipeg, Manitoba. For. Can., North. For. Cent., Edmonton, AB., Study NOR-05-09, File Rep. No. X. [in preparation].

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: September 1990 Estimated Completion: on-going

17. Resources 1991-92:

PY's:	Prof.:	Hirsch	0.9
	Tech.:	Ogilvie	0.1
	Total:		1.0

O&M: $6,000
Capital: Nil

18. Signatures:

Investigator

Program Director, Protection and Environment

Regional Director General

NOR-05-09

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 4, 1991
(revised April 2, 1991)

1. Project: Fire Management Research

2. Title: Fire environment research

3. New: X Cont: 4. No.: NOR-5-09

5. Study Leader: W.J. De Groot

6. Key Words: Prescribed fire, fire use, fire effects, fire ecology, integrated resource management, fuels, fire history, smoke emissions

7. Location of Work: Northwest Region

8. Problem:

With establishment of new National and Regional Strategic Plans, there has been considerable emphasis placed on sustainable development in forestry. This, of course, goes beyond sustained yeild principles to include consideration of environmental values in forest management decisions. As a result, there will be new initiatives to support multiple land-use planning and integrated resource management (IRM).

Fire management plays a significant role in attaining the various objectives of IRM. This is demonstrated by the increased use of fire by client agencies in the Northwest Region. Consequently, the demand for new information and assistance in the application and role of fire is also increasing.

Because of the size of the region and the number of clients, there is a variety of areas in which clients are interested. These include the use of fire for wildlife habitat, range management, maintenance of ecological condition, control of weed species, site preparation, fuel hazard reduction, and control of insect and disease. There is also interest in fire history studies for resource planning purposes; and information on smoke emissions.

9. Study Objectives:

1. To determine fire use applications, problems, and considerations for an array of management objectives and vegetative situations in the region.

2. To develop information on the effects of fire on various ecosytems in the region; and to develop information on the environmental role of fire.

3. To establish guidelines for the application of prescribed fire in various fuel types within the Northwest Region.

10. Goals for 1990-91:

1. Participate in project strategic planning sessions; assess client agency needs in fire environment research; determine objectives for Study NOR-5-09 and tie goals into national and strategic plans.

2. Participate in cooperative projects with the Forestry Canada Prescribed Working Group.

3. Provide i) advise and services with respect to prescribed fire, fire effects, environmental fire concerns, and integrated studies and ii) participate in other activities related to Study NOR-5-09.

11. Accomplishments in 1990-91:

1. Strategic planning sessions were conducted within the project; discussions were held with client agencies on numerous occasions to identify study needs in environmental fire research; Study objectives were determined and goals were identified in conjunction with national and regional strategic plans.

2. Participated in the annual meeting of ForCan's Prescribed Fire Working Group (PFWG) at Hinton Alberta from May 27 to June 2, 1990.

3. i. Provided the following consultative services to clients:

a) met with Alberta Forest Service (AFS) staff to discuss prescribed fire research priorities on numerous occasions;

b) gave a presentation on an overview of fire use by various agencies across Canada, and an outline of the PFWG goals, objectives and activities at Hinton on Feb. 26-28, 1991;

c) met with various resource staff of the NWT at Fort Smith on Feb. 4-5, 1991 to discuss an integrated resource management study on the Mackenzie Bison Range;

d) gave a presentation on fire behavior, fire effects and the application of fire for wildlife habitat improvement at an GNWT Wildlife Biologist's convention in Yellowknife on Mar. 14-16, 1991;

e) participated in Preparedness System futuring sessions with other fire researchers, AFS staff, and Sask. fire operations staff;

f) assisted AFS wildlife and fire staff, and the Rocky Mountain Elk Foundation to monitor a winter burn on the east slopes on Feb. 2, 1991;

g) provided consultation in development of AFS fuel sampling manual;

ii. Participated in the following other activities:

a) attended a workshop on prescribed fire and smoke management in Prince George on Mar. 26-27, 1991;

b) met with the Climate Change research group and discussed research initiatives;

c) met with U of Alberta Forest Science faculty to discuss research areas and possible cooperative efforts;

d) instructed a fire science lab at the U of Alberta on the FWI and FBP Systems on Mar. 11;

e) assisted in preparation of a TT package on the FBP System for the Fire Danger Rating Working Group;

f) provided consultation in planning and preparation of the 1991 Advanced Fire Behavior Course at the Forest Technology School;

g) reviewed and edited numerous papers from other authors;

h) organized and chaired the 16th annual meeting of the Central Region Fire Weather Committee (minutes were distributed in Jan.);

i) assisted in compilation of fire study proposals for the Canada-Saskatchewan Forest Resource Partnership Agreement;

12. Present Status of Study:

The study was initiated in Jan. 1991. Through discussions with clients, other fire project staff and the project leader, the scope of the study was defined, and goals and objectives were delineated. Individual tasks, staff time, O&M, and a time frame for each goal are being determined in consultation with the client agencies. Field studies will commence early in 1991-92.

13. Goals for 1991-92:

1. Participate in prescribed fire studies in cooperation with AFS wildlife and fire staff, the Forest Technology School, the Elk Foundation, U of Alberta (and other possible cooperators including the Canadian Parks Service) to assist in gathering information for the development of fire effects guidelines. [NSP-923;RSP-V,VI,5]

2. Participate in an Integrated Resource Management Study on the Mackenzie Bison Sancutary, NWT in cooperation with land managers, biologists and forestry and fire staff of the NWT as well as U of Alberta. This case study will provide information and guidelines on the role and application of fire in northern resource management. [NSP-923;RSP-V,VI,5]

3. Participate on ForCan's Prescribed Fire Working Group by:

   a) attending the joint Canada-US prescribed fire meeting in Missoula on April 20, 1990 and making a presentation on prescribed fire research activities in the Northwest Region; [NSP-920,923;RSP-V,VI,5]

   b) attending the annual meeting of the PFWG in Missoula on April 20-21, 1991; [NSP-920,923;RSP-V,VI,5]

4. Participate in other studies related to fire environment research, as well as other fire project studies as necessary.

14. Publications 1990-91:

De Groot, W.J. 1990. Development of Saskatchewan's 1989 Fire Suppression Preparedness System. In Proceedings of the Sixth Central Region Fire Weather Committee Scientific and Technical Seminar (April 4, 1989, Winnipeg, Man.), K.G. Hirsch (ed.). Govt. Can., For. Can., Manitoba District Office, Winnipeg, Man. Study NOR-36-03-1. File Report No. [in press]

De Groot, W.J. 1991. The effects of climate variation on forest fires in Saskatchewan. In Proceedings of the Saskatchewan Climate Advisory Committee Annual Workshop (Oct. 30, 1990, Regina, Sask.). Atmos. Environ. Serv., Regina, Sask. [in prep]

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: 1991 Estimated Completion: 1996

17. Resources 1991-92:

PY's:	Prof: De Groot	1.0
	Tech: Maffey	0.7
	Total	1.7

O&M: $ 6,000
Cap: $ 16,000

18. Signatures:

Investigator

Program Director, Protection and Environment

Regional Director General

NOR-6-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 18, 1991

1. Project: Forest Economics Research

2. Title: Forest economics research and coordination

3. New: X Cont.: 4. No.: NOR-6-01

5. Study Leader: W.A. White

6. Key Words: Forest economics, interdisciplinary research, socioeconomic impact evaluation, decision support systems, operations research, risk analysis, forest industry, NFEP, economics of sustainable development, cost effectiveness, financial analysis.

7. Location of Work:Edmonton

8. Study objectives:

   1. To provide high quality theoretical and applied economics research through individual studies as well as joint interdisciplinary studies with NoFC scientists from all program areas and industrial, academic and government clients. Study areas could include the economics of silviculture, integrated resource management and environmental issues, community stability and forest sector dependence, economics of pest control and other areas of client interest.

   2. To coordinate FORCAN forest economics research activities in the region and provide committee participation to discuss provincial, regional and national research issues and opportunities.

   3. To provide supervision of economics research contracts generated through federal-provincial/territorial accords, the NFEP, the Green Plan and other such initiatives.

   4. To promote and develop support and cooperation for the forest resource economics research project with other projects at NoFC and with external clients.

9. Goals for 1990-91:

New study in 1991-92. See NOR-3-03.

10. Accomplishments 1990-91:

New study in 1991-92. See NOR-3-03.

11. Goals for 1991-92:

1. Develop project proposals and act as project authority for contracts developed under funding initiatives such as the new PAIFs, the NFEP, the Green Plan etc.

2. Work on joint research with scientists involved in pest control, peatland drainage, vegetation management, site classification and other areas of interest.

3. Establish priorities for joint studies with U of Alberta Department of Rural Economy NoFC scientists and other clinets and commence work on studies of highest priority.

4. With U of Alberta collaborators, publish staff paper and submit journal articles on "Forest Sector Dependency in the Prairie Provinces."

5. Provide peer reviews and comments on journal articles, FORCAN reports and contract proposals as required by NoFC and as associate editor of the Forestry Chronicle.

7. As an adjunct professor at the U of Alberta Department of Rural Economy, provide teaching as required and otherwise maintain close relations with the department by serving on graduate thesis committees etc.

8. With the U of Alberta, organize an international "Forestry and the Environment: Economic Issues" for March 1992 in Jasper.

9. Act as Project Leader for NOR-06 and NoFC representative on national, provincial and regional committees associated with forest economics research issues such as NFEP, PAIF economics working groups etc.

10. Develop study plan for NOR 6-02 when vice-DeFranceschi is staffed.

11. Provide advice guidance and assistance to the Program Director Regional Development and the NoFC Management Committee.

12. Present Status of Study:

This is a new study which combines the forest resource economics research thrust which was the principal study objective of NOR-3-03 with the forest resource economics research coordination objective of NOR-03-01. Thus all activities associated with forest economics research are centred in this study, from carrying out theoretical and applied research to the supervision of research contracts to provincial, regional and national committee representation on economics research matters.

13. Publications 1990-91

New study in 1991-92. See NOR 3-03 for 1990-91 INFO

14. Environmental Implications:

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

15. Duration:

Started: 1991 Completion: continuing

16. Resources 1991-1992:

PYs:	Prof.:	White	1.0
		vice-DeFranceschi	0.75
	Tech.:		0.0
	Total:		1.75
	Term/Student:		0.65

O & M: $15,000

17. Signatures:

Investigator

A/Program Director, Development

Regional Director General

NOR-7-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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

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

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-7-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Environmental Stresses on Forest Ecosystems

2. Title: Analytical Services Laboratory

3. New: Cont.: X 4. No.: NOR-7-06

5. Study Leaders: Y.P. Kalra, D.G. Maynard,

6. Key Words: Analysis, soils, vegetation, water

7. Location of Work: Northern Forestry Centre

8. Problem Analysis:

Many of the studies at NoFC require high quality analysis of soil, plant and water samples in order to meet their objectives. In some cases analytical techniques must be modified or developed to meet the specific requirements of the users. Maintaining a high quality analytical laboratory suitable to support ongoing research and the continuing improvement, modification and development of techniques are essential to meet the needs of the users at NoFC.

9. Study Objectives:

1. Maintain a high quality analytical laboratory suitable to support ongoing research studies by providing precise analyses of soil, vegetation, and water samples.

2. Develop analytical techniques as required by user request.

10. Goals for 1990-91:

1. Provide analytical services to research scientists and cooperators as requested and approved by the Program Directors. This may include a substantial commitment to complete the analysis of the proposed resampling of the ARNEWS plots within the Northwest Region. (Kalra)

2. Publish an Information Report (approx. 100 pages) entitled "Methods manual for forest soil and plant analysis". (Kalra, Maynard)

3. Manage and arrange safe disposal of old chemicals. Undertake duties related to the storage of chemicals and WHMIS. (Shuya)

4. Participate in inter-laboratory check sample programs on a national (Long Range Transport of Air Pollutants, GLFC, Forestry Canada) and international level. (LABEX, Wageningen, Netherlands) (Kalra, Maynard)

5. Publish chapter on nitrate and ammonium nitrogen in soils in the Canadian Society of Soil Science methods manual, 3rd edition. (Maynard, Kalra)

6. Present a paper on the use of microwave ovens in the digestion of tree foliage and organic soils in total elemental analysis by ICP-AES at the Association of Official Analytical Chemists annual workshop in Olympia, Washington, June 21-22, 1990. (Kalra, Maynard)

7. Assess the study on the effects of storage practices on extractable nutrients to determine if there is sufficient information to justify further work in this area. (Maynard, Kalra)

Added goals:

8. Present a poster paper on the determination of cation exchange capicity and extractable cations by a mechanical vacuum extractor at the 14th International Congress of Soil Science, Kyoto, Japan, August 12-18, 1990. (Kalra, Maynard)

9. Form a working group of Forestry Canada's soil and plant analysis laboratories. (Kalra)

11. Accomplishments 1990-91:

1. Provided analytical services to research scientists and cooperators in particular NOR - 4, 7, 11, and 28. The estimated analysis are expected to be approximately 26 000 on 2250 samples. (Kalra)

2. The Information Report entitled "Methods manual for forest soil and plant analysis" has been reviewed and edited and is being typeset. Publication of the manual is scheduled for the end of the fiscal year. (Kalra, Maynard)

3. Aprroximately 20% of Shuya's time is given to laboratory safety and disposal of chemicals. During 1990, 828 L of organic solvents and 10 kg dry chemicals were disposed of according to the Transportation of Dangerous Goods (TDG) regulations. (Shuya)

4. Participated in inter-laboratory check sample programs on a national (Long Range Transport of Air Pollutants, GLFC, Forestry Canada) and international (LABEX program, Wageningen, Netherlands) level. (Kalra, Maynard)

5. The chapter on nitrate and ammonium nitrogen in soils in the Canadian Society of Soil Science methods manual, 3rd edition was submitted in January 1990, as required;

however, delays in reviewing the 40 odd chapters have resulted. It is hoped the chapter will be reviewed within the next 3 to 4 months. We have no control over when the reviews will be completed. (Maynard, Kalra)

6. A paper entitled "The use of microwave ovens in the digestion of tree foliage and organic soils for multi-element analysis by ICP-AES" by Kalra, Maynard and Radford was presented at the Association of Official Analytical Chemists annual workshop in Olympia, Washington, June 21-22, 1990.

7. An assessment of this goal was done and there was insufficient data to warrant further work in this area at the present time. (Maynard, Kalra)

8. A poster paper by Kalra and Maynard was presented at the 14th International Congress of Soil Science, Kyoto, Japan, August 12-18, 1990. (Kalra, Maynard)

9. A working group of Forestry Canada's soil and plant analysis laboratories was formed and the inaugural meeting was planned and held at NoFC, November 1-2, 1990. The working group will be called Group of Analytical Laboratories (GOAL). (Kalra)

12. Present Status of Study:

The analytical services laboratory provides support services to NOR-4, 7, 11, 12, and 28 on an on-going basis. The laboratory will do approximately 26 000 analysis on 2 250 samples in 1990-91. Quality control has been maintained through participation in several check sample programs. A major accomplishment has been the completion of an Information Report on analytical methods. Revisions based on comments by all the Forestry Canada analytical laboratories were completed, the manuscript edited and submitted for typesetting. It is hoped the manual will be published before March 1991, and will lead to the standardization of many of the methods used in forest soil laboratories within Forestry Canada. The establishment of a working group for Forestry Canada's analytical laboratories was finally completed in 1990. NoFC hosted and organized the inaugural meeting in November.

13. Goals for 1991-92:

1. Provide analytical services to research scientists and cooperators as requested and approved by the Program Directors. This may include a substantial commitment to complete the analysis of the proposed resampling of the ARNEWS plots within the Northwest Region. (Kalra)

2. Manage and arrange safe disposal of old chemicals. Undertake duties related to the storage of chemicals and WHMIS. (Shuya)

3. Participate in an inter-laboratory check sample program (Long Range Transport of Air Pollutants, GLFC, Forestry Canada). (Kalra, Maynard)

4. Publish a chapter on nitrate and ammonium nitrogen in soils in the Canadian Society of Soil Science methods manual, 3rd edition. (Maynard, Kalra)

5. Co-author (with J. Benton Jones Jr.) a paper on the status of soil testing and plant analysis in North America for presentation at the plenary session of the 1991

International Symposium on Soil Testing and Plant Analysis in the Global Community, Orlando, Florida, August 22-27, 1991. (Kalra)

6. Associate referee for pH measurements in soils for the Association of Official Analytical Chemists (AOAC). (Kalra)

7. Participate in the activities of the Group of Analytical Laboratories (GOAL); Serve as chairperson for a two-year term. (Kalra)

8. Participate in the activities of the Western Enviro-Agricultural Laboratory Association (WEALA). (Kalra)

14. Publications 1990-91:

Kalra, Y.P.; Maynard, D.G. 1990. An evaluation of a mechanical vacuum extractor for the determination of cation exchange capacity and extractable cations in calcareous soils. (Extended summary) Pages 451-452 in Transactions of the International Congress of Soil Science, Kyoto, Japan. Vol. II, Commission II.

Kalra, Y.P; Maynard, D.G. 1991. Methods manual for forest soil and plant analysis. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-319. (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: 1970 Completion:On-going

17. Resources 1991-92:

PYs:	Prof:	Kalra	0.8
		Maynard	0.1
	Tech.:	Shuya	1.0
		Radford	0.2
	Total:		2.1
	Term/Student:		0.6

O&M: $10 K
Captial: $23 K

18. Signatures:

Y. P. Kalra
Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-7-07

FORESTRY CANADA

STUDY WORKPLAN

1991-92

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

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

Y.P. Kalra
Investigator

Investigator

NOR-10-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Mixedwood Silviculture

2. Title: Silvicultural investigations

3. New: Cont.: X 4. No.: NOR-10-03

5. Study Leader: L.G. Brace

6. Key Words: Mixedwoods, mixedwood DSS, planning, free-to-grow, stand tending, vegetation management, early stand development, harvesting and mechanization of silviculture, forest management systems, technology transfer

7. Location of Work: Northwest Region

8. Problem:

A sustained and even increased supply of economically usable timber is a key element in the long-term economic health of Northwest Region and of Canada as a whole. Timber supply is affected by many factors, including available capital, accessibility and marketability of different species, utilization standards, process technology and efficiency, land base and changes in land allocation, losses to insects, disease and fire scale and effectiveness of silvicultural practices and possibly major climatic shifts (greenhouse effect).

Changes in any of these factors can affect timber supply and the nature and extent of silvicultural problems.

Currently one of the most acute regional silvicultural problems revolves around the need to successfully establish and bring softwood (both pine and spruce) to a free-to-grow state on mixedwood sites. The scale of the problem has increased over the last decade with the increase of softwood nursery stock production from about 10 million to 70 million seedlings annually. Once these trees are planted or regenerated by scarification on mixedwood sites, brush and grass competition interfere with survival and growth. Mixedwoods constitute about 30 percent of productive forest land in the region (about 14,000,000 ha), often on the most productive softwood sites. The investment in regeneration of conifers on mixedwood sites is increasing yearly and remains at risk in terms of mortality as well as quality and growth reduction for

periods of up to 80 years, with attendant yield losses of up to 30 or 40 percent, if effective silvicultural practices are not applied. These include adequate site preparation, use of high quality planting stock (properly planted) and control of competing vegetation up to the free-to-grow state. Risks to pine regeneration in mixedwoods are even higher than to spruce due to shade intolerance and consequent high mortality.

Future silviculture problems in the region will be different as a result of a new emphasis on aspen utilization and in the long run possibly due to climatic shifts caused by the greenhouse effect, which predictive models now suggest may cause a substantial northward shift of boreal mixedwood boundaries (300-400 km by 2060 AD) with attendant increases in survival growth, insect, disease and fire control problems for the primary species. Until recently, aspen (which represents 96% of the hardwood inventory, which in turn represents over 1/3 of gross merchantable wood inventory in the region) was less than 10% utilized. Current plans for aspen utilization in conventional pulp, CTMP pulp, a paper mill, a sawmill and a number of Oriented Strand Board (OSB) plants will increase use substantially (up to 5.6 million m^3) by 1991.

In Alberta alone there were new or expanded industrial forestry projects with investment totalling $3.4 billion announced between October 1987 and December 1988, primarily in the mixedwood zone. The effect of this trend on silvicultural problems can be illustrated with respect to NSR. Traditionally, regional silvicultural problems have been stated in terms of softwood NSR, which is estimated to total over 500,000 ha, of which 300,000 ha is in mixedwood burns and cutovers. The NSR problem would be significantly reduced if aspen became acceptable for regeneration, as many of these areas are already stocked with aspen. This situation generates a new set of problems. For example:

- How many softwood NSR areas are adequately stocked with aspen and how will this affect land base decisions, stocking standards etc?

- What constitutes adequate aspen stocking and how can aspen stocking be effectively assessed and controlled? Are new assessment methods needed - i.e., are stocking and density measures as used for conifer appropriate for aspen?

- How is mechanized site preparation implicated in aspen stocking control?

- What are the relative growth and yield trade-offs between spruce, pine and aspen on the same sites and how do they perform in mixed stands? What about mixedwood regeneration standards?

- What are the regeneration, growth, and utilization prospects for associated balsam poplar and white birch in mixedwoods.

- What is potential role and need for R&D in the area of non-chemical competition control in future forest management/silviculture work to achieve "free-to-grow" standards?

Increased aspen utilization may also solve problems. For example, logging economics will improve with removal of larger volumes per unit of area, reduced slash loads will make site preparation and softwood planting easier and cheaper, and make re-entry for tending more efficient, and acceptance of aspen as regeneration improves reforestation options. In the near future balsam poplar and white birch utilization can also be expected to increase. If they are left

unutilized and standing in cutovers they will seriously impede the development of a new healthy aspen forests from suckers.

The nature of silvicultural problems in the region is changing. ForCan recognizes that much of the information needed to address these changes is known and requires effective R&D application and technology transfer. There is also a need for specific R&D initiatives, especially in the areas of harvesting and mixedwood regeneration, stock quality, early tending response, relative performance of hardwood and softwood species and utilization, particularly of aspen, balsam poplar, and white birch - all within a decision support system (DSS) framework.

9. Study Objectives:

   1. To conduct silviculture R&D and publish scientific and technical reports of silvicultural interest, regionally and nationally, within a forest management systems (DSS) framework, including harvesting, regeneration and early stand tending sub-systems. Early stand development R&D will assess chemical and non-chemical means of competition control.

   2. To provide liaison and input as required to relevant regional and national programs, such as the ForCan Vegetation Management Working Group, the Expert Committee on Weeds, and harvesting and mechanization of silviculture programs (FERIC), emphasizing biological aspects, and to promote the development and dissemination of silvicultural knowledge through work with national, regional, and local committees, workshops and other related techniques.

   3. Supervise research contracts and develop in-house research studies as an outgrowth of contracts where appropriate.

10. Goals for 1990-91:

    1. Continue protection of understorey white spruce project. (Brace/vice Gorman/Lux)

       a. relocate and assess logging damage plots on Blueridge area logged March 1990. Prepare file report on all areas. (vice Gorman)

       b. locate and measure 60 spruce plots and 120 aspen plots to assess growth and regeneration respectively across a range of site and density conditions on harvested areas at Drayton Valley, Hinton, and Blueridge. Prepare data summary and file report on all areas. (vice Gorman/Rentz)

    2. Act as project leader NOR-10 and Maintain related duties:

       a. chair and report to SRAC on June 1990 RRTC meeting in NWT. (Brace)

       b. participate in LOG, FMG, FERIC (ACSER, ACFER) ECW, Vegetation Management Working Group, Forest Management Liaison Committee (FMLC) and other committees as required. (Brace/vice Gorman)

c. Provide advice on silviculture investigations and vegetation management studies - including environmental screening committee - in Alberta, Saskatchewan (Cataldo) and Manitoba (Ball). (Brace)

3. Complete preparation of multi-disciplinary mixedwood management strategic plan and its integration into Resources Group studies and link to Prince George office of ForCan. (Waldron/Brace)

4. Assess opportunities to co-operate with provincial and industrial clients and organizations like FERIC (west) in the design, installation and evaluation of harvesting and silviculture equipment and technique studies as appropriate within the context of mixedwood management systems pending agreement funding. (vice Gorman)

5. Provide advice to regional NoFC staff on adaptation and costs of incorporating harvesting and silviculture mechanization components into R&D and TT projects. (vice Gorman)

6. Interpret large scale aerial photographs to provide data for assessment of impact of harvesting equipment on mixedwood site productivity and/or assessment of blowdown risk on such sites - see goal 1. (Moore)

7. Conduct a workshop to identify information needs for the mixedwood management program at NoFC at various levels of forest management planning. (Waldron/Walker)

8. Continue co-operative work on the forest vegetation management project, Grande Prairie, Alberta with NOR-07 and NOR-03, measuring fourth-year treatment response on Method II (site preparation) and second-year treatment response on Method I (release). (Brace)

Added Goals:

9. Organize Forestry Canada Vegetation Management Working Group meeting in Grande Prairie, make silviculture presentation and prepare survey to determine status of vegetation management in Canada, for the Forestry Canada Vegetation Management Working Group.

10. Contribute to/present a paper on the sustainability of the aspen resource at the Symposium on Aspen Management for the 21st century - November 20-21, 1990, Edmonton.

11. Prepare/negotiate via DSS a contract to determine the current status of wildlife/forestry interface R&D in mixedwoods to determine future wildlife - forestry R&D priorities for Northwest region boreal mixedwoods.

12. Attend and prepare reports on Green Plan information sessions in Grande Prairie and Calgary.

11. Accomplishments in 1990-91:

1. a) Assessed logging damage on Blueridge area logged March 1990.

b) Relocated all damage assessment plots and re-established plot centres and tags. Assessed conifers and aspen suckers, and recorded blowdown using new criteria. Prepared an updated data file for previous and 1990 data on all nine stands.

c) Reviewed AFS circular on criteria for understory protection - preliminary to incorporation into operating procedures.

2. Project leader duties:

a) Chaired and presented SRAC report on RRTC meeting in Whitecourt, which featured a PHSP training session.

b) Participated activity in ACSER, ACFER, and the Vegetation Management Working Group.

c) Provided advice to silviculture personnel in Saskatchewan and Manitoba as requested, including manuscript review.

3. Strategic plan completed and 5-year action plan appended.

4. Minimum activity as incumbent (Gorman) retired early 1990 and emphasis was placed on completing the understory spruce logging and assessment in co-operation with FERIC.

5. Advice provided was minimal due to retirement. (Gorman)

6. Photos were assessed and some visual interpretation done by Rentz to determine extent of logging disturbance. Techniques used by others assessed by Moore but no application of high-tech assessments was done.

7. No workshop conducted.

8. Method I crop trees assessed and a status report on crop trees for the entire area was prepared for FRDA publication.

9. Meeting organized and chaired and report presented. Survey prepared and distributed. Returns to date not complete.

10. Paper presented at aspen symposium on November 21, 1990.

11. Contract prepared and initiated for completion March 31, 1991.

12. Attended and reported on Green Plan consultations in Grande Prairie and Calgary.

12. <u>Present Status of Objectives</u>:

1. Silviculture R&D and reporting on regeneration silviculture has continued under the study to date, with the competition control emphasis primarily on mechanical site preparation. This approach was altered in 1985 by the addition of both manual and chemical control studies under the Alberta FRDA, which is co-ordinated through study NOR-10-03. Future

A-base work on competition control and early stand tending will lead to a focus on smaller equipment demonstrations for a variety of purposes, with less emphasis on site preparation with large equipment. There will be a shift toward work on harvesting systems in mixedwoods and their co-ordination with regeneration systems (including natural) in the future within a DSS framework.

2. National program involvement in mechanization of silviculture, through FERIC (west) will continue. Involvement is being continued in the National Vegetation Management Working Group because of the continuing interest in vegetation management in this region.

   Regional committee activity continues to focus on technical committees like RRTC, which have taken on a more important role recently in R&D planning strategy in this region and contributions to the Expert Committee on Weeds (ECW) will continue. Membership in ACFER and ACSER (FERIC (West)) will begin in 1990.

3. Contracts have been a particularly important part of the FRDA programs, where substantial funding has been available since 1985, and contracts continue to be an important adjunct to staff R&D in this study. No FRDA support is anticipated in 1990/91 but specific study goals for PAIF work will only be added if funding is provided.

13. Goals for 1991-92:

1. Assist in development of mixedwood DSS concepts and contribute to knowledge base as a preliminary to development of mixedwood DSS.(PAIF dependent) (Brace)

2. Continue protection of understory white spruce project. (Brace/Lux/Rentz)

   a) assess status of aspen suckers and spruce blowdown on plots in 9 harvested areas.

   b) complete establishment/progress report and slide file for project and provide input to wind damage (blowdown) survey of Navratil/Edwards as extension of (a).

3. Continue duties of project leader - NOR-10, including:

   a) chair and report to SRAC on 1991 RRTC meeting in Manitoba. (Brace)

   b) participate in CPPA (LOG, FMG), FERIC (ACSER, ACFER), ECW, Vegetation Management Working Group and other committees as required. (Brace/Lux)

   c) provide advice re silvicultural R&D and TT in Manitoba and Saskatchewan District Offices, including PAIF related issues. (Brace)

4. Publish Aspen Monograph (Peterson report). (Brace)

5. Continue Grande Prairie Vegetation management project: (Lux/Rentz)

   a) measure and report 5th year crop tree response on Method II area.

b) do plot maintenance on Method I and II areas.

c) update annual progress report.

d) prepare summary report of all aspects of project to date co-operatively with NOR-07-04 (Sidhu).

6. Assess opportunities to co-operate with provincial and industrial clients and FERIC (west) in the design, conduct and assessment/reporting of harvesting/silviculture studies within the context of mixedwood management DSS, including: (Lux, Rentz)

   a) area selection for future studies of harvesting and tending in mixedwoods, including immature aspen stands with understory.

   b) area evaluation for the demonstration of new approaches to mixedwood management (see Corn's test areas). Link to (a) above and to old Forestry Canada field trials in Alberta. (Green Plan demo or model forest connections)

   c) assess relevance of old Forestry Canada R&D and demonstration studies in the region as a source of concepts and knowledge (data) for mixedwoods DSS - both harvesting and non-harvesting studies (contract + Lux/Rentz)

7. Complete and report on the status of vegetation management in Canada for the Forestry Canada Vegetation Management Working Group. (Brace/committee members)

8. Re-organize/computerize regional PSP records and reservation status reports. (Lux)

9. Co-operate with study NOR-10-08 to complete 1991 field assessments in the Hinton life table study. (Lux)

10. Co-operate with study NOR-04-02 in field measurement of PSP's relevant to aspen and mixedwood DSS. (Lux)

14. Publications 1990-91:

Brace, L.G. 1990. A test of three logging systems in Alberta Can. For. Ind. 110(8):24-29.

Brace, L.G.; Todd, P. 1990. A summary of crop tree results: vegetation management project, Grande Prairie, Alberta. Final Report. Canada/Alberta FRDA (in press).

Expert Panel on Forest Management. 1990. Forest management in Alberta. Report of the Expert Review Panel. Government of Alberta Pub. No. 1/340. Edmonton, Alberta. May 1990. (Brace co-author)

Penner, D.F. 1990. Effects of hexazinone herbicide on small mammals under field conditions - 1986 to 1988 inclusive. Final report on contract work on the Grande Prairie vegetation management site, funded by Wildlife Toxicology Fund and ForCan (Contractor: D. Penner and Assoc., Sherwood Park, Alberta).

Todd, P.; Brace, L.G. 1990. Establishment and progress report 1985-90, Grande Prairie forest vegetation management study. Report on silviculture component of the Canada-Alberta FRDA vegetation management project. (File)

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: 1984 Completion: 1995

17. Resources 1991-92:

A-Base

PYs:	Prof.:	Brace	1.0
	Tech.: vice	Gorman	1.0
		Rentz	0.9
		Lux	0.6
	Total:		3.5
	Term/Student:		0.3

O & M: $35 K

NOTE: Requesting 68 K, 25 K, and 25 K for 1991-92 under the Alberta, Saskatchewan and Manitoba PAIF's respectively to enhance work on 1991-92 goals, which will be revised accordingly if funds are available.

The above funding does not include a share of the Resources project request for 720 K for stand level mixedwood DSS in 1991-92 under the Alberta PAIF, or 20 K, 20 K and 8 K requested for forest level mixedwood DSS in 1991-92 under the Alberta, Saskatchewan and Manitoba PAIF's respectively.

Capital: $ 5.5 K (Slide storage; color monitor)

18. Signatures:

L.G. Brace
Investigator

A/ Program Director, Resources

Regional Director General

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Mixedwood Silviculture

2. Title: Evaluation of mortality in stands of young trees in plantations and scarified areas

3. New: Cont.: X 4. No.: NOR-10-08

5. Study Leader: C.L. Rentz

6. Key Words: Jack pine, Pinus banksiana Lamb., lodgepole pine, Pinus contorta Dougl., white spruce, Picea glauca (Moench) Voss, insect damage, tree diseases, stocking standards, site classes, reforestation, browsing, rodent damage, technology transfer, juvenile tree survival and growth

7. Location of Work: Northwest Region

8. Problem:

In recent years there has been an increased awareness that Canada's forests are not going to last forever without assistance from forest managers. Many of the areas that are harvested, or have been burned do not naturally regenerate themselves with the desired tree species and density, and require site preparation or planting in order to provide satisfactory stocking levels. Whatever the procedure used, the operation is expensive, especially if it has to be repeated on the same site. Surveys are therefore conducted in order to determine whether or not the area under consideration is adequately stocked. However, the standards for making this decision are somewhat arbitrary because of the tree mortality that will occur between the time when the survey is conducted and when the tree is finally ready for harvesting. At the moment, a value of 80% stocking is considered to be adequate, but this is not necessarily valid for all sites. With jack pine and lodgepole pine especially, there is every reason to believe that the amount of mortality will vary between sites. some of this variability will be related to edaphic factors, but some will also be due to the differing effects of insect and disease attacks on trees in various sites.

What seems to be required, then, is an assessment of tree mortality from the time of establishment until crown-closure at age 25 to 35 years. An estimate of this mortality can be obtained by establishing plots in a number of different age classes, on a variety of sites, and

assessing the mortality for a relatively short period of time. This will allow a composite survival curve to be drawn up for each ecological site, possibly in about 5 years, which can be modified as more information becomes available. These curves should provide the information needed to determine what modifications, if any, of the stocking standards in relation to site class are required.

Each sampling unit will be a plot of 20 trees, and as many of these plots will be established in each area as in practical, typically 40 such plots per area. Several replicates will be established in a number of site and age classes. They will then be examined periodically to determine the amount and cause of mortality.

Insect and disease attack on jack pine and lodgepole pine are probably more important than in white spruce. Therefore, initial emphasis will therefore be concentrated on these two species.

9. Study Objectives:

To determine whether or not pine tree survival from establishment to age 35 years is related to site conditions, and if so, to prepare a set of survival curves for each site class.

10. Goals for 1990-91:

1. Prepare summaries of 1988-89 mortality for lodgepole pine in the Hinton, Alberta area.

2. Expand on 1988 file report to provide detail on all field aspects of project, especially plot layout and measurement details and any changes during project, and definition of each tree condition code noting how observed, objectivity and reliability.

3. Upgrade the progress report "Life tables for juvenile lodgepole pine in the foothills of west-central Alberta" by incorporating annual survival data for 1987-1990. Begin the preparation of an inforamtion report for publication in 1991-92.

4. Upgrade the progress report "Survival and growth of young planted jack pine in the Sandilands Provincial Forest, Manitoba" by incorporating the 8-year survival data. Begin the preparation of an information report for publication in 1991-92.

5. Stratify selected plot transects in the Hinton area into site productivity classes for young lodgepole pine, using aerial photographs. (Moore)

6. Assess 8-year mortality of young jack pine in the Sandilands Provincial Forest. Manitoba plantations.

7. Do necessary plot maintenance (repainting and retagging of trees) in Manitoba plantations.

8. Co-ordinate the retagging and painting of approximately 10 plots in Hinton area.

9. Assess the ninth year mortality of lodgepole pine in plots in the Hinton area.

10. Code and edit 1990-91 Hinton survival data and enter into computer.

11. Code and edit 1990-91 Manitoba survival data and enter into computer.

11. Accomplishments in 1990-91:

1. Mortality summaries for 1988-89 prepared for Hinton area. (Rentz)

2. Completed updated background to project by incorporating the first file report for the project. (Rentz)

3. Progress report initiated but not completed due to priority on "Forest Insects of Canada" publication. (Ives)

4. Work in Manitoba cancelled due to funding cut.

5. No progress beyond photo acquisition and preliminary assessment.

6. Work in Manitoba cancelled due to funding cut.

7. Work in Manitoba cancelled due to funding cut.

8. Completed retagging and painting of Hinton plots. (Rentz)

9. Completed 9th year mortality assessment at Hinton. (Rentz)

10. Completed coding and editing of 1990-91 Hinton survival data. (Rentz)

11. Work in Manitoba cancelled due to funding cut.

12. Present Status of Study:

Analyses of the data collected in the Hinton study indicate that continuing the study for another five-year period would be very worthwhile. The present data cover a 7-year period (1981-88), and therefore do not include a complete snowshoe hare cycle. These animals are apparently increasing in numbers at the present time, and fresh damage is starting to increase. Atypical hare damage to the basal stem of 25-year-old trees was common in three sample areas during the peak of the last cycle, but may be an unusual case. The trees in several widely spread out areas are now approaching the same age, and continuation of study would allow an evaluation of how common this type of damage is.

Also, present life table construction depends upon pooling data from a large number of areas in order to cover the desired range in age classes. Another five years data for most of the areas would allow construction of more life tables since the amount of pooling required for their construction would be reduced. Four new plots have been established since 1984. A few plots should therefore be established in young regeneration, in order to provide an estimate of current mortality in young stands.

Analyses of the data on jack pine survival in Manitoba indicate that factors responsible for most of the mortality of lodgepole pine in Alberta are of minor importance for jack pine in Manitoba. The infrequency of examination precluded the construction of life tables for jack pine survival, but drought appears to be the most important factor. It was suggested that these plantations be examined in 1990 and again in 1991 but this was not possible and the future of the Manitoba data is now in question.

Rentz has been conducting all of the field work and data coding and editing for this study during the last six years. Ives retired in March 1989, and Rentz is now study leader. Ives will be available for advice on a part-time basis and should be able to prepare the information reports in 1991-92 if this is desirable.

13. Goals for 1991-92:

1. Check 5 to 10 year height increments on selected areas at Hinton to verify height data used in site classification procedure. (Rentz)

2. Conduct a preliminary survey in June 1991 to assess the possible relationship between basal girdling and rusts in Hinton pine. (Rentz)

3. Complete progress report initiated in 1990-91. (Ives)

4. Prepare report summarizing 1981-90 results for the Hinton area emphasizing life table concepts and including fluctuations for selected pests (e.g., Pissodes, Petrova). (Ives/Rentz)

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:

Start: 1981 Completion: 1995

17. Resources 1991-92:

PYs:	Prof.:	vice Ives	0.6 (Wildlife Specialist)
		Ives	0.3 (Emeritus)
	Tech.:	Rentz	0.1
	Total:		1.0

Students: 0.0

O & M: $2,000

NOTE: requesting 50 K for 1991-92 via Alberta PAIF. Goals will be added to supplement Hinton data if funds available.

Capital: Nil

18. Signatures:

Investigator

A/Program Director, Resources

Regional Director General

NOR-10-09

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Mixedwood Silviculture

2. Title: Forest vegetation management techniques and tools for forestry

3. New: Cont.: X 4. No.: NOR-10-09

5. Study Leader: L.G. Brace (Cooperators: S. Navratil, P. Loseth, J. Ball)

6. Key Words: Vegetation management, nurseries, prescriptions, site preparation, stand maintenance, treatments, manual, mechanical, chemical, efficacy, tolerance, silvicultural response, survival, growth, environmental impact, economics, public consultation

7. Location of Work: Northwest Region

8. Problem Analysis:

Forestry has traditionally been a major provider of wealth in our economy and recently the Canadian Council of Resource and Environment Ministers (CCREM) established new goals for a 40% increase in the harvest and a doubling of forest productivity by the year 2000 is part of a plan for increasing employment and economic gain from forestry. These plans coincided with the realization that our reforestation and stand maintenance record across Canada is inadequate, with nonsatisfactorily restocked (NSR) stands totalling about 25 million hectares and vast areas of forest operating below their productive capability because of poor maintenance.

Regionally, the mixedwood forest illustrates the problem well. Mixedwoods occupy 50% of our regional forest land base and account for 300 000 of the 500 000 ha of nonsatisfactorily restocked NSR land in the region. Desirable softwood species are difficult to regenerate and grow because of competition from grass, brush, aspen suckers and damage from hares.

A new vegetation management strategy is needed to overcome these problems, including a plan for research to provide more information about the effectiveness and costs of an array of site preparation and stand maintenance tools, including manual, mechanical, and chemical treatments, prescribed fire and combinations thereof. Ideally this research requires a

framework of treatment prescriptions set within an ecological classifi- cation system to facilitate technology transfer to operational use. It should also be relevant to mixedwood forest management systems strategies which include natural regeneration systems as an option.

A recent problem analysis indicates that in the period 1975-85, approximately $92 MM was invested in site preparation and planting of 240,000 ha to white spruce or competition prone spruce sites in the region. If this investment is to be maintained some form of follow-up vegetation management - manual, mechanical, chemical or combinations of these - is essential. Failure to do so could result in softwood yield losses of 30 to 40 percent on these areas.

Recently there has been considerable emphasis on herbicides as a tool for site preparation and stand maintenance. National groups like the Canadian Confederation of Professional Foresters' Association (of which the CIF is a member) and the CPPA have issued policy statements emphasizing the need for herbicide use in forestry. The CCREM formed a special committee in 1981 to increase the number of herbicides available for forestry use and to shorten the period required for registration of herbicides. A recent PRUF contract report prepared for the NoFC, entitled "Herbicide Use in Forestry: A literative survey and assessment of its environmental impact and its future potential for forest management in the prairie provinces of Canada" documents the need for increased herbicide use in forestry. In 1984, a national tree nursery herbicide committee was formed to promote the registration of more herbicides for nursery use.

Forestry Canada has responded to the need for more herbicide research by initiating a National Forest Weeds Program with a Herbicide Sub-Program and a Forest Weeds Planning and Coordinating Committee. This Committee functions in a policy/coordinating role for Forestry Canada. The recent ForCan policy on forest pest management which addresses herbicides - is a major step forward in supporting vegetation management R&D in the ForCan.

The NoFC increased its regional forest vegetation management R&D which began in 1980 with small scale rate and timing trials of selected herbicides in support of the herbicide registration program at FPMI (see study NOR-10-04). This work was extended mainly through Agreement-financed programs in the region to include larger-scale experiments. A-base resources are the primary source of personnel and lab support for new programs. The project is multi-disciplinary, involving work on silvicultural, environmental and economic aspects of a range of alternation vegetation management tools, including manual, mechanical, chemical and fire.

The forest vegetation management project at NoFC is developing using A-base resources as a primary source of personnel and lab support and agreement resources for financial support. Both elements are critical to program success.

Recently a Forestry Pesticides Census has been formed with members from all forestry sector interests across Canada involved in pest management to:

1. provide input to the Federal Pesticide Registration Review Team;

2. facilitate development of economic risk/benefit assessments for forestry pesticides and pest management generally,

3. assist the Canadian Council of Forest Ministers to implement recommendations for pest protection under the National Forestry Sector strategy for Canada.

This project was subjected to national peer review in January 1985, November 1985, and June 1988.

9. Study Objectives:

1. Co-ordinate the development of a regional forest vegetation management R&D project plan and components incorporating. A-base and Federal-Provincial Agreement resources (3 provinces, NoFC and regional offices in Saskatchewan and Manitoba). The plan should incorporate components of project NOR-10 (Mixedwood Silviculture), NOR-7 (Environmental Impact and Residue Chemistry) and NOR-3 (Forest Resource Economics).

2. Conduct the silviculture R&D component of the forest vegetation management project plan, emphasizing efficacy, crop tolerance and crop growth aspects of alternative vegetation management techniques.

3. Maintain liaison with other related ForCan projects, national (FPMI) and regional, as well as related provincial and industrial projects (ECW, etc.).

4. Co-operate with other agencies in developing public consultation on herbicide use in forestry, contributing to procedural as well as factual aspects in this process.

10. Goals for 1990-91:

1. Continue to plan and coordinate regional A-base forest vegetation management R&D in Alberta (particularly NOR-10), and provide liaison and consultation on Manitoba and Saskatchewan projects.

2. Continue as co-ordinator of Alberta FRDA R&D (including project work in silviculture), act as Scientific Authority on related contracts under FRDA as required and provide liaison and consultation on Manitoba and Saskatchewan projects.

11. Accomplishments in 1990-91:

1. A-base work in Alberta continued under NOR-10-12. Chemical treatment by single-stem Vision injections of aspen under NOR-10-12 with financial assistance from Pelican Spruce supplementing A-base and FRDA funds was continued and the logging phase is due for completion before April 1991.

There was no new A-base work in Saskatchewan in 1990.

Manitoba had no new A-base work in 1990.

2. FRDA work in Alberta on the Grande Prairie test site has progressed according to the work plant except for Economic assessment which awaits data. Manual and chemical (Pronone 10-G) release treatments were completed in spring 1989 and measurements of fourth-year site preparation results and second-year release results were made for both silvicultural and environmental components. Progress on Satellites A, B and C is reported in study NOR-10-12. The small mammal contract (Penner and Associates) was completed and reported under NOR-10-03.

12. Current Status of Study Objectives:

See component studies.

13. Goals for 1991-92:

1. Continue to co-ordinate regional A-base vegetation management R&D in Alberta (NOR-10-03 and NOR-10-12) and provide liaison and consultation on Saskatchewan and Manitoba projects as required.

2. Continue to co-ordinate regional PAIF related vegetation management R&D in Alberta - funding permitting - transferring priority activities to A-base if funding fails, and provide liaison and consultation on Saskatchewan and Manitoba projects as required.

14. Publications 1990-91:

See NOR-10-03 and NOR-10-12.

15. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the proposed study activities. On the basis of the following clarifications provided by the study and project leaders the committee concludes that no further screening action is required.

1. Field performance refers to the survival and growth of planted seedlings. It has no specific environmental impact implication. The Alberta project, on the Grande Prairie benchmark site, has been reviewed by Technical advisory Committee of the Alberta Environment Centre and by the Pesticides Chemical Branch of Alberta Environment. The project was covered by a permit from Alberta Environment before proceeding. All other aspects of the study were screened under the studies in which they originated.

16. Duration

Start: 1985 Completion: tentatively 1993 for PAIF work if funding available, ongoing for A-base

17. Resources 1991-92:

PYs: Prof.: (See individual studies)

O & M: - PAIF still questionable so A-base is only current commitment
Capital: - (see individual studies)

18. Signatures:

Investigator

A/ Program Director, Resources

Regional Director General

NOR-10-12

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Mixedwood silviculture

2. Title: Aspen silviculture in mixedwood and hardwood management

3. New: Cont.: X 4.No.: NOR-10-12

5. Study Leader: S. Navratil

6. Key Words: Aspen regeneration, aspen silviculture, mixedwood silviculture, silviculture systems, vegetation management, competition estimates, stand development, release treatments, site preparation, regeneration prescriptions, technology transfer

7. Location of Work: Northwest Region

8. Problem:

With dramatic increase in aspen utilization in the Prairie provinces successful renewal and management of hardwood and mixedwood stands becomes critical. In Alberta alone, annual harvest of aspen will reach 6 million m^3 in 1991 and 8.5 million m^3 in 1993 to satisfy the consumption of the current and newly announced forest industry. The 1991 aspen utilization level can be projected to about 50,000 ha of cutover area to be regenerated to aspen annually.

Necessary knowledge and techniques are urgently required to develop aspen silviculture systems responsive to the objectives of intensive and extensive management and hardwood and softwood production. R&D and technology transfer on regeneration, stand establishment and stand development that

a) encourage aspen regeneration and promote hardwood growth

b) deter and control aspen competition for the benefit of softwood regeneration and resource on designated areas,

c) ensure the optimal growth and stand development of mixed (aspen & conifer) regeneration and juvenile stands has become the most significant and pressing challenge.

NoFC has been in the forefront of R&D on aspen and vegetation management and the study in its present form combines current research needs and past experience. Foresters need tools, alternative to herbicide use, for controlling unwanted aspen competition. Non-chemical methods of aspen control such as site preparation and mechanical release need to be tested more vigorously than in the past and their biological specifications developed. Similarly, pre-harvest, single-tree treatments are becoming more significant as environmentally safe methods. The trials in progress established under the 1989-90 Canada-Alberta FRDA Vegetation Management - Aspen control project reflect the above needs and new approaches such as mechanical release trials are in progress.

Industry and provincial governments have acknowledged the magnitude of regeneration and juvenile stand problems on mixedwood and softwood cover types. Competition assessments and free-to-grow projections to decide whether the renewal phase has been successful are in the forefront of current forestry issues. Particularly needed is information that will enable us to accurately estimate future growth, species composition, development and yield of new, largely mixed forest. In response the work on aspen ingress,competition , growth trajectories in aspen-conifer regeneration and juvenile mixed stands has been expanded. This knowledge is a prerequisite for evaluating silvicultural treatments and for modelling and forecasting juvenile stand development. Its linkage with site classification (NOR-02) and Growth and Yield (NOR-4) will make possible to rank sites and stands for treatments and silviculture investments and to relate juvenile stand growth to wood supply projections and management planning.

Shortfalls in age class distribution and tree-sizes in some geographic areas will require research directed towards intensive silviculture, shortened rotations and possibly improved stand and tree quality . Stand density management trials and short rotation technology may need to be evaluated as potential components of intensive aspen silviculture.

The expected greater use of forest management systems using a multidisciplinary approach and variety of silviculture systems will require a synthesis of the knowledge on regeneration capabilities of aspen and associated species - white spruce, balsam poplar, white birch - and its integration with the better understanding and linkage of harvesting-renewal cycle. The ultimate goal of the acquisition of knowledge base is an expert system that predicts regeneration density and initial growth and stand development and advises decision-makers on the most suitable harvesting and silviculture strategies and treatments.

9. Study Objectives:

1. To develop silviculture systems, including opportunities for increased productivity, to manage the aspen resource in pure hardwood stands and as a component of mixedwood stands.

2. To conduct silviculture R&D on chemical and non-chemical means of aspen competition control for the maximum growth of conifer crop at pre-harvest, establishment and early development stage of softwood and mixedwood stands.

3. To assess aspen ingress, competition and growth trajectories and juvenile stand development for formulation of silviculture treatments and management strategies for mixed stands.

4. To develop knowledge bases and concepts for the Regeneration modules for Aspen and Mixedwood Decision Support Systems.

10. Goals for 1990-91:

1. Supervise re-measurements of plots and related work on the Satellite trial B and major trial at Grande Prairie (Method 1 only).

2. Supervise continued treatments, plot establishment and assessments on Single-tree treatment trial in cooperation with Weyerhaeuser Canada Ltd., Drayton Valley.

3. Complete the first version of "Aspen and pine competition" model and test its predictive ability by supplementary data collection and model verification. Strengthen the model by:

   a. adding the functions of competition dynamics and mortality of aspen and pine

   b. responses to release treatments (see item 5)

   c. developing concepts for linking growth and competition model of mixed (Aw and Pl) regeneration with G & Y and stand development models, jointly with NOR-4 (Bella, Ciesziewski).

4. Initiate planning and conceptual development of white spruce - hardwoods growth and competition model of mixed regeneration.

5. Supervise assessments and analyses jointly with ForCan Saskatchewan and AFS of mechanical release trials of pine and spruce.

6. Participate in development of the Mixedwood Management Advisory System (Forest Resources team) and Aspen Advisory System

   a. conceptualize and coordinate the regeneration modules of the first version of Mixedwood Management Advisory System

   b. develop aspen regeneration knowledge base and module that predicts density growth and competition (spatial distribution components in cooperation with NOR-2; evaluation of data bases jointly with Alberta Forest Service).

7. Participate in advisory capacity in evaluation of the ForCan-Saskatchewan hardwood regeneration survey (Productive Forest Land Depletion) (potentially Scientific Authority of Saskatchewan FRDA contract Limiting factors of aspen regeneration).

8. Cooperate with AFS in assessing application of the Prognosis model components (Regeneration establishment, Cover, Canopy) for aspen and mixed regeneration.

9. Facilitate and coordinate jointly with TDU NoFC and PCC, Aspen Silviculture workshop to be held in Alberta in late months of 1990.

10. Function as the Secretary-Treasurer of Poplar Council of Canada and manage the Secretariat of PCC at NoFC.

11. Prepare a review/problem analysis in a draft form for ForCan Info report "Wind and snow damage risk rating and cultural treatments for minimizing losses in silviculture systems of mixedwoods".

12. Publish the paper "Aspen ingress of seed origin on lodgepole cutovers in Alberta" in Forestry Chronicle.

13. Prepare a paper "Growth and competition in mixed juvenile stands of aspen and lodgepole pine in Alberta" for IUFRO Working Party S 1.05.03 meeting, IUFRO Congress, Montreal.

14. Publish the paper "Sampling for zero-time residues and dissipation of hexazinone in forest soils in northern Alberta", J. Feng and S. Navratil (submitted to Can. J. For. Res.).

15. Publish the paper "Internal quality in aspen: wood defects and associated organisms" in Proceedings of Wood decay measurement workshop, AFS-ForCan, January 1989, Edmonton (in press).

16. Publish the paper "Aspen and lodgepole pine growth interactions in mixed regeneration ", S. Navratil and P. Phillips, in Proceedings of the Vegetation management workshop, Prince George, February, 1990 (in press).

Added Goals:

17. Prepare and present a paper "Regeneration challenges" at the Aspen Management Symposium, Edmonton.

18. Participate in the 1990 meeting of Vegetation Management Working Group, August, Grande Prairie.

19. Prepare jointly with Bella/Ejsmont/Yang a poster on Aspen DSS for Aspen Management Symposium, Edmonton.

11. Accomplishments in 1990-1991:

1. Plots on Satellite trial B and major trial at Grande Prairie (Method 1) were re-measured. Three-year results from Satellite trial A and Grande Prairie (Method 2) were summarized in a FRDA final report (see list of publications).

2. Second herbicide treatments, plot establishment and assessments of tree mortality and suckering (in part) and wood sampling were completed. Contracts were prepared and completed on testing of OSB wood properties (Alberta Research Council) and herbicide residuals in wood (A&S Environmental Testing, Reading, Penn, USA).

3. Supplementary data collection for model verification and assessment of release response were completed; statistical analyses and modelling was hindered by the delays in hiring a supporting staff (System Analyst).

   a) contract on Modelling of competition dynamics and mortality was completed; it provided useful concepts, but no definite model;

   b) responses to release treatments were included in the data base;

   c) cooperation continued; NOR-4 provided consultation and Cieszewski developed height growth functions for aspen seedlings and suckers (a potential publication);

   d) in addition, contract is in progress on Site indexing of juvenile growth of lodgepole pine and aspen; a letter of agreement was prepared to facilitate sharing of the findings from two similar contracts on site indexing of juvenile growth between AFS and ForCan.

4. Methodology of Competition PSPs was developed and PSPs established on Satellite B (aspen-spruce) and Grande Prairie Method 2 trial (aspen-pine).

5. ForCan Saskatchewan mechanical release trial was assessed; no remeasurements were done on AFS and Weldwood disking trials in Alberta.

6. Participated in development of Aspen DSS and Mixedwood DSS:

   a) an initial planning stage of Mixedwood DSS did not require specific input beyond general participation;

   b) participated in planning of aspen DSS; initiated work on formulation of the knowledge base and a preliminary concept for regeneration module of aspen DSS and communicated it to NOR-4.

7. Participated with Saskatchewan Prov. and ForCan, Prince Albert in interpretation of the survey of hardwood cutblocks (Productive Forest Land Depletion) and planning of a joint work under new PAIF.

8. No work required by AFS or contractor.

9. Organized and co-chaired Aspen Management Symposium 1990 held on November 20-21, 1990 in Edmonton.

10. Functioned as the Secretary-Treasurer of Poplar Council of Canada and managed the Secretariat of PCC at NoFC.

11. Prepared an outline of the report, screened literature for pertinent information and compiled notes from contacts with European foresters.

12. No progress in writing in 1990.

13. Prepared and presented a paper "Growth interactions and competition in juvenile mixed stands of lodgepole pine and aspen in western Alberta, Canada" at IUFRO Working Party S 1.05.03, IUFRO Congress, August 1990, Montreal.

14. Paper on sampling residues of hexazinone published in Can. J. For. Res. 20:1549-1552, 1990.

15. Paper on Internal quality in aspen is in press.

16. Paper on aspen and lodgepole pine growth interactions published (see the list of publications).

17. Presented a paper "Regeneration challenges" at the Aspen Management Symposium 1990, November 20-21, 1990, Edmonton.

18. Participated in and presented a progress report co-authored with R. Hayward at the 1990 meeting of Vegetation Management Working Group, August, Grande Prairie.

19. Co-authored with Bella, Ejsmont, Yang a poster "Developing a Decision Support System for Aspen Stand Management in western Canada" for the Aspen Management Symposium, November 20-21, Edmonton.

12. Present status of study objectives:

Direction and scope of the study has widened in response to the current R&D needs in mixedwood and hardwood management and NoFC Strategic Plan initiatives. The development of silviculture system for the aspen resource in hardwood and mixedwood stands remains the overall, ongoing goal and is reflected in the study objectives listed in item 9.

The need for renewed R&D into management of hardwood and mixedwood stands under the framework of forest land management system and for the development of Aspen and Mixedwood DSS (Northwest Region's Strategic Plan 1990-95) will require a sizable synthesis of the current and past knowledge on aspen regeneration and silviculture and mixedwood regeneration.

As a result acquisition of the required knowledge bases and formulation of the Regeneration Modules for Aspen DSS and Mixedwood DSS have gained a high priority among the study components. A variety of regeneration options will need to be formulated for silviculture prescriptions (PHSPs) addressing a multitude of management, site and silviculture alternatives. The Regeneration modules will need to integrate the regeneration silvics of aspen and associated forest tree species such as white spruce, balsam poplar and white birch, intensity levels of management, harvesting principles, site suitability and site limitations and other. At the same time a strong emphasis will have to be placed on the concepts of silviculture systems and dynamics of the renewal processes and stand development as opposed to decision-making on separate treatments.

Some aspects of this work are at a limited scale addressed in the current 1991-92 goals; the major efforts are pending new PAIFs.

Regeneration surveys (e.g., Saskatchewan Productive Forest Land Depletion Survey) in the region have raised concerns about deficiencies in aspen regeneration after harvesting hardwood and mixedwood cover types. The observed inadequate aspen regeneration likely results from a combination of site factors, topography and harvesting activities. One solution how to alleviate and prevent the problem is to develop a hazard rating system for predicting aspen regeneration deficiencies. The system, structured later as an expert system, would become a essential component of the Regeneration module of Aspen DSS.

The main components of R&D on aspen control are the trials established under the 1985-90 Canada-Alberta FRDA Vegetation Management project and the Single-tree treatment trial jointly with Weyerhaeuser Canada, Drayton Valley. All trials have progressed well as planned though the delays due to herbicide moratoria will extend their completion, and will require resources, beyond the duration of the 1985-90 FRDA.

Three new trials of competition release by non-chemical, mechanical means were established in Alberta (Alberta Forest Service and Weldwood, Hinton) and Saskatchewan. Further work concentrates on a better understanding of the processes that create competition and needs for treatments, linking aspen control and competition studies, and economic analysis of aspen control alternatives.

The extent of mixed regeneration after harvesting mixedwood and softwood cover types is increasing in the region. Our work on aspen ingress and competition in mixed regeneration has been designed to answer some of the concerns about competition, free-to-grow status and yield performance of mixed juvenile stands. Modelling approaches are, and will be increasingly used to define the dynamics of competition and stand development in mixed regeneration and to evaluate the validity of renewal and stand tending strategies. Intensive competition studies involving PSP establishment and long-term, sequential measurements will be needed to explain and model the interactive processes in crop tree response to competition and site. The outcome of this work will be recommendations to clients on free-to-grow issues and a Competition/Mixed regeneration module of Mixedwood DSS.

13. Goals for 1991-92:

1. Supervise remeasurements of plots and related work on the Satellite trail A, Satellite B, and Satellite C and major trial, Grande Prairie and summarize results in a progress report.

2. a) Supervise continued assessments on single tree treatment trial, Weyerhaeuser Canada, Drayton Valley.

   b) Prepare contracts for OSB wood properties testing (ARC, funded by Weyerhaeuser Canada) and herbicide residual analyses (pending new PAIF). (Navratil)

   c) Prepare a draft of a paper on Glyphosate residuals in the wood of treated trees, jointly with J. Feng.

3. Continue work on the first version of Aspen Lodgepole pine competition and Free to grow model by:

a) adding responses to treatments by remeasurements of mechanical release trials, jointly with AFS, Weldwood and ForCan, Sask. (Navratil/Dendwick)

b) continue remeasurements of competition PSPs in aspen-pine regeneration. (Dendwick)

c) initiate a joint work with NOR-4 (Bella, Cieszewski) on developing and linking growth and competition models.

4. Provide input on wind damage issues to NOR-10-08 (Brace) including preparation of a review "Wind damage risks in released understory white spruce". Information report pending PAIF and coauthorships with Kuhnke and Edwards.

5. Initiate work on aspen regeneration knowledge base and module for aspen DSS including:

   a) extraction and interpretation of aspen literature (Navratil/Todd)

   b) compilation of data base on aspen density and juvenile growth from available old and new ForCan studies, AFS and Sask. Govt. surveys. (Todd) (pending PAIF)

6. Participate in development of Mixedwood DSS by planning and coordinating Regeneration/Silviculture modules (pending new PAIF).

7. Assess the feasibility of a joint project (ForCan + clients) addressing competition, crop tree responses and Free-to-grow in hardwoods - white spruce regeneration. (pending PAIF).

8. Assess the feasibility of developing a hazard rating system for predicting aspen regeneration deficiencies jointly with Saskatchewan Provincial Government and Alberta Forest Service (implementation pending PAIF). (Navratil/Edwards)

9. Publish the paper "Aspen ingress of seed origin on lodgepole pine cutovers in Alberta" Forestry Chronicle or Can. J. For. Research.

10. Draft of a paper on Five-year field performance of mycorrhizae inoculated white spruce and lodgepole pine seedlings in Alberta, coauthored with W. Fast.

11. Coordinate jointly with P. Chapman publication of the proceedings of Aspen Management Symposium held November 20-21, 1990.

12. Function as the Secretary of Poplar Council of Canada and participate in planning of Aspen Innovation Centre (NoFC Strategic Initiative).

14. Publications 1990-91:

Bella, I.E.; Ejsmont, M.; Navratil, S.; Yang, R.C. 1990. Developing a decision support system for aspen stand management in western Canada. A poster presented at the "Aspen Management Symposium, Edmonton, November 20-21, 1990.

Feng, J.; Navratil, S. 1990. Sampling for zero-time residues and dissipation of hexazinone in forest soils in northern Alberta. Can. J. For. Res. 20:1549-1552.

Navratil, S. 1989. Internal quality in aspen: wood defects and associated organisms. Proceedings of Wood Decay Measurement Workshop, AFS-ForCan, January 1989, Edmonton. (in press).

Navratil, S. 1991. Regeneration challenges. Proceedings of the Aspen Management Symposium, Edmonton, November 20-21, 1990. [in press].

Navratil, S.; Bella, I.E.; Petersen, E.B. 1990. Silviculture and management of aspen in Canada: the western Canadian scene. Pages 39-60 in R.D. Adams, ed. Proceedings of the Aspen Symposium, Duluth, Minnesota, USA. July 25-27, 1989. USDA For. Serv., North Cent. Exp. Stn., Gen. Tech. Rep. NC-140.

Navratil, S.; Branter, K.; Zasada, J. 1991. Regeneration in the mixedwoods. Proceedings of the Northern Mixedwoods Symposium, Fort St. John, B.C., September 1989 (in press).

Navratil, S.; Hayward, R. 1990. Management of initial density of aspen regeneration. Report on aspen control component of the Canada-Alberta FRDA Vegetation Management project. (in press).

Navratil, S.; Phillips, P. 1991. Aspen and lodgepole pine growth interactions in mixed regeneration in Proceedings of the Vegetation management workshop, Prince George, February 1990.

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.

1. All experimental herbicide applications have been done under permits issued by Alberta Environment, Environmental Protection Services (Pollution Control Division), and the studies are registered with FICP.

2. Either the plots are distant from any water bodies or there was a buffer zone of 30-50 m between the plots and a water body.

3. Plots are being monitored over long term to assess the effects of herbicide application on vegetation and forest crop species.

4. Methods of application included spot-gun spray or single tree injections. As a result, no aerial drift of herbicides was expected or observed.

16. Duration:

Start: April 1988 Completion: 1998

17. Resources 1991-92

PYs:	Prof.:	Navratil	1.0
		Todd	1.0
	Tech.:	Dendwick	1.0
	Total:		3.0
	Terms	MacIsaac	0.3
	Students:		0.6

O&M: $45,000

NOTE: Reguesting 39 K (goal 1 and 2), 44 K (goal 5), 10 K (goal 4) under the Alberta PAIF and 20 K (goal 8) under the Sask. PAIF to enhance work on 1991-92 goals.

The above funding does not include a share of the Resources and separate component requests for Aspen (B-I-1 a, b) and mixedwood DSS (B-II-1 b, c) in 1991-92 under the Alberta, Saskatchewan and Manitoba PAIFs.

The goals will be revised accordingly if funds are available.

Capital: $ 3,200 (PC computer for DSS work)

18. Signatures:

Investigator

A/ Program Director, Resources

Regional Director General

NOR-10-13

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Mixedwood Silviculture

2. Title: Forest soil research in boreal mixedwood management

3. New: X Cont: 4. No.: NOR-10-13

5. Study Leader: I. K. Edwards

6. Key Words: Aspen ecosystems, soils, harvesting, windthrow, understory, site disturbance, regeneration, competition, juvenile growth, stand development, Populus tremuloides Michx., Populus balsamifera L., Picea glauca (Moench) Voss, Pinus contorta Dougl.

7. Location of Work: Northwest Region

8. Problem:

Development of technology for utilization of aspen for pulp and assorted wood products has resulted in a sharp increase in interest in, and importance of, this tree species. The increased utilization of aspen has presented forest managers of boreal mixedwood and aspen ecosystems with new problems, not the least of which relates to stand management. For example, depending on the system used in harvesting boreal mixedwood forests, the result is a range in disturbance of soil and site conditions. The degree of disturbance manifests itself in problems related to regeneration, competition, juvenile growth, and, subsequently, stand development.

Currently, in harvesting the dominant species or overstorey in a mixedwood stand, consideration has to be given to preservation of the sub-dominant species or understorey component of the stand. Frequently, when the stand is opened by selective harvesting, the remaining trees are prone to windthrow and/or blowdown. Soils characteristics are implicated in these phenomena. Therefore, characterization of soils in mixedwood and aspen stands, determination of the relationship between such characteristics and windthrow/blowdown phenomena, and development of a windthrow hazard rating for soils within such stands is a priority.

Investigation and solution of problems encountered in the management of boreal mixedwood and aspen ecosystems will facilitate development of a Decision Support System (DSS) or technical modelling framework, through which forest managers will be assisted in using the land judiciously and with minimal impact on productivity. Completion of an adequate DSS, including contributions based on studies of soil-plant interaction, will provide relevant prescriptions for enlightened harvesting, site preparation, and stand establishment/management practices in boreal mixedwood and aspen forests.

Completion of an adequate management framework for boreal mixedwood and aspen ecosystems within the Northwest Region should include studies of soil-related problems. Particular soil-related problems that arise in mixedwood management concern the assessment of site disturbance and the effects of forest management activities on vegetational succession. Also, soil compaction is known to increase bulk density and reduce plant establishment and growth over the long term. Development of a DSS should include measures for the avoidance or mitigation of such disturbances, based on sound forest soil studies, including a review of relevant historic Forestry Canada R & D in the Northwest Region.

9. Study Objectives:

   1. Plan and conduct forest soil research and development studies to solve soil-related problems in mixedwood management.

   2. Provide knowledge, advice, and consultation related to regeneration, competition, juvenile growth, and stand development for a range of disturbed and undisturbed soil and site conditions for major tree species in boreal mixedwood forests, within a DSS framework.

   3. Prepare and supervise contracts related to forest soil research and development in the Northwest Region.

   4. Plan and conduct research to promote and expedite transfer of soil science information relevant to nursery and regeneration problems among forestry clientele.

10. Goals for 1990-91:

    (New Study)

11. Accomplishments in 1990-91:

    (New Study)

12. Present Status of Study:

    The study is being initiated to research problems related to soil-plant interaction in the management of boreal mixedwood and aspen ecosystems. Soil research results will contribute to development of a DSS to provide scientific support for sound forest land management practices.

13. Goals for 1991-92:

1. Participate in development of the mixedwood and aspen DSS by providing soil-related input to formulation of concepts and knowledge base. (Edwards)

2. Review literature and undertake field work on windthrow and soils- related assessment criteria to complement NOR-10-12 (Navratil/Brace). (Edwards/van Dyk)

3. Review literature on soil factors limiting aspen regeneration, define the scope of the problem in Alberta, and develop an action plan for complementing ongoing work in NOR-10-12 (Navratil). (Edwards/van Dyk).

4. Assess white spruce understories for survival and growth potential following harvesting of overstory. (Edwards/van Dyk)

5. Assess soils data for old Forestry Canada R & D and Demonstration projects pertaining to site disturbance and successional implications of forest management activities (linkages to NOR-04-02, Bella; NOR-10-03, Brace). (Edwards)

6. Provide advisory consultation on nursery technology and forest soil problems related to mixedwood/aspen regeneration and DSS prorities. (Edwards/van Dyk)

7. Initiate revision of the publication NOR-X-214E. (Edwards/Dymock)

8. Publish proceedings of the 1989 meeting of the Prairie Tree Nursery Association held at Smoky Lake, Alberta. (Edwards)

9. Conduct greenhouse study on acidification of soils from Weldwood Canada planting sites near Hinton. (Edwards/van DyK)

10. Review contractor's final ENFOR report on applicability of the FORCYTE model to aspen ecosystems in Alberta and publish as a Contractor's Report (linkage to NOR-28-06, Powell). (Edwards)

11. Liaise with D. Maynard to maintain contact between the Environmental Effects project (NOR-07) and Mixedwood Silviculture (NOR-10). (Edwards)

12. Examine present management of the greenhouse/nursery complex and develop options for its future use and management. (Edwards)

14. Publications for 1990-91:

(New Study)

15. Environmental Implications:

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

16. Duration

Started: 1991 Estimated Completion: Continuing

17. Resources:

PYs:	Prof.	Edwards	0.9
	Tech.	van Dyk	1.0
	Total:	1.9	

Term/Student:

O & M: $7,600

Capital: Nil

18. Signatures:

Investigator

a/ Program Director, Resources

Regional Director General

NOR-11-01

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: 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

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

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

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

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

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-12-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 31, 1991

1. Project: Nursery Management and Tree Improvement

2. Title: Forest tree seedling and seed physiology

3. New: Cont.: Term: X 4. No.: NOR-12-01

5. Study Leader: I.J. Dymock

6. Key words: Tree seedling physiology, cold hardiness, dormancy, physiological and biochemical testing, phenology, bareroot and container stock production, accelerated growth, flowering, cone and seed production.

7. Location of work: Northern Forestry Centre, Edmonton, Alberta; locations within Western and Northern Region as may be required.

8. Problem:

Inadequate forest regeneration has recently been identified as a major problem area, and a limiting factor in achieving sustained yield forest management. This is apparent both in the Western and Northern Region, as well as across the country. With the greatly increased demand for conifer seedlings for reforestation, there has been a concomittant increase in the demand for good quality conifer seed, and demands on nurseries for increased production of high quality seedlings for planting purposes. The increased demand for both container and bareroot seedlings to meet the increasing needs of both government and private sector reforestation has been receiving considerable attention.

Earlier research efforts were often focussed on applied aspects of intensive container and bareroot stock production, with emphasis on the assessment of growth requirements (nutrient, lighting, temperature and watering regimes), conditioning of seedlings for overwintering, methods of assessing dormancy and freezing damage, determination of adequate winter storage conditions, preplanting conditioning, and assessment of field performance(growth and survival) following outplanting. Some effort has gone into determining the negative and positive effects of accelerated growth, and other rearing practices on field performance of seedlings. Various methods of physiological testing of seedling quality and condition have been devised.

What has been absent is an in depth analysis of the environmental factors that influence seedling growth and development in both container and bareroot seedling production situations. Phenology, the study of the interaction of climatic factors with any biological process, can yield an inordinate amount of valuable information pertaining to overall seedling quality or condition, that can be utilized in the development or improvement of nursery management and tree improvement practices.

Thus, there is a need for detailed, long term analyses of the phenology of early growth and development of each conifer species of economic importance. These must employ the specialized testing techniques for monitoring environmental parameters as well as assessing morphological, physiological and biochemical events that occur from seed germination through to early field performance. A better understanding of the events that occur in the environment in which the seedling grows, and within the seedling itself, would provide information that would be useful in the development of new methods and procedures to assist production nurseries in the intensive culture of improved forest seedling stocks.

The requirements for greater quantities of high quality seed or for more genetically improved seed stocks, warrant further analysis of cone and seed production strategies. This leads to the need for a re-examination of methods for promoting early and enhanced flowering in those species that are recalcitrant in flowering, and seed production. Analysis of current practices indicates that flower induction treatments for some species could be initiated much earlier than was previously reported. For some species, this could be as early as during the first six months of growth. The interactions between supplemental lighting sources, the photoperiod used, and the use of applied endogenous growth regulators must be more fully examined for each species of interest for tree improvement and reforestation purposes.

Results could readily be applied to tree improvement programs for the development of seed orchards. Retrospective testing of seed from genetically superior seed stocks, that have established family test plantation histories of ten to fifteen years, should be carried out under optimal conditions for accelerated growth. Where strong positive correlations exist between field trials and early screening for superior growth and form under accelerated growth conditions, then culling of inferior stock could occur much earlier in the growth cycle. Under optimal accelerated growth conditions, seedling stocks might also be screened at an early age for insect and disease resistance, cold hardiness, and drought resistance.

Research investigations under this study, thus examine the physiological basis of nursery management and tree improvement practices. This entails the planning, conduct, analysis and reporting of basic and applied research in the primary areas of: a) overwintering physiology of container-grown nursery stock, b) accelerated growth practices, and c) the promotion and enhancement of early flowering and cone and seed production in economically important conifer species.

9. Study Objectives:

1. Conducts investigations into the physiological aspects of: a) growing, conditioning, and physiological testing of container and bareroot seedlings, b) the assessment of field performance of tested seedling materials; and c) the promotion and enhancement of early flowering and cone and seed production.

2. Analyses and interprets existing and new research data in support of nursery management practices for seedling production, seedling conditioning, physiological testing, and the assessment of early field performance; and tree improvement practices related to accelerated growth and the promotion of early and enhanced flowering for tree breeding and cone and seed production.

3. Provides consultative services to federal, provincial and industrial agencies concerning the physiological basis of seedling production, conditioning, testing and field performance, and all aspects of the physiology of flowering and cone and seed production.

4. Performs the duties of a seed analyst for certification of forest reproductive material from the Western and Northern Region moving in international trade.

10. Goals for 1990-91:

1. Seedling physiological research

a. Complete review/revisions/publication of the scientific journal article "Phenology and seasonal variation in overwintering physiology of containerized lodgepole pine seedlings", in Can. J. For. Research.

b. Complete writing of scientific journal article on comparative overwintering physiology of containerized white and black spruce, and submit for peer review.

c. Initiate preparation/writing of scientific journal article on comparative overwintering physiology of containerized jack and red pine.

2. Cone and seed physiological research on accelerated growth and the promotion of early/enhanced flowering in conifers

a. Continue lP study. Complete peer review/revision of scientific journal article "Early accelerated growth in conifers: I. Supplemental light and photoperiod effects in lodgepole pine", and submit to the Can J. For. Res. Complete writing scientific journal article "Early accelerated growth in conifers: II. Growth regulator effects in lodgepole pine", and submit for peer review. Following peer review and revision submit to Can. J. For. Res. Complete deferred measurement/assessment of 1989 growth in all outplanted lP by April 15. Monitor 1990 flowering during May and June. Measure/assess 1990 growth and collect cones/assess seed production of all outplanted lP during October.

b. Continue wS study. Complete writing two scientific journal articles in the series on early accelerated growth in conifers: "III. Supplemental light and photoperiod effects in white spruce", and "IV. Growth regulator effects in white spruce", and submit for peer review. Complete deferred measurement/assessment of 1989 growth in all outplanted wS by April 15. Monitor 1990 flowering during May/June. Collect cones/assess seed production during August. Measure/assess 1990 growth of all outplanted wS during October.

c. Continue jP study. Complete deferred measurement/assessment of 1989 growth in all outplanted jP by April 15. Monitor 1990 flowering during May/June. Measure/assess 1990 growth and collect cones/assess seed production during October.

d. Continue bS study. Complete deferred measurement/assessment of 1989 growth in all outplanted bS by April 15. Monitor 1990 flowering during May/June. Collect cones/assess seed production during August. Measure/assess 1990 growth during October.

3. Provision of consultative services

a. Provide consultative services to NoFC and FORCAN staff and regional clients on matters concerning tree physiology and nursery management and tree improvement practices.

b. Continue collaboration with Drs. R.P. Pharis (adjunct professor), F.C. Yeh and B.P. Dancik (Univ. of Alberta, For. Sci. Dept.), on their study: "Characterization of native growth hormones of juvenile lodgepole pine and their relationship to inherent superiority in vegetative growth".

c. Continue collaboration with Drs. F.C. Yeh, I.B.-C. Jiang, R.P. Pharis (adjunct professor) and Ph.D. student Wu Xiaming (Univ. of Alberta, For. Sci. Dept.) on their study: "Early testing of lodgepole pine".

4. Perform duties as seed analyst on a request basis.

11. Accomplishments in 1990-91:

1. Seedling physiological research.

a. The scientific journal article "Phenology and seasonal variation in overwintering physiology of containerized lodgepole pine" was rejected by the Can. J. For. Res. on March 27, 1990. Reviewers recommended re-writing the original manuscript as two separate manuscripts. Work on the revisions has been initiated on these manuscripts under the following working titles:
- Influence of temperature and duration of exposure during rapid freezing of containerized lodgepole pine seedlings.
- Environmental factors affecting overwinter success of containerized lodgepole pine seedlings.
A draft of the first manuscript has been completed to the end of the Results section. The second manuscript has been organized, but writing has not yet begun.

b. Goal deferred until initiation and completion of revisions under 1.a.

c. Goal deferred until initiation and completion of revisions under 1.a.

2. Cone and seed physiological research on accelerated growth and the promotion of early/enhanced flowering in conifers.

a. Continued lP study. Completed peer reviews/revisions to scientific journal article "Early accelerated growth in conifers: I. Supplemental light and photoperiod effects in lodgepole pine". Submitted to Can. J. For. Res. January 4, 1991. The second early accelerated growth in conifers journal article: "II. Use of root-applied gibberellin $A_4/7$ and naphthalene acetic acid in lodgepole pine" is complete to the Discussion. It will be ready for peer review in April 1991. Completed deferred measurement/assessment of 1989 growth in all outplanted lP April 30, 1990 (Chapman). Completed monitoring of 1990 lP flowering (Short). No progress on measuring/assessing 1990 growth, collection of cones, or assessment of seed production of any outplanted lP.

b. Continued wS study. No progress on preparation of two scientific journal articles pending completion of writing goals under 2.a. and 1.a. Completed deferred measurement/assessment of 1989 growth in all outplanted wS April 30, 1990 (Chapman). Completed monitoring of 1990 wS flowering (Short). No progress on measuring/assessing 1990 growth of any outplanted wS.

c. Continued jP study. Completed deferred measurement/assessment of all outplanted jP April 30, 1990 (Chapman). Completed monitoring of 1990 jP flowering (Short). No progress on measuring/assessing 1990 growth of any outplanted jP.

d. Continued bS study. Completed deferred measurement/assessment of all outplanted bS April 30, 1990 (Chapman). Completed monitoring of 1990 bS flowering (Short). No progress on measuring/assessing 1990 growth of any outplanted bS.

3. Provision of consultative services.

a. Responded to 142 client-initiated contacts and provided consultative services or published materials as requested on matters relating to tree and general plant physiology, botany, greenhouse and nursery management, tree improvement and cone/seed collecting and processing.

b. Continued collaboration with Drs. R.P. Pharis, F.C. Yeh and B.P. Dancik (Univ. of Alberta, For. Sci. Dept.), on their study: "Characterization of native growth hormones of juvenile lodgepole pine and their relationship to inherent superiority in vegetative growth". This was accomplished through telephone discussions of results to be included in scientific journal manuscript being prepared by R.P. Pharis, and co-authored by all collaborators.

c. Continue collaboration with Drs. F.C. Yeh, R.P. Pharis (adjunct professor) and Ph.D. student Wu Xiaming (Univ. of Alberta, For. Sci. Dept.) on their study: "Early testing of lodgepole pine". Student Wu Xiaming (Univ. of Alberta, For. Sci. Dept.) completed study of 120 Alberta lP families and returned all equipment borrowed from NoFC in August 1990. Provided advise/supervision in rearing 16 Alberta lP families at NoFC by Univ. of Alberta, For. Sci. Dept. personnel starting October 13, 1990.

4. Provision of seed analyst services. No requests for seed analysis were received in 1990.

12. Present Status of Study:

The study was initiated in February 1981, with the hiring of the present study leader (I.J. Dymock). During 1981-82, the final requirements for his Ph.D. degree in Plant Physiology were successfully completed. At the same time, he developed a study proposal to investigate the physiology of overwintering in containerized conifer seedlings. This would involve studying the phenology of overwintering of economically important conifers under outdoor, ambient conditions.

This problem area for physiological research had been identified by nursery clients at the 1980 Prairie Federal-Provincial Nurserymen's Meeting, held November 13, 1980 at the Northern Forest Research Centre. It was felt that there was a decided lack of basic information on the development of dormancy and cold hardiness in overwintered containerized nursery stock, and of the possible effects of overwinter storage conditions on the survival potential of stored seedlings. The study was designed to monitor the phenology of dormancy and cold hardiness development in overwintering containerized seedlings, and its effects on overwintering success. This involved using methods that were currently available for use in nursery production for assessing dormancy and cold hardiness, and the assessment of any newly reported techniques that had potential for use in the Northwest Region. Preliminary testing began on lP and wP during the latter part of winter in 1981-82, and continued with these species on a regular basis during the 1982-83 overwintering period. After some technical modifications, full scale weekly morphological assessments and dormancy and cold hardiness testing of lP and bS were conducted throughout the 1983-84 overwintering season. Following this season, a replicated testing program was initiated, whereby each species would be subjected to two subsequent years of biweekly replicate testing for each method used, following the inital year of weekly testing.

Testing of wS and rP were initiated during the 1984-85 overwintering season, as well as replicate work on lP and bS. Additional biweekly freezing tolerance/conductivity tests on shoots and roots of all four species were incorporated into the program. During 1985-86, the testing of jP was initiated, and replicate testing of the other four species continued. Replicate testing of lp, bS, wS and rP were completed during the 1986-87 overwintering season, and replicate work on jP was completed during the 1987-88 overwintering period.

Interim results have been reported to peer groups and clients at eight scientific conferences to date. Seven technical reports on the work have been presented at meetings and workshops, four published in meeting proceedings, and a fifth technical report presently awaits publication. Four invited lectures were also presented to university or FORCAN audiences. One scientific journal article on physiology of overwintering in lP was submitted to Can. J. For. Res. for review in December 1989, but was not accepted for publication. Reviewers recommendations for revisions will be incorporated into two separate scientific journal articles on this subject in early 1991. Additional scientific journal articles on overwintering physiology in wS, bS, jP and rP will be prepared for peer review following completion of the revised lP manuscripts.

Accelerated growth physiological research was initiated during 1982-83 with a study to investigate the comparative effects of fluorescent vs. high pressure sodium lights on early growth of twelve conifer species. This was completed in collaboration with Ms. S. Wilson and Dr. J. Hoddinott (Botany Dept., Univ. of Alberta) and a technical report was prepared, presented to clients and published.

A study on the interactions of light quality and quantity, photoperiod and the use of applied growth regulators as means of accelerating early growth to promote early, enhanced flowering and cone and seed production in four economically important conifer was initiated in late 1983. Interim results have been reported to peers at five scientific conferences. Three technical reports were presented to clients at meetings and workshops and published. Two invited lectures were presented to university audiences. Two scientific journal articles on early accelerated growth in lP have been written. The first has been submitted to Can. J. For. Res., while the second is in peer review prior to submission to the same journal. Two more scientific journal articles on early accelerated growth in wS are in the planning stages for preparation in 1991.

Accelerated growth strategies may play a useful role in screening for inherent superiority in vegetative growth at an early age, under controlled environment conditions. Collaboration with Drs. R.P. Pharis, F.C. Yeh and B.P. Dancik (Univ. of Alberta, For. Sci. Dept.) continues on their study "Characterization of native growth hormones of juvenile lodgepole and their relationship to inherent superiority in vegetative growth", initiated in 1987. A termination date in 1991 is anticipated, on completion of a scientific journal manuscript being prepared by R.P. Pharis. Collaboration with Drs. F.C. Yeh, I.B.-C. Jiang, R.P. Pharis and Ph.D. student Wu Xiaming (Univ. of Alberta, For. Sci. Dept.) continues on their study "Early testing of lodgepole pine" that was initiated during 1989.

A collaborative study on "Altitude and latitude effects on lodgepole pine cone and seed maturation in the Alberta Foothills", was initiated in 1984, with Dr. A.K. Hellum (Forest Science Dept., Univ. of Alberta), and was completed in 1985. A research paper was prepared, presented at a symposium in 1985 and was subsequently published in the meeting's proceedings. Two invited lectures were presented to university audiences. This study has been terminated.

All long term physiological studies are to be terminated when the Nursery Management and Tree Improvement Project (NOR-12) is dismantled effective March 31, 1991.

13. Goals for 1991-92:

Study terminated; active publication goals transfered to NOR-02-01

14. Publications 1990-91:

Dymock, I.J. 1991. Monitoring dormancy and cold hardiness in containerized lodgepole pine - phenological considerations in nursery management. In Proceedings of the 1989 Prairie Tree Nursery Association (formerly called the Federal-Provincial Nurserymen's Association) Meeting, September 12-14, 1989, Smoky Lake, Alberta. I.K. Edwards, compiler. For. Can. Northwest Reg., North. For. Cent., Edmonton, Alberta. (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:

Overwintering studies - started 1981. Terminated March 31, 1991.
Cone/seed/accelerated growth/flowering studies - started 1983. Terminated - March 31, 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

A/ Program Director, Resources

Regional Director General

NOR-12-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 11, 1991

1. Project: Nursery Management and Tree Improvement

2. Title: Forest nursery research and technology transfer

3. New: Cont.: Term: X 4. No.: NOR-12-04

5. Study Leader: vacant

6. Key Words: Root pruning and wrenching, storage and packing, storage mold, disease control, seedling mortality, Pinus, Picea, conifer seedbed culture, containerized seedling rearing, quality control, stock quality monitoring

7. Location of Work: Northern Forestry Centre, Edmonton; Provincial Tree Nursery, Oliver; Alberta Forest Service Nursery, Smoky Lake, Weldwood Canada Ltd., Hinton; Blue Ridge Lumber (1981) Ltd., Whitecourt; Prairie Sun Greenhouses, Joffre, Alberta; Saskatchewan Department of Parks, Recreation and Culture Nurseries, Big River, Prince Albert, PFRA Tree Nursery, Indian Head, Saskatchewan; Pineland Nursery, Hadashville; Dakota Ventures, Portage la Prairie; Clearwater Provincial Forest Nursery, The Pas, Manitoba

8. Problem:

Alberta, Saskatchewan, and Manitoba shipped over 51 million containerized and bareroot tree seedlings in 1984 and future increase is anticipated. The signing of the Forest Resources Development Agreements for Manitoba and Saskatchewan in 1984 will ensure that seedling productive capability will increase to meet increased demands. The present cost of producing a seedling of plantable size is 9 cents for container stock and 11 cents for bareroot stock. The operating costs of nurseries in the region is in excess of 6 million dollars per annum. While it is important to ship sufficient numbers of seedlings in order to maintain adequate stocking in the field, it is of equal or even greater importance to ensure that the seedlings shipped are of high quality so that they will establish and grow rapidly in the field. Poor plantation establishment and later growth and survival are often a result of cultural problems in the nursery. Plantation failure usually necessitates costly re-scarification, site preparation and planting.

Size standards for suitable planting stock are lacking in the region. It is important to determine desirable morphological qualities that will enable stock to establish on particular sites. Stock that has certain morphological characteristics may be more suited to a particular site than stock with differing morphological characteristics. Field performance of various size classes of nursery stock several years after outplanting is the best test of the effectiveness of any size class standards.

In addition to knowing the size class of stock that is planted, it is also important to continually monitor the quality of the stock. Material attributes such as bud dormancy, water status, mineral nutrition, carbohydrate status and morphology as well as performance attributes such as vigor tests, root growth potential and frost hardiness should be closely monitored. The prairie region is behind some of the other regions, for example, British Columbia, Ontario and Oregon, in evaluating the quality of nursery stock. Some of the techniques from these regions should be adopted and modified for conditions specific to the prairie region. The predictive abilities of these techniques should be quantified by outplanting trials. Size classes and stock quality are largely influenced by seedbed density in the nursery. High density may result in poor root system, poor top form and high top/root ratio. Low density may result in lower productivity and therefore higher cost of seedling production. Root culturing treatments such as root pruning and wrenching have been used in adequately spaced beds in order to improve root system fibrosity, increase root regeneration potential, decrease top/root ratio, and improve seedling growth and survival in stressful conditions in the field. Proper seedbed spacing and root culturing treatments may be used to improve the size class and stock quality of nursery stock in the prairie region.

Weed control is an ongoing problem at all bareroot nurseries and at some container nurseries where seedlings are placed outside the greenhouses for a 'hardening off' period. Weeds compete for valuable water and nutrients and may cause a serious reduction in nursery stock quality. Due to the rising cost of labor and the danger of damaging small seedlings, hand weeding is often not a viable method of weed control. There is an extreme shortage of herbicides registered for use in forest tree nurseries in Canada. As of January 1984, the only herbicides registered for use in nurseries were dazomet and methyl bromide (soil fumigants) and dacthal and simazine (pre-emergent herbicides). Presently, there are several herbicides that are registered in Canada that have potential for minor use in forest nurseries. Relevant data on crop tolerance and efficacy are needed for these minor use registrations. In July 1984, a Tree Nursery Weed Control Committee (R.Hallet, ForCan, Fredericton; E. Harvey, ForCan, Edmonton; J. Maxwell, B.C.F.S., Surrey; B. Neill, C.D.A., Indian Head; and C. Waywell, O.M.N.R., Guelph) was formed to set priorities on choice of herbicides and species for submission for minor use registration and to establish a standard testing and reporting procedure for herbicide testing in nurseries.

9. Study Objectives:

1. To conduct laboratory, greenhouse, and field research into seedling production, handling, storage problems, size class standards and stock quality monitoring.

2. To improve general nursery practices, including seedling handling, disease control, weed control, cultural operations, and innovations for seedbed treatments.

3. To advise on containerized and bareroot production of seedlings.

4. Maintain liaison between NoFC and regional nursery facilities.

5. To conduct OECD seed inspections as required.

10. Goals for 1990-91:

1. Provide advisory service and investigate seedling growth problems in greenhouses and bareroot nurseries, as required.

2. Publish proceedings of the 1989 meeting of the Prairie Tree Nursery Association held at Smoky Lake, Alberta.

3. Act as lead NoFC contact in cooperating with the Manitoba Forestry Branch, organizers of the 1990 meeting to be held at Hadashville, Manitoba.

4. Publish Forest Management Note on size class standards and stock quality monitoring in Saskatchewan nurseries.

5. Provide appropriate recommendations on soil fertility management to nursery managers in Alberta and Saskatchewan, based on results of soil and plant analyses.

6. Maintain contact with the Canadian Forest Nursery Weed Management Association and obtain information for dissemination to regional nurseries.

11. Accomplishments in 1990-91:

1. Provided advisory service and investigated seedling growth problems in greenhouses and bareroot nurseries, as required. (See NOR-12-06)

2. Compiled, reviewed and edited the proceedings of the 1989 meeting of the Prairie Tree Nursery Association held at Smoky Lake, Alberta. The papers have been returned to the word processor for corrections.

3. Acted as lead NoFC contact in cooperating with the Manitoba Forestry Branch, hosts of the 1990 meeting of the Prairie Tree Nursery Association held at Falcon Lake and Hadashville, Manitoba.

4. The report on size class standards and stock quality monitoring in Saskatchewan nurseries was presented at the 1989 meeting of the Prairie Tree Nursery Association and is included in the proceedings.

5. Provided appropriate recommendations on soil fertility management to nursery managers in Alberta and Saskatchewan, based on results of soil and plant analyses.

6. Maintained contact with the Canadian Forest Nursery Weed Management Association and atended the annual meeting of the association held in Prince Albert, Saskatchewan.

12. Present Status of Study:

Jack pine and white spruce seedlings from Saskatchewan nurseries have been sampled during lifting and graded into various size classes. Generally, the study indicated short but balanced white spruce whereas jack pine tended to be deficient in root growth relative to that of the shoot. Monitoring of physiological characteristics indicated that a 21-day root growth potential test was superior to either a 7-day or a 14-day test.

All of the older nurseries and some of the newer ones have been visited. A few new tree nursery operations (two each in Alberta and Saskatchewan and one in Manitoba) have been established with contract production in greenhouses to supplement production at provincial installations and there are plans to increase these, substantially, in the coming year.

Liaison was maintained with client nurseries and technology transfer was achieved through reports, meetings, and workshops. An introductory course for growers of containerized tree seedlings in Alberta was given in Edmonton for seven new contract growers; 20 people attended. Disseminated information on planned meetings and contacts regarding mycorrhizae and equipment development.

There has been participation in the Canadian Tree Nursery Weed Control Association (now Canadian Forest Nursery Weed Management Association) but none since E. Harvey's departure. Previously, an experimental plan for a national trial of oxyfluorfen (Goal) in forest nurseries was developed.

The study is being terminated on March 31, 1991. The technology transfer work will be the responsibility of a Technology Development Unit that is being formed.

13. Goals for 1991-92:

Study terminated, effective March 31, 1991.

14. Publications in 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: 1984 Completion: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

A/ Program Director,Resources

Regional Director General

NOR-12-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 11, 1991

1. Project: Nursery Management and Tree Improvement

2. Title: Nursery soil fertility and seedling growth

3. New: Cont.: Term: X 4. No.: NOR-12-06

5. Study Leader: I.K. Edwards

6. Key Words: Nutrient uptake, plant nutrition, Pinus contorta, Pinus banksiana, Picea glauca, Picea mariana, Pinus resinosa

7. Location of Work: Edmonton, Smoky Lake, Alberta; Prince Albert and Big River, Saskatchewan; Hadashville and The Pas, Manitoba

8. Problem:

Demand for conifer seedlings in the Prairie Provinces has been increasing steadily to meet reforestation needs. Traditionally, bareroot seedlings (lodgepole pine and white spruce in Alberta, jack pine and white spruce in Saskatchewan, and jack pine, red pine, Scots pine, white spruce, and black spruce in Manitoba) have been used to meet reforestation targets. However, sub-optimal quality of the nursery stock is a recurring problem owing to a) poor choice of location, soil too fine-textured for conifers and b) improper cultural practices and soil management techniques. The ideal soil texture for producing conifer seedlings is a sand or loamy sand, i.e., the total of silt and clay fractions should not exceed 20 percent. At one Alberta site, clay alone varies between 23 and 76 percent. Fine-textured soil reduces root growth because of high bulk density, drains slowly, and damages the root system during lifting.

Bareroot nurseries in Saskatchewan and Manitoba, although located on coarse or moderately coarse textured soil, are derived from calcareous parent material and are highly calcareous within or just below the root zone, depending on the fluctuating level of the groundwater. Because the soils are coarse, minimum levels of organic matter are necessary; because their pH is unsuitably high, acidification of the soil and irrigation water is required.

The intensive nature of seedling production (high seedling density, three-year crop cycle, and the removal of the complete plant from the soil at harvest) results in a "mining action" where

the plant nutrients are concerned. Replacement of soil fertility and plant available nutrients through fertilization and judicious application of irrigation water are necessary to maintain or improve the quality of stock produced. Plot experiments will be required to determine appropriate levels for seedling density and soil amendments.

Greenhouse production of containerized seedlings has been increasing steadily since 1970 to supplement the number of seedlings available for reforestation by client agencies. Operational development progressed so quickly that, in some cases, questions were being asked of Forestry Canada before we had the answers. Although requirements for light (quality and intensity), photoperiod, temperature, nutrients, growing medium, and container type and configuration are being tested for different species in different regions, minimal research and development was being done on conifer species that are of economic importance to the prairie provinces. Nutrition experiments have centred on proprietary fertilizers to determine the most effective dosage but there have been no factorial experiments to test nutrient combinations for these species.

Nature of Study:

Growing bare root and containerized coniferous stock under different fertilizer regimes and cultural practices in provincial nurseries in order to optimize production.

Benefits to be expected from the solution:

1. Higher quality of seedlings in terms of height, weight, top/root ratio and higher survival in stand establishment.

2. Reduced growing cycle in the nursery thus affording more efficient use of resources.

Probability of Success:

High but progress will be slow. Seedlings are grown in nurseries for three years before being field-planted. Besides, subsidiary work may be necessary to establish firm conclusions about certain treatments either in the nursery or at field sites.

Probability of results being put into practice:

Potentially high but decision rests entirely with provincial nursery management. Demonstration plots may be necessary to accomplish implementation.

Method Used:

Seedlings are grown in the nurseries in the presence of different combinations of N, P, and K fertilizers. The optimum combination will be selected according to seedling quality in the nursery and on field survival. Support studies of cultural practices will provide data on such aspects as best nutrient source, time and method of fertilization.

9. Study Objectives:

1. To determine the nutrient requirements for growth and hardening off of bareroot and containerized conifer seedlings.

2. To determine the effect of residual soil fertility on growth of bareroot seedlings.

3. To develop guidelines for efficient water use in bareroot nurseries.

10. Goals for 1990-91:

1. Provide advisory service, investigate seedling growth problems, and offer recommendations in soil fertility and seeding nutrition as requested by industry and government agencies.

2. Initiate revision of the publication NOR-X-214E, "Guidelines for rearing containerized conifer seedlings in the Prairie Provinces", and incorporating research findings on hardening-off and overwintering methodology.

3. Publish a FMN on the effects of residual fertility on bareroot white spruce and jack pine at Prince Albert nursery.

4. Conduct a greenhouse experiment to determine the effect of acidifying agents on alkalinity in soil from a planting site near Hinton, using a native white spruce provenance to evaluate the effect on growth.

Added Goals:

5. Prepare and present paper at the 1990 meeting of the Prairie Tree Nursery Association.

11. Accomplishments in 1990-91:

1. Provided advisory service, investigated seedling growth problems, and offered recommendations in soil fertility and seedling nutrition as requested by:

Alberta: Alberta Forest Service, consultation on bareroot nursery fertilization; Millar-Western , performance of outplanted seedlings; Weldwood Canada Ltd., seminar on stock care and handling, determination of root growth potential; Contract Growers, Bragg Creek, Mannville.

Saskatchewan: Saskatchewan DPRR, training course for contract growers, consulation on bareroot nursery fertilization; Weyerhaeuser, advice re water qualtiy and supply development for seed orchard; Contract Growers, Saskatoon, Outlook, Big River, Kyle.

2. Initiated revision of the publication, NOR-X-214E, "Guidelines for rearing containerized conifer seedlings in the Prairie Provinces", with a review of the "Nutrition" section. Input from I. Dymock was not made, because of the higher priority assigned to preparation of manuscripts for journal publication.

3. Little progress was made on publication of the FMN on effects of residual fertility on bareroot conifer seedbeds. Priority was given to providing advisory and technology transfer. Data was provided to the Saskatchewan Nursery Specialist on this matter.

4. The greenhouse experiment was initiated and is in progress. Preliminary analytical results indicate that the soil is very alkaline and calcareous. Growth of local provenances of white spruce and douglas fir is being evaluated under different levels of stratification.

5. Prepared and presented a paper, "Quality Control in Growing Containerized Seedlings" at the 1990 Meeting of the Prairie Tree Nursery Association in Falcon Lake, Manitoba.

12. Present Status of Study:

Objective 1 is partially completed. In bareroot nurseries, the main thrust, presently, is soil calibration by relating soil nutrient inputs to stock quality produced. Work on hardening-off of containerized seedlings will continue and wrap up with a further revision of the present "guidelines" publication. Milestones are described below.

i) Nutrient status of the seedbed and transplant areas at the Prince Albert and Big River nurseries has been determined through soil sampling and chemical analysis (NOR-X-46, 1973; NOR-X-189, 1977)

ii) Experiments involving fertilizers (amount, type, form, and frequency), peat, sulphur and leaching have been conducted on jP and wS at Prince Albert (Forestry Report No. 24, 1981). These results have formed the basis for fertilizer prescriptions at nurseries not only in Saskatchewan but also in Alberta and Manitoba.

iii) Fertilizer experiments were conducted at the Provincial Tree Nursery, Oliver, Alberta. The soil was unsuitable for a conifer nursery owing to its heavy texture and a laboratory study to ameliorate it chemically, indicated that this was impractical. Use of tolerant hardwood species was recommended (NOR-X-187, 1977).

iv) Annually (since 1981), soil and plant samples have been collected at nurseries in Alberta, Saskatchewan, and Manitoba and submitted to NoFC for chemical analysis. On the basis of the analytical results, fertilizer prescriptions have been prepared for the nurseries prior to the next cropping season. (As of 1988, samples from Manitoba have been analyzed, under contract, by the University of Toronto.)

v) Experiments to determine nutrient requirements of containerized seedlings in the rapid growth phase have been completed. On the basis of the results, a manual with guidelines was prepared in 1979 and later revised (NOR-X-214E, 1983). This publication is in use throughout the Prairies and enjoys wide circulation, generally.

vi) Nutrient requirements during hardening-off of lP, jP, wS, and bS have been determined. A report was presented at the 1989 meeting of the Intermountain Forestry Nursery Association and will be published in the Proceedings.

vii) Technology transfer has been achieved throughout the duration of the study. Research presentations are made at nurserymen's meetings, annually, in the region and beyond and there is interaction with client agencies and organizations in investigating seedling

growth problems and providing technical advice. Workshops on nursery soil fertility, water use, and stock quality monitoring were given in 1980 (Edmonton and Prince Albert) and 1987 (Winnipeg) and a course for growers of containerized tree seedlings was given in 1989 (Edmonton).

Objective 2:

An experiment to determine the effect of fertilizer inputs on residual soil fertility and growth of jP and wS at Prince Albert was completed in 1987. A FMN is in preparation. The results indicate nutrient loss from the soil, probably through leaching.

Objective 3:

This objective was postponed because of a Canada-Saskatchewan FRDA contract that was let in 1987 to review and assess cultural practices at Prince Albert and Big River nurseries. Recommendations included monitoring of soil moisture and increased water use efficiency. A nursery technician has been hired by Saskatchewan DPRR to implement the recommendations prescribed for both nurseries.

The project, Nursery Management and Tree Improvement, is to be terminated on March 31, 1991 and this study will be terminated also at that time. Advisory service and technology transfer will, initially, be provided by the Study Leader under NOR-10-13 but increasingly over the next 2-3 years, the duties will be the responsibility of a nursery and tree improvmenet specialist within a Technology Development Unit (TDU).

13. Goals for 1991-92:

Study terminated, effective March 31, 1991.

14. Publications 1990-91:

Edwards, I.K. 1990. Quality control in growing cntainerized seedlings. Proceedings of the 1990 meeting of the Prairie Tree Nursery Association, held at Falcon Lake, MB September 10-12, 1990. (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: 1972 Completion: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

Program Director/Resources

Regional Director General

NOR-13-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: 31 January 1991
(revised 21 March, 1991)

1. Project: Forest Hydrology and Microclimate Research

2. Title: Transfer of technology derived from the Alberta Watershed Research Program.

3. New: Cont: Term: X 4. No.: NOR-13-01

5. Study Leader: R. H. Swanson

6. Key Words: Hydrologic model, forest climate, gauged basin, soil water, WRENSS, HSPF.

7. Location of work: Alberta, Saskatchewan, Manitoba, Northwest Territories

8. Study Objectives:

   1. To design and propose specific land management practices to increase annual water yield, retard flood peaks or improve on-site watershed condition.

   2. To assist in the evaluation of land management practices with respect to their influence on the hydrologic regime of specified test areas. (To NOR-28-08)

   3. To act as consultant and adviser in proposing and evaluating the influence of various land management practices on the local and regional surface and groundwater hydrology.

9. Goals for 1990-91:

   1. Publications:

      a. Submit for review a journal article on the WRENSS procedure for estimating annual water yield change from forested watersheds in both rain and snow dominated hydrologic regions of Canada. (Swanson)

b. Revise, update to WRNSHYD and reissue Forest Management Note No. 37, "A programmed procedure for evaluating the effect of forest management on water yield." Send revised Note and updated PC program to registered users (currently 92 registered users). (Swanson)

2. Interaction with provincial clients:

a. Continue work with Saskatchewan Water Corporation and Saskatchewan Parks officials to find a watershed management solution to the levels of water in Kenosee Lake, Moose Mountain Provincial Park. (Swanson)

b. Continue work to develop HSPF and its interface into an operational system that forest industries or provincial forest management agencies can readily use to conduct assessments of the effects of industrial operations on the aquatic environment. (Swanson, vice Bernier)

3. Technology transfer:

a. Conduct a modeled assessment (using WRNSHYD and HSPF) of the cumulative effects of the past, current and proposed forest harvesting in the Peace-Athabasca river system on water quantity, regime and quality as related to water supply, flood potential, and impact on downstream or instream water users. (Swanson, Fisera)

b. Continue to assist in the use of WRENSS and HSPF on *ad hoc* basis. (Swanson)

4. Interaction with outside agencies and NoFC staff:

a. Carry out duties as General Chairman, Western Snow Conference through two-year term expiring at the conclusion of the 1990 annual meeting in Sacramento, California. Attend 1990 annual meeting 17-20 April, Sacramento, California. (Swanson)

b. Work with various Forestry Canada research centres in Victoria, Quebec City and Fredericton to implement the HSPF model on their VAX computer on *ad hoc* basis. (Swanson)

c. Continue to work up Marmot data into machine compatible formats and to supply to users upon request. (Fisera, Hurdle)

d. Continue to work with USFS watershed management personnel on Flathead National Forest to adapt the WRNSHYD hydrologic procedure to their Data General land use database. (Swanson)

e. Conduct tour of western Canada watershed research and management sites for IUFRO Congress. (Swanson)

f. Continue to serve as Associate Editor, (plant water relations), for Canadian Journal of Forest Research. (Swanson)

10. Accomplishments 1990-91:

1. Publications:

   a. The article is in preparation.

   b. I am in the process or re-writing this management note as a "users manual" for the WRNSHYD program. The requests that I have been getting for assistance in operating this program indicate that most recipients of it do not have access to the original WRENSS publication upon which our program is based. Therefore, I am incorporating some material from the WRENSS handbook into the users manual. A draft should be ready for internal review by June 1991.

2. Interaction with provincial clients:

   a. Was contacted by Saskatchewan Parks official re possible cutting to increase water levels in Kenosee Lake, Moose Mountain Park. Sent him material furnished to his department earlier. No further correspondence.

   b. Work on the interface for HSPF was put on hold in order to make some requested modifications to the WRNSHYD program. Still in contact with Alberta Forest Service and Alberta Fish and Wildlife officials re use of HSPF. There is still an apparent and growing need for the model.

3. Technology transfer:

   a. Met with Alberta Forest Service officials to discuss this study. They agreed to the need for it and have furnished maps and timber harvest plans for the Diashowa FMA for the first area to work on. We outlined the watersheds involved and are in the process of gathering streamflow and precipitation data in order to start the assessment.

   b. Spent a considerable amount of time with Alberta Forest Service Land Use personnel working with the WRNSHYD program (see "user manual" goal above).

4. Interaction with outside agencies and NoFC staff:

   a. Completed term as General Chairman, Western Snow Conference. Am still on the Executive Committee for this conference. Attended their annual meeting in Sacramento, California.

   b. Minor contact with PFC and UBC re implementation of HSPF.

   c. All of the Marmot data that we have on hand has been transferred to machine-compatible format.

   d. Spent considerable time on the telephone with the hydrologist on the Flathead National Forest in Kalispell, Montana, re their desire to interface our WRNSHYD program with their data base on their Data General computer. We added routines to read and write WRNSHYD data fields in ASCII format to the program.

e. Conducted 29 members of the IUFRO on the tour of research sites from Calgary to Victoria.

f. Acted on 18 articles for Canadian Journal of Forest Research.

11. Present Status of Study:

1. This project is being terminated and the relevant studies transferred to NOR 28-08. The Marmot and Streeter experimental basin programs have been terminated and the results published. Data from these and other research facilities have been incorporated into a procedure (WRNSHYD) for evaluating the effect of existing or proposed forest practices on annual water yield.

   In the area of technology transfer, the WRNSHYD procedure for rain- or snow-dominated watersheds has been made available to forest managers in this region, and to the water resources community throughout Canada. There remains a continuing need to make the more comprehensive HSPF model useable in a way similar to WRNSHYD, to provide reasonable estimates of the effects of forestry operations on the water levels and water chemical/biological quality in streams or rivers at critical periods, e.g. flood peaks from storms or snowmelt, low flows to maintain fish populations in late summer, etc. Our ultimate goal is still to create an easy to use PC program that will interface the user with the HSPF model and allow its operation on either a VAX or IBM PC, and make it available to industrial and/or consultant users via Technology Development Units at Forestry Canada centres across Canada.

12. Goals for 1991-92:

Study terminated, relevant goals transferred into NOR-28-08.

13. Publications 1990-91:

Swanson, R.H.; Dickinson, W.T.; Young. G.J. 1988. Canadian Research Basins - in review. Nature and Resources XXIV(2-4):21-31 (In Russian).

14. 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.

15. Duration:

Started: 1963 Terminated: 1991 (See NOR-28-08)

16. Resources 1991-92:

Nil study terminated - See NOR-28-08.

17. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-13-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: 31 January 1991
(revised 21 March 1991)

1. Project: Forest Hydrology and Microclimate Research

2. Title: Snow disposition and plant-water relations in managed forests.

3. New: Cont.: Term: X 4. No.: NOR-13-02

5. Study Leader: R. H. Swanson, Vice Bernier

6. Key Words: Hydrologic modelling, snow accumulation, snowmelt, evapotranspiration, soil water movement, transpiration.

7. Location of work: James River microclimate site; southern Alberta; other areas in Prairies/Northern Region as needed.

8. Study Objectives:

   1. To develop process-oriented vegetation manipulation models for the description and assessment of the effects of natural occurrences, forest management, and silvicultural activities, on water resources, plant water relations, and photosynthetic productivity. (To NOR-16-03)

   2. To conduct studies to define relationships between quantitative energy-mass exchange and physiological-physical processes, (e.g.; aerodynamics of snow accumulation, evaporation from snow, snowmelt, soil water accretion, soil water movement, carbon dioxide exchange, xylem sap flow, water vapour exchange, inter-tree competition, etc.) in naturally occurring stands as well as in those created by partial and/or complete forest harvest. (To NOR-16-03)

9. Goals for 1990-91:

   1. Publications:

a. Prepare paper on using the heat pulse velocity method for measuring transpiration and as an indicator of physiological activity. Incorporate material from investigations of HPV's in beetle attacked trees as example and new analysis techniques for fast sap speeds. (Swanson)

b. Prepare paper on "The influence of opening size on snow evaporation." (Bernier, Swanson)

2. Research activities:

a. Complete preparation of the Marmot Twin Creek climate data hourly data set. Calibrate and operate HSPF on these data and attempt to evaluate effect of Twin "honeycomb" clearing treatment on snowmelt and streamflow. (Swanson, Hurdle)

b. Continue developing interface microcomputer program for writing HSPF control files. Test and use this program to write control files for HSPF modelling of stream regime and water quality in the Peace-Athabacsa River system. (Vice Bernier, Swanson)

c. Obtain FORTRAN source code for Running's transpiration and photosynthesis model. Replace existing evaporation routine in HSPF with Running's if possible. Develop canopy resistance and soil water parameters for spruce and lodgepole pine stands. (vice Bernier, Swanson, Rothwell and Liefers [U of A], Bernier [LFC])

d. Complete specification and testing of sensor configuration and analysis methods for the measurement of fast sap speeds with the HPV method. Provide necessary assistance to PFRA, Indian Head, Saskatchewan, to get their transpiration measurement program operational this Spring. (Hurdle, Swanson)

e. Select sites and start transpiration, photosynthesis and canopy resistance measurements in support of growth competition modelling and climate change research (Boreal Forest and GEWEX Experiment). (Swanson, Hurdle, vice Bernier)

f. Establish air temperature and humidity measuring stations in 1, 3, 5H and 20+ha clearings at James River Microclimate Site. Conduct short term measurements of snow evaporation, air temperature and relative humidity in these same clearings with eddy flux apparatus during the period Jan-March 1991. (Swanson, Hurdle)

10. <u>Accomplishments 1990-91:</u>

1. Publications:

a. Was unable to test new analysis technique for fast sap speeds because of wet weather. Will complete HPV paper for internal review during the next year and try to incorporate fast sap speed analysis during revisions. (Swanson)

b. Cannot complete the paper on snow evaporation until we get the data from this winter's James River study. The first data collection run during the week of January 7-11, went well, but winds were negligible and evaporation was nil. The

second data collection run scheduled for 11-15 February was cancelled, and a third occurred 6-8 March. The necessary data are now in hand and the paper should be ready for review this summer. (Swanson, Bernier - LFC).

2. Research activities:

   a. The hourly data sets for Twin subbasin, Marmot, are almost complete and in the form necessary for use within the HSPF model. We expect that some calibration runs with HSPF may be available before the end of March. (Swanson, Vice Bernier, Hurdle)

   b. An preliminary draft of this program is being used to write control files for the Twin subbasin calibration and test. Our experiences with using this program on Twin will be used to refine the program for its more intensive use in the FMA evaluation. (Vice Bernier, Swanson)

   c. Running advised against working with the FORTRAN code of his model because it always exists as a current translation from his PASCAL source. All of the current developments and modifications are being made on the PASCAL source, and Running recommends that we do the same as he can support us better. Therefore, it was not possible to replace the evaporation routines in HSPF with Running's code. We did not do any field work toward developing canopy resistance and soil water parameters for local species. (Swanson, vice Bernier, Rothwell and Liefers [U of A], Bernier [LFC])

   d. We suggested an alternative analysis method for fast sap speeds, based on numerical analysis, but were unable to determine if it was valid. This work will continue as a minor component of our overall work in the next year. (Swanson, Hurdle)

   e. This work was approved for funding under S&T for 1991-92. When that money comes through, we will start selecting and instrumenting sites. (Swanson, Hurdle)

   f. The sites were instrumented and data collection is ongoing for specified weather events. We need a few days of -15 to -5 °C temperatures with wind speeds 10 to 30 km h^{-1}

11. Present Status of Study:

   1. This study has been used as the scientific source for the coordination and technology transfer work being conducted under study NOR-13-01. The results from numerous experiments and studies have been published and incorporated into the WRENSS procedure that is currently our primary technology transfer vehicle.

   2. This study is also being used as a vehicle for intra-project cooperative research within the NoFC. A current example is the allocation of Hurdle's time to assist other researchers with their instrumentation and data analyses problems.

   3. The studies currently under way within this project are being transferred to NOR 16 (Climate Change).

4 With respect to climate change research, we already have an active research program in sap flux transpiration measurement, one of the primary water vapour flux measurements required in both the BOREAS and GEWEX projects. This should be strengthened and extended to include carbon dioxide fluxes as well. Sap flux measurements, with the heat pulse or thermal heat balance methods, are expected to validate aerodynamic resistances in homogeneous canopy situations and to supply the actual fluxes in non homogeneous canopy or terrain situations. These same studies should provide realistic measurements for the validation of photosynthesis and transpiration models, which ought to be utilized to understand the role of light, moisture and aerodynamic competition in tree growth. In addition to these thrusts in support of climate change and competition studies, snow transport and evaporation studies, particularly in southern Alberta, are still needed to assist in the resolution of regeneration problems that we suspect may be caused by snow-loss.

5. Staffing. This project has been understaffed for the past three years. I have not been able to make even one-two year research plans with the 3-6 month term extensions of the past two years. I need to be planning now for research that will occur in 1993 to 1997. We need to replace Bernier (preferably with a scientist with an inclination toward physical microclimatology) immediately, and hire an additional scientist in 1992-93, with training in plant water relations, who can assist me with my sap flux work within the GEWEX and climate change program.

12. Goals for 1991-92:

Study terminated, relevant goals transferred to NOR-16-03

13. Publications 1990-91:

Nil

14. 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.

15. Duration:

Start: 1968 Terminated: 1991 with some activities transferred to NOR-16-03.

16. Resources 1991-92:

Nil see NOR-16-03.

17. Signatures:

Robert W. Swanson
Investigator

Program Director Protection & Environment

Investigator

Regional Director General

NOR-16-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 22, 1991

1. Project: Canadian Forests and Climate Change

2. Title: Scientific leadership and coordination for the Forestry Canada research program on climate change.

3. New: X Cont.: 4. No.: NOR 16-01

5. Study Leader: M. J. Apps, S. Zoltai

6. Key Words: Boreal forests, climate change, greenhouse effect, carbon cycle, forest productivity, bioenergy, simulation modelling, ecophysiological modelling, BOREAS, N-BIOME, FORET, ZELIG, FORENA, FORCYTE, LINKAGES, JABOWA

7. Location of work: Canada, the world

8. Problem analysis:

Climate change is increasingly recognised as a threat to the environmentally sustainable economic development of the Canadian Forest Sector. While the issue of global climate change and our response to it remains controversial, there is now a large measure of consensus amongst the world's scientists that significant changes will take place in the coming decades. Regardless of how the future climate unfolds in detail, there is an urgent need to identify and explore adaptation and mitigation strategies which will allow the forestry community to take advantage of the opportunities which might arise and to prepare for the potential detrimental impacts of such changes. As Canada enters a new era of forest management under the banner of "sustainable development", it is imperative that we focus existing knowledge, and where necessary develop new understanding, of the potential impacts of these changes: climate change poses what is perhaps the most severe long-term threat to the health and productivity of Canada's forests.

For policy makers, decisions will be required to be made in an aura of great scientific uncertainty. While there is a consensus that "the trees we are planting now will mature and decline in an environment to which they are increasingly poorly adapted", precise estimates of these changes and their impacts are not available, and are not likely to be forthcoming in the near term.

Uncertainties exist both in the timing and magnitude of the climate change and in the response of forest ecosystems to any such change. Nevertheless, basing management strategies on assumptions of unchanging ecological and climatic conditions will obviously lead to significant errors if the climate changes projected with the enhanced greenhouse effect prove to be the future reality.

Forestry activities can affect a number of critical ecosystem characteristics which can enhance (positive feedback) or mitigate (negative feedback) climate change. How do alternative forestry and land-use practises influence the global carbon cycle, surface albedo, surface energy and momentum exchanges, and the small- and large-scale hydrologic cycle?

These are critical questions to address if the Canadian forestry sector is to meet the challenges that the threat of climate change poses for (environmentally) sustainable (economic) development. We need to develop predictive capability by encapsulating existing knowledge in decision-support structures; simulation modelling provides one of the few mechanisms for achieving this goal. In general, the same practices which optimise environmental sustainability, also optimise the long-term economic development and returns from traditional forest industry. Optimising future wood supply is likely to also optimise future carbon sequestration, for example.

The immediate challenge for FC research is to formulate and then communicate the best estimates (or even guesses in the absence of hard data) that science has to offer about 1) the consequences of environmental change on the resource sustainability and 2) the management strategies which best meet economic and environmental needs.

CORE assigned FC-NWR a leadership role for the implementation of a National climate change program. As a first step in this direction a National Climate Change Action Plan (NCCAP) has been developed which draws upon the expertise of the Forestry Canada Climate Change Working Group. The basic tenet of the NCCAP is that:
the required national research program must be based on teamwork making use of the talents of scientists at each of the FC establishments.

In keeping with CORE's charge, the NCCAP outlines a scientific leadership role to be filled by the NWR as lead centre in the delivery of the national program. One of the main functions of this leadership role is to foster the establishment of these inter-establishment teams. The responsibilities of the lead centre are spelled out in the NCCAP and will be further refined by CORE and senior FC management. The objective of this study is to implement this leadership structure and provide scientific leadership and coordination at all levels of Forestry Canada involvement.

This study also provides coordination and leadership for significant national and international research activities on climate change and forests which are underway or planned for the region. The following are of particular, immediate relevance:

BOREAS. (BOReal Ecosystem Atmospheric Study). This Canada-US (NASA) joint project will be started in 1992, culminating with intensive field campaigns in 1994, at two boreal forest sites near the northern (Nelson House, Manitoba) and southern (Prince Albert National Park) ecotones. These two sites form fixed points for a conceptual transect (proposed under several studies in the 1991-92 S&T proposal) which may become a focus for FC climate change research. One of the key issues to be addressed by BOREAS is that

of spatial scaling; how to integrate up from processes at the leaf and micro-site level to response at the stand and whole forest level - an issue of paramount importance to the FC-NWR research. (Apps was appointed in 1990 by the Canadian-NASA management committee to serve on the BOREAS Science Steering Committee)

NBIOME. (Northern Biosphere Observation and Modelling Experiment). This ten-year multi-disciplinary, inter-agency project is one of two from Canada which have been accepted in NASA's EOS (Earth Observing System) program. This project attempts to link observational databases (satellite remote sensing, biomass and soils inventories) to process modelling of organic matter dynamics and carbon sequestration in forests and agricultural systems at the national scale. Opportunities for leveraging external resources to support the FC-NWR program are considerable and one of the cornerstone activities of NBIOME (proposed by Apps and involving University as well as Government researchers) is to model the carbon dynamics across a transect through the grassland- boreal forest - tundra, including the BOREAS sites. (Apps is one of the original Co-investigators named in the proposal to NASA, and has played an active role in several inter-agency workshops on NBIOME)

GEWEX. (Global Water and Energy Exchange Experiment). This project, an IGBP project, is in the advanced stages of planning. It is designed to provide a basic understanding of water yield from forested areas, with strong implications for climate change. While field sites have yet to be confirmed, it can be anticipated that both the BOREAS and MBIS sites will be strongly considered. (Swanson is a member of the Canadian science advisory committee)

MBIS. (MacKenzie Basin Impact Study). This study is a group of interagency projects being organized by the Canada Climate Centre (AES, Env. Canada). to study the potential effects of climate change on this major drainage system. FC participation is not yet decided but FC-NWR scientists have proposed 7 separate projects for inclusion in MBIS; FC-Pacific have also proposed 2 projects, which may provide collaborative opportunities.(Zoltai acts as the principal FC-NWR point of contact)

S&T OPPORTUNITIES FUND. On behalf of the Forestry Canada Working Group, a submission was made to this fund with 12 projects from a number of different FC establishments included. If successful, coordination and leadership for the fulfilment of the objectives of this program submission would be the responsibility of M. Apps. This program would "kickstart" the National Climate Change Action Plan. (M. Apps is the designated coordinator as well as major research participant)

NCCAP. (National Climate Change Action Plan). This implementation plan compliments Forestry Canada's Strategic Plan. It consists of a framework and a set of specific national-scope and establishment-specific research activities and calls for regular reviews and revisions to adaptively monitor progress. If approved, FC-NWR would have significant responsibilities for coordination and scientific leadership of the national research program (as discussed above). (Apps and Zoltai have acted as principal authors of the NCCAP)

CBM. (Carbon Budget Model of the Canadian Forest Sector). This national-scope research project is being conducted jointly with ESSA Ltd. (principal investigator Werner Kurz) funded under the ENFOR program. It has involved a number of scientists from several FC establishments under the leadership of M. Apps. Phase 1, an assessment of the current

carbon inventory of all Canadian forest ecosystems and the budget for reference year 1986 was completed in 1990. Phases 2 and 3, 1991-1992, will address the impact of climate change and forest resource policy on the Canadian carbon budget. (See also NOR 16-05 and NOR 28-06) (M. Apps is responsible for the project and coordinates FC involvement in addition to acting as scientific authority for the ESSA contract)

9. Study Objectives:

1. To provide leadership and program coordination for the regional research program on climate change and forests of the Northwest region.

2. To play a leadership role in the National Climate Change research program.

3. To act as science spokesperson on climate change related issues as required.

10. Goals for 1990-91:

(New Study. The following are all Added goals)

1. Perform duties as appointed member of the International Science Steering Committee for BOREAS project. Attend meetings in Washington, Ottawa, Edmonton, Winnipeg. (M. Apps)

2. Participate as one of 5 members of a Canadian delegation at the Canada-USSR working Group on Forestry in Moscow, Oct 23 - Nov 4 1990. (Apps)

3. Participate in the Canada/US Symposium on the Impacts of Climatic Change and Variability on the Great Plains, Calgary, Sept. 10-13, 1990. (Singh, Swanson, J. Powell, M.Apps)

4. Prepare Seminar presentation for FC Senior Management on Climate Change, N-BIOME, BOREAS and the Carbon Budget Model at Ottawa, Mar 7 1991. (M. Apps)

5. Organise workshop to develop National Climate Change Action Plan. Establish and act as Scientific Authority for contract with ESSA Ltd. to act as facilitators. (M.Apps)

6. Coordinate preparation, and act as principal authors of National Climate Change Action Plan document (M.Apps, S.Zoltai)

7. Prepare, submit, and present 1991 submission to FC Special Opportunities Science and Technology Fund on behalf of the Climate Change Working Group. (M. Apps, S. Zoltai)

8. Contribute to the writing of Chapter 3 on the environment for the State of the Forests Report to Parliament, Nov 1990 - Mar 1991. (M.Apps)

9. Participate as NWR representatives on the FC Climate Change Working Group and attend inaugural meeting Jan. 29, 1990, Ottawa. (S. Zoltai, M.Apps)

10. Coordinate and develop an NWR Climate Change Program. (M.Apps, S. Zoltai)

11. Represent FC-NWR at Green Plan consultation meetings in Edmonton and Calgary (11-13 June 1990). (M. Apps, S. Zoltai, R. Swanson, S. Malhotra)

12. Participate in the "Public Forum on Climate Change", sponsored by the Manitoba Climate Advisory Committee, Winnipeg, Oct. 4, 1990. (M. Apps)

13. Participate in C.I.F. public meeting on "Climate Change and Sustainable Development", Winnipeg, November 26, 1990. (M.Apps)

14. Organise information exchange seminar for FC Climate Change Working Group members with AES climate change global circulation modelling group, Downsview, Feb. 4, 1991. (M. Apps)

15. Act as coauthor of "Boreal Ecosystems-Atmospheric Study (BOREAS): report on the Ottawa workshop", for Canadian Global Change Program Report No.5, Royal Society of Canada.

16. Prepare and present paper on "Aspen in a changing Climate" for Symposium on Aspen Managment for the 21st Century, Edmonton, Nov 19-21, 1990. (S. Zoltai, T. Singh, M.Apps)

17. Organise public climate change seminar "Modelling the effects of changes in land use and climate on terrestrial carbon storage" by visiting scientist Dr. R. Dewar (U.K.) and coordinate meetings with NWR and U of Alberta staff, Jan 24-25, 1991. (M. Apps)

18. Participate in N-BIOME workshop in Ottawa, Oct 17-18, 1990. (M. Apps)

19. Prepare and present paper on the National Climate Change Action Plan for presentation at the 6th Forestry Canada Modelling Working Group Workshop, Kananaskis, Dec. 12-14, 1990. (M. Apps)

20. Act as co-organisers of the 6th Forestry Canada Modelling Working Group Workshop at Kananaskis, Dec. 12-14, 1991 (H. Grewal, M. Apps)

21. Act as invited chairman for session "Environment and Modelling" at National Conference "G.I.S. for the 90's" at Ottawa, Mar 5-8, 1990 (M. Apps)

22. Review manuscript 90-371 for editor of Canadian Journal of Forest Research, Jan 91. (M. Apps)

23. Act as external reviewer for NRSERC Group Strategic Grant Application, Sep 1990. (M. Apps)

24. Act as one of 3 International Reviewers of US NAPAP State of Science and Technology Report # 28 "Development and use of tree and forest response models" (approx 300 pages). (M. Apps)

11. Accomplishments 1990-91:

1. Apps was appointed member of the International Science Steering Committee for the BOREAS project and attended six working meetings held in Washington, Ottawa, Edmonton, Winnipeg. (M. Apps)

2. Apps was appointed acting head of the Canadian delegation at the Canada-USSR working Group on Forestry in Moscow, Oct 23- Nov 4, 1990, and signed the offficial protocol on behalf of ADM Maini (who left after the second day). Climate change, BOREAS, NBIOME and sustainable development were kept at the forefront of discussions with the Soviets. (M. Apps)

3. Swanson, Singh, Powell, and Apps participated in the Canada/US Symposium on the Impacts of Climatic Change and Variability on the Great Plains. Apps chaired the workshop session on Forestry at the Symposium (last minute replacement for Dr. J. Maini, ADM Policy) and presented the group's summary in the final plenary session. Singh was an invited speaker in Apps' session. (Singh, Swanson, J. Powell, M.Apps)

4. Apps gave a 25 minute presentation in a 60 minute seminar (along with J. Cihlar, D. Brand, J. P. Hall) for FC Senior Management (J.C. Mercier, Y. Hardy, T. Lee, F. Pollett and others) on Climate Change, N-BIOME, BOREAS and the Carbon Budget Model at Ottawa, Mar 7 1991. (M. Apps)

5. A workshop was organised to develop a National Climate Change Action Plan with members of FC Climate Change Working group and Science Directorate HQ. A contract was established with ESSA Ltd. to act as facilitators. (M.Apps)

6. Apps and Zoltai have acted as principal authors of the Forestry Canada National Climate Change Action Plan. (M.Apps, S. Zoltai)

7. The 1991 submission to FC Special Opportunities Science and Technology Fund on behalf of the Climate Change Working Group was successfully prepared, submitted, and presented. (M. Apps, S. Zoltai)

8. Apps made substantial contributions to the 457 rewritten versions of Chapter 3 on the environment for the State of the Forest Report to Parliament, Nov 1990 - Mar 1991. (M.Apps)

9. Zoltai and Apps have actively represented FC-NWR on the FC Climate Change Working Group and attended inaugural meeting Jan. 29, 1990, Ottawa. Zoltai accepted the appointment as chairman of the working group. (S.Zoltai, M.Apps)

10. An NWR Climate Change Program has been developed, team goals identified and needed resources identified. The NWR program has been well situated within the national climate change action plan. (M.Apps)

11. FC-NWR was well represented at Green Plan consultation meetings in Edmonton and Calgary (June 11-13, 1990). (M. Apps, S. Zoltai, R. Swanson, S. Malhotra)

12. Apps delivered an invited presentation "Climate Change and Canadian Forests: part of the solution or part of the problem" at the "Public Forum on Climate Change", sponsored by the Manitoba Climate Advisory Committee, Winnipeg, Oct. 4, 1990. (M. Apps)

13. Apps was an invited speaker at C.I.F. public meeting on "Climate Change and Sustainable Development", Winnipeg, November 26, 1990. (M.Apps)

14. An information exchange seminar for FC climate change working Group members with AES climate change global circulation modelling group was arranged with 20+ participants from across the country at Downsview, Feb. 4, 1991. (M. Apps)

15. Apps acted as coauthor for "Boreal Ecosystems-Atmospheric Study (BOREAS): report on the Ottawa workshop", published by the Royal Society of Canada. Apps also acted as member of the organising committee as well as acting as chairnman of 2 separate sessions. Swanson also chaired a session. (M.Apps, R. Swanson)

16. A manuscript "Aspen in a changing Climate" was prepared, submitted and accepted for Symposium on Aspen Managment for the 21st Century, Edmonton, Nov 19-21, 1990. (S. Zoltai, T. Singh, M.Apps)

17. A public climate change seminar "Modelling the effects of changes in land use and climate on terrestrial carbon storage" by visiting scientist Dr. R. Dewar (U.K.) was organised and meetings with NWR and U of Alberta staff were arranged. (M. Apps)

18. Apps participated in a national N-BIOME workshop in Ottawa, Oct 17-18, 1990. (M. Apps)

19. A paper "Modelling to address climate change policy issues" was prepared and presented at the Forestry Canada Modelling Working Group Workshop, Kananaskis, Dec. 12-14, 1990. (M. Apps)

20. Apps acted as co-organiser (with H. Grewal) of the 6th Forestry Canada Modelling Working Group Workshop at Kananaskis, Dec. 12-14, 1991.

21. Apps acted as invited chairman for session "Environment and Modelling" at National Conference "G.I.S. for the 90's" at Ottawa, Mar 5-8, 1990.

22. Apps acted as external reviewer for climate change related NRSERC Group Strategic Grant Application, Sep 1990. (M. Apps)

23. Apps acted as one of 3 International Reviewers of US NAPAP State of Science and Technology Report # 28 "Development and use of tree and forest response models" (approx 300 pages).

12. Present Status of Study:

New study.

13. Goals for 1991-92:

1. Publications and presentations:

a. Prepare and present paper on BOREAS for the International Symposium on Cold Region Development (ISCORD) being held in Edmonton, June 16-21, 1991. (M.Apps)

b. Prepare and deliver opening address " Global and regional programs addressing climate change and particularly programs focussing on Boreal forests" at plenary session of conference " Climate Change and the Boreal Forest", 30th Annual Conference of Canadian Society of Zoologogists, Thunder Bay, May 8-11, 1991. (M. Apps)

2. Leadership and coordination activities:

a. Continue to perform duties as appointed member of international BOREAS Science Steering Committee.(M. Apps)

b. Continue as co-investigator and active participant in NBIOME - the Northern Biosphere Observation and Modelling Experiment (M.Apps)

c. Provide leadership and program coordination for regional research activities on climate change and forests of the Northwest region. (S. Zoltai, M. Apps).

d. Play a leadership role in the National Climate Change research program by participating in the Forestry Canada Climate Change and Modelling Working Groups. Continue to monitor, review and refine the National Climate Change Action Plan (subject to its acceptance). (M.Apps)

e. Act as coordinator for the Forestry Canada Climate Change Working Group's program proposed under the Science and Technology Special Opportunities Fund (1991 - 92). (If proposal is successful). (M. Apps, S. Zoltai)

f. Act as chairman of Forestry Canada Climate Change Working Group. (S. Zoltai)

g. Act as Forestry Canada team leader on the Carbon Budget Model for the Canadian Forest Sector (see also No16-05 and NOR 28-06). (M. Apps)

h. Act as spokesperson at regional, national and international level on climate change related science issues as required. (M. Apps, S. Zoltai)

14. Publications 1990-91:

Apps, M.; and others. 1991. Boreal Ecosystems-Atmospheric Study (BOREAS): report on the Ottawa workshop, Canadian Global Change Program Report No.5, Royal Society of Canada.

Apps, M.J.; MacIsaac, D. 1990. The role and use of models in decision support, In proceedings of Fourth Modelling Workshop, FC Working Group, Fredericton, N.B., Oct. 24-25, 1989. ForCan, Maritimes Region, Fredericton, N.B.

Zoltai, S.C.; Singh, T.; Apps, M. 19 . Aspen in a changing Climate, In Proceedings of Symposium on Aspen Managment for the 21st Century, Edmonton, Nov 19-21, 1990.

In addition significant presentations were made as follows:

Apps, M. 1990. Climate Change and Canadian Forests: part of the solution or part of the problem, Invited presentation at the "Public Forum on Climate Change", sponsored by the Manitoba Climate Advisory Committee, Winnipeg, Oct. 4, 1990. (to be published.)

Apps, M. 1990. Climate Change, Sustainable Development and Forestry, Invited presentation at C.I.F. public meeting on "Climate Change and Sustainable Development", Winnipeg, November 26, 1990.

Apps, M. 1990. Climate Change, N-BIOME, BOREAS and the Carbon Budget Model Presentation to FC Senior Management (J.C. Mercier, Y. Hardy, T. Lee, F. Pollett and others) at Ottawa, Mar 7 1991.

Apps, M. 1990. Modelling to Address Climate Change Policy Issues, Presented at the Forestry Canada Modelling Working Group Workshop, Kananaskis, Dec. 12-14, 1990.

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: 1991 Estimated Completion: 2001

17. Resources 1991-92:

P/Ys:	Prof:	Apps	0.4
		Zoltai	0.2
		FO or equivalent	1.0
	Total		1.6

O&M: $4 K (A-base)
Other potential sources: $40 K (Green Plan)

NCCAP coordination	12K identified in NCCAP
CCWG	15K
BOREAS SSC	8K
International travel	5K

Capital:

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-16-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibity Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Canadian Forests and Climate Change

2. Title: Carbon sequestration in peatlands in a changing climate

3. New: X Cont.: No.: NOR-16-02

5. Study Leader: S.C. Zoltai

6. Key Words: Peatland, peat accumulation, macrofossils, peatland dynamics, carbon fluxes, vegetation, climate change

7. Location of Work: Northwest Region

8. Problem:

The study of peatland ecology (NOR 28-02) has shown that different kinds of peatlands develop under different climatic conditions. General droughtiness and fluctuating water tables preclude peat formation on the prairies; bog formation requires a certain minimum of precipitation. Permafrost development is directly related to temperature regime, as is the thawing of permafrost in peat.

Peat, having been deposited in situ, is an accurate record of the plants that grew in the peatland. Many of the peat macrofossils are readily identifiable. By comparing the present environmental limits of the fossil plant communities, the paleoenvironments of peatlands can be established at various times in the past. This gives a powerful tool to determine the degree and extent of changing climates within the past 10,000 years. This knowledge can be applied to indicate the effect of anticipated climates on peatland development, and by inference, on the regional water table. The studies of paleoenvironments of peatlands therefore serve as analogs of changes to be expected.

Peat is composed of plant materials in various stages of decomposition that have been deposited and accumulated in areas of poor drainage. Peat has been accumulating in such areas for thosands of years, therefore peatlands are places where carbon, taken from the atmosphere by plants, is stored for indefinite period. This makes the peatlands one of the few terrestrial ecosystems where atmospheric carbon is sequestered for thousands of years. Although peat is

subject to very slow anaerobic decomposition, with methane as a byproduct, long term acumulation rates show that peatlands are effective reservoirs of carbon.

There are approximately 475,000 km^2 of peatlands in Alberta, Saskatchewan, and Manitoba. The District of Mackenzie contains an additional 250,000 km of peatlands, most affected by permafrost. Carbon accumulates in peatlands at an average rate of 28 g m~h-2~s, this means that over 13 million tonnes of carbon are withdrawn from the atmosphere and stored in the peatlands of the Prairie provinces every year. On the other hand, billions of tonnes of peat, deposited during the past 8000 years, are potential sources of CO~l2~s if the climate change caused the peatlands to dry out and the peat to decompose.

Methane, an important greenhouse gas generated by the anaerobic decomposition of peat, is released to the atmosphere in large amounts in some wetlands. Such conditions are expected to become more prevalent under a changing climate. An accurate estimate of methane production under the expected changing conditions is necessary to evaluate this problem.

Peatlands are, therefore, important long-term sinks of atmospheric carbon, as well as potential sources of additional greenhouse gases. At the present, only preliminary estimates of the carbon balance of peatlands is available from the region and from the rest of Canada. Early results indicate that climate affects both the growth and the decomposition of peat through temperature and water table fluctuations. Carbon flux rates must, therefore, be established in climatically defined wetland regions to provide reliable estimates. Regional studies must be oriented to fit into a national framework, potentially linking with similar studies in different wetland regions.

The results of these studies, when applied to the extent of peatlands in Canada, as determined by accurate surveys, will define the role of peatlands in the long term sequestration of atmospheric carbon. It will also identify the kinds of wetlands that will be subject to substantial changes in their carbon budget under changing climatic conditions.

9. Study Objectives:

1. Determine the carbon flux of different kinds of wetlands in the Wetland Regions within the Northwest Region and collaborate with appropriate scientists or agencies to develop similar information at the national level.

2. Determine the possible effects of climate change on wetlands in various Wetland Regions of Canada.

10. Goals for 1990-91:

New study; goals transfered from NOR 28-02

1. Prepare and submit for publication a journal paper "Estimating the age of peat deposits from the weight of peat". (Zoltai)

2. Attend the 5th International Congress of Ecology (Yokohama, Japan). Present an invited paper on the development of permafrost in Canadian peatlands. (Zoltai)

3. Present paper on the role of aspen in a changing climate at Aspen Management Symposium. (Zoltai, Singh, Apps)

4. Act as chairman of Forestry Canada's Climatic Change Working Group. (Zoltai)

Added Goal:

5. Cooperate in the preparation of a Forestry Canada Action Plan on Climate Change. (Apps, Zoltai)

11. Accomplishments:

1. Paper "Estimating the age of peat deposits from the weight of peat" has been published in the new journal "The Holocene".

2. A paper "Development of permafrost in peatlands of Subarctic Canada" was presented at the Vth International Congress of Ecology, Yokohama.

3. Paper "Aspen in a changing climate" has been presented at Aspen Management Symposium, November 20-21, 1990, Edmonton, and will be published in proceedings.

4. Workshop of the Climatic Change Working Group was held in November in Edmonton.

5. Draft copy of Forestry Canada Action Plan on Climate Change has been prepared.

12. Present Status:

Work on climate change impacts on wetlands is proceeding, mainly by using existing data. New work will be initiated if funding can be secured.

13. Goals for 1991-92:

1. Identify peatlands suitable for study along a northeast-southwest transect, including the BOREAS sites in Manitoba and Saskatchewan. (Zoltai, Apps, Swanson, Singh)

2. Conduct field work in at least ten permafrost peatlands to document permafrost regeneration cycles in northwestern Alberta, as an analog of the expected permafrost degradation in a warmer climate (Zoltai, Siltanen)

3. Explore the possibility of forming a task force of experts in Canada and elsewhere on the technical aspects measuring the carbon budget (peat accumulation, carbon dioxide and methane emissions) of peatlands. (Zoltai)

4. Prepare manuscript on the rate of long-term peat accumulation in boreal peatlands of Northwest Region. (Zoltai, Gorham)

5. Initiate manuscript on the development of permafrost in the peatlands of northern Alberta, relating it to climatic change. (Zoltai)

6. Organize a network of scientists to obtain carbon flux estimates from wetlands in the different wetland regions of Canada. (Zoltai)

14. Publications 1990-91:

Zoltai, S.C. 1991. Estimating the age of peat deposit from the weight of peat: a study from west-central Canada. The Holocene. 1(1):68-73.

Zoltai, S.C.; Singh, T.; Apps, M.J. 1991. Aspen in a changing climate. In Proceedings Aspen Management Symposium, November 20-21, 1990, Edmonton.

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 concluded that these activities are not potentially detrimental to the environment.

16. Duration:

Started: 1991 Estimated Completion: 1997

17. Resources for 1991-1992:

PYs:	Prof.:	Zoltai	0.2
	Tech.:	Siltanen	0.3
	Total:		0.5
	Term/Student:		0.0

O&M: $4,000 (A-base)
$5,000 (Special funding)

Capital: Nil

18. Signatures:

S.C. Zoltai
Investigator

Program Director, Protection & Environment

Regional Director General

NOR-16-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Canadian Forests and Climate Change

2. Title: Vegetation - Climate interaction measurement and modelling

3. New: X Cont.: 4. No.: NOR-16-03
(Some goals formally NOR-13-02)

5. Study Leader: R. H. Swanson

6. Key Words: Evapotranspiration and photosynthesis modelling, succession modelling, soil water movement, transpiration, heat pulse velocity, snow accumulation, snowmelt.

7. Location of work: Boreal Forest, BOREAS sites in Manitoba and Saskatchewan; James River microclimate site; southern Alberta; other areas in Northern region as needed.

8. Background:

The driving force for climate change research is a modeled change in temperature and precipitation in response to measured changes in the Ozone layer and CO_2 concentration in the upper atmosphere. At this point, and very likely within the time frame of our proposed research, none of these changes will be measurable with any reasonable degree of confidence. We are therefore totally dependent upon the ability of atmospheric scientists to accurately model the global circulation and to predict the effects that will be evident in the climate in a given region. At present we have reasonably reliable predictions only for very large and homogeneous areas of Canada, such as the prairies, the central portions of the Boreal forest, and the arctic tundra.

The areal scale of the problem as currently identified is global. The current Global Circulation Models (GCM's) operate on a scale of approximately 400 by 400 km (forest scale?). Hopefully, we will have GCM's that will be able to predict effects on climate over a grid of approximately 100 by 100 km by the turn of the century and models with areal scale approaching that of the current digital weather forecasting models of 20 by 20 km (approximately the size of many forest stands of fire origin) by the year 2010. As a minimum research effort, we need to increase the areal scale of our present ability to measure CO_2

and water vapour exchange from points to stands in anticipation of similar improvements in scale by the GCM modellers. Our research should eventually produce measures of, or provide methods (such as digital models linking terrain features to fields of temperature, wind, humidity and radiation exchange) to estimate, the interaction of vegetation and other terrain features, such as lakes and wetlands, with atmospheric gas exchange over a 400 km^2 area in order to operate at the stand level.

The time frame for this research, and the potential funding is very limited when compared against the scale of the scientific problem. GCM's with suitable areal resolution at the scale of current forestry operations (on stands mostly of fire origin) may not be available for 15 to 20 years, but we can anticipate the type of linkages and data that will be required to contribute to their development and to utilize their output. Within our limited budget and personnel resources, we should do research that will have value in both predicting the future response of forests to climate change and monitoring/understanding the response of forest ecosystems to current climate. Any response by higher vegetation, such as trees to a change in climate will most likely appear long after this study is completed. Monitoring of climate and growth processes should thus be continuing activities in order to establish trends against which climate-caused departures can be evaluated.

Because of the length of time required for tree establishment and growth, the dependence of that growth on suitable climatic conditions and the scope of research required in order to make reliable and probable predictions of future climate, we should also seek to be active participants in the development and tests of GCM's to describe the atmospheric system in sufficient detail and with sufficient accuracy so that their predictions can be used by us in the planning of forestry operations in anticipation of the growth-climate conditions expected between regeneration and harvest. The BOREAS project should provide the first such opportunity to close the spatial scale gap between GCM's and point measurements of CO_2 and water vapour exchange; the GEWEX project should provide an opportunity to link these exchanges at forest scale with the areal scale of the present-day GCM's. We need to look carefully at those aspects of biological productivity that are most likely to be affected by a change in climate in the next 10 to 15 years and that can be linked to the global circulation modeled output; i.e., CO_2, O_2, and H_2O exchanges and exchange processes in both plants and resident fauna with limited mobility.

Our first focus should be to develop measurement techniques and/or models to estimate CO_2 and water vapour exchange and site productivity for areas of the BOREAS scale (20 by 20 km) and that of the GEWEX program (400 by 400 km). We need to be ready with data and preliminary methodology to test at the BOREAS scale by 1994, and at the GEWEX scale by 1998.

Secondly, we need to focus our research on physical areas that will eventually be used to link with the GCM work. Target areas have been chosen for the Boreal Forest and are being discussed for the GEWEX projects. We should ensure that we do our research on the BOREAS sites and take part in the GEWEX discussions and site selections so that forests that we are interested in are within the targeted areas.

Thirdly we need to focus our research on forest succession and productivity within the target areas. Until such time as reliable and realistic scale GCM's are available, the types of climates present during the past should be ascertained from various sources, such as dendrochronology, peatland cores, pollen records, and used as input to physiologically- and

climatically-based ecological succession models to simulate potential forestry conditions under similar climate change scenarios.

Research Priorities:

1. Evaluate several physiologically and climatically based growth models that may provide the necessary degree of linkage between growth processes and climate variables. Investigate possible ways to link short-time scale physiological growth models to long-time scale ecosystem succession models in a way that incorporates climatically-relevant variables common to both types of models.

2. Establish experimental plots on the BOREAS sites and work with the GEWEX committee to select sites that will be appropriate within the forestry context and eventual linkage with the Canadian Climate Centre's GCM.

3. On the BOREAS sites, start monitoring those aspects of vegetative growth, mortality and decay processes, and climate that are necessary to calibrate growth models and to link them with ecological succession models.

4. Assess potential effects on ecosystem stability through observation of current climate state and climate state as predicted at various time intervals into the future.

9. Study Objectives:

   1. To develop process-oriented vegetation/climate models for the description and assessment of the effects of climate, climate change, and silvicultural activities, on soil water resources, plant water relations, photosynthesis, respiration and site productivity.

   2. To develop appropriate linkages between climatically- and physiologically-based tree and stand productivity models and ecological succession models for the simulation of climate effects on forest dynamics under existing and/or changing climate.

   3. To conduct studies to define or refine relationships between quantitative energy-mass exchange and physiological-physical processes, (e.g.; aerodynamics of snow accumulation, evaporation from snow, snowmelt, soil water accretion, soil water movement, carbon dioxide exchange, xylem sap flow, water vapour exchange, inter-tree competition, etc.) in naturally occurring stands as well as in those created by partial and/or complete forest harvest.

10. Goals for 1990-91:

    N/A See NOR-13-02

11. Accomplishments 1990-91:

    N/A See NOR-13-02

12. Present Status of Study:

    New study.

13. Goals for 1991-92:

    1. Publications:

        a. Prepare paper on using the heat pulse velocity method for measuring transpiration and as an indicator of physiological activity. Incorporate material from investigations of HPV's in beetle attacked trees as example and new analysis techniques for fast sap speeds. (Hold over from NOR-13-02: Swanson)

        b. Prepare paper on "The influence of opening size on snow evaporation." (Hold over from NOR-13-02: Bernier (LFC), Swanson)

    2. Research activities:

        a. Select sites, instrument and conduct preliminary measurements to calibrate S.W. Running's Forest-BGC and transpiration/photosynthesis model across a south-north transect through the Boreal Forest. (Swanson, Apps, Hurdle)

        b. Start measurement and modelling of evapotranspiration and CO_2 exchange and do literature review for models/methods of scaling measurements at points to stands to forests. (Swanson, Hurdle, Term programmer - Green plan)

        c. Continue testing of theoretical methods for resolving fast sap speeds with the HPV technique. (Hold over commitment to PFRA from NOR-13-02: Swanson, Hurdle)

14. Publications 1990-91:

    New Study

15. Environmental implications:

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

16. Duration:

    Start: 1991 Estimated Completion: 1998

17. Resources 1991-92:

P/Ys:	Prof:	Swanson	0.5
		Apps	0.1
	Tech:	Hurdle	0.8
	Total:		1.4
	Term/Student:		0.5 (Programmer - Green Plan)

O&M: $4000 A-base ($28,000 Green plan)
Capital: $14,000 A-base ($110,000 Green plan)

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-16-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Canadian forests and climate change

2. Title: Climatic change modelling

3. New: X Contd.: 4. No.: NOR-16-04

5. Study leader: T. Singh, H. Grewal

6. Key words: Boreal forest, ecosystem productivity, climatic change, simulation modelling, risk analysis.

7. Location of work: Northwest Region

8. Problem:

Climate is a major factor determining the type, distribution, growth and productivity of vegetation over major forest regions of the world. It provides the basic framework for classifying and managing forest ecosystems. A change in climate will alter the environmental conditions, making it either less or more favourable for the existing vegetation. On a regional scale, conditions for optimal growth will shift and initiate vegetation adaptation to the changed environment. This process will involve changes in the reproductive success, growth rates, and productivity of the forests. A clear understanding of the effects of a changing climate on forests is crucial to the future management and utilization of forest resources. This study focuses on the potential impacts of projected climatic change on the growth and productivity of the Western Canadian interior boreal forest.

Sensitivity of the Boreal Forest. Boreal forest is defined by the thermal boundaries of 600 and 1,300 growing degree-day isolines as approximations for its present northern and southern limits. These boundaries have shifted to the north and south during the past climatic changes.

The implications of the increasing greenhouse effect and global warming are serious for the boreal forest. This is because of the forest's sensitivity and the fact that the greatest temperature increases are projected for the high latitudes which are the location of the circumpolar boreal forest.

Projected Climatic Change. The projected global climate is radically different from the present climate. According to the recent IPCC (Intergovernmental Panel on Climate Change) estimates, the average global temperatures for a doubling of atmospheric CO_2 would increase 1.5 to 4.5^0 C by about 2050 A.D..

The simulations of the second generation General Circulation Model (GCM) of the Canadian Climate Centre show a global average surface temperature increase of 3.5^0 C, and precipitation and evaporation increases of 3.8 %. However, the precipitation increase will be largest over the ocean, and evaporation increase largest over the land. Climate change under this scenario would cause average soil moisture depletion of 6.6 %, with larger values occurring in the northern summers.

Modelling Boreal Productivity. As climate affects forest productivity and zonation of vegetation, the ever increasing probability of future climatic changes will require more precise determination of the relationship between climate and the boreal ecosystem productivity. The driving variables for such research are temperature, moisture, or combinations thereof.

On the world scale, net primary productivity rises with both temperature and precipitation. The influence of temperature is clearest in "humid" regions (such as Europe and eastern North America) where the boreal forest grades southward into temperate deciduous forest. In Finland, the geographic distribution of forest growth rates is well correlated with temperature accumulations in the growing season.

Most of the boreal forest region in western Canada is "dry subhumid". Moisture and temperature limitations are both pronounced in the Canadian prairies. The more complex responses to controls on growth are important considerations in the boreal ecotones in such locations. The boreal forest is limited in the south by increased moisture stress.

Productivity and Zonation under Climatic Change. The maximum potential for height growth for the boreal tree species such as aspen is in the mid-boreal latitudes, and shows a gradual decline at the southern and the northern transitions to grassland and tundra, respectively.

The growth and productivity of the boreal forest is likely to be adversely affected when the climate of its southern ecotone shifts into the mid-boreal. Model simulations under moisture limitations show considerable northward expansion of the parkland and grassland at the expense of productive forest.

The present mid-boreal climate moving into the northern ecotone will have a favourable influence on the growth rates of northern locations. However, soil limitations and low nutrient levels would make the northern extension of the boreal forest less productive in such areas. On the other hand, the boreal productivity in non-ecotone zones is likely to increase slightly in the initial stages of climatic change.

Risks to Boreal Forest Productivity. Fires which frequently result in destruction of large areas comprising the future growing stock are a common occurrence in the boreal forest. During the past two decades the forest area lost in Alberta due to fires averaged 0.5 % annually, which is considerable because of the long rotations under which the boreal forests are managed. During a rotation of 100 years, for example, nearly a half of Alberta's forest area can be expected to suffer fire losses if all stands were equally prone to fire hazards. In addition, the mortality due

to insect and disease infestations can cause considerable errors in prediction and realization of annual allowable cut.

The existing risks from fire, and insects and disease infestations, will be enhanced by the future increases in temperature. Combined with the likely reduction in total area of the boreal region, this would mean reduced biomass productivity if the increased warming trends continue unabated.

Forest Management Strategies. Long-term planning of forest management is largely determined by the expectation of return on investment and management efforts. Losses from climate change, fire, insects and disease risk factors must be included in such projections. As these risks are predictable for large areas within a given time frame, their objective assessment will help in developing optimal management and timber harvesting strategies.

The climatic change scenarios and their impacts on the boreal forest productivity would be simulated and tested for the decision making process in the boreal forest of western Canada.

Methodology

Forest ecosystem simulation under global warming involves selection, calibration, and modification of the currently available models developed in U.S.A. It also includes tasks related to the development of modules for specific purposes, such as risk analysis and carbon budget, to be incorporated into the main model.

Data on regional climate, growth and yield inventories, forest fire occurrences, and insect and disease infestations are essential inputs for the study. Probability theory, operational research, and process simulation techniques will be used to predict future yields under the projected climate change, and associated risks and uncertainties.

Selected locations across the boreal region will provide climate and site data to simulate the effects of global warming scenarios. When the modelling infrastructure has been adequately developed, the productivity impacts would be used for determining optimal strategies under various risk factors. Mathematical concepts of decision theory will be applied to actual management units in each of the three subregions of the boreal forest.

Initial emphasis will be on pulpwood and timber resources of the boreal forest. Subsequently, the simulation methodology will be extended to non-timber resources as well, because of their prime importance under global warming.

9. Study Objectives:

1. To model boreal forest ecosystem productivity responses to climatic change at the stand and forest level in west-central Canada.

2. To simulate future timber supplies and annual allowable cut under the changing climate risks and uncertainties.

3. To develop optimal management strategies for the commercial and non-commercial uses of the boreal forest under specific climatic change scenarios.

10. Goals for 1990-91

New Study, several goals were transferred from NOR-28-07.

1. Publish a paper on the vulnerability of boreal forest to climatic warming.

2. Initiate draft of a paper on the FORMAN model for simulating the effects of infestation levels on volume losses.

3. Provide statistical advice to clients and colleagues in the ongoing programs of NoFC, represent Forestry Canada and NoFC on advisory committees and other groups, and participate in the planning and development of their activities.

4. Validate Shugart's model for forest biomass estimates of the main boreal tree species in western Canada.

5. Initiate preparation of a chapter on "Risk analysis in forestry" for a book to be published by CRC Press, U.S.A.

Added Goals:

6. Present a paper on climate change and productivity at the Canada/U.S. Symposium on the Impacts of Climatic Change and Variability on the Great Plains, September 11-13, 1990 in Calgary, Alberta.

7. Prepare a submission for the Canadian Global Change Program, Terrestrial-Forest Ecosystems and Climatic Change.

8. Prepare a paper on the impact of climatic change on aspen productivity for the Aspen Management Symposium to be held in Edmonton during November 20-21, 1990.

9. Prepare a PAIF proposal for Phase II of risk management strategies development program.

11. Accomplishments in 1990-91:

1. A paper entitled "Boreal forest sensitivity to global warming: Implications for forest industries in western interior Canada" was prepared, reviewed, submitted to Forestry Chronicle, and has been accepted for publication.

2. An initial draft of User's Manual for FORMAN model and its modification to deal with risk and uncertainty has been prepared. Further work on testing the modifications and finalizing is needed for completion.

3. Statistical advice was provided on an as needed basis to clients and colleagues in the ongoing programs of NoFC. Also represented Forestry Canada and NoFC on advisory committees and other groups, and participated in the planning and development of their activities.

4. Shugart's model has been obtained and initial familiarity with its methodology and approach gained. Any further work with its validation in the boreal forest of west-central Canada will require updating of equipment and programming capabilities.

5. Initial draft of the chapter "Risk analysis in forestry" was prepared Additional information on climatic change risks and uncertainties will be added as the climate change risk modelling study progresses.

6. An invited paper entitled "Climate change and forest productivity" was prepared and presented at the Canada/U.S. Symposium on the Impacts of Climatic Change and Variability on the Great Plains.

7. A submission was prepared and submitted to the Canadian Global Change Program; it has been incorporated in "Implications of global change for terrestrial ecosystems - Potential Canadian projects" by R.B. Stewart and J.W.B. Stewart.

8. A paper was prepared and presented at the Aspen Management Symposium, and is included in the Proceedings.

9. A proposal entitled "Boreal forest improved strategies development project: risk management" was prepared for PAIF funding under the forest yield and improved management program.

12. Present Status:

Risk analysis has been identified as a major study for the climate change project, with the main focus on calibration and validation of the four initially selected simulation models in the present study. Funding for computer upgrading and a full-time forest simulation modeller/risk analysis technician is essential to fulfil commitments and goals.

13. Goals for 1991-92:

1. Select permanent sample plot (PSP) locations in the boreal forest of Alberta to provide needed input data required for the calibration and testing of the four models (Zelig, Linkages, Boreal, Forena) selected for predicting the long-term succession trends under projected climate change scenarios in west-central Canada. (T.Singh, H.Grewal)

2. Identify data gaps and limitations in the existing locations, especially in the northern and the southern transitions of the boreal forest, and plan for field collection of required data in 1992-93. (T.Singh, H.Grewal)

3. Obtain parameter estimates for calibrating Zelig model on the basis of currently available data, and report results on the initial runs made as such. (T.Singh)

4. Visit and consult with Dr. Pastor in Minnesota regarding adaptation of Linkages model for boreal forest application. (H.Grewal)

5. Obtain parameter estimates needed for calibrating Linkages model on currently available data, and report results provided by the initial runs. (H.Grewal)

6. Compare the outputs from Zelig and Linkage models, and recommend the likely modifications to meet requirements of NoFC users. (H.Grewal).

7. Rate the potential application of all four models under specific climate change scenarios in the boreal forest of western Canada. (T.Singh)

8. To improve on knowledge of climate change/forest issues by participation in appropriate meetings, workshops, or conferences as opportunities arise. (T.Singh, H.Grewal)

9. Prepare and present paper at the SAF National Convention in Berkeley, California, and visit Dr. Botkin regarding gap dynamic models. (H.Grewal)

10. Prepare paper on the impact of climatic change on cold region ecosystems of Alberta for presentation at the International Symposium on Cold Region Development to be held in Edmonton during June 16-21, 1991. (T.Singh, S.Zoltai)

11. Prepare paper on the global warming impacts on boreal ecosystem productivity for presentation at the 10th World Forestry Congress being held in France during September 17-26, 1991. (T.Singh, E.Wheaton).

12. Finalize chapter on "Risk analysis in forestry" for a book to be published by CRC Press. (T.Singh)

14. Publications 1990-91:

Singh, T. 1990. Climate warming risks to hydrologic environment. Alberta Climatological Assoc., Gen. Cir., Summer 1990. p. 5-6.

Singh, T. 1991. Climate and productivity. Proc. Canada/U.S. Symposium on the Impacts of Climatic Change and Variability on the Great Plains. GFWG Pubn. Series 323-4200-91 (in press).

Singh, T.; Wheaton, E.E. 1990. Terrestrial-forest ecosystems and climatic change. Submission for the Canadian Global Change Program, Action Plan. Saskatchewan Research Council Publication No. E-2000-10-F-90.

Singh, T.; Wheaton, E.E. 1991. Boreal forest sensitivity to global warming: Implications for forest management in western Interior Canada. Forestry Chronicle (in press).

Zoltai, S.; Singh, T.; Apps, M.J. 1991. Aspen in a changing climate. Proceedings of Aspen Management Symposium, Forestry Canada. Edmonton, Alberta. November, 1990 (in press).

15. Environmental Implications:

The study involves computer simulation work during the first year. The NoFC Environmental Screening Committee will be provided with the experimental plan when the study progresses to the field work status in subsequent years.

16. Duration:

Started: 1991 Completion: 1996

17. Resources 1991-92:

PYs:	Prof.:	Singh	0.9	
		Grewal	0.8	
	Tech.:		1.0	(Forest modelling/risk analysis)
		Siltanen	0.4	
	Total		3.1	

O & M: $ 4 K

Capital:

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-16-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 22, 1991

1. Project: Canadian Forests and Climate Change

2. Title: Modelling the role of northern forests and forestry in the global carbon cycle in a changing climate.

3. New: X Cont.: 4. No.: NOR-16-05

5. Study Leader: M. J. Apps

6. Key Words: Carbon cycle, carbon budget , carbon sequestering, greenhouse effect, boreal forests, climate change, forest productivity, bioenergy, simulation modelling, ecophysiological modelling, BOREAS, N-BIOME, FORET, ZELIG, FORENA, FORCYTE, LINKAGES, JABOWA

7. Location of work: Canada

8. Problem analysis:

The Carbon cycle and climate change:

The principal factor driving global warming concerns is man's influence on the natural greenhouse effect through changes in the atmospheric loading of radiatively active gases. Carbon dioxide is still the main anthropogenetic greenhouse gas and global forest ecosystems account for approximately 50% (100 gigatons of carbon) of the annual exchange of this gas with the atmosphere. In addition to their significant and dynamic role in the annual carbon cycle, global forest ecosystems represent huge carbon pools in their soils (1500 gigatons C) and standing biomass (650 gigatons C).

Human activities are upsetting the world's carbon balance by burning fossil fuels and by removing active biological sinks for carbon dioxide through deforestation and other land use changes. An increasingly important question to Canadians is the extent to which our forests are part of the problem or can be part of the solution. This question has three parts: how much carbon is currently stored in Canadian forests, how much do they currently contribute

to the atmospheric budget, and how will these carbon storage pools and exchanges change in the future as a consequence of climate change and forest management?

The Carbon Budget Model of the Canadian Forest sector:

This project addresses the above questions in a three phase study:

Phase 1 - assessment of the current carbon budget using best available data;
Phase 2 - evaluation of the likely/possible consequences of alternative forest resource managment strategies on future carbon budgets; and
Phase 3 - evaluation of the likely/possible consequences of alternative climate change assumptions on future climate budgets.

This work has been initiated as a team effort between Forestry Canada and ESSA Ltd. The ESSA part of the collaborative team is funded under the ENFOR program (see NOR-28-06), while this study work plan outlines the Forestry Canada component of the research.

The main function of the Forestry Canada part of the collaborative project is to provide both scientific leadership (see also NOR-16-01) and development of parts of the new science understanding required to complete Phases 2 and 3 of the research. It became clear at a National workshop on the Carbon Budget Model (see added goal 1 for 1990-91), that a significant research effort would be required to adequately capture the existing state-of-the-art science understanding in order to address aspects of phase 2 and 3. Requiring investment in development of new science skills, this part of the work could not be appropriately contracted out. The scientific community at the workshop also stressed the need for a careful evaluation of the databases and sensitivity of the phase 1 model results to these data.

Furthermore, the development of an in-house science team on the carbon budget model (as distinct from contracting it all to ESSA, for example) ensures continuity, flexability, and cost effectiveness for the future. It is expected that after completion of the phase 2 and phase 3 framework and prototype model, there will be a period of science and policy recommendation output resulting from gaming analysis with the prototype model. This will be followed by an ongoing use of the model framework to test, refine and formulate projections of future carbon budget questions which incorporate the improvement in our knowledge, understanding and data. The carbon budget model is expected to be a major integrating tool for the overall Forestry Canada National Climate Change researh program.

Relationship of study to BOREAS:

It is expected that the carbon budget model for the Canadian Forest Sector will be tested and used as part of an NWR project proposal for the international BOREAS study by adapting, and applying, it to a transect from the grasslands through the BOREAS boreal forest sites and into the tundra. This transect is expected to become an integrating thread for a number of Forestry Canada's climate change research projects (see NOR 16-01) and the carbon budget is a central component of this activity.

Relationship of study to NBIOME:

In addition it is expected to eventually link up with the inter-agency NBIOME (Northern Biosphere Observation and Modelling Experiment). This ten-year multi-disciplinary, inter-agency project is one of two from Canada which have been accepted in NASA's EOS (Earth Observing System) program. Apps is one of the original Co-investigators named in the proposal to NASA, and has played an active role in several inter-agency workshops on NBIOME. This project attempts to link observational databases (satellite remote sensing, biomass and soils inventories) to process modelling of organic matter dynamics and carbon sequestration in forests and agricultural systems at the national scale.

Opportunities for leveraging external resources to support the FC-NWR program are considerable and one of the cornerstone activities of NBIOME (proposed by Apps and involving University as well as Government researchers) is to model the carbon dynamics across a transect through the grassland- boreal forest - tundra, including the BOREAS sites as mentioned above.

9. Study Objectives:

To provide the best available estimates of northern forests contributions to the global carbon budget in a changing environment by:

1. developing a quantitative modelling framework within which to capture the changing state-of-the-art science knowledge and data;

2. developing modelling approaches supported by field studies and data synthesis to evaluate the effects of resource management strategies on the carbon sequestration potential of northern forests for incorporation in the modelling framework;

3. adapting existing gap-phase dynamics succession models and ecophysiological response models for incorporation in the modelling framework to assess the changes in carbon sequestration potential of northern forests to possible changes in the global environment (such as global warming).

4. interfacing these models to large scale data accumulation programs (such as remotely sensed data) to assist in the detection and interpretation of global changes.

10. Goals for 1990-91:

New Study. The following are all Added goals

1. Organise national workshop on "Climate Change, Forest Resource Management and the Carbon Budget Model for the Canadian Forest Sector", Gananoque, Ontario, Feb. 26 - March 1 1991. (M.Apps)

2. Participate in National workshop on "Natural Sources and Sinks of Greenhouse Gasses" at Toronto, Feb. 5-7, 1991. Act as Invited Speaker on "Carbon Transfers: Forest and Wetland Ecosystems" in plenary session. (M. Apps, S. Zoltai)

3. Participate in International Conference "Global Biomass Burning" in Williamsburg, Virginia, Mar 16-24, 1990. Prepare manuscript "The Contribution of Biomass Burning

to the Carbon Budget of the Canadian Forest Sector: A conceptual Model" with coauthor Kurz, for inclusion in proceedings published by MIT press. (M. Apps)

4. Acquire and develop working knowledge of the FORET class of gap dynamic models. Establish working contacts with key ecosystem simulation modellers active in climate change research. (M. Apps, T. Singh, H. Grewal)

5. Prepare and present three posters at the XIX IUFRO World Congress in Montreal Aug 5-11, 1990 (M.Apps)

6. Act as science member of special team to prepare technical background for carbon sequestering potential of "trees for Canada" program (June 25-30, July 9-22, 1990, Ottawa). (M.Apps}

7. Submit abstract for International Conference on "Global Warming: A call for International Coordination", Chicago, Apr 8-11, 1991. (M.Apps)

8. Establish a contract and act as Scientific Authority for contract with Nawitka Renewable Resources Consultants Ltd. and act as coauthor on a manuscript on potential of Canadian marginal farmland for sequestering carbon through a tree planting program. (M.Apps)

9. Perform International Review of 2 Global Change research proposals on "Terrestrial Carbon Dynamics and Forest Effects Program" on behalf of E.P.A, Corvallis, May 1990. (M.Apps)

10. Prepare and present paper on the Carbon Budget Model for the Canadian Forest Sector for the 6th Forestry Canada Modelling Working Group Workshop, Kananaskis, Dec. 12-14, 1990. (M. Apps)

11. Review manuscript 90-371 on carbon cycling for editor of Canadian Journal of Forest Research, Jan. 1991. (M. Apps)

12. Establish a contract and act as Scientific Authority for contract with Ecological Land Surveys Ltd. to develop a database for carbon content of forest soils in Canada. (M.Apps, S. Zoltai)

11. <u>Accomplishments 1990-91</u>:

1. A national workshop on "Climate Change, Forest Resource Management and the Carbon Budget Model for the Canadian Forest Sector" was organised at Gananoque, Ontario Feb. 26 - March 1 1991. DM J.C. Mercier opened the first session. Over 30 invited particpants took part in the 4 day meeting. (M.Apps)

2. Zoltai and Apps participated in the national workshop on "Natural Sources and Sinks of Greenhouse Gasses" sponsored by Office of Energy R &D and organised by Environment Canada, at Toronto, Feb. 5-7, 1991. Apps was an invited plenary session speaker on "Carbon Transfers: Forest and Wetland Ecosystems". (M. Apps, S. Zoltai)

3. Apps participated in the International Conference "Global Biomass Burning" in Williamsburg, Virginia, Mar 16-24, 1990. Submitted manuscript "The Contribution of Biomass Burning to the Carbon Budget of the Canadian Forest Sector: A conceptual Model" with coauthor Kurz, which was accepted for publication in volume "Global Biomass Burning", MIT press, 1991. (M. Apps)

4. Apps and Singh visited Prof Shugart's laboratory to acquire working knowledge of the FORET class of models. Gap dynamic models (ZELIG, JABOWA2, and LINKAGES) were acquired and installed on NWR computers for preliminary gaming. Working contacts were established with Shugart, Pastor, Running and Urban. These and other contacts will be nurtured in the coming year (M. Apps, T. Singh, H. Grewal)

5. Three poster papers were prepared and presented at the XIX IUFRO World Congress in Montreal Aug 5-11, 1990.
   1) "Forest Ecosystems in Canada: a net source or net sink of carbon", M.Apps with coauthor Kurz
   2) "Evaluation of the benchmark FORCYTE-11 ecosystem simulation model", M.Apps
   3) "Using FORCYTE-11 to examine the medium and long-term effects of mixedwood management in western Canada", Grewal and Apps.

6. Apps played an active role as science member of a special team to prepare technical background for carbon sequestering potential of proposed "Trees for Canada" program (June 25-30, July 9-22, 1990, Ottawa). (M.Apps)

7. An abstract "Assessing the role of Canadian forests and forest activities in the global carbon balance" was submitted and was the only Canadian paper accepted for the International Conference on Global Warming: A call for International Collaboration" (M.Apps)

8. A contract was established with Nawitka consultants and work begun on a collaborative manuscript on the potential of Canadian marginal farmland for sequestering carbon through a tree planting program. (M.Apps)

9. Apps acted as one of 2 invited International Reviewers of 2 Global Change research proposals on "Terrestrial Carbon Dynamics and Forest Effects Program" on behalf of the Environmental Protection Agency, Corvallis, May 1990. (M.Apps)

10. A paper "The carbon budget model of the Canadian forest sector: status report" was prepared and presented at the 6th Forestry Canada Modelling Working Group Workshop, Kananaskis, Dec. 12-14, 1990. (M. Apps)

11. Manuscript 90-371 on carbon cycling was reviewed for editor of Canadian Journal of Forest Research, Jan 1991. (M. Apps)

12. A contract was established with Ecological Land Surveys Ltd. to develop a database for carbon content of forest soils in Canada. (M.Apps, S. Zoltai)

12. Present Status of Study:

New study.

13. Goals for 1991-92:

1. Publication goals

   a. Prepare paper on "The role of the Canadian Forest Sector on the global carbon cycle and the greenhouse effect" for the International Symposium on Cold Region Development (ISCORD) being held in Edmonton, June 16-21, 1991. (M.Apps)

   b. Prepare a manuscript on "Assessing the role of Canadian Forests and forest activities on the global carbon balance" for presentation by coauthor Kurz at the second International Confernece on "Global Warming - a call for international coordination" at Chicago, April 8-11. (M.Apps)

   c. Prepare a manuscript on Forest management implications of the carbon budget for the Canadian forest sector for presentation with coauthor Kurz at the Canada/US Symposium on "Implications of Climate Change for Pacific northwest Forest Management" Seattle, Washington, Oct. 23-25, 1991. (M.Apps)

   d. Revise and publish "The Carbon Budget Model of the Canadian Forest Sector: Phase 1", the results of phase 1 activities as an ENFOR information report. (M.Apps)

2. Install the Carbon Budget Model of the Canadian Forest Sector on NoFC computers and develop working expertise with the code and the data files by conducting part of the sensitivity analysis to support a science publication of the results of the Phase 1 model. (Apps, Mair)

3. Act as senior FC scientist and FC team leader in the collaborative development of the Carbon Budget Model framework by Forestry Canada and ESSA Ltd. (see also NOR-28-06 goal 11). Establish a secondary contract with ESSA Ltd. (or enhancement of existing ENFOR contract) to collaborate on enhanced evaluation of Phase 1 Carbon Budget model and preparation of journal manuscript. (M. Apps)

4. Investigate potential for application of the Phase 2&3 Carbon Budget Model to the regional transect (grasslands-boreal forest-tundra) in preparation for a BOREAS science proposal. (Apps, PDF/Res Assoc)

5. Investigate techniques for incorporating existing ecosystem simulation models (gap-phase dynamics and ecosphysiological response models) in the carbon budget framework (phase 2 and 3). Two approaches are considered viable: 1) modifying the existing code to incorporate them directly in the Carbon Budget Model framework, or 2) using them to construct meta-models (response surfaces for various climate, management scenarios) externally to the Carbon Budget Model. A major factor in the choice will be the preceived resulting flexabilty for incorporating future improvements in ecosystem simulation models. (Apps, Mair, PDF/Res Assoc)

6. Act as graduate student research advisor (and collaborator where appropriate) for graduate students (Ruth Ann Gal, U of Alberta; Mathew Williams, U of East Anglia) in the development of ecosystem simulation, carbon accumlation models which can be linked with remotely sensed data and which are sensitive to climate variables. This will be a continuing goal for several years and will provide NoFC links to BOREAS, NBIOME and the Carbon Budget Model for the Canadian Forest Sector, phase 3 (M. Apps).

7. Participate in selection of sites for the case study transect, including upland and wetland components (Grassland - boreal forest - tundra) for conceptual model development for carbon sequestering in conjunction with Swanson (NOR-16-03) and Zoltai (NOR 16-02), and other transect studies proposed under the 1991 S&T proposal which link to the BOREAS and NBIOME inter-agency projects. Our specific task is to evaluate the potential sites for verification/validation of the adapted Carbon Budget Model within the BOREAS project (see also goal 4). (M. Apps, Zoltai, Swanson, Res Assoc/PDF)

8. Organise expert workshops (drawing on the Canadian and International science community as resources permit) to examine and refine specific portions of the carbon budget model during Phase 2 and 3 development as required. At this time, a workshop to capture the best available scientific understanding of peatland dynamics across the grassland-boreal forest-tundra in a synthesising simulation model is required. (NB: execution of the workshop activity may be contracted)(M. Apps, S. Zoltai)

9. Act as scientific authority for assembly of a national soil carbon database for use in calibrating the Carbon Budget Model. (M. Apps, S. Zoltai)

14. Publications 1990-91:

Although a new study, the following publications and presentations were added goals relevant to this study:

Apps, M.J. 1991. Carbon Transfers: Forest and Wetland Ecosystems. Invited plenary session presentation at the national workshop on "Natural Sources and Sinks of Greenhouse Gasses" at Toronto, Feb. 5-7, 1991.

Kurz, W.A.; Apps, M.J. 1990. The Contribution of Biomass Burning to the Carbon Budget of the Canadian Forest Sector: A conceptual Model, In Global Biomass Burning; atmospheric, climatic, and biospheric implications, Abstracts for Chapman conference, March 19-23, 1990, Williamsburg, Virgnia.

Kurz, W.A.; Apps, M.J. 1990. Forest Ecosystems in Canada: a net source or net sink of carbon, Page 463 In Proc. Division 1, Vol. 2, XIX IUFRO World Congress, Montreal Aug 5-11, 1990.

Kurz, W.; Apps, M.J.; Webb, T.M.; McNamee, P.J.; Lekstrum, T. 1990. The Carbon Budget of the Canadian Forest Sector: Phase 1. ESSA Ltd., Vancouver, B.C. Aug 24, 1990.

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: 1991 Estimated Completion: 2001

17. Resources 1991-92:

P/Ys:	Prof:	Apps	0.5
		Swanson	0.1
		Zoltai	0.1
	Tech:	Program Modeller	1.0
	Total:		1.7
	ResAssoc/PDF		1.0(Green Plan)
	Summer student:		0.3

O&M: $4 K
(Green Plan/S&T $100 K ?)

Capital: $ 23 K (A-base) Workstation: 20 K ($20 K Green Plan ?)
Bernoulli Box: 3K

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-28-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 19, 1991

1. Project: Wetlands and Hydrology

2. Title: Peatland development and ecology

3. New: Cont.: X 4. No.: NOR-28-02

5. Study Leaders: S.C. Zoltai and J.D. Johnson

6. Key Words: Peatland, soils, chemistry, peat, vegetation, succession.

7. Location of Work: Northwest Region

8. Problem:

Peat is constituted by the largely undecomposed remains of vegetation growing in wet places. It usually occurs in depressions and other poorly drained areas, and supports a variety of vegetation from stunted trees to shrubs and sedges. In its natural state the high water table prohibits fast tree growth, but when sufficiently drained it can produce as well or better than the best upland sites. As a raw material, it has many uses depending on its quality, from peat moss as a soil conditioner to liquification as gas fuel.

The Prairie Provinces have enormous areas of peat, all north of the prairie zone. The most recent estimates show that about 28% of Alberta, 12% of Saskatchewan and 42% of Manitoba is covered with peat. This translates into approximately 180,000 km in Alberta, 68,000 km in Saskatchewan and 230,000 km in Manitoba.

The amount of peat involved is equally impressive. Conservatively calculating on a basis of 1.5 m average thickness in Alberta and Saskatchewan, and 2 m in Manitoba, the peat resources are 270×10^9 m^3 in Alberta, 102×10^9 m^3 in Saskatchewan, and 460×10^9 m^3 in Manitoba. Estimating the total dry peat content on the basis of 100 kg/m^3, this would amount to 27.0×10^9 tonnes in Alberta, 10.2×10^9 tonnes in Saskatchewan, and 46.0×10^9 tonnes in Manitoba; a total of 83,200,000,000 tonnes of dry peat.

The resources involved are considerable, whether viewed as a growth medium for forestry, range, agricultural or horticultural resources, or as raw material. Any development plans for

the use of these resources must be based on the understanding of peatland ecology to determine the suitability of various kinds of peatlands for different uses and the possibilities of rehabilitation of exploited areas. The present state of knowledge of peatland development in the western region is very incomplete, and all available information is confined to a few local areas.

Peatlands are unique as the ecosystem (plants, water, soil, climate) creates its own environment. Accumulation of peat, upon reaching a critical thickness, can bring about a drastic change in the chemistry and nutrient levels of the peat. This in turn allows the invasion of different peat-forming vegetation, changing the complexion of the peatland. Conversely, interference with the natural ecosystem by partial drainage or excavation will interrupt this cycle in the short term and initiates the regeneration of peatland in the long term. The understanding of peatland dynamics is essential in predicting the response of a peatland to manipulation (as for example the drainage studies undertaken in NOR-28-03), in order to avoid disappointment, failure, or the creation of wastelands.

A study of peatland dynamics is in progress within the Boreal Wetland Regions of Alberta, Saskatchewan and Manitoba. This study characterizes the various peatland types in terms of vegetation, past and present, chemistry of surface and peat deposits, quantifying and characterizing the peat occurring in various peatland forms. The rate of peat deposition is measured by studying the layering and secondary root development of trees, and by obtaining radiocarbon dates of suitable peat sequences. The information gathered will be used to characterize the dynamics of various peatland forms in the Boreal Wetland Regions.

Based on this background knowledge, guidelines can be established to recognize the value of wetlands for various uses. The suitability of wetlands for forestry can be predicted with reasonable certainty, and management techniques can be recommended for the improvement of drainage and tending of the forest.

9. Study Objectives:

   1. Determine the ecology of peatland development within the region.

   2. Develop drainability classification, and prepare guidelines for peatland management and rehabilitation, including conservation aspects.

10. Goals for 1990-91:

    1. Initiate study of wetland drainability classification and evaluation, in cooperation with Alberta Research Council, dependent on availability of funding from Alberta FRDA and A-base resources. (Zoltai, Johnson)

    2. Coordinate study of climate change, if funded by Science and Technology Opportunity Fund. (Zoltai)

    3. Act as Scientific Authority on three studies of climate change, if funded by Science and Technology Opportunity Fund. (Zoltai)

    4. Continue to serve on the National Wetlands Working Group by providing classification standards and technical advice on wetland conservation strategy. (Zoltai)

5. Represent Forestry Canada on various regional, national and international committees, working groups and workshops relating to wetlands and climate change, including the International Mire Conservation Group and the Environmental Assessment and Coordinating Committee (EACC). (Zoltai)

6. Initiate work on manual for prerequisites of peatland use for forestry, and other land uses. (Zoltai)

7. Revise the manuscript on bog development in a continental climate. (Zoltai and Johnson)

Added Goals:

8. Prepare and submit for publication a journal paper "Estimating the age of peat deposits from the weight of peat". (Zoltai) (Transferred to NOR-16-02)

9. Attend the 5th International Congress of Ecology (Yokohama, Japan). Present invited paper on the development of permafrost in Canadian peatlands. (Zoltai) (Transferred to NOR-16-02)

10. Present papers on the peatlands of Canada at symposia in Sapporo and Kushiro, Japan. (Zoltai)

11. Present paper on the role of aspen in a changing climate at Aspen Management Symposium. (Zoltai, Apps, Singh) (Transferred to NOR-16-02)

12. Act as chairman of Forestry Canada's Climatic Change Working Group. (Zoltai) (Transferred to NOR-16-02)

11. Accomplishments in 1990-91:

1. Wetland drainability classification was not initiated, as Alberta FRDA was not finalized in time to begin work. Feasibility study confirmed the expected success of the classification.

2. Funding by Science and Technology Opportunity was not sufficient to initiate study as planned. Participated in developing an Action Plan for Northwest Region.

3. Goal could not be met due to lack of funding.

4. Participated in a meeting of the National Wetlands Working Group.

5. Participated in workshops and meetings relating to wetlands and climate change. Forestry Canada representative on the Environmental Assessment and Coordinating Committee passed to J.M. Powell as of August 1, 1990, but remain on three of their subcommittees.

6. Discussion was initiated through the National Wetlands Working Group for a manual on peatland use for forestry.

7. Manuscript on bog development in a continental climate was not revised due to lack of time.

Accomplishments under goals 8, 9, 11 and 12 were transferred to NOR-16-02, see accomplishments 1-4.

10. Two illustrated talks were presented: Wetlands of Southern Canada. Sapporo, September 3, 1990; and Wetlands of Arctic Canada. Kushiro, September 5, 1990.

12. Present Status:

A proposal has been prepared in cooperation with Alberta Research Council for the drainability classification of peatlands in Alberta. This proposal will be submitted for funding under the Alberta PAIF, after the agreement is in force.

13. Goals for 1991-92:

1. Continue to act as project leader, developing and coordinating research at the study, project and program level. (Zoltai)

2. Initiate study of wetland drainability classification and evaluation, in cooperation with Alberta Research Council, dependent on availability of funding from Alberta PAIF and A-base resources. (Zoltai, Johnson)

3. Initiate a contract for the inventory of wetland types in Manitoba, with special emphasis on potentially productive peatlands. Ac t as scientific authority. (Johnson, Zoltai) (Dependent on funding by Canada-Manitoba PAIF)

4. Continue to serve on the National Wetlands Working Group by providing classification standards and technical advice on wetland conservation policy. (Zoltai)

5. Assist colleagues in the identification of vegetation. (Johnson)

6. Make data on physical and chemical characteristics of Northwest Territories, Alberta, Saskatchewan, and Manitoba peatlands available in electronic form. (Siltanen, Zoltai)

7. Represent Forestry Canada on various regional, national and international technical committees, working groups and workshops relating to wetlands. (Zoltai)

14. Publications 1990-91:

Johnson, J.D. 1989. Additions to the vascular flora of Manitoba. Can. Field-Nat. 103(1):291-293.

Zoltai, S.C. 1990. Development of permafrost in peatlands of subarctic Canada. Page 84 in Abstracts, V International Congress of Ecology, Yokohama, August 23-30, 1990.

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: 1981 Estimated Completion: 1994

17. Resources for 1991-92:

PYs:	Prof.:	Zoltai	0.9
		Johnson	0.5
	Tech.:	Siltanen	0.6
	Total:		2.0
	Term/Student:		0.0

O & M: $3,000

Capital: Nil

18. Signatures:

S.C. Zoltai
Investigator

Program Director, Protection & Environment

J.D. Johnson
Investigator

Regional Director General

NOR-28-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 15, 1991

1. Project: Wetlands and Hydrology

2. Title: Increasing wood production through forest land drainage (Wetland drainage and improvement program)

3. New: Cont.: X 4. No.: NOR-28-03

5. Study Leaders: G.R. Hillman and J.D. Johnson

6. Key Words: Wetlands, peatlands, regeneration, forest growth, Larix laricina, Picea mariana, ditches, groundwater, soil water, hydrology, hydrodynamics, site preparation

7. Location of Work: Boreal forest, Northwest Region

8. Problem:

In Alberta, concern about the decreasing productive forest land base as more forest land was withdrawn for other uses led foresters to consider increasing the wood-growing capability of forested wetlands. About 4 million ha in Alberta are considered suitable for drainage and conversion to productive forest. There is, however, very little information available on the long-term effects of forest drainage on tree growth and the environment.

The wetland drainage and improvement program, funded by the Canada-Alberta Forest Resource Development Agreement, arose in response to the concerns and shortcomings outlined above. In 1985, three forested wetland areas were selected as experimental drainage sites: a treed fen (McLennan, 259 ha), a treed fen (Wolf Creek, 132 ha), and a treed swamp (Goose River, 320 ha). Portions of each area were designated for ditching, and the remainder preserved as control. The experimental design required that data be collected before and after drainage.

Drainage ditch network designs were prepared so that different ditch spacings on the same site could be evaluated. Ditching was completed on the Goose River area (135 ha ditched) in September, 1986; on McLennan (90 ha) in July, 1987; and on Wolf Creek (60 ha) in October, 1987.

In 1986, transects were established and instrumentation installed on a control site and on three different ditch spacings for each experimental drainage area. Peat, water, and foliage samples were collected on each transect to determine its nutrient status. Ground temperatures and groundwater table levels were monitored during 1986 through 1989. To evaluate the effects of drainage on ground vegetation composition and tree growth, permanent sample plots were established and measured. Stream water samples were collected periodically to determine the effects of ditching on stream water chemistry and suspended sediment loads.

Preliminary results indicated that ditching produced a significant drop in average groundwater table levels for the three experimental areas. Additional data, obtainable through automatic water sampling, is required to properly evaluate the impact of drainage on sediment loads and inorganic chemical water quality in streams. There is also a need for studies on the effects of drainage on other aspects of the aquatic environment, particularly on the organic chemistry of water courses downstream from the drained areas. An evaluation of the effects of drainage on streamflows is also essential.

Forestry Canada and Alberta Forest Service (AFS) cooperated closely on all aspects of the study. The AFS was responsible for most of the operational activities, and ForCan carried out the scientific research. Responsibility for installing tree growth PSPs was shared. On the Goose River site, the AFS established fertilizer-thinning studies and also implemented ditch mounding trials.

9. Study Objectives:

   1. Evaluate the growth potential of commercial tree species on treed wetland (peat or mineral soil) sites where water tables have been lowered.

   2. Measure the effects of drainage on hydrological parameters such as water table depths, and on critical soil characteristics such as moisture content, temperature, fertility, hydraulic conductivity and subsidence.

   3. Monitor the effects of drainage on the composition of competing vegetation.

10. Goals for 1990-91:

   1. In cooperation with AFS, complete final report as required by the Wetlands Drainage and Improvement Program, Canada-Alberta Forest Resource Development Agreement. (Hillman, Johnson)

   2. To publish in the Forestry Chronicle a paper entitled "Tree growth on drained forested peatland near Fort McMurray, Alberta". (Hillman)

   3. Write journal article on McLennan drainage study. (Hillman)

   4. Coauthor paper on the effects of drainage on peat water content (Hillman in cooperation with R.L. Rothwell, Forest Science Dept., U. of Alberta)

   5. Continue to monitor groundwater table levels and ground temperature at Wolf Creek; and to continue monitoring stream water quality at Wolf Creek and Goose River. (Hillman, Robson)

6. Continue preliminary economic feasibility analysis of forest drainage in Alberta (White, Hillman) [see study NOR-3-03]

7. Select, instrument and monitor three forested peatland basins to determine the effects of drainage on streamflows and stream water quality. (Hillman, Robson)

8. Select, and plan drainage or other treatments for, highly productive but wet mineral site that have been cutover and consequently, are difficult to reforest. (Hillman, Robson)

9. Provide scientific and technical advice on forest drainage projects and problems. (Hillman)

Added Goal:

10. To develop an automatic integrated stream water level recording/water sampling system.

11. Accomplishments in 1990-91:

1. The final FRDA report on the wetlands drainage and improvement program is ready for publication.

2. The paper "Black spruce growth on drained forested peatland in northern Alberta" is being prepared as a FMN.

3. The journal article on the McLennan study entitled "Controlling groundwater table levels to improve tree growth in Alberta's boreal forest" is under review.

4. Statistical analyses for the proposed paper has been completed.

5. Groundwater table levels, ground temperature and stream water quality were monitored at Wolf Creek. Water quality sampling at Goose River has been postponed until the automatic integrated stream water level recording/water sampling system becomes available.

6. Cost figures for the economic analyses are being gathered from the Alberta Forest Service.

7. and 8. These goals were not met because they are dependent on resources provided by a new Canada-Alberta PAIF.

9. Scientific and technical advice was provided as required.

10. The automatic water level recorder/water sampler system was completed and tested under field conditions. It is expected to be operational by the 1991 field season.

12. Present Status of Study:

As of November 1987, all three sites had been ditched, bringing to an end the pre-treatment data collecting period. A minimum of one summer's and a maximum of two summers' pretreatment data were collected from the sites. Preliminary analyses on the effects of

drainage on groundwater table levels and on stream water quality were completed (Objective 2).

136 tree growth and 150 ground vegetation permanent sample plots were established on the three drainage sites. A few years of post treatment data are required to meet objectives 1 and 3.

Because such information will not be available from the FRDA experimental areas for several years a study near Fort McMurray was undertaken. Its purpose was to obtain estimates of the change in tree growth rates that can be expected as a result of lowering water tables (Objective 1). The Ft. McMurray study area was drained in 1975-80.

Preliminary results from the study were presented at symposia in Edmonton, Joensuu (Finland) and Quebec City. A more comprehensive description of results will appear in the final FRDA report to be completed in 1990. (Objectives 1, 2, and 3).

Groundwater table levels, ground temperature and stream water quality continue to be monitored at Wolf Creek.

13. Goals for 1991-92:

1. To publish in the Forestry Chronicle a paper entitled "Tree growth on drained forested peatland near Fort McMurray, Alberta." (Hillman)

2. Complete journal article on the McLennan drainage study. (Hillman)

3. Prepare report on the Wolf Creek forest drainage study. (Hillman)

4. Co-author paper on the effects of drainage on peat water content. (Hillman, in cooperation with R.L. Rothwell, Forest Science Dept., U. of Alberta)

5. Continue to monitor groundwater table levels and ground temperature at Wolf Creek; and to continue monitoring stream water quality at Wolf Creek and Goose River. (Hillman, Robson)

6. Continue preliminary economic feasibility analysis of forest drainage in Alberta. (White, Hillman, see study NOR-6-01)

7. Select instrument and monitor three forested peatland basins to determine the effects of drainage on streamflows and stream water quality (Hillman, Johnson and Robson)

8. Select, and plan drainage or other treatments for highly productive but wet mineral sites that have been cutover and consequently are difficult to reforest. (Hillman, Robson)

9. Provide scientific and technical advice on forest drainage projects and problems. (Hillman)

14. Publications 1990-91:

Hillman, G.R. 1991. The Canada-Alberta wetlands drainage and improvement program for forestry: An update report. Pages 54-61 In Jeglum, J.K. and Overend, R.P., eds. Proceedings Symposium '89 Peat and Peatlands Diversification and Innovation. Volume 1 - Peatland Forestry. Quebec City, Quebec, August 6-10, 1989.

Hillman, G.R.; Johnson, J.D.; Takyi, S.K. 1990. The Canada-Alberta wetlands drainage and improvement for forestry program. 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:

Start: 1985 Completion: 1996

17. Resources 1991-92:

PYs:	Prof.:	Hillman	1.0
		Johnson	0.5
	Tech.:	Robson	1.0
	Total:		2.5
	Term/Student:		0.3

O & M: $6,000

Capital:

18. Signatures:

Investigator

Program Director, Protection & Environment

Investigator

Regional Director General

NOR-28-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Wetlands and Hydrology

2. Title: An assessment of the energy potential of forest biomass in the Northwest Region

3. New: Cont.: X 4. No.: NOR-28-06

5. Study Leader: J.M. Powell

6. Key Words: Biomass, energy, fuels, climate, productivity, availability, harvesting, simulation models, resource data, impacts

7. Location of Work: Northwest Region

8. Problem:

Fossil fuels such as crude oil, natural gas, tar sands and coals are relatively abundant in Canada, but nevertheless of finite extent. Because such reserves are dwindling, there has been a fresh look at forest fuels as renewable resource. Forest biomass, the total quantity of organic matter in the forest, is an energy source that is currently largely untapped and in many cases going to waste. At the initiation of this program Canada derived about 4% of its total energy supply from forest biomass. The federal program established in 1978 aimed at generating sufficient knowledge and technology to realize a marked increase in the contribution of forest biomass to Canada's energy supply.

Current biomass productivity in the forested areas of the Prairie Provinces and the Northwest Territories ranges from less than 1 t/ha/yr in the north to over 3 t/ha/yr in some southern parts of the provinces. The initial estimate of the above-ground tree biomass reserve in Alberta alone is more than 1 billion tons of oven-dry material. Annual biomass production amounts to 25 million oven-dry tons.

Forestry Canada is the lead agency in administering the federal ENergy from the FORest (ENFOR) program, part of the Federal Panel on Energy R&D (PERD). The NoFC studies are an integral part of the national For Can ENFOR program to assess the potential of biomass as an alternate energy source. The main areas of the For Can ENFOR program have

looked at resource assessment, environmental effects, mechanization, silviculture and socio-economic technical studies.

9. Study Objectives:

1. To develop and test biomass prediction equations for regional tree species and lesser vegetation and demonstrate their integration with resource inventory programs.

2. To investigate the impact of biomass removal on site quality, nutrient status, silvicultural option and long-term site productivity on selected sites in the prairie provinces.

3. To determine production and delivery costs of biomass under various operation conditions and to provide a basis for evaluating the feasibility of using various forms of biomass for energy.

4. To develop and operate a computerized biomass data bank and information retrieval system to provide for more effective use of information and technology transfer.

10. Goals for 1990-91:

1. Publish Information Report entitled "Economics for industrial utilization of aspen". (P-207) (Scientific Authority: W. Ondro)

2. Publish journal paper "Variation in crown components of main tree species in the Northwest Territories Canada". (P-169) (Scientific Authority: T. Singh)

3. Complete review and publish journal note entitled "Biomass prediction for small trees in the boreal forest of west-central Canada". (P-314 extension) (T. Singh)

4. Review the final report "Data analysis of biomass and nutrient content in Alberta aspen ecosystems" and prepare for ENFOR publication. (P-205) (Scientific Authority: I.K. Edwards)

5. Review the report "A nominal dataset for the FORCYTE-11 modelling framework for aspen ecosystems in Alberta, Canada" and prepare for ENFOR publication. (P-314) (Scientific Authority: I.K. Edwards)

6. Publish Information Report "Wood density of Canadian tree species" based on contract report by FORINTEK. (P-335) (Scientific Authority: J.M. Powell)

7. Oversee the completion of contract "Economic feasibility of utilizing logging slash and fire-killed timber for energy in Manitoba and Saskatchewan" scheduled for completion in March 1991. Assist consultant in preparation of short publication on the preliminary results of the slash inventory phase. This work to be an extension of the existing contract. Oversee proposal development and subsequent work on another extension to the existing contract which would provide detailed statistics on domestic fuel wood users. Conduct reviews of contractor's final report. (P-379) (Scientific Authority: J. De Franceschi)

8. Publish FORCYTE-11 documentation, including the "Scientific Foundations" for the model and the user's manual. (P-377) (M.J. Apps)

9. Establish and oversee a contract to complete and publish the Forestry Canada technical and scientific evaluation of FORCYTE-11. (P-397A) (Scientific Authority: M.J. Apps)

10. Participate in the national FORCYTE-11 review and regional applications and present findings at IUFRO World Congress at Montreal in August. (M.J. Apps, H. Grewal)

11. Present results of Phase 1 of the Annual Carbon Balance of the Canadian Forest Sector at the Chapman International Conference on global biomass burning at Virginia and at the IUFRO World Congress at Montreal. (P-387 extension) (M.J. Apps)

12. Establish and oversee a contract to address phase 2 of the Annual Carbon Balance of the Canadian Forest Sector: assessment under alternative management and policy options and structure to include potential climatic change effects. (P-387) (Scientific Authority: M.J. Apps)

13. Establish and oversee a contract, and participate in the update of a case study of early stand biomass productivity in aspen cutovers in the Calling Lake and Kinuso regions. Prepare a report on the results. (P-395) (Scientific Authority: H. Grewal)

14. Use FORCYTE-11 to assess and predict the medium- and long-term sustainability of alternative forest management practices in aspen-white spruce mixedwood stands. (P-396) (Scientific Authorities: H. Grewal, M.J. Apps)

15. Establish and oversee a contract to assess the feasibility and cost of restructuring FORCYTE-11 for application to larger scale issues (including climate change). (P-397B) (Scientific Authority: M.J. Apps)

16. Continue to act as FC lead agency for FORCYTE, including coordination of use of the model by others. (M.J. Apps)

17. Continue coordination of NoFC ENFOR projects ensuring their completion and publication. Act as establishment representative on the national committee and submit reports on the program as required. (J.M. Powell)

11. Accomplishments in 1990-91:

1. The Information Report entitled "Economics of 15 options for industrial utilization of poplar" was published. (P-207) (W. Ondro)

2. Work on a non-linear model during the year resulted in further improvements in prediction quality of the biomass equations. In view of the current focus on climate change, the draft is being expanded to provide comparative biomass productivity levels in the NWT vs. prairie provinces. (P-169) (T. Singh)

3. The non-linear model mentioned above also provided better estimates for the small tree equations for ten tree species of the prairies, and the results obtained are being incorporated in a manuscript for journal publication. (P-314 extension) (T. Singh)

4. Two volumes of data, entitled "Biomass and nutrient content of aspen ecosystems in Alberta, Canada" (Volume 1 and Volume 2) have been submitted by the contractor. The final report has not been delivered; the contractor indicated that a higher priority was assigned to completion of another contract. (P-205) (I.K. Edwards)

5. The report was not reviewed because additional sensitivity analyses are expected from the contractor. An Appendix, describing the dataset in detail, and a diskette containing an updated dBase III file of references were expected also, but were not delivered owing to downgrading in priority by the contractor. (P-314) (I.K. Edwards)

6. The Information Report entitled "Wood density of Canadian tree species" was published. (P-335) (J.M. Powell)

7. This two-year contract continued on schedule. An interim report was prepared providing preliminary economic analyses including work done towards non-timber costs/benefits associated with slash utilization. Two extensions were approved: 1) A pamphlet entitled "Residual wood for energy and manufacture: New opportunities in Saskatchewan and Manitoba" was published (300 copies). This provided a quick summary of waste wood volume information derived from the field sampling and was intended to alert prospective users to this potential source of wood. 2) To measure the economic impact on domestic fuelwood users of increasing utilization of waste wood by industry. The final report, with appendices, entitled "Economic feasibility of utilizing logging slash and fire-killed timber for energy: Saskatchewan and Manitoba" was received. In addition the study results were presented by the consultant at the conference "Energy from biomass and wastes XV" held in Washington, D.C. March 25-29, 1991. (P-379) (J. De Franceschi)

8. The contractors report entitled "Scientific foundations for the simulation of ecosystem function and management in FORCYTE-11" was received in June and is with the editorial group for preparation as an Information Report, while the manual "FORCYTE-11 user's manual for the benchmark version" was published in August. (P-377) (M.J. Apps)

   The model and its manual has been distributed to researchers in government agencies, universities, and industries in Canada, USA and other countries. Researchers' problems related to using/applying FORCYTE-11 have been responded to (M.J. Apps, H. Grewal).

9. The contract to complete the technical and scientific evaluation of FORCYTE-11 was completed at the end of March 1991. (P-379A) (M.J. Apps)

10. Organized a FORCYTE-11 users workshop held at Kananaskis Centre in May attended by ForCan researchers from NFC, Newfoundland and B.C. Prepared and presented two poster papers "Using FORCYTE-11 to Examine the Medium- and Long-term Effects of Mixedwood Management in Western Canada" (Grewal and Apps) and "Evaluation of the benchmark FORCYTE-11 Ecosystem Simulation Model" (Apps) at the XIX IUFRO World Congress in Montreal in August. (M.J. Apps, H. Grewal)

11. An overview of the Carbon Budget Model for the Canadian Forest Sector was presented at the International Chapman Conference on Global Biomass burning in Williamsburg,

Virginia (March 1990) and a manuscript submitted for publication of the proceedings by M.I.T. Press. The results of Phase 1 of this project were presented in a poster "Forest Ecosystems in Canada: A net source or a net sink of carbon" at the IUFRO World Congress in Montreal in August. A draft report on Phase 1 results has been reviewed by a panel of international experts and is being prepared for publication as an ENFOR Information Report. There is great interest in the results from this study and elements were included in the environment section for the State of Forest Report to Parliament and on a number of other occasions. (P-387 extension) (M.J. Apps)

12. Phases 2 (management intervention analysis) and 3 (climate change scenario analysis) of the Carbon Budget Model for the Canadian Forest Sector are on schedule with completion following another year of collaboration with the ESSA Ltd. contractors. A major 4 day workshop with an estimated 30 selected participants was held at Gananoque, Quebec, Feb. 26 to Mar. 1, 1991. (P-387) (M.J. Apps)

13. The contract was completed with receipt of report "Biomass productivity in six year old cutovers" in December. Further work is underway to prepare a journal paper on the study results. (P-395) (H. Grewal)

14. Continued to develop the FORCYTE-11 model framework for studying mixedwood (spruce and aspen) forest management. Presented a poster paper "Assessing the management of mixedwood forests in western Canada in the next 60 years using FORCYTE-11" at the Canada's Timber Resources Conference in Victoria in June. (P-396) (H. Grewal, M.J. Apps)

15. The contract to assess the feasibility and cost of restructuring FORCYTE-11 for application to larger scale issues was not put into place due to lack of qualified personel. The decision was made to postpone this work pending better delineation of the climate change program needs. (P379) (M.J. Apps)

16. NoFC continued to act as FC lead agency for FORCYTE. Enquiries for use of the model by others were serviced and, where necessary, agreements for its research use or application were signed. This role was coordinated by both Apps and Grewal during the year. (M.J. Apps, H. Grewal)

17. Coordination of NoFC ENFOR projects was continued and the ENFOR Technical Committee attended in Ottawa in late November when four new proposals were submitted. One was agreed to for immediate funding (see last entry under 13 above), another was suggested for consideration under the EMR portion of the Program and the others were recommended for the 1991-92 program. Facilitated the submission of various reports for the completion of the ENFOR Program Bibliography being put together by I.S. Alemdag. (J.M. Powell)

J. De Franceschi was appointed as the FC representative on the IEA Bioenergy Agreement, Task VI, Activity 7, "Economics of Wood Energy Supply Systems".

12. Present Status of Study:

Since the inception of the program NoFC has undertaken 35 ENFOR contracts of which 32 have been completed except for some final publications. Of the remainder, two final reports are awaited, one is on-going through 1991-92.

Contracts to establish biomass prediction equations for regional tree species have been completed, and publications published, although two additional publications refining prediction equations for small diameter components are currently under review.

A major contract to investigate the impact of aspen biomass removal on site quality and nutrient status has been completed although we await the final report. Much of this data and data collected under another study has been used as input to an adaptation of the FORCYTE model for Alberta aspen stands. Major effort is now being expended to document the FORCYTE-11.4 model and evaluate the model in a number of regions. A FORCYTE-11 User's Manual was published, and a report on the Scientific Foundations for the model is under review.

Two contracts provided production and delivery costs of poplar biomass under two operational regimes. Industrial options for use of poplar for products were also assessed including as an energy source; reports have been published.

Studies were completed and published on the effects of climate and tree growth/biomass including a literature survey and through tree ring analysis. A comprehensive source book of wood density data for Canadian tree species was published. Major input was also provided for the Canadian Biomass inventory including studies of non-inventoried forested areas in the region, and development of a pilot computer mapping system. A current study is assessing the Annual Carbon Budget of the Canadian Forest Sector.

13. Goals for 1991-92:

1. Revise and submit manuscript entitled "Comparative biomass productivity estimates of three boreal tree species in prairies vs. NWT" for journal publication. (P-169) (Scientific Authority: T. Singh)

2. Summarize results and submit for a journal note entitled "Predicting biomass productivity of main tree species of the prairie provinces". (P-314 extension) (T. Singh)

3. Review the final report "Biomass and nutrient content of aspen ecosystems in Alberta, Canada" and prepare it for an ENFOR publication. (P-205) (Scientific Authority: I.K. Edwards)

4. Review the final report, "A nominal dataset for the FORCYTE-11 modelling framework for aspen ecosystems in Alberta, Canada" and prepare for an ENFOR publication. A review of all deliverables is also planned. (P-314) (Scientific Authority: I.K. Edwards)

5. Prepare a journal paper, coauthored with W. Fast, Hugh Hamilton Ltd. (contractor) on the biomass productivity study of six-year-old aspen cutovers near Slave Lake and Calling Lake (P-395) (H. Grewal)

6. Continue to act as Forestry Canada contact for FORCYTE-11 project including distribution of model and trouble-shooting for researchers. The response to initial offer of the model to the research community around the world has been overwhelming. Researchers are asked to sign a research agreement before the model is released. (M.J. Apps, H. Grewal)

7. Organise a FORCYTE-11 user's workshop for fall of 1991 to bring together model developers and users from Forestry Canada establishments, other federal agencies e.g., Canadian Wildlife Service, provincial forestry departments e.g., B.C. Ministry of Forests, industries e.g., MacMillan Bloedel Ltd., and Universities. Speakers will also be invited from the ecological modelling research community. The objective of the workshop is evaluation of the model and publication of proceedings. (P-409) (H. Grewal)

8. Publish "Scientific foundations for the FORCYTE-11 model". (P-377) (M.J. Apps)

9. Publish a generic reference manual on PROBE, and a manual for PROBE's use with FORCYTE (both FORCYTE-10 and 11). (P-369) (M.J. Apps)

10. Publish Information Report Phase 1 of the Carbon Budget Model for the Canadian Forest Sector. (P-387) (M.J. Apps)

11. Oversee completion of Phases 2 and 3 of the Carbon Budget Model for the Canadian Forest Sector. Review output for presentation at appropriate meetings and as final report. (P-387) (Scientific Authority: M.J. Apps)

12. Consider preparation of an Information Report or other publications outlining the highlights of the study, "Economic feasibility of utilizing logging slash and fire-killed timber for energy in Manitoba and Saskatchewan". (P-379) (Scientific Authority: J. De Franceschi)

13. Present a paper featuring the work completed under P-379 at the IEA Task VI, Activity 7 - Economics of Wood Energy Supply Systems meeting to be held in Norway, May 1991. (J. De Franceschi)

14. Oversee contract "Development of a decision support system (DSS) for aspen management. (P-408) (Scientific Authority: I.E. Bella)

15. Serve as the Forestry Canada representative on the IEA Task VI, Activity 7 - Economics of Wood Energy Supply System, as required. (J. De Franceschi)

16. Continue coordination of NoFC ENFOR projects ensuring their completion and publication. Review the "Strategic Plan for Bioenergy Research 1992-1997". Act as NoFC representative on the ENFOR Technical Committee, and submit reports on the program as required. (J.M. Powell)

14. Publications 1990-91:

Apps, M.J. 1990. Evaluation of the Benchmark FORCYTE-11 Ecosystem simulation model. Proc. XIX IUFRO World Congress, August 5-11, 1990. Montreal, Canada. Division 4. Page 497.

Apps, M.J.; MacIsaac, D. 1990. The role and use of models in decision support. Pages 95-108 in M.F. Ker, compiler. Proceedings of Fourth Modelling Workshop, Forestry Canada Modelling Working Group. Fredericton, N.B., 24-25 October, 1989. For. Can. Maritimes Reg., Fredericton, N.B.

Bunce, W.F.; Blakeney, K.J.; Richmond, A.E. 1991. Economic feasibility of utilizing logging slash and fire-killed timber for energy: Saskatchewan and Manitoba, Canada, 1991. Proc. Energy from Biomass and Wastes XV, Washington, D.C., March 25-29, 1991 (in press)

Gonzalez, J.S. 1990. Wood density of Canadian tree species. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-315.

Grewal, H.; Apps, M.J. 1990. Assessing the management of mixedwood forests in western Canada in the next 60 years using FORCYTE-11. Proceedings. Canada's Timber Resources Conference, June 3-6, 1990, Victoria, B.C. (in press).

Grewal, H.; Apps, M.J. 1990. Using FORCYTE-11 to Examine the Medium- and Long-term Effects of Mixedwoods Management in Western Canada. Proc. XIX IUFRO World Congress, August 5-11, 1990. Montreal, Canada. Division 4. Page 500.

Grewal, H.; Apps, M.J. 1990. Using FORCYTE-11 to Examine the Medium and Long-term Effects of Mixedwood Management in Western Canada. (Abstract). Page 15 in Aspen Management for the 21st Century, Aspen Symposium, Nov. 20-21, 1990. Edmonton, Alberta. For. Can., Alta. For. Lands & Wildlife, For. Serv., Poplar Counc. Can.

Grewal, H.; Apps, M.J.; MacIsaac, D. 1990. Using a traditional growth and yield model (STEMS) to drive a management simulator (FORCYTE-11). Page 225-233 in L.C. Wensel and G.S. Biging, technical editors. Forest Simulation Systems. Proc. Int. Union For. Res. Organ. Conf., November 2-5, 1988, Berkeley, California. Univ. of Calif., Div. Agric. Nat. Resour., Oakland, California. Bull. 1927.

Hugh Hamilton Ltd. 1990. Biomass productivity in six year old aspen cutovers. Alberta Div., Edmonton, Alberta. Contract report. December 1990.

Kimmins, J.P. 1990. The scientific foundations for the simulation of ecosystem function and management in FORCYTE-11. U. British Columbia, Fac. For., Dep. For. Sci., Vancouver, B.C. Contract report. June 1990.

Kurz, W.A.; Apps, M.J. 1990. Forest Ecosystems in Canada: A net source or a net sink of carbon? Proc. XIX IUFRO World Congress, August 5-11, 1990. Montreal, Canada. Division 1. Page 463.

Kurz, W.A.; Apps, M.J. 1990. The contribution of biomass burning to the carbon budget of the Canadian forest sector: A conceptual model. In Global Biomass burning: Atmospheric, Climatic, and Biospheric Implications, Abstracts for Chapman Conference, March 19-23, 1990, Williamsburg, Virginia. (in press)

Kurz, W.A.; Apps, M.J.; Webb, T.M.; McNamee, P.J.; Lekstrum, T. 1990. The Carbon Budget of the Canadian Forest Sector: Phase I. ESSA Environment and Social Systems Analysis Ltd., Vancouver, B.C. Contract report. August 24, 1990.

Nicholas, A.R. 1990. Impacts on wildlife of utiizing logging slash and fire-killed timber for energy in Manitoba and Saskatchewan: A preliminary evaluation. August 1990. Appendix to November interim report; Reid, Collins and Associates.

Ondro, W.J. 1991. Economics of 15 options for industrial utilization of poplar. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-320.

Reid, Collins, and Associates. 1990. Economic feasibility of utilizing logging slash and fire-killed timber for energy: Saskatchewan and Manitoba. Interim Report Tasks 1, 2, and 3. ENFOR Project P-379. April.

Reid, Collins and Associates. 1990. Economic feasibility of utilizing logging slash and fire-killed timber for energy: Saskatchewan and Manitoba. Interim Report. ENFOR Project P-379. November.

Reid, Collins and Associates. 1991. Economic feasibility of utilizing logging slash and fire-killed timber for energy: Saskatchewan and Manitoba. Contract Report ENFOR P379 with Appendices volume. March 1991.

Reid, Collins and Silviba. 1990. Residual wood for energy and manufacture: New opportunities in Saskatchewan and Manitoba. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Pamphlet.

Silviba Services Ltd. 1991. Identification of domestic and commercial fuelwood usage in certain regions of Saskatchewan and Manitoba. Contract Report ENFOR P379-Extension 2. January.

Thomas Brook and Company. 1990. Survey report - Silviba Services. Interim report for Extension 2, Enfor project P-379. November.

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: 1978 Completion: 1997

17. Resources 1991-92:

PYs: Prof.: Edwards 0.1
Grewal 0.2

Tech.: 0.0

Total: 0.3

Term/Student:

O&M: Nil

Contracts & In-house R&D: $132,500 ENFOR funding
Management: $ 9,000 ENFOR funding

Total: $141,500 (from For Can ENFOR allocation from PERD funding)

18. Signatures:

Investigator

ENFOR Representative

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-28-07

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 18, 1991

1. Project: Wetlands and hydrology

2. Title: Boreal forest risk factor modelling

3. New: Cont.: Term.: X 4. No.: NOR-28-07

5. Study leader: T. Singh

6. Key words: Fire hazard, insect and disease infestations, risk factor modelling, timber supply, annual allowable cut, boreal forest.

7. Location of work: Edmonton laboratory, prairie provinces, N.W.T.

8. Problem:

Boreal forest is a major forest region of Canada and comprises approximately 82% of the forest land in the country. In Alberta, the boreal tree species are of vital importance in the production of sawlogs and pulpwood. Improved techniques to enable realistic projections of future timber supplies are needed in Alberta and other prairie provinces and Northwest Territories.

Prevailing climatic conditions of long, cold winters and short growing season are responsible for slow growth rates typical of the boreal tree species. Fires which frequently result in destruction of large areas comprising the future growing stock are a common occurrence. During the past two decades the forest area lost in Alberta due to fires averaged 0.5 % annually, which is considerable because of the long rotations under which the boreal forests are managed. During a rotation of 100 years, for example, about a half of Alberta's forest area can be expected to suffer fire losses if all stands were equally prone to fire hazards. In addition, there is mortality due to insect and disease infestations. All these risk factors can cause considerable errors in prediction and realization of annual allowable cut (AAC). These problems have not so far been objectively handled in resource allocation and management in the boreal forest, mainly because of a general lack of available tools for such predictions.

Long-term planning of forest management should be mainly based on expectation of return on investment and management efforts. The fire, insect, and disease risk losses must be

included in projected expectations as these are predictable for large areas within a given time frame. The objective assessment of these risk factors and uncertainties is a necessity for rational formulation of management and timber harvesting strategies in the boreal forest of western Canada.

Development of risk factor model for forest yield prediction will be based initially on Alberta data. The existing data on risk factors and growth and yield will be located and examined through necessary data screening, computer programming, and preliminary modelling procedures under the guidance of the Study Leader. Permanent sample plot data and the data collected by researchers at NoFC for their specific and related purposes will be accessed. Similarly, the historic data will be retrieved from provincial records on fire and insect and disease occurrences, and from the Canadian Climate Centre for climatic data. The data so examined will be used in expressing the various causative factors determined in the study.

Field collection of the most recent data would be useful a) to fill in data gaps and b) to validate the model and its components. The model will have potential for application in the boreal ecoregions in the remaining prairie provinces after necessary modification, validation, and testing. The study will need cooperation from interested project and study leaders at NoFC because of its multi-disciplinary nature. Inputs from growth and yield, fire, insect and disease, and forest resource groups will form an essential part of the study strategy. As the mathematical techniques for probability and risk analysis are basically similar in these disciplines, the study will provide a unifying link among them. There will also be an opportunity to cooperate with provincial agencies and forest industry to meet their requirements for realistic determination of future yields when subjected to the above-mentioned risk factors and uncertainties.

A total of five years is estimated to cover all stages of the study. These stages are:

1. **Initial stage**: a review of risk and uncertainty factors in growth and yield due to fire and insect and disease occurrences; collation and evaluation of data relating to such factors.

2. **Preliminary development stage**: preliminary attempts at development of a conceptual model dealing with risk factors relating to growth and yield.

3. **Intermediary stage**: implementation of model concepts and strategies to achieve parameter estimation, calibration, and AAC prediction.

4. **Refinement stage**: improvement and refinement of risk factor model and parameter estimates to enhance model capabilities, and a validation test on independently collected and most recent data in a different geographical location.

5. **Final stage**: finalizing risk factor model and its components for the boreal forest, and recommendations for its extension to disjunct outliers or ecoregions, including preparation of a manual for operational use and guidelines to prescribe management and timber harvesting strategies.

The three modelling methodologies to be used are: a) stochastic or probabilistic, b) deterministic, and c) dynamic modelling. This would enable a comparative assessment of the merits of the three approaches adopted in the study. Decision support models based on a combination of these approaches will be developed to deal with risk and uncertainty.

McLeod working circle in the leasehold of Champion Forest Products Ltd. was selected for the initial formulation and development of a risk model. Preliminary version of FOrestry RIsk Model (FORIM) based on fire risk and growth and yield data from this working circle is ready. For other risk factors, FORMAN model was selected and tested for impacts on AAC in the Footner Lake and the Peace River volume sampling regions in northern Alberta. This model is now being modified to extend its application to adjoining boreal ecoregions. Dynamic methodology based on a combination of the above-mentioned approaches is to be adopted for developing decision support models under risk and uncertainty.

9. Study Objectives:

1. To model the risk of fire at the stand and forest level to aid management decisions on the effect of such occurrences on allowable cut and future timber supplies.

2. To determine the frequency of large-scale insect and disease occurrences and derive a model to assess their effect on the present and future forest yields.

3. To test, review, and modify the fire, insect and disease, and climate change risk factor models to extend application over other boreal forest regions in western Canada.

10. Goals for 1990-91

1. Initiate development of climate-driven models for predicting boreal forest zonation and productivity under different climatic change scenarios (Singh, Wheaton, Thorpe).

2. Use preliminary results from Goal #1 and initiate modelling future timber supplies and AAC in western Canada under various climatic change risk scenarios (Singh, Van Kooten).

3. Publish a paper on the vulnerability of boreal forest to climatic warming (Singh, Wheaton).

4. Initiate draft of a paper on the FORMAN model for simulating the effects of infestation levels on volume losses.

5. Provide statistical advice to clients and colleagues in the ongoing programs of NoFC, represent Forestry Canada and NoFC on advisory committees and other groups, and participate in the planning and development of their activities.

Revised Goals (after S & T Funding):

1. Publish a paper on the vulnerability of boreal forest to climatic warming.

2. Initiate draft of a paper on the FORMAN model for simulating the effects of infestation levels on volume losses.

3. Provide statistical advice to clients and colleagues in the ongoing programs of NoFC, represent Forestry Canada and NoFC on advisory committees and other groups, and participate in the planning and development of their activities.

4. Validate Shugart's model for forest biomass estimates of the main boreal tree species in western Canada.

5. Initiate preparation of a chapter on "Risk analysis in forestry" for a book to be published by CRC Press, U.S.A.

Added Goals:

6. Present a paper on climate change and productivity at the Canada/U.S. Symposium on the Impacts of Climatic Change and Variability on the Great Plains, September 11-13, 1990 in Calgary, Alberta.

7. Prepare a submission for the Canadian Global Change Program, Terrestrial-Forest Ecosystems and Climatic Change.

8. Prepare a paper on the impact of climatic change on aspen productivity for Aspen Management Symposium to be held in Edmonton during November 20-21, 1990.

9. Prepare a PAIF proposal for Phase II of risk management strategies development program.

11. Accomplishments in 1990-91:

1. A paper entitled "Boreal forest sensitivity to global warming: Implications for forest industries in western interior Canada" was prepared, reviewed, and submitted to Forestry Chronicle.

2. An initial draft of a paper on FORMAN model and its modification to deal with risk and uncertainty in decision making was prepared. Further work on testing and finalizing the modifications is in progress.

3. Statistical advice was provided on an as needed basis to clients and colleagues in the ongoing programs of NoFC. Also represented Forestry Canada and NoFC on advisory committees and other groups, and participated in the planning and development of their activities.

4. Shugart's model was obtained and preliminary work done on identifying needed changes for use in the boreal forest of west-central Canada.

5. Initial draft of the chapter "Risk analysis in forestry" is ready for updating and incorporating additional information on climatic change as a risk.

6. Prepared and presented a paper entitled "Climate change and forest productivity" for the Canada/U.S. Symposium on the Impacts of Climatic Change and Variability on the Great Plains, held in Calgary.

7. Prepared submission for the Canadian Global Change Program, Action Plan.

8. A paper was prepared and presented at the Aspen Management Symposium.

9. A proposal entitled "Boreal forest improved strategies development program: risk management" was prepared for PAIF under the forest yield and improved management program.

12. Present Status:

The study has been terminated and the climate-related tasks have been incorporated into a new study (NOR-16-04)

13. Goals for 1991-92:

Nil, study terminated

14. Publications 1990-91:

Singh, T. 1990. Climate and productivity. Proc. Canada/U.S. Symposium on the Impacts of Climatic Change and Variability on the Great Plains. Calgary, Alberta.

Singh, T. 1990. Climatic warming risks to hydrologic environment. Alberta Climatological Assoc., Gen. Cir., Summer 1990, p. 5-6.

Singh, T. 1990. Soil temperature variations in the boreal forest clearcuts. Proc. of the 14th Ann. Gen. Meet., Alberta Climatological Assoc., Edmonton, Alberta.

Singh, T.; Wheaton, E. 1990. Terrestrial ecosystems and climatic change. Saskatchewan Research Council Publication E-2000-10-F-90.

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 of Project:

Started: 1987 Completion: 1991

17. Resources 1991-92:

Nil

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-28-08

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 28, 1991

1. Project: Wetlands and Hydrology

2. Title: Hydrologic modelling and technology transfer.

3. New: Cont: X No. 4: NOR-28-08 (Formerly NOR-13-01)

5. Study Leader: R. H. Swanson

6. Key Words: Hydrologic model, forest climate, soil water, water quality, GIS, WRENSS, WRNSHYD, HSPF.

7. Location of work: Alberta, Saskatchewan, Manitoba, Northwest Territories

8. Problem Definition:

This study was originally part of the Alberta Watershed Research Program which was intended to produce forest management options to maximize water yield from the Saskatchewan River's headwaters watershed. It was centred around the Marmot and Streeter experimental basin programs which have been terminated and the results published. Data from these and other research facilities have been incorporated into an IBM-PC program (WRNSHYD) for interactively evaluating the effect of existing or proposed forest practices on annual water yield.

The WRNSHYD program, which gives estimates of annual water yield changes resulting from silvicultural operations for rain- or snow-dominated forested watersheds, has been made available to forest managers in this region, and to the water resources community throughout Canada. However, there remains a continuing need for a more comprehensive model that could be used in a manner similar to the WRNSHYD program to estimate the effects of silvicultural operations on daily or on some occasions even hourly streamflow and water quality. The US Environmental Agency's HSPF model has the necessary characteristics, and we propose to make the it useable in a way similar to WRNSHYD, to provide reasonable estimates of the effects of forestry operations on the water levels and water chemical/biological quality in streams or rivers at critical periods, e.g. flood peaks from storms

or snowmelt, low flows to maintain fish populations in late summer, etc. Our ultimate goal is still to create an easy to use mainframe or microcomputer program that will interface the user, via a graphical information system (GIS) with the HSPF model and the climatic/hydrologic data necessary to use it, and make it available to industrial and/or consultant users via Technology Development Units at Forestry Canada centres across Canada.

9. Study Objectives:

   1. To design and test hydrologic simulation modelling tools that can be easily used to evaluate the effect of various land management practices on water yield, water quality, streamflow and near-surface groundwater. (Green plan)

   2. To assist in the evaluation of land management practices with respect to their impact on the aquatic environment of specific areas.

   3. To provide a decision support system to provincial and industrial forest managers for their use in evaluating the influence of various existing and proposed land management practices on local and regional surface and near-surface groundwater hydrology. (Green plan)

10. Goals for 1990-91:

    See NOR-13-01

11. Accomplishments 1990-91:

    See NOR-13-01

12. Present Status of Study:

    See NOR-13-01 for current status.

13. Goals for 1991-92:

    1. Publications:

       a. Submit for review a journal article on the WRENSS procedure for estimating annual water yield change from forested watersheds in both rain and snow dominated hydrologic regions of Canada. (Swanson)

       b. Prepare a "users manual" for the WRNSHYD program (instead of a reissue of Forest Management Note No. 37, "A programmed procedure for evaluating the effect of forest management on water yield"). Send users manual and updated WRNSHYD program diskette to all registered users (currently 102). (Swanson)

       c. Prepare paper on "A modeled assessment of the effect of small-patch clearcuts on water yield and regime at Twin subbasin, Marmot Creek, Alberta." (Swanson)

    2. Research activities:

a. Complete evaluation of the Marmot (Twin subbasin) honeycomb harvest pattern using the HSPF model. (Swanson)

b. Continue development of PC program to write HSPF control files. Test and use this program to write control files for modelling stream water quantity and quality in the Peace - Athabasca FMA assessment. (Term programmer, Swanson - Green plan)

3. Technology transfer:

a. Conduct a modeled assessment (using WRNSHYD and HSPF) of the cumulative effects of the past, current and proposed forest harvesting in the Peace-Athabasca river system on water quantity, regime and quality as related to water supply, flood potential, and impact on downstream or instream water users. (Swanson, Fisera, Term programmer - Green plan)

b. Continue to assist in the use of WRENSS and HSPF on *ad hoc* basis. (Swanson)

4. Interaction with outside agencies and NoFC staff:

a. Continue to serve as member of the Executive Committee of the Western Snow Conference. Attend annual meeting enroute to and in Juneau, Alaska, April 11-15, 1991. (Swanson)

b. Continue to supply Marmot data in machine readable form on an ad hoc basis. (Swanson, Hurdle)

c. Continue to work with USFS officials to implement the WRNSHYD program on their Data General database. (Swanson, Term programmer)

d. Continue as associate editor, Canadian Journal of Forest Research. (Swanson)

e. Assist Kurth Perttu, Upsalla, Sweden, to incorporate Scandinavian climatic conditions into WRNSHYD. Potential one-week trip to Sweden (at their expense) in 1991. (Swanson)

f. Continue as member of Canada GEWEX planning committee. (Swanson)

g. Carry out functions as Chairman, IUFRO Subject Group S1.03-00 "Environmental Influences". (Swanson)

h. Prepare and present paper on "Forest harvesting influences on on-site and off-site water resources" for Flowing to the Future Rivers Conference, April 25-28, 1991. (Swanson)

i. Conduct survey to ascertain rate of regrowth under various site preparation methods on clearcuts of various dimensions, ages and topographical orientation on various aspects, elevations, slope and ecological classification for improving the accuracy of WRNSHYD for estimating water yield through a rotation. (Bergstrom

accuracy of WRNSHYD for estimating water yield through a rotation. (Bergstrom [FLUB-AFS], Fisera, student assistant)

j. Conduct poll of technical staff in NoFC to ascertain interest in working with Hurdle to develop instrumentation and data handling skills with the goal of becoming an alternate source of such expertise. (Hurdle, Program Directors)

14. Publications 1990-91:

See NOR-13-01

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: 1991 Estimated completion: 1998 (FMA assessment 1993)
(HSPF/DSS - 1998)

17. Resources

PY's:	Prof:	Swanson	0.4
	Tech:	Hurdle	0.2
	Total		0.6
	Term/Student:		0.5 (? Green Plan)

O&M: $2000 ($6,000 Green Plan?)

Capital: ($18,000 Green plan?)

18. Signatures:

Investigator

Program Director, Protection & Environment

Regional Director General

NOR-33-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 15, 1991

1. Project: Technology Transfer and Communications

2. Title: Scientific and technical editing and publishing

3. New: Cont.: X 4. No.: NOR-33-01

5. Study Leader: B.L. Laishley

6. Key Words: Editing, publishing, printing, information reports, journal articles, scientists, resource managers, industrial managers

7. Location of Work: Northwest Region

8. Problem:

There is a need for the Northern Forestry Centre to ensure that regional clients (forest resource and industrial managers, scientific community, and educational community) are adequately informed of the results of research and development programs in a relevant and timely manner and at a reasonable cost.

9. Study Objectives:

1. Edit, publish, and distribute scientific, technical, and other publications of the Northern Forestry Centre and its two district offices.

10. Goals for 1990-91:

1. Assist the research staff, through the provision of editing and publishing services, in the preparation and publication of approximately:

a) 12 Information Reports
b) 10 Forest Management Notes
c) 27 Pest Leaflets (revisions and reprinting)
d) 50 Journal articles and miscellaneous publications.

2. Prepare and publish the Program Review 1988-90 of the Northern Forestry Centre.

3. Oversee production and printing or reprinting of locally published scientific and technical information.

4. Continue responsibility for the distribution of scientific and technical publications, by maintaining a mailing list, responding to requests for scientific and technical information, and carrying out the necessary correspondence.

5. Analyze the survey of mailing list subscribers to evaluate by which media they prefer to receive scientific and technical information (publications, audiovisuals, conferences, computer disks, etc.).

6. Provide editorial, typographical, and printing assistance for public information activities.
7. Publish an updated NoFC bibliography for 1987-89 publications as an Information Report.

8. Order new desk-top publishing equipment and software, arrange for training, and implement new procedures and guidelines.

9. Serve on in-house, regional, and national working/advisory committees, as required, including chairing a regional publications review committee to recommend publications options in terms of content, review procedures, formats, technology requirements, distribution, and costs.

Added Goal:

10. Edit and publish Northwest Region Strategic Plan, "Toward the 21st century forest: the Northwest Region's Strategic Plan, 1990-95", and accompanying bilingual brochure for public distribution.

11. Accomplishments in 1990-91:

1. Assisted the research staff, through the provision of editing and publishing services in the preparation and publication of
   a) 3 Information Reports (+ 3 in press)
   b) 3 Forest Management Notes
   c) 37 Journal and miscellaneous publications (+ 2 in press)
   d) 26 Proceedings and symposium articles

   Assisted the research staff, through the provision of revising and editing services in preparation to publish 13 Pest Leaflets.

2. Program Reviews have been discontinued (subsequent to a discussion to do so reached at the Forestry Canada Editors meeting in Victoria, May 1990). Subseuqently ratified by Departmental Publishing Committee.

3. Oversaw the production and printing or reprinting of locally published scientific and technical information.

4. Continued to distribute scientific and technical publications, respond to requests for scientific and technical information, maintain a mailing list, and carry out the necessary correspondence. A major update of the mailing list was carried out in conjunction with Regional Development.

5. Tabulated results of the survey of mailing list subscribers and results were distributed to management and incorporated into Regional Communications plan.

6. Provided editorial, typographical, graphic and printing assistance for public information activities.

7. Did not meet objective to publish an updated NoFC bibliography for 1987-89 publications as an Information Report. (See #5, Goals for 1991-92)

8. Received new desk top publishing equipment and software on Oct. 10, 1990. Initiated basic training for graphic artist and typesetter/wordprocessor. Implemented new procedures and guidelines pertaining to system management and operations.

9. J. Samoil served on in-house, regional and national working/advisory committees. She chaired a regional publications review committee, and recommended publications options in terms of content, review procedures, formats, technology requirements, distribution and costs. She completed revised regional publication procedures which were distributed to all staff and management for immediate implementation.

10. Edited and published Northwest Region Strategic Plan, "Toward the 21st century forest: the Northwest Region's Strategic Plan, 1990-95", and accompanying bilingual brochure for public distribution.

12. Present Status of Study:

Since 1970, 320 Information Reports, 50 Forest Management Notes, 33 Forestry Reports, and 792 journal and symposium articles and miscellaneous publications have been edited and produced.

13. Goals for 1991-92:

1. Assist the research staff, through the provision of editing and publishing services, in the preparation and publication of approximately:
   a) 15 Information Reports
   b) 10 Forest Management Notes
   c) 13 Pest Leaflets (revisions and reprinting)
   d) 50 Journal articles and miscellaneous publications
   e) 1 Special report
   f) 10 Conference proceedings.

   Provide editorial, typographical, and printing assistance for public information activities.

   Oversee production and printing or reprinting of locally published scientific and technical information.

2. Continue responsibility for the distribution of scientific and technical publications, by maintaining a mailing list, responding to requests for scientific and technical information, and carrying out the necessary correspondence. Enroll D. Leroy (Distribution Clerk) in WordPerfect training.

3. Publish an updated NoFC bibliography for 1987-90 publications as an Inforamtion Report.

4. Supervise indeterminate and term employees. Provide leadership, coordination, work assignment, priority assessment & training. Arrange for more training on new desk top publishing equipment for E. Schiewe and D. Lee.

5. Take inventory, organize, and catalogue all of NoFC publication stored materials (i.e., negatives for all Information Reports, Forest Management Notes, and miscellaneous publications, etc.).

14. Publications 1990-91:

Alexander, M.E.; Andrews, P.L. 1989. Wildland fire occurrence and behavior analysis in the year 2000 and beyond. Fire Manage. Notes 50(4):35-37.

Alexander, M.E.; Bisgrove, G.F., technical coordinators. 1990. The art and science of fire management. Proc. First Inter. West Fire Counc. Annu. Meet. and Workshop, October 24-27, 1988, Kananaskis Village, Alberta. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-309.

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Brace, L.G. 1990. A test of three logging systems in Alberta. Can. For. Ind. 110(8):24-29.

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Chrosciewicz, Z. 1990. Site conditions for jack pine seeding. For. Chron. 66(6):579-584.

Chrosciewicz, Z. 1990. Post-cut burning and black spruce regeneration. Pages 35-44 *in* B.D. Titus, M.B. Lavigne, P.F. Newton, and W.J. Meades, editors. The silvics and ecology of boreal spruces. Proc. 1989 IUFRO Working Party SI.05-12 Symp., August 12-17, 1989, St. Johns, Newfoundland. For. Can., Nfld. For. Cent., St. Johns, Newfoundland. Inf. Rep. N-X-271.

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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: 1970 Completion: Continuing

17. Resources 1991-92:

PYs:	Prof.:	Laishley	1.0
		Mason	1.0
	Support:	Schiewe	1.0
		Graphic Artist	1.0
	Total:		4.0
	Term/Student:	Distribution Clerk:	1.0

O&M: $87,000

Capital:

18: Signatures:

Investigator

Regional Manager, Technology Transfer & Communications

Regional Director General

NOR-33-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 12, 1991

1. Project: Technology Transfer and Communications

2. Title: Technology transfer and extension services

3. New: Cont.: X 4. No.: NOR-33-02

5. Study Leader: R.G. Newstead

6. Key Words: Technology transfer, forestry extension, innovations, research application

7. Location of Work: Northwest Region

8. Problem:

At NoFC, technology transfer has been conducted largely on an "ad hoc" basis and has generally been effective in encouraging the implementation of research results. Scientific information dissemination has been achieved primarily by traditional publication of research findings, but the more significant achievements have been the result of personal involvement and commitment to implementation on the part of research and technical personnel.

The technology transfer process must encourage the use of planned adoption and innovation procedures. This approach will result in improved estimates of costs involved and benefits accrued and will enable senior management to better estimate time, money, and human resource requirements. This process will also encourage full "user" or "client" participation in any given undertaking. Communication means, methods, and media can be identified and planned and budgeted beforehand. In addition, forthright evaluation can be undertaken in comparison with anticipated goals.

9. Study Objectives:

1. Co-ordinate and promote the planning and delivery of an effective regional technology transfer and extension forestry program.

2. Co-ordinate the development and integration of all information and communications activities of Forestry Canada in the prairie provinces and the Northwest Territories.

10. Goals for 1990-91:

1. Provide project leadership and coordination of technology transfer, communications, and other information services and activities within Northwest Region including public information, public relations, scientific and technical editing and publishing, extension services, library and photographic services. (R.N.)

2. Serve on in-house, regional, national and NGO working/advisory committees as required. (R.N.)

3. Participate as required in the negotiation and signing of regional federal-provincial forestry agreements and develop the necessary communications plans required to deliver these agreements. (R.N.).

4. Present findings of retrospective analysis of NoFC research and development accomplishments (1977-86) to NoFC staff and coauthor final report submitted to Canadian Journal of Research Evaluation for publication. (R.N.)

5. Implement or participate in the planning and implementation of up to three specific NoFC technology transfer endeavors in accordance with technology transfer guidelines established in 1988/89. (R.N.)

6. Attend semi-annual meeting of Federal Laboratory Consortium for Technology Transfer. (R.N.)

7. Maintain liaison with the Chinese Academy of Forestry in Harbin, P.R.C. and assess opportunities to engage in a twinning arrangement between NoFC and the CAF. (R.N.)

8. Continue development of a photographic records system and library including acquisition and duplication of general purpose forestry information slides and photos. (H.S.)

9. Develop and implement NoFC public exhibition schedule to include major regional exhibitions, National Forest Week events, Information fairs, and other invitational events. (H.S.)

10. Co-ordinate and provide tours and other extension services to schools, youth groups and other publics visiting NoFC. (H.S.)

11. Maintain inventory control, stock supplies, re-order schedules etc. for all NoFC Public Information materials, exhibition materials and supplies as required to present and distribute same to public audiences. (H.S.)

11. Accomplishments in 1990-91:

1. Coordinated activities of technology transfer and information project staff within NoFC, including pubic information, public relations, scientific and technical editing and publishing, extension services, library, and photographic services.

Additional activities during the study year included:

- completed three staffing actions to replace Regional Communications Officer, Head-Publications Section, and Scientific Editor

- completed training courses on "Conducting Effective Business Meetings" and "The Profitable Manager II" (PERFORM)

- assisted authors in the development and editing of 3 issues of "Technology Transfer Notes" and 3 issues of "Manitoba Forestry Demonstrations Areas" inserts

- participated in semi-annual meetings of Regional Communications Managers

- coordinated the preparation and submission of annual regional communications strategies and operational plans

- participated in the development of the Northwest Regional 5-year Strategic Plan and accompanying information brochure

- represented NoFC in all phases of planning National Forest Week events under the auspices of the Alberta Forestry Association and participated in opening ceremonies at the Provincial Forestry Capital - Peach River

- cooperated with Alberta Forest Service and Alberta Career Development in the production of a forestry careers information folder and brochures. Reviewed the Ontario "Focus on Forests" junior and senior school curriculum packages for application in an Alberta pilot program.

2. Served on in-house, regional, and NGO Committees as follows: (R.N.)

   - NoFC Computer users committee
   - NoFC Management Committee
   - National Forest Week organizing committee
   - CIF Rocky Mountain Section member
   - Alberta Forestry Association Education Committee
   - Alberta Registered Professional Foresters Assoc Communications Committee

3. Acted as Forestry Canada regional representative in the negotiation and development of 5-year communications strategies under the proposed Canada-Manitoba and Canada-Saskatchewan Partnership Agreements in Forestry. (R.N.)

4. The opportunity to present findings of a retrospective analysis of NoFC research and development accomplishments to scientific and technical staff did not arise. A revised manuscript of the study has been accepted for publication in the Canadian Journal of Research Evaluation. (R.N.)

5. Neither time nor opportunity enabled planning or implementation of specific NoFC technology transfer endeavours. Assistance was provided to the Regional Director General with respect to promotion and presentation of the inaugural "Alberta Forestry Innovation Award" and announcement of the 1991 competition. (R.N.)

6. Attended the fall meeting of the Federal Laboratory Consortium for Technology Transfer in New Orleans and re-established network contacts and technology searching mechanisms. (R.N.)

7. By invitation of the Heilongjiang Academy of Forestry Sciences travelled to northern China to present a series of lectures on forest fire management in western Canada. Re-established dialogue with the HAFS regarding a revised working relationship between NoFC and that institute. All expenses to, from, and within China were covered by the HAFS. (R.N.)

8. Maintained the photographic records system and library including the duplications of general purpose forestry information slides, photos, and video tapes. (H.S.)

9. Developed and implemented and assisted District Office personnel with annual public information exhibits at major regional exhibitions including Red River Exhibition, Klondike Days, and other invitational events including the Edmonton Sportsman's Show, the Prince George Forestry Show, Edmonton Clean Air Day, Lethbridge Ag. Expo, Second Alberta International Forestry Show, Edmonton, National Forest Week, Forestry Centre of Alberta exhibit at Peace River, AFPA annual meeting at Jasper Park Lodge and Alberta Science Teacher's Conf.. Region-wide, NoFC and District Office personnel contacted 92,000 members of the general and other targeted publics and distributed more than 50,000 pieces of literature in the process. (H.S.)

10. Coordinated or provided responses to public inquiries, requests for lab tours, presentations and the like. Acted as regional distribution centre for AFA "Forever a Tree" tree planting program. Distributed 2500 tree seedlings to Edmonton school groups, Girl Guides and Boy Scout troops for outplanting. Contracted for the private production of 20,000 Colorado blue spruce and produced 5500 in-house for public distribution at fairs and exhibits. Tours of the Centre were provided to Alberta Vocational Centre students, Junior Forest Wardens, Girl Guides, various groups of elementary school students and N.A.I.T. students. Several in-school presentations were provided to Edmonton and area schools. (H.S.)

11. Maintained stocking and control of NoFC inventory of public information and extension literature, exhibition materials and supplies and ordered replenishment or new supplies as required. Packaged and shipped or mailed information/education materials as required in response to public, institutional, or ForCan District Office requests. (H.S.)

12. Present Status:

Initiated in 1984 as an aggregate study (technology transfer, extension services, public information, library services and photographic services) at the time of Project establishment. In 1987-88 desegregation of study activities ensued such that technology transfer and extension services became a distinct study. Increasing emphasis is being given to communications planning and management. Project leader is a member of NoFC Management Committee. In 1990-91 responsibility for administration of regional library services was transferred to the Forestry Development Directorate.

13. Goals for 1991-92:

1. Provide project leadership and coordination of technology transfer, communications, and other information services and activities within Northwest Region including public information, public relations, scientific and technical editing and publishing, extension services and photographic services. (R.N.)

2. Serve on in-house, regional, national and NGO working/advisory committees as required. (R.N.)

3. Participate as required in the negotiation and signing of regional federal-provincial forestry agreements and implement the necessary communications plans required to deliver these agreements. Serve as Canada-Alberta PAIF Communications sub-committee co-chairman. (R.N.).

4. Attend semi-annual meeting of Federal Laboratory Consortium for Technology Transfer. (R.N.)

5. Maintain liaison with the Heilongjiang Academy of Forestry Sciences (HAFS) in Harbin, P.R.C. and implement opportunities to engage in a twinning arrangement between NoFC and the HAFS. (R.N.)

6. Continue development of a photographic records system and library including acquisition and duplication of general purpose forestry information slides and photos. (H.S.)

7. Develop and implement NoFC public exhibition schedule to include major regional exhibitions, National Forest Week events, Information fairs, and other invitational events. (H.S.)

8. Co-ordinate and provide tours and other extension services to schools, youth groups and other publics visiting NoFC. (H.S.)

9. Maintain inventory control, stock supplies, re-order schedules etc. for all NoFC Public Information materials, exhibition materials and supplies as required to present and distribute same to public audiences. (H.S.)

10. Partipate as required in the development and implementation of Departmental Communications initiatives, and the like, that stem from such national program activities as the Green Plan, BOREAS Project etc. (R.N.)

14. Publications 1990-91:

Moore, W.; Newstead, R.G. 1991. Evaluation of Research and Development Accomplishments - Northern Forestry Centre. Canadian Journal of Research Evaluation. Vol. 6, No. 2. (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 study activities are not potentially detrimental to the environment.

16. Duration:

Started: 1984 Completion: continuing

17. Resources 1991-92:

PYs:	Prof.:	Newstead	1.0
	Tech.:	Stewart,H.	1.0
	Total:		2.0
	Student:		

O & M: $20,000
Capital: Nil

18. Signatures:

Investigator

Regional Director General

NOR-33-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 12, 1991

1. Project: Technology Transfer and Communications

2. Title: Communications

3. New: Cont.: X 4. No.: NOR-33-04

5. Study Leader: J. Samoil

6. Key Words: Communications, public relations, media relations, public information, photography

7. Location of Work: Northwest Region

8. Problem:

Awareness of Forestry Canada activities and programs in the Northwest Region by client agencies is high, accomplished largely through advisory and technology transfer mechanisms. Opportunities for targeted contact with other audiences remain, keeping financial and personnel constraints under consideration.

9. Study Objectives:

1. Create increased public awareness and understanding of Forestry Canada and Northwest Region initiatives in the forestry sector, and inform target audiences of the benefits of the forest resource both to people in our region and Canadians as a whole.

2. Enhance internal Forestry Canada and Northwest Region communications opportunities to exchange information, solicit feedback, and identify and act upon concerns or issues warranting attention.

3. Provide a range of public and media relations services.

4. Provide a full range of photographic support services to NoFC personnel.

10. Goals for 1990-91:

1. Develop and implement a comprehensive 1990-91 Operational Communications Plan for the region, in consideration of the departmental communications strategy covering the same period.

2. Continue coordination of general information services and activities on a regional basis, including translation, public information, public relations, media relations, media training and coordination, and internal communications (including issues management involving headquarters).

3. Prepare and publish on a regular basis NoFC quarterly Timberlines and internal newsletter Inside Information.

4. Update and print NoFC brochure in French and English.

5. Update and print NoFC "Contacts" summary in French and English or bilingual format.

6. Provide photographic and advisory services to NoFC research and development projects including processing, printing, slide duplication, photo enlargement/reduction, specialized photo layouts, and/or monitor the performance of contract services for same.

Added Goals:

7. Prepare and publish a brochure summarizing the regional strategic plan and develop and implement a special release strategy for the plan and brochure.

8. Develop and submit to Headquarters a regional strategic communications plan and a regional advertising plan.

9. Participate on selection boards for two district office communications officers and the Head of Publications.

11. Accomplishments in 1990-91:

1. Developed and implemented a comprehensive 1990-91 Operational Communications Plan for the region, in consideration of the departmental communications strategy covering the same period.

2. Coordinated general information services and activities on a regional basis, including translation, public information, public relations, media relations, media training and coordination, and internal communications (including issues management involving headquarters).

3. Prepared and published on a regular basis NoFC quarterly Timberlines and internal newsletter Inside Information.

4. Updated and printed NoFC brochure in French and English.

5. Updated and printed NoFC "Contacts" summary in French and English or bilingual format.

6. Provided photographic and advisory services to NoFC research and development projects including processing, printing, slide duplication, photo enlargement/reduction, specialized photo layouts, and/or monitor the performance of contract services for same.

7. Prepared and published a brochure summarizing the regional strategic plan and developed and implemented a special release strategy for the plan and brochure.

8. Developed and submitted to Headquarters a regional strategic communications plan and a regional advertising plan.

9. Participated on selection boards that resulted in the hiring of two district communications officers and the Head of Publications.

12. Present Status of Study:

Regional surveys of clients in 1990 showed strong support for ongoing activities but also pointed out new directions. A telephone survey of representatives of the region's primary client groups in January 1990 indicated that they had a fairly good knowledge about Forestry Canada, Northwest Region's role. There was, however, a desire for more information about current and future research activities plus more personal contact with Forestry Canada staff. The need for greater emphasis on interim research results, shorter and more applications-oriented publications, and personal contact was reiterated in the results of a questionnaire sent to the scientific and technical publications mailing list also in 1990.

As a result of these surveys, an operational communications plan was developed that outlined activities directed to both external and internal audiences. Delivery of these communications goals depends on action by staff throughout the region and is not restricted to the Technology Transfer and Communications personnel. Implementation of some activities has been delayed because of staff changes within the project.

Several unknowns are expected to impact significantly on the Communications' study's activities over the next year. Forestry Canada's role in the Green Plan has yet to be finalized in terms of available resources. Partnership agreements are being negotiated with the region's three provincial governments and one territory, so details of communications activities have yet to be determined. The impact of program shifts and reorganization of projects will be felt in the upcoming year and may require additional internal communications activities.

13. Goals for 1991-92:

1. Prepare, implement, monitor, and assess regional communications plans such as the strategic communications plan, the advertising plan, and the operational communications plan.

2. Coordinate general information services and activities on a regional basis, including French translation, public information, public relations, media relations, media training and coordination, and internal communications (including issues management involving Headquarters).

3. Prepare and publish on a regular basis the monthly Inside Information newsletter and the quarterly Timberlines magazine, including a special program preview insert to appear in the April 1991 issue.

4. Update and print the Northwest Region's Contacts brochure in English and French.

5. Act as regional coordinator of communications activities under the Saskatchewan and Manitoba forestry partnership agreements, including signing ceremonies and attendant media activities, in conjunction with the district office communications officers; act as regional coordinator of communications activities for national programs such as Green Plan.

6. Conduct a feasibility study into the possibility of adapting the Northwest Region's pest leaflets into a national series of leaflets, soliciting responses from other Forestry Canada regions and Headquarters and preparing a proposal and action plan.

7. Update the Northwest Region's slide-tape presentation.

8. Act as chairperson of Forestry Canada's publications strategic planning committee.

14. Publications 1990-91:

Ascher, A.A. 1990. Contacts '90. For. Can., Northwest Reg., Edmonton, Alberta. Brochure.

Ascher, A.A. 1990. Forestry Canada, Northwest Region. For. Can., Northwest Reg., Edmonton, Alberta. Brochure.

Ascher, A.A., editor. 1989 and 1990. Inside Information. Monthly, December 1989 to August 1990. For. Can., Northwest Reg., Edmonton, Alberta.

Ascher, A.A., editor. 1990. Timberlines. Nos. 11, 12, and 13. For. Can., Northwest Reg., Edmonton, Alberta.

Ascher, A.A. 1990. Toward the 21st century forest. For. Can., Northwest Reg., Edmonton, Alberta.

Samoil, J.K., editor. 1990 and 1991. Inside Information. Monthly, September 1990 to March 1991. For. Can., Northwest Reg., Edmonton, Alberta.

Samoil, J.K., editor. 1991. Timberlines. For. Can., Northwest Reg., Edmonton, Alberta.

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 study activities are not potentially detrimental to the environment.

16. Duration:

Start: 1987 Completion: Ongoing

17. Resources 1991-92:

PYs: Prof: Samoil 1.0

Total: 1.0

O&M: $15,000

Capital: Nil

18. Signatures:

J Samoil
Investigator

A. R Lint
Regional Director General

NOR-36-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 13, 1991

1. Project: Regional Devleopment

2. Title: Canada-Manitoba Partnership Agreement in Forestry and District Office

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

5. Study Leader: J. McQueen

6. Key Words: Forest renewal,intensive management, resource data base, fire management, fire protection, nursery management, public information, agreement, administration, evaluation, job creation, economic development

7. Location of work: Manitoba District Office, Winnipeg and Manitoba wide

8. Study Objectives:

   1. To manage and coordinate the implementation of federally-funded initiatives and monitor the use of federal funds related to the Canada-Manitoba Partnership Agreement in Forestry by:

      a) assisting in the development and maintenance of timber supplies sufficient to ensure the long term viability of the forest industry in Manitoba;

      b) promoting the efficient utilization of the forest resource in Manitoba; and

      c) contributing to the economic development of the Manitoba forestry sector including the improvement of employment opportunities in the sector.

      d) assessing Forestry Canada and Manitoba Natural Resources forestry related needs.

   2. To provide regional liaison for all ForCan activities occurring within the Province of Manitoba.

   3. To coordinate the implementation of sectoral forestry employment stimulation programs in Manitoba.

4. To facilitate the maximization of funding available to the Forestry sector in Manitoba from other federal agencies.

5. To represent Forestry Canada in matters related to federal and provincial governments, industry and the general public.

9. Goals for 1990-91:

The following represents district goals for 1990-91. The responsibilities will be carried out by the most appropriate individual or individuals.

1. Facilitate the administration and delivery of all Forestry Canada research and technology transfer programs in Manitoba and represent the department in areas that relate to Forestry Canada activities in Manitoba.

2. Participate in the negotiation of federal-provincial forestry agreements, MOAs with other federal departments and agencies, MOUs with Indian Bands and other cooperative ventures.

3. Ensure the implementation of mechanisms and systems to implement agreements, MOAs, MOUs and other cooperative ventures including policies and procedures, standards and data systems to satisfy local, regional and national requirements.

4. Maintain regular contact with representatives of WDO, INAC, CEIC, Environment Canada, MFA, Repap, Abitibi-Price and other agencies sharing mutual interests with Forestry Canada in Manitoba with an increased emphasis being placed on the first four agencies.

5. Maintain bi-weekly contact with Senior Managers at NoFC through personal visits, E-mail or telephone conversations to ensure cooperation, information sharing and understanding of issues and concerns impacting on Forestry Canada operations in Manitoba.

6. Represent Forestry Canada as requested on committees of senior officials.

7. Manage the financial and human resources of the Manitoba office in cooperation with NoFC Management Committee.

Fire Management:

8. Continue to provide technology transfer services to the provincial fire management agency.

9. Complete reports including: "A Chronological Overview of the 1989 Fire Season in Manitoba, Canada" for possible publication in the Forestry Chronicle; a report on fire weather and fire behaviour of the 1989 fire season in Manitoba, and; a report on 20 year fire occurrence averages for Manitoba.

Tree Improvement:

10. Provide technological advancement and training to clients.

11. Prepare three Forest Management Demonstration Notes.

Silviculture Research and Technology Transfer:

12. To prepare an establishment report on the stock-site trials at Pine Falls.

13. To organize data entry of Red Earth SK study.

14. To compile and analyse 10 and 15 year field performance data of container and bare-root research at Candle Lake, SK.

Insect and Disease Surveys:

15. To conduct insect and disease surveys as required within the Province.

Forest Renewal and Intensive Management:

16. Assist native bands with forest management programs on reserve lands.

17. Assist forest industry with renewal and intensive management programing.

18. Select and remeasure field plots for use as demonstration areas in Manitoba.

10. Accomplishments in 1990-91:

1. No forest renewal agreement was signed until the end of fiscal year 1990/91. As a result, activities, during the fiscal year, were at a much lower level than anticipated. Several projects however continued or were completed. All activities were of the type where relatively little out of pocket expenses were incurred. Industry helped defray expenses in one case.

2. Negotiations for a new Canada-Manitoba Partnership Agreement in Forestry continued through the year. Late in the fiscal year the official agreement signing occurred. The agreement requires the Government of Canada and the Government of Manitoba, each to provide $15,000,000 towards the completion of a variety of projects in the area of forest research, technology transfer, public information and forest renewal.

3. Development of programs such as the native land program, MOU discussions, standardization of data requirements occurred during the year. With a new agreement in place it will be possible to carry out the intent of these activities.

4. Regular contact was maintained with various groups such as industry, WDO, the provincial forestry branch and other government departments during policy discussions and during the negotiations for a new agreement.

5. Significant contact was maintained with various senior managers at the Northern Forestry Centre. While there were a variety of reasons for this contact, the most significant reason during the past year involved the development of projects for the new Canada-Manitoba Partnership Agreement in Forestry.

6. Forestry Canada was represented by Manitoba staff on a variety of committees. The most significant activities during the year related to Green Plan, EARP and the Manitoba Forest Research Advisory Council. Inspite of low funding, the public information program was maintained at a significant level. It is estimated that 50,000 contacts were made through our attendance at fairs and exhibitions. Significant volumes of material were supplied to varius schools through out the province.

7. The small budget of $85,000 on the one hand was relatively easy to manage, on the other hand the low level of funding required a significant evaluation of different projects to determine which projects could be financed. Priority was usually given to activities which were high in Forestry Canada involvement and low in out-of-pocket expenditures.

Fire Management

8. K. Hirsch returned to Forestry Canada after his secondment to the province and continued with his technology transfer activities.

9. K. Hirsch transferred to a fire research position at NoFC in August and continued his report writing activities in that position.

Tree Improvement

10. A. Nanka participated in a nursery design excercise with staff of Weyerhaeuser paper company at Prince Albert. The firm paid for all out-of-pocket expenses. Significant time was also spent with Manitoba staff conducting tree improvement studies.

11. Priorities were changed and no Forest Management Demonstration notes were prepared. Reports on the design and layout of tree improvement seed orchards are in the final stages of completion.

Silviculture Research and Technology Transfer

12. The Abitibi stock trial report will be available in early May of 1991.

13. The data entry for the Red Earth Saskatchewan project was completed and turned over to the Saskatchewan District Office.

14. Candle Lake data on 10 and 15 year field performance has been partially compiled. No report will be produced in this fiscal year.

Insect and Disease

15. The traditional insect and disease surveys were conducted within the province. This was likely the only project that did not suffer from funding cuts. In addition, surveys were completed for acid rain and permanent sample plots were monitored in a cooperative effort with the province.

Forest Renewal and Intensive Management

16. One forest inventory survey was completed on the Fort Alexander Indian Reserve adjacent to Pine Falls. Initial discussions have been held with the Swampy Cree Tribal Council who strongly support the concept of a forest inventory and forest management plan for their areas of jurisdiction. Other bands have expressed an interest as well.

17. The 16,000 tree Abitibi stock trial continued on the Bear River Road, on the Trans-licence road and on Highway 304. With no forest renewal agreement in place, no reforestation activities of any kind occurred.

18. Two stand demonstration notes were produced and two more were at the printers at the end of the fiscal year. Two more sites have been measured and reports will be produced in the next fiscal year. The cost of maintaining and upgrading the Stand Demonstration books has proven to be a time consuming task. It is planned to produce a less expensive manual covering the completed projects and to discontinue the concept of up-grading a three ring text book.

11. Goals for 1991-92:

1. Facilitate the administration and delivery of all Forestry Canada research and technology transfer programs in Manitoba. and represent the department in areas that relate to Forestry Canada activities in Manitoba.

2. Deliver the recently signed Canada-Manitoba Partnership Agreement in Forestry under the three major headings:

Program A: Reforestation and Wood Supply Enhancement

Management of federal crown lands; Private land forests; Wood supply enhancement

Major goals in this area are to 1) obtain staff for the latter two programs, 2) complete forest inventory on 10 reserves, 3) hold the inaugural meeting of a provincial woodlot association and 4) deliver the various projects approved for Program A.

Program B: Applied Research, Marketing and Tech. Transfer

Technology transfer; Forestry research and development; Integrated resource management planning; Forest resource data

Major goals in this area are to 1) obtain the computer oriented forestry staff required to implement the various research and technology transfer programs, most of which appear to be computer oriented, 2) create a program which would bring all forest user groups to the same table and develop scenarios which would accommodate the needs of various groups and 3) deliver the various projects approved for Program B.

Program c: Public Information, Education and Agreement Support

Public Information and education; Administration, monitoring and agreement support

Major goals in this area are to 1) obtain the computer-GIS hardware necessary to support the research and development programs in fire and silviculture, 2) continue with the existing public contact program, 3) begin discussions with the province and the education system on the development and implementation of the "Focus on Forests" program and 4) deliver the various projects approved for Program C.

3. Ensure the implementation of mechanisms and systems to implement agreements, MOAs, MOUs and other cooperative ventures including policies and procedures, standards and data systems to satisfy local, regional and national requirements.

4. Maintain regular contact with representatives of WDO, INAC, CEIC, Environment Canada, MFA, Repap, Abitibi and other agencies sharing mutual interests with Forestry Canada in Manitoba.

5. Maintain bi-weekly contact with Senior Manager at NoFC through personal visits, E-mail or telephone conversations to ensure cooperation, information sharing and understanding of issues and concerns impacting on Forestry Canada operations in Manitoba.

6. Represent Forestry Canada as requested on committees of senior officials.

7. Manage the financial and human resources of the Manitoba office in cooperation with the Northern Forestry Centre management committee.

12. Publications 1990-91:

Ball, J. Regenerating cut-over rock-ridge sites by seeding and planting conifers on bladed strips, East Central Manitoba.

Ball, J.; Dyck, J. Pine Falls stock site trials. Forestry Canada-Abitibi-Price Inc.

Cataldo, N. Release of white spruce from aspen aerial application of 2,4-D herbicide. Forest Management Demonstration Notes No.15

Grandmaison, M. Forest insect and disease conditions in Manitoba in 1990.

Kolabinski, V. Effects of cutting method and seedbed treatment on black spruce regeneration in Manitoba. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alta. Information Report NOR-X-316.

Nanka, A. Development of jack pine mass selection seed orchards in Northern Manitoba.

Nanka, A. Development of jack pine mass selection seed orchards in Interlake Maniotba.

Walker, N. Planting conifers in the Spruce Woods 1904-1979. Forest Management Demonstration Notes No. 14.

13. Present Status of Study:

This study has been in a holding pattern/maintenance mode since the expiry of the Canada-Manitoba Forest Renewal Agreement in March 1989. With the signing of a new Canada-

Manitoba Partnership Agreement in Forestry this will enhance Forestry Canada's ability to deliver programs in Manitoba.

14. Environmental Implications:

All measures to be carried out under this Agreement shall be subject to the requirements of all environmental protection legislation of Canada and the province, including the Environmental Assessment Review Process guidelines order made pursuant to Section 6 (2) of the Government Organization Act, 1979 and such measures will be carried out in accordance with any and all such legislation

15. Duration:

Start: 1984 Completion: Continuing

16. Resources 1991-92:

PYs:	Agreement:	9.0
	A-base:	4.0
	Total:	13.0

O & M: $8 K (A-base)

Capital:

Salaries:

Grants & Contributions

15. Signatures:

District Manager

Program Director, Regional Development

Regional Director General

NOR-36-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 12, 1991

1. Project: Regional Development

2. Title: Canada-Alberta Partnership Agreement in Forestry

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

5. Study Leader: J. De Franceschi

6. Key Words: Canada-Alberta Partnership Agreement in Forestry, reforestation, forestry research, marketing, demonstration, hardwood development, public information, administration, evaluation, job creation, economic development, agreement reports, integrated resource management stand improvement, Green Plan, Community Tree Planting Program.

7. Location of Work: Northwest Region

8. Problem: N/A

9. Study Objectives:

   1. To manage and coordinate the implementation of federally-funded initiatives and monitor the use of federal funds related to the Canada-Alberta Partnership Agreement in Forestry by:

      a) ensuring the availability of long term economically accessible timber supplies in Alberta through planning, forest management, applied research and technology transfer;

      b) optimizing management and utilization of Alberta's forest resources including improved knowledge and understanding of non-timber forest values through planning, applied research, market development, technology transfer, training and public information; and

      c) contributing to the economic health and diversification of the Alberta forest sector, including the improvement of employment and human resource development through applied research, market development, technology transfer and public information.

2. To review socio-economic events, regionally, nationally, and internationally and assess impacts in terms of ForCan mandate and programs in relation to regional development in the forestry sector.

3. To coordinate the development, implementation and administration of forestry employment stimulation programs in Alberta as required.

4. To provide effective administration and financial control and technical support services for the Regional Development Agreement Program.

10. Goals for 1990-91:

1. Participate in the negotiation of federal-provincial forestry agreements, MOA's with other federal departments and agencies, MOUs with Indian Bands and other cooperative ventures.

2. Ensure the implementation of mechanisms and systems to implement agreements MOAs, MOUs, and other cooperative ventures including policies and procedures, standards and data systems to satisfy local, regional and national requirements.

3. Represent Forestry Canada on committees and at meetings of senior officials as required.

4. Manage Alberta Agreement financial and human resources.

5. Assist Manitoba and Saskatchewan District Office managers in the implementation of new agreements as required.

6. Coordinate liaison effort with Forestry Canada HQ on matters pertaining to regional development.

Added Goals:

7. Prepare program proposal for Alberta's participation in the Green Plan Community Tree Planting Program. Coordinate response to incoming proposals.

8. Deliver the Indian Lands program in Alberta.

11. Accomplishments in 1990-91:

1. Federal-Provincial agreements were negotiated for Manitoba and Saskatchewan. NWT negotiations are underway. Delays were encountered in Alberta agreement negotiations due to the inability of the provincial government to allocate resources on a sectoral basis. Regional MOU's were developed with DIAND in Alberta and Saskatchewan. Discussions are underway with other federal departments (i.e. Correctional Services of Canada, DIAND, CEIC,) regarding forestry related activities in the Region. As well, discussions took place with other federal departments regarding federal funding assistance programs.

2. Planning and systems were initiated to implement Agreements. Working committees were established for each program area. Evaluations of the effectiveness of the existing information system were initiated.

3. Participated at meetings and committees as required including sessions with university and forest industry.

4. Limited budget was provided and interim PY's were approved by Treasury Board.

5. Documents including Memorandums to Cabinet, Treasury Board Submissions, Legal Agreements, and Schedules A and B were prepared for the Canada-Manitoba and Canada-Saskatchewan Partnership Agreements in Forestry. Federal Treasury Board approval and Orders in Council were successfully obtained.

6. Ministerial briefing and other briefing notes for Forestry Canada HQ were prepared as requested. An example of information prepared/assembled for HQ includes silvicultural statistics, Indian Lands data, provincial forestry expenditures, labour statistics and others.

7. Proposals were developed for appropriate funding scenarios. Incoming requests are being addressed on an ongoing basis as circumstances evolve.

8. In the absence of a Canada-Alberta agreement, $75,000 bridge financing provided by Headquarters allowed delivery of a modest Indian Lands program in Alberta. Forest inventories and management plans were undertaken for several Indian Reserves. A limited amount of silviculture work was also conducted on these lands.

12. Publications 1990-91:

Reports prepared: See attached list.

13. Goals for 1991-92:

1. Complete negotiations of forestry agreements in Alberta. (National Strategic initiative #7)

2. Promote forestry programs in cooperation with federal agencies such as EIC, DIAND, Corrections Canada, WED and others. (National strategic initiative # 6)

3. Ensure implementation of mechanisms and systems to implement agreements, including policies and procedures, standards and data systems to satisfy local, regional, and national requirements. (National Strategic initiative #'s 1,3,5).

4. Represent Forestry Canada on committees and at meetings of senior officials as required. (eg. International Energy Agency, Bioenergy Agreement, Forestry Canada Working Group on Indian Lands Forestry).

5. Manage the Canada-Alberta Partnership Agreement in Forestry financial and human resources.

6. Assist Manitoba and Saskatchewan District Office managers in the implementation of new agreements as required.

7. Coordinate liaison effort with Forestry Canada HQ on matters pertaining to regional development.

8. Complete work transferred from NOR-03-04 (Economics Project) including documentation and reporting to the ENFOR study, white spruce release study and the silviculture labor production study.

14. Environmental Implications:

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

15. Duration:

Start: 1984 Completion: Continuing

16. Resources 1991-92:

PYs:	Prof:	De Franceschi	1.0
		Vice-Stephen	1.0
		Ross	1.0
		Mrklas	1.0
	Tech:		
	Support:	Abma	1.0
		Brokop	1.0
	Total:		6.0

O&M: $7,000 A-Base
Capital:
Grants & Contribution:

16. Signatures

Alberta Agreement Manager

A/Program Director, Regional Development

Regional Director General

REPORTS PRINTED UNDER THE CANADA-ALBERTA FRDA 1990-91

Name	Author(s)
Trial of a double-drum flail delimber/debarker processing small-diameter frozen timber: Phase II	R. Berlyn - FERIC
Directory of secondary wood-using industries in Alberta - 1989	R. Bohning - ForCan
Dimensional stabilization	Alberta Research Council
Duration of load	Alberta Research Council
Fire retardancy	Alberta Research Council
Market acceptance	Alberta Research Council
Mixed Species	Alberta Research Council
The Canada-Alberta wetlands drainage and improvement for forestry program	G. Hillman, J. Johnson - ForCan; S. Takyi - A/FLW
Destructive testing of stressed skin panels	Alberta Research Council
An economic analysis of wood supply from private land in Alberta	M. Messmer, M. Percy, W. Phillips, D. Boylen - U of Alberta
Forest pest management and damage appraisal	P. Amirault - ForCan
Forest yield predictions: risk modeling and simulation	T. Singh - ForCan
Juvenile furniture from Alberta pine and aspen	H.P.C. Construction Ltd.
Short term technical assistance	Alberta Research Council
Promotions and presentations	Alberta Research Council
Testing of laminated timber crossarms	J. Fargey, D. Himmelfarb, B. Watson - Western Archrib
Tree improvement applied research and technology transfer	Alberta Forest Service
Materials handling	Alberta Research Council
Environmental impacts of vegetation management by mechanical and chemical methods including residue chemistry	S. Sidhu, J. Feng - ForCan

NOR-36-02-4

FORESTRY CANADA

STUDY WORK PLAN

1991-92

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

NOR-36-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 13, 1991

1. Project: Regional Development

2. Title: Canada-Saskatchewan Partnership Agreement in Forestry and District Office

3. New: Cont.: X 4. No.: NOR-36-03

5. Study Leader: V.C. Begrand

6. Key Words: Canada-Saskatchewan Partnership Agreement in Forestry, renewal, growth enhancement, technology transfer, public information, evaluation, job development, management, economic development, liaison, woodlots.

7. Location of Work: Saskatchewan District Office, Prince Albert and Saskatchewan wide

8. Study Objectives:

1. To manage and co-ordinate the implementation of federally-funded initiatives and monitor the use of federal funds related to objectives of the Canada-Saskatchewan Partnership Agreement in Forestry:

a) to contribute to accelerated economic development in the forest sector through the implementation of improved forest management practices, technological innovation, and industrial expansion within the context of federal and provincial policies;

b) to maintain and create direct and indirect employment opportunities in the province by enhancing the long-term viability of the forest industry;

c) to contribute to an increased timber supply;

d) to promote improved utilization of the forest resource;

e) to strengthen research and technology transfer capability in support of forest management activities, and to shorten the time between conclusion and implementation of research; and

f) to support improved forest management on federal and provincial crown lands, private woodlots, and industrial forest management license areas.

2. To provide regional liaison for all Forestry Canada activities related to the Canada-Saskatchewan Partnership Agreement in Forestry.

3. To provide technical input into the implementation of forestry employment programs in Saskatchewan.

4. Represent Forestry Canada in Saskatchewan within the federal and the provincial governments, industry, and the general public.

5. To facilitate the maximization of funding available to the forestry sector in Saskatchewan from other funding agencies.

9. Goals for 1990-91:

1. Forest Renewal/Growth Enhancement and Stand Tending:

- develop a framework for the next Canada-Saskatchewan Agreement in conjunction with Industry, Indian bands, woodlot owners, provincial government and forest technical committees;

- continue in a leading role in developing new techniques and technologies for silvicultural operations including The Grizzly, Rome 50" Disc, Mechanical Release, Seeding, and Chemical Release;

- continue to monitor the seedlings planted on the development trials;

- complete projects outlined in the multi-year plans for Forest Industry, Indian Bands and woodlot owners;

- review, amend and process for approval Project Authorization Forms (PAFs) for forestry projects under the FRDA in conformance with the work plan;

- plan, implement (directly or indirectly), monitor and audit federally delivered forestry projects;

- review and monitor provincially implemented cost-shared projects in Programs 1 and 2;

- produce Technical Notes or File Reports on silvicultural trials completed during 1984-89;

- continue to support the implementation of the Productive Forest Land Depletion Classification;

- liaise and co-ordinate with the other administrative and research activities in the District and Regional offices (Supervisor: FO-2, Renewal and Intensive Management Co-ordinator (RIM); 2 EG ESS 6's, RIM Specialists).

2. Agreement Co-ordination and Management:

   - represent Forestry Canada on the Program Management Committee (PMC);
   - consult, liaise and co-ordinate with other federal agencies having impacts in regional development including DRIE (NEDSA), INAC (Indian forest, job creation), CEIC (Jobs Strategy, training), FEDC (ERDA Co-ordination), PFRA/PWC (construction services);
   - direct, co-ordinate and consult with sub-committee of the PMC including Nursery Development, Public Information, GIS and Evaluation;
   - co-ordinate with and advise the FRDA Directorate and the MOU Sub-committee;
   - provide overall day-to-day direction to programs under the FRDA with industry, Indian bands, the Province, within Forestry Canada and other federal departments;
   - co-ordinate and facilitate the strong technology transfer aspect of the programs funded from the FRDA thorugh liaison, work planning, program review, research work planning and training;
   - to continue to promote and develop Agro-forestry and Forest Belts;
   - to continue to promote and develop the Christmas tree industry;
   - to co-host the 1990 Canadian Christmas Tree Growers' Association Annual Meeting in conjunction with the Saskatchewan Christmas Tree Growers' Association;
   - co-ordinate a workshop directed at the Mixedwood or Hardwood Management and field demonstration directed at Vegetation Management;
   - maintain communications with forest related organizations, institutions or agencies concerned with programs implemented in the FRDA.

3. Silviculture Investigations:

   - evaluate stocking surveys on provincial plantations established 10 or more years ago to determine levels of stocking to intended species and present stocking to all commercial species;
   - continue to promote and participate in discussions with Saskatchewan Parks and Renewable Resources on third level plantation surveys;
   - continue technology transfer activity in the Cypress Hills Provincial Park related to regeneration of native lodgepole pine stands;
   - continue to participate with Weyerhaeuser Canada on a contract to evaluate Busulphan as a chemo-sterilant for use in hare population control.

4. Fire Management:

   - provide a technology and information transfer function through communication with Fire Research staff, the "Saskatchewan Forest Fire Notes" technical newsletter, participation on committees, training workshops, seminars, field work and personal contact.

5. Forest Mensuration Research:

   - continue provision of advice and services and technology transfer in the areas of GIS and growth and yield research and development to the client base in Saskatchewan.

10. Accomplishments 1990-91:

1. Forest Renewal/Growth Enhancement and Stand Tending:

   - contributed to the development of a framework which served as a base document for negotiation of the new PAIF;

   - seven silviculture development field trials were completed and two new techniques, the A-2 Forester site preparation implement and a helicopter-mounted aerial seeder, were introduced, demonstrated and now used operationally in Saskatchewan;

   - remeasurement of the 3rd year results of the six Red Earth site preparation type 2-regeneration trial was completed and the data was computer compiled and analyzed;

   - draft technical reports have been prepared for three development trials;

   - Productive Forest Land Depletion Classification survey on the NorSask FMLA was completed on 78,000 hectares including compilation, final mapping and data summary and analysis;

   - ensured the completion of 10 reforestation projects on six Indian reserves and site preparation projects on four reserves;

   - completed forest inventories on three Indian reserves.

2. Agreement Co-ordination and Management:

   - maintained contacts with all federal agencies and departments which have forestry interests such as INAC, CEIC, WDO, Environment Canada;

   - maintained strong communications with the forest industry, provincial departments, notably SPRR, Indian Bands and several interest groups;

   - continued to facilitate the technology transfer aspect of the program funded from FORCAN in Saskatchewan through liaison, work planning, program review and training;

- successfully organized and hosted the first Western Woodlot Extension Specialist Seminar in Prince Albert;

- organized and hosted the Annual Meeting of the Canadian Christmas Tree Growers' Association in Prince Albert;

- work continued with the Saskatchewan Research Council, the Farm Woodlot Association of Saskatchewan and the Saskatchewan Agriculture Development Fund to obtain scientific data on

  agricultural crop responses and wood fibre opportunities as a result of the use of forest belts;

3. Fire Management:

   - technology and information was transferred to clients through communication with Fire Research staff, the Saskatchewan Forest Fire Notes, technical newsletter, participation on committees, training workshop, seminars and personal contact;

   - in December, 1990, fire specialist W. De Groot transferred to the Fire Research team at NoFC.

4. Forest Mensuration Branch:

   - continued to support and assist in the implementation of the WESBOGY program in Saskatchewan;

   - a report "Site index estimation from environmental factors in Saskatchewan" was completed;

   - assistance was provided to SPRR and Mistik Management on nelder plot establishment and remeasurement procedures.

11. Goals for 1991-92:

    1. Agreement Co-ordination and Management:

       - establish working groups and sub-committees as required for the PAIF and will co-ordinate, direct, and utilize their recommendations;

       - prepare work plans for consideration by the PAIF Management Committee;

       - implement, monitor and audit federal direct projects and will review and monitor provincial direct projects;

       - prepare reports for the PAIF Management Committee as it requires;

       - facilitate the administration and delivery of all Forestry Canada's research and technology transfer programs in Saskatchewan;

- maintain regular contacts with 1) representatives of federal departments such as WDO, INAC, CEIC, IS&T and Environment; 2) representatives of provincial departments such as SPRR and Agriculture; 3) representatives of the major forest industries such as Weyerhaeuser, Mistik, SFPC and MB; and 4) representatives of interest groups such as SFA, SCTGA, FWAS, SCIFI and the Saskatchewan Indian Community;

- ensure the maintenance of regular contact with NoFC staff to ensure co-operation, information sharing and understanding of issues and concerns which may impact on Forestry Canada's operations in Saskatchewan.

2. Communications and Public Information

   - co-ordinate and administer the planning and delivery of an effective forestry communications program in Saskatchewan.

   - promote increased public awareness and understanding of Forestry Canada and PAIF initiatives in the forestry sector, inform targeted publics in Saskatchewan of the benefits of the forest resource.

   - develop and coordinate agreement-related media activities for Forestry Canada in Saskatchewan.

3. Private Land Forestry

   - to provide continued assistance to the development of private land forest management in Saskatchewan.

   - to promote the continued involvement of the Farm Woodlot Association of Saskatchewan, industry and other government agencies in the development of private land forestry and agro-forestry initiatives in Saskatchewan.

4. Forest Mensuration Research

   - to interface closely with DPRR personnel and with industry representatives with the objective of undertaking specific projects relating to growth and yield data manipulation and analysis.

   - to contribute through technology transfer to the development and advancement of growth and yield data analysis procedures and growth projection systems.

   - to provide an advisory role on growth and yield-related projects under the Canada-Saskatchewan Partnership Agreement in Forestry and provide liaison with other regions and agencies participating in growth and yield research projects.

   - to interface closely with DPRR personnel and industry representatives with the objective of undertaking specific projects relating to geographic information systems, and the advancement of GIS technology in Saskatchewan.

- to interface closely with other Forestry Canada personnel within the Saskatchewan District Office and at NoFC for the full implementation of geographic information systems at the District and Region level.

5. Federal and Indian Lands Forestry

   - to manage and co-ordinate the implementation of federally-funded initiatives and monitor the use of federal funds related to the Canada-Saskatchewan Partnership Agreement in Forestry on Federal Lands

   - to provide regional liaison for all Forestry Canada activities related to Federal Lands under the Canada-Saskatchewan Partnership Agreement in Forestry.

   - to provide technical input into the implementation of forestry employment programs in Saskatchewan

6. Forest Backlog Renewal, Stand Tending and Young Stand Surveys

   - to co-ordinate the implementation of direct federal delivery of operational forest backlog renewal (A.1), stand tending (A.3), and young or disturbed stand surveys (A.4) in co-operation with the Saskatchewan forest industry and the Provincial Forestry Branch.

7. Silviculture Investigations and Technology Transfer

   - to co-ordinate the implementation of silviculture investigations and technology transfer in Saskatchewan in response to Saskatchewan stakeholder needs; to advance present knowledge and available technology with the ultimate goal of enhancing present silviculture practices in mixedwoods, softwoods and hardwood forest types. This will include the following:

   - co-operate with NoFC staff in Regional Silviculture, Nurseries and Tree Improvement thrusts as applicable to Saskatchewan.

12. Publications:

    Nil

13. Present Status of Study:

    This study has been in a holding pattern/maintenance mode since the expiry of the Canada-Saskatchewan Forest Resource Development Agreement in March 1989.

    The signing of a new Canada-Saskatchewan Partnership Agreement in Forestry on March 26, 1991, has provided the much needed resources to enhance Forestry Canada's ability to deliver programs in Saskatchewan.

14. Environmental Implications:

The Chief, Saskatchewan District, has been directed by Management Committee to include all pertinent related information on the PAF associated with this project. The PAF will serve as the official document which the Environmental Screening Committee will review.

15. Duration:

Start: 1984 Completion: Continuing

16. Resources 1991-92:

PY's	Prof.:	V. Begrand	1.0
		M. Newman	1.0
		P. Loseth	1.0
		L. Worster	1.0
	Tech.:	D. Sidders	1.0
		J. Johhnston	1.0
	Support:	K. Gaudet	1.0
	New:		6.0
	Total:		13.0

O&M: $ 8 K (A-base)

Capital:

Grants & Contributions:

Total:

17. Signatures:

District Manager

Program Director, Regional Development

Regional Director General

NOR-36-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 12, 1991

1. Project: Regional Development

2. Title: Canada-Northwest Territories Cooperation Agreement in Forestry

3. New: X Cont.: 4. No.: NOR-36-04

5. Study Leader: M. Stephen

6. Key Words: Canada-Northwest Territories Cooperation Agreement in Forestry, reforestation, forestry research, marketing, demonstration, hardwood development, public information, administration, evaluation, job creation, economic development, agreement reports, integrated resource management stand improvement, Green Plan, Community Tree Planting Program.

7. Location of Work: NWT

8. Problem: N/A

9. Study Objectives:

   1. To manage and coordinate the implementation of federally-funded initiatives and monitor the use of federal funds related to the Canada-Northwest Territories Cooperation Agreement in Forestry by:

      a) ensuring the availability of long term economically accessible timber supplies in the NWT through planning, forest management, applied research and technology transfer;

      b) optimizing management and utilization of the NWT's forest resources including improved knowledge and understanding of non-timber forest values through planning, applied research, market development, technology transfer, training and public information; and

c) contributing to the economic health and diversification of the NWT forest sector, including the improvement of employment and human resource development through applied research, market development, technology transfer and public information.

2. To review socio-economic events, regionally, nationally, and internationally and assess impacts in terms of ForCan mandate and programs in relation to regional development in the forestry sector.

3. To coordinate the development, implementation and administration of forestry employment stimulation programs in the NWT as required.

4. To provide regional liaison for all Forestry Canada activities related to the Canada-NWT Co-operation Agreement in Forestry.

10. Goals for 1990-91:

1. Initiate preliminary documentation and negotiation towards development of a Canada-NWT Co-operation Agreement in Forestry.

11. Accomplishments in 1990-91:

1. Preliminary documentation was prepared and initial negotiations were conducted.

12. Publications 1990-91:

Nil

13. Goals for 1991-92:

1. Complete negotiations of the Canada-NWT Cooperative Agreement in Forestry.

2. Develop, manage, implement and deliver the NWT CAIF.

3. Represent Forestry Canada interests in the NWT by participating in appropriate meetings, committees, workshops, etc. as required.

14. Environmental Implications:

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

15. Duration:

Start: 1991 Completion: Continuing

16. Resources 1991-92:

PYs: Prof:

O&M: $ 800 A-Base
Capital:
Grants & Contribution:

16. Signatures

NWT Agreement Manager

A/Program Director, Regional Development

Regional Director General

NOR-36-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 31, 1991

1. Project: Regional Development

2. Title: Library Services

3. New: Cont.: X 4. No.: NOR-36-05

5. Study Leader: E. Hopp

6. Key Words: Library, acquisitions, cataloguing, interlibrary loans, circulation, reference, on-line literature searching, automated library systems, information science, data bases, aspen information data base.

7. Location of Work: NoFC

8. Problem:

The library is responsible for providing the staff at the centre and the District Offices with access to publications and the printed materials to meet the needs of NoFC's mandate within Forestry Canada. the library also serves university and college personnel, staff from other federal, provincial and municipal government departments and members of the public.

9. Study Objectives:

1. To budget, plan and develop library services to support ongoing forestry related activities in the Northwest Region.

2. To develop and maintain a collection which contains copies of all Forestry Canada publications and significant internal reports and other publications required to meet the ongoing and planned needs of NoFC and its district offices.

3. To provide reference and current awareness services.

4. To coordinate requests for translation of relevant scientific and technical literature.

5. To select and obtain library materials by means of purchase, gift or exchange.

6. To provide a means of access to the collection by cataloguing and classifying library materials according to a recognized standard or system.

7. To provide information or publications through interlibrary loan services where items are not available in the local collection and cooperative with other libraries by supplying reciprocal interlibrary loan services.

10. Goals for 1990=91:

1. To continue to provide library services to support the research, development, and technology transfer at NoFC and its District Offices.

2. To undertake training on the serials, circulation and acquisitions modules.

3. To continue to implement Sydney so that each module if sully operational, and to have 10,000 records entered by April 1, 1991, with assistance from a computer programmer.

4. To develop and formulate a plan for the retrospective conversion of the card catalogue, by collaborating and cooperating with other Forestry Canada libraries.

5. To attend the proposed Forestry Canada libraries' meeting in 1990 either in Ottawa in conjunction with the Canadian Library Association's Annual Meeting, or in Pittsburgh in conjunction with the Special Libraries Association Annual Conference.

6. To assist in formulation the overall archival policy, as required, in collaboration with the subcommittee and to revise and implement the policy as it pertains to the library.

7. To continue to provide guidance and assistance with regard to the Manitoba and Saskatchewan District Office and Forest Fire Research libraries to maximize their usefulness by producing a proposal and by developing an action plan.

8. To develop a 5 year plan for the Library and its services.

Added Goal:

9. To obtain electronic linkage to University of Alberta library and to implement ENVOY 100.

11. Accomplishments in 1990-91

1. The library continued to provide services as required in order to support the research conducted at NoFC and its District Offices.

The number of interlibrary loans has decreased due to the cancellation of the CAN/SDI Service in Oct., but still reaches to about 700, with numerous translations.

Additional human resources have been made available to assist with the overall library operations, with emphasis on data entry into Sydney.

The library has undergone extensive renovations which has resulted in a new work area for library staff and an expanded user reading area.

Approximately 10 boxes of duplicates have been sent to the Canadian Book Exchange Centre.

The library to receive publications by way of gifts on an on-going basis.

2. Both the librarian and library technician completed their Sydney training on the circulation, acquisitions and serials modules.

3. Due to unforseen circumstances (a major Sydney crash in the summer and library renovations) the library was unable to attain its goal of 10,000 Sydney records. Despite these setbacks, approx. 6,700 titles have been entered into Sydney, with an additional 6,000 titles in MARC format awaiting editing.

   At the end of the fiscal year, 2,500 records in dBase were purchased to commence the bibliography which will comprise part of the new Aspen Innovation Centre activities. This bibliography will be imported into Sydney in the new fiscal year.

4. Plans for national retrospective conversion of card catalogues are on-going.

5. The librarian attended both the Canadian Library Association's Annual Meeting and the Forestry Canada libraries' meeting in Ottawa.

6. The first draft of the archival policy has been formulated.

7. Guidance and assistance are being provided on an on-going basis to both the Manitoba and Saskatchewan District Offices.

8. The first draft of a 5 year plan for the library has been prepared.

9. On-line searching capabilities are now available to the University of Alberta Library and Envoy 100 is operational.

12. Goals for 1991-92:

1. Continue to provide library services to support the research, development, and technology transfer at NoFC and its District Offices.

2. Undertake refresher courses and training in such areas as using MARC in library automation, cataloguing, and Sydney (when the new version comes out).

3. To continue to implement Sydney; to complete the editing of the 6,000 titles currently in MARC plus enter an additional 5,000 titles into Sydney.

   Continue facilitating the bibliography being developed for the new Aspen Innovation Centre.

4. Pursue the retrospective conversion of the card catalogue by collaborating with Regional Development's Information Systems Specialist and other Forestry Canada libraries.

5. Attend the Special Libraries Association annual conference and Forestry Canada's librarians' annual meeting.

6. Reactivate the Library Users Advisory Committee to assist in assessing the Northwest Region's library needs.

7. Continue to provide guidance and assistance to the Manitoba and Saskatchewan District Offices.

8. Finalize the 5-year plan for the library.

9. Provide advice and act as liaison for library related needs in the development of the Aspen Innovation Centre and Technology Development Unit.

10. Obtain two computer terminals for library users; one to be dedicated to on-line searching and the University of Alberta's computer catalogue, the other solely to Sydney.

12. Publications 1990-91:

N/A

13. 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 study activities are not potentially detrimental to the environment.

14. Duration:

Start: 1970 Completion: Ongoing

15. Resources 1991-92:

PYs:	Prof:	Hopp	1.0
		Clerical Assist:	0.3
	Total:		1.3

O&M: $55,000
Capital:

18. Signatures.

Investigator

Program Director, Regional Development

Regional Director General

NOR-36-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 31, 1991

1. Project: Regional Development

2. Title: Information Systems and Technology Development Unit

3. New: X Cont.: 4. No.: NOR-36-06

5. Study Leader: M. Stephen

6. Key Words: Data Base, Information Systems, GIS, Technology Development Unit, Aspen Innovation Centre.

7. Location of Work: Northwest Region

8. Study Objectives:

   1. To fulfill Northern Forestry Centre information system requirements.

   2. To establish Northwest Region Technology Development Unit.

9. Goals for 1990-91

   Nil

10. Accomplishments in 1990-91

    Nil

11. Goals for 1991-92

    1. Establish a Technology Development Unit at NoFC and integrate with District Office activities to facilitate technology transfer between researchers and practising field foresters.

    2. Establish in cooperation with other Program Directors at NoFC an Aspen Innovation Centre to facilitate information development and sharing research concerning aspen, aspen products, and aspen biotechnology.

3. To provide data base/information system expertise and data processing services to Regional Development staff and clients.

12. Publications 1990-91:

N/A

13. 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 study activities are not potentially detrimental to the environment.

14. Duration:

Start: 1991 Completion: Ongoing

15. Resources 1991-92:

PYs: Prof: Chief TDU (vacant) 1.0
Kruger 1.0

Tech.: TDU, Silviculture operations (vacant)1.0
TDU, Nursery/tree improvement specialist (vacant0 1.0

Total: 4.0

O & M : $ 1,000 (A-base)
Capital:

18. Signatures.

Investigator

Program Director, Regional Development

Regional Director General

NOR-51-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 26, 1991

1. Project: Management Services

2. Title: Financial Services

3. New: Cont.: X 4. No.: NOR-51-01

5. Study Leader: D. Benke

6. Key Words: Finance

7. Location of Work: NoFC, Edmonton

8. Problem:

N/A

9. Study Objectives:

To supply financial services and advice to NoFC, Saskatchewan District Office and Manitoba District Office.

10. Goals for 1990-91:

1. Process all invoices within 10 days of receipt in finance unless written evidence of problems is on the file, with the exception of major utilities which will be processed within two days of receipt in finance so no late payment charges are incurred.

2. Process all travel claims within 10 days of receipt in finance.

3. When it is not possible to travel with the use of individual travel cards, process all travel advances so all requestors receive their advances at the latest on the day they require them.

4. Maintain a monthly record of:

   a) turnaround time
   b) No. of invoices
   c) No. of travel claims
   d) No. of travel advances.

   Provide this information to the Manager, Management Services by the fifth working day of the following month.

5. Using the automated J.V. system, process JV's for gas, stores, and other chargebacks within 3 working days of having received them in Finance.

6. Maintain a commitment system. Commitments will be input to FINCON within 2 days of receipt. A system which enables quick access to the actual document setting up the commitment will be maintained. Commitments will be analyzed monthly in finance to ensure only "good" commitments are in the system. All commitments must be based on written documentation.

7. Continue to reconcile DSS statements, FINCON statements, Batch ledger and monthly financial statements monthly for all T.B.A.s.

8. Requests for adjustments to the system will be performed within 1 working day of the request.

9. Requests for information such as from Manager, Management Services, HQ, Program Directors, Project Leaders, study leaders will be processed within 24 hours of the request or the deadline requested if later.

10. Accurate financial statements will be provided to Program Directors and HQ within 5 working days of monthly close off, including statement of individual study status distributed via E-mail.

11. Monitor accumulation of frequent flier points and recommend use of points to reduce costs as appropriate.

12. Coordinate and monitor use of Individual Travel Cards.

13. Reconcile agreement reporting and systems to ensure proper control and integrity in numbers used and communicated.

14. Perform agreement audits as requested by Regional Development personnel or as required.

15. Know at all times, the total agreement funds by province and be able to reconcile all information (received from headquarters) on funding within this total.

16. Become fluent with two commercial software packages (symphony and Word Perfect).

17. If FI-1 takes education leave in 1990, replace the position on a term basis and continue to function at the present level.

18. Set up new agreement coding and financial procedures to implement new agreements.

19. Complete cost allocation process for 1989-90 by June 30, 1990 using the space allocation formula and general admin formula per P.Y.

20. Implement and maintain DSS on-line pay as NoFC authorizer.

11. Accomplishments in 1990-91:

1. Achieved. Late payment charges with major utilities have been eliminated. Average turn around time was 5.9 days compared to 6.8 days for the same period last year. Total invoices processed was 2323. Stats - Edmonton only (January 90 - December 90). District office statistics are: Sask. 291; Manitoba 196.

2. Achieved. No. of travel claims processed was 920. Average turn around was 3.4 days compared to 3.4 days for the same period last year. Stats - Edmonton only. District office statistics are: Sask. 50; Manitoba 57.

3. Achieved. Positive compliments continue to be received from various employees regarding the achievement of this goal. No. of advances issued was 255. Stats - Edmonton only. District office statistics are: Sask. 6; Manitoba 5.

4. Achieved in a timely and accurate manner for NoFC and the two districts.

5. Achieved. No. of J.V.'s processed was 356. Stats - Edmonton only. The J.V. process is now automated for gas, stores, telephone, as well as payment of petty cash. District office statistics are: Sask. 10; Manitoba 6.

6. Achieved. In addition to free balance, respective open and closed commitments by study are provided via computer to program directors/project leaders/study leaders weekly for their review. No. of commitments input were 2553. Stats - Edmonton only. Commitment descriptions have been incorporated into inquiries. Commitments are reviewed in detail monthly by management and finance to ensure their integrity.

7. Monthly reconciliations of DSS, FINCON and the batch log, are being conducted regularly, with the working papers being retained on file. Adjustments are up to date. Salaries are not reconciled monthly due Headquarters delay in loading FINCON as of December 1990.

8. Achieved normally on a same day basis.

9. Achieved normally on a same day basis or within requested deadline.

10. Achieved. Monthly financial report includes detail on budgets by study/project/program within T.B.A. and person year information. Study status info is now distributed via E-mail to all personnel (Program Directors/Project Leaders/Study Leaders) weekly.

11. Achieved. Estimated value of points on hand is $20,000.00.

12. Achieved.

13. Achieved. Wrap up of agreements required ad hoc reporting in beginning of 1990-91. New agreements are expected in February/March of 1991.

14. No audits external to NoFC were requested. Reconciliations between agreements reporting and financial records were requested and provided.

15. Achieved.

16. Achieved. Symphony is currently used for both monthly financial reporting and ad hoc reporting. Word perfect is used regularly.

17. Achieved.

18. Achieved. Preliminary coding format is in place. Financial procedures are being communicated.

19. Achieved in a timely manner given receipt of necessary information. Symphony is used to achieve this goal.

20. Achieved.

Added accomplishments:

21. In addition to continuing as a member of the PY system committee, our region regularly tests new enhancements to the PY system as they were developed. Two versions had to be tested in 1990-91. Emphasis has been on the salary forecasting capabilities of the system.

22. Maintenance computer invoicing system.

23. Participated as a member of the departments Financial System Review Committee.

24. Developed plans for renovation of the conference room/cafeteria, hallway and storage area in the basement of NoFC.

25. Supported reorganization of District Office Admin staff to net a saving of 3 PY for region.

12. Goals for 1991-92:

1. Process all invoices within 10 days of receipt in finance unless written evidence of problems is on the file, with the exception of major utilities which will be processed within two days of receipt in finance so no late payment charges incurred.

2. Process all travel claims within 10 days of receipt in finance.

3. When it is not possible to travel with the use of individual travel cards, process all travel advances so all requestors receive their advances at the latest on the day they require them.

4. Maintain a monthly record as required by the Manager, Management Services and provide this information to him by the fifth working day of the following month.

5. Using automation, process JV's for gas, stores, telephone and petty cash payments within 3 working days of having received them in Finance.

6. Maintain a commitment system. Commitments will be input to FINCON within 2 days of receipt. A system which enables quick access to the actual document setting up the commitment will be maintained. Commitments will be analyzed monthly in finance to ensure only "good" commitments are in the system. All commitments must be based on written documentation.

7. Continue to reconcile DSS statements, FINCON statements, Batch ledger and monthly financial statements monthly for all T.B.A.s.

8. Action requests for adjustments to the system within 1 working day of the request.

9. Process within 24 hours or the deadline requested if later requests for information such as from Manager, Management Services, HQ, Program Directors, Project Leaders, study leaders.

10. Provide accurate financial statements to Program Directors and HQ within 5 working days of monthly close off, inlcuding statement of individual study status distributed via computerized budget system.

11. Monitor accumulation of frequent flier points and recommend use of points to reduce costs as appropriate.

12. Coordinate and monitor use of Individual Travel Cards.

13. Reconcile agreement reporting and systems to ensure proper control and integrity in numbers used and communicated.

14. Perform agreement audits as requested by Regional Development personnel or as required.

15. Know at all times, the total agreement funds by province and be able to reconcile all information (received from headquarters) on funding within this total.

16. If FI-1 takes education leave in 1991, replace the position on a term basis and continue to function at the present level.

17. Maintain DSS on-line pay as NoFC authorizer.

18. Assume and conduct accounts payable function for District Offices. One position will be required in Finance to achieve this goal. Net saving to the Region will be 3 PY's.

19. Implement new commitment system for gasoline, petty cash, stores, and long distance chargebacks such that funds are committed in each study.

13. Publications 1990-91:

Nil

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Benke	1.0	
	Iskra	1.0	
	Owens	1.0	
	Cooper	1.0	
	vacant	1.0	(Pending Agreement PY approval)
	Total:	5.0	

O & M: $ 23,400

Capital: $ 4,000

16. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-51-02

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 3, 1991

1. Project: Management Services

2. Title: Management Services

3. New: Cont.: X 4. No.: NOR-51-02

5. Study Leader: P.G. Stewart

6. Key Words: Management services

7. Location of Work: NoFC, Winnipeg, Prince Albert

8. Problem:

N/A

9. Study Objectives:

To provide financial, material management and administrative and facilities support services to NoFC Director General, Program Directors, Project Leaders, Study Leaders, District Offices, and employees.

10. Goals for 1990-91:

1. Oversee financial, administrative, materiel management, vehicles and building operations (see other study statements).

2. Collect monthly data on functions under Management Services

3. Participate in Management of NoFC by attending Management Committee Meetings and advising on Finance and Admin issues.

4. Monitor NoFC resources on a monthly basis and draw attention to problem areas. Provide monthly financial statements by the fifth working day of the next month at the latest.

5. Visit each District Office at least once during the year.

6. Attend two (2) meetings of Managers, Management Services.

7. Monitor capital budgets.

8. Liaise with tenants in the building. Arrange for chargebacks per the formula.

9. Act as Secretary to the Project Leaders Meeting. Issue notice one week before meeting, issue agenda one day prior to meeting and circulate minutes within one week of the meeting.

10. Attend Manager, Management Services meeting to discuss capital construction budget for 1991-92.

11. Participate in Health and Safety Committee and LMCC.

12. Conduct forum to discuss role of Management Services with all members of the unit.

11. Accomplishments in 1990-91:

1. Oversaw financial, administrative, materiel management, vehicles and building operations (see other study statements in Project 51).

2. Collected monthly data on functions under Management Services; reviewed it and used as management tool to allocate work and resources.

3. Participated in Management of NoFC by attending Management Committee Meetings and advising on Finance and Admin issues.

4. NoFC resources were monitored on a monthly basis and attention was drawn to problem areas. Provided monthly financial statements by the fifth working day of the next month at the latest.

1989/90 Year End Resource Status

	Budget	Expenditure
O&M - A-base	1363.2	1363.2
PY's	142.0	145.67 (Overages approved)
Capital-equip	564.6	564.6
Construction	214.2	214.2
O&M Agreements	1201.5	1201.5
Capital Agreements	46.0	46.0
Contributions	1281.7	1278.9

5. Visited Saskatchewan District Office in April; did not visit the Winnipeg District Office.

6. Attended two (2) meetings of Managers, Management Services. One at PFC in June 1990 and another held at Ottawa in October 1990.

7. Monitored capital budgets. Capital equipment allocation process changed; only monitored on a program basis (oversaw construction projects).

8. Liaised with tenants in the building.

9. No Project Leaders Meeting were held in 1990.

10. Attended Manager, Management Services meeting to discuss capital construction budget for 1991-92 held Banff, Alberta.

11. Participated in Health and Safety committees at NoFC. Help start regular safety inspections.

12. A forum was conducted and a mission statement for Management Services was developed and accepted.

Added Accomplishments

13. Participated in the Executive Leadership Program as the NoFC Representative. Attended 3 meetings to discuss the Strategic Plan and prepared Action Statements for 2 of the 24 Strategic Initiatives, made presentations at SMC and to NoFC staff.

14. Participated in pilot project for the new Planning System. Final assessment is yet to be completed.

15. Staffed the Administration Officer position. In co-operation with J. Powell, staffed the Secretary position vacated by R. Bown.

16. Accepted responsibility for the Computing Services Group as a result of the re-organization in June 1990. Since then, have worked with W. Chow in organizing the unit, setting priorities and assessing performance.

17. Prepared a proposal for saving as a result of the restraint program and implemented that proposal to save $191.0 K in 1990/91.

18. Attended PERFORM II Course.

19. Attended Manual Writing Course and wrote chapter on "Purchasing of Goods" for the manual.

20. Co-ordinated the logistics and accommodation for R. Kelly from Treasury Board who made a presentation on the new contracting policy in the Federal Government.

21. Participated in the NoFC Space Committee and made presentation to staff on the recommendations.

22. Participated in the Administration Sub-committees for the Saskatchewan and Manitoba Partnership Agreements. Made recommendations for changes under the new agreements.

12. Goals for 1991-92:

1. Oversee financial, administrative, materiel management, vehicles and building operations (see other study statements including 53-01).

2. Collect monthly data on functions under Management Services

3. Participate in Management of NoFC by attending Management Committee Meetings and advising on Finance and Admin issues.

4. Monitor NoFC resources on a monthly basis and draw attention to problem areas. Provide monthly financial statements by the fifth working day of the next month at the latest.

5. Visit each District Office at least once during the year.

6. Attend two (2) meetings of Managers, Management Services.

7. Liaise with tenants in the building. Arrange for chargebacks per the formula. Co-ordinate the removal of DFO from the building.

8. Act as Secretary to the Project Leaders Meeting. Issue notice one week before meeting, issue agenda one day prior to meeting and circulate minutes within one week of the meeting.

9. Attend Manager, Management Services meeting to discuss capital construction budget for 1992-93.

10. Participate in Health and Safety Committee and LMCC.

11. Attend ELG meeting in Quebec City to discuss corporate values.

12. Co-ordinate moves and changes in building as a result of approved space plan.

13. Choose, order and put in place new furniture for enlarged Boardroom by April 30, 1991.

14. Implement financial and Administration structure for the new Agreements.

13. Publications 1990-91:

N/A

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs: P. Stewart 1.0

Total: 1.0

O & M: $35,900
Capital: $ 34,000
Construction Capital: $225,000

16. Signatures:

Manager, Management Services

Regional Director General

NOR-51-03

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 3, 1991

1. Project: Management Services

2. Title: Administration

3. New: Cont.: X 4. No.: NOR-51-03

5. Study Leader: J.E.L. Griffin

6. Key Words: Word processing, records management, mail processing, telecommunications, administration

7. Location of Work: NoFC

8. Problem:

N/A

9. Study Objectives:

To provide reception, word processing, records management, mail processing, telecommunications and general administrative service to NoFC.

10. Goals for 1990-91:

Word Processing:

1. Provide the following turn around time to clients:

1 - 5 pages	1 working day
5 - 25 pages	3 working days

2. Provide training to operators to ensure they understand and use the Wordperfect system to full capabilities. Training is ongoing as new features and capabilities are brought on line.

3. Provide daily switchboard relief on rotating basis.

4. Provide help in Central Registry with mail when required.

5. Provide Switchboard duties while switchboard operator was sick and on annual leave.

Records Office:

1. Open and record all incoming mail, with the exception of advertisements, newspapers, magazines.

2. Distribute all incoming mail within one hour of receipt as per routing.

3. Hand-deliver, upon receipt, to addressee's office or put in mail box, all facsimilie and telex messages.

4. Prepare and forward mail to the District Offices 3 times a week and daily to Ottawa by Priority Post.

5. Prepare mail for pick-up each day by Canada Post and private courier.

6. Ensure photocopier in mail room is working and properly supplied; call maintenance within one hour of machine being reported as mal-functioning.

7. Maintain workload counts as presently being done.

8. Maintain and operate a BF system for subject files and material on circulation.

9. Maintain scientific records room by clearing up returned MS projects, pulling and listing housekeeping files for destruction, archiving financial records, filing dormant records in allocated space.

10. Purge active files, de-classify documents and organize classified documents.

Telecommunications:

1. Review rental charges each month to ensure they are accurate and correct. Maintain monthly detail of rental costs.

2. Place an order for repair or change within two days of receiving the order or when economically feasible (if not urgent).

3. On a monthly basis, provide finance with billings on each study for long distance chargeback.

4. Evaluate and implement an upgrade to the SL-1 system if funds become available.

5. Check out and monitor possibilities of setting up a chargeback system for GTA (Centrex).

Reception:

1. Answer the telephone switchboard, take messages, forward calls and maintain monthly statistics.

2. Greet visitors, refer to the appropriate employee in NoFC.

3. Prepare correspondence and contracts within 24 hours of receiving them.

4. Maintain a log of all typing and provide monthly statistics.

5. Maintain the Atari Message Board and update as required.

6. Maintain a current list of employees absent from the office and publish and distribute list weekly on Friday or Monday.

Administration:

1. Submit 1990-91 Conference Plan to HQ by Febrary 2, 1990.

2. Issue call letter and prepare listing for review by Management Committee for the 1991-92 Conference Plan to meet the deadline set by HQ.

3. Monitor the 1990-91 Conference Plan:

   a. to ensure approved attendee's know they are on the plan and make their arrangements;

   b. to make changes and substitutions as necessary.

   c. to submit quarterly reports to HQ.

   d. Input data to conference file on VAX by April 1, 1990 and update within 2 days of changes occuring throughout 1990/91.

4. Action classification and staffing requests within 2 days of receiving them, as long as there are no extenuating circumstances. Ensure all packages forwarded to Personnel are complete. Keep record of actions completed.

5. Monitor Training Plan by:

   a. Informing attendees of approvals; arranging for approval documentation.

   b. Ensuring all necessary documentation is completed, forwarded and filed within 2 weeks of the course completion.

   c. Prepare 1991-92 training plan by December 1990.

   d. Prepare 1991/92 Training Plan documentation.

6. Prepare, monitor, and do not exceed budget for administration without specific approval from Manager, Management Services. Do expenditure review by July 31, Sept. 30 and December 31, 1990.

7. Compile monthly statistics and provide to Manager, Management Services.

8. Prepare, monitor and maintain organization charts for region. Provide updated charts for April 1 and October 30 and in addition to this as requested.

9. Investigate alternate methods of producing Organization Chart.

10. Submit to Finance within five working days of June 30, September 30, December 31, March 31 the details of amounts to bill non-NoFC users in the building. Charges are for telex, telephone long distance and equipment charges, copier, etc.

11. Ensure all employees in District Offices obtain a current ID Card.

11. Accomplishments for 1990-91:

Word Processing:

1. Provided the following turn around time to clients:

1 - 5 pages	1 working day
5 - 25 pages	3 working days

Number of jobs: January 1, 1990 to December 31, 1990 = 1760; pages printed 26,231; Environment = 142; Mgmt. Services = 408; Forest Protection = 223; Forest Resources = 324; Tech. Transfer and Communications = 130; Regional Development = 102; Personnel = 110.

Average turnaround time was approximately 1/2 day.

# of priority jobs = 472

2. Transfered from AES system to PC's operating on VAX. Transfered all documentation currently on AES to Wordperfect on VAX successfully. The system is working well and NoFC is saving $4,000 annually by cancelling the AES agreement.

3. Provided training to operators to ensure they understood and used the Wordperfect system to full capabilities. Training is ongoing and more and more features are being used.

4. Provided daily switchboard relief on a rotating basis.

Added Accomplishments:

5. Provided help in central registry with mail when required.

6. Provided switchboard duties while switchboard operator was sick and on annual leave.

7. Twice yearly cleaned up workspaces (subdirectories) by deleting reports that are completed to maintain minimum space on the VAX.

8. Entered addresses into publications list for the publication Department; approximately 400 addresses.

Records Office:

1. Opened and recorded all incoming mail, with the exception of advertisements, newspapers, magazines.

2. Distributed all incoming mail within one hour of receipt as per routing.
Number pieces incoming mail = 47,606.

3. Hand-delivered, upon receipt, to addressee's office or put in mail box, all facsimilie messages.

   # incoming fax messages = 3,278
   # outgoing fax messages = 3,121

4. Prepared and forwarded mail to the District Offices 3 times a week and daily to Ottawa by Priority Post.

   # envelopes = 434

5. Prepared mail for pick-up each day by Canada Post and private courier.

   # pieces outgoing mail = 49,692

6. Ensured photocopier in mail room was working and properly supplied; called maintenance within one hour of machine being reported as mal-functioning.

   # copies on Cannon 8570 (mail room only) = 569,876.

7. Continued workload counts as presently being done and submitted monthly report.

8. Maintained and operated a BF system for subject files & material on circulation.

9. Sorting through records in Scientific Records Room on a time available basis.

10. Purged active files, de-classified documents and organized classification documents.

Added Accomplishments:

11. Re-organized records office furniture and facilities to improve access to cheques and files.

12. Re-organized mailroom boxes to improve delivery of mail and faxes and provide a space for each employee.

Telecommunications:

1. Reviewed rental charges each month to ensure they were accurate and correct. Maintained monthly detail of rental costs.

2. Placed orders for repair or changes within two days of receiving the order.

3. On a monthly basis, provided finance with billings on each study for long distance chargeback.

4. Set up a charge back system for GTA (Centrex).

Reception:

1. Answered the telephone switchboard, took messages, forwarded calls and maintained monthly statistics.

   # of calls answered January - December 1990 = 48,617.

2. Greeted visitors, referred to the appropriate employee in NoFC.

3. Prepared correspondence and contracts within 24 hours of receiving them. Maintained a log of all typing.

   # of jobs completed January - December 1990 = 1,129/1005 pages and 1297 labels.

4. Maintained a log of all typing and provided monthly statistics.

Added Accomplishments:

5. Translated letters both from English to French and French to English throughout the year. The number of pages translated was approximately 15.

6. Maintained the Atari Message Board and updated as required.

7. Maintained a current list of employees absent from the office and published and distributed list daily.

Administration:

l. Prepared and submitted the 1990-91 Conference Plan for the deadline set by HQ.

2. Issued call letter and prepared listing for review by Management Committee for the 1991/92 Conference Plan to meet the deadline set by Headquarters.

3. Monitored the 1990-91 Conference Plan:

   a. ensured approved attendee's knew they were on the plan and made their arrangements;

b. made changes and substitutions as necessary.

c. submitted quarterly reports to HQ.

d. conference file on VAX was input by April 1, 1990 and updated within 2 days of changes occuring throughout 1990/91.

4. Actioned classification and staffing requests within 2 days of receiving them, as long as there were no extenuating circumstances. Ensured all packages forwarded to Personnel were complete.

   # of completed packages to Personnel = 243.

5. Monitored Training Plan by:

   a. Informing attendees of approvals; arranging for approval documentation.

   b. Ensuring all necessary documentation was completed, forwarded and filed within 2 weeks of the course completion.

   c. Inputing Training Plan on VAX by April 1, 1990 and updated within 2 days of changes occuring throughout 1990/91.

   d. Issued call letter for 1991/92 training plan by December 1990.

6. Prepared, monitored, and did not exceed budget for administration without specific approval from Manager, Management Services.

7. Compiled monthly statistics and provided to Manager, Management Services.

8. Prepared, monitored and maintained organization charts for region on an ongoing basis. Issued updated charts for April 1 and December 1, 1990.

9. Investigated alternate methods of producing Organization Chart and they are now done by the Graphics Artist who produces a more readable chart.

10. Submitted to Finance within five working days of June 30, September 30, December 31, March 31 the details of amounts to bill non-FoFC users in the building. Charges are for telephone long distance and equipment charges, copier, etc.

11. Maintained ID card system, updated cards adn issued new cards as required. Input all information to ID card file on VAX.

    # ID Cards issued = 11.

12. Issued call letter and prepared a listing for review by Management Committee for the 1991/92 Training Plan to meet the deadline set by Headquarters.

12. Goals for 1991-92:

Word Processing:

1. Provide the following turn around time to clients:

1 - 5 pages	1 working day
5 - 25 pages	3 working days

2. Provide training to operators to ensure they understand and use the Wordperfect system to full capabilities. Training will be ongoing as new features and capabilities are brought on line.

3. Produce a telephone list quarterly of FORCAN employees (including Sask. & Man.) plus the 3 tenants and distribute to all of the above.

4. Provide daily switchboard relief on rotating basis.

5. Purchase updated equipment for Unit to solve storage and CPU problems by April 30, 1991.

6. Review workload and schedule 1/2 of a PY to work in central registry, if appropriate, by April 1, 1991.

7. Provide help in central registry with mail when required.

8. Provide switchboard duties while switchboard operator is sick and on annual leave.

Records Office:

1. Open and record all incoming mail, with the exception of advertisements, newspapers, magazines.

2. Distribute all incoming mail within one hour of receipt as per routing.

3. Hand-deliver, upon receipt, to addressee's office or put in mail box, all facsimilie and telex messages.

4. Prepare and forward mail to the District Offices 3 times a week and daily to Ottawa by Priority Post.

5. Prepare mail for pick-up each day by Canada Post and private courier.

6. Ensure photocopier in mail room is working and properly supplied; call maintenance within one hour of machine being reported as mal-functioning.

7. Maintain workload counts as presently being done.

8. Maintain and operate a BF system for subject files and material on circulation.

9. Maintain scientific records room by clearing up returned MS projects, pulling and listing housekeeping files for destruction, archiving financial records, filing dormant records in allocated space.

10. Purge active files, de-classify documents and organize classified documents.

11. Assess present Canon Copier and determine if change required after June 1991. Order new copier or have new contract in place for present copier by May 1, 1991.

Telecommunications:

1. Review rental charges each month to ensure they are accurate and correct. Maintain monthly detail of rental costs.

2. Place an order for repair or change within two days of receiving the order or when economically feasible (if not urgent). Maintain numbered work-order system so individual jobs on bill can be identified to work done.

3. On a monthly basis, provide finance with billings on each study for long distance chargeback.

4. Evaluate and implement an upgrade to the SL-1 system if funds become available.

Reception:

1. Answer the telephone switchboard, take messages, forward calls and maintain monthly statistics.

2. Greet visitors, refer to the appropriate employee in NoFC.

3. Prepare correspondence within 24 hours of receiving them.

4. Maintain a log of all typing and provide monthly statistics.

5. Maintain the Atari Message Board and update as required.

6. Maintain a current list of employees absent from the office and pubish and distribute list daily.

Administration:

1. Submit 1991-92 Conference Plan to HQ by Febrary 22, 1991.

2. Issue call letter and prepare listing for review by Management Committee for the 1992-93 Conference Plan to meet the deadline set by HQ.

3. Monitor the 1991-92 Conference Plan:

   a. to ensure approved attendee's know they are on the plan and make their arrangements;

b. to make changes and substitutions as necessary.

c. to submit quarterly reports to HQ.

d. Input data to conference file on VAX by April 1, 1991 and update within 2 days of changes occuring throughout 1991/92.

4. Action classification and staffing requests within 2 days of receiving them, as long as there are no extenuating circumstances. Ensure all packages forwarded to Personnel are complete. Keep record of actions completed.

5. Monitor 1991-92 Training Plan by:

a. Informing attendees of approvals; arranging for approval documentation.

b. Ensure training forms are filled out upon notice of approval for training.

c. Ensuring all necessary documentation is completed, forwarded and filed within 2 weeks of the course completion.

d. Input data to Training file on VAX by April 1, 1990 and update within 2 days of recieving final course costs throughout 1991-92.

6. Issue call letter and prepare 1992-93 Training Plan by December 1991.

7. Prepare 1992/93 Training Plan documentation.

8. Prepare, monitor, and do not exceed budget for administration without specific approval from Manager, Management Services. Do expenditure review by July 31, Sept. 30 and December 31, 1991.

9. Compile monthly statistics and provide to Manager, Management Services by fifth working day of the following month.

10. Prepare, monitor and maintain organization charts for region. Provide updated charts for April 1 and October 30 and, in addition to this, as requested.

11. Submit to Finance within five working days of June 30, September 30, December 31, March 31 the details of amounts to bill non-NoFC users in the building. Charges are for telex, telephone long distance and equipment charges, copier, etc.

12. Ensure all employees in northwest region have a current ID Card. Maintain log and BF system for ID cards.

13. Input a plan into computer for Foreign Work Travel.

13. Publications 1990-91:

N/A

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Griffin	1.0
	Earl	1.0
	Simunkovic	1.0
	Ratansi	1.0
	Phillips	1.0
	Total:	5.0
O & M:	$ 152,100.00	
Capital:	$ 5,000	

16. Signatures:

J. E. L. Griffin
Investigator

Manager, Management Services

Regional Director General

NOR-51-04

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 15, 1991

1. Project: Management Services

2. Title: Materiel Management

3. New: Cont.: X 4. No.: NOR-51-04

5. Study Leader: G.R. Fawcett

6. Key Words: Material management, purchasing, inventory, supplies, stores, removal

7. Location of Work: NoFC, Edmonton, Alberta

8. Problems

N/A

9. Study Objectives:

To provide purchasing, removal, stores, inventory and Material Management Services to NoFC including functional guidance to the District Offices.

10. Goals for 1990-91:

Purchasing

1. Provide a 24 hour turnaround time on all requisitions so that end document is issued within one (1) day of receipt in purchasing as long as all information is supplied. This turnaround time will be documented and given to the Manager, Management Services each month.

2. Ensure proper signing authority is on each requisition before actioning. Code all requisitions including line objects.

3. Follow up on all documents issued:

   a. within 10 working days of issuing if delivery date is not known (PASS requisitions).

   b. within 2 working days if good/services are not received on delivery date. Written documentation will be placed on each file of this follow-up.

4. Records will be maintained of all documents issued and received.

5. Monthly reports will be prepared on the above.

6. Necessary documentation will be kept on file for all exceptional purchasing (e.g., emergencies).

7. Implement version 4 MMIS and resolve any problems caused by the change in data formats.

8. Present a course on purchasing procedures and rationale to the Northwest Region personnel.

Stores

1. An inventory of all stores items will be maintained. An inventory of expendables and stationary will be performed on April 30, July 30, Oct. 30, and Jan. 30. A report will be written. The aim is to achieve 10% or less error rate.

2. G. Fawcett and M. Keryliuk will review items for charge back and produce a revised list of chargeable items.

3. Items requested will be available. If not available, it will be acquired or at least ordered within 24 hours of a request if it is a stores issue item. A record of the number of issues will be maintained and reported monthly.

4. A minimum/maximum system will be maintained and stores supply will be within these limits the budget allowing.

5. The budget will not be exceeded without specific permission from the Manager, Management Services.

6. Monthly costs for receivable items will be provided to Finance by the second (2) working day of the following month for JVing back to projects.

7. The individual bar code card system will be maintained.

8. Ensure proper warehousing of all parts of the storage shed so space is used most efficiently and assigned areas are clearly marked.

9. Purchase and co-ordinate installation of new pallet racking and reorganization of equipment to maximize use of available space in the warehouse.

10. Provide stores service from 08:30 TO 09:30 and from 13:00 TO 14:00.

Inventory

1. All equipment and attractive items will be tagged and furniture, equipment and attractive items entered into the inventory before the item is released from stores. Assigned holders will sign for all equipment issued.

2. Arrange disposal of surplus equipment.

3. Perform inventories in Manitoba district office and NoFC.

11. Accomplishments for 1990-91:

Purchasing

1. Provided a average turnaround time of 0.75 day on all requisitions so that end document was issued within one (1) day of receipt in purchasing as long as all information was supplied. This turnaround time was documented and given to the Manager, Management Services each month. The number of purchase orders including petty cash transactions processed between 01-Jan-90 and 31-Dec-90 totalled 2,233.

2. Ensured proper signing authority was on each requisition before actioning. Coded all requisitions including line objects.

3. Followed up on all documents issued:

   a. within 10 working days of issuing if delivery date was not known (9200's).

   b. within 2 working days if good/services were not received on delivery date. Written documentation was placed on each file of this follow-up. The number of follow-ups actioned between 01-Jan-90 and 31-Dec-90 totalled 245.

4. Records were maintained of all documents issued and received.

5. Monthly reports were prepared on the above.

6. Necessary documentation is kept on file for all exceptional purchasing (e.g., emergencies).

7. MMIS version 4 was implemented sucessfully.

8. The course on purchasing procedures was not presented and has been resheduled for early in the next fiscal year.

Additional Accomplishments

9. Ms. Sayko and Ms. Keryliuk attended the Materiel Management meeting hosted by NoFC between Sep. 17 to Sep. 18, 1990.

10. Mr. Fawcett completed the first draft of the Forestry Canada Administrative Manual chapters 7.1 through 7.6 dealing with Materiel Assets Management. This task was completed two months ahead of schedule on 25-OCT-90.

Stores

1. An inventory of all stores items was maintained. An inventory of expendables and stationary was performed on April 30, July 30, and Jan. 30. A report was written. The aim to achieve a 10% or less error rate was not accomplished although the rate has dropped from a 23% average to 14.5%. Ms. Keryliuk has been commended on her diligence resulting in such a dramatic improvement since taking over the stores position.

2. The annual review of stores stocked items was carried out and lists were amended to add additional charge back items.

3. Items requested were available, acquired or ordered within 24 hours of a request for stores issue item. A record of the number of issues was maintained and reported monthly. A total of 1,846 consumers were served between 1-Jan-90 and 31-Dec-90.

4. A minimum/maximum system was maintained and stores supply were within these limits the budget allowing.

5. Requested office supplies were available and the budget was not exceeded without specific permission from the Manager, Management Services. The projected stores budget to March 31, 1991 is $19,000.00.

6. Monthly costs for receivable items was provided to Finance by the second (2) working day of the following month for JVing back to projects.

7. The individual bar code card system has been maintained. A full integration of our barcode system with MMIS version 4 was accomplished with assistance from computing services.

8. Ensured proper warehousing of all parts of the storage shed so space was used most efficiently and assigned areas were clearly marked.

9. Due to budget restraints only one section of new pallet racking was obtained and installed.

10. Stores service was provided daily from 08:30 to 09:30 and from 13:00 to 14:00.

Inventory

1. All equipment and attractive items were tagged and furniture, equipment and attractive items entered into the inventory before the item is released from stores. Assigned holders signed for all equipment issued.

2. Arranged the disposal of 407 items surplus equipment with a total value of $2,654,209.87. This consisted of 23 CADC forms being completed.

3. Inventories in the Manitoba district office were carried out between Apr. 14 and 19, 1990. The inventories of NoFC will be completed by March 31, 1991.

12. Goals for 1991-92:

Purchasing

1. Provide a 24 hour turnaround time on all requisitions so that end document is issued within one (1) day of receipt in purchasing as long as all information is supplied. This turnaround time will be documented and given to the Manager, Management Services each month.

2. Ensure proper signing authority is on each requisition before actioning. Code all requisitions including line objects.

3. Follow up on all documents issued:

   a. within 10 working days of issuing if delivery date is not known (PASS requisitions).

   b. within 2 working days if good/services are not received on delivery date. Written documentation will be placed on each file of this follow-up.

4. Records will be maintained of all documents issued and received.

5. Monthly reports will be prepared on the above.

6. Necessary documentation will be kept on file for all exceptional purchasing (e.g., emergencies).

7. A course on purchasing methods and procedures will be put on in April/May, 1991.

Stores

1. An inventory of all stores items will be maintained. An inventory of expendables and stationary will be performed on April 30, July 30, Oct. 30, and Jan. 30. A report will be written. The aim is to achieve 10% or less error rate.

2. G. Fawcett and M. Keryliuk will review items for charge back and produce a revised list of chargeable items.

3. Items requested will be available. If not available, it will be acquired or at least ordered within 24 hours of a request if it is a stores issue item. A record of the number of issues will be maintained and reported monthly.

4. A minimum/maximum system will be maintained and stores supply will be within these limits the budget allowing.

5. The budget will not be exceeded without specific permission from the Manager, Management Services.

6. Monthly costs for receivable items will be provided to Finance by the second (2) working day of the following month for JVing back to projects.

7. The individual bar code card system will be maintained.

8. Ensure proper warehousing of all parts of the storage shed so space is used most efficiently and assigned areas are clearly marked.

9. Purchase and co-ordinate installation of new pallet racking and storage bins and reorganization of equipment to maximize use of available space in the warehouse.

10. Provide stores service from 08:30 TO 09:30 and from 13:00 TO 14:00.

Inventory

1. All equipment and attractive items will be tagged and furniture, equipment and attractive items entered into the inventory before the item is released from stores. Assigned holders will sign for all equipment issued.

2. Arrange disposal of surplus equipment.

3. Perform inventories in Prince Albert district office and complete NoFC.

13. Publications 1990-91:

Nil

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Fawcett	0.5
	Sayko	1.0
	Keryliuk	0.5
	Total:	2.0

O & M: $19,900

Capital: Nil

16. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-51-05

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 15, 1991

1. Project: Management Services

2. Title: Building Maintenance

3. New: Cont.: X 4. No.: NOR-51-05

5. Study Leader: H. Schoendube

6. Key Words: Maintenance, building upkeep, building repairs, major renovations

7. Location of Work: NoFC

8. Problem:

   N/A

9. Study Objectives:

   To conduct maintenance and repairs to the NoFC facilities to ensure they are in a superior state of upkeep and repair, supervise the construction and/or renovation of facilities at NoFC.

10. Goals for 1990-91:

    1. Provide general maintenance in the building.

    2. Clear snow from driveways and parking lots as required by 7:30 am the day following a storm.

    3. Maintain the grounds during the summer, including cutting the grass, planting flowers, and maintaining flowers and shrubs.

    4. Live within budget provided unless overexpenditure specifically approved by Manager, Management Services. Forecast expenditures monthly. Starting July 1990.

5. Continue the regular preventative maintenance program. By December 1990 have system computerized with all information input.

6. Oversee the electrical contract.

7. Realign and level northside fence.

8. Replace and or fabricate and install new wooden enclosures for court-yard flower bed and southend lawn area.

9. Replace some tools and replenish the stock of parts and electrical motors.

10. Replace the caulking of all concrete cladding joints of the building's perimeter walls at a cost of appr. 75 K.

11. Commence renovation of front lobby at appr. 100 K.

12. Modify washroom facilities on main floor to accommodate wheelchair access. Estimated cost 10 K.

13. Upgrade air conditioning in boardroom.

14. Upgrade boardroom to accommodate more people (project could involve major renovations of the administration wing).

15. Exchange the power operated steam generator, used for the operation of the still, with either a gas fired steam generator or a reverse osmosis unit.

16. Upgrade the heating facilities for the chemical storage rooms from electric to natural gas. (This is in accordance with recommendations given through the energy audit which was conducted by the provincial energy conservation survey).

17. Maintain the berm, replace damaged or dead trees, and keep the weeds under control.

18. Build insectary for Dr. D. Langor next to the northend of the metal shed.

19. Complete renovation in room 2053 (FIDS), including installation of T-bar ceiling and new light fixtures.

11. Accomplishments in 1990-91:

1. Provided general maintenance in the building.

2. Cleared snow from sidewalks and parking lots as required by 7:30 AM. the day after the storm.

3. Maintained the grounds during the summer including cutting the grass, planting flowers, maintaining flowers and shrubs.replacing dead or damaged trees on the berm and keeping the weeds under control.

4. Lived within the budget provided unless over expenditures were approved by the Manager, Management Services. Forecasts were provided for the months of July 1990 throughout the month of December 1990.

5. Continued regular preventative maintenance program as outlined in the work schedule and the respective work orders issued for this proposal.

6. Oversaw the electrical work done by Public works Canada.

7. Realigned and levelled parts of the North fence and gates.

8. Replaced the wooden ties around the shrubbery beds in the court-yard.

9. Replaced $964.00 worth of tools and replenished our stock of parts and electrical motors at a cost of $ 14,000.00.

10. Replaced all caulking around the cladding on the buildings perimeter walls at a cost of $ 59,200.

11. Started on front lobby plans through Envirotech.Due to Government restraint program this project was cancelled.

12. Modified a washroom facility on the main floor in Admin.to accommodate access for wheelchair users at a cost of $2000.00

13. Demolished the vault in M006 and integrated this area with room M005 into a new office space for Program Director.

14 Upgraded boardroom by taking down the wall between room M007 and M009, installing a new self contained air conditioning unit for rooms M007, M010 and M011,installed a T-Bar ceiling in M007 as well as new carpet tiles at a total cost of $ 19,500.00.

15. Acquired a Reverse Osmosis machine to replace the water still in the penthouse.

16. Upgraded the heating for the chemical storage rooms from electric to a natural gas boiler at a cost of $ 1,200.00.

17. Built an insectary for Dr. Langor next to the northend of the storage shed at a cost of $8,800.00.

18. Completed renovations in room 2058 . Divided this room into three small offices with a drop ceiling (T- Bar). Added electrical outlets,changed arrangement of ceiling lights, and mounted several bookcases as requested.

<u>Added Accomplishments</u>

19. Built a computer desk for M025.

20. Assisted in overseeing the cleaning contract.

21. Relocated white board from M005 to 2013 .

22. Painted 25 rooms throughout the building.

23. Repaired the TV cart in the lobby.

24. Installed a bookshelf in 2053.

25. Installed a bookshelf in 3067.

26. Repaired telephone outlets in M013 and M020.

27. Converted the room 2058 into three separate office for the FIDS. this included adding some electrical outlets,changing the ceiling to a T-BAR type ceiling and hanging bookcases.

28. Mounted some shelves in M012 and painted this office.

29. Mounted shelves and painted room no. M027.

30. Removed all drain piping from 2062 because of a bad odour and replace it with new piping.

31. Repaired some display lights for H.Stewart.

32. Repaired a humidifier in the photo-lab.

33. Repaired a fumehood drain in M043.

34. Repaired five blenders for C. Feng.

35. Removed a bookcase from 3001.

36. Renovated rooms #3035 and 3036 for some new tenants.

37. Modified the drainage under the fumehoods in M109 .We added separate p-traps to all sinks in that lab with lab-line.

38. Removed hallway door from 2058.

39 Repaired a clock and a scale from M095 and B070 .

40. Installed an aspirator in M109.

41. Repaired a chair for word processing and another for finance in M015.

42. Repaired some tiles in 2068.

43. Removed a map and moved a credenza in room no.M011.

44. Made some renovations for EPS on the third floor. (i.e., removed counters and bookshelves from 3067 and reinstalled in another room).

45. Replaced the pop cooler display case in the kitchen.

46. We installed a new refrigerator for keeping staff lunches.

47. Repaired a chair in room 136A.

48. Repaired the desk in 2058 A.

49. Installed a hasp on a cabinet for computing dept in the storage shed.

50. Fabricated four red triangular warning signs for F. Dendwick's project.

51. Fabricated a new storage box for pens in the central registry.

52. Cut down a dozen dead trees from the nursery.

53. Installed some handicap parking signs at the North parking lot.

54. Installed three bookcases in M075.

55. Installed a new lock on a drawer in the reception area.

56. Removed two bookcases from B001 and installed one in 2043 the other in 2046.

57. Relocated four bookcases from 3067 to 3069.

58. Mounted twenty nine picture frames in the cafeteria on the East wall that was dedicated as a Wall for Retirees.

59. Removed the wall out between M007 & M009 to expand the boardroom. We resurfaced and painted the walls.

60. Controlled work and materials by issuing 259 work orders for all projects undertaken and kept an inventory of spare parts.

61. Completed the painting of the ceiling tiles in all main corridors.

12. Goals 91-92:

1. Provide general maintenance in the building.(ie: repair furniture, paint desks, walls, move the chairs and tables around in conference room etc,).

2. Clear snow from driveways, parking lots and sidewalks,as required by 7:30 the day following a storm.

3. Maintain the grounds during the summer,including cutting the grass, planting flowers, maintaining flower beds and shrubs, replacing damaged trees and keeping the weeds controlled on the berm.

4. Live within the budget provided unless overexpenditure specifically approved by the Manager,Management services. Forecast expenditures monthly starting July 1991.

5. Continue the regular preventative maintenance program.Finalize computer program by January 1992.

6. Oversee the electrical work done by Public Works Canada.

7. Realign and level the northwest fence and raise posts to the proper level.

8. Install new wooden enclosures for the shrubs at the south lawn area.

9. Replace broken and worn out tools . Replenish our stock of parts and electric motors.

10. Complete the upgrading in the boardroom.

11. Oversea the renovations to the conference area in the basement at an estimated cost of $225,000.00.

12. Replace the cooling coils on the supply air system number (1) one at an estimated cost of $ 45,000.00.

13. Complete renovations to the library, and the changes brought on by the new space allocations.

14. Complete the upgrades to the boiler controls at an estimated cost of $25,000.

15. Install a separate self contained air conditioner for the admin wing. Estimated cost of this project is $ 40,000.

16. Modify the John deer tractor to accommodate an existing snow blower at a cost of approx. $500.00.

17. Keep control of work and material by issuing work orders for all projects undertaken.

18. Paint all main corridors in the building.

13. Publications 1990-91:

N/A

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Schoendube	0.5
	Thibodeau	0.9
	Schmidt	1.0
	Burton	1.0
	Total	3.4

O & M: $31,600

Capital:

Construction: $ 45 K

16. Signatures:

H. Schoendube
Investigator

Manager, Management Services

Regional Director General

NOR-51-06

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 3, 1991

1. Project: Management Services
2. Title: Building Operations
3. New: Cont.: X 4. No.: NOR-51-06
5. Study Leader: H. Schoendube
6. Key Words: Building operations
7. Location of Work: NoFC
8. Problem:

   N/A

9. Study Objectives:

   To maintain the heating, ventilation, and air conditioning systems at NoFC.

10. Goals for 1990-91:

    1. Monitor energy savings and effect cost savings in relation to laboratory operations with respect to air quality and heat distribution.

    2. Daily monitor the operation of the boilers and equipment to ensure safe and efficient operation.

    3. Daily check the greenhouses and adjust temperature, air, etc. to meet specifications set out by the greenhouse users and similarly for the chemical storage rooms. Keep records of numbers of daily checks.

    4. Carry out daily building checks and make adjustments as required to the heating, ventilating, air conditioning, and safety system to ensure safe and efficient operations.

5. Provide heat, light, natural gas, water, and air conditioning services to the building.

6. Carry out preventative maintenance on boilers and associated equipment as required.

7. Control work and material by issuing work orders for all projects undertaken.

8. Supervise cleaning, waste management, elevator maintenance, and commissionaire's contracts to ensure a high quality of services. Update content, specifications and retender as required.

9. Reslope gravel bed around greenhouses by August 31, 1990.

10. Provide drainage ditch to the southend of greenhouses by August 31, 1990.

11. Clean and paint boilerroom by 30 April 1990.

12. Clean and paint penthouse by 30 September 1990.

13. Install fluorescent lights in penthouse by 30 September 1990.

14. Purchase and install cooling coil in H&V discharge ducts by 31 July 1990.

15. Purchase and install PC terminal in boilerroom office by 30 April 1990.

16. Implement a system to ensure commissionaires in the building check out and in before and after doing their external rounds.

11. Accomplishments in 1990-91:

1. Monitored energy savings & effective cost savings in relation to laboratory operations for heat and air distribution.

2. Monitored the operation of boilers & equipment daily to ensure safe efficient operations.They were maintained above 80%.

3 Checked greenhouses and chemical storage rooms daily, adjusted temperatures, humidistats, to meet the specifications set out by users of greenhouses and chemical storage rooms. Performed 15,875 readings from 1 Jan 90 to Dec. 31 1990.

4. Carried out daily building checks and made the required adjustments to ensure heating,ventilating,air conditioning and safety systems were working in a safe and efficient manner.

5. Provided heat,light,power,natural gas,water, compressed air and air conditioning for the building.

6. Carried out preventative maintenance on boilers and associated equipment. In 1990 this involved dismantling of each piece of equipment, gauging the wire replacing worn or defective pieces and assembling the equipment again. This also included cleaning and testing.

7. Controlled work and materials for all projects and repairs undertaken. Issued 275 work orders in 1990.

8. Supervised contracts for cleaning, waste management, elevator maintenance, commissionaire, and ensured high quality of service was maintained, updated content and tendered contract specifications.

9. Cancelled the sloping of gravel beds until a commitment is made in regards to further greenhouse use.

10. Cancelled drainage ditch for the same reasons as # 9.

11. Cleaned boiler room and started repainting. Completed 60%.

12. Started cleaning but had to stop as another project interfered with these plans see item 13. To date 20% completed.

13. Installed fluorescent lights in penthouse in exchange for high wattage incandescent fixtures. Work was completed Oct 90.

14. Put on hold the purchase and installation of H & V cooling coil because of renovation plans to admin wing.

15. Computer terminal was installed in the boiler room office by the middle of June and is a definite asset. The terminal is used for mail, safety minutes, First aid and CPR files, equipment update information etc.

16. Implemented a checking system through the Canada Place Commissionaires Station to ensure the safety of commissionaires when they are making outside rounds.

Additional accomplishments:

17. Rehung and aligned air receiver tanks in boiler room.

18. Replaced nine pumps for swamp coolers that were not working.

19. Replaced salt brine tank in boiler room.

20. Recalibrated safety valves on # 1 & # 2 boilers.

21. Tested building for heat loss with D.P.W. on 11 October 90.

22. Replaced PRV for special cooling tower and some water lines.

23. Moved equipment and trailers north of shed for beautification of site.

24. Tested fire alarms and smoke detectors twice, April and October. .

25. Purchased and installed new batteries for emergency generator.

26. Cleaned electrostatic filters [twice].

27. Acid cleaned cooling coils.

28. Installed new telephone lines to and in various rooms as requested approximately 20 moves.

29. Operated hot water boiler and equipment to conserve energy from May to October.

30. Repaired lagging and insulation in equipment rooms.

31. Repaired condensate lines in boiler room.

32. Checked, cleaned and tested HVAC unit on the roof of stores on a monthly schedule.

33 Participated in the preparation of a mission statement for management services.

12. Goals for 1991-92:

1. Monitor energy savings and effective cost savings in relation to laboratory operations with respect to air quality and heat distribution.

2. Monitor the daily operation of boilers and equipment to ensure a safe and efficient operation.

3. Carry out preventative maintenance on boilers and associated equipment as required.

4. Daily check the chemical storage rooms, coldrooms, greenhouses and adjust temperatures, air, etc. to meet the specifications set out by users.

5. Carry out daily building checks and make adjustments as required to the heating, ventilation, and safety systems to ensure safe and efficient operation.

6. Control work and materials by issuing work orders for all projects undertaken.

7. Provide heat, light, natural gas, water, vacuum, and air conditioning services to the building.

8. Supervise cleaning, waste management, elevator maintenance and commissionaire's contracts and ensure a high quality of service is maintained. Meet monthly with cleaning contractor to discuss performance and problems. Document all meetings. Renew and re-tender contracts so no lapses in service occur.

9. Operate hot water boiler and equipment to conserve energy from May to October.

10. Test fire alarms and smoke detectors twice yearly.

11. Complete the cleaning and painting of the boiler room by December 1991.

12. Complete the cleaning and painting of the penthouse by December 1991.

13. Remove, purchase and install cooling coils in # 1 unit by contractor. Complete project by 1 June.

14. Replace/update wiring and boiler controls.

15. Calibrate or replace all "Bailey Meter" equipment.

16. Overhaul / replace # 12 condensate transfer pump and purchase and install new condensate receiver tank.

17. Install capacitors in switching gear.

18. Start installation of separate air systems for administrative wing.

1991-92

19. Replace lines in headerhouse pits if commitment is made for greenhouse use. ($3,000)

20. Install insulation to lines in pits of headerhouse as for above. ($2,500)

21. Replace control air lines in greenhouses. ($3,000)

Goals for long range planning next five years.

1992-93

1. Overhaul # 31 air compressor top end.

2. Replace / recalibrate safety valves on unfired pressure vessels.

3. Overhaul condensate transfer pump in basement. 6.0 k

1993-94

1. Overhaul emergency power generator.

2. Ultrasound unfired pressure vessels.

3. Overhaul vacuum pump.

4. Overhaul chiller pumps if required. 15.0 k

1994-95

1. Overhaul cooling water pumps for chillers.

2. Overhaul chilled water pumps.

3. Overhaul / replace control air compressor. 7.0 k

1995-96

1. Overhaul / replace # 31 air compressor.
2. Replace vacuum pump for chillers.
3. Recalibrate boiler safety valves. 7.5 k

1996-97

1. Overhaul demineralizer. 5.0 k

13. Publications 1990-91:

Nil

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Schoendube	0.4
	Fisher	0.75
	Lybbert	1.0
	De Costa	0.9
	Total	3.05

O & M: $262,700

Capital: Minor Construction: $25,000

16. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-51-08

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 15, 1991

1. Project: Management Services

2. Title: Camps

3. New: Cont.: X 4. No.: NOR-51-08

5. Study Leader: H. Schoendube

6. Key Words: Camps

7. Location of Work: Hinton, Chip Lake, (Alberta), Candle Lake, (Saskatchewan), Oakbank (Manitoba)

8. Problem:

N/A

9. Study Objectives:

To maintain the Physical Facilities of the NoFC camps at Hinton, Candle Lake, Chip Lake, and Oakbank.

10. Goals for 1990-91:

1. Open and close Hinton Camp in spring and fall of 1990 respectively.
2. Replace propane gas line on undercarriage of trailers with black iron piping.
3. Clean out the water well.
4. Revarnish doors on trailers that require painting.
5. Repair undercarriage of some of the trailers.

6. Repair some windows and screen doors.

7. Replace all stairs for the trailers. (old ones are in a poor condition).

8. In Candle Lake camp raise the floor of the centre section of the log buildings to make the floors level.

9. Replace the cracked sink in the north end log building.

10. Install a dead bolt lock in northern log building.

11. Replace all curtains in log building.

12. Provide for propane, light, and water for the summer season.

13. Arrange for contract cleaning of all trailers including walls, floors, furniture, kitchen appliances, etc. by May 31, 1990.

14. Bring back propane tank and generator from Chip Lake by May 31, 1990.

11. Accomplishments 1990-91:

1. Opened the Hinton campsite in May and closed it in September

2. Not completed because of time constraints.

3. Arranged for the contract and completed the cleaning out of the well.

4. Did not revarnish the trailer doors because time did not permit.

5. Repaired the undercarriage of five trailers where mice and squirrels gained access.

6. Repaired broken windows on three (3) trailers.

7. Replaced the stairs and decks on all the trailers.

8. Repaired the cabin in Candle Lake. Repaired a leak in the water line. Levelled the floors

9. Replaced the sink in the north cabin.

10. Repaired the door lock on the north cabin.

11. Replaced all curtains in the log building.

12. Provided the camp with propane, electricity and water for the summer season.

13. Oversaw the cleaning of all trailers in Hinton camp including walls, floors, furniture, kitchen appliances, etc. by June 30,1990.

14. Brought back the generator from Chip Lake.

Added Accomplishments.

15. Oversaw the contract to move two trailers from Chip Lake to Hinton to replace the two which were sold.

16. Reroofed a small storage shed on the northeast end of the compound in Hinton camp.

12. Goals for 1991-92:

1. Open and close camps - spring and fall of 1991.

2. Arrange for electricity, propane and water at Hinton and Candle Lake field stations.

3. Replace the copper line under two (2) trailers in Hinton with black iron piping.

4. Arrange for the cutting of the grass at the Hinton field station through C. Rentz.

5. Revarnish trailer doors where required.

6. Block and level two (2) trailers which were moved from Chip Lake to Hinton trailer camp.

7. Arrange for cleaning of these two trailers.

8. Repaint eavesthroughs on log cabin in Hinton.

9. Revarnish eavesthroughs and exterior of the log cabins in Candle Lake camp, revarnish the interior windows.

10. Arrange for the sale of the two (2) remaining trailers in Chip Lake camp.

11. Arrange to have the propane tank and the water trailer moved from Chip Lake to Edmonton and the disposal of the metal storage shed.

12. Arrange to have the septic tank pumped out at Hinton camp.

13. Publications 1990-91:

N/A

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Schoendube	0.1
	Thibodeau	0.1

De Costa	0.1
Total:	0.3

O & M: $3,300

16. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-51-09

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 15, 1991

1. Project: Management Services

2. Title: Vehicles

3. New: Cont.: X 4. No.: NOR-51-09

5. Study Leader: G.R. Fawcett

6. Key Words: Vehicles

7. Location of Work: Northwest Region

8. Problem

N/A

9. Study Objectives:

To maintain an adequate fleet to meet the needs of NoFC and to report the necessary information in order to perform proper fleet management.

10. Goals for 1990-91:

1. Assign vehicles for the 1990 field season by May 1, 1990.
2. Integrate 1990/91 replacement vehicles into the fleet. Dispose of the vehicles the new ones are replacing.
3. Order 1991/92 replacement vehicles in October 1990.
4. Ensure all vehicles in the fleet have the required maintenance performed on them per a written maintenance schedule. Perform scheduled safety maintenance requirements.
5. Provide monthly the required FMIS information by the 10th of the following month using the computerized system.

6. Develop by April 30, 1990 the kilometre charges which included both gasoline and repairs for 1990/91. By the tenth (10) working day of the following month provide to Finance the charges by study for the previous month.
   Implement a rate which includes both gasoline and repairs.

7. Within reason satisfy all requests for vehicles during the fiscal year.

8. Do not exceed the budget provided without permission from the Manager, Management Services.

9. Ensure proper safety and winter emergency kits are available in vehicles stores.

10. To arrange for the permanent mounting of vehicle extension cords during the winter season.

11. Complete the changing of decals on all vehicles to Forestry Canada decals.

11. Accomplishments for 1990-91:

1. Assigned vehicles for the 1990 field season by May 1, 1990.

2. Integrated 7 1990/91 replacement vehicles into the fleet. Disposed of the 7 vehicles the new ones replaced.

3. Ordered 9 1991/92 replacement vehicles in October 1990.

4. Ensured all vehicles in the fleet had the required maintenance performed on them per a written maintenance schedule. Performed scheduled safety maintenance requirements.

5. Provided monthly FMIS information by the 10th of the following month using the computerized system.

6. Developed by June 1, 1990 the kilometre charges for 1990/91. By the tenth (10) working day of the following month provided Finance with the charges by study for the previous month.

7. Within reason all requests for vehicles during the fiscal year were satisfied.

8. The budget provided was not exceeded without permission from the Manager, Management Services.

9. Ensured proper safety and winter emergency kits were available in vehicles stores.

10. Arranged for the permanent mounting of 40 vehicle extension cords during the winter season.

11. Completed changing decals on all vehicles to Forestry Canada decals.

12. Goals for 1991-92:

    1. Assign vehicles for the 1991 field season by May 1, 1991.

    2. Integrate 1991/92 replacement vehicles into the fleet. Dispose of the vehicles the new ones are replacing.

    3. Order 1991/92 replacement vehicles in October 1991.

    4. Ensure all vehicles in the fleet have the required maintenance performed on them per a written maintenance schedule. Perform scheduled safety maintenance requirements.

    5. Provide monthly the required FMIS information by the 10th of the following month using the computerized system.

    6. Develop by April 30, 1991 the kilometre charges which includes both gasoline and repairs for 1991/92. By the tenth (10) working day of the following month provide to Finance the charges by study for the previous month.
       Implement a rate which includes both gasoline and repairs.

    7. Within reason satisfy all requests for vehicles during the fiscal year.

    8. Do not exceed the budget provided without permission from the Manager, Management Services.

    9. Ensure proper safety and winter emergency kits are available in vehicles stores.

13. Publications 1990-91:

    Nil

14. Environmental Implications:

    N/A

15. Resources 1991-92:

PYs:	Fawcett	0.5
	Keryliuk	0.5
	Total:	1.0

O & M: $8,200

Capital: $ 122,200 Vehicles (9)

16. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-51-10

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: January 3, 1991

1. Project: Management Services
2. Title: Safety
3. New: Cont.: X
4. No.: NOR-51-10
5. Study Leader: H. Schoendube
6. Key Words:
7. Location of Work: NoFC
8. Problem:

   N/A

9. Study Objectives:

   To provide safety training to NoFC employees.

10. Goals for 1990-91:

    1. Conduct four (4) First Aid requalification courses.
    2. Conduct one (1) First Aid Courses.
    3. Conduct two (2) CPR courses.
    4. Requalify two (2) First Aid instructors.
    5. Provide SCBA and fire extinguisher training and demonstration.
    6. Provide two (2) "Student Orientation Programs" during the spring of '90.

7. Carry out twelve (12) safety inspections of building, equipment, and grounds.

8. Select and send several staff members on safety and W.H.M.I.S. upgrading grounds.

9. Purchase up-dating supplies for safety, First Aid, and CPR.

11. Accomplishments 1990-91:

1. Conducted two [2] requalification First Aid courses. Trained 10 people.

2. Conducted three [3] First Aid courses. Trained 30 people.

3. Cancelled both CPR courses. Not enough interest.

4. Re-qualified two First Aid and CPR instructors.

5. Provided SCBA and fire extinguisher training for maintenance staff.

6. Provided two [2] Student Orientation Programs during Spring of 1990. The number of attendees was 19.

7. Carried out 12 safety inspections of the buildings and equipment.

8. Selected and sent training list to Labour Canada for loading of upcoming courses.

9. Purchased training supplies and emergency air for S.C.B.A. [Scott air packs].

Added Accomplishments:

10. Purchased and installed emergency air supply for Room 2004.

11. Updated mailing list for Safety Meeting minutes.

12. Instructed training programs [CPR and First Aid] for other Government Departments. The number of attendees was 20.

13. Carried out inspections with Labour Canada.

12. Goals for 1991-92:

1. Conduct two [2] First Aid requalification courses.

2. Conduct three [3] First Aid courses.

3. Conduct two CPR courses.

4. Requalify First Aid and CPR instructors.

5. Provide training and demonstrations with SCBA and fire extinguishers.

6. Provide two [2] Student Orientation Programs during Spring 91.

7. Carry out twelve [12] safety inspections of building, equipment and grounds.

8. Select and send several members on safety and WHIMIS training courses.

9. Purchase up dating supplies for safety, First Aid and CPR.

10. Carry out safety inspections with Labour Canada personnel.

13. Publications 1990-91:

N/A

14. Environmental Implications:

N/A

15. Resources 1991-92:

PYs:	Fisher	0.25
	Total	0.25

O & M: $2,600

16. Signatures:

H. Fisher
Investigator

Manager, Management Services

Regional Director General

NOR-51-11

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: April 19, 1991

1. Project: Management Services

2. Title: Greenhouse and nursery operations

3. New: Cont.: X Term: 4. No.: NOR-51-11 (formerly NOR-12-05)

5. Study Leader: vacant

6. Key Words: NoFC greenhouse and nursery, facilities maintenance, management and planning

7. Location of Work: NoFC, Edmonton

8. Study Objectives:

   1. To administer NoFC greenhouse and nursery facilities.

   2. To provide advice on rearing bareroot and container stock to NoFC R & D staff.

9. Problem:

   N/A

10. Goals for 1990-91:

    1. Administer and maintain the NoFC greenhouse and nursery facility.

    2. Maintain the nursery area by weeding, rotortilling and other cultivation.

    3. Cultivate and fertilize the Colorado spruce component of the nursery shelterbelt and continue the upkeep and pruning of the poplar trees and removing dead trees.

    Added Goal:

4. Establish a committee to look at the future requirements for the greenhouse and nursery facilities and to come forth with proposals for maintenance and management of the facilities.

11. Accomplishments in 1990-91:

1. Administered and maintained the NoFC greenhouse and nursery faciltiy.

2. Maintained the nursery area by weeding, rototilling, and other cultivation.

3. Cultivated the Colorado spruce component of the nursery shelterbelt but no fertilization was done owing to lack of funds. Poplar trees within the shelterbelt were prunned, as required and dead trees were removed.

4. A meeting was held of the major users of the green house nursery facilities to discuss its future managmeent. Agreed that the major users would rotate managing the facilities and this procedure would be reviewed during the year. Request would be made to hire a summer student to help with maintenance of facilities, particularly the nursery.

12. Present Status of Study:

Three greenhouses, a headerhouse and a nursery have been administered for the benefit of users at NoFC and other agencies.

Assistance is provided to all users of the facility re cultural practices, fumigation, and application of herbicides and pesticides.

The greenhouses are kept tidy for the benefit of other users and the nursery facility is weeded and cultivated each growing season.

Advice on safety procedures and on proper clothing has been provided to greenhouse users.

Chemicals, equipment, and supplies for general use have been ordered for the greenhouse users and an inventory of material is maintained.

Bedding plants and tropicals have been grown and maintained for the building and grounds at NoFC, but this activity has been terminated.

Management of the greenhouse and nursery will be carried out by a team of the major users on a rotation basis. Nursery equipment maintenance will be the responsibility of the user with assistance from the building maintenance staff.

13. Goals for 1991-92:

1. Administer and maintain the NoFC greenhouse and nursery facility.

2. Maintain the nursery area by weeding, rotortilling and other cultivation.

14. 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.

15. Publications 1990-91:

Nil

16. Duration:

Start: 1984 Completion: Ongoing

17. Resources 1991-92:

PYs: (covered under other studies)

O&M: $2,500

18. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-53-01

FORESTRY CANADA

STUDY WORK PLAN

1991 - 92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: February 15, 1991

1. Project: Computing and Data Processing Services.

2. Title: Computing and Data Processing Services.

3. New: Cont.: X 4. No.: NOR-53-01

5. Study Leader: W. Chow

6. Key Words: Computing, electronic data processing (EDP), systems analysis, workstations, telecommunications, office automation, EDP training, personal computers, data entry.

7. Location of work: Northwest Region

8. Study Objectives:

   1) To manage the Computer Centre and provide computer and data processing services for scientists, personnel, and administrative staff and to provide consulting services regarding various types of analyses using the in-house computer (VAX 8350), personal computer systems, work stations, and other collection and analytical systems for mathematical and scientific analyses, financial, personnel and management systems. To provide EDP planning assistance as projects attempt to acquire new computing resources - by reviewing needs, assisting with justifications, helping to prepare purchase orders and getting quotes. Recommending hardware repair bureaus. Preparing yearly estimates for EDP services and acquisiitions. Making site visits to the district offices.

   2) To provide programming services for the VAX, micro computers and field recorders as required; to help users with debugging problems with their own programming. To develop and maintain programs and systems on the various computers. To advise on statistical procedures and packages available, computer related problems, program analysis and design, and to provide any other computer related services and advice which may be required by NoFC staff, other agencies or outside users who are working on joint projects with NoFC.

3) To provide system management of the VAX by finetuning the system and disk usage distribution, updating systems and developing system tools to help users with their computing, preparing system user manuals and informing users as to changes necessary when upgrades are installed and to help users with PC and workstation to VAX communications. To install new systems - PC, workstation, and VAX - providing networking, cabling and connections, installing and testing software and assisting with any adjustments and upgrades. To trouble-shoot harware problems and assist with software problems; maintain all EDP software and assist with diagnosing hardware problems.

4) To provide training on various software packages used on the VAX and other computers, consulting and programming assistance on the usage of the in-house computer, work stations, personal computers, plotters, printers and graphics terminals. To trouble-shoot software problems, and assist with hardware problems. Prepare forms and macros for users to assist with various reports. Prepare user handouts which reflect the information in the training sessions. Assist with EDP planning.

5) To provide data entry and operational assistance, tape backup and restore, address label printing and national workplan updates. Service the various EDP hardware by changing ribbons, cleaning read heads, changing pens, adding paper and recording usage statistics of the laser printers.

9. Goals for 1990-91:

1. Prepare yearly report on computer usage by projects.

2. Prepare the annual EDP report (IMP) for headquarters by updating the various tables, by March 1, 1991.

3. Assist users buying EDP products with justification statements.

4. Maintain communications with the ForCan EDP director, coordinator and other EDP people at HQ.

5. Participate in a publishing study at NoFC and offer suggestions as to hardware and software selection.

6. Prepare the annual study and project plans, including budget estimates for the Computer Centre, by February 25, 1991; prepare the annual EDP requirement plans for the Computing Centre, by February 25, 1991.

7. Prepare the annual Computing Centre staff appraisals, by March 15, 1991.

8. Write, modify or adapt programs and systems as required and provide documentation; develop, expand and maintain programs and systems.

9. Assist with the installation of the various information systems.

10. Continue with the national work plan rollup and enter year end corrections.

11. Prepare a charge-back system to reflect EDP charges for VAX usage by project (and study).

12. Prepare a study workplan automated system; data would be generated from the Wordperfect files held by the steno pool and updated as needed by study leaders.

13. Provide training and assistance as required with in-house courses.

14. rouble-shooting when users have problems with their terminals, PC's, programmes, other software, laser printers, graphics and plotters.

15. Revise and upgrade Computer Centre handout pamphlets, as required when changes are made to exisiting equipment and software.

16. Assist users with INGRES, DATATRIEVE, MINITAB and SAS and other systems.

17. Provide data entry, backup-restore services and other operations services required by various projects.

18. Continue with assistance to the district offices regarding personal computers, data processing, word processing and telecommunications; make regular site visits to both offices.

19. Keep current with all aspects of computing, word processors, personal computers and telecommunications by attending workshops, trade shows and reading trade magazines and literature, by attending meetings of the local computer group - EARLUG (Edmonton ARea Local Users Group - a DECUS affiliate).

20. Tune the laser printers, network, VAX, PACS and Wordperfect; expand and maintain the local area and printer networks and set up new fonts for the HP laser printers. Install printer server and Decserver 500 upgrades. Test software for the VAX and PC's on a loan basis.

21. Four summer students to assist with SAS, INGRES, MMIS, SYDNEY, LABEL system, fire section programming, FIDS section, takes the operator's place when she's on holidays, help with systems, other programming and trouble-shooting.

22. Participate in the testing of the HQ PIMS system - NoFC to be a test site for this updated system.

23. Assist with installation of the finance section's updates to the FINCON and pay systems here and in the district offices.

24. Attend technical meetings with ARC and LFW regarding the use of ARC/INFO on the ARC's VAX.

10. Accomplishments for 1990-91:

1. Prepared yearly report on computer usage for presentation at the computers users meeting April 4, 1991.

2. Prepared the annual HQ (IMP) report, by updating the various tables, by March 1, 1991.

3. Assisted with 6 PC justifications and with 20 purchases of other EDP equipment - laser printers, scanners, expansion boards, various software packages - Symphony, Wordperfect, Drawperfect, Harvard graphics, Ventura Publishing, Corel Draw, Windows 3, etc. by going over features of products and reviewing tenders.

4. Kept in contact with the ForCan EDP coordinator (Scott Burrell) and the Director of ForCan EDP (Misa Gratton) - both were here for site visits during the year and several phone calls were made, as well as meeting with them and the other people at HQ at the ITAC meeting in Petawawa.

5. Participated in a publishing upgrade study at NoFC and made suggestions as to hardware and software. Exchanged a monichrome monitor for a VGA monitor and installed new releases of software, as received.

6. Prepared the annual study-work and project plans, including the budget estimates for 1991/92, by February 25, 1991, and the EDP capital acquisition plans for the Computer Centre for 1991/92, by February 15, 1991.

7. Prepared annual Computing Centre staff appraisals for 1990/91, by March 15, 1991.

8. Wrote (w), modified (m) or adapted (a) programs and systems, including the following:

a) DAP data entry program for Resources -	major	w
b) DAP data entry program for FIDS -	major	w
c) Mailing list letter program -	> 1 day	w
d) Repid program - development -	> 1 day	w
e) Convert program for Radford -	> 1 day	w
f) Damage analysis program - Resources -	major	w
g) SAS / graph - Maynard -	> 1 day	w
h) Training / conference - Admin	major	m
i) Committee report - Admin	> 1 day	m
j) Mailing list system - Info Centre / Devel	major	m
k) DEVMIS - Development	major	m
l) Publication Inventory - Development	> 1 day	m
m) Library System - Development	< 1 day	m
n) Budget system - Admin	> 1 day	m
o) Label Database - development	< 1 day	a
p) Wordperfect macros - various	major	w
q) RAF routines - Radford	> 1 day	w
r) Workplan prototypes - Management	> 1 day	w
s) Databases for EDP wiring - Computer Centre	> 1 day	w
t) Bar Code / INGRES - Admin	major	m
u) Commands for file transfer - Admin	< 1 day	w

v) PM phone messages from receptionist to all	> 1 day	w
w) Performance analysis for VAX - Comp Ctr	< 1 day	w
x) SHIP program - Computer Centre	< 1 day	m
y) MEMO macro - all	< 1 day	m
z) Competition macro - personnel	> 1 day	m
aa) Appointment macro - personnel	> 1 day	m
bb) Resource allocation form - Management	> 1 day	m
cc) Priority macro - personnel	> 1 day	w
dd) Staff memo macro - Admin	> 1 day	w
ee) LPSIM interface - Resources	> 1 day	m
ff) Numerical programs - Resources	major	w/m
gg) Justification macro - Computer Centre	> 1 day	w
hh) Training report - Admin	major	w/m
ii) Report program - Admin		majorw/m
jj) Forms design and macros - Admin	> 1 day	w
kk) Notify program - Computer Centre	> 1 day	m

9. Installed the new MMIS system and various software updates - Datatrieve, VMS, C, MINITAB, INGRES, FORTRAN, LMS, etc.

a) Bitstream fontware
b) MS-DOS
c) Norton Utilities
d) PCSA/DECNET-DOS
e) Windows 386 and 3.0
f) Ventura
g) Corel Draw
h) Scanning Gallery
i) Wordscan
j) Adobe type manager
k) Postscript typefaces
l) PC Paintbrush
m) Freedom of Press
n) Publishing special software drivers and programs
o) RAF
p) SAS
q) Wordperfect-DOS
r) Wordperfect-VMS
s) Wordperfect utilities
t) Wordperfect Office
u) Y-modem

10. Completed the old year and new year national work plan entries and revisions.

11. Enhanced the VMS reporting system to give VAX usage by project and/or study - gives CPU usage by user. Also reports on DATAPAC usage were prepared and both are now set up to automatically print out on month's end.

12. Automated study-work plan - this project was put on hold after meeting with the PIMS people from Ottawa, who are incorporating these features into their system, which we are evaluating - see # 22.

13. Gave in-house courses to new users of the VAX system. Prepared, updated and presented VAX and PC courses to personnel in the district offices and NoFC, including the following:

a) Wordperfect	36 attendees
b) Planperfect	4 attendees
c) Intro to VMS	7 attendees
d) Intro to SAS	12 attendees
e) Intro to PC and DOS	2 attendees
f) Intro to Lotus 1-2-3	6 attendees
g) Intro to VMS Mail	3 attendees

14. Did trouble-shooting when users had problems with their terminals, PC's, laser printers, graphics and plotter, response time was within 15 minutes for 90% of the time; other requests required sending things out for repairs, where the turn around was dependent on the supplier; most repairs were done within a week; the odd piece of equipment had to be surplussed due to high repair costs, which would not be cost-effective - a new item was recommended or a replacement was located.

15. Wrote and upgraded several pamphlets on how-to-use the printers, plotter, Wordperfect, E-mail, etc., including:

a) Tricks, Techniques and Shortcuts in Wordperfect 5.0
b) Moving to Wordperfect 5.0 from 4.2
c) Using Fonts in Wordperfect 5.0
d) Using the Memo, Letter and Label Macros in Wordperfect 5.0
e) File Transfers between the NoFC VAX and a PC
f) DAP data entry manuals
g) Training/conference user manual
h) MLIST manual update
i) Publication Inventory user manual.

16. Assisted users with DATATRIEVE, MINITAB, INGRES and SAS systems used for data bases and statistics; helped with database organization, programmes and other software problems:

a) organize files - Resources	> 1 day
b) ICP program - Radford	major
c) SAS - 3 users	< 1 day each
d) Mailing list - 8 users	< 1 day each
e) Training/conference data - Admin	< 1 day
f) Planperfect - Development	< 1 day
g) Publication Inventory - Development	< 1 day
h) Fortran - Fire	< 1 day
i) Wordperfect consulting - all	> 100 responses for help
j) RAF	> 16 responses for help

k) SAS	> 25 responses for help
l) Planperfect	> 15 responses for help
m) VMS mail	> 40 responses for help
n) DOS	> 10 responses for help
o) Ventura	> 4 responses for help
p) Harvard Graphics	> 15 responses for help
q) Miscellaneous products	> 35 responses for help

Software assistance request response time was generally immediate, within 15 minutes, many of the counts above had more than one request under the responses - the time spent with each person varied from a simple answer, taking 30 seconds to spending several hours over the year with a person; in total the estimated time spent on consulting was over 1/2 of a PY.

17. Provided data entry services, backup and restore, label processing and other operations services, including:

	Prot	Reso	Devel	Pers	Tech	Mgmnt	Total
operations requests	184	111	34	5	8	303	645
time	65	47	14	1	15	460	602
data entry requests	16	7	22	45			
time	40	17	6	63			

18. Continued with assistance to the district offices and set up regular visits as proposed by the CUC (Computer Users' Committee) - visited Saskatchewan September 11 - 14, 1990; visited Manitoba, October 16 - 19, 1990.

19. Tried to keep current with computing, word processing, personal computers and telecommunications by attending workshops, such as DECUS-US; trade shows, such as DEXPO, Edmonton Computer Show, Digital Trade Show and presentations; reading trade magazines, such as Digital Review, PC magazine, Computing Now, DEC & VAX Professional, etc. and other EDP literature, such as the MINITAB journal, Wordperfectionist, SAS users journal, Ventura journal, etc., attending the EARLUG meetings.

20. Tuned the laser printers, network, VAX, and Wordperfect; expanded and maintained the local area and printer networks and set up new fonts for the HP laser printers. Installed a printer server and Decserver 500 upgrades.

21. One summer student assisted with SAS, INGRES, MMIS systems, fire section programming, FIDS section; substituted for the operator when she was on holidays; helped with systems, other programming and trouble-shooting.

22. Participated in the testing of the HQ PIMS system.

23. Assisted with the installation of updates for finance to the FINCON and pay systems here and in the district offices.

24. Attended several meeting with ARC and LFW on the ARC/INFO system and its use on the ARC VAX; NoFC sent two people to courses at ARC on ARC/INFO; the system at ARC is not being used at present by the GIS project and the Computer Centre has not been notified of any meetings since last summer.

Additional Accomplishments:

25. Assisted with the hiring of a CS 2 for Development and acted as functional supervisor for him.

26. Attended INGRES SQL course and a DATAPAC course.

27. Hired a temporary to fill in for the trainer/programmer, who was given the job of systems manager, who is taking a leave of absence for a year.

28. Attended an on-line pay seminar.

29. Attended a seminar on job classification and sat on three classification boards.

30. Attended a special ITAC meeting to help prepare a presentation for senior management as to the thrust that EDP should be taking in ForCan; a report is being prepared on behalf of ITAC.

31. Interviewed project leaders and others at NoFC - B. Lee and staff, J. Volney and staff, P. Stewart and study leaders, D. Yang, I. Corns about his project and the resources program, M. Apps and his group, we also talked to B. Swanson, D. Maynard, S. Navratil and earlier we had discussions with J. McQueen, P. Loseth and A. Kruger in the development program regarding their computing needs for the short-term and the next few years; made recommendations for hardware and networking.

32. Prepared a detailed plan to bring together the recommendations in the previous two items; drafted a plot of what the new requests would look like; prepared a schematic to show what the EDP layout would look like after the plan was implemented.

33. Held a computer users' committee meeting to assess EDP capital needs for the Northwest Region, incorporating requirements discussed in item 7 above; a sub-committee was formed to amalgamate all requests and to come up with a strategy to present to management; a recommendation as to the Computing Centre EDP requirements would also be forwarded to the Manager, Management Services for 1991/92, by February 20, 1991.

34. Prepared a monthly Computer Centre newsletter, which is now circulated to other regions and to the Director of Informatics at HQ (this takes the place of monthly reports to HQ - items can be extracted for inclusion in her roll-up); the raison d'etre was to become familiar with Ventura Publishing and it has turned into a very good document and showpiece for the Computing Centre.

35. Went on a field trip for a week with the resources group to check the DAP program for data entry.

36. Installed test versions of VMS software,

    a) Diskeeper
    b) Filemaster
    c) Scriptserver

11. Present Status:

    1. The Computing Centre is providing the best service to NoFC users possible with the present computer configuration and personnel. We cover data processing, programming, system analysis, computer modelling, graphics, information retrieval, evaluations of personal computer requests, work station and micro-VAX requests, word processing and telecommunications and we provide assistance with office automation. We are in the process of setting up a Sun workstation in the Development section and are anticipating the acquisition of other workstations and perhaps a micro-VAX for the Districts. Since this is a service study, our goals tend to be continued from year to year.

12. Goals for 1991-92:

    1. Prepare yearly report on computer usage by project and/or study.

    2. Prepare the the annual IMP report of EDP expenses and future plans, for headquarters by updating the various tables included in the report, by March 1, 1992.

    3. Assist with PC, workstation and software purchase justifications, and with the purchase and/or selection of EDP products.

    4. Maintain contact with HQ EDP personnel.

    5. Continue to work with the publishing section with their scanner, slide-maker, other equipment and software.

    6. Prepare the annual study and project plans, including budget estimates by December 31, 1991; prepare the annual EDP requirement plans for the Computing Centre and correlate and integrate EDP plans for the rest of the Northwest region, by February 25, 1992.

    7. Prepare the annual Computing Centre staff appraisals for 1991/92 by March 15, 1992.

    8. Write, modify or adapt programs and systems and provide documentation, as required by users and the Computer Centre.

    9. Install new and updated software and systems as received.

    10. Continue with the national work plan (PIMS) and enter year-end corrections, prepare year-end roll-up and enter new year figures.

    11. Develop, expand and maintain programs and systems, such as the MAIL-LABEL system and BUDGET programs and assist Development with DEVMIS.

12. Prepare a detailed list of PC software, including serial number, version, serial number of the PC which has the software loaded on it, owner of the software and PC; prepare a list for record keeping by PC and have the owner sign the list to verify the legality of the software; the list will be updated each time the owner buys new software or upgrades or transfers the software to another user - in which case the old version must be erased from the former PC; by so doing, we hope to protect the Computer Centre from any trouble with the R.C.M.P., who may or may not be doing a site inspection for illegal software.

13. Give in-house courses and provide other training and assistance with the VAX, PC and workstation software products. Give courses and prepare new courses, as needed, to NoFC and District office personnel, including the following, when there are enough requests:

    a) Introduction to Wordperfect
    b) Intermediate Wordperfect
    c) Advanced Wordperfect
    d) Introduction to Planperfect
    e) Introduction to SAS
    f) Introduction to Lotus 1-2-3
    g) Introduction to Harvard Graphics
    h) Introduction to PC's and DOS
    i) Introduction to Ventura
    j) Introduction to MINITAB
    k) How to use E-mail
    l) VAX editor EDT
    m) Other courses will be prepared and presented, if requested.

14. Continue to trouble-shoot problems with terminals, PC's, VAX software, programmes and other software, printers and plotters, etc..

15. Continue to prepare, modify and upgrade Computer Centre handouts and manuals for users; one in particular being planned will cover the basics of the UNIX operating system, including the VI editor and MAIL, as well, other UNIX system utilities will be touched on.

16. Assist with the software packages for the various personal computers. Assist users with INGRES, MINITAB, SAS, PLANPERFECT, OFFICE and WORDPERFECT - systems for data bases, statistics and document editing. Help users with C and FORTRAN. Assist with the plotting system, slide and overhead presentations.

17. Provide data entry services and backup and restore services as required by various projects; provide various other operator services. Try to come up with a formal backup strategy/policy for PC's and workstations.

18. Set up two site visits to the district offices during 1991/92 and continue with assistance to them on EDP.

19. Attempt to keep current with all aspects of computing, word processors, personal computers and telecommunications by attending workshops, trade shows and reading

trade magazines and literature, by attending meetings of the local computer groups (CIPS & EARLUG-DECUS) and by attending courses as appropriate on the VAX. Attend the U.S. DECUS meeting to obtain the very latest news in DEC and DEC compatible hardware and software and attend meetings dealing with VAX problems. Attendance at the DECUS-Canada bi-annually and the GIS symposia bi-annually alternately is also an on-going source of information.

20. Continue to expand ethernet LAN and terminal server network as new users are hooked up to the system. Continue to work on full integration of the PC's, VAX, workstations, printers, plotters, micro-VAXes, word processing and document preparation (publishing) systems. Maintain network between ForCan HQ, NoFC, and other regions and increase networking capabilities with other R & D and educational sites around the world with Bitnet, Internet, CA*net, etc..

21. Hire three students to provide programming and EDP consulting assistance to various projects, to fill in when Computer Centre staff is on holidays and to help with trouble-shooting and hardware maintenance.

22. Wind up the testing of the PIMS system and make recommendations as to the usefulness of the system; install on our VAX if accepted.

23. Assist with the finance section's upgrades to hardware and software.

24. Continue to keep in touch with ARC and LFW, as necessary, when there are technical or administrative meetings about the ARC GIS system and use of same, and to advise the GIS project leader of the results of the meetings.

25. Assist with the screening and selection of a permanent position CS in the Development section; functionally supervise all CS's in projects other than the Computing Centre.

26. Attend courses as approved.

27. Attend various seminars put on by personnel, PSC and others.

28. Attend ITAC annual meeting and other special ITAC meetings if called.

29. Continue to coordinate EDP purchases for NoFC and the District offices.

30. Continue with the Computer Centre newsletter on a monthly basis.

31. Provide a monthly statistical report to the Manager, Management Services on the operation of the Computer Centre containing the following breakdown -

    i) Projects completed
        a) major
        b) > 1 day
        c) < 1 day
    ii) CPU hours used
    iii) Connect hours
    iv) Data input jobs & hours
    v) Troubleshooting VAX/hours other/hours

vi) Backups number/hours
vii) Courses given number/hours
viii) Datapac usage hours/costs

32. Hold two meetings of the computer users' committee in June, 1991 and January, 1992 to assess EDP service needs and capital requirements. Minutes to be taken and distributed.

13. Publications 1990-91:

Nil.

14. Environmental Impact:

N/A.

15. Duration:

Start: 1969 Estimated Completion: Ongoing.

16. Resources 1991-92:

PYs:	Prof.:	Chow	1.0
		Irwin	1.0
		Carrigan	1.0
	Tech.:	Hai	1.0
	Total:		4.0
	Term/Students		1.0

O & M: $81,000

Capital: $123,000.

17. Signatures:

Investigator

Manager, Management Services

Regional Director General

NOR-54-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 18, 1991

1. Project: Management of Regional Development Program

2. Title: Management of Regional Development Program

3. New: Cont.: Term.: X 4. No.: NOR-54-01

5. Study Leader: M. Stephen, (Acting)

6. Key Words: Management, common support, economic development, agreements, job creation, prairie region, National Data Base, Information Systems, GIS, library services, Industrial Development, Green Plan

7. Location of Work: Northwest Region

8. Study Objectives:

   1. To manage the delivery of NWT, Manitoba, Saskatchewan, and Alberta federal-provincial forestry Agreements, Trees Canada and other programs related ton forest sector development including programs of job creation, forest inventory, and industrial liaison.

   2. To promote and facilitate economics and statistical research.

   3. To participate in corporate management decisions for the NWR as part of the NWR Management Team.

   4. To provide leadership to development and economics personnel and opportunities for career development and employment satisfaction.

   5. To manage Northern Forestry Centre Library Services and information system requirements.

9. Goals for 1990-91:

   1. To deliver the large array of programs associated with NOR-36.

2. To manage, through the District Managers the Manitoba and Saskatchewan Offices.

3. To develop long term strategies for the future of the district offices in anticipation of new federal-provincial forestry agreements.

4. To advocate forestry's interest to CEIC, DRIE, and other related Government departments and agencies.

5. To manage the NOR-3 economics program, through the project leader(s).

6. To cooperate with the various Ottawa DG's directed programs which have a regional expression.

7. To cooperate with various corporate government exercises such as ERDA's and Western Initiatives.

8. To manage Northern Forestry Centre Library Services.

10. Accomplishments for 1990-91:

1. Delays were encountered in the approval of new Forestry Agreements in the 3 prairie provinces. However bridge financing was approved for federal lands programming which permitted delivery of a number of projects on Indian lands. These included forest inventories, management plan development, and silvicultural activities. In addition several silviculture projects were maintained in Manitoba and Saskatchewan.

2. Documentation in support of Agreement negotiations were prepared as required. These included Memorandums to Cabinet, Treasury Board Submissions legal agreements and Schedules
A and B.

3. Forestry program planning in conjunction with clients needs was finalized and incorporated into agreement documents.

4. Forestry's interests were advocated with other agencies including EIC, Ag Canada, Statistics Canada, WED, INAC and Corrections Canada. Opportunities in job development programming, economic diversification through forestry, federal land programming, and national soil conservation programs were explored and implemented where possible. In addition, investigations into the licensing and patenting of NoFC research innovations were conducted in cooperation with Forestry Canada HQ. Patent search conducted and patent application filed with respect to silvicultural equipment developed by the Saskatchewan District Office.

5. The NOR-3 forest economics and statistics program was managed through the project leader. The program addresses both research as well as development projects. In the economics projects, several reports were prepared on a variety of research topics including forest sector dependent communities, sustainable development and secondary wood-using industries. In addition a study was concluded on the economics of utilizing logging slash for energy, the regional strategic plan was finalized and developmental work on IRM strategy is underway. Further research on a number topics was accomplished through support of several graduate

students at the University of Alberta. The Economics projects also contributed to the National Forest Economics Project on Canada's Timber Supply. In the statistics project, work is underway on national forest management statistics and a forest industry data base and retrieval software was developed.

6. Regular attendance at meetings of Regional Development Directors ensured continued contact with Headquarters personnel as well as Forestry Canada personnel from across Canada. Involvement in the development of guidelines for new federal-provincial forestry agreements; guidelines for private land forestry programs and a memorandum of understanding between Forestry and Indian Affairs on regional level to dovetail with the National MOU.

7. Meetings were held with WED personnel concerning WED initiatives and new ERDA initiatives. Background information concerning the forest sector was provided as requested. Forestry Canada HQ personnel and the Deputy Minister have been apprised of all regional dealings with WED

8. Library Services were managed. Personnel changes, expansion of library completed and the library automated system upgraded.

11. Goals for 1991-92:

Study terminated (See NOR-50-08 and NOR-36)

12. Publications 1990-91:

See NOR-3 and NOR-36

13. Environmental Implications:

The NoFC Environmental Screening Committee has evaluated the study activities with regards to their environmental implications. Based on information provided by the study leader, the committee concluded that the study activities present no potential to cause detrimental effects on the environment.

14. Resources 1991-92:

Nil

15. Signatures:

A/Program Director, Regional Development

Regional Director General

NOR-55-01

FORESTRY CANADA

STUDY WORK PLAN

1991-92

Responsibility Centre: NORTHERN FORESTRY CENTRE

Date: March 31, 1991

1. Project: Personnel Administration

2. Title: Personnel Administration

3. New: Cont.: X 4. No.: NOR-55-01

5. Study Leader: R.P. Czuj

6. Key Words: Personnel; Classification; Staffing; Pay and Benefits; Staff Relations; Training; Health and Safety; Official Languages; Human Resource Planning; Employment Equity;

7. Location of Work: Northwest Region

8. Problem Definition:

There is an ongoing requirement to provide personnel services to the management and staff of NoFC and two district offices located in Prince Albert, Saskatchewan and Winnipeg, Manitoba. The specialty areas covered are: Classification, Staffing, Staff Relations, Pay and Benefits, Training, Human Resource Planning, Employment Equity, Official Languages, and in part Health and Safety.

9. Study Objectives:

1. Provide ongoing services to the Northwest Region of Forestry Canada in the specialty areas identified above.

2. Coordinate services for the Northwest Region with external agencies (i.e.: other federal government departments) in order to ensure the proper level of service is maintained on a consistent basis.

3. Ensure changes to policy and procedure are introduced to the Northwest Region and arrange for any appropriate training required in order to incorporate change.

4. Deal with special projects as required ensuring the balance of the operation is maintained at all times (i.e.: conversion exercises, work force adjustments, training needs, staffing requests, reorganizations, etc.).

10. Goals for 1990-91:

Continue activities in the areas of:

1. Classification
2. Staffing
3. Pay and Benefits
4. Staff Relations
5. Training
6. Health and Safety
7. Official Languages
8. Human Resource Planning
9. Employment Equity
10. General operations

11. Accomplishments in 1990-91:

1. **Classification:**The backlog of classification actions was cleaned up during the year and credit in achieving this goal is directed at HQ's personnel who provided assistance to the region while the RPM completed compulsory training requirements for accreditation. The major mile stone for the year was the receipt of full classification accreditation effective November 23, 1990 along with a level B rating. Our region also survived its first departmental classification audit with minor observations. Turn around on classification actions has gone down considerably.

2. **Staffing:**A second personnel officer position has been created to look after the staffing function for the region. This new position was created and filled by SAPP on December 1, 1990. Staffing actions have been dealt with promptly and our overall success rate in finding suitable candidates to fill positions has increased over the past year. One appeal against a proposed selection was lodged and successfully defended.

3. **Pay and Benefits:** This was one of the most active areas over the past year with a great deal of activity backing up from the year before. Accomplishments include: a successful pay audit was completed by HQ's; all pay actions for summer students were finalized; CR/ST equalization adjustment processed; EG conversion exercise finalized; CH retro pay finalized; a time reporting function incorporated; pay and counselling services were

provided to Work Force Adjustment employees; several employee elections were calculated. In addition, the on line pay function was incorporated and is functioning in the region.

4. **Staff Relations:** Grievance activity remains light. Employee complaints and personal problems increased over the past year. It is felt the uncertainty of the Work Force Adjustment exercise played an important role in this up swing of activity. Discussions with the union are open and friendly. Designations were dealt with in anticipation of the upcoming collective bargaining process.

5. **Training:** As a follow up the pre-retirement session held last year, NoFC pay and benefits staff coordinated two Financial Planning Seminars for the staff of the Northwest Region. Personnel staff including employees from the Management Services unit were retrained on the On Line Pay system. Compulsory courses such as MMOP and SOP were identified in training needs and given priority consideration. Assistance provided to Administration in the collection of data and information for the annual regional training plan.

6. **Health and Safety:** Continue to provide advice and assistance as required on this topic. Responsibility for this area outside of information has be transferred to Management Services.

7. **Official Languages:** Arrangements have been made for staff of the Northwest Region to continue to receive evening classes in French. This process has changed since last year and the training now has a direct cost associated to it.

8. **Human Resource Planning:** Input into the HRIS is nearing completion on all avenues. Classification and Official Languages data is still in need of update. It is anticipated that data for these areas will be either completed in the region in the future or it will be coordinated with HQ's. Several staffing actions aimed at HRP have been completed and retirements and work force adjustment exercises have been dealt with on a professional scale.

9. **Employment Equity:** This program is reviewed for every staffing action to monitor potential and placement of candidates. Several staffing actions over the past year have capitalized on EE programs in cooperation with the PSC. New quotas have been set for the region in the different areas of the EE program and it is the intent of the regional staff to ensure these quotas are reached. The region was the recipient of a second award presented by the PSC (Alberta) for efforts made to increase program awareness.

10. **General Operations:** Personnel has reorganized over the past year and a new officer position has been created. Provided a full time PY can be found, the unit should increase by one.

12. Present Status of Study:

The main issue of concern at this point in time is the placement of priority staff who are now at the surplus stage of the Workforce Adjustment exercise. It is anticipated that all of the employees involved will find alternate employment. The new agreements will increase personnel's workload and will also give the region some additional breathing space.

Classification is steady and ongoing. The introduction of a new personnel officer position along with a trainee means additional work for the short term. Training for the new trainee will follow PSC guidelines.

13. Goals for 1991-92:

1. **Classification:** Now that the region has an accredited classification officer on site, it is our goal for the next year to concentrate more time and effort in this specialty area. Emphasis will be placed on quick turnaround of classification actions, monitoring of draft classification actions prior to formal submission, better coordination of committee ratings and general information flow, arranging for course training in classification rating and job description writing, emphasis on cyclical reviews to make jobs more current, and preparation for the upcoming Treasury Board Triennial Classification Review in 1991.

2. **Staffing:** Strive for a better level of service to managers and staff in all staffing actions including the provision of courses of a general nature. Maintain an ongoing awareness of changes in policy and procedure affecting the region and insuring the information is passed on to the appropriate individuals. Deal with work force adjustment situations in a professional manner. Ensure new departmental delegations are in place and are understood by all. Set goals and a training plan in place for the new personnel officer position.

3. **Pay and Benefits:** Maintain the level of service to all staff. Utilize the new version of HRIS (when available) to better service the needs of all staff whether it be the provision of information or the update of policy and/or procedure. Generate statistical reports for managers in a computerized format.

4. **Staff Relations:** Provide ongoing advice and assistance as required. Keeping abreast of changes. Monitor strike situations which may become an issue in the coming year. Ensure that confidentiality is maintained at all times when dealing with employee complaints and problems and ensuring that professional advice is available at all times. Efforts will continue to maintain timely Labour Management Consultation Committee meetings.

5. **Training:** Coordinate a series of short one or two day training sessions on personnel related issues. Arrange for compulsory training (i.e.: MMOP, SOP, etc.) to be taken locally and update staff on future requirements.

6. **Official Languages:** This is one area where a fair amount of attention will have to be placed in the coming year. The department will have to review its bilingual needs in greater detail in the coming year and personnel has been tasked with the responsibility to assist management in the monitoring of all situations where official languages will be or could be an issue.

7. **Human Resource Planning:** Expand where feasible the use of the new HRIS to enhance managerial awareness and application. Develop a system in this region aimed at career planning. Assistance in the career planning venture will be sought from HQ's.

8. **Employment Equity:** In cooperation with individual managers review staffing needs with an aim of increasing our representation of Employment Equity quotas where feasible. Continue to monitor special opportunities to take advantage of EE situations.

9. **General Operations:** Review the workload of the personnel unit to ensure even dispersal of work. Provide training to personnel staff to better link functions of the unit. The RPM will also hold the position of Chairman for the Northern Alberta Chapter of Personnel Administrators for 1991.

14. Publications 1990-91:

Nil.

15. Environmental Implications:

N/A

16. Duration:

Start: Completion: Ongoing

17. Resources 1991-92:

PY's:	Prof.	Czuj	1.0
	Support	Grauman	1.0
		Grbavec	1.0
	Total:		3.0
	Term:	Peacock	1.0

O&M: $34,100

Capital: Nil

18. Signatures:

Investigator

Regional Director General