Forest Pest Management and Damage Appraisal

Final Report

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ABSTRACT

Activities under the Forest Pest Management and Damage Appraisal project of the Canada/Alberta Forest Resource Development Agreement are summarized. Five main areas of endeavour are outlined. Progress was made in adapting a hazard rating system for the mountain pine beetle, assessing the impact of dwarf mistletoe in jack pine stands, technology transfer, development and implementation of pest surveys in young stands, spruce beetle pheromone development, root rot surveys in jack pine stands, spruce budworm pheromone trapping in northern Alberta, spruce budworm surveys in northern Alberta, jack pine budworm pheromone development, adapting a geographic information system to forest insect and disease survey use, and diagnostic and advisory services. Project expenditures are summarized and recommendations as to the future of various projects are made.

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INTRODUCTION

The Canada/Alberta Forest Resource Development Agreement provided funding for the development of programs in Forestry Research, Development and Demonstrations (Program B.3; Anon, 1984). The purpose of the subprogram was to facilitate the prompt transmission and ultimate utilization of research results from Forestry Canada scientists to practicing field foresters. Included among the projects funded was Forest Pest Management and Damage Appraisal.

The proposal for the Forest Pest Management and Damage Appraisal project outlined five primary areas of endeavour. They were;

- hazard rating systems for forest pests;
- impact of forest pests and damage appraisal;
- technology transfer;
- development or applications of forest pest survey methods;
- diagnostic and advisory services.

In July of 1985 a Forest Insect and Disease Specialist was hired to coordinate these programs. This report will summarize the progress achieved under each of the five topics, and project expenditures. In implementing the projects the Forest Insect and Disease Specialist has worked within the framework of the Forest Insect and Disease Survey (FIDS) of Forestry Canada (ForCan). A good deal of direction has come from the Forest Protection Branch of the Alberta Forest Service (AFS).

For the most part this document contains summarizations of project activities. Other sources that contain more detailed accounts of project activities are mentioned where appropriate.

HAZARD RATING SYSTEMS FOR FOREST PESTS

MOUNTAIN PINE BEETLE

At the beginning of the Forest Resource Development Agreement (FRDA) program, the most severe outbreak of the mountain pine beetle in the province's history was subsiding. The activities of this insect brought about the implementation of a control program that cost the provincial government over $6 million to deliver (Anon., 1986). During the course of the outbreak (1977-86), the beetle was estimated to have caused the death of some 3,483,371 lodgepole pine in southwestern Alberta (annual FIDS reports, 1978- 1987).

As the infestation subsided the question of what could be done to lessen the damage of future outbreaks remained. One option begins by applying a hazard-rating system to classify stands as to their vulnerability to the pest (i.e. low, moderate, or high levels of expected mortality). Classifications are based on a series of factors, some of which (e.g. stand age, stand density) can be altered silviculturally. Forest managers could then begin the task of minimizing the amount of area rated highly susceptible, through silvicultural treatments (McGregor et al., 1987; Amman et al., 1988; Amman and Schmitz, 1988). By following these steps both the amount of timber lost and the cost of control in subsequent outbreaks can be minimized.

Several different hazard-rating systems have been developed for the mountain pine beetle (Safranyik et al., 1974; Amman et al., 1977; Mahoney, 1978; Berryman, 1978; Schenk et al., 1980; and Waring and Pitman, 1980). All six of these systems have been tested in Alberta (Moody, 1988) and elsewhere (Amman, 1985). The system proposed by Amman et al. (1977) has shown some potential, and components of it are employed by the State of Montana to assign harvest schedules and treatment activities to lodgepole pine stands (Kohler, 1981). This system bases hazard on average stand age, a measure of climatic suitability for the stand consisting of latitude and average elevation, and average stand dbh (diameter at breast height) for trees with a dbh of at least 12.7 cm. Stands are given a score of 1, 2, or 3 on each of these points and the resulting total score determines whether it is rated as low, moderate, or high (Table 1).

The FRDA role in this process began with attempting to apply this system to the forests of southwestern Alberta. A method of doing this was proposed. The forest inventory prior to the recent beetle outbreak was rated for mountain pine beetle vulnerability. The predicted mortality was then compared to the actual mortality, and some conclusions as to the usefulness of the system were made. A report on this subject is being revised to account for reviewers comments. Further information can be obtained from the author on request.

Table 1. Parameters used to hazard rate lodgepole pine stands by the Amman *et al*. (1977) method. Values in parentheses assigned to stand are multiplied to give a stand hazard rating (low = 1-9, moderate = 12-18, high = 27)[a].

Elevation - Latitude		Average Age		Average dbh (cm)	
High	(1)	< 60	(1)	< 17.7	(1)
Moderate	(2)	60-80	(2)	17.8-20.3	(2)
Low	(3)	> 80	(3)	> 20.3	(3)

[a] One exception occurs when all three factors are rated moderate, but the factor (8) falls within the range of low risk. This should be considered moderate hazard for beetle potential.

IMPACT OF FOREST PESTS AND DAMAGE APPRAISAL

DWARF MISTLETOE IN JACK PINE STANDS

The impact of dwarf mistletoe on jack pine in east-central Alberta was assessed using timber cruising techniques. The objective was to compare areas of mistletoe infected and uninfected trees within the same stands to determine if mistletoe was affecting tree growth and survival. The first step in the technique was to locate infected stands and then establish a cruise line through them. Trees on either side of the line were rated for mistletoe infections using the six point system proposed by Hawksworth (1977). If the average rating/tree was ≥ 3 that portion of the stand was recorded as heavily infected. If the rating was <3 lightly infected, and the third category was uninfected. Throughout the stands, in portions representing each infection category, sample plots were located. On the plots tree heights, diameters, growth rates, and ages were measured and infection categories were assigned. Plot and stand volumes, and the percentages of the stands in each infection category were calculated. In total eight stands were surveyed.

Stand volumes in heavy and uninfected stands did not prove to be dramatically different (Table 2). In general it was found that uninfected areas were poorly stocked, resulting in low volumes. Comparisons of tree heights and radial increments between various infection categories were compiled. All project information has been summarized in an internal report and is available from the author on request.

Table 2. Characteristics of jack pine stands containing dwarf mistletoe infections (East-Central Alberta). Averages from the eight stands surveyed.

Uninfected			Lightly Infected			Heavily Infected		
% of stand	BA M^2/ha	Vol. M^3/ha	% of stand	BA M^2/ha	Vol. M^3/ha	% of stand	BA M^2/ha	Vol. M^3/ha
43.3	13.6	88.1	37.7	21.7	143.9	19.0	10.5	64.0

TECHNOLOGY TRANSFER

The subject of technology transfer has been addressed in various ways. One has been through the preparation and/or distribution of informational material. For example a slide-tape presentation entitled "Major Forest Insect Pests of Alberta" was prepared and has been used as a training tool at various gatherings.

Reports on project activities and current pest conditions have continuously been prepared and delivered. Projects that have been predominantly agreement efforts have been summarized as agreement reports (e.g. Amirault et al., 1988 and Amirault and Pope, 1989). Other work that may have been undertaken in conjunction with FIDS activities were included in the FIDS annual reports.

Other methods of technology transfer included acting on specific requests for information submitted by clients, and through formal presentations to client gatherings. On example of the latter is a workshop on forest pests that was presented to industry and government forestry staff at the request of Weldwood of Canada Ltd. (who hosted the Workshop, June 5-8, 1989). Presentations have also been given to professional gatherings outside the province (Amirault, 1989).

DEVELOPMENT OR APPLICATIONS OF FOREST PEST SURVEY METHODS

PESTS OF YOUNG LODGEPOLE PINE STANDS

Prior to 1987 surveys of pests in young stands were not a regular part of the annual Forest Insect and Disease Survey conducted by Forestry Canada in the Northwest Region. In March of that year a Committee of Plantation Pests Surveys (COPPS) was formed with representatives of Forestry Canada, the provinces within the region (Alberta, Saskatchewan, and Manitoba), the Northwest Territories, and the University of Alberta. Included in the objectives of the committee were to plan and initiate surveys to determine the incidence, distribution, and general abundance of known insect and disease pests, newly introduced pests, and other damaging agents in young coniferous stands within the region.

In the spring of 1987 surveys were implemented throughout the region. In Alberta the majority of survey activity was conducted using personnel and resources provided by the Canada-Alberta FRDA. During the course of 1987 and 1988, 67 lodgepole pine stands in west-central Alberta were surveyed using the technique proposed by COPPS. A total of 14 different pest problems/damaging agents were encountered during the course of the survey. Survey results were summarized as to pest distribution and impact (Amirault and Pope, 1989).

The initiative to develop a survey procedure for pests in young stands continued in 1989. The data collected by all COPPS cooperators in the previous two seasons was given to a contractor for analysis. The ultimate goal of the analysis was to propose a survey methodology capable of determining pest impact to a specified level of confidence. The Can.-Alta. FRDA was a major funding source for the contract ($15,000 of a total of $29,850). In addition the main field initiative of FRDA staff in 1989 was to collect data to be used by the contractor in his analysis. The project involved measuring the location, and determining the pests associated with every tree on two one hectare areas of lodgepole pine regeneration, and a one-half hectare area that had been precommercially thinned. On the large plots this involved around 16,000 trees/plot. This data was provided to the contractor. A final report and a data summation software package have been received from the contractor. It is expected that the proposed survey design will be adopted by FIDS, and that surveys of young stands will become an annual endeavour.

SPRUCE BEETLE PHEROMONE DEVELOPMENT

The Canada-Alberta Forest Resource Development Agreement was one of three Alberta-based organizations (Table 3) that contributed funding to a project to develop an improved pheromone lure for the spruce beetle. The main participants in the project were Dr. Hal Wieser, Dr. Elisabeth Dixon, and Mr. Alan MacKenzie (Dept. of Chemistry, Univ. of Calgary); and Dr. Herb Cerezke (Forestry Canada, Edmonton).

The project involved identifying the aggregation pheromone produced by

the spruce beetle, synthesizing these pheromones, and field testing their attraction capacity. The investigators were able to identify a component of the pheromone that had not been previously identified. The pheromone lure with the new element was field tested against the commercially available pheromone and consistently resulted in the capture of more beetles. Two project status reports have been received and the final report is in preparation. The University of Calgary has applied for patents on the pheromone.

It is hoped that the new pheromone will become an important tool in the management and control of the spruce beetle, using techniques such as are discussed in Lindgren (1988). It is also expected to be a useful tool in monitoring beetle population levels.

Table 3. Alberta-based funding sources for a project to develop an improved pheromone lure for the spruce beetle, 1986-89. (Source; Personal Communication, Dr. Hal Wieser).

Fiscal Year	Amount	Source
1986-87	$28,600	Alberta Forest Service
	$ 7,700	Alberta Forest Development Research Trust Fund
1987-88	$20,000	Alberta Forest Service
	$10,000	Can.-Alta. Forest Resource Development Agreement
1988-89	$23,270	Alberta Forest Service
	$21,980	Can.-Alta. Forest Resource Development Agreement

ARMILLARIA ROOT ROT/DWARF MISTLETOE IN JACK PINE STANDS

Casual observations in jack pine stands (same stands in which the dwarf mistletoe impact studies were conducted) indicated that many of the trees in heavy infection centres also had armillaria root rot infections. This raised the question; is there a consistent relationship between the two diseases? The author and Dr. K.I. Mallett (Forest Pathology Research Scientist, Northern Forestry Centre) decided to investigate.

In the spring of 1989 four of the stands in the Lac La Biche Forest were staked using the "trap-log" method of armillaria detection (Mallett and Hiratsuka, 1985). This technique involves inserting aspen stakes into the ground, if the fungus is present the stakes will become colonized over time. In this case aspen stakes (2) were inserted at 10m intervals along the original cruise lines. This was done over a total distance in excess of 2 kilometres throughout the stands. The goal was to remove the stakes (fall

1989) and compare the distribution of armillaria root rot to the intensity of mistletoe infections. Preliminary results should be available from survey participants in early 1990.

SPRUCE BUDWORM PHEROMONE TRAPPING IN NORTHERN ALBERTA

Agreement resources were used to expand the spruce budworm pheromone trapping program initiated by FIDS in 1985. This program has employed the methodology outlined in Allen et al., 1986. It is hoped that eventually pheromome trapping will provide an alternative to the more time consuming methods currently employed (e.g. larval and egg mass sampling) to assess spruce budworm population levels. Preliminary results from other areas (Allen et al., 1986) have indicated that variations in catches from a single cluster of traps can indicate population trends over several hundred hectares of forest. It may be possible for predictions of extensive defoliation to be made up to six years in advance (Sanders, 1988). This would be on the basis of three successive years of increasing trap catches or a threshold level of 50 moths/trap.

To develop the predictive potential of a pheromone trapping program in a region, data specific to that area must be collected. Trap catches are correlated with other measures (such as the number of second instar larvae/10 m^2 of foliage in the subsequent generation) of budworm population densities within a stand. This involves collecting various samples from a network of candidate stands, which encompass a range of spruce budworm population densities for a number of years. In this case data was collected for three years (Table 4). The one case where very high trap catches were recorded (Chinchaga 1985) was followed by a major upsurge in spruce budworm populations in 1987. One other catch (Steen River 1985) exceeded the critical 50 moths/trap level proposed by Sanders (1988). It remains to be seen if outbreak conditions will develop in this area. The data collected during the FRDA program is being analysed along with data from other co-operators.

SPRUCE BUDWORM SURVEYS IN NORTHERN ALBERTA

Forest Resource Development Agreement Personnel have been assisting the Alberta Forest Service and the Forest Insect and Disease Survey monitor an outbreak of the spruce budworm in the Footner Lake Forest. The outbreak began in 1987 and has expanded annually since then. The project officer and his assistants have helped to map defoliation, conduct egg-mass and defoliation surveys, and have prepared status reports (Amirault et al., 1988a; and Amirault et al., 1988b). Over the course of the outbreak AFS staff have taken over most of the survey activities as they have become familiar with the procedures. In light of the fact that the infestation has persisted, it is now a primary forest management concern in the area. The project officer has been advising those involved in the area's management.

Table 4. Numbers of spruce budworm caught in pheromone traps (average number of moths/trap) in white spruce stands in Northern Alberta.

Site	AFS FMU	Budworm/Trap 1985	1986	1987
Thickwood Hills	A5	2.3	2.7	0.0
Draper Crossing	A3	0.3	0.3	0.0
Ft. McKay	A7	2.0	0.3	0.0
Steen River	F9	80.7[1]	1.0	12.7
Chinchaga River	F12	281.3[1]	17.7	74.0[12]
Hutch Lake	F15	14.7	1.0	1.7
Senex Creek	F2	-	1.3	0.0
Freeman River	W3	-	25.3	10.7
Fox Creek	W2	_	18.5	5.3
Little Smoky	G5C	-	11.0	0.3
House River	L3	-	0.0	0.0

[1] exceeds the critical threshold value as proposed by Sanders, 1988.
[2] moderate defoliation in this stand in 1987.

JACK PINE BUDWORM PHEROMONE DEVELOPMENT

The jack pine budworm was defoliating extensive areas of central and western Canada in the mid-1980's. At that time a dependable pheromone lure for monitoring the budworm was not available. Representatives from the provinces of Alberta, Saskatchewan, Manitoba, and Ontario decided to contract the development of an improved lure for the insect. In the case of the Prairie Provinces FRDA funds were used to sponsor the project. In Alberta the totals were $5,941 in the 86/87 fiscal year and $6,086 in 87/88. Cooperation was provided in collecting budworm for pheromone extraction, and field testing the pheromone produced by the contractor (the Research and Productivity Council, Fredericton). The contractor was able to identify previously unknown minor components of the pheromone lure. Field trials with the synthesized product have shown mixed results.

ADAPTING A GEOGRAPHIC INFORMATION SYSTEM TO FOREST INSECT AND DISEASE SURVEY USE

The Forest Insect and Disease Survey has been conducted for over 50 years in Canada. The amount of data that has been compiled in that time is enormous (for example see Van Sickle, 1989). The effective management of this information would be impossible without computer technology. Much of the information collected is based on geographic locations with associated data attributes, therefore the use of a geographic information system (GIS) for data management can be an effective tool. While purchasing a GIS is not difficult to justify, the implementation of a system is not as straightforward (Jorden, 1989).

The role of the FRDA project officer and his assistant has been in user training and applications development. To date the following has been acheived;

- FIDS technical staff have received training,
- Regional defoliation maps for the spruce budworm, forest tent caterpillar, and jack pine budworm for the last ten years have been digitized,
- data attributes for the defoliation maps have been entered (i.e. defoliation classes),
- a system for storing data from pest surveys from young stands (previously discussed) has been proposed, and data entry has begun.

The potential number of uses for a GIS system in the FIDS operation is impressive. The overall goal is to employ the technology to facilitate the "every-day" work of the unit.

DIAGNOSTIC AND ADVISORY SERVICES

Diagnostic and advisory services have been ongoing since the beginning of the agreement period. Much of this is done by identifying insect and disease specimens received from clients. In most cases identifications were made in-house (in consultation with other staff members). Specialized identifications involved sending specimens to the Biosystematics Research Institute (BRI) in Ottawa. Inquiries on such topics as pest control and management have been received and answered through correspondences or field visits.

SUMMARY AND RECOMMENDATIONS

The majority of effort in the Forest Pest Management and Damage Appraisal program was in the Development or Application of Forest Pest Survey Methods. In this area of endeavour there were seven different projects involving the spruce beetle, the spruce budworm, the jack pine budworm, armillaria root rot, dwarf mistletoe, the pests of young lodgepole pine stands, and adapting a geographic information system (GIS) to Forest Insect and Disease Survey (FIDS) use. One project relating to Hazard Rating Systems for Forest Pests (involving the mountain pine beetle) and Impact of Forest Pests and Damage Appraisal (dwarf mistletoe in jack pine stands) were conducted. Technology Transfer and Diagnostic and Advisory Services were ongoing throughout the agreement period. Table 5 summarizes the expenditures for the project in all but the 1989/90 fiscal year.

Table 5. Expenditures for the Forest Pest Management and Damage Appraisal Project (1985/86 - 1988/89).

Fiscal Year	Project Number	Total Expenditures
1985/86	1410	$5992
	1414	$33807
1986/87	1410	$48550
	1414	$43488
1987/88	1410	$110977
1988/89	1410	$120914

In retrospect, the most significant progress was made in pest surveys of young stands, adapting a GIS to the FIDS, and spruce beetle pheromone development. In the first two cases agreement resources/personnel were instrumental in laying the groundwork for programs which should become part of regular FIDS activities. In the case of the spruce beetle pheromone, the FRDA assisted in the development of a product which could be a useful forest management tool.

The following discussion addresses individual projects as to their current status, and makes recommendations for the future of these activities. Technology Transfer and Diagnostic and Advisory Service activities are ignored as it is assumed they will continue due to client demand. Individual discussions are as follows;

- Hazard rating for mountain pine beetle - available to forest managers and should be considered as an option in an integrated pest management

program.

- Impact of dwarf mistletoe in jack pine stands - data collected to date should be complemented by continued monitoring of plots. The project should be taken over by FIDS who have a strong mandate to develop impact data.
- Surveys of pests of young stands should become a regular part of the FIDS activities in the Northwest Region.
- Spruce beetle pheromone development - the FIDS and AFS should test the utility of the pheromone as a pest monitoring and forest management tool.
- Armillaria root rot/Dwarf mistletoe in jack pine stands - depending on the results of the current survey, the continued investigation of this issue could become a priority.
- Spruce budworm pheromone trapping - depending on the results of the FIDS review, could continue as a regular part of the FIDS program.
- Spruce budworm surveys in Northern Alberta - the AFS has been taking an increasingly active role, this trend should continue. Personnel from FIDS and FRDA should act as advisors.
- Jack pine pheromone development - project complete.
- Adapting a GIS to FIDS - FIDS has to develop their capabilities in this area, FRDA personnel could continue to be helpful in this regard.

Some thought should be given to what should be done in the area of pest studies in the event of another agreement. Time must also be taken to reflect on how the process could be altered to better deliver products with agreement funds. It is the opinion of the author, that due to the continued abundance of the forest tent caterpillar and the current push to utilize the aspen resource, that further study of the caterpillar is necessary. Critical questions regarding the impact of repeated defoliation are not well understood. Decay of aspen is also a problem to those who want to utilize that resource. The re-emergence of the spruce budworm in Northern Alberta could provide several research opportunities (e.g. impact, population dynamics). There are many others in addition to the three I have just mentioned, anyone familiar with the forest pest management scene in Alberta could name others.

My feeling on subsequent agreements is that the pest management portion should be in the form of specific projects to answer specific questions. Those undertaking the projects would have the generalized methodology outlined, a timetable set, and the products to be delivered clearly spelled out. I think that the advantages of this are obvious when compared to the approach taken in the current agreement. For example requesting that topics such as the hazard rating of forest pests be investigated is far too general. In closing I would like to say that I feel opportunities to make advances in pest management via the agreement route remain excellent, and is one area where investment of research dollars at this time could pay big returns in the future.

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