



**A study of methods currently in use in Canada  
to harvest or salvage or treat  
lodgepole pine stands affected by the  
mountain pine beetle**



Prepared by

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for

Canadian Forestry Service  
Pacific Forest Research Centre  
506 West Burnside Road  
Victoria, B.C.  
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March 1984

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March 1984

## FOREWORD

This report was prepared under contract from the Pacific Forest Research Centre by Progressive Forest Management Systems of Vancouver and is part of the work planned under the Canada/USA joint agreement on mountain pine beetle-caused problems in Western North America. The report addresses action plan I D which reads: Establish process to fully document and disseminate information on methodology currently in use and that which will be developed, including research results.

This report concentrates on those forest districts in British Columbia with a high hazard from mountain pine beetle and a history of damage. Also included are highlights of work done on the eastern slopes of the Rocky Mountains and Cypress Hills. Because of this emphasis, not all forest regions in Western Canada are treated equally and within a region the districts are likewise given varying degrees of coverage.

To conform with the Canada/USA agreement, the report contains: a catalogue of methods in use in western Canadian forests to deal with mountain pine beetle caused problems; a list of reports available describing procedures used; a list of personnel involved in an operational or advisory capacity, and a discussion of some of the procedural and environmental problems encountered.

It is recognized that responsibility for pest management resides with the provinces and that overall policy on pest management is established in the Provincial Ministries of Forests and then applied in the regions according to specific local requirements. It was not our intention to document this flow of policy into practice or the various sources of funding employed because of the report's emphasis upon currently used field procedures.

D.M. Shrimpton  
Pacific Forest Research Centre

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## ABSTRACT

Personnel from the Alberta Forest Service, B.C. Ministry of Forests, Canadian Forestry Service in Victoria and Edmonton, B.C. Ministry of Lands, Parks and Housing, Parks Canada, Balco Industries Ltd., Crown Forest Industries Ltd., Revelstoke Sawmills Ltd., Timberline and Weyerhaeuser Canada Ltd. were consulted during the preparation of this report. The names, addresses and phone numbers of these officials are included in the Appendix.

Most agencies initially detect mountain pine beetle infestations by conducting aerial surveys. Further details of the extent of the outbreak are obtained from ground surveys. Precise methods for conducting aerial and ground surveys vary from agency to agency. These differences are detailed in the report.

Harvesting of unattacked timber and salvaging infested trees, preferably those still containing beetles, are the two main methods of beetle control currently used in Canada. However, when infestations are small, or when logging is not a viable option, single tree disposals are implemented. Usually this technique takes the form of a 'cut and burn' where single infested trees are cut, bucked, piled together and burned. Cutting and selling individual trees is another method of single tree disposal used occasionally.

Pheromones are used in connection with harvesting and cut and burn operations to 'clean up' any residual beetle population which may remain after completion of the initial treatment. Trees baited with pheromones are

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also used to contain beetles in an area to be logged after the beetle flight period. Other applications include the concentration of beetles in a proposed cut block and the interception of migrating beetles.

Bans may be placed on the hauling of infested material during the beetle flight period. This is especially applicable where logs containing beetles are to be transported through uninfested stands. Hot-milling logs once they arrive at the mill helps to prevent the escapement of beetles from log decks stored in the mill yard.

Other control techniques used in Canada include chemical insecticide treatments of individual trees, road building policies to provide access to highly susceptible stands, implementation of rap-attack crews to conduct treatments in remote areas, removal and burning of all slash and cull logs that remain after a harvesting operation and a controlled broadcast burn of infested stands. Each of these methods are described within the report.

Mountain pine beetle infestations inevitably cause conflicts between concerned groups and organizations. Most problems have been resolved through personal contact between the parties involved, and a number of committees have been formed to assist in this area. Examples of these committees and the type of conflicts that they address are provided.

It is hoped that this report will provide forest managers with improved control options by combining their expertise and experience.

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1983

1984

1985

1986

1987

1988

1989

1990

1991

1992

## TABLE OF CONTENTS

Page

ABSTRACT

ACKNOWLEDGEMENTS

INTRODUCTION

1. GENERAL PUBLICATIONS

2. SURVEY AND DETECTION

3. CONTROLS

3.1 Harvesting

3.2 Single Tree Disposal

3.3 Pheromones

3.4 Hauling Bans and Hot-Milling

3.5 Other Techniques

4. CONFLICTS

5. LITERATURE CITED

APPENDIX 1 - list of personnel active in  
mountain pine beetle control.

APPENDIX 2 - cards and forms used to assess  
mountain pine beetle problems.

THE UNITED STATES OF AMERICA

DEPARTMENT OF JUSTICE

OFFICE OF THE ATTORNEY GENERAL

WASHINGTON, D. C. 20530

MEMORANDUM FOR THE ATTORNEY GENERAL

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FROM: [REDACTED]

SUBJECT: [REDACTED]

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REPORT

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## INTRODUCTION

Information for this report was obtained from as many different sources as possible. Provincial forest services in both Alberta and British Columbia were contacted, personnel at the Canadian Forestry Service Research Centres in Edmonton and Victoria were consulted, administrators of the national parks and British Columbia's provincial parks were interviewed, and representatives of the private forest industry were contacted.

This report will be divided into five separate sections: General Publications, Survey and Detection, Controls, Conflicts and Literature Cited. The first section contains references to publications which provide general information pertaining to the biology, detection and/or management of the mountain pine beetle (Dendroctonus ponderosae Hopk.). The second section includes aerial and ground survey techniques for recording infestation data, and also various methods of filing and retrieving this information. The third part details the use of various methods to control the beetle, including harvesting, single tree disposal, pheromones and hauling bans and hot-milling. Section four outlines any conflicts which the various agencies have encountered when carrying out the management of beetle-infested stands, and the steps they have taken to overcome these conflicts. In the body of the report, only the document's title, author's name and publication date are provided. A full reference for each publication, including the name of the person or agency which supplied the document, is listed in the final section.

The names and positions of key personnel for each agency and company consulted, along with their addresses and phone numbers, are given in Appendix 1. Further details concerning the information provided in this report may be obtained from them. Appendix I is organized alphabetically by the name of the governing agency or company, ie. the Protection Branch of the B.C. Ministry of Forests is listed under British Columbia Ministry of Forests, after the Prince Rupert Region and before the Quesnel Forest District. Appendix 2 contains many of the cards and sheets and charts and forms used by different offices for forestry operations and to assess the necessary action.

It is hoped that this report will assist forest managers to combine their expertise and experience in order to provide improved mountain pine beetle control.

## 1. GENERAL PUBLICATIONS

Included in this section are documents of a general nature which contain information on more than one aspect of mountain pine beetle management. As such they do not fit into any individual section of this report. Also included are the guidelines drafted by forest regions and individual districts within British Columbia.

Anon. 1981a. Unpublished proceedings of a symposium on mountain pine beetle, February 1981.

Representatives of the Alberta Forest Service, the British Columbia Ministry of Forests, Alberta Provincial Parks, Alberta and British Columbia private forest companies, the Montana State Forest Service, the United States Forest Service and Canadian Forestry Service, Pacific and Northern Research Centres attended this symposium to discuss management and control options for the mountain pine beetle.

Anon. 1981d. Position paper on mountain pine beetle problems with special reference to the Rocky Mountain Parks.

Anon. 1982b. A review of mountain pine beetle in Canada.

Hall, P.M. 1983. Bark beetle guidelines

At this time, the British Columbia provincial guidelines are in a draft stage. However, the report discussed beetle biology, hazard rating of susceptible stands, survey methods, control strategies and stand management as it applies to British Columbia.

Lacey, T. 1984. Forest pest assessment - Grant and Finnegan drainages.

This memo is a complete description of the proposed management of an infested drainage. Details include use of rap-attack crews in inaccessible areas, implementation of pheromone baits to hold the infestation in the drainage, road building to the area, harvesting prior to the 1985 beetle flight and post-treatment monitoring.

Lukes, K. 1983. 1983/84 pest management program, 100 Mile House Forest District.

This reports the planned activities to survey, record and manage mountain pine beetle during the 1983/84 fiscal year.

McDonald, J.A.D. 1981. Standards for mountain pine beetle probes and reporting procedures to assess amount of mortality.

This memo was written to standardize the procedures used throughout the Cariboo Region. It is largely a duplication of what is found in the regional guidelines.

Monts, J.S., C.A. Campbell, R.J. Chorney and R.D. Edward.  
1981. Kamloops regional pest management guidelines.

A description of all pests in the Kamloops Region is included, with specific sections referring to the pine beetle.

Price, L. and P. Corbett. 1983. Supply Block G pest management report.

This is the first of seven reports outlining the pest management problems, including the mountain pine beetle, in each of the Golden Forest District's supply blocks.

Renwick, A.J. 1981. Nelson Region guidelines for pest management.

This report is the Nelson Region's version of guidelines to manage pests. It is very much the same as the previous guidelines in structure, but also includes an explanation of the B.C. Ministry of Forests filing system and copies of all sampling sheets used within the region.

Rowswell, R.P. and A.J. Stock. 1983. Bark beetle detection, assessment and control guidelines for the Prince Rupert Region.

This set of management guidelines is presently being updated, and will be included as an insert in the region's Protection Manual.

Safranyik, L., D.M. Shrimpton and H.S. Whitney. 1974. Management of lodgepole pine to reduce losses from the mountain pine beetle

This report outlines the guidelines to manage a pine beetle infestation, including detection, hazard rating, damage assessment and control methods.

Shrimpton, D.M., ed. 1982. Proceedings of the joint Canada/  
U.S.A. workshop on mountain pine beetle related  
problems in western North America. November 3 & 4, 1981  
Fairmont Hot Springs, B.C.

This details the proceedings of the meeting between public and private concerns from both Canada and the United States to discuss the present mountain pine beetle epidemic.

Smith, G.J. 1983. Mountain pine beetle surveillance and studies in the Bow/Crow Forest

This study, prepared by the Alberta Forest Service's Bark Beetle Technical Advisor, details the locations where beetles are present in the forest management area, and the control methods used to contain the insect.

Wallach, A. undated. Williams Lake Forest District pest management and procedures manual.

This acts as the pest guidelines for the Cariboo Region of British Columbia. It contains information on the detection, assessment and control of all pests found in the region, with particular reference to the mountain pine beetle.

## 2. SURVEY AND DETECTION

Tom Lacey, Resource Officer - Protection for the Merritt Forest District, has stated that "Without good detection in the air and on the ground, all controls are suspect." (Tom Lacey pers. comm.). It is not surprising, therefore, to find extensive documentation pertaining to survey techniques.

Most agencies rely at least partly on the data provided by the Forest Insect and Disease Survey (FIDS) of the Canadian Forestry Service. The procedures for sampling the mountain pine beetle have recently been standardized, and may be found in:

Van Sickle, G.A. 1980. Survey procedures for western bark beetles and dwarf mistletoes.

Aerial surveys are carried out in late July and August, using airplanes flying 300 to 400 m above ground level at 150 km/hr. One or two observers sketch areas of infestation on 1:100 000, 1:125 000 or 1:250 000 scale maps. When more detail is required, helicopters are implemented. Oblique 70 mm and 35 mm normal colour photographs are also taken of the infestations. Ground surveys are carried out in ten to twelve stands in B.C. during September and October. Their purpose is to identify the extent of the green-attacked trees beyond the mapped areas. Prism plots are established every 50 m on the cruise line. In Alberta, ground surveys are conducted only by request. A trend survey during the spring in up to fifteen stands evaluates the dynamics of the population. In such a survey, ratios of the progeny per sample to the number of entrance holes are calculated. A ratio, or R-value, of less than 2.5 indicates a declining

population, an R-value of 2.6 to 4.0 shows a static population and a ratio of greater than 4.0 is indicative of an increasing beetle population. The ratios may also be calculated as the number of currently-attacked stems to those of the previous year. In this system R-values of less than 1, 1 and greater than 1 exhibit decreasing, static and increasing populations, respectively. In three to five of the stands examined in the trend survey, winter mortality of the beetle is determined. Further information on the FIDS surveys may be found in the following reports.

Cerezke, H.F. 1982. Mountain pine beetle winter survival studies, Alberta and Kootenay National Park, 1982.

Winter survival study details, calculations of number of live larvae, number of galleries and percentage of larvae attacked by predators.

Cerezke, H.F. 1983. Surveys and interpretation of large-scale colour aerial photographs of mountain pine beetle infestations in Kootenay National Park in 1982.

A discussion of a joint project with Parks Canada to obtain 1:5000 photos, ground truth the images and use two methods to estimate mortality.

Cerezke, H.F. and H.G. Gates. 1983. Surveys and impact estimation of mountain pine beetle damage in the Bow-Crow Forest, Alberta, during 1982.

For details of aerial and ground survey methods and procedures of estimating areas attacked, the number of trees killed and the volume destroyed.

Shore, T.L. In preparation. General instruction manual.

A manual to instruct FIDS rangers in exact methods of taking bark samples, recording precise data, executing prism plots, etc.

Two more descriptions of aerial photography as a survey technique for mountain pine beetle infestations are found in:

Harris, J.W.E., A.F. Dawson and R.G. Brown. 1982. Evaluation of mountain pine beetle damage using aerial photography, Flathead River B.C., 1980.

Harris, J.W.E., A.F. Dawson and R.G. Brown. 1983. Evaluation of mountain pine beetle damage using aerial photography taken with a hand-held 70 mm camera, Gold Bridge-Clinton B.C., 1981.

Parks Canada relies heavily on the information provided by the FIDS rangers. Normally the Park Warden accompanies the ranger during the aerial survey, marking infestations on a 1:250 000 or 1:125 000 scale map. The information is later transferred to a 1:50 000 map. Aerial photography of park infestations has also been used as a means of recording mountain pine beetle outbreaks (Cerezke 1983). Aerial surveys are normally followed by extensive ground surveys.

The B.C. Provincial Parks are also surveyed by FIDS rangers. The following report is an example:

Wood, R.O. 1983. Mountain pine beetle in Manning Park -  
A post-control survey.

The Alberta Forest Service conducts their own surveys. Infestations are sketched directly onto aerial photographs during aerial surveys, and are later transferred to a map. Oblique aerial photos are taken of outbreaks at the same time as the sketch mapping. When a new area of beetle-killed timber is found, it is immediately surveyed on the ground by probe lines through the infestation. All trees in close proximity to the compass line are checked. Using this system, an infestation of mountain pine beetle was recently discovered in limber pine (Pinus flexilis James) on the upper ridges and grassy knolls of the Porcupine Hills. The Haig and Mangin Glaciers were surveyed during the beetle flight period to monitor any beetle migrations over the Continental Divide. Sticky traps were placed in mountain passes as another method of invasion monitoring.

Pest management personnel of the British Columbia Ministry of Forests generally base their surveys on the FIDS reports, but also carry out many of their own surveys. The Timber Branch of the B.C. Ministry of Forests has included a column on its Cruise Card, F.S. 205 (Fig. 1, appendix 2), to note beetle damage. An explanation for the proper use of this column is included in the B.C. Ministry of Forests Cruising Manual, Section A.9 (Damaged Stands), with particular references to the mountain pine beetle in Section A.9.1 (Pest Damage) and Section A.9.13 (Attack Codes for Balsam and Pine). For further information contact Victor Dove, Appraisal Field Forester, Valuation Branch, B.C. Ministry of Forests.

The Protection Branch of the same Ministry outlines its survey techniques in the 'Bark Beetle Guidelines' (Hall 1983). It suggests that the ground survey procedures described in Timber and Valuation Branches' manuals are adequate for large infestations. Further pest management

probes may be necessary on the outer fringes of an infestation to delineate the exact extent of attack. In carrying out probe lines, most (more than 60%) of the trees found within 5 m on either side of the compass line should be checked. Prism plots should be established every 200 m to determine the stand information. Probe lines are valuable for a fast survey of the attack area, to determine the extent of the infestation. A grid system is more appropriate to obtain detailed information about the stand. Compass lines are run 50 m apart, extending 100 m past the last attacked tree or until the survey crew moves out of the susceptible timber type. Prism plots are established every 100 m.

The survey methods used by each region vary somewhat from the Protection Branch's guidelines, and each forest district within a region has its own unique variations. The guidelines of the Cariboo Region (Wallach undated) include discussions on mapping procedures and timing of aerial surveys, details of procedures to be used in different ground surveys (ie. walk-throughs, probes, probe/cruises, population assessments), a method to rate susceptible stands, calculations to determine the rate of population growth and a method to survey beetle emergence and winter mortality. Included in the guidelines is the following publication.

Taylor, S.P. 1982. Procedures for aerial sketch mapping  
and volume determination of forest insect infestations.

The report details the use of 1:31 680 maps to record damaged stands. Smaller scale maps, 1:250 000, are used to organize the large scale maps for the observer. Prior to the survey flight, non-forest areas are marked on the map and colour-coded to assist the observer. Such areas include lowland brush of non-merchantable value, land under cultivation, swamp or

water, areas logged or not satisfactorily restocked and open range, alpine or meadow. Examples of volume estimation are also provided.

The Cariboo Region uses the survey data provided by the FIDS rangers. In addition, aerial surveys are carried out in each district with personnel from the regional and district offices mapping infestations on 1:40 000 maps. This provides the districts with more detailed information than is available from the federal surveys, so that they may prioritize their cutting permits. Three districts were contacted in this region, the 100 Mile House Forest District, the Quesnel Forest District and the Williams Lake Forest District.

In the 100 Mile House Forest District, ground surveys follow regional guidelines and are concentrated in areas of high priority. A beetle control boundary has been established in this district, with all forests to the east of the line classified as high priority stands. Walk-throughs are used to locate possible single tree disposal treatments and probe lines spaced at 200 m intervals, are used for more detailed investigations of an area. However, this district prefers to check trees within 100 m on each side of the compass line, instead of the 5 m figure used in the provincial guidelines. In this way, 100% of the area is covered and small infestations are not overlooked. The pest crew fills out its Survey Report (Fig. 2, Appendix 2), the report is circulated throughout the office following a Route Card (Fig. 3, Appendix 2) and the information is recorded on the Pest Management Work Chart (Fig. 4, Appendix 2).

Quesnel Forest District officials use the results from their aerial surveys to determine where the ground work should be done. Timber crews assist with the probes. The crews complete this district's version of the

Probe Report (Fig. 5, Appendix 2) and Compass Sheet (Fig. 6, Appendix 2). These two reports are being combined in an upcoming Pest Damage Report (Fig. 7, Appendix 2). The data from these reports are recorded on a Bark Beetle Status Chart (Fig. 8, Appendix 2), which is presently being revised to a Bark Beetle Summary Ledger (Fig. 9, Appendix 2). The above procedure is covered in:

Kossinn, R. 1982. Protection processing procedures for pest and disease infestations.

The pest management policy of this district, as stated in the above report, is to survey and monitor bark beetle infestations, and to make recommendations to the Timber Section.

The guidelines used in the Cariboo Region originated in the Williams Lake Forest District. They detail the survey procedures in this district, including the following filing system. A base mylar (1:50 000) is continually updated with information regarding cut blocks, road construction, etc. A new copy of this base mylar is produced each year, and the current beetle infestations, as determined from an aerial survey, are marked on it. This provides a valuable overlay system to trace the movements of the beetle. For more details, refer to the Cariboo Region's guidelines, Section 2.3 Mapping History (Wallach undated). One of the requirements of this system is the availability of adequate time and labour to keep the maps and mylars updated. Ground probes are conducted on the basis of the information obtained from the mylars using probe line Field Traverse Cards (Fig. 10, Appendix 2). The exact location of attacked trees are marked on these cards. Infestations are then recorded on the Status History Ledger (Fig. 11, Appendix 2), as described in Section 2.4 of

Wallach's guidelines. Often, combined pest and timber cruises are implemented. The crew has the ability and authority to locate infestations and, if necessary, delineate an area to be salvaged by Short Form Direct Sales. The crew returns to the office with beetle activity information, as well as the data required to set up a cut block. Under these circumstances, the Ministry of Forests' Compass and Traverse Sheet, F.S. 375 (Fig. 12, Appendix 2), is used to record the survey information.

The Kamloops Region guidelines (Monts et al. 1981) describe aerial surveys as a method to locate infestations for further survey on the ground. They also discuss a system of stand susceptibility rating, and detail the use of various ground survey systems. A recce system is used for infestations no larger than one half a hectare or involving no more than 25 trees. This system involves investigation of all trees within a 100 m radius of the infestation centre. The probe system provides volume data, and is used for infestations larger than half a hectare involving more than 25 trees, or where less than 1% of all trees exhibit red crowns. The Bark Beetle Survey Card (Fig. 13, Appendix 2) is used for such a survey. The cruise system is implemented to survey highly susceptible areas or large infestations. It uses the Cruise Tally Sheet, F.S. 205 (Fig. 1, Appendix 2), as described previously. The Merritt, Penticton and Vernon Forest Districts of this region were contacted for further details of beetle management.

The Merritt Forest District personnel conduct their aerial surveys using an airplane, and compare the results with the FIDS surveys. New infestations are recorded on maps. Oblique 35 mm colour photographs of the infestations are taken, including a distinct landmark in each picture. This aerial overview is used as a guide for the placement of probe lines.

As in FIDS surveys, a helicopter is used to obtain more detailed information, with data initially marked on 9X9 photographs and later transferred to maps once the surveyor is on the ground. The priorities of this district are detection and assessment, as indicated by the quote used as an introduction to this section.

A helicopter is the preferred means of conducting aerial surveys of Crown and, if possible, company land in the Penticton Forest District. Two people, the Resource Officer - Protection and the Resource Officer - Timber, mark infestations on a reduced 20 chain planning map. Decisions pertaining to subsequent action are made in the air. Possibilities include ground probing, relegating the problem to the appropriate forest company, implementing a control programme or leaving the area entirely untouched. Oblique photographs are also taken during the aerial survey. Ground probes are split between the Ministry of Forests and the forest companies, with each company using the district's probe cards. The company returns the results of the probe, and their requests, to the district (Fig. 14, Appendix 2) and this information is placed on the district's Pest Management Ledger (Fig. 15, Appendix 2). A report on each infestation is then written and filed (Fig. 16, Appendix 2).

As in Penticton, a helicopter is used for aerial surveys in the Vernon Forest District. However, officials regularly include company holdings in their flights, later forwarding pertinent information to the company. Some companies then proceed to initiate their own ground surveys. Areas of attack are marked on aerial photos, and photo mosaics of the district have been prepared. The infestations are then transferred to white prints of the history maps (1:20 000) and stored in that form. Ground probes are done in as many areas as possible, using the regional probe card (Fig. 13,

Appendix 2) in a system similar to the recce described in the Kamloops Regional guidelines (Monts et al. 1981). For scattered pockets of attacked trees and for large areas, the region's probe system is used, with lines spaced 100 m apart, including all trees within 2.5 m on either side of the compass line. After completing the ground survey, a Pest Survey Report (Fig. 17, Appendix 2) is written, and if the area is to be harvested, this report is forwarded to the Timber Section.

The guidelines of the Nelson Region (Renwick 1981) include a system of mapping infestations from the air on at least 1:125 000 scale maps, photographing the areas and further checking the attack from a helicopter or on the ground. Surveys to determine winter mortality are also described. Only the infestations to be treated are surveyed on the ground. Timber crews assist in some of the ground work, as do the forest companies. In this region, personnel from the Cranbrook, Golden and Invermere Forest Districts were interviewed.

The survey techniques used in the Cranbrook Forest District are included in that district's 1981/82 Annual Report. A helicopter is the preferred platform when conducting aerial surveys. Two observers use 1:50 000 maps to record infestations, and they compare their results after the survey is completed. The information is then placed on a 1:125 000 overlay in the office. Aerial surveys are used to locate an infestation, and a subsequent ground survey determines the intensity of the outbreak. Recording sheets used for ground surveys are the same as those included in the regional guidelines. A two man crew, the compassman/chainman and the recorder, conducts the ground probe. Prism plots are not used, but the average diameter and height of trees is recorded every 100 m along the

probe line.

The FIDS surveys provide enough aerial survey information for the needs of the Golden Forest District's pest management officials. Instead of using the regional survey cards, they distribute their own Pest Damage Detection Cards (Fig. 18, Appendix 2) to all Ministry Timber, Silviculture and Regeneration Crews and also to all industry personnel. These cards are used whenever a stand is entered. Larry Price of the Golden Forest District has prepared a summary describing the proper use of the card, and this summary accompanies each card. When conducting a probe line, plots are established every 150 m, and information is recorded on the district's own Bark Beetle and Root Rot Plot Card (Fig. 19, Appendix 2). A brief report entitled 'Detection - Emergency Funding' was prepared in response to the Emergency Pest Fund established by the B.C. Ministry of Forests in 1981. It describes in detail the survey methods used by the Golden Forest District. Infestation information is recorded on Probe Line Summary Sheets (Fig. 20, Appendix 2) and then transferred to the Pest Management Work Chart (Fig. 21, Appendix 2).

The aerial survey system described by Taylor (1982), included in the guidelines of the Cariboo Region (Wallach undated), has been adopted by the Invermere Forest District of the Nelson Region. Ground surveys may take the form of either a normal inventory cruise or a recce with prism plots established at regular intervals. The survey cards for the latter system (Fig. 22, Appendix 2) have been modified recently, allowing the survey crews to replace prism plots with bark sampling (Fig. 23, Appendix 2). The procedures for carrying out ground surveys are detailed in three reports, 'Emergency Bark Beetle Projects - Office File Procedure', 'Beetle Survey Requirements' and 'Mountain Pine Beetle Survey Lines'. After the ground

survey is complete, it is summarized on a Line Summary Sheet (Fig. 24, Appendix 2) and forwarded to the Pest Management Officer. An Insect Summary Sheet provides a central listing of all infestations. A complete explanation of the data included on this sheet is listed in 'Insect Summary Sheet (Attachment No. 1)', available from the Invermere Forest District. The mapping system used by this district to update their files is outlined in:

Cohen, P. undated. Timber susceptible to spruce bark beetle and mountain pine beetle in the Invermere T.S.A.

Some private forest companies rely on B.C. Ministry of Forests data, while others carry out their own beetle surveys. Crown Forest Industries Ltd. personnel receive the infestation maps prepared by the B.C. Ministry of Forests. They then extend probe lines out from the centre of the infestation, spacing lines 150 to 200 m apart. They record all red- and green-attacked trees which are visible from that line. Information obtained from these surveys is used to establish the company's harvesting priorities.

Revelstoke Sawmills Ltd. also relies on B.C. Ministry of Forests' data. However, the company does its own probe lines to prioritize infested stands for salvage logging. Beetle activity data is collected in association with area and timber volume and quality information using their own Reconnaissance Cards (Fig. 25, Appendix 2). A new card will be developed in 1984 to incorporate other potential control measures such as single tree disposals, single load logging and pheromone baiting.

Weyerhaeuser Canada Ltd. undertakes its own aerial surveys in August, using a helicopter to check the infestation information provided by the

Ministry of Forests. All outbreaks detected from the air are then studied on the ground, walking across the contours of the land to establish a base line, and then running probe lines perpendicular to that base line. In this manner, the crew can determine the extent of the infestation.

Timberline is a Vancouver-based consulting firm experienced with 70 mm aerial photography as a detection technique for mountain pine beetle. They have surveyed red- and grey-crowned trees for both Revelstoke Sawmills Ltd. of Radium Hot Springs B.C. and Crestbrook Forest Industries of Cranbrook B.C. The procedure used by this company is detailed in their report to Revelstoke Sawmills.

Anon. 1981b. A pilot study investigating the suitability of using low level, fixed base, 70 mm aerial photography to determine the extent, stage, and severity of mountain pine beetle infestations.

Medium scale (1:10 000) photographs of the survey area are obtained. Sample plots are selected from these plots, and 1:1 000 scale photographs are taken. A selection of these plots are then ground surveyed to determine the number and extent of green-attacked trees. This current infestation data is then related to the total number of pine trees in the survey area.

### 3. CONTROLS

The Cariboo and Kamloops Regions of the B.C. Ministry of Forests have included a guide to appropriate control procedures in their pest management guidelines (Wallach undated; Monts *et al.* 1981) (Table 1). This guide relies on two control techniques, harvesting and single tree disposal. Both of these methods will be discussed in this section, as well as other measures currently used in British Columbia, Alberta and Saskatchewan to control or manage the mountain pine beetle.

Wallach (undated) describes the duties of each branch of the Ministry of Forests with regard to beetle control.

Another publication which discusses general control measures is:

Robinson, P. 1982. Management options for mountain pine beetle in Manning Park.

While stressing that each infestation within any park's boundaries must be studied separately, and that the actions taken in Manning Park should not set a precedent, this report outlines possible options for controlling a beetle infestation in a park.

#### 3.1 Harvesting

Harvesting green-attacked trees still containing beetle populations and susceptible but unattacked timber are the two most common control strategies presently used in Canada. However, such practices are not allowed in national and provincial parks, forcing these agencies to rely on alternate techniques. Such methods will be described in later sections.

Table 1

Figure 26. Ground Action Rating Guide used by the Kamloops Region, B.C. Ministry of Forests (from Monts et al. 1981)

Age (Code)	Risk Group	No Green Attack Present	0-1% Green Attack	2-5% Green Attack	6%+ Green Attack
(7, 8 9) 121-130+	1	Harvest over a 5 year plan	Harvest on a one year plan	Harvest on a one year plan or less	HARVEST (priority cut)
(5, 6) 81-120	2	Harvest over a 10 year plan	S.T.D.: <25 trees or .50 ha Harvest: >25 trees or .50 ha	HARVEST (priority cut)	HARVEST (priority cut)
(4) 61-81	3	Harvest over a 20 year plan	S.T.D.: as above Harvest as above	S.T.D. <.25 ha Harvest >.50 ha.	HARVEST (priority cut)

In the Crowsnest area of Alberta, over 700 000 m<sup>3</sup> of beetle-attacked timber, covering an area of about 4 000 ha, has been removed over 4.5 years from the fall of 1979 to the spring of 1984 (Smith 1983). For further information regarding the salvage operations of the Alberta Forest Service, contact Jim Nowasad of the AFS' Calgary office.

The Valuation Branch of the B.C. Ministry of Forests has developed policies to evaluate damaged stands in order to assist in calculations of reduced stumpage rates on beetle-attacked timber harvested in salvage operations. Manuals outlining these policies have been published for each of the six Forest Regions. The standard manual is presently being drafted.

Harvesting practices cited in the Protection Branch's guidelines (Hall 1983) include harvesting of timber beginning at the outer edges of the infestation, and then moving towards the centre of the outbreak. This process removes the trees containing beetles first and salvages the dead wood without beetles second. Removal of slash and cull logs is stressed in the guidelines, since this material may harbour beetles already present in the trees prior to harvest.

In the guidelines prepared by Wallach (undated) for the Cariboo Region, the following priorities are proposed:

- 1) green infested timber within high risk stands
- 2) susceptible healthy trees near infestations
- 3) smaller infestations in low risk stands
  
- 4) salvageable red and grey trees

One hundred percent of the pine harvest in the Cariboo Region's Chilcotin, Quesnel and Williams Lake Forest Districts is beetle-attacked

wood. Recently, an agreement, known as the Great Western Sale, was signed in the Cariboo Region to sell 5 million cubic metres of wood over ten years. These figures indicate the extent of the beetle epidemic in this region, and the means that are being used to salvage as much wood as possible.

The 100 Mile House Forest District forwards a map marked with appropriate beetle information to each company. The company responds with proposed cut blocks, and these plans are then evaluated by Ministry officials to ensure that the attacked area is included in the block (Fig. 26, appendix 2).

Both the 100 Mile House and Quesnel Forest Districts rely heavily on Small Business Licences and Short Form Direct Sales to salvage small infestations not economically attractive to a larger company. However, the results from the smaller operators are not consistent, and infested trees are not always removed prior to beetle flight.

The Kamloops Region of the B.C. Ministry of Forests also uses Short Form Direct Sales. The harvesting priority for this region is to remove green-attacked trees. According to the 1982/83 Regional Audit, 8 570 ha of such priority cut was harvested in the 1982/83 fiscal year.

Tom Lacey of the Merritt Forest District provided harvest figures for his jurisdiction. An estimated 375 ha of beetle-infested wood was salvaged in 1983/84 and 920 ha was salvaged in 1981/82. These data were obtained from the district's 1983/84 and 1981/82 Technical Audits, respectively.

In the Penticton Forest District, the Resource Officer - Timber is responsible for the Small Business Licences. Harvesting is reserved for large infestations when single tree disposal methods, to be discussed in

the next section, are impractical. Occasionally, only lodgepole pine (Pinus contorta Dougl.) is harvested, leaving Abies and Larix species behind to naturally regenerate the new openings in the stand. However, this practice may encourage mistletoe growth in the regeneration.

The Vernon Forest District presently uses prioritized harvesting as its only tool for mountain pine beetle control. Areas salvaged were 200 ha in 1979, 250 ha in 1980, 354 ha in 1981, 519 ha in 1982 and 569 ha in 1983 (from the 1979/80, 1980/81, 1981/82, 1982/83 and 1983/84 Technical Audits, respectively). This is a total of 1 892 ha over five years.

The Nelson Forest Region also salvages small infestations using Small Business Licences. Larger harvesting operations include outlying trees on the perimeter of the infestation. This is done to remove individual green-attacked trees and to make the cut more economically viable for the company. Areas salvaged in recent years total over 11 000 ha in this region (Table 2).

The Cranbrook Forest District has established a system of rating susceptible stands and prioritizing stands for harvest. Further information about these systems may be obtained from Steve Byford of the Cranbrook Forest District. Harvesting is the most powerful control method used in this district.

Sixty percent of the Invermere Forest District's annual allowable cut (AAC = 670 000 m<sup>3</sup>) is lodgepole pine. Eighteen percent of that pine, or 72 360 m<sup>3</sup>, is green-attacked (Emile Begin pers. comm.). Harvesting techniques, combined with single tree disposals, have been effective in controlling beetle activity in the Steamboat Mountain - Cartwright Lakes area.

**Table 2. Area of timber cut in the Nelson Region of the B.C. Ministry of Forests to manage the mountain pine beetle. Figures obtained from the Regional Audits for 1982/83 and 1983/84**

FOREST DISTRICT	AREA (ha) SALVAGED IN	
	1982/83 <sup>1</sup>	1983/84 <sup>2</sup>
Cranbrook	525	395
Invermere	1 000	2 682
Golden	652	511
Arrow	131	140
Boundary	5 801	424
Kootenay Lake	0	25
<b>Total</b>	<b>8 109</b>	<b>4 177</b>

<sup>1</sup> Includes extra area required to make a cut economically viable.

<sup>2</sup> Infested area only.

The East Kootenay Insect and Disease Control Committee (EKIDCC) was established to aid cooperation between the public Ministry of Forests and the private forest companies in planning management strategies for the mountain pine beetle. They have drafted a 'Mountain Pine Beetle Master Salvage Plan' (Attachment No. 2, EKIDCC Annual General Meeting, March 9, 1982) as one method of beetle control. Copies of the minutes of these meetings were obtained from Steve Byford, Cranbrook Forest District, B.C. Ministry of Forests.

Balco Industries Ltd. conducts "what may be termed a commercial thin prompted by the mountain pine beetle" (Trevor Jeanes pers. comm.). In such cases, the lodgepole pine is removed from the stand, allowing the remaining species to dominate the forest.

Crown Forest Industries Ltd. feels that beetle-killed wood is salvageable within two years after attack (Howie Carter pers. comm.). Using this policy, and by readjusting the species mix sent to its mills, this company has been able to keep up with new infestations. Seventy percent of the harvested pine is beetle-attacked wood. The following priority system is used in Crown Forest's management strategy:

- |                         |  |                        |
|-------------------------|--|------------------------|
| 1) heavy infestation    |  | remove green- and red- |
| 2) light infestation    |  | attacked trees first   |
| 3) no infestation       |  |                        |
| 4) light stands of pine |  |                        |

Most of the infestations on the land managed by Revelstoke Sawmills Ltd. are large and must be managed through harvesting techniques. Areas of attack are prioritized by the degree of attack, the stage of attack and by the quality of wood involved. This company has also found a market for the

small diameter wood which is removed with larger trees. Products such as fence posts and barn board may be produced from these immature stems.

Weyerhaeuser Canada Ltd. relies on harvesting as their major method of beetle control. In lodgepole pine, the distribution of attacked trees throughout the stand is estimated and a large scale cut block is laid out which includes the affected area. However, since the beetle does not spread as rapidly in ponderosa pine (Pinus ponderosa Laws.) stands, insect populations in Ponderosa pine are only monitored during annual surveys.

### 3.2 Single Tree Disposal

When harvesting of small infestations is not viable, or when harvesting is simply not possible, as in a park, the attacked trees may be treated individually. Infested trees lying outside a cut boundary may also be controlled in this manner. Single tree disposals may take the form of either a 'cut and burn', where the trees are felled, bucked into manageable lengths, piled and then burned, or, alternatively, removed for sale. It is necessary to treat red-attacked trees without beetles as well as the green-attacked stems so that the infestations will not continue to be detected during subsequent aerial surveys.

In the spring of 1982, Parks Canada cut and burned 570 attacked trees in Kootenay National Park. Only one tree in the control area was attacked during the 1982 beetle flight. This project is described in:

Anon. 1982. Mountain pine bark beetle sanitation cut,  
Kootenay National Park, winter 1982.

All facets of the preparation and implementation of a single tree disposal programme are described in this report, including recommendations for

similar projects. Trees were cut very close to the ground and the stumps were peeled of bark to expose all beetle galleries. Bolts were piled, covered with fine fuels and dead trees, doused with diesel oil and then burned. The fine fuels and dead trees were required to provide a fire hot enough to completely burn the bolts. Because of the thoroughness of this operation, no visible trace of the action is expected within two years after treatment. The following winter, 1982/83, 129 trees were treated in Banff National Park, and a further 82 trees were destroyed in Kootenay National Park. These projects were in response to the recommendation of the intragency technical committee (see Section 4). As yet, no beetle-caused mortality has been reported in the forests of Jasper National Park.

Some B.C. provincial parks have similar control programs. During the winters of 1981/82 and 1982/83, a total of 5 500 trees were burned in Manning Provincial Park. The situation continues to be monitored by the Canadian Forestry Service (Wood 1983), and with the treatment of 19 trees in the spring of 1984 the programme will be regarded as a success (Kerry Joy, B.C. Ministry of Lands, Parks and Housing, pers. comm.). A beetle infestation in Birkenhead Lake Park and its treatment are described in:

Roberts, D. 1983. Mountain pine beetle - Birkenhead Lake Park.

During the spring of 1983, Parks crews treated 34 attacked trees, while Ministry of Forests personnel were responsible for the burning of 7 trees.

In the Cypress Hills Provincial Park, which straddles the Alberta/Saskatchewan border, cut and burn projects have been used extensively to control the spread of beetles. During the winter of 1980/81, 400 trees were treated on the Alberta side of the park, with 200 trees cut on the

Saskatchewan side. More recently, 1 600 trees were burned in Alberta's portion of the park during the winter of 1982/83, with 2 000 more trees treated in Saskatchewan's jurisdiction during the same winter. These figures were obtained from Bob Miyagawa of the Alberta Forest Service's Edmonton office and the following documents:

Cerezke, H.F. and B.H. Moody. 1983. Forest insect and disease conditions in Alberta, Saskatchewan, Manitoba, and the Northwest Territories in 1982 and predictions for 1983.

Minutes of the meeting of the Inter Agency Technical Committee on Mountain Pine Beetle, held October 3 and 4, 1983. Chairman, Les Safranyik, Pacific Forest Research Centre, Canadian Forestry Service.

The committee cited in the preceding reference will be discussed in further detail in Section 4 of this report.

Single tree disposals are used in the forests managed by the Alberta Forest Service. In accessible areas, the single trees are salvaged. However, in more remote locations stems are felled, bucked and either burned or debarked prior to beetle flight. If the logs are not to be burned, a debarking tool is attached to an ordinary chain saw. This method is effective, but is strenuous for the operator and should be used only occasionally. In the Porcupine Hills - Crowsnest River Valley area, cut and burn programmes have been used effectively, treating from 1 to 200 trees per site. In 1980 24 000 trees were burned, in 1981 18 000 trees were treated, and in 1982 8 000 trees were cut. The declining numbers of trees treated is an indication of the declining beetle population. The Castle Drainage was left untreated and the infestation there is still increasing. While this method of control is effective, it simply prolongs

the inevitable spread of the insect (Bob Miyagawa pers. comm.). In other areas of the province, 36 000 trees were removed from the north side of Highway 3 during 1981/82, and during 1983 118 trees were treated in the Kananaskis Country. In the latter area, most attacks are believed to have been caused by immigrating beetles from the west side of the Continental Divide.

Included in the Cariboo Region guidelines (Wallach undated) is a detailed procedure for conducting single tree disposals. Generally, the Cariboo Region uses this technique only in an attempt to exclude the beetle from high priority stands. For the programme to be effective, it must be used on a continuing basis. Some projects carried out in 1982 under the B.C. Ministry of Forests' Emergency Pest Fund include the treatment of 447 trees in the 100 Mile - 122 Mile Project (C36409, File 720-10-1-6), 2 481 trees in the Scottie Creek - Meadow Lake Project (C36410, File 720-10-1-6) and areas of infestation in the Spokin - Squawk Lakes area (C36406, File 720-10-1-6). The first project cited was credited with slowing the eastward movement of the beetle. All three projects were deemed successful. However, with the absence of the Emergency Pest Fund, the region has been unable to continue single tree treatments in these areas.

The 100 Mile House Forest District has used single tree disposal as a means of controlling beetle escapements from trees stored in mill yards. It has also proved effective in controlling small, new infestations, and as such is regarded highly by pest management personnel in that district (Kevin Lukes pers. comm.). It is hoped that single tree disposals may be combined with current harvesting techniques to provide cleaner and more effective salvage logging operations.

The Quesnel Forest District also uses cut and burns to control small infestations in areas with no previous occurrence of the beetle. In 1983, 2 500 trees were treated in this manner, but few infestations are expected to be controlled using this technique in 1984. Available funds are being directed to probing and cruising in this district.

The Williams Lake Forest District uses single tree treatments selectively in areas where the surrounding, healthy timber is to be preserved. This control practice is viewed only as a three to five year delaying measure (Wayne Hendy, Alex Wallach pers. comm.). Occasionally, access to remote areas provides a problem, but this is normally overcome by renting extra equipment (ie. snowshoes and snowmobiles). In 1982, 735 trees were treated. This figure includes trees cut in an effort to control both the mountain pine beetle and the Douglas-fir beetle (Dendroctonus pseudotsugae Hopk.).

Single tree disposal methods receive limited use in the Kamloops Region because they are only a delaying procedure. If harvesting of the entire stand is planned within two or three years, cut and burn tactics may be effective (Ron Edward pers. comm.). This procedure is used more in the Merritt Forest District than anywhere else in the Kamloops Region, but only under certain circumstances. If the infestation is small, involving no more than 150 trees, has no access and is located in a high priority stand, then single tree disposal will be considered. In the Gordon Creek drainage, 600 trees have been treated over a five year period. The beetle population has been kept at an acceptable level, and the drainage has been protected adequately. In providing this information, Tom Lacey stressed that this form of control requires a continuing commitment. If this

commitment is not present, then the entire effort will be wasted. It is also necessary to fall both red- and green-attacked trees, and to peel and burn the stumps, to receive the maximum effect from cut and burn treatments.

In the Penticton Forest District, single tree disposal measures are used only in highly visual areas and only if the infestation is relatively small. Approximately 1 200 to 1 500 trees are treated annually. Rap-attack crews, used mainly for initial fire suppression, assist in the operations. To obtain an effective fire in the burning portion of cut and burn procedures, this district has developed the following formulation:

- 1) Fill a 45 gallon (205 l) drum 5/6 full of 'rubber dust', or tire shavings, available from a local tire shop or vulcanizer.
- 2) Add 2 to 3 gallons (9 to 14 l) of diesel oil.
- 3) Mix well.
- 4) Store in a cool place, away from direct heat.
- 5) Place in ungreased plastic pails, transport to site of proposed burn, and sprinkle liberally on piled bolts.
- 6) Ignite.

When funds are available, the Vernon Forest District has used cut and burns with various degrees of success. In some locations, the beetle population was reduced to acceptable levels, while in other areas the success of the operation was questionable. Although no single tree

disposals are scheduled for this winter and spring, the district has treated 1 960 trees over the past five years.

Ernie Morris of the Nelson Region also recognizes that single tree disposal treatments are effective only when used on a continuing basis. When conducting such controls, a 100% ground survey of the area is conducted to ensure that all trees containing beetles are removed. As insurance, a few trees are baited with pheromones to attract and absorb beetles from infested trees that may have been overlooked. These trees are then destroyed the following year. Reduction of funding has drastically curtailed the use of cut and burn programmes in this region (Table III).

As a means of postponing large scale infestations by one or two years, single tree disposal is a successful and effective treatment in the eyes of the Cranbrook Forest District pest management personnel (Steve Byford pers. comm.). The degree of success depends upon a number of factors, including topography, weather and proximity of the treatment area to other infested stands.

The procedures used by the Golden Forest District to carry out a cut and burn control are described in a letter from P. Corbett of the Golden Forest District to an employee of Evans Products Co. Ltd., dated November 19, 1982 (File 255-52). This district has also produced two publications pertaining to single tree disposals.

Stewart, R. 1982. The West Bench cut and burn project,  
Golden T.S.A.

Stewart, R. and L. Price. 1982. Experimental aerial  
extraction of infested lodgepole pine on the West  
Bench, Golden T.S.A.



The latter publication compares the costs involved in a regular cut and burn procedure with those incurred using a helicopter to log the infestation. Costs for both systems were comparable, with the aerial extraction method requiring half the man hours to complete the procedure.

As mentioned previously in the discussion of harvesting beetle-attacked wood, the Invermere Forest District has successfully used cut and burn treatments in connection with logging operations to control outbreaks in the Steamboat Mountain - Cartwright Lakes area. Pheromones and cut and burn tactics have been used elsewhere to sanitize areas on the periphery of a cut block. Single tree disposals are effective only when used in conjunction with a flexible logging plan (Emile Begin pers. comm.).

In a document dated February 24, 1982, obtained from the Prince George Region of the B.C. Ministry of Forests, the finances of a cut and burn treatment of 20 trees are detailed (Gagnon 1982). This control occurred in the Tezzeron Lake area of the Fort St. James Forest District.

Data from the 1982/83 Prince Rupert Regional Audit show a total of 5 739 trees treated by single tree disposal. Most (2 381) were in the Bulkley Forest District, with others in the Lakes (774), Morice (2 074), Kispiox (280) and Kalum (230) Forest Districts.

The Inter Agency Technical Committee on Mountain Pine Beetle (see section 4) has directed cut and burn projects in the Palliser River (348 trees, Project NC-2-04), Upper Cross River (458 trees, Project NC-2-05) and Elk River Drainages (2 393 trees, Project NC-1-01). These figures are from the minutes of the committee meetings held on March 24, 1982 in Edmonton, Alberta and June 22 and 23, 1982 in Invermere, B.C. Copies of the minutes

were obtained from committee chairman Les Safranyik of the Pacific Forest Research Centre, Canadian Forestry Service.

Balco Industries Ltd. uses single tree disposals in remote areas only.

Trees are baited with pheromones first, to concentrate the beetle population. These baited trees, and any other nearby trees containing beetles, are then cut and burned.

Crown Forest Industries Ltd. treated about 30 trees in 1983 using cut and burn procedures. The small infestation controlled was the first to appear in an area which had not yet been slated for logging. The treatment has been viewed as a success, keeping the remaining trees relatively beetle-free until the area can be harvested in about two years.

Officials at Weyerhaeuser Canada Ltd. feel that their harvesting policies allow them to remain in step with new infestations. Although they have had no need for single tree disposals in the past, they are interested in the results of treatments carried out by the B.C. Ministry of Forests in 1984.

### 3.3 Pheromones

The use of pheromones has already been mentioned in connection with both harvesting and single tree disposal control practices. Further details of the uses of pheromones will be provided in this section.

Officials of Canada's National Parks leave the use of pheromones to provincial agencies. In the Cypress Hills Provincial Park, 100 baited trees were used on the Alberta portion of the park, with 300 trees baited on the Saskatchewan side of the border. These traps were used for various purposes, namely to intercept immigrating beetles, to concentrate the

beetles in specific stands and to contain the insects within present infestation areas curtailing their spread elsewhere.

In 1983, the Alberta Forest Service used about 500 pheromone traps in Kananaskis Country to contain beetles in an area already designated for cutting after the flight period. Results of this project are still being analysed. A further 424 traps were used in the Crowsnest control zone, and 71 more were placed elsewhere in the Kananaskis to concentrate beetles in particular stands for later treatment.

Operational trials of pheromones used in the Cariboo Region of the B.C. Ministry of Forests were unsuccessful, probably due to the vast size of the beetle population to be controlled. Pheromones may be useful to contain populations as a pre-harvest treatment (Don Doidge pers. comm.).

The Quesnel Forest District uses pheromones for this very reason. A recent attempt to prevent beetles from leaving an infested stand is reported by Ralph Kossinn, Pest Management Officer of Quesnel, in a letter dated December 2, 1983 (File 720-4-7) to Dr. John Borden of Simon Fraser University. The report is entitled 'Management of the Mountain Pine Beetle with Semiochemicals - Ramsey Creek Baiting Project' (Kossinn 1983).

Lindgren Funnel Traps are used by the Merritt Forest District, Kamloops Region, to determine the flight period of the beetle. The information provided from weekly monitoring of the traps allows pest management personnel to invoke and end the ban on hauling infested logs through uninfested stands. (The hauling ban technique of pine beetle control will be discussed further in the next section.) Pheromones are