BACKGROUND AND TECHNIQUES USED IN THE BRITISH COLUMBIA BARK BEETLE PROGRAM

by

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BRITISH COLUMBIA MINISTRY OF FORESTS

VICTORIA, B.C.

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Table of Contents

BACKGROUND

Bark beetles in the genus Dendroctonus, notably the mountain pine beetle (D. ponderosae) and spruce beetle (D. rufipennis), are the most damaging native forest insect pests in western Canada and the northwestern United States. These insects are capable of causing extensive mortality to large diameter, mature and over mature pine and spruce. Killed trees may dry and check, making them non-merchantable within a few years if not salvaged.

Interior pine and spruce, together, represent approximately 47% of the total annual provincial cut. Therefore, the loss of extensive volumes of these species to bark beetles represents a major threat to the timber supply needs in many of the interior communities. The loss of supplies to these communities would severely disrupt local and provincial economies as many communities in the province are wholly, or to a large extent, dependent upon the forest industry, and therefore on a continued supply of large mature volumes of the major tree species, pine and spruce.

Bark beetle infestations have been noted since surveys of B.C. forests began. However, earlier infestations were not considered as a major threat to timber supply as they were often in areas remote from processing facilities or were not very extensive. Natural wildfires were common and served to limit the amounts of mature and overmature pine available to bark beetles and therefore the size of infestations was restricted by the natural creation of age-class mosaics. However, fire suppression practices have become sophisticated and effective with the result that there now exists extensive areas of mature pine, ideally suitable for maintaining an outbreak of mountain pine beetle.

Small patches of trees killed by mountain pine beetle were first detected in the early 1970's in several areas of the province. Also, a large infestation was active in the U.S. in Glacier National Park, which bordered the Flathead River Valley in southeastern B.C. Little was done to control these incipient spots due to their remote locations, uncertainties concerning their potential for spread, and because lodgepole pine had only recently been identified as a merchantable tree species.

These spots rapidly expanded and coalesced, new spot infestations arose in susceptible stands, and large beetle populations moved northward into the Flathead Valley from Glacier National Park. By 1978, 82,000 ha were infested by mountain pine beetle in the interior of the province. By 1983, more than 460,000 ha were under attack with over 17,000,000 m^3 of pine killed in that year alone. To date, estimates of total cumulative mortality approximate 50,000,000 m^3.

Spruce beetle is also a native insect which periodically kills large volumes of large diameter, mature and over mature spruce. Spruce beetles normally infest freshly downed material such as windthrow, slash and other logging debris. However, when beetle populations are large and standing trees have reduced vigour due to drought or other causes, standing trees will be successfuly attacked and killed. Spruce beetle infestations usually occur in years following extensive blowdown or after the presence of large amounts of suitable logging slash has allowed a beetle population to build up.

Infestations of spruce beetle are currently active in most forest regions. 1983 surveys indicated that infestations covered over 58,000 ha and killed over 3,000,000 m^3 of spruce in that year alone.

TABLE 1 Areas and Volumes of Bark Beetle Killed Trees as of 1984 Surveys [1, 2]

REGION	MOUNTAIN PINE BEETLE		SPRUCE BEETLE	
	Area(ha)	Vol. (000 m^3)	Area (ha)	Vol. (000 m^3)
Cariboo	381,000	7,600	2,200	22
Kamloops	58,000	2,734	700	1
Nelson	21,000	660	3,700	116
Prince George	2,800	97	26,120	524
Prince Rupert	14,500	1,103	13,600	1,116
Vancouver	5,000	80 (est.)	---	---
TOTAL	482,300	12,274	46,320	1,779

1. Data from Canadian Forestry Service, FIDS, 1984 Annual Report.
2. Figures are not cumulative and show losses in 1984 only.

Extensive areas of highly susceptible pine and spruce stands still exist throughout the province and represent the major mature components in many Timber Supply Areas (TSA). If no action is taken against existing bark beetle infestations and/or presently uninfested stands are not monitored and protected, severe timber shortages can be expected to occur well before the shortfalls predicted by the current timber supply models.

MANAGEMENT APPROACHES

Management of pine and spruce forests to reduce or prevent losses to bark beetles may be categorized in two ways: long term management strategies designed to reduce stand susceptibility over several rotations and limit the size of infestations that do occur; and short term direct control strategies designed to retard the expansion of infestations and provide time to implement more long term solutions.

Long term management strategies to reduce bark beetle losses are integral parts of general forest management and should be taken into consideration when developing harvesting and silvicultural prescriptions for an area. Indirect practices are dependent on modifying forest conditions or forestry practices which are conducive to buildup of beetle populations.

Many spruce beetle infestations can be avoided through adherence to close utilization practices and prompt salvage of stands with heavy windthrow. Routine use of trap trees will also aid in maintaining low-level populations. Harvesting plans incorporating beetle hazard ratings will remove susceptible material before it becomes infested. These preventative practices should greatly reduce the size and duration of future outbreaks.

The greatest problem in long term management of lodgepole pine to reduce future losses to mountain pine beetle is the extensive inventory of susceptible stands. Eventually, age-class or species mosaics should limit the extent of future infestations. Removing stands before they reach a susceptible age (> 100 years) will also limit future losses.

The implementation of long term management of both tree species requires ready access into supply areas and good market conditions so that priority stands may be harvested on an orderly basis. While the implementation of these silvicultural approaches is desirable and important, the capability for detection surveys and limited direct control must also be maintained.

Direct Control of existing bark beetle infestations will not provide a final solution to the problem. However, direct control of bark beetles in priority areas will slow the rate of expansion of infestations and allow

greater time to implement more orderly management plans. Also, remote drainages without access may be protected and maintained until the required access is developed. The intent of direct control is not to provide a permanent solution (which is impossible) but to buy time.

Direct control methods include such practices as directed harvest, trap tree programs for spruce beetle, and single tree treatments such as felling and burning infested trees. All methods have only one purpose: to destroy as many beetles as possible, thereby reducing the beetle population and the level of subsequent infestation. The use of pheromones in such programs enhances the efficiency of the primary method by concentrating the beetle population in treatable stands.

Direct control programs are most effective when directed towards small to medium sized infestations where available resources can be expected to achieve a significant population reduction over a two to five year period. Extensive infestations should not be considered when planning such operations. These areas should be scheduled for harvest and salvage to extract what timber values remain before significant degradation occurs.

Direct control programs should incorporate all relevant practices as there is no one treatment suitable in all circumstances. Also, a capability for detection and direct control action must be maintained even in long term management. The principle of rapid and thorough initial attack on new infestations will ensure the greatest benefit. Direct control must be thorough and include provisions for follow-up work in successive years.

CURRENT PROGRAM

In 1981, a two year, $11.4 million program was approved for an expanded program for management of bark beetles. Activities covered by this program included detection surveys, ground surveys to gather information to set treatment priorities, single tree treatment programs, trap tree programs for spruce beetle, and access construction into infested areas. This program was originally intended to both allow the removal of infested and threatened stands of timber and to slow the rate of expansion of selected beetle infestations through the application of direct treatment techniques.

This program was terminated in its second year due to financial constraints. As a result of the termination, the second phase of many projects was not carried out and the benefits of the program were greatly reduced from those anticipated. That is, although surveys, etc., had been undertaken and treatment priorities established, the follow-through and implementation of treatment was curtailed. This interrupted program illustrates the need for continuous funding of projects once they have been initiated. Failure to carry through all phases of control programs can often result in no change in the rate of expansion of infestations and resultant reduction in the benefits accruing from the funds initially expended.

Infestations continued to expand in most areas of the province and in 1984 another submission was made to the Forest Service Executive and to the Provincial Cabinet requesting a total of approximately $50 million to be spent over a five-year period on bark beetle related activities. This submission received support and $5 million were approved for spending between October and March during fiscal year 1984/85.

Individual projects were developed and ranked at the district level to address priority problems. District packages were then forwarded to the regional office for review and ranking of all proposals. Criteria for ranking included (not necessarily in order of importance):

1) are costs realistic, appropriate and itemized by activity?
2) what % of an infestation will be addressed?
3) what will be the project's impact on the infestation in succeeding years?
4) does the project restrict itself to a workable area with discreet infestations?
5) does the project tie in with projects planned in neighbouring drainages, districts, and regions?
6) is the proposed combination of treatments feasible and suitable?
7) what is the capability for completion?
8) how does the proposal relate to regional priorities?

The regional packages were then forwarded to Victoria, Protection Branch, for final review and approval. Allocations totalling $5 million with account numbers were established and projects were initiated using contractors or direct hire with short term discharge cheques.

Monthly reports summarizing actual and committed expenditures, and amount and type of work done during the reporting period were required. As well, a final report describing the objectives of each project, costs incurred, and accomplishments was required. It is expected that this system of project development, ranking, and final approval will continue over the additional years of the program (Appendix I.)

Allocations to each region for fiscal year 1984 - 1985 were as follows:

REGION	# OF PROJECTS	ALLOTMENT ($)
Cariboo	15	1,644,330
Kamloops	11	714,507
Nelson	34	824,347
Prince George	26	461,872
Prince Rupert	36	1,273,130
Vancouver	4	17,620
Victoria (contingency)		64,194
Total	126	5,000,000

The objectives of this program were similar to those for the 1981 program. Funds and activities were to be directed towards dealing with those infestations in priority areas where there existed a good opportunity to contain the infestation, restrict the rate of expansion, and protect surrounding susceptible stands. The overall strategy is to "buy time" in which to re-organize management plans so that long term reductions in losses to bark beetles can be achieved.

SUITABLE ACTIVITIES

A number of tactics have been assessed as being effective and are therefore considered to be suitable should funding permit and should the infestation under consideration be amenable to treatment. The ultimate objective of all activities is to achieve a significant population reduction and therefore a resultant reduction in subsequent tree mortality. Thus,

actions are directed into areas where beetles are actively infesting trees. Areas with extensive components of old dead material (areas for salvage) or areas where the beetles have not been able to establish themselves (because of climate or small host component) have been given lower priority.

Activities suitable for funding are:

Surveys for initial detection and for subsequent assessment to set priorities for follow-up treatment. Such surveys include aerial overview and detailed surveys which may be carried out by sketch mapping or, in some circumstances, by aerial photography. Annual photography of the same area should be permitted only with good justification as succeeding year's surveys can be mapped directly onto the initial photo set.

Ground surveys include probing to establish actual infestation intensities for treatment allocations (including harvesting), more intensive surveys to delineate infestation boundaries (where such surveys do not overlap the function of cruising), and surveys to lay out single tree treatment projects or for placement of pheromones.

Access development or improvement into otherwise inaccessible, priority currently infested or susceptible stands. Such access will allow the removal through logging of significant beetle populations, or, in some cases, will allow the removal of valuable timber before it is rendered non-merchantable due to bark beetle activity. Funding for access development under the bark beetle program should be permitted only after other avenues such as appraisal or Section 88 have been considered as these projects are expensive and therefore greatly reduce the amount of resources available for other activities. Similarly, the grade of access developed should only be

of sufficient quality to allow accomplishment of specified objectives. Timber accessed by these projects should be removed within a short time frame (3 years). If it is unlikely that timber can be sold or removed soon after access construction, then these projects should have a lower priority.

Directed harvesting of stands currently infested by bark beetles is the most efficient and effective method of removing a significant portion of a beetle population. Costs associated with this treatment include initial detection and assessment surveys to priorize stands and the use of aggregating semio-chemicals (pheromones) to reduce dispersal of the beetle population. These costs, if not covered under appraisal or Section 88, are suitable for funding under the bark beetle program.

Single tree treatments are particularly applicable for disposing of isolated patches of pine attacked by mountain pine beetle or for mopping up infested trees around the periphery of cut blocks.

Single tree treatments are effective in suppressing incipient infestations in timber where cutting is not planned to take place within 2 to 3 years. The size of infestation appropriate for single tree treatment will depend upon resources available, the importance of the area being considered, terrain, method of access, and risk to adjacent areas should the infestation not be contained.

Currently, two methods of single tree treatment are considered to be operational:

a) felling and burning infested trees - trees currently infested with live brood are felled as close to the ground as possible, bucked into

sections, piled, and burned to kill the brood beneath the bark. These activities are best conducted outside of fire season to reduce the risk of forest fire.

b) hack and squirt application with MSMA - trees newly infested by mountain pine beetle may be treated with MSMA if done within 3 weeks of attack. A shallow frill is made at the base of infested trees and MSMA is applied. The translocation of this arsenical will kill the beetles and their brood under the bark. Translocation ceases after about 3 weeks making this treatment ineffective thereafter.

Single tree treatments must be thorough to be effective and must be followed up in succeeding years to assure success. A good survey system is required to identify attacked trees in an area. The use of aggregating semio-chemicals can make these treatments much more efficient (to be discussed below under use of semio-chemicals.)

Trap tree programs for spruce beetle. Spruce beetles preferentially infest downed material such as windthrow, log decks, stumps, and logging debris. This habit can be taken advantage of through the use of conventional or lethal trap trees.

All trap trees for spruce beetle are living, large diameter host trees felled into the shade before the beetle flight period and left unbucked and unlimbed. These trees, if felled in adequate numbers in appropriate locations, will absorb the flying beetles and reduce attack on standing trees. Trap trees must be subsequently removed and processed or otherwise treated before the next beetle emergence period to kill the beetles under the bark.

a) conventional trap trees - are used in areas that are accessible and where the trees can (and must) be removed and processed. Trees are felled as described above and normally removed during logging operations.

b) lethal trap trees - are used in areas with poor or no access where timber must be preserved until logging operations can begin (usually 2 - 3 years in the future). Trees are selected in early spring and treated with MSMA as described for mountain pine beetle single tree treatment. These trees are left standing for 2 weeks to allow for translocation of the MSMA and then felled. Treated trees are just as attractive to beetles as untreated trees but will kill arriving beetles and prevent brood establishment. No follow-up treatment of these trees is required.

Use of aggregating semio-chemicals (pheromones). Aggregation pheromones are naturally produced by bark beetles to ensure adequate colonization of susceptible trees. They serve to attract more beetles of both sexes to selected trees and thereby induce mass attack. These chemicals have been commercially synthesized and their use offers an opportunity to enhance the effect of direct control techniques. It must be remembered, however, that these chemicals do not control beetle populations by themselves and they should not be used alone (Appendix II).

Pheromones are currently considered to be operational for two general purposes:

a) to restrict beetle dispersal out of the proposed cut blocks. Infested cut blocks which cannot be removed prior to the beetle flight period may be baited with pheromones. These baits will serve to prevent emigration of the resident beetle population out of the block and thereby make the

sanitation cut much more effective. Further, baits placed around the periphery of cut blocks will concentrate residual beetles and facilitate treatment or removal.

b) to improve the efficiency of single tree treatment. Areas where single tree fell and burn have been carried out should be baited to concentrate any remaining beetles resulting from incomplete treatment or "missed" trees. This will greatly improve the efficiency of follow-up as newly attacked trees will be easily located in proximity to the baits. Such baiting and ease of locating new attacks will greatly increase the efficiency and use of MSMA applications.

Although the above activities are the most common that are suitable for funding under the bark beetle program, other innovative approaches are possible. These should not be ruled out as a matter of course, but should be examined for their potential benefits. Such proposals should be evaluated on an individual basis by relevant specialists and decisions for funding determined individually.

No single treatment will be applicable to all situations and it is unlikely that any treatment by itself will solve a particular problem. Rather, each infestation should be assessed individually and the most appropriate combination of treatments should be applied.

MONITORING AND COMMUNICATION

As this expanded bark beetle program continues, it will be necessary to monitor both the progress of individual projects and the resultant impact on a target infestation. Regional staff will coordinate and monitor

activities within involved districts, while Protection Branch will ensure that the overall program progresses smoothly. Such monitoring at both regional and Branch levels will entail periodic on site examinations and program reviews. Regular technical audits will also be conducted. Such audits are necessary to ensure that management priorities are being addressed, that the techniques being used are the best available, and that the prescribed treatment plan is the most appropriate. The monitoring process, including technical audits, is intended to have a positive impact. Problems in operations or planning should be identified and solutions developed. Refinements will also be possible to procedures based on field experience with their use.

New, more efficient procedures will be incorporated into the operational programs as they are developed and proven effective. Contact is maintained between the Forest Service and research and development information sources including the Canadian Forestry Service, U.S. Forest Service, University of British Columbia, Simon Fraser University, and appropriate technical literature. As new techniques are developed, operational trials carried out by the Forest Service will be conducted to establish the usefulness of the technique and refine procedures. Proven approaches will then be suitable for inclusion in the program.

A number of committees or groups are active in regard to bark beetle management. These committees serve as both forums for technical transfer of information and as coordinating groups to deal with bark beetle problems in border areas or where more than one agency or administrative unit is concerned. This group of committees includes:

The Forest Pest Review Committee. This committee is comprised of representatives of agencies with forest management concerns. Agencies represented include the Ministry of Forests, Ministry of Environment, Ministry of Lands, Parks and Housing, Environment Canada, forest industries, and B.C. universities. This committee meets twice each year to discuss all facets of forest pest management including bark beetles.

Interagency Committee on Mountain Pine Beetle. The membership of this committee includes B.C. Ministry of Forests, Ministry of Lands, Parks and Housing, Alberta Forest Service, Canadian Forestry Service, and Parks Canada. This group was first formed to coordinate mountain pine beetle control operations in the B.C./Alberta border area. Although this function still continues, the technical subcommittee also provides an excellent opportunity to discuss operational methods, problems with execution, and results.

Canada/U.S. Mountain Pine Beetle Agreement. Participating agencies in this agreement include B.C. Ministry of Forests, Alberta Forest Service, Canadian Forestry Service, U.S. Forest Service, and various state agencies involved with mountain pine beetle management problems. These agencies cooperate to review past and current mountain pine beetle outbreaks; discuss the state of knowledge concerning biology, ecology and management of lodgepole pine stands and beetle populations; study management options and develop a joint U.S./Canada action strategy.

Other action and planning committees exist within individual forest regions and Timber Supply Areas to address specific problems.

Continuing program reviews, technical audits, on-site examinations and discussions between operational and research organizations will help to ensure that management efforts are the most effective possible and that they are properly directed.

SUMMARY

The current bark beetle infestations throughout the province represent a major threat to the forest resource. To deal with this problem, a multi-year program has been established. The objectives of this program are:

- to develop access to allow for priorized sanitation logging of heavily infested, valuable stands and thereby reduce subsequent attacks in adjacent stands.
- to apply direct control in specific circumstances to reduce beetle populations and protect stands or drainages until more long term management can be imposed.
- in general, to "buy time" in which to reorganize management plans to address the problem as a whole.

The intent of the program is not to totally control the beetle outbreaks. Rather, the intent is to reduce losses in both the short and long term.

ADDITIONAL READING

Amman, G.D., M.D. McGregor, D.B. Cahill, and W.H. Klein. 1977. Guidelines for Reducing Losses of Lodgepole Pine to the Mountain Pine Beetle in Unmanaged Stands in the Rocky Mountains. U.S.D.A. For. Serv. Gen. Tech. Rept. INT-36.

B.C. Ministry of Forests. Protection Manual. Chapter 9. Bark Beetles. In preparation.

Dyer, E.D.A. and R.S. Hodgkinson (eds.). 1980. Spruce Beetle Management Seminar and Workshop Proceedings in Abstract. B.C. Ministry of Forests Pest Management Rept. 1.

Safranyik, L., D.M. Shrimpton, and H.S. Whitney. 1974. Management of Lodgepole Pine to Reduce Losses from the Mountain Pine Beetle. Envir. Can., Can. For. Serv., For. Tech. Rept. 1.

APPENDICES

Appendix I - Memorandum describing process of program development and approval

Appendix II - Paper discussing use of pheromones for management of mountain pine beetle

APPENDIX I

MEMORANDUM DESCRIBING PROCESS OF PROGRAM DEVELOPMENT AND APPROVAL

Province of British Columbia
Ministry of Forests

MEMORANDUM

To: Regional Manager
All Forest Regions

From: Protection Branch
Date: September 17, 1984
File: 720-4

Re: Special Funding for Bark Beetle Management Activities

As noted in the telex of September 14, approximately $5 million have been allocated for bark beetle activities. Regional allotments were listed in the telex. This memorandum provides guidelines for proposal development, review, approvals and funding mechanisms.

Attached please find:

1. format for initial proposal
2. monthly activity reporting format
3. monthly financial reporting format

In general, the procedure for proposal approval shall be as follows:

1. Districts shall prepare project proposals according to the enclosed format. Projects should include all activities directed at managing a particular infestation within well defined geographical boundaries (e.g. a drainage). Therefore, each project will doubtless incorporate a combination of suitable activities such as survey, single-tree treatments, harvesting, pheromone use, etc.

   Regions will be responsible for preparing proposals for large-scale activities such as extensive access construction, inter-district aerial/ground detection capabilities, priorization of harvest, or coordination of funding requests for pheromone/pesticide use to take advantage of any bulk order purchase benefits. Each project proposal must be accompanied by a detailed project budget.

2. When all District proposals have been completed, they must be ranked by importance. Rankings should consider:
   a) the impact of the project on timber supply
   b) project costs versus potential benefits
   c) estimated probability of success
   d) relative ease of completion

   When the District set of proposals have been completed and priorities determined, they should be forwarded to the Regional office for review and approval (attn: R.S.M. Forestry, Protection Officer).

3. Regions shall be responsible for approving projects and funding up to the total allotted to the Region (as per September 14 telex). It will be the Regional Staff Manager's responsibility to ensure that those proposals dealing with aspects such as engineering or timber management are reviewed by the appropriate staff experts. This will ensure road standards, etc., are built only to meet project requirements. Project budget proposals must be reviewed by Regional Finance Officers to ensure that they are realistic and that contract requirements will be met. Final review and recommendations will be made by the Pest Management Coordinator after consultation with other relevant staff and approval from the Regional Manager.

   Regional staff project reviews must ensure that proposals are biologically, logistically, and financially sound in view of the project objectives and the value of the resource to be preserved. Recommendations and suggestions for improvements must be noted and incorporated where needed.

   Regions shall assemble a priorized "package" of approved District and Region proposals and submit it to Victoria, attn: Director, Protection Branch.

4. The Director, Protection Branch, will ensure that proposals are reviewed and approved by appropriate Branches. Protection Branch will give final approval, assign a project number, and inform Financial Services Branch.

   Financial Services Branch will assign an account number, confirm the level of funding with an allotment and notify the appropriate Region, with information copied to Protection Branch. The Region will keep records of accounts and notify the appropriate District.

5. Monthly updates (as per attached formats for activity and financial reporting) must be prepared by project initiators, either District or Region, and submitted with maps to the Region Pest Management Coordinator at the end of each month. The PMC will summarize the reports for the Region and forward the summary to the Director, Protection Branch.

   It will be the PMC's responsibility to ensure that particular projects are implemented and progressing satisfactorily. This should involve periodic reviews and inspections.

   It will be possible to modify projects or reallocate funds but this will only be possible after a new project proposal has been written and approved.

6. Final reports for each project detailing work done, actual budgets, and impact on the infestation trends will be required. Such reports must include data on the volumes of timber harvested and/or accessed as a result of this program. A format will be developed.

We must also begin planning for next year's programs. To this end, Treasury Board has requested further information. We will have to provide data on the gross costs of the program versus the anticipated revenues obtained as a result of activities. Therefore, could you please provide (by year) estimates of program costs which should already be available and an estimate of volumes harvested and resultant stumpage obtained as a result of probing, access construction and other activities. This information will be required by the end of October.

If any of the above requires clarification, please contact the Director, Protection Branch.

H.G. Doerksen
Director
Forest Protection

Attachments

DRAFT

INITIAL BARK BEETLE MANAGEMENT PROJECT PROPOSAL

Region:_____ District: _____ Proposal No. _____

District Project Priority (ranking): _____ of _____ Date_____

I. Location:

a) TSA _____

b) Drainage/Area _____

II. Current Beetle Status (include map):

a) Beetle species _____ b) Host species _____

c) Intensity (H, M, L) _____ (also include on map if more than 1 infestation occurs in area)

d) Area currently attacked (ha) _____

e) Volume currently attacked (m^3) _____

f) % susceptible volume killed _____

g) At risk (estimate for 5 yr. period): volume (m^3) _____ area (ha) _____

III. Timber Supply:

a) Is the area included in Net Operable Land Base? (Y or N) _____

b) Is the timber included in: 1) current 5 yr. development plan? (Y or N) _____
2) proposed 20 yr. development plan? (Y or N) _____

c) What impact will the loss of the susceptible timber in this area have on short and long term timber supply in the TSA? _____

_____

_____

_____

d) Does this infestation threaten timber in adjoining TSA's? (Y or N) _____

e) If yes to (d), which other TSA's? _____

IV. Project Objectives (check those applicable)

a) salvage volume (m^3) _____ area (ha) _____

b) beetle population reduction by:
1) sanitation logging volume (m^3) _____ area (ha) _____
2) other sanitation treatment (describe): _____

c) removal of threatened timber volume (m^3) _____ area (ha) _____

d) other (describe): _____

V. Methods: (fill in where appropriate; estimate where not completely known)

a) General description of proposed approach: _____

b) Detection/assessment

1) aerial - area (ha) to be surveyed _____
- fixed wing _____ rotary wing _____
- sketch mapping _____ other (describe) _____

2) ground - area (ha) to be surveyed _____
- method (describe or refer to appropriate documentation): _____

c) Access

1) road access - new _____ km; upgrading _____ km
2) bridge const. - new _____; upgrading _____
3) helipads - number _____ (indicate locations on map from II)
4) other (describe) _____

d) Harvesting

1) area (ha) _____ 2) volume (m^3) _____
2) indicate proposed blocks on map

e) Single tree treatments

1) no. of sites _____
2) no. of trees _____
3) method (describe) _____

f) Trap tree program

1) conventional and/or lethal? (C and/or L) _____
2) number of sites _____
3) number of trees/site _____
4) indicate sites on map

g) Pheromone (to be used in conjunction with c, d or e)

1) pheromone to be used _____
2) amount/dosage _____
3) number of baits required _____
4) describe application _____
5) indicate locations on map

h) Other methods including any proposed use of rappel crews _____

VI. Assessment

a) How is the proposed impact to be measured? _____

b) Estimate project accomplishments over program duration:

		Accomplishments 1st year	2nd year	3rd year
salvage	ha.			
	vol.			
sanitation logging	ha.			
	vol.			
timber accessed	km access			
	vol. accessed			
beetle population reduction (%)				

c) Describe potential constraints to success of project (e.g. environmental concerns, fish and wildlife concerns, seasonal logistics, etc.): _____

VII. Implementation

a) Are trained contractors available? List.
b) What are their pertinent qualifications?
c) What pre-project training is required?
d) Who will do such training?
e) How will work be monitored (quantity and quality)?
f) What type of detailed recording system of work done, etc., will be maintained? (describe)

VIII. Signed _____ _____
R.O. Protection District Manager

IX. Region Review (for Region use only)

a) Date received _____
b) Reviewed by

Position	Signature	Date

c) Suitability of:

	O.K.	O.K. with changes	Inappropriate
1) location			
2) objectives			
3) methods			
4) assessment			
5) implementation			

d) Recommendations/Suggestions _____

e) Approved (Y or N) _____ f) Cost _____

g) Regional Priority (ranking) _____ of _____

X. Branch Review (for Branch use only)

a) Date received _____

b) Reviewed by

Position	Signature	Date

c) Recommendations/Suggestions _____

_____

_____

_____

_____

_____

d) Approved (Y or N) _____ e) Account # _____

f) Date project initiator advised _____

SPECIAL FUNDING PROGRAM
MONTHLY UPDATE - ACTIVITIES*

REGION_____ DISTRICT_____ MONTH ENDING_____

PROJECT #	ACCOUNT #	AREA SURVEYED (ha) AERIAL	AREA SURVEYED (ha) GROUND	# SINGLE TREES TREATED	TRAP TREES # SITES	TRAP TREES # TREES	LETHAL OR NON-LETHAL (L OR N)	LOGGING AREA (ha) VOL (m^3)	PHEROMONES (Y OR N)	ACCESS KM COMPLETED

* include map showing locations of activities within the control area.

SPECIAL FUNDING PROGRAM
MONTHLY UPDATE - FINANCIAL

REGION_____ DISTRICT_____ MONTH ENDING_____

PROJECT #	LOCATION	ACCOUNT #	TOTAL FUNDS ALLOCATED	EXPENDITURE THIS MONTH	EXPENDITURE TO DATE

APPENDIX II

PAPER DISCUSSING USE OF PHEROMONES FOR MANAGEMENT OF MOUNTAIN PINE BEETLE

USE OF PHEROMONES IN BRITISH COLUMBIA FOR MANAGEMENT OF MOUNTAIN PINE BEETLE

British Columbia is a province largely dependent upon the forest resource and the forest industry to ensure a viable economy. The forest resource of the province is large, totalling forty-seven million hectares of productive forest land and supporting an annual allowable cut (AAC) of seventy-five million cubic meters of timber. A large component of this resource is made up of stands of mature or overmature, even aged pine which are potentially susceptible to attack by the mountain pine beetle.

Although mountain pine beetle is native to B.C. pine forests, and outbreaks have been recorded since 1914, infestations of this insect have not been dealt with to any great extent until about two decades ago. Pre-eminent among the reasons for this previous lack of action was remoteness of such infestations from processing facilities and also because, until recently, pine was not favoured as a commercial species in B.C. Both of these factors have now disappeared: timber processing is now the major industry of the interior of the province, and pine now represents approximately 22 percent of the Provincial AAC.

The current cycle of infestations in B.C. began in the early 1970's. Infestations were detected concurrently in the western portion of the Chilcotin Plateau (Kleena Kleene River drainage) and in the extreme south-eastern portion of the province (Flathead River Valley). In 1975 the Canadian Forestry Service Forest Insect and Disease Survey estimated that

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there were about 32 000 hectares of pine infested in the province. By 1984, this figure has risen to over 480 000 hectares of current attack alone - i.e., this figure is not cumulative and represents the area of red attack only. Estimates place the volume of timber killed in the past year near 12 million cubic meters. Major infestations of mountain pine beetle can be found in four of the six forest regions in the province and the other two regions also have some problems. Further extensive areas of apparently susceptible pine are at risk as the infestations expand and as new epicenters become established.

Yes, we have a problem. Solutions to this problem must be found, both for the short and long-term. A short-term solution of totally suppressing a mountain pine beetle outbreak is unreasonable and probably impossible. The conditions leading to the outbreak would remain and therefore the problems would recur as soon as the pressure of control was removed. Also, saying direct control is entirely inappropriate or useless is not realistic. Completely unrestrained beetle populations would most probably continue to expand and intensify, rapidly outstripping harvesting capacities and diminishing available timber supplies leaving no alternative supplies required to maintain the economic viability of milling facilities and their dependent communities.

Rather, a balanced approach must be taken. Direct control practices must be implemented in appropriate areas to slow the rate of expansion of beetle populations and mortality. Slowing the expansion in selected areas will buy time in which to revise management plans and gradually impose more long-term solutions that will avoid or minimize future losses to mountain pine beetle while deriving some value from presently attacked timber.

Direct control programs are designed with one intention: to remove or significantly reduce the size of the beetle population available to attack and kill new hosts. Principle methods are directed harvesting into currently infested stands rather than salvage of old dead material, and single tree treatments such as fell and burn or use of insecticides. The use of pheromones enhances the efficiency of these operations.

Now, I've come to the main topic of this panel: operational use of pheromones. At present, I will restrict this discussion to the use of aggregation pheromones (semiochemicals). Pheromones can be an effective tool for augmenting direct control programs in that they will (or should) enhance the efficiency of control treatments or reduce the amount of survey time required prior to treatment.

Trials using various potential aggregating pheromones have been conducted in British Columbia since the mid 1970's. The initial compounds used, primarily by Canadian Forestry Service researchers, were trans-verbenol with alpha-pinene, sometimes with ethanol included. Although the attractiveness of these combinations was less than expected, the results were positive, and when combined with single tree treatments such as preflight treatment with contact insecticides, postflight treatment with arsenicals (e.g. cacodylic acid and MSMA), and preflight treatment of infested trees with a penetrating insecticide for brood reduction, the trials showed marked reductions in subsequent attack when compared to check areas. However, considerable

refinement of the pheromone complex was required before the use of this tool could be considered operational.

Researchers at Simon Fraser University, notably Dr. John Borden, have now provided us with a usable semiochemical. After several years of field trials testing various combinations of potential chemical combinations, consistently good aggregation resulted from a combination of trans-verbenol, exo-brevicomin, and myrcene. Again, trials using this lure in combination with direct control treatments showed significant population reduction as evidenced by reduced attack subsequent to treatment. As of about 1982, the use of aggregating pheromones to enhance the effect of treatment was judged to be acceptable on an operational basis for control of mountain pine beetle.

However, it must be emphasized that aggregation pheromones, by themselves, will not control beetle populations, and may in fact aggravate the problem. These pheromones manipulate populations and are generally used to restrict dispersal, they do not reduce the population size. Therefore, they must be used in coordination with the actual control method. Without the subsequent use of harvesting or single tree treatment, the target infestation may actually expand more than if pheromones were not used. The portion of the beetle population which may normally be lost through dispersal is reduced and these beetles are more assured of finding suitable host trees, thereby potentially increasing the number of infested trees over the number which may otherwise have occurred. Also, as the criteria for selecting trees for baiting requires the largest trees available, the resulting diameter

distribution of attacked trees may be somewhat higher than normal and brood production may be greater. Furthermore, some baiting patterns may spread the beetle population out more, resulting in lower attack densities, reduced larval competition, and therefore higher survival. All of these possible hazards can be avoided as long as pheromones are not considered as a treatment unto themselves. It is our policy that aggregation pheromones must only be used to enhance other planned control efforts.

In British Columbia, we are advocating and using two use patterns of aggregation pheromones in our bark beetle related activities. Attractants are being used (1) for containment of beetle populations within proposed sanitation cut blocks and (2) as an aid in treatment of small infestation patches using single tree treatments.

Sanitation harvesting, i.e. logging and processing of stands with beetle brood producing trees, is the most efficient method of reducing beetle populations. Not only is a beetle population removed from an area, but values are received for the timber products.

If a block cannot be scheduled for cutting prior to the beetle emergence and flight period, significant emigration of the emerging beetles out of the block can often be expected. Peripheral stands will be attacked, or widely dispersing beetles may initiate additional infestation centers some distance away. The maximum effect of the sanitation cut will be lost: more trees will be killed, beetles may establish themselves in inaccessible areas, and extensive and expensive surveys will have to be conducted to relocate and

treat the escaped population. At this point, treatment of some stands may no longer be feasible.

This emigration of the target population can be reduced, or even prevented through the use of pheromones. Live, apparently susceptible trees within the block can be baited with pheromones prior to the beetle flight period. When beetles emerge and begin searching for and attacking new hosts, the previously baited trees are usually the first attacked. Once baited trees are attacked, the natural attractant bloom produced by the beetles will further concentrate the population. Thus beetles emerging within the treated stand will be prevented from dispersing to unknown areas not scheduled for treatment. An additional bonus of this treatment may be the attraction of beetles outside of the treated area into the baited stand. Harvesting after the beetle flight period will therefore remove the entire resident beetle population (except those individuals left in stumps) and beetles immigrating into the block as a result of the pheromone treatment. In other words, the use of aggregation pheromones will enhance the efficiency of sanitation logging and allow the removal and disposal of a greater proportion of the resident beetle population in an area.

B.C. has been using two methods of baiting for sanitation logging. In smaller blocks, baits are put on trees at 50 metre grid intervals starting 25 metres in from the block boundaries. Thus, beetles emerging from brood trees should be no further away from a baited tree than 35 m.

The second method entails baiting trees 50 metres apart in two lines also 50

metres apart around the boundary of the proposed block. Also, areas where brood trees are concentrated within the block are baited on a 50 metre grid. Therefore, the bulk of the emerging beetles will find themselves in close proximity to baited trees and the remaining population within the treated area should either naturally find host trees within the block or be arrested at the periphery.

Measuring the effects of this baiting is difficult. Assessments have been conducted by the Forest Service at a variety of intensities and in a number of ways. Surveys have been conducted in treated blocks after the attack period. In most cases baited trees appeared to have been the first trees attacked, and if non-baited trees are also found, they are usually close to baited trees and may be attributable to a spill-over effect. In the case of treatment to isolated infestations little or no attack was found outside the treated area. District Forest Service staff are satisfied that the project objectives were met.

A more definitive trial of containment baiting was carried out in the Nelson Region in B.C. Small blocks were baited in a 50 metre grid before the beetle flight period. After beetles had attacked, the baited block and a surrounding 150 metre zone were 100 per cent surveyed to assess ratios of green attacked trees to brood trees. Although the final results of this trial have not been completely summarized, preliminary results show that baited areas had more than 5 times the concentration of new attacks than adjacent untreated areas. Results of this trial and information from the surveys

mentioned above have been consistant and we have confidence that the baiting program is performing as expected. Both Forest Service and industry pest management and timber personnel are enthusiastic over this technique and further applications are expected.

The level of use for containment baiting is increasing in the province. This is as a result of general acceptance of the technique and because, currently at least, we have a special bark beetle program underway which has sufficient funding to accommodate pheromone use. Up to now, most of the purchasing and placing of pheromones has been conducted by the Forest Service. However, now the industry is involved and active, conducting containment programs under either the credits to stumpage allowance (Section 88 of the Forest Act) or as a direct cost of doing business. In 1982, the Forest Service used less than 100 baits, mainly for demonstration trials. In 1983, the number rose to about 2000 baits; more than 7000 baits were used in 1984 and for 1985 the Forest Service alone is purchasing over 34,000 baits to be used for containment and mop-up of single tree treatment sites. This increase in use is a reflection of the confidence in the technique. Sanitation cutting incorporating the use of aggregating pheromones is being planned in all six of the forest regions. We believe the technique works when used in situations where beetle populations outside of the blocks are not extreme or so high that even cutting using baits will not significantly reduce the population in an area. That is, as with all applications of direct control, the techniques should not be used where there is no possibility of success.

The other major use of aggregation pheromones now employed in B.C.

is in augmenting single tree treatment projects such as fell and burn, or injection of MSMA. Single tree treatment projects are implemented to sanitize lightly infested stands, remove small patches in inaccessible areas or that cannot be removed through small volume timber sales, and to mop-up around the periphery of sanitation logging.

One of the most labour intensive and time consuming tasks in those types of projects involves finding and marking currently attacked trees containing viable brood. Pheromones have greatly reduced this component and therefore make the work more efficient.

It can be assumed (or assured) that sanitation logging will not remove all the beetles in a localized area. We have had many instances of cutting out infestations and then later finding small infested patches of trees around the periphery of the blocks. Whether these beetles came from brood trees not included in the cut block or whether they represent the population remaining in stumps after cutting before the flight period does not really matter. These new patches do represent the potential for further devastation of the surrounding stands and should be dealt with promptly if the stand is within a beetle control area.

However, expensive aerial and ground surveys are usually required to find and mark these patches. This requirement can be replaced to a great extent with placement of aggregation pheromones prior to the beetle flight period. If a block has been logged in the spring or summer prior to the beetle flight

period, baits can be placed around the block during the final phases of logging. Blocks logged in the late summer or in the fall should be revisited early the following summer and baited. Baited trees in the stand surrounding a new cut block should be located about 25 m in from the edge and be spaced at 100 m intervals in the remaining susceptible type around the edge of the block. These baited trees will serve as aggregation foci and the residual beetle population in the area should be clumped around these predetermined spots. After the beetle flight period, attacked trees may be harvested with small timber sales, felled and burned, or, if treatment is possible within three weeks of attack, they may be treated with a hack and squirt application of MSMA.

Single tree treatment to sanitize stands not scheduled for harvest within a few years or in remote areas where high value stands are threatened is practiced in British Columbia to buy time. Again, the greatest expense is locating and marking the trees for disposal which may often require helicopter access and multiple entries for survey and location and again for treatment. As mentioned previously, the chances are that some trees will be missed and therefore not treated or that there will be some beetle production from remaining stumps or incompletely treated trees. Thus, further tree mortality should be expected in years subsequent to the initial treatment and the strategic use of pheromones will make further treatments more efficient as the searching time required will be substantially less.

When single tree treatments are done from late winter up to the beetle flight

period, a few trees should be baited around the spot just as the site is left. These trees should serve as foci for aggregating the residual population and therefore additional trees attacked can easily be found and treated.

The use of MSMA is an effective treatment against mountain pine beetle but must be applied within three weeks of a tree being infested. This narrow window for application has previously limited the use of this technique. The use of pheromones to pre-select sites and trees may increase the application of MSMA. There are a number of advantages for MSMA use over more conventional felling and burning. Application of MSMA is relatively simple and needs little equipment. It is also much less labour intensive than felling and burning so that more trees may be treated and smaller crews can be used. This use is applicable to areas with reasonable access and small patches of infested trees. The populations can be held on site with baits and then treated afterwards. This treatment is increasing in B. C. So far it has been used on a limited basis in the Cariboo and Kamloops regions. Forest Service staff are currently planning additional treatment areas for 1985 and will be treating several sites and hundreds of trees.

The foregoing has explained how aggregation pheromones are used in British Columbia. We believe that these chemicals will usually perform as advertised and that they can significantly improve the effectiveness of direct control programs. There are a number of cautions, however.

The timing and selection of trees to bait are important. Baits must be placed

in the field well before any beetle flight and the resultant establishment of natural, unknown attractant centres. I doubt that the synthetic lures currently available would compete successfully with the natural attractant. Care must also be exercised to ensure that baits are not put out too early as some of the components may dissipate before beetle emergence and therefore decrease the effectiveness.

Trees selected for baiting must be the largest, most apparently susceptible trees available. As the beetle normally has a preference for such trees, this will increase the effectiveness of the bait and ensure the best chance for attack.

The greatest caution in the use of pheromones at present is that they must only be used in conjunction with other practices. They are not a population reduction treatment in themselves and, as discussed earlier, they may actually increase the problem if left untreated. As with any other pest management or forestry treatment option, the best possible combination of activities should be directed at specific circumstances and followed through to completion.

I have confined myself to discussing the use of aggregation pheromones as applied to living trees. At this time, we are not encouraging the use of artificial traps for mountain pine beetle. Traps such as the funnel trap have given erratic results, at best to date, and there is no way of relating trap catches to the impact on a given beetle population. Such traps may have some use in monitoring the start and end of the beetle flight period, but there are also other methods to accomplish this objective.

I have also not discussed the potential use of repellant pheromones or chemicals. Although the use of such chemicals may protect selected trees or stands, the effect is to disperse the population to unknown areas and, used alone, do not seem to offer a practical application in the reduction of beetle populations. There may be some applications if their use is combined with and coordinated with the effect of aggregation pheromones and this possibility should be explored.

In summary, we believe that aggregation pheromones are useful, we are encouraging their use, and we expect their use to increase given adequate funds. Eventually their use may be incorporated into normal harvesting operations. Such a use would help in maintaining endemic beetle populations.

Inherent in our belief in the application of pheromones for manipulating populations, is our underlying belief that direct control can meet the objectives of delaying the expansion of infestations and of buying some needed time. Direct control programs are not universally applicable. They must be thorough and such programs must only be directed to deal with infestations of limited size and in areas which are not immediately under pressure from an overwhelming source of beetles. Every effort must be made to apply the best possible treatment or combination of treatments to ensure that the greatest population reduction is achieved. The use of pheromones will significantly aid in meeting project objectives.

I believe that bark beetle pheromones (or semiochemicals) are no longer just a scientifically interesting phenomena. They have finally found a home as an operational tool useful in the manipulation, and therefore, the management of bark beetle populations.

However, it must always be kept in mind that the use of pheromones (attractants, repellants, whatever) by themselves are unlikely to have any application, except for monitoring purposes. They must be used in coordination with other appropriate techniques in a coordinated fashion.

Direct control is not an alternative to the implementation of more long-term solutions to beetle losses. Rather, it must be considered as an interim approach that will achieve limited objectives. Forest management programs must include considerations for management to reduce or avoid losses to bark beetles. Such programs should incorporate the various practices that reduce the long term impacts of bark beetles but a capability for survey and limited suppression through harvesting or other treatment must be maintained. Tools such as synthetic semiochemicals have to be incorporated into our programs as they enable us to meet our objectives.