REVIEW OF THE BRITISH COLUMBIA BARK BEETLE MANAGEMENT PROGRAM: 1984-1989

BY

D.M. SHRIMPTON*
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* Malcolm Shrimpton is a research scientist with Forestry Canada on work transfer to the Protection Branch, British Columbia Ministry of Forests.

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EXECUTIVE SUMMARY

Pest control operations under the emergency program for bark beetle were reviewed at the request of the Protection Branch of the British Columbia Forest Service (BCFS). The available documents were reviewed; the original Treasury Board Submission, annual project proposals, infestation assessments, pest management plans and any relevant standard operating procedures. Pest Management Staff in regions and districts were interviewed and some field sites visited. The following objectives were applied broadly throughout:

To determine whether the available knowledge has been applied in operations to control bark beetles.

To determine the adequacy of current technological information for bark beetle control in the field.

To evaluate the mechanisms currently used to transfer technology to the field staff responsible for bark beetle operations.

To identify any knowledge needed to improve the effectiveness of the pest management strategies and procedures used against bark beetles.

To review, in general, current reforestation programs for their probable consequences with respect to bark beetles.

A series of recommendations were prepared as follows:

1. The available records on mountain pine beetle incidence, which are currently in unorganized paper files in both regional and district offices, should be assembled into a permanent electronic data base.

2. Requisite to a province wide data base, basic records on mountain pine beetle should be collected according to a standard format and stored in a uniform and readily retrievable manner.

3. The BCFS should organize a cooperative program to develop a pest management information system for the mountain pine beetle; Forestry Canada's Pacific Centre and British Columbia Institute of Technology (BCIT) are probable collaborators.

4. The British Columbia Forest Service should offer to have operational staff, as well as Branch, cooperate with the Pacific Forestry Centre in the analysis of the data collected during the province wide survey of stands attacked by the mountain pine beetle to ensure that an operationally valid profile of stand hazard is extracted from this data base.

5. More use should be made of aerial colour photography for recording outbreaks, this would improve monitoring and increase communication about pest impacts through the Forest Service.

6. In areas where mountain pine beetle infestations have now subsided to a low level, harvesting should be planned as the first step in a preventative management program for mountain pine beetle.

7. An over dependence upon pheromones is a very real danger. An information effort which targets staff outside pest management and highlights the probable consequences if pheromone treated areas are not harvested on schedule is needed.

8. A clear strategy needs to be developed to define the use of monosodium methane arsenate (MSMA), this must ensure that the circumstances for use are clearly prescribed. Some communications effort oriented to the safety of those who contact treated trees is warranted. Quality control checks of single tree treatments must continue.

9. More use should be made of the several silvicultural prescriptions available for management programs relative to mountain pine beetles; in particular, field tests of spacing regimes to control diameter of lodgepole pine are needed.

10. The Forest Service should organize a series of seminars and field demonstrations on the spruce beetle to increase awareness of the potential impact of this pest and improve the ability to diagnose and prescribe for it.

11. A subtle communications effort is warranted to ensure that the sanitary practices to control Douglas-fir beetle are maintained. PesTopics could be an appropriate means.

12. An analysis of probable demand for balsam would quantify and justify the probable need for management of the balsam bark beetle.

13. A staff training program is needed to ensure that field staff manage contracted operations effectively and regain familiarity with the technical procedures and planning associated with contract management.

14. Job descriptions for the R.O. protection do not reflect the current effort on pest management, this should be corrected and thereby increase the recognition of pest management within the Forest Service.

15. A certification program for contractors eligible to carry out probing, pheromone applications and control treatments is needed to ensure that these operations are done correctly.

16. A number of areas were identified where limited knowledge is causing problems; stand rehabilitation, mountain pine beetle dispersal, field demonstrations of the effectiveness of silvicultural options, fuel management after an outbreak and utilization of "grey dead" timber. Research efforts in these areas need to be strengthened.

FOREWORD

As part of his duties as Visiting Scientist at Protection Branch during 1988-89, we asked Dr. Malcolm Shrimpton to review our capabilities in dealing with outbreaks of the bark beetles in Provincial Forests. Our concerns, as focused within Dr. Shrimpton's review, were primarily related to what had to be done, how we were doing it, and whether or not B.C. Forest Service staff fully understood the opportunities and limitations of various strategies and treatments.

This report contains Dr. Shrimpton's technical evaluations of our efforts during the period 1984-1989 when significant funding was allocated to conduct an "emergency" bark beetle program. This program was the first organized effort by the Forest Service and forest industry to reduce the effects of widespread and intensive outbreaks of bark beetles.

Other reviews and audits will be conducted on the dozens of projects in this five year program. Readers are encouraged to contact Dr. Shrimpton and Protection Branch to compare views and the offer suggestions for improvements in future programs.

R.F. DeBoo, Manager
Forest Health Program
Forest Protection Branch
B.C. Forest Service
Victoria, B.C.
V8W 3E7

INTRODUCTION

Bark beetles are a persistent part of British Columbia's forest environment. This is evidenced by the references in explorers diaries and the repeated scientific records and newspaper reports since the turn of the century. In the last decade, there have been several large outbreaks of both mountain pine beetle and spruce beetle throughout central and southern British Columbia. In response to these outbreaks an emergency program by the British Columbia Forest Service was funded to counteract the effects of bark beetles on the timber supply. This program has been in place for the past five years (1984 - 1989).

A number of objectives were set for this review of the special bark beetle program. These were:

To determine whether the available knowledge has been applied in operations to control bark beetles.

To determine the adequacy of current technological information for bark beetle control in the field.

To evaluate the mechanisms currently used to transfer technology to the field staff responsible for bark beetle operations.

To identify any knowledge needed to improve the effectiveness of the pest management strategies and procedures used against bark beetles.

To review, in general, current reforestation programs for their probable consequences with respect to bark beetles.

These objectives were set to augment the audit of the special bark beetle program by Price Waterhouse. They have been applied broadly throughout the review.

There are several species of tree killing bark beetles in British Columbia forests; mountain pine beetle, however, has been responsible for the most tree death over the five year period of the special program. Accordingly, this report will deal principally with the treatments and management approaches used in response to this pest. It will focus primarily upon current control practices and recommend improvements to the procedures. Several other species of bark beetles also cause losses. Spruce beetle being the most important of this group. Approaches to the control of these other species are also referred to.

A rich resource of knowledge and experience on bark beetles exists in British Columbia and also in the United States. This resource has been drawn upon to build a good program of management for forests affected by bark beetles and protection staff have well established links to the institutions which produce new knowledge. These links will be even more important in the future as the Forest Service develops management tools that satisfy the multiple demands being made on the forest.

MANAGEMENT APPROACHES

A unique opportunity currently exists to develop a systems approach to the management of forests with a history of mountain pine beetle problems. At the beginning, the bark beetle program was very reactive. However, each district has now developed a clear strategy to deal with the problems caused by mountain pine beetle. Some districts have begun to develop a systems approach and this avenue represents the best means to improve current procedures. A management system can be built upon a computerized data bank which is based upon the Forest Insect and Disease Survey (FIDS) records and then refined into a useable data base with the information and experience gained during the five year special program. It is important to consolidate this data and experience into a permanent record before too many staff changes occur and files become mislaid. This permanent data bank of the incidence and direction and rate of spread of infestations can provide credible answers to the most frequently asked questions about mountain pine beetle, as well as recording the consequences where control actions were not taken. All the preliminary work has been done to build a pest management information system for the mountain pine beetle; a good historical record bank is available, a large scale stand survey has been completed, stem analysis data available, models on the spread of mountain pine beetle outbreaks are being tested and the raw data base is in filing cabinets. Electronic mapping methods are readily available.

Three things are needed to implement a pest management information system. The first is the technical capability which is now adequately available. The second need is a reliable data bank which can certainly be assembled and the third need is a willingness of operational staff to accept the system and adapt to its use. Again, in my judgement, a window of opportunity exists here. Protection staff, certainly in those areas where mountain pine beetle outbreaks are frequent, are accustomed to and proud of the Fire Management System. Hence staff are likely to respond positively to a second system, particularly now that the impact of mountain pine beetle is acknowledged.

There is still much intuition as well as personal experience being used at present to formulate detection and control activities for the mountain pine beetle. Many of the operational pest management staff are very adept at identifying probable locations and spread patterns for this pest. This body of experience in field staff is strengthened by contact with a number of agencies including the Forest Insect and Disease Survey Rangers (FIDS). This intuitive approach however is a fragile basis for forest management, is no substitute for a permanent data base and has low credibility. The need is for a concerted effort to collate and synthesize the available information and experience into a province-wide data base before staff members move on and their judgement can no longer be called upon.

The benefits of a well organized operationally oriented data bank will increase with time and will outlive current staff. This real data is the baseline upon which future programs can be developed and against which they can be evaluated. This is particularly important where long-term and multiagency approaches are taken to the management of forests where this pest is concerned.

Data on mountain pine beetle infestations has been collected differently in each office and by industry. These differences reflect specific local requirements and points of view. However, the degree of difference will make the raw data extremely difficult to draw into a uniform data bank if this is not done while the present staff members are still available. For future data collection, some underlying uniformity of recording is needed and then the specific local needs added to this basic record structure.

Each relevant Timber Supply Area (TSA) has developed a management strategy to guide decisions regarding treatments relative to the mountain pine beetle. These strategies are influenced largely by accessibility but are also a function of the known geographic distribution of mountain pine beetle. However, not enough use is made of the variations in stand structure to refine management plans and set the appropriate treatments. A management plan based upon an analysis of inventory and stand conditions to define stand hazard and locate roads to areas of greatest hazard was implemented in the Hawkins-Freeman drainage (Nelson Region). This should be reviewed for its usefulness throughout the southern part of the range of mountain pine beetle.

At the very least, a broad analysis of the inventory by age class for pure and leading pine followed by a geographic analysis of the location and continuity of mature pine would alert district staff to the potential for problems.

An extensive province-wide sampling of stands attacked by the mountain pine beetle has now been completed by the Pacific Forestry Centre this was part of the U.S./Canada agreement on mountain pine beetle and the data is currently being analyzed. The Forest Service should ensure that operational staff have a direct input to the analysis to ensure that information of direct benefit to the Forest Service is recovered. This data on stands attacked by the beetle should provide the basic forestry data needed to drive a pest management information system for the mountain pine beetle.

Harvesting timber at maturity, in the final analysis, is the optimum control method for mountain pine beetle. The beetle is dependent upon mature stands with large diameter stems to maintain epidemic population levels, analysis of the pine component in the inventory can be a very effective way to estimate the scale of the pine beetle problem through time and provide the framework for many of the management decisions regarding lodgepole pine. Some TSA's are quite far advanced in using the inventory to anticipated the scale and location of pine beetle problems. Harvesting can then be applied as a preventative strategy. In the majority, however, this connection has yet to be made.

Recommendations:

1. **The available records on mountain pine beetle incidence, which are currently in unorganized paper files in both regional and district offices, should be assembled into a permanent electronic data base.**

2. **Requisite to a province wide data base, basic records on mountain pine beetle should be collected according to a standard format and stored in a uniform and readily retrievable manner.**

3. **The BCFS should organize a cooperative program to develop a pest management information system for the mountain pine beetle; Forestry Canada's Pacific Centre and British Columbia Institute of Technology (BCIT) are probable collaborators.**

4. **The British Columbia Forest Service should offer to have operational staff, as well as Branch, cooperate with the Pacific Forestry Centre in the analysis of the data collected during the province wide survey of stands attacked by the mountain pine beetle to ensure that an operationally valid profile of stand hazard is extracted from this data base.**

DETECTION PROCEDURE

Overall trends and probable locations for current mountain pine beetle infestations are assessed from the historical trends and annual overview prepared each autumn. This is followed by the detection of new infestations the next summer and then documentation of these infestations. Aerial sketch maps or aerial colour photographs are obtained for each specific location when it is certain that trees have turned colour, usually in July. This is followed by a quick ground survey. There is considerable variation in the way this survey data is gathered between regions. However, the procedures are adequate to set local priorities for cutting and to estimate the size of cut blocks. The differences in the way data is gathered, however, present a severe limitation to the development of a province-wide data base.

Aerial sketch maps are preferred in some regions to document infestations because the information is available immediately. Colour photography, on the other hand, is usually only available several weeks after the photographs are taken but documentation is invariably superior. However, this delay can prevent the use of MSMA for single tree treatments and may even prevent the allocation of cutting permits prior to the next beetle flight. These photographs, however, provide more detailed and precise information than the sketch maps and they have been used to great advantage in some locations. They are also useful to several Forest Service divisions. In addition to better information and possible cost sharing, the use of a common set of aerial photographs could enhance the flow of information about pests throughout the Forest Service. The need is to develop a fast track for the photo development process. This could fit well with some government schemes to enhance "high-tech" programs.

Recommendation 5: More use should be made of aerial colour photography for recording outbreaks, this would improve monitoring and increase communication about pest impacts through the Forest Service.

THE HARVESTING OPTION

The most important criteria for treatment of mountain pine beetle infestations are prompt action and thoroughness when these infestations are first detected. Detection and preliminary ground surveys are done in July and August. This leaves about 10 months before the infestation is spread by the following year's beetle flight. This 10 month interval is sufficient under the present system, to let and complete a cut block. But the 10 months are too short if problems need to be evaluated before harvesting or if sensitive

environmental questions need to be addressed. At present, it does not seem feasible to extend this time period because of the technical problems associated with earlier detection. This emphasizes the importance of harvesting infestations when small. Some regions are making good use of the Small Business Program in this regard. Further emphasized is the need to keep on top of the problem now that infestation levels are close to the long-term average, which also emphasizes the value of pheromones to the harvesting program, because pheromones can be used to restrict the spread of beetles. But if the harvesting program breaks down through soft markets, or questions of accessibility or if large beetle populations migrate into the area, the problem can grow out of hand very quickly. A more diversified management approach is necessary which employs a variety of silvicultural treatments and timber management considerations.

Harvesting, in large part, has been a responsive strategy to mountain pine beetle infestations. Now that mountain pine beetle infestations are at a lower level in many areas, it is possible to use the annual harvest as part of a preventive management strategy and make good use of pheromones to hold the size of cut blocks to a minimum. The objectives should be to "break-up" the existing large areas of mature pine and achieve more diversity in the next rotation.

Recommendation 6: In areas where mountain pine beetle infestations have now subsided to a low level, harvesting should be planned as the first step in a preventative management program for mountain pine beetle.

PHEROMONE APPLICATIONS

Pheromone application to concentrate mountain pine beetle populations and thereby limit the area needing treatment are a recent and significant development in forest management. These pheromone "baits" are used to concentrate beetles in areas scheduled for logging, to hold small infestations in a known locality for single tree disposal and for general monitoring of beetle populations. Field trials are also in preparation to "hold" beetles in a location for two to three years before the harvest is planned. This strategy has never been field tested and must be monitored carefully because it is a risky strategy. Foresters who are not knowledgeable in pest biology, do not always realize that this pheromone response is a critical part of the beetle's success in killing trees and starting outbreaks. Think of pheromone use as "playing with fire." The infestation can be intensified and timber losses accelerated if the pheromone treated area is not promptly harvested or the beetles in the pheromone treated trees destroyed. A major treatment failure could damage the credibility of this excellent tool.

The pheromone packages are robust enough to survive handling and still function even if they are not placed at an optimum position on the tree. Again, the technical capability is firmly established in the Forest Service Pest Management staff and procedures for pheromone use have been written clearly for each district. But, staff associated with cutting permits, and the industry foresters involved, need to be made aware of the probable consequences if pheromone treated areas are not harvested prior to the subsequent beetle flight.

Recommendation 7: The mis-use of pheromones is a very real danger. An information effort which targets staff outside pest management and highlights the probable consequences if pheromone treated areas are not harvested on schedule is needed.

SINGLE TREE TREATMENTS

Single tree treatments can be very useful to delay the spread of very small infestations. They cannot be relied upon, however, for long-term control of infestations. They must, therefore, be only part of a reactive strategy to counteract bark beetle problems which must ultimately rely on harvesting. Two methods are presently used, felling and burning or treatment with MSMA shortly after the beetles have attacked. The chemical option (MSMA) seems to be gaining in popularity, although the choice is often made after considering the problems of access at different times of the year.

Field staff are aware of the strengths and weaknesses and costs of single tree methods and in general are quite capable of these applications. Any problems seem to be the result of hurried applications. Many of these treatments, however, are now applied by contractors which places field staff in a managerial, supervisory and quality control function. This places a different and unfamiliar set of demands upon field staff which may even include conducting training programs for the contracted individuals. This training needs to focus upon the detection of infested trees as well as on the thoroughness of the treatment. The Forest Service must ensure that field staff are thoroughly familiar with the pitfalls of contractual processes because the consequence of error when measuring and treating mountain pine beetle infestations can be serious; the infestation could intensify and also destroy confidence in the treatment procedures. The real problem here is quality control.

The issue of toxic chemical applications in forested areas will not go away. The MSMA program must be viewed from this perspective. Some excellent work has been done on defining the application window and the effectiveness of treatments. Procedures for the application of MSMA have been prepared in each region. The issue of residues has also been partly addressed. The questions raised to date about MSMA appear to have been answered satisfactorily. But experience has shown that chemical applications in forestry are a recurrent issue. The Forest Service must be seen to be acting responsibly by defining the strategy for the use of MSMA so that the circumstances under which this chemical will be used are clearly prescribed.

The window of application for MSMA is critical for success and must be set from the time of beetle attack. Hence, pheromones, checked regularly to set the time of attack accurately, are an important contributor to success. There are, therefore, particularly in areas where access is difficult, very real practical problems which have led to some questionable applications.

Cutting, piling and burning is the other single tree treatment used. Burning the trees appears such an obviously good solution. But there are some examples of incompletely burned logs and high stumps which have provided excellent sources of new beetles.

In fairness, it must be said that the majority of single tree treatments have been done well and the record has improved over time. But a few mistakes can be very costly.

Recommendation 8: A clear strategy needs to be developed to define the use of monosodium methane arsenate (MSMA), this must ensure that the circumstances for it's use are clearly prescribed. Some communications effort oriented to the safety of those who contact treated trees is warranted. Quality control checks of single tree treatments must continue.

SILVICULTURAL OPTIONS

Major benefits from the special bark beetle program have been the heightened awareness throughout the forestry sector in British Columbia of pest impacts and the realization that something can be done. Silviculture offers a preventative management approach because a number of silvicultural options are available to reduce the susceptibility of stands to mountain pine beetle which can be part of a long range management plan. Some work on spacing stands or typecutting to encourage a species and age mixture is underway. This should reduce the risk of future beetle damage. These approaches can be particularly useful in sensitive areas, watersheds for instance, and should be considered for more frequent use.

Spacing and thinning trials were included in the action plan of the USA/CANADA agreement on mountain pine beetle. Some good trials are now in place. These semi-operational trials, both in B.C. and in the USA should provide a sufficient data base to put a good program into place.

One silvicultural proposal for lodgepole pine that has not yet been evaluated in field tests in British Columbia is the control of stem diameter through spacing. This option has good potential to limit mountain pine beetle damage in the future, because beetle populations are very dependent on adequate stem diameter. This approach could yield a useful alternative to the age or species mixture usually recommended to provide developing forests with some resistance to mountain pine beetle. Each of these options needs to be evaluated when planning reforestation programs in areas which are subject to mountain pine beetle infestations and are predominantly lodgepole. Clauses could then be written and included in management plans for lodgepole pine in these areas.

Preharvest silvicultural prescriptions are beginning to consider the certain influences of the mountain pine beetle. Mountain pine beetle concerns aside, public demands for multiple uses of forested land and the preservation of scenic vistas as well as the economic suggestions that more diversity of forest products is needed, lead to the conclusion that smaller scale harvesting for specific timber types will be more common in the future. However, lodgepole pine remains the species of choice in many locations which have a chronic history of mountain pine beetle outbreaks. In these areas, outbreaks will certainly happen in the next rotation unless something is done. It is possible to rely upon a reactive harvesting program to keep timber losses to a minimum. But, if this is the only approach taken, a breakdown in the system can be disastrous. A more diversified approach which includes a number of silvicultural treatments is preferable.

Recommendation 9: More use should be made of the several silvicultural prescriptions available for management programs relative to mountain pine beetles; in particular, field tests of spacing regimes to control diameter of lodgepole pine are needed.

SPRUCE BEETLE

The spruce beetle was responsible for a significant amount of tree killing in the early years of the special program. This had the predictable response that some very large areas were cut, in a few years, to salvage the timber killed by this insect. In some districts, the emphasis upon spruce beetle killed timber was in direct competition with pine stands needing attention, which emphasizes the need for consistent and sound forest management practices which keep all bark beetle problems at a manageable level.

The reliance upon salvage logging, which is not a pest management activity, together with the observation that spruce beetle populations can be concentrated in "blow-down," has led some to the conclusion that outbreaks are solely dependent on blow-down and the problem can be solved by harvesting. For spruce beetle this is a dangerous attitude. In mature spruce stands, resident populations of spruce beetle are always high enough to cause significant damage should favourable conditions exist for the beetle. Hence, this beetle has a very explosive capacity to cause damage. Trees can be killed over very large areas in a single season and often with no apparent warning. Outbreaks are not solely dependent upon patches of "blow-down" and "blow-down" does not always result in an outbreak even though this can be a major contributing factor. Routine detection surveys in spruce stands are essential because of the unpredictable nature of spruce beetle outbreaks. However, any and all activity in spruce stands does need to consider the windfirmness of the site. Programs to control this beetle, need to focus on prompt clean-up of any downed trees, sanitary logging practices and special attention to cut block design and clean up of any blowdown at the edge of blocks.

Pest Management staff are aware of the unpredictable nature of the spruce beetle and are conscious of the need for good sanitation and a continued detection program with respect to this pest. However, knowledge of this beetle is not as strong as mountain pine beetle. A further problem is that staff, particularly those not in Pest Management, can become complacent about the pest because periods with very little damage occur between outbreaks, which is the present situation. Some continuing information regarding the impact of this insect is important to counteract a tendency toward complacency. A series of seminars could be the start of this program. The Pacific Forestry Centre is the greatest source of information regarding this pest and should prove a valuable resource for these seminars.

Recommendation 10: The Forest Service should organize a series of seminars and field demonstrations on the spruce beetle to increase awareness of the potential impact of this pest and improve the ability to diagnose and prescribe for it.

DOUGLAS-FIR BEETLE

Control of the Douglas-fir beetle is dependant upon sanitary forestry practices. There were extensive outbreaks of this pest during the 1950's and 1960's. However, since the adoption, in the 1960's, of strict sanitary standards which were designed to restrict the potential of this beetle to cause damage, the Douglas-fir beetle has remained a minor problem despite favourable climatic intervals. Clauses which ensure that these, Douglas-fir beetle prompted, sanitary standards are followed are a mandatory part of harvesting plans for interior Douglas-fir. The pest is, however, still present and the potential for damage remains as the few "flare-ups" which have occurred in recent years attest. These can be traced to a relaxation of the sanitary standards. The standards which emphasize low stumps, prompt removal of harvested timber and blow-down, and treatment of debris must be maintained. The problems have evidently stemmed from complacency and the relaxation of standards. It is essential that these sanitary standards be maintained given the current approach to Douglas-fir management in the interior. Some information efforts to ensure that all concerned remain aware of the potential of this pest and aware of the reasons for the sanitation standards used for interior Douglas-fir could be valuable. PesTopics or other newsletters could be a suitable communication vehicle.

Recommendation 11: A subtle communications effort designed to ensure that the sanitary practices designed to control Douglas-fir beetle are maintained is warranted. PesTopics could be an appropriate means.

BALSAM BARK BEETLE

Concern over this beetle is increasing. This pest is largely a problem of the older trees in a stand. It is difficult to treat, partly because the structure of most stands containing balsam has a mixture of ages and sizes and often other tree species. Furthermore, knowledge base on this pest is weak. A good thesis is being completed at Simon Fraser University on this pest and some useful work on a related species of beetle was done in Oregon, but overall not much is known. At this time logging is the only approach taken to control, however, pheromones are under development. An analysis of probable demand for balsam is warranted. If this species should become a significant component of the harvest then more information on the pest will be needed before clear treatment methods can be formulated.

Recommendation 12: An analysis of probable demand for balsam would quantify and justify the probable need for management of the balsam bark beetle.

CONTINUING EDUCATION

Continuing education is important for the staff in pest management not only to gain new information but also to confirm personal experience regarding pest behaviour through discussion with specialists. One excellent way to achieve this is through attendance at workshops and scientific meetings. The advanced pest management course given at BCIT received very favourable comment in this regard. In addition to keeping current on knowledge about pests, it is also necessary to keep current with administrative procedures. As the Forest Service adjusts to new staffing levels and new amendments to the Forest Act, a

number of new and in some cases unfamiliar demands are being placed on pest management staff. External contractors need to be trained, contracts written and managed, and the quality of work done by contractors verified. A certification program for external contractors could go far towards ensuring that the quality of contracted work is adequate. Colleagues in allied disciplines within the BCFS also need specific training on pest issues. Whatever new procedures are adopted in response to these demands, the success of the overall programs will depend upon a well trained staff within the Forest Service.

In my judgement, the best means to define the required training programs is to approach the issue from the ground up and see what is needed. I recommend selecting a TSA and then, in cooperation with local staff and management, build a pest management information system for mountain pine beetle with the attendant field procedures. As discussed earlier, all of the necessary elements for this system are available. The need is to synthesize and adapt them to forest management needs and operating procedures. The specific operating requirements of the new system should define the necessary training programs.

Also on the question of staff development, a number of comments were made that job descriptions do not reflect the growing importance of Pest management in Forest Protection activities. A further point, job incentive programs have been very useful to provide people for protection activities, but supervision is an added responsibility.

Recommendation 13: A staff training program is needed to ensure that field staff manage contracted operations effectively and gain familiarity with technical procedures and planning associated with contract management.

Recommendation 14: Job descriptions for the R.O. protection do not reflect the current effort on pest management, this should be corrected and thereby increase the recognition of pest management within the Forest Service.

Recommendation 15: A certification program for contractors eligible to carry out probing, phenomore applications and control treatments is needed to ensure that those operations are done correctly.

PRESERVING AMENITY VALUES

Each district is experiencing a steady increase in demands to preserve the visual quality of forested areas and the non-timber values. Provincial wildlife and fisheries staff are concerned with the preservation of a number of specific habitats. The tourist industry is concerned with the visual quality of the landscape throughout the Province. Range land is an issue in many areas.

From my discussions, concerns surrounding non-timber values, the preservation of sites and landforms and the quality of water in streams and lakes are increasing in frequency and intensity. These non-timber land uses are being addressed in the long range plans for each TSA. This is generally viewed as a good thing. However, several concerns were expressed about past deviations from these plans, in response to insect outbreaks, which have resulted in large clearings in some major valleys. Attendant problems of siltation in streams and lakes were also raised. Other problems raised were the need to leave some both large and small size organic debris following logging,

especially near streams. Questions about access roads were raised repeatedly and two points re-occurred; the need for roads to by-pass sensitive areas and a road layout that permits a circular driving pattern was criticized because this encourages people to drive the entire length of the road. On the other hand, the current willingness to close secondary roads when no longer in use was favourably received. Several groups concerned with non-timber values argue for more diversity in the structure of interior forests, including small meadows. All of these concerns are compatible with good management for bark beetles and the problems have arisen when outbreaks got out-of-hand and large scale logging was the response. A forest management strategy which insists upon the treatment of infestations while they are small and the prevention of outbreaks in the future through the development of a mosaic of age classes, different species, mixed types and lodgepole diameter classes and low stem densities and even small clearings will meet many of the concerns over non-timber values.

The concerns of groups who defend non-timber values have been met in some districts through clean and small scale logging of newly developing infestations. The Small Business Program has been very useful in this regard and, in the long term, greater diversity of forest products from additional tree species will be helpful. A number of silvicultural approaches, type cuts and thinning regimes, even with horse logging, are being tested in various locations. These can be very useful to generate timber value and also preserve the non-timber land uses. More use could be made of these silvicultural approaches.

There was general agreement that each of the concerns expressed to me could be addressed best by clearly identifying all important non-timber values at the start of the TSA planning process. As the plan is implemented these identified non-timber values need to be given equivalent status to the concerns over harvesting timber.

RESEARCH AND DEVELOPMENT NEEDS

I have discussed a number of problems that operational staff still experience during the course of this review. There is a general sense that one must now look to the problems of the future. In locations where mountain pine beetle outbreaks have subsided to historic levels there is an excellent opportunity to apply preventible management strategies to the next rotation. The silvicultural approaches discussed earlier need to be field tested in a more systematic way. Some valuable demonstration areas have been set up, however, I encourage the Forest Service to increase the use of silvicultural methods to reduce the overall hazard from mountain pine beetle. Through the application of a sound silvicultural program the mosaic of stand types and stand forms can be achieved for the next rotation which will lessen the probability of serious bark beetle problems.

The problems of the future are the problems of prediction; when, where and how severe future outbreaks will be. The problem most frequently identified was the appearance of outbreaks in unexpected locations or a re-occurrence of small infestations with no apparent source of beetles. Some better predictive means based on knowledge of beetle habitats and patterns of dispersal is needed. This coupled with a good interactive historical data base of the incidence and severity of past outbreaks would do much for forest management.

Research in these areas is underway at PFC. This research includes field studies of dispersal patterns and those conditions that encourage dispersal. Also underway are the development of models to predict the probable impact of an infestation on stands and studies to explain regional variations and calibrate these models for location specific differences in the impact on stands. The B.C. Forest Service should encourage this to be extended and make an effort to interact with the studies as they progress. This knowledge will provide the practical benefit of directing surveillance programs and anticipating control programs.

Other problems raised were on the question of stand rehabilitation. There is a need for baseline information on the changes that occur in stand structure following an outbreak. A related question is the problem of fuel management in stands in the years following a mountain pine beetle outbreak. Several concerns were expressed in this area over the adequacy of available knowledge. Both the problem of stand rehabilitation and fuel management would benefit from greater harvesting of the grey dead timber. Several foresters felt that Forintek should have another look at the problems of processing this "grey dead" timber after their personal experience indicated that this timber was more useful than previously thought.

Recommendation 16: A number of areas were identified where limited knowledge is causing problems; stand rehabilitation, mountain pine beetle dispersal, field demonstrations of the effectiveness of silvicultural options, fuel management after an outbreak and utilization of "grey dead" timber. Research efforts in these areas need to be strengthened.

SUMMARY

Overall my assessment of the technical capability of British Columbia Forest Service (BCFS) field personnel to deal with mountain pine beetle is favourable. There is, however, a need for a more forward looking approach to the management of this pest with a greater emphasis upon prevention. A number of silvicultural approaches are available which are receiving very limited use at the moment. In the long term, however, the solution lies in developing greater diversity in the forest within those geographical regions where the hazard to mountain pine beetle is high, this together with an orderly harvesting program. An excellent opportunity now exists to develop a systems approach to forest management with respect to mountain pine beetle.

Forest Service field personnel assigned to pest management have in general, a good command of the knowledge available on the dynamics and potential of the two major bark beetles, mountain pine beetle and spruce beetle. Processes have been developed in each affected district which proceed smoothly from the initial detection, through a decision process based upon the management strategy developed for the area and finally to a particular course of action. However, as the Forest Service contracts more of the field operations, there is a real danger of loosing contact with the forest. The scale of the problem in some districts is still placing a considerable strain on the resources available and the inaccessible location of several new infestations remains an impediment to good treatment.

Industry in general has responded well to the disruption in timber supply caused by the beetle. Industry certainly is now capable of responding quickly and effectively when needed because of bark beetle infestations. This industry capability is an important aspect of control programs for mountain pine beetles because orderly harvesting remains an essential aspect of the long-term strategy against this pest.

Continuing education is important for staff in pest management and allied disciplines. This should include field demonstrations from acknowledged experts and the attendance by field staff at workshops and seminars. Some extension activities are also warranted, for instance, to impress upon industry foresters, as well as other Forest Service staff, the potential dangers of improper pheromone use.

A few problems have been encountered because of wildlife requirements or other non-timber values. These have been resolved reasonably well. However, this does point out an aspect which will continue to require attention, which can be approached effectively in the TSA planning process, but which does not appear to be a central part of Forest Service Policy at this time.

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