Mountain Pine Beetle Management in British Columbia Parks and Protected Areas

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Abstract

British Columbia is currently experiencing a mountain pine beetle epidemic due to natural beetle population cycles, successive mild winters, and an abundance of mature pine forests as a result of fire suppression. Of the 4.2 million ha currently infested provincially, approximately 623,000 ha of forests in over 60 parks and protected areas are being affected. The priorities for management of bark beetle infestations in parks are to prevent spread of beetles across boundaries while maintaining park ecological values. There are two distinct phases of park management associated with the epidemic: short-term infestation management and long-term post-infestation management. Short-term infestation management is focussed on prevention of infestation spread. Long-term post-infestation management is focussed on issues such as hazard tree management, post-epidemic pine deadfall, fuel hazard reduction and wildfire management, maintenance of recreation and habitat values, and management of access caused by forest harvesting adjacent to parks.

Introduction

British Columbia (BC) is currently experiencing a mountain pine beetle (*Dendroctonus ponderosae*) epidemic throughout the range of lodgepole pine (*Pinus contorta*) forests in the province. The epidemic is the result of a number of factors including natural beetle population cycles, successive mild winters, and an abundance of mature pine forests as a result of fire suppression. A discussion of the epidemic origins and spread will be presented in this paper, along with an examination of short-term infestation mangement and long-term post-infestation management in parks.

Outbreak Origins

Mountain pine beetles attack a wide variety of pine species; however, lodgepole pine is BC's most economically valuable and most susceptible pine species. Lodgepole pine may be BC's most predominant tree species due to its wide ecological range (Lotan and Perry 1983) and comprises a large volume component in BC's forests. Lodgepole pine is a fire-maintained sub-climax species that requires heat from

Mountain Pine Beetle Symposium: Challenges and Solutions. October 30-31, 2003, Kelowna, British Columbia. T.L. Shore, J.E. Brooks, and J.E. Stone (editors). Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-399, Victoria, BC. 298 p.

wildfires to open its serotinous cones (Lotan 1973) and the ecological dependence of lodgepole pine to fire is well understood by forest managers.

While the ecological dependence of lodgepole pine stands to fire is well known, the ecological dependence of lodgepole pine to mountain pine beetle as a disturbance agent is not commonly understood. Some researchers have suggested that mountain pine beetle infestations serve as a critical thinning agent for stagnant lodgepole pine stands and that lodgepole pine has actually ecologically adapted to depend on mountain pine beetle disturbances (Peterman 1978).

The three way ecological relationship between lodgepole pine, mountain pine beetles and fire has been upset by our past fire control efforts, creating the elements necessary to favor an epidemic. Lodgepole pine forests often grow in ecosystems subject to frequent fire return intervals; however, fire control has been practiced throughout much of the range of lodgepole pine forests for many decades. Analysis of the lodgepole pine profile in BC has shown that 65% of the lodgepole pine in forests of BC is mature and susceptible to mountain pine beetle infestations. The current amount of mature lodgepole pine is estimated to be over 20% greater than what would be expected in a natural fire regime (Personal Communication, A. Carroll, Natural Resources Canada, Victoria, BC). It may be stated, in fact, that BC is facing an epidemic of mature lodgepole pine rather then an epidemic of mountain pine beetles.

Mountain pine beetle populations may be reduced by cold winter temperatures (-37°C), or cold early fall temperatures (-27°C) (Unger 1993). Areas currently experiencing the mountain pine beetle epidemic have not received these temperatures since the onset of the epidemic in 1994, providing no natural control of the populations. Recent research has shown that this is may be the result of global climate change (Environment Canada 2000). The combination of warm weather and abundant hosts has lead to the rapid expansion of mountain pine beetle populations in many lodgepole pine forests across the province.

Forests in parks largely share the same forest profiles as other BC forests due to past fire control policies which, until the last decade, stipulated that fires must be suppressed in parks (BC Parks 1982). Accordingly, many park forests are facing epidemic mountain pine beetle infestations. These parks share management challenges common to other similarly affected forests, such as a history of fire control, abundant host, and remote location limiting access and treatment. Since parks are relatively unmanaged landscapes, they may act as a natural "canary in the coalmine" for forest ecosystems, by reflecting the latent potential for natural disturbance events which may have become unbalanced by human forest management actions.

Spread of the Mountain Pine Beetle Epidemic

A popular misconception developed that the current provincial mountain pine beetle epidemic began in Tweedsmuir Provincial Park. While there is a very large infestation in Tweedsmuir that has no doubt contributed to the beetle population in some areas of north-western BC, infestation centres in many other lodgepole pine stands across the north central and southern part of the province also developed almost simultaneously with the Tweedsmuir infestation and have rapidly grown beyond control.

This province-wide inception of the epidemic is further confirmed by a 2003 retrospective mapping project done by Ministry of Forests Research Branch to show cumulative provincial levels of mountain pine beetle attack for 1999, 2000, 2001 and 2002 (Personal communication, M. Eng, BC Ministry of Forests, Victoria BC). The mapping shows that, in 1999, incipient mountain pine beetle infestation centers were widely dispersed throughout most of the range of lodgepole pine in the province. As the epidemic progressed through 2000, 2001 and 2002, it is apparent that localized infestations such as the Tweedsmuir infestation spread regionally, however, on a provincial basis, infestations basically filled in between the widely separated infestation centers around the province.

Current Mountain Pine Beetle Situation in British Columbia Parks and Protected Areas

Approximately 4.2 million ha of forest are currently infested in BC, the most extensive mountain pine beetle epidemic in BC's recorded history (British Columbia Ministry of Forests 2003a). Of the total area infested, approximately 623,000 ha of forests in over 60 parks and protected areas are also infested with mountain pine beetle (Personal communication, T. Ebata, BC Ministry of Forests, Victoria BC). The scale of the infestation in parks is variable, however, and while some parks may only contain a few ha of infestation, others such as Tweedsmuir may contain hundreds of thousands of ha of infested forest. This is the largest recorded natural disturbance to ever take place in BC's provincial parks and protected areas.

The level and relative percent infestation can be determined for infested areas within parks and compared to those at the regional and provincial scale. This information is summarized in Table 1.

Table 1. Park forest infestations compared to total Regional and Provincial forest infestations.

Forest Region	Non Park Forest Land Infested (ha)	Park Forest Land Infested (ha)	Total Infested Forest Area (ha)	Park % of Total Infested Forest Area
Cariboo	2,277,201	79,309	2,356,510	3.4%
Prince George	931,186	93,961	1,025,147	9.1%
Prince Rupert	307,708	239,500	547,208	43%
Vancouver	12,571	204,946	217,517	94%
Kamloops	55,162	2,456	57,618	4.2%
Nelson	24,684	2,452	27,136	9.0%
Totals:	3,608,512	622,624	4,231,136	14.7%

The area of "light infestation" in parks (1% – 10% of trees attacked) accounts for 302,017 ha of the total infested area of 622,624 or just under 50% (48.5%) of all infestations in parks. "Moderate infestation" (11% to 29% of trees attacked) accounts for 145,174 ha or 23% of the infested area and "severe" (30% + of trees attacked) accounts for 175,383 ha or 28% of park infestations.

The summary shows that on a provincial basis, park forest infestations account for 14.7% of the total provincial infested area. Since parks account for approximately 12% of the landbase of BC, this infestation rate seems relative to the total park area. When the level of regional infestations is considered, park infestations in the Cariboo, Prince George, Nelson and Kamloops regions account for 9% or less of the infested area in these regions. If an average is taken for these four regions, park infestations average 5.1% of the total infested area.

The regions with the largest relative infestations, Prince Rupert (43%) and Vancouver (94%) are both highly influenced by one park, Tweedsmuir Park, which is the largest park in BC and contains the largest infestation of all BC parks. The Tweedsmuir Park infestation accounts for the largest infestation in the Vancouver region.

Park Forest Management

The management of the mountain pine beetle epidemic in BC's parks and protected areas presents many challenges. Since epidemic levels of infestations in protected areas cannot be managed independently from surrounding landscapes adjacent to parks, BC Parks has worked closely with the BC Ministry of Forests, the forest industry, affected communities, First Nations, and non-government organizations in dealing with this complex park management issue.

While mountain pine beetle infestations are considered part of a natural forest renewal process in parks and protected areas, they are considered destructive in forests allocated for timber production. Since insects do not recognize jurisdictional boundaries, they move unobstructed from protected area forests into crown forests or conversely, from crown forests into protected area forests. BC Parks recognizes that the management of park beetle infestations to prevent spread of beetles across boundaries, while maintaining park ecological values is extremely important for the protection of adjacent forest economic values. Management of mountain pine beetle infestations in protected areas, however, is often more difficult than management in adjacent forests for several reasons:

- beetle management in protected areas may, in some cases, require a higher level of planning to protect unique protected area values;
- infestations in protected areas are often located in remote locations requiring air access; and,
- aerial photography, forest mapping and forest inventories routinely undertaken in adjacent forests often stop at protected area boundaries.

It is recognized by park managers that there will be two distinct phases of park management activities associated with the mountain pine beetle infestation:

- activities that take place in parks to manage the actual infestation – infestation management; and,
- activities that take place in parks to address the ecological changes associated with large areas of dead pine trees after the infestation has abated – post-infestation management.

Infestation Management

Infestation management activities in parks and protected areas are conducted in cooperation with the BC Ministry of Forests in accordance with the Provincial Bark Beetle Management Technical Implementation Guidelines (British Columbia Ministry of Forests 2003b) which divides landscapes into beetle management units irrespective of administrative boundaries. Beetle management units are defined by the level of infestation and associated management actions undertaken in the unit. Units with low levels of infestation which can be comprehensively treated are defined as "control" units. Beetle management units with larger infestations which cannot be comprehensively controlled are called "holding" units if there is a possibility of reducing infestation levels; or, "salvage" or "monitoring" units if infestation levels are overwhelming and no infestation management is possible. Beetle control is generally only undertaken in parks and protected areas which fall into "control" beetle management units. When overwhelming infestation rates occur in parks or protected areas and no control mechanisms are ecologically or economically feasible, the infestation is allowed to progress as a natural process.

Beetle control in parks and protected areas is more complex than beetle management in other forests because park management must balance beetle control activities with maintenance of park values. The most common control treatment used in parks and protected areas in BC is to use pheromone baits to concentrate insect populations and then fall and burn individual trees on site to kill the insect larvae. In the winter of 2001/02, approximately 15,000 trees in 38 parks were treated this way. For the winter of 2003/04 there are plans to undertake mountain pine beetle treatments in 32 parks, although this may be subject to change based on funding limitations and updated mountain pine beetle probing assessments and associated treatment goals.

Where larger infestations occur, prescribed burning is used to kill hundreds or even thousands of ha of infested trees. Prescribed burning was used to control initial infestations in Tweedsmuir Park in 1995 when 600 ha were burned (Safranyik et al. 2001) and again in 1997 when 250 ha were burned. By 1998, however, the infestation had progressed to over 15,000 ha and due to the overwhelming size of the infestation, it was determined that no control was possible and control activities ceased.

Issues associated with managing the epidemic in parks and protected areas include:

- Preventing the spread of beetles from park and protected areas to working forest or private forests where possible;

- Managing increased access and other ecological effects resulting from logging near park boundaries;
- Responding to community and First Nations concerns about social, economic and ecosystem changes associated with beetle infestations, and,
- Responding to non-government and environmental group concerns that beetle management actions may adversely affect natural values in protected areas.

Post-Infestation Management

The long-term impact of mountain pine beetle infestations on park ecosystems and associated wildlife will be highly variable depending on the many factors including both the intensity of infestation and the composition of the park forest species prior to the infestation. From an ecological perspective, pine beetle infestations do not appear to be an "ecological disaster" for parks as they are often described. Mountain pine beetles kill only pine trees and leave all of the surrounding tree species, vegetation and ecological components undisturbed. So, while the pine trees are dying, the rest of the ecosystem is still alive and in some cases other tree species are stimulated to grow faster. For example, many parks affected by the beetle infestations have mixed forest types. Spruce (*Picea* spp) and fir (*Abies* spp) understory will be released as the pines die and in 20 years, where there are now red trees, there will be a green forest with grey tops of dead pines scattered throughout. Preliminary forest sampling conducted in the most severely affected sections of North Tweedsmuir park has shown that immature understory and codominant tree species growing among the beetle-killed pines will form an equivalent forest in the near future (Cichowski 2000).

There are cases, however, where critical habitats may be affected by lodgepole pine mortality. For example, in the Entiako Park and Protected Area, critical caribou winter range is being monitored to determine if deadfall associated with pine mortality will create mobility problems for migrating caribou or, if forest succession following the infestation will alter critical habitat attributes. If mobility or critical habitat attributes are affected, active ecosystem management may be required to maintain habitat values.

As a result of pine mortality, there has been concern expressed that uncontrollable wildfires similar to the Yellowstone fire of 1988 would immediately follow. A massive wildfire associated with the current mountain pine beetle infestation has not happened, however, and the actual wildfire threat may decrease in the short term. Wildfire threat will likely decrease as beetle-killed pines lose their needles and the capacity to support a crown fire. In the long term, however, the potential for high intensity fires due to deadfall in beetle-killed pine forests will increase long after the infestation has collapsed. Three primary periods of increased fire hazard in lodgepole pine stand following mountain pine beetle outbreaks have been identified (Environment Canada 1982):

- Immediately following an outbreak, when needles and small branches are retained on standing dead trees, stand susceptibility to crown fires may be increased. Understory response to the outbreak will also affect stand susceptibility during this period by affecting the potential for ground fire to simultaneously occur.
- An elevated fire risk also occurs about ten years after the outbreak, when tree bark begins to slough off.
- The most extreme risk occurs after beetle-killed trees have fallen, approximately 20 to 50 years after the outbreak, when fuel-loading is at its maximum. Fuel quantity and arrangement may produce extremely high intensity fires.

Most parks affected by the mountain pine beetle epidemic have passed through the first phase of the increased fire hazard, leaving them between phase 1 and 2 and at a relatively low risk for fire hazard. As deadfall begins to take place in the next 20 years, however, parks will begin to experience the second slightly higher risk and the third extreme risk. Park managers are currently planning to reduce fuel accumulations due to pine mortality through the use of prescribed fire and tree removals where required. Likely, there is probably a 15- to 20-year "window of opportunity" to deal with potential future fuel

hazard issues. As more trees fall, fuel hazard will increase and may result in wildfires of high intensity, which are extremely difficult to control.

Fire hazard management may be required to create fuel breaks or reduce fuel loading in situations where cross boundary values including facilities, private lands, or the working forest may be at risk from protected area wildfires. This issue will require on-going efforts for many years following infestations, as deadfall rates will accelerate as time progresses.

Post-infestation management activities in parks and protected areas will include:

- Monitoring critical wildlife habitats in beetle-killed forests;
- Initiating research to predict park vegetation response to the infestation;
- Ensuring visitor safety from hazard trees;
- Maintaining recreation values;
- Planning for wildfire control and fuel hazard reduction in community and facility interface areas; and,
- Planning to address potential high intensity fires in areas of high fuel loading.

Research, Planning and Long-term Treatment Projects

Research

Research requirements associated with the mountain pine beetle infestations in protected areas are mainly focused on providing science-based information for ecosystem management actions. Research issues associated with protected areas ecosystem management include the determination of:

- long-term range of variability of park forested ecosystems;
- current forest variance from natural conditions based on long-term natural disturbance intervals;
- wildfire spread rate and intensity in beetle-killed pine stands;
- dead fall rates and fuel loading in beetle-killed pine stands;
- rate and species of natural regeneration of beetle-killed pine stands;
- habitat changes and associated wildlife responses to beetle-killed pine stands;
- increased access and habitat fragmentation associated with logging adjacent to protected areas;
- species composition and habitat use in beetle-killed pine stands;
- rate of regeneration and co-dominant succession in beetle-killed stands; and
- long-term vegetation and ecosystem response to pine mortality.

To address some of these research questions an interagency research program has been proposed by the Canadian Forest Service, the BC Ministry of Forests and the BC Ministry of Water, Land and Air Protection to determine wildfire response in beetle-killed pine stands. The program will assess probability of ignition and wildfire response of beetle-killed pine stands compared to live pine stands. Research results will be used to plan prescribed burns in parks and provide information for wildfire control and threat reduction.

Planning and Management

Planning and management are required to deal with the wide range of issues which will arise from the post-epidemic forests in parks and protected areas. Specialized plans and management actions to deal with thousands of ha of post-infestation beetle-killed pine stands will need to be prepared. Planning and management actions include:

- fuel hazard management plans and fuel reduction treatments;
- prescribed burn prescriptions and prescribed burns to reduce fuels, maintain habitats and support forest diversity; and
- long-term monitoring to determine park ecosystem response to an infestation.

Examples of planning and management actions in BC parks and protected areas include:

- Strategic Wildfire Risk Assessment for Manning Provincial Park – this assessment identifies wildfire risk and associated potential fuel management and wildfire threat reduction activities for the park.
- Ecosystem Management Plan for Mount Robson Provincial Park – this plan identifies the requirement to vary the forest matrix of the park through the use of prescribed burns. Prescribed burning will reduce infestation rates, remove infested hosts, create a fuel break for adjacent facilities and create early seral forests and habitats. A 2,500 ha prescribed burn was planned for the Moose River area of the park, but was postponed due to the wildfire crisis in the southern part of BC in the summer of 2003.
- Fuel Reduction Project for Silver Star Provincial Park – this project is planned to reduce forest fuels and associated wildfire risk associated with dead and dying pine trees as a result of a mountain pine beetle epidemic in Silver Star Park. The project will reduce fuels, remove infested trees and create wildfire control access in the park to help protect park facilities and the adjacent Silver Star Ski resort from wildfires.

Conclusion

The mountain pine beetle epidemic in BC in parks and protected areas crosses many ecological, social, and economic boundaries. The objective of the BC Parks mountain pine beetle management program is to manage beetle infestations to reduce impacts to crown forests where possible, but also to maintain the natural values of parks and protected areas.

Management of the mountain pine beetle epidemic in parks and protected areas goes beyond insect control. Since many park ecosystem and forest management plans call for prescribed burning, there is need for a coordinated burning program. Prescribed fires reduce beetle host and also bring forests back into natural mosaics, create firebreaks and reduce fuel loads. Forest cover inventories for many parks need updating and studies to determine fire hazards, fall down rates and vegetation responses associated with beetle infestations should be initiated.

No one is sure when the mountain pine beetle epidemic in BC will collapse. While the infestation is not considered an ecological disaster for the affected parks, the epidemic will present management challenges in affected protected areas for decades following the actual epidemic collapse. Issues such as: hazard tree management; post epidemic pine deadfall; fuel hazard reduction and wildfire management; maintenance of recreation values; and management of adjacent access will require continuing efforts from protected area managers following infestation collapse.

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