TIMBER SUPPLY AND THE MOUNTAIN PINE BEETLE INFESTATION IN BRITISH COLUMBIA

Ministry of Forests
Forest Analysis Branch
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BRITISH COLUMBIA

FOREST SERVICE BRITISH COLUMBIA

Cover picture was taken by Lorraine Maclauchlan - Ministry of Forests, on July 22, 2003. The location is the Red Lake/Red Plateau area, north-west of Kamloops.

Introduction

In BC's central interior, a mountain pine beetle infestation has been increasing in size since 1994. During the last two years, both the rate of spread and the attack intensity have increased. Based on preliminary results of the 2003 aerial surveys, the beetle infested a further 4.2 million hectares. Compared to about 2.0 million hectares reported in 2002, this represents a significant further expansion of the infestation.

Given the economic importance of lodgepole pine and the potential impact of the current beetle infestation on forest-dependent communities in BC's interior, the forest industry and government jointly created the **Mountain Pine Beetle Emergency Task Force**[1] in 1999 to manage and reduce the impact of the infestation.

The Task Force has helped to ensure that management strategies are well-planned and as effective as possible. These strategies have been aggressive and have been successful in making a difference in reducing the spread of the infestation and limiting the amount of killed-timber in some areas. However, in some areas that have extremely high beetle populations, even with aggressive control measures and harvesting strategies, stands of beetle-killed timber are being left behind.

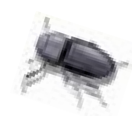
In order to continue to develop effective management responses, it is important to understand both the potential timber supply* impacts, and which of the factors associated with the infestation may be subject to management intervention. This report describes the results of an assessment undertaken by the Ministry of Forests of the possible timber supply* impacts of the current infestation. The objective of the study is to provide information to assist the Task Force and others involved in developing beetle management and mitigation strategies at the local and provincial levels.

Accurate mapping of the extent and intensity of the epidemic is difficult given the large area affected, the variable rates of infestation within forest stands, and the fact that new areas are infested every year. Nevertheless, an understanding of the types of impacts the infestation may have on timber supply can be developed based on the best currently available information and knowledge. The review and analysis discussed in this report examines the possible timber supply impacts in 7 timber supply areas (TSAs) and 5 tree farm licences (TFLs) in BC.

Although this report focuses on the timber supply impacts, there will also be a host of environmental considerations and other socioeconomic values affected by the beetle infestation. The epidemic beetle population, by killing very large numbers of mature pine trees, will inevitably affect the structure of the forests in affected areas, and the supply of various kinds of natural habitats.

[1] For more detailed information on provincial strategies, see the **Mountain Pine Beetle COFI Task Force** web site at www.mountainpinebeetle.com

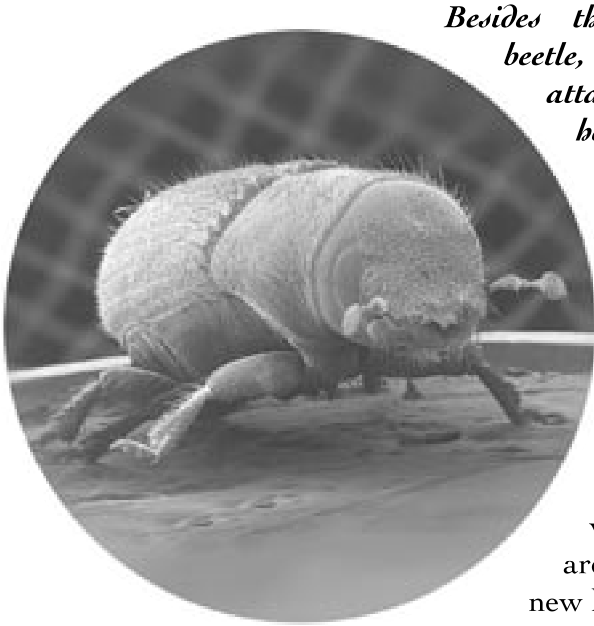
*__Timber supply__ is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.



*Throughout this report, an asterisk at the end of a word or phrase indicates that a definition can be found in the margin.

Description of the mountain pine beetle infestation[2]

Besides the mountain pine beetle, other insects are attacking BC's forests, however for this report the focus is the pine beetle.



***Mountain pine beetles** are small, cylindrical insects that attack lodgepole pine, ponderosa pine and white pine trees from late spring through summer. Individual trees are generally killed soon after they are attacked.

Mountain pine beetles* play an important role in the natural life cycle of lodgepole pine forests by attacking older or weakened trees that are then replaced by new healthy pine forests. In BC, pine beetles have reached epidemic levels several times over the last century, mostly in areas south of Quesnel.

Two key factors contributing to the recent expansion of the mountain pine beetle infestation are the large amounts of older lodgepole pine on the land base and the relatively warm weather conditions experienced in recent years in the interior of the province. Both fire and insects have historically played an important role in the natural disturbance and replacement of lodgepole pine forests in much of the province's interior. However, fire control measures undertaken to protect the forest resource, infrastructure and private property have contributed to an accumulation of old pine forest above historical levels. Once lodgepole pine trees are mature (generally older than 80 years), they are highly susceptible to attack by the pine beetle particularly during times of prolonged favourable weather conditions. While both factors – available mature pine and warm weather – are likely necessary for an epidemic to occur, experts claim that the more significant factor is the increasing amount of mature lodgepole pine forests.

The Canadian Forest Service (CFS) has estimated that largely due to fire suppression efforts, the amount of mature lodgepole pine forests is about three times larger than it was in 1910.[3] Of the 14.9 million hectares of lodgepole pine of all ages in BC, the area of mature pine forest increased from about 2.5 million hectares in 1910 to over 8 million hectares in 1990.

The second factor has been hot, dry summers and mild winters that have allowed the mountain pine beetle population to reach epidemic levels in mature pine forests. The warmer weather has created favourable conditions allowing the beetle to spread into higher elevations and more northern latitudes. As well, due to drier conditions, trees in many areas of BC are drought-stressed, which increases their susceptibility to beetle attack.

The Ministry of Water, Land and

2 For more detailed information, consult the Ministry of Forests web site: www.for.gov.bc.ca/hfp/bark_beetles.

3 *Effects of disturbance on lodgepole pine forest susceptibility to mountain pine beetle infestation in British Columbia.* S.W. Taylor and A.L. Carroll, Natural Resources Canada, Canadian Forest Service. Unpublished report, Victoria, BC. 2003.

Air Protection report *Indicators of Climate Change for BC 2002* noted that in the area affected by the epidemic (south and central interior) the average minimum temperatures during the winter have increased by +2.2°C to +2.6°C over the last 100 years (see Figure 1 lower left of quartered pie). Climate models project that this warming trend will continue.

Given this trend in climate warming, regions that are currently too cold for the mountain pine beetle are likely to become more suitable.

This information suggests that future climatic conditions in the central and northern interior may become more conducive to sustaining high beetle populations. While the climate cannot be controlled, over the longer term it may be possible to manage the characteristics and amount of the host for the beetle (mature lodgepole pine) through silviculture and fire management.

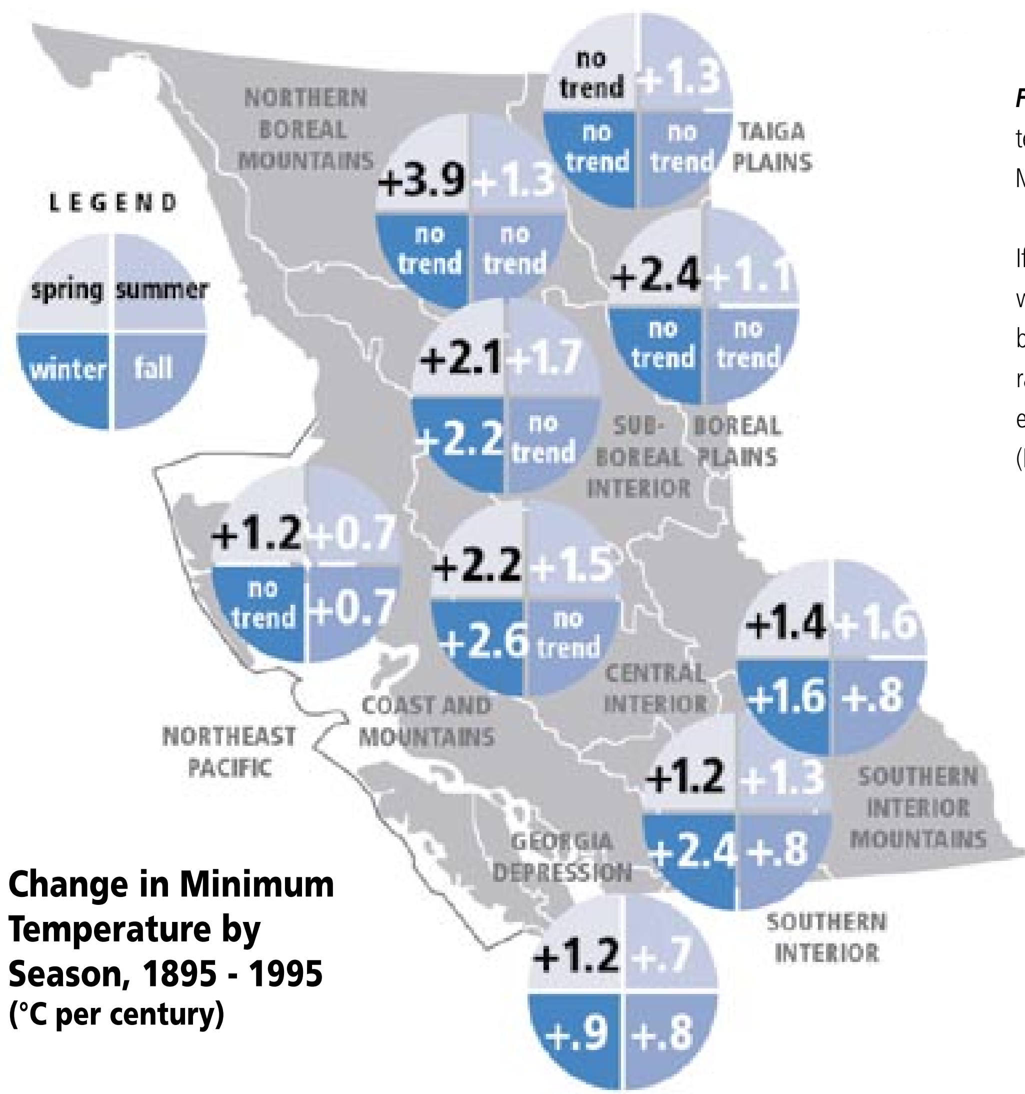
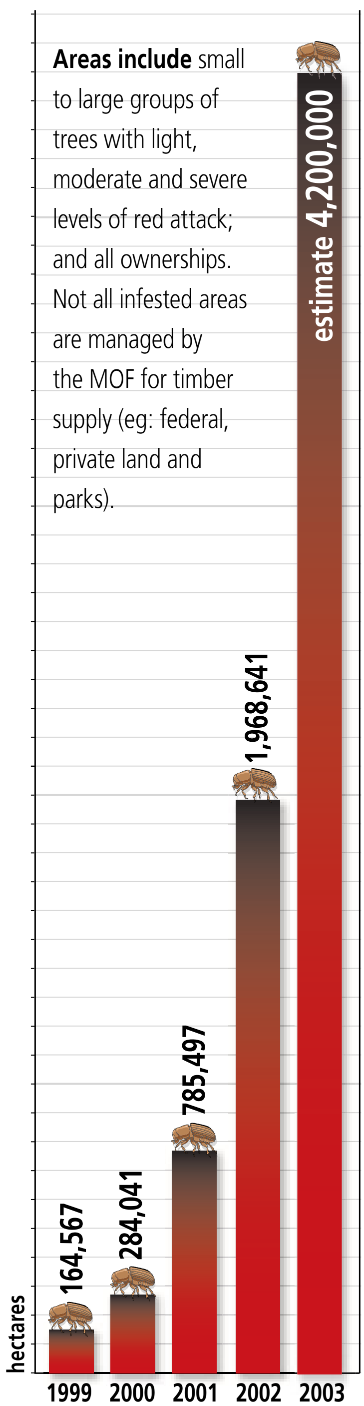


Figure 1. Change in the minimum temperature by season, 1895-1995, MWLAP.

If the global climate continues to warm, the mountain pine beetle may be able to significantly expand its range into former climatically hostile environments.
(Logan and Powell 2001).

Size of the current beetle infestation

Figure 2. Amount of mountain pine beetle red-attack surveyed in BC by year (hectares) Source: Ministry of Forests, Forest Practices Branch, 2003 Aerial Overview Survey. These areas are not cumulative (see main text).



The Ministry of Forests regularly monitors the health of BC's forests. Since 1995, the ministry has completed aerial surveys that map the total amount of red attack* in a given year.

Based on a summary of Ministry of Forests aerial surveys for 1999-2002 provided by Forest Practices Branch, the infested area covered about 2 million hectares of pine forests as of Fall 2002. As Figure 2 shows, estimates for 2003 indicate that red attack areas have doubled and now cover about 4.2 million hectares. Since these surveys cover very large areas, estimates of infested area associated with individual or groups of attacked trees must be made. Therefore, the overall area is an estimate subject to some uncertainty. It does however, constitute the best available information at this time.

It is difficult to determine the cumulative area of attack based on red-attack areas as a hectare classified as red-attack may also have some green unattacked trees. In subsequent years, these green trees may be killed. Therefore it is not appropriate to cumulatively add all the red-attack areas surveyed in different years, since the same area could be included in each years' survey results.

The aerial surveys include an estimate of the attack severity within stands based on the percentage mortality. The severity categories are **light** (1-10 percent of trees recently killed), **moderate** (11-29 percent of trees recently killed) and **severe** (over 30 percent of trees recently killed in an area).

***red attack -** One year after the trees are attacked and killed, the needles turn red. The red attack trees are easily observed and mapped. In the following year, the needles fall off and the trees are then classified as gray attack.

Figure 3 shows the Ministry of Forest's aerial surveys of the red-attack areas from 1999 to 2003. Since 1999, the beetle attack

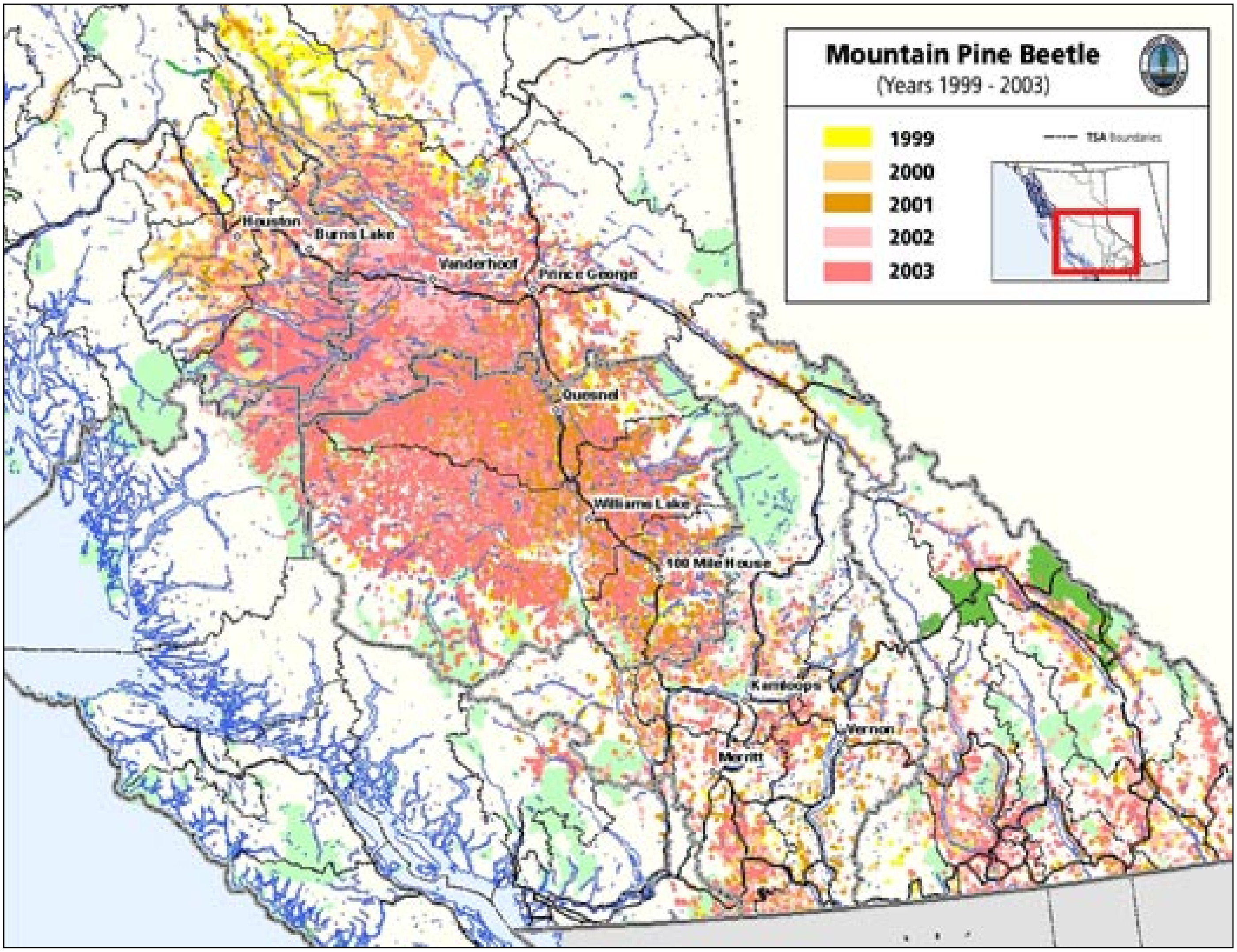


Figure 3. Area of annual red attack from 1999 - 2003, MoF. 2003
Of the 4.2 million hectares estimated as red-attack in 2003, 64% were classified light, 18% as moderate and 18% as severe.

has continued to spread over a significant portion of the south and central interior.

The Mountain Pine Beetle Emergency Task Force has also provided approximations of the extent of the infestation. The Task Force estimated that the infestation covered about 8 million hectares in 2002; the total area cumulatively affected by the beetle. Although the hectares are reported differently, both the Ministry of Forests and the Task Force agree that as of 2002, about 108 million cubic metres of wood had been infested in BC. As well, both agree that the outer periphery is continuing to expand as shown on the map.

Timber supply impact study

A mountain pine beetle takes flight.

To examine the potential impact of the mountain pine beetle on timber supply, the ministry examined 7 timber supply areas (TSAs) and 5 tree farm licence areas (TFLs), referred to as the 12 management units in this report. These areas represent the more severely infested areas in central BC, stretching from Houston to Kamloops. The areas include the Morice, Lakes, Prince George, Quesnel, Williams Lake, 100 Mile House and Kamloops TSAs; and TFLs 5, 42, 49, 52 and 53 (see Figure 4).

On these 12 management units, mature pine-leading stands (forests comprised of more than 50 percent pine older than 80 years) cover about 3.3 million hectares or about one third of the 9.9 million hectares of timber harvesting land base* (see Table 2). Mature pine-leading stands are the most susceptible to beetle attack. An additional 1.4 million hectares are occupied by stands composed of between 10 and 50 percent of mature lodgepole pine trees. Since these forests have other non-susceptible trees such as Douglas-fir, spruce, hemlock, cedar, and true firs, they may not be affected as much as the pine-leading stands. The remaining area is comprised of about 2.8 million hectares of mixed species less than 80 years old, and about 2.4 million hectares of mature species other

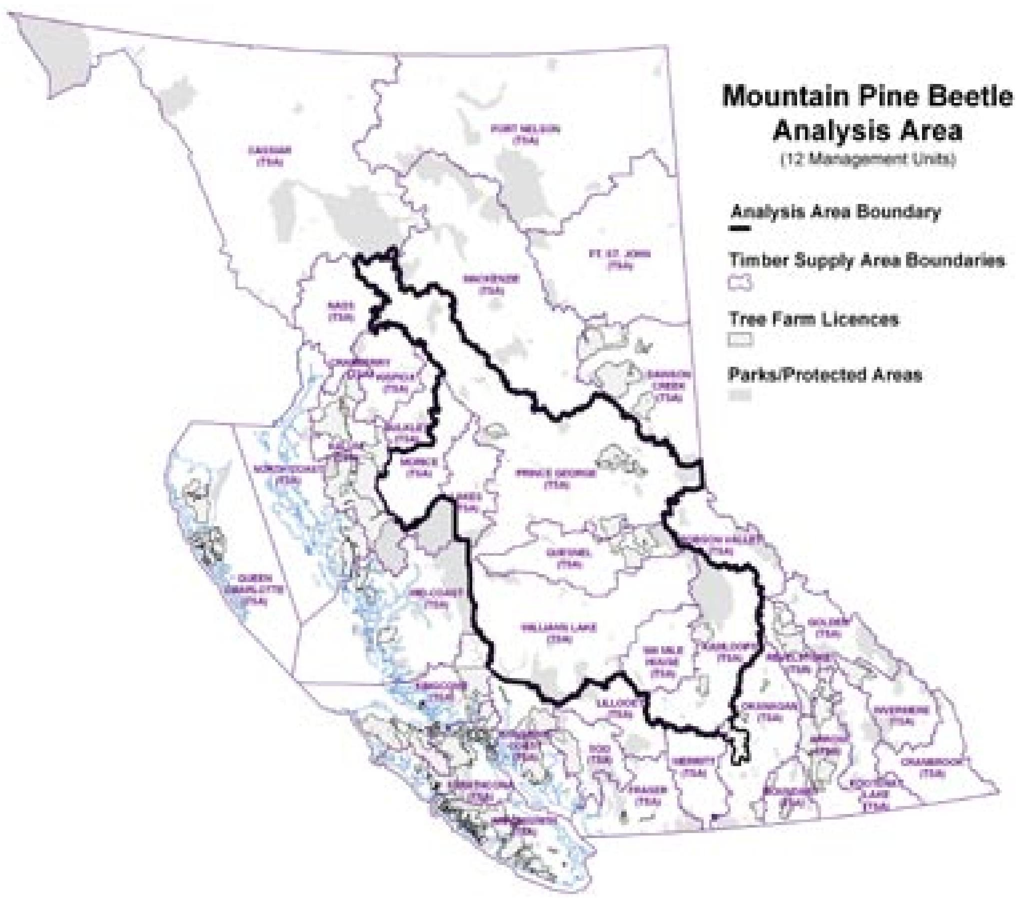


Figure 4: Map outlining the 12 management units included in the timber supply impact analysis. These 12 management units contain about 9.9 million hectares of timber harvesting land base*. (see Table 2).

timber harvesting land base
- land that is considered available for harvest taking into account economic, environmental, social and cultural considerations.

than pine, such as Douglas-fir, spruce, hemlock, cedar and true firs.

The timber harvesting land base in the 12 units contains about 1.7 billion cubic metres of merchantable mature timber volume, of which two-thirds is pine.

The total provincial allowable annual cut (AAC) for TSAs and TFLs (Aug 2003) is 74.4 million cubic metres a year. Currently for the 12 management units, the total AAC is about 30 million cubic metres a year (see Table 3).

About 6.8 million cubic metres a year, or about 9 percent of the provincial AAC, is attributable to mountain pine beetle uplifts* assigned to 7 of the 12 management units.

The ministry selected the 12 units for this study to examine the potential timber supply impact in the areas where the epidemic presented the most severe risks to timber supply as of Fall 2002. However, it should be noted that beetles are also active in mature pine-leading stands in areas outside the study area, including the Mackenzie, Robson Valley, Merritt, Lillooet, Okanagan, Boundary, Cranbrook and Invermere TSAs. On the timber harvesting land base within these additional TSAs, 1 million hectares are occupied by mature pine-leading forest, and an additional 850,000 hectares are covered by mature stands comprised of 10 to 50 percent mature pine.

***Uplifts -** B.C.'s chief forester has increased some allowable annual cuts temporarily to respond to the current infestation. Temporary uplifts involve the same detailed technical analysis and public review normally required for harvest level determinations, and all logging and forest practices are projected to meet standards required under the Forest Practices Code.*

Total provincial THLB (37 TSAs & 34 TFLs)	**23 million hectares**	
THLB in the 12 units total	**9.9** million hectares	**43.0%** of total
THLB in the 12 units with >50% mature pine	**3.3** million hectares	**14.0%** of total
THLB in the 12 units with >10% mature pine	**4.7** million hectares	**20.5%** of total

Table 2 - Provincial timber harvesting land base (THLB), Aug 2003.

Provincial allowable annual cut (Aug 2003)	
Total - 37 TSAs and 34 TFLs	**74.4** million m3/yr
12 units - 7 TSAs and 5 TFLs (includes uplifts)	**30.0** million m3/yr
7 uplifts - (Lakes, PG, Quesnel, WL, TFL 5, 42 & 53)	**6.8** million m3/yr

Table 3 - Provincial allowable annual cut, Aug 2003.

Assumptions for assessing the timber supply impact in the 12 management units

***shelf life** – is a key factor in determining the impact of the infestation. Once pine trees have been killed, they can remain standing for a number of years. However, their commercial value deteriorates steadily over time. The number of merchantable years is influenced mostly by weather. The drier and warmer areas, such as the Chilcotin, have reported a shelf life of more than 15 years. In wetter and colder areas, such as parts of the Prince George area, the shelf life may be less than 10 years.*

The analysis examined only the impacts of the current beetle infestation and an estimate of the extent to which it might spread. No attempt was made to forecast beetle infestations that may occur in future decades, or future changes to forest management practices such as reforestation and fire management.

There are many uncertainties about the size of the infested area on the timber harvesting land base, the level of severity, the rate of spread and the rate at which timber will deteriorate to a non-merchantable condition after being killed. This last factor has been called the **shelf life***. The uncertainties related to these issues required several general assumptions in the analysis. While it is difficult to derive the exact magnitude of the mountain pine infestation and its impacts[4], analysis can increase understanding of the degree to which timber supply may be affected by important factors such as deterioration rate (shelf life) and the length of time before areas of killed trees are reforested.

Of the 4.2 million hectares of red attack estimated in the province in 2003, the red attack in the 12 management units covered over 80 percent of the provincial total. The number of infested hectares on the timber harvesting land base (as opposed to the total forest area) has not been explicitly mapped by the Ministry of Forests, therefore it was necessary to estimate the area for the timber supply analysis. As of Fall 2003, infestation levels were high in the Lakes, Prince George and Quesnel TSAs and the five TFLs, and lower in the Williams Lake, 100 Mile House and Kamloops TSAs. If the infestation continues at its current rate of spread, it will likely affect many mature pine-leading stands in the 12 units as well as other TSAs with mature pine. However experts[5] advise that not all the pine will be lost equally in all areas. The degree of mortality will vary; all trees in some stands may be killed while other stands may have light or no mortality. Nonetheless, if the current trends in the annual expansion rates are projected over the next one to three years, then it is possible that on average for the 12 units, that 50 percent of the stands could be affected.

It is acknowledged that this is a simplified version of the infestation, as it does not take into account risk-rating of individual stands. For the analysis of the 12 units, it

4 Industrial Forest Services Ltd - A Technical Peer Review of Allowable Annual Cuts & Mountain Pine Beetles in B.C. from a Timber Supply Perspective. July 2003 – "There is no clearly defined methodology for modeling MPB epidemics – scientists in both Canada and the USA seem to shun the action because it involves too much conjecture."

5 Dr. Les Safranyik – (given the current infestation) taken over large areas such as a TSA, the most reasonable expectation would be 30 to 50% depletion (by number of stems, which will be mainly from the largest diameter classes) of the susceptible pine-leading stands.

was assumed that 50 percent of the mature pine-leading stands (total of 3.3 million hectares) were infested by 2002.

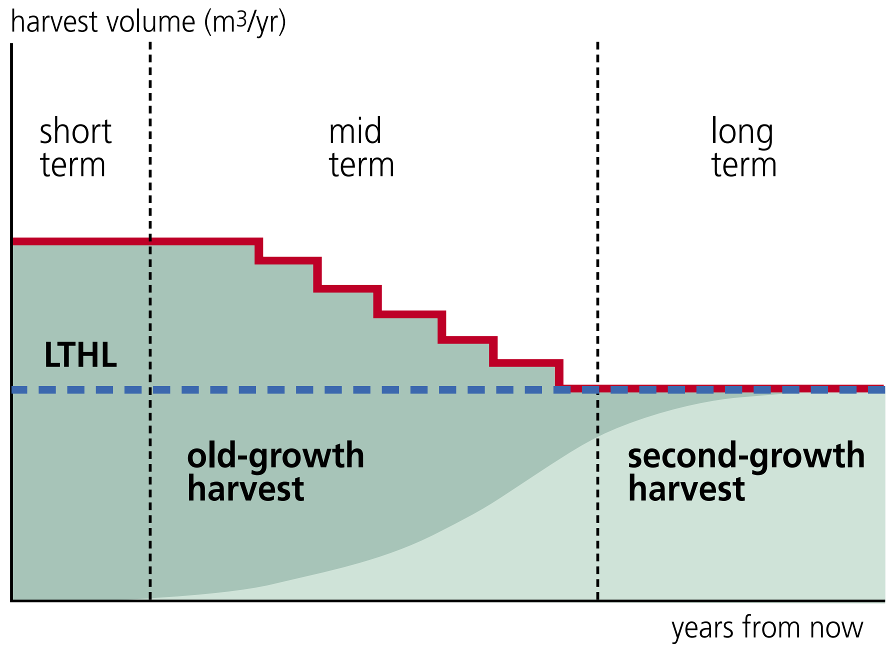
The following key assumptions reflect the best estimate of the possible dynamics of the infestation averaged over the 12 units:

- Half of the 3.3 million hectares of susceptible pine stands (older than 80 years with more than 50 percent pine) in the 12 units were assumed to have been attacked and killed at the start of the analysis in 2002;
- Attacked and killed trees would take 15 years to deteriorate to an unmerchantable condition;
- Attacked areas that are not salvage-harvested were projected to take 20 years to regenerate. Harvested areas were assumed to be regenerated within 1 to 3 years after harvest; and
- Over the first 15 years, harvests were projected to consist on average of 60 percent pine and 40 percent other species. This composition broadly reflects the 2002 harvest profile averaged over the 12 units.

Rate-of-spread trends were not incorporated into the analysis of the 12 units. The assumption was that the infestation would attack half of the susceptible pine-leading stands, then stop. The result of this assumption depleted about 480 million cubic metres of pine from the short-term timber supply.

As noted earlier, as of 2002, about 108 million cubic metres had been infested. Therefore, the assumption that 480 million cubic metres could be infested in one to three years—given continued warm weather conditions, available pine and rates of spread—is a possible scenario. For the Quesnel TSA analysis (see page 14), the current infested area and rate of spread statistics were incorporated into the timber supply analysis. As well, a different modeling technique was applied as discussed in the appendix to this report.

Timber Supply Forecast Timeframe



The timber supply impact analysis was completed using FSSIM (Forest Service Simulator), a timber supply computer model developed by the BC Forest Service. Timber supply projections were made for 250 years to assess the impacts over the short (present to 20 years from now), medium (20-100 years) and long terms (beyond 100 years from now). It is recognized that significant uncertainties exist about the future, however, long range projections are needed to ensure that current harvest levels will allow for stable and sustainable timber supply in the future.

Timber supply results for the 12 units

Trunk of lodgepole pine showing "pitch tubes" from a mountain pine beetle attack.

Figure 5 shows the projection of timber available for harvest based on the assumptions described in the previous section. Timber supply is projected to decline significantly in 15 years after the attacked and killed trees have deteriorated and are considered unmerchantable.

The current AACs for the 12 units include uplifts that amount to about 6.8 million cubic metres a year, which were set as temporary measures to help manage the current infestation. Since the AAC uplifts are temporary, the pre-uplift AAC level of 23.2 million cubic metres is the best baseline for measuring the mid-term timber supply impacts. After 15 years, the decline relative to the pre-uplift AACs – from 23.2 million cubic metres a year to 18.7 million cubic metres a year – is about 4.5 million cubic metres a year. This represents a projected 19 percent decline in the mid-term harvest level.

Given the scenario of 50 percent mortality of mature pine stands, after 15 years the total infested area would be 1.6 million hectares on the timber harvesting land base, with an infested volume of 480 million cubic metres.

Both the harvest level and the proportion of the harvest made up of pine will affect the volume of damaged wood that will remain unharvested. For example, if the annual harvest level remained at 30 million cubic metres a year, the estimated total timber losses could be as high as 200 million cubic metres over the next 15 years (the volume represented by the shaded area in Figure 5). If the allowable annual cut were increased above 30 million cubic metres a year, the amount of unsalvaged losses could be reduced from 200 million cubic metres.

In the analysis, the proportion of the harvest level that was comprised of pine was 60 percent and other species comprised 40 percent. This was based on the actual harvested percentages for the 12 units in 2002. If the pine percentage was increased to 80 percent, then the amount of unharvested beetle-killed timber could be reduced by almost half, from 200 million cubic metres to about 120 million cubic metres. As well, the mid-term timber supply would decline by 3.0 million cubic metres a year, which is an important improvement over the 4.5 million cubic metres shown in Figure 5. There may be many operational reasons why increasing the percentage of pine harvested would not be realistic.

If killed trees deteriorate more quickly (in less than 15 years), losses would be greater than shown in Figure 5, unless harvests were increased. If the shelf life were longer than 15 years, less volume would be lost given the current AAC and the mid-term impacts could be reduced.

If infested but unharvested areas were to become reforested more quickly than the 20 years assumed for the base projection, short-term timber supply would not be affected. However, either the mid-term levels could be increased slightly, or the long-term harvest level could be increased about 20 years sooner. Conversely, longer regeneration delays would lead to a lower mid-term level or a longer time to achieve full long-term productivity.

Other scenarios were examined and showed that with more severe infestation and mortality (more than 50 percent) there would be proportionately more severe impacts on mid-term timber supply.

The proportion of individual TSAs and TFLs that will be affected by the beetle will vary and cannot be predicted with certainty. However, the assumptions applied in the analysis are based on observed trends and are informed by data and expert opinion. In addition, there is evidence that in some TSAs with a large component of mature pine, such as the Quesnel TSA, that the level of mortality will be higher than 50 percent. The Quesnel TSA analysis is discussed further next.

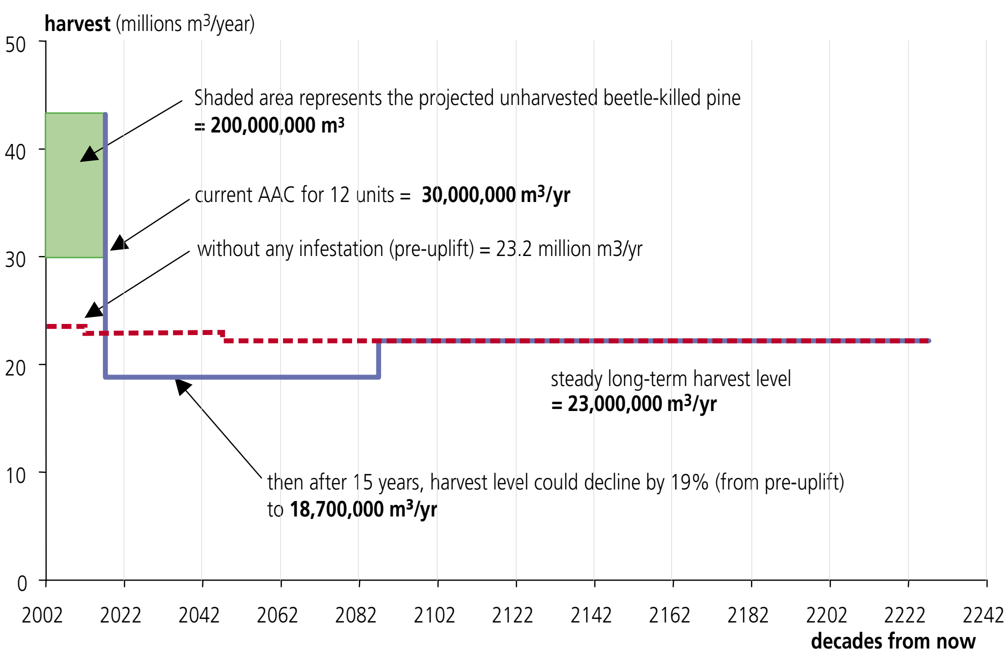


Figure 5. Timber supply forecast for 12 units if 50 percent of susceptible pine stands are infested

Timber supply assumptions for assessing the impact in the Quesnel TSA

A more detailed analysis was undertaken for the Quesnel TSA. Of the three severely infested TSAs, Quesnel was examined due to concern about the timber supply given the increased rate of beetle attack in Fall 2002.

In this analysis, as in the assessment of the 12 management units, only the current infestation –including an estimate of the degree to which it will ultimately spread – was examined. No attempt was made to forecast future beetle infestations that may occur in future decades, or future changes to forest management practices such as reforestation and fire management.

The Quesnel TSA covers a total of about 1.6 million hectares in central BC. The area considered available for timber harvesting is approximately one million hectares. Of this area, susceptible pine-leading stands cover about 60 percent (590,000 hectares) and stands consisting of between 25 and 50 percent susceptible pine cover another 15 percent (150,000 hectares). Local Forest Service staff have observed high levels of attack in pine forests as young as 60 years. Therefore, susceptible pine stands were defined as stands older than 60 years for the Quesnel TSA analysis, rather than 80 years as applied in the analysis of the 12 management units. On the remaining area, 19 percent has mixed stands that are younger than 60 years, and 8 percent has species other than pine that are older than 60 years. The total volume of mature pine is about 105 million cubic metres.

For the Quesnel analysis, an averaged rate of spread and current level of intensity were incorporated, rather than the assumption that 50 percent of pine-leading stands would be infested as applied in the 12-unit analysis. The information used for modeling the current infestation level and rate of spread is discussed below.

An important first step in the Quesnel analysis was determining the area currently infested within the timber harvesting land base. Based on aerial surveys, the Ministry of Forests reported that the total forested area of red-attack in 2002 was about 370,000 hectares. Information gathered by Industrial Forest Services Ltd. (IFS) for the Mountain Pine Beetle Emergency Task Force reported that about 215,300 hectares were infested on the timber harvesting land base. Since the timber supply impact depends on infested area on the timber harvesting land base, not the total forest area, the Task Force figure of 215,300 hectares was used as the initial infested area. The Task Force data also included the severity of infestation for the 215,300 hectares, which was used as a starting point for projecting the potential growth in the infestation (see Figure 6).

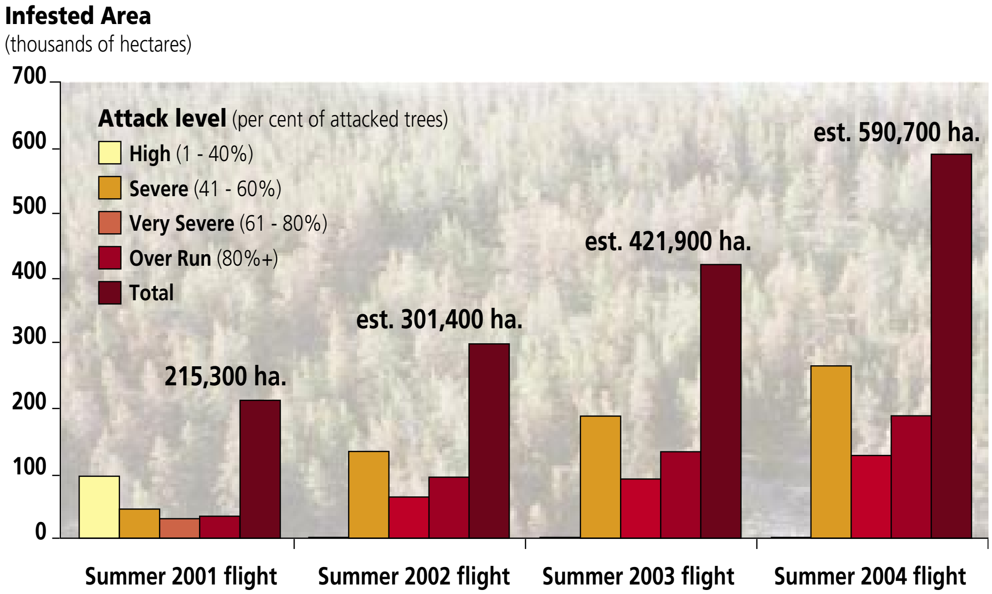


Figure 6. Projection of a 40% increase in the infested area, Quesnel TSA.

Ministry of Forests regional staff reported that the infestation increased in size by an average of about 40 percent per year from 1994 to 2000. Based on this, an average expansion rate of 40 percent per year was used for the timber supply analysis. However, the Ministry of Forests Forest Health data base indicates that the rate of spread since 2000 has been significantly more rapid than in previous years. The area of red attack in 2001 was 82,578 hectares and in 2002 it was 370,000 hectares. If the infestation continues to expand at the rate experienced over the past two years, the beetle would infest all susceptible stands more quickly than projected in this impact analysis. A more rapid rate of spread could mean that timber supply impacts may occur slightly sooner than projected in this analysis.

For the Quesnel analysis, the following key assumptions reflect an estimate of the possible growth and intensity of the infestation:

- 215,300 hectares (resulting from the 2001 summer beetle flight) was the initial infested area. Within this area, the intensity of the infestation was 45 percent high, 22 percent severe, 16 percent very severe and 17 percent over-run.
- the infestation was assumed to spread at a conservative rate of 40 percent per year from the Summer 2001 area until all 590,000 hectares of pine-leading stands were infested. The relative amounts in each severity class (see previous bullet) were assumed to increase as well (see Figure 6). As the Summer 2004 bars show, the projected area of infestation was not fully categorized as over-run (80%+ infested). After that time, if the beetle population has not collapsed, the severity could

continue to increase, as discussed further below;

- the initial harvesting rate was modeled at 3.2 million cubic metres a year, of which about one million cubic metres is attributable to the beetle uplift set in 2001 and 80 percent of severely infested stands were harvested first;
- based on advise from regional Ministry of Forests staff, trees were assumed to remain merchantable once infested (shelf life) for 10 to 15 years depending on local conditions. On average, trees are estimated to become unmerchantable after about 13 years in the Quesnel TSA.

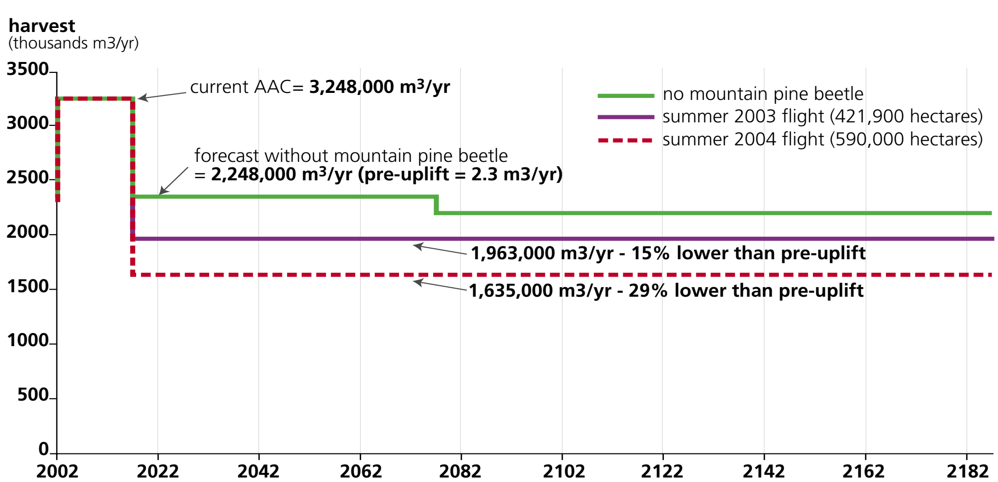
Figure 7 shows timber supply projections for three scenarios:

- if there were no mountain pine beetle infestation;
- if the infestation stopped at the projected summer 2003 level (421,900 hectares); and
- if the infestation stopped at the projected summer 2004 level (all 590,000 hectares of pine-leading stands are attacked by severity classes but not overrun).

The projection for no beetle infestation follows the forecast in the most recent Timber Supply Review analysis (TSR2). The level of 2.3 million cubic metres per year was the AAC for the Quesnel TSA prior to 2001. The AAC was increased to 3.248 million cubic metres per year to address the pine beetle infestation.

Based on the 2002 estimates of the infested area on the timber harvesting land base and the severity for the Quesnel TSA provided by IFS, and a conservative 40 percent rate of expansion, by the fall of 2003, the total infested timber harvesting land base is projected to be 421,900 hectares. This level of attack would not be visible as red attack until 2004. In this scenario, with a very cold 2003/2004 winter and no further spread of the infestation, the timber supply would decline after about 15 years from its current uplift level of 3.248 million cubic metres a year, to about 1.96

Figure 7. Timber supply projections for various mountain pine beetle infestation levels in the Quesnel TSA (Note: these harvest projections reflect an even-flow approach, alternative harvest flows were also examined.)



million cubic metres. This is about 15 percent lower than the pre-uplift level of 2.3 million cubic metres.

The lower forecast level in Figure 7 shows the potential effects if the beetle continues to spread by 40 percent during the summer of 2004 and infests all 590,000 hectares of pine-leading stands older than 60 years according to the varying degrees of intensity shown in Figure 6. However, given the more recent rates of spread, which are closer to 200 percent, it is quite possible that the infestation has already reached the level projected for 2004. For 2004, the analysis shows that after about 15 years, the timber supply could decline to 1.63 million cubic metres a year. At this point, about 67 percent of the mature pine volume is assumed to be fully infested. This level of infestation reduces the mid-term harvest level by about 29 percent, compared to the pre-uplift level.

If the infestation continued beyond next summer and all pine-leading stands became over run, projected timber supply would decline to a low of about 1.17 million cubic metres a year. However at this time, experts generally do not believe that 100 percent of the pine will be killed. In the past, large-scale mountain pine beetle outbreaks have collapsed due to localized depletion of suitable host trees in combination with adverse effects of weather (Safranyik 1978). As well, some pine trees may be resistant to attack or protected by distance from the current beetle population.

Harvesting at the current AAC of 3.248 million cubic metres a year will likely not keep up with the expansion rate of the infestation. Although not illustrated in the Figure 7, the analysis assumes that by the fall of 2004, about 76 million cubic metres of mature pine in the Quesnel TSA will be harvested or infested. If the current AAC of 3.248 million cubic metres is maintained for 15 years, about 42 million cubic metres (3.248 million cubic metres a year for 15 years) could be harvested, leaving about 34 million cubic metres unharvested. With higher harvest levels, timber losses could be reduced, although the decline to the same mid-term timber supply level would still occur.

It is not possible to predict the weather or the exact rate of spread of the infestation. If next winter is sufficiently cold or if the pine remains merchantable for longer than assumed for the analysis, the projected declines may not be as large as shown in Figure 7.

The Quesnel analysis reinforces the importance of lodgepole pine to timber supply. The analyses show that once significant amounts of lodgepole pine are killed, the timber supply declines after about 15 years, coinciding with the assumed deterioration of the pine to an unmerchantable condition.

Summary of the timber supply analyses

Unsalvaged losses could be reduced if harvesting is increased to salvage infested timber and possibly reduce the spread of the infestation.

Timber supply analyses were undertaken to assess the potential timber supply impacts of the ongoing mountain pine beetle infestation. The analyses include estimates of the degree to which the infestation may ultimately spread. Those estimates were generalized and coincide with existing survey information and expert opinion. However, risk-rating and predictive modeling of the epidemic were not part of the analyses, hence the analysis did not involve sophisticated projection of the dynamics of the infestation. Nevertheless, the best available information was employed, and the analyses provide useful information on potential timber supply impacts and potential practices related to forest management and salvage of killed timber.

The first assessment covered 12 management units in the central interior of BC. These units comprise 9.9 million hectares or 43 percent of the provincial timber harvesting land base. Mature lodgepole pine comprises about 60 percent of the total growing stock on the timber harvesting land base of the 12 management units. Uncertainties about the infestation required general assumptions about several key factors that attempt to reflect the best estimate of the possible dynamics of the infestation averaged over the 12 units. While it is difficult to derive the exact magnitude of the mountain pine infestation and its impacts, analysis can increase understanding of the degree to which the factors related to the infestation, such as deterioration rate (shelf life), time for reforestation, and harvest profile may affect timber supply over time.

The 12-unit analysis projected a significant decline in timber supply after about 15 years from now, when killed trees might deteriorate beyond a merchantable condition. The projected reduction in mid-term timber supply (16 to 100 years from now) was 19 percent relative to the pre-uplift AAC (23.2 million cubic metres). At the uplift harvest level of 30 million cubic metres per year, about 200 million cubic metres of dead pine would not be harvested.

Based on the current high levels of beetle attack and mature pine in the Lakes, Prince George and Quesnel TSAs, the rate of mortality and hence the timber supply impacts will occur in these areas first.

Analysis showed that the mid-term reduction in timber supply could be mitigated somewhat, or timber losses could be reduced if:

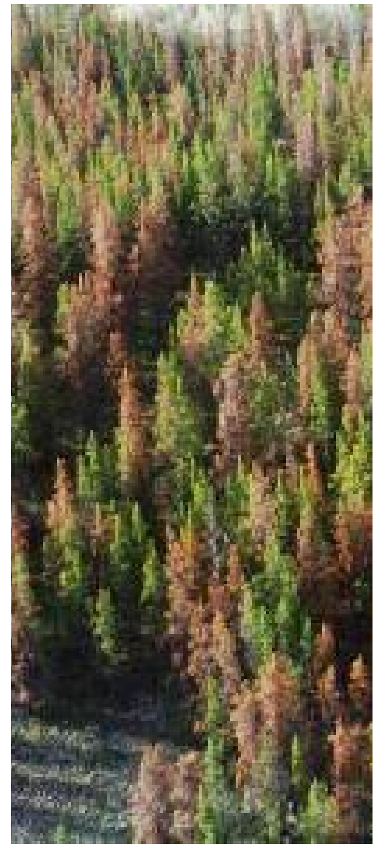
- Harvesting is targeted towards the more severely infested timber and at reducing the spread of the infestation;
- Harvesting is focussed more on harvesting pine than other species;
- Infested forests are regenerated more quickly than assumed.

The ultimate extent of the infestation is uncertain and the deterioration rate of killed trees is beyond management intervention. However, timber supply declines might be lessened if harvests were focused in areas where deterioration rates are more rapid.

A timber supply impact assessment was completed separately for the Quesnel TSA. This analysis incorporated estimates of the extent and severity of the infestation, and a conservative rate of spread (40 percent annual increase). However, the recent rate of spread has been higher than 40 percent, and therefore it is likely the infestation has already reached next year's projected level. Given this possible scenario, the impact to the mid-term harvest level could be up to 29 percent compared to the pre-uplift level. Similar to the aggregated 12-unit analysis, the decline is forecast to coincide with the deterioration of killed timber, or in about 15 years from now. This level of decline reflects the severe infestation in the Quesnel TSA. This analysis highlights that the timber supply impacts will vary among management units.

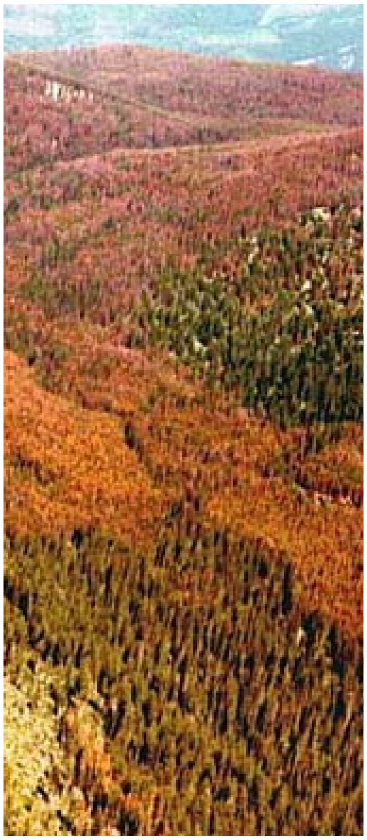
The deterioration rate or shelf life – the length of time the standing killed timber retains its merchantability – is an important factor in determining impacts. Although the forecasts reflect the loss of timber supply after trees become unmerchantable, continued economic activity could occur if alternative uses were found for the beetle-killed timber. Under this scenario, harvesting could potentially continue at rates above the projected mid-term levels. Currently, research is under way to refine the estimates of the merchantable life span of beetle-attacked pine, and to investigate alternative wood products that could be made from beetle-killed timber. Findings could help to focus harvesting where deterioration is expected to be more rapid and to expand salvage potential. In addition, the provincial Forest Investment Account and the federal Mountain Pine Beetle Initiative are funding studies of mountain pine beetle dynamics, beetle-control methods, mapping and detection methods, risk rating, impacts of climate change and other topics.

In conclusion, if warm weather trends continue for the next one to three years, then as the timber supply analyses indicate, the current mountain pine beetle infestation will likely have a significant impact on the available timber supply over the mid term. Efforts will need to be made to maximize utilization of killed timber in infested forests, and to develop local strategies that recognize the effects of the infestation. As discussed below, over the longer term, management practices can be designed to reduce the risk of catastrophic beetle infestations in the future.



Timber supply impacts will vary among management units.

Environmental impacts of the beetle infestation



Mountain Pine Beetle killed trees

Before extensive fire suppression, BC's central interior forests naturally underwent relatively frequent and large-scale stand-replacing events brought on by wildfire and insect outbreaks. Fires and insect outbreaks have been a part of normal ecosystem dynamics in BC, most likely for thousands of years. However, much more of the province is now occupied by older pine forests - with large beetle-susceptible trees - than historically has been the case.

With the epidemic population of mountain pine beetles and the abundance of susceptible mature pine, the rate of conversion from older to younger forested habitats will now inevitably be increased, by insect attack followed by eventual blowdown, or by harvesting to control the rate of spread or to salvage the attacked timber. Even with harvesting, both live and dead stands unaltered by harvesting will remain on the landscape.

Nonetheless, both the epidemic beetle population and timber harvesting, either for insect control or for salvage, will result in complex consequences for pine forests and associated wildlife habitats in BC's interior.

Building a strategy to manage the beetle infestation

The BC government, the forest industry and private landowners are all taking action to manage the beetle infestation as best as possible. All actions to date strive to integrate on-going strategies with existing land and resource management plans and current standards as required under the Forest Practices Code. Management strategies need to continue to be directed at controling the spread of the infestation and harvesting the areas with the highest mortality.

Under leadership of the Mountain Pine Beetle Task Force, both the Ministry of Forests and the forest industry have been examining all possible options to mitigate impacts to communities and to the province. A draft strategy framework is currently being developed, called the Bark Beetle Management Strategy Framework for BC, which will be available in Fall 2003.

In addition to the Task Force's strategy framework, the province will be holding a special symposium this fall in Quesnel to identify the issues and develop solutions.

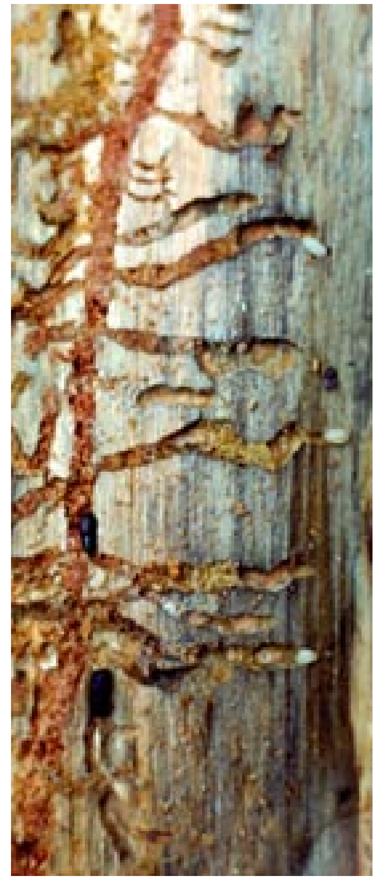
Given the current uncertainties about the infestation, it will be important to re-assess and re-analyze the infestation when new information becomes available to ensure that the timber supply forecasts are kept current. The Ministry of Forests and the Canadian Forest Service are continuing to analyze the infestation in more detail at the provincial level and further results should be available by spring 2004.

Over the longer term, the key will be to find innovative ways to manage large areas of even-aged lodgepole pine forests in BC. The Mountain Pine Beetle Emergency Task Force and Ministry of Forests web sites contain descriptions of potential management practices related to preventive strategies that can be used to reduce the amount of forest favourable to the beetle. Such strategies include reducing tree density; establishing a mix of species, age classes and sizes within an area; and harvesting pine trees as soon as they become mature.

While the focus of this report has been on the mountain pine beetle, a major factor in the epidemic, as mentioned earlier, is the presence of large amounts of mature lodgepole pine in an ecosystem where fires historically have replaced stands and reduced the amount of old forest. Experiences in the United States such as the 1988 Yellowstone Park fire, and BC's own fires in 2003 have highlighted the risks of attempting to restrict the role of forest disturbance, specifically natural fires. Perhaps the longer-term challenge facing forest managers is to "...assure that the effects of fire (as an ecosystem process) are replicated in ecosystems in a way that is socially and environmentally successful." (Schmidt 1996). Prescribed fire and other forest management treatments can be employed to restore a semblance of the natural fire process (Arno 1996).

Ongoing research into alternative wood products that could be made from beetle-killed timber, marketing considerations, and maximizing value recovery may affect the ability to utilize beetle-killed wood and thereby reduce timber supply and economic consequences relative to those projected in the analyses discussed here.

While the focus over the next several years will be to minimize the spread and maximize the utilization of beetle-killed timber, over the longer term the challenge will likely be determining how to ensure that management actions are designed with consideration to mountain pine beetle dynamics so that risks of future epidemics are reduced.



Mountain Pine Beetle galleries with larva visible. Photo by Robert Hodgkinson, BC Forest Service

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Web sites

Ministry of Forests bark beetle web site:

www.for.gov.bc.ca/hfp/bark_beetles

Mountain Pine Beetle COFI Task Force web site:

www.mountainpinebeetle.com

Natural Resources Canada. Mountain Pine Beetle Initiative:

http://mpb.cfs.nrcan.gc.ca/research/approved_e.html

Appendix

Different Approaches for Modeling the Mountain Pine Beetle Infestation

Concentrated *versus* dispersed attack

The impacts of a mountain pine beetle infestation on a stand can be modeled to reflect two different patterns of infestation and harvest:

- the attack is concentrated and harvesting activities are targeted to only infested timber (see figure 1).
- the attack is dispersed within a stand, and both non-infested and infested timber are harvested (figure 2).

If the attack is concentrated, the stand can be divided into an attacked area and a live area, and each portion effectively treated as a separate stand in the timber supply model. If for example, the infestation level is 50 percent, then the approach that best represents the concentrated attack would be to "kill" all the volume from 50 percent of the area occupied by susceptible stands. The killed volume would be available to contribute to harvests until it deteriorates (i.e., for the "shelf life"). This method can be termed an "area" approach to modeling the infestation. The area approach was used in the analysis of the 12 units.

Alternatively, if the attack is dispersed more or less evenly through a stand, the dynamics of the infestation are better represented by assuming that 50 percent of the volume from all susceptible stands is killed. This can be called a "volume" approach to modeling the infestation. The volume approach was used in the analysis of the Quesnel TSA.

For a given harvest level, more killed timber will be harvested under the area approach than the

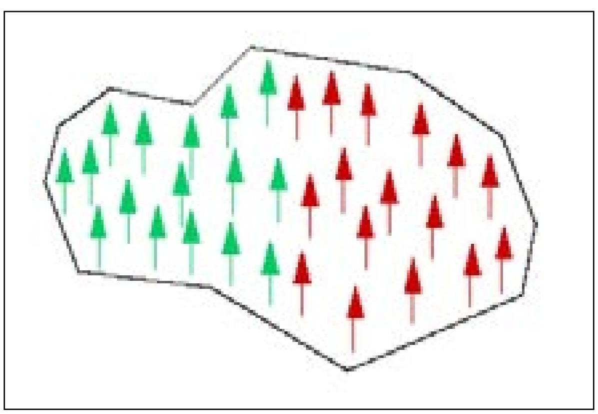


Figure 1. Concentrated attack

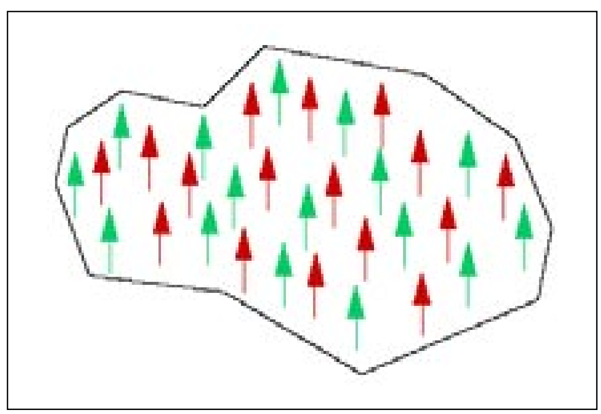
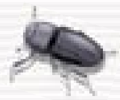


Figure 2. Dispersed attack

volume approach since the volume approach assumes that part of the harvest comes from non-attacked timber. Alternatively, the overall harvest would have to be higher under a volume approach than with an area approach to ensure the same volume of killed timber is harvested.

Either the area or the volume approach could be used to model both types of situations. However, the area approach is more directly and simply applicable to concentrated attack and harvests, while the volume approach is more applicable to dispersed attack and harvesting that includes some unattacked timber.

Neither approach is universally right or wrong. The most appropriate approach depends on the nature of the infestation and the associated management strategies, most notably, how much non-attacked timber is harvested along with the beetle-killed timber.



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