

Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak:

Update of the infestation projection based on the
2009 Provincial Aerial Overview of Forest Health
and the BCMPB model (year 7)

by:

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1 Introduction

For each of the past six years, a team led by the BC Ministry of Forests and Range, Research and Knowledge Management Branch has released an update to the provincial-level projection of the current mountain pine beetle outbreak based upon new information produced by the Provincial-Level Mountain Pine Beetle Model (BCMPB)¹. The model uses forest cover maps², the Provincial Aerial Overview of Forest Health³ and information from a stand level mountain pine beetle (MPB) population model⁴ to estimate the current extent of pine mortality, and to project a possible course of the infestation into the future.

A revised estimate of current and potential future impact of the MPB infestation is now complete based on the 2009 Provincial Aerial Overview of Forest Health and the BCMPB model (aka “the model”). This year’s results are slightly different than what was anticipated from last year⁵, and continue to be complicated by an incomplete 2008 overview survey for the Northern Interior Forest Region (NIFR) due to poor weather conditions and contractor availability. However, as in previous years the model results continue to provide insight into how the infestation has progressed and may progress in the future.

It is important to note that the results of the projection of the infestation described in this document do not include any effects of forest management. Only the infestation itself is discussed in this report.

¹ <http://www.for.gov.bc.ca/hre/bcmpb>

² <http://www.for.gov.bc.ca/hts/vri/>

³ <http://www.for.gov.bc.ca/hfp/health/overview>

⁴ <http://cfs.nrcan.gc.ca/subsite/mpb/stand-mpbsim>

⁵ <http://www.for.gov.bc.ca/hre/bcmpb/BCMPB.v6.BeetleProjection.Update.pdf>

2 Model Background and Factors Affecting the Current Results

The Provincial-Level Mountain Pine Beetle Model (BCMPB) is a discrete probability transition model that runs on an annual time-step. The probability that a location will be in a given state (No Beetle, Endemic, Low, Moderate, Severe or Very Severe) depends on the beetle state at that location in the previous year, the estimate of the cumulative amount killed by beetles at that location in previous years of the outbreak, the age, percentage of pine, and climatic conditions of the stand, and the amount of beetle pressure from nearby infestations.

The successive years of data collected through the Provincial Aerial Overview of Forest Health (aerial overview) since 1999 are pivotal to BCMPB. Specifically, the aerial overview influences the beetle state at a location in the previous year, the cumulative amount killed by beetles at a location in all previous years, and the amount of beetle pressure from nearby infestations.

As a result, BCMPB output is highly sensitive to variations in aerial overview survey techniques and timing. Although BCMPB attempts to compensate for some inter-year variations due to inconsistencies in aerial overview mapping (see Year 3 model documentation⁶), it cannot compensate for all inconsistencies. In particular, BCMPB cannot smooth out sudden increases or decreases when they occur in the most recent year of the aerial overview. It is only in the subsequent year when new data shows these sudden changes to be “bumps” or “troughs” can the model, in certain situations, smooth them.

Usually the inter-year inconsistencies are fairly minor. In the 2008 aerial overview, however, the inconsistencies were substantial. These were in part due to weather conditions and contractor availability that resulted in completion of the 2008 aerial overview survey for portions of the Northern Interior Forest Region (NIFR) much later than is optimal⁷. The forest management units most negatively affected were Lakes, Mackenzie and Dawson Creek Timber Supply Areas, and the Vanderhoof, Fort St. James and Prince George Forest Districts (Figure 1).

As a result, the Lakes, Mackenzie and Dawson Creek Timber Supply Areas and the Vanderhoof, Fort St. James and Prince George Forest Districts all showed a drop in overall infestation levels in 2008 according the aerial overview surveys. Due to the model’s ability to smooth bumps and troughs, the addition of the 2009 aerial overview survey has resulted in an increase in estimated 2008 observed annual mortality in all of the management units improperly surveyed in 2008. However, even with the model’s ability to smooth sudden increases or decreases in infestation severity, the model cannot fully correct all inconsistencies. As a result, the impact of missed or inconsistent aerial overview surveys on the annual and cumulative pine mortality will never be fully known.

⁶ <http://www.for.gov.bc.ca/hre/bcmpb/BCMPB.v3.ModelDocumentation.Update.pdf>

⁷ The optimal period for aerial surveys of mountain pine beetles is listed in Table 1 of http://ilmbwww.gov.bc.ca/risc/pubs/teveg/foresthealth/aerial-04.htm#p162_17805

For this and other reasons, it is imperative to collect accurate estimates of cumulative pine loss due to MPB within those management units nearing the end of their infestation (e.g. 100 Mile House, Lakes, Prince George, Quesnel, Vanderhoof) using either field sampling or aerial photograph interpretation techniques.

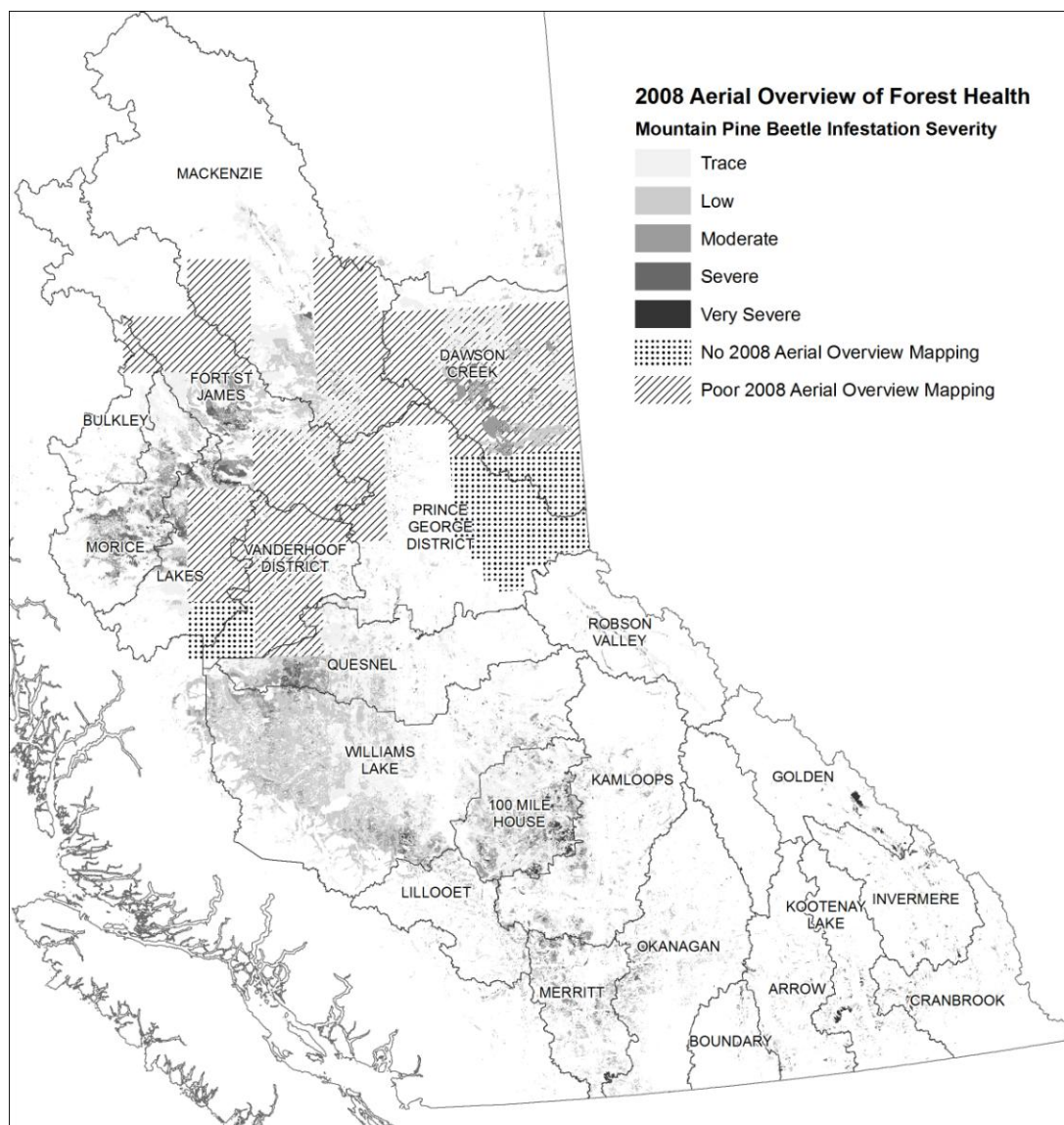


Figure 1. 2008 mountain pine beetle infestation severity as mapped by the Provincial Aerial Overview Survey of Forest Health. Note areas which received no or inconsistent (poor) aerial overview surveys.

3 Summary of Results

3.1 Annual Mortality

3.1.1 Observed Annual Mortality

As reported in last year's BCMPB update report, it is estimated that the provincial peak in annual kill of pine volume for this outbreak occurred during the summer of

2004 and was observed by the Provincial Aerial Overview of Forest Health during the summer of 2005⁸. At the peak, there was an annual mortality of approximately 141 million m³ of mature (>60 years old) merchantable (>12.5 cm dbh) pine on the Timber Harvesting Land Base (THLB)⁹. It is now estimated that approximately 45 million m³ of mature merchantable pine on the THLB were observed killed (red-attack phase) during the summer of 2009 (green-attack phase during the summer of 2008) (Figure 2).

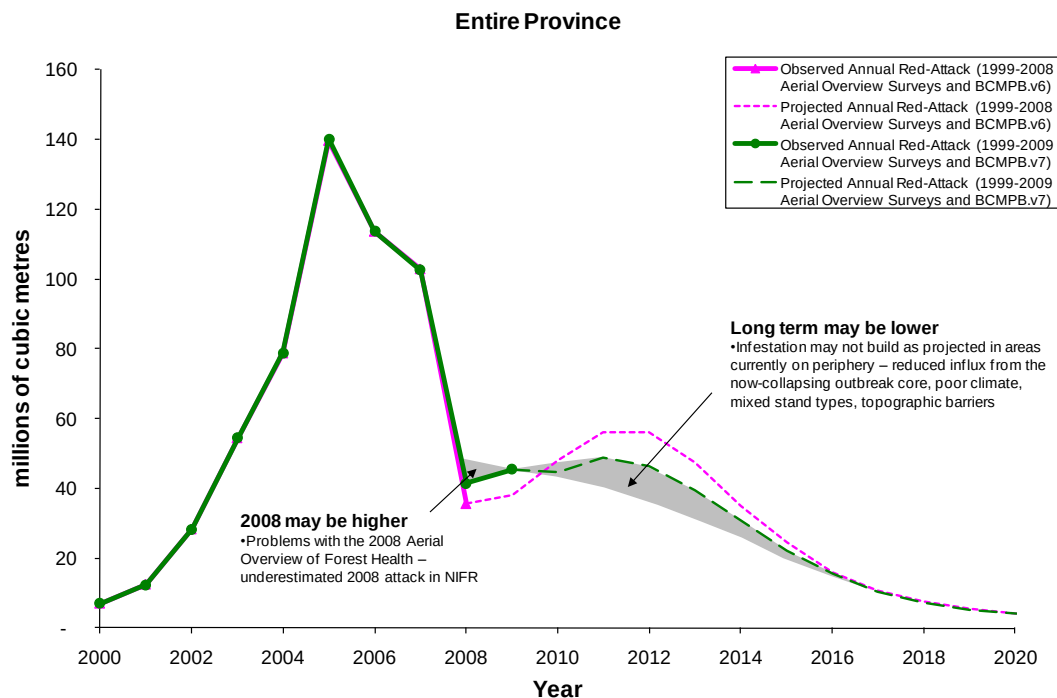


Figure 2. Observed and projected annual mature pine volume killed (red-attack) on the Timber Harvesting Land Base of the entire province. Also a comparison between results produced last year, which were based on the 1999 to 2008 aerial overviews, and current results, which include the 2009 aerial overview. The grey area highlights the uncertainty surrounding the long term estimates of volume loss. The long term estimates may be lower if the beetle does not proceed as projected within those management units at the periphery of the current infestation that have large volumes of pine, but may not be suitable for mass infestation either due to marginal climate, mixed forest types or topographic barriers to dispersal.

In last year's BCMPB update report it was estimated that 36 to 43 million m³ of mature merchantable pine on the THLB were observed killed¹⁰. With the inclusion of the 2009 aerial overview survey, the estimate of 2008 observed red-attack has

⁸ Note that the mortality caused by MPB (green-attack) occurs in the year prior to that in which it is observed by the Provincial Aerial Overview of Forest Health (observed as red-attack). The model (BCMPB) results and projections are based on the Provincial Aerial Overview of Forest Health, and therefore "observed mortality" is presented in graphs and tables unless otherwise specifically noted.

⁹ All volume figures reported are for the Timber Harvesting Land Base only.

¹⁰ 36 million m³ of pine killed in 2008 on the THLB is what last year's BCMPB model was reporting given the 2008 aerial overview. However, the amount killed was estimated to be approximately 7 million m³ higher if some compensation was made for inconsistencies in mapping the 2008 aerial overview within Lakes, Mackenzie and Dawson Creek Timber Supply Areas, and Vanderhoof, Fort St. James and Prince George Forest Districts.

risen to 41 million m³ as a result of the model's ability to smooth out certain rapid increases or decreases in red-attack severity.

This is the first time in four years that the volume of observed mature red-attack pine on the THLB has increased. However, it remains difficult to determine if the increase is real or remains an artifact of the problems with the 2008 Aerial Overview Survey of Forest Health. As stated earlier, the BCMPB model is able to smooth out certain sudden increases or decreases in infestation severity, however, the model is not able to adjust all possible inconsistencies. For example, it is entirely possible that the rapid drop in 2008 observed red-attack in Mackenzie TSA remains a result of the inconsistencies in the 2008 aerial overview survey. If this is the case, the volume of red-attack pine in 2008 may be up to 9 million m³ higher than currently estimated for 2008, which would mean that the provincial volume of merchantable red-attack pine may have actually continued to drop since 2005.

3.1.1.1 *"Pine Unit" Variation*

The 22 "pine units"¹¹ can roughly be divided into four categories based on their relative changes in mature pine volume in red-attack phase since the 2008: 1) large relative decrease (>30% drop), 2) small relative decrease (30%-11% drop), 3) essentially unchanged (+/- 10%), and 4) relative increase (>10% increase) (Figure 3). In general, the "heart of the outbreak" (comprised of Lakes TSA, west Quesnel TSA and Vanderhoof Forest District) and most adjacent units (Morice TSA, Prince George Forest District, Williams Lake TSA, 100 Mile House TSA, and Kamloops TSA) are still experiencing descending rates of pine mortality, although the current infestation has almost finished in these areas (excluding Lakes and Kamloops TSAs).

Interestingly, Vanderhoof shows only a minor decrease in red-attack. Although this may be a result of the current infestation ending in Vanderhoof, the relative decrease may have been larger if the aerial overview survey had been completed adequately in Vanderhoof in 2008. Similarly, Fort St James Forest District and Dawson Creek TSA both seem to have stable amounts of red-attack between 2008 and 2009. However, both of these units may, in fact, have experienced minor decreases in red-attack between 2008 and 2009 if the aerial over survey had been completed correctly in these units in 2008.

Mackenzie TSA experienced the only substantial increase in red-attack between 2008 and 2009. Although an increase most likely did occur, the amount of relative increase, which was more than 500% according to the BCMPB results, is most likely an artifact of the underestimation of the amount of red-attack in 2008 due to the incomplete aerial overview survey conducted in Mackenzie in 2008.

¹¹ Pine units are defined as those Timber Supply Areas (TSA) where more than 10% of the merchantable volume is pine. Note that the individual forest districts in the Prince George TSA are reported on separately.

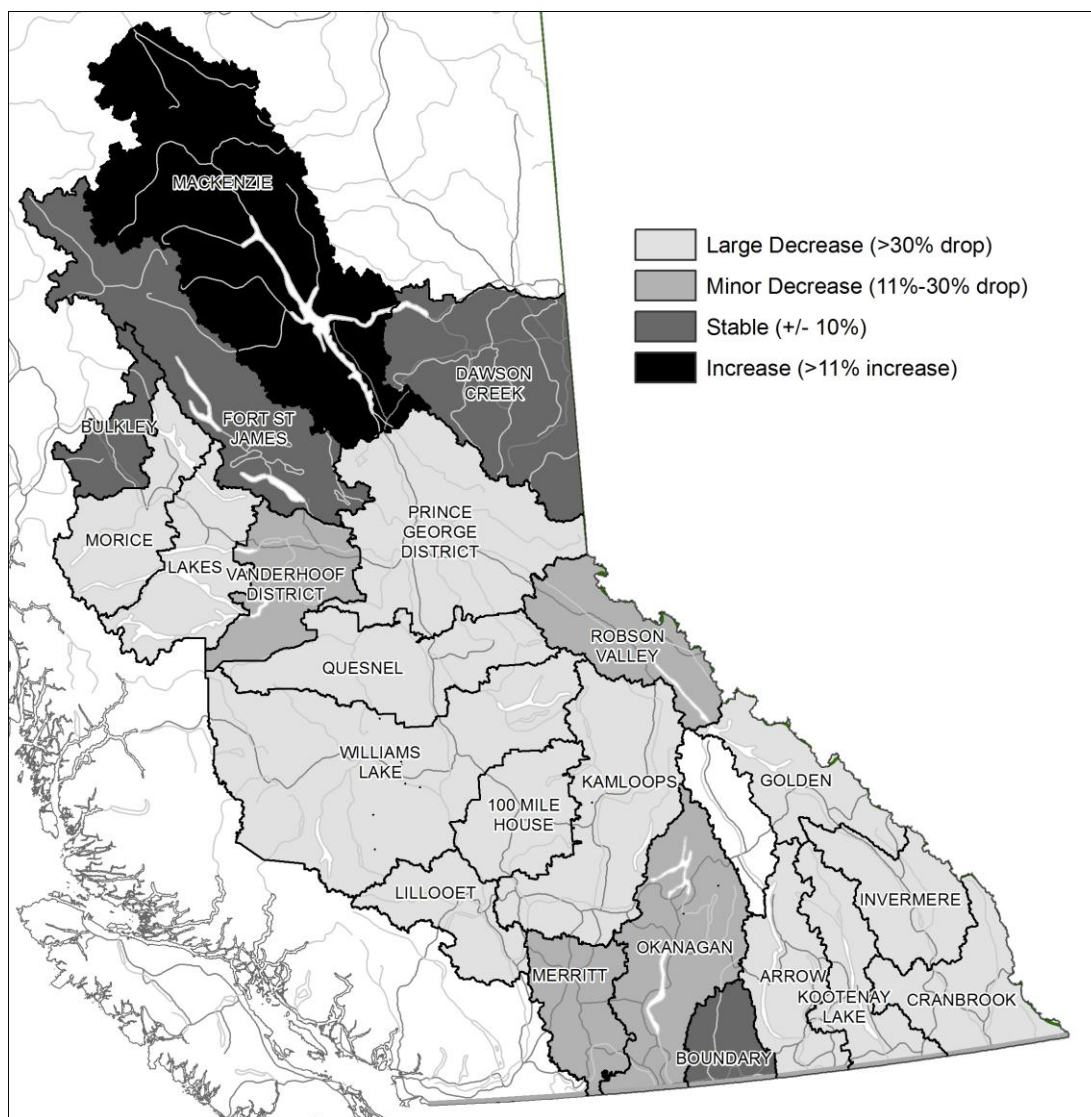


Figure 3. Relative changes in observed red-attack volume from 2008 to 2009 for the 22 pine units.

The pine units in the south east of the province have, for the most part, experienced decreases in observed red-attack between 2008 and 2009. This is in marked contrast to the changes between 2007 and 2008, where most of these management units experienced increases in red-attack. Although these management units have been experiencing relatively large, and sometimes alternating, year to year changes over the past three years, these management units have for the most part been experiencing either a decreasing (Golden, Arrow, Okanagan) or stable (Boundary Kootenay Lake, Cranbrook, Invermere) amount of red-attack when averaged over this time period.

Similar to what was reported in last year's BCMPB update report, Table 1 shows that there were 4 "pine units" where the peak in annual volume of mature pine killed (red-attack) probably occurred in 2005 (green-attack in 2004): Vanderhoof Forest District, Quesnel, Lakes and Prince George Forest District. The peak in annual red-attack probably occurred in the summer of 2006 in Williams Lake, 100 Mile House and Kamloops, and the summer 2007 in Fort St. James, Morice and Lillooet.

Mackenzie most likely experienced peak annual red-attack during the past summer of 2009. The remaining pine units, near the periphery of the current outbreak, are projected to peak in red-attack between 2010 and 2014.

Table 1. Observed (2005 – 2009) and projected (2010 – 2014) annual volume (in millions m³) of mature merchantable red-attack pine for the THLB portion of the 22 “pine units” (peak year of kill is highlighted by an outlined box). Note that the mortality caused by MPB (green-attack) occurs in the year prior to that in which it is observed by the Provincial Aerial Overview of Forest Health (observed as red-attack).

	Year									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Pine Unit	Observed					Projected				
Vanderhoof District	24.8	7.1	3.9	0.3	0.2	0.1	0.0	0.0	0.0	0.0
Quesnel	23.7	11.9	5.1	0.9	2.0	1.2	0.9	0.7	0.6	0.6
Lakes	15.0	9.8	6.4	1.8	0.7	0.3	0.2	0.1	0.1	0.1
Prince George District	12.7	8.2	8.0	0.4	0.2	0.2	0.2	0.2	0.2	0.3
Williams Lake	19.3	20.5	17.8	4.8	2.0	1.2	0.9	0.7	0.6	0.6
100 Mile House	8.6	17.9	7.6	1.9	0.1	0.0	0.1	0.1	0.1	0.1
Kamloops	6.1	8.9	6.9	2.1	0.4	0.5	0.7	1.0	1.2	1.3
Ft St James District	10.7	8.9	14.9	5.1	4.8	5.1	5.7	5.2	4.0	2.6
Morice	3.7	6.3	7.1	6.5	2.1	1.9	2.1	1.7	1.2	0.8
Lillooet	0.4	0.9	1.3	1.1	0.7	1.0	1.3	1.3	1.2	0.9
Mackenzie	0.6	2.1	5.1	3.5	21.4	16.8	13.4	8.4	4.9	2.7
Robson Valley	0.1	0.2	0.3	0.4	0.3	0.4	0.4	0.4	0.3	0.2
Merritt	1.2	2.4	3.8	3.7	3.3	3.7	3.9	3.5	2.9	2.1
Dawson Creek	0.0	0.1	2.7	1.5	1.6	2.9	3.6	3.5	2.5	1.6
Bulkley	0.1	0.1	0.2	0.4	0.5	1.0	1.7	1.9	1.5	0.9
Arrow	0.5	0.6	0.2	0.2	0.1	0.2	0.4	0.6	0.6	0.5
Okanagan	1.0	1.3	1.7	1.6	1.2	1.9	3.1	3.9	3.9	3.6
Boundary	0.1	0.2	0.1	0.1	0.1	0.2	0.7	1.3	1.8	1.7
Kootenay Lake	0.3	0.4	0.3	0.5	0.2	0.3	0.5	0.8	0.9	0.9
Invermere	0.2	0.3	0.2	0.3	0.2	0.3	0.6	0.8	0.8	0.7
Cranbrook	0.5	0.5	0.3	0.6	0.3	0.4	0.9	1.6	2.2	2.3
Golden	0.2	0.3	0.1	0.1	0.0	0.1	0.1	0.3	0.3	0.4
Pine Unit Total	130.2	108.9	94.0	37.8	42.5	39.7	41.4	38.0	32.0	24.9
Provincial Total	140.2	113.6	102.6	41.4	45.4	44.6	48.7	46.3	39.3	30.8

3.1.2 Projected Annual Mortality

It is now projected that in general the annual volume of mature merchantable red-attack pine on the THLB will remain stable until 2012 if: 1) the MPB continues to kill significant volumes of pine in both Mackenzie and Merritt, and 2) the infestation increases as projected in the periphery units such as Dawson Creek and Okanagan. After 2012, the infestation is projected to subside rapidly, and within 8 years it is estimated that less than 5 million m³ will be killed annually.

There is substantial uncertainty surrounding the rate of progress of the provincial annual kill (see Figure 2). This uncertainty arises, in part, from the uncertainty around when and how intensely the infestation will peak in areas on the periphery of the current outbreak, and the degree to which these areas are driven by influx from the now-collapsing core of the outbreak. Although BCMPB projections include a “dispersal pressure” component to capture some effect of beetle movement between regions, the true extent and importance of dispersal remains unknown, and BCMPB

projections do not completely replicate the observed spatial structure in the infestation data. Outbreaks in peripheral management units may either subside faster than expected, or not experience the projected peak annual mortality projected by BCMPB. This is in part due to uncertainty about the role of dispersal from central regions¹², effects of weather, topography, the mix of tree species and ages within the peripheral management units, and further complicated by the lack of standard aerial overview surveys conducted in the Northern Interior Forest Region in 2008.

In particular, there are four pine units on the periphery of the current outbreak with significant amounts of live pine (i.e. Mackenzie, Merritt, Okanagan, and Dawson Creek). The timing and intensity of the outbreak in these areas will influence the provincial rate of infestation over the next few years (Figure 4). It is possible that these periphery units will either decrease in annual mortality quicker than projected or not experience their projected peak annual mortality, and as a result the provincial projection of annual mortality may subside sooner than currently projected to less than 5 million m³ killed annually.

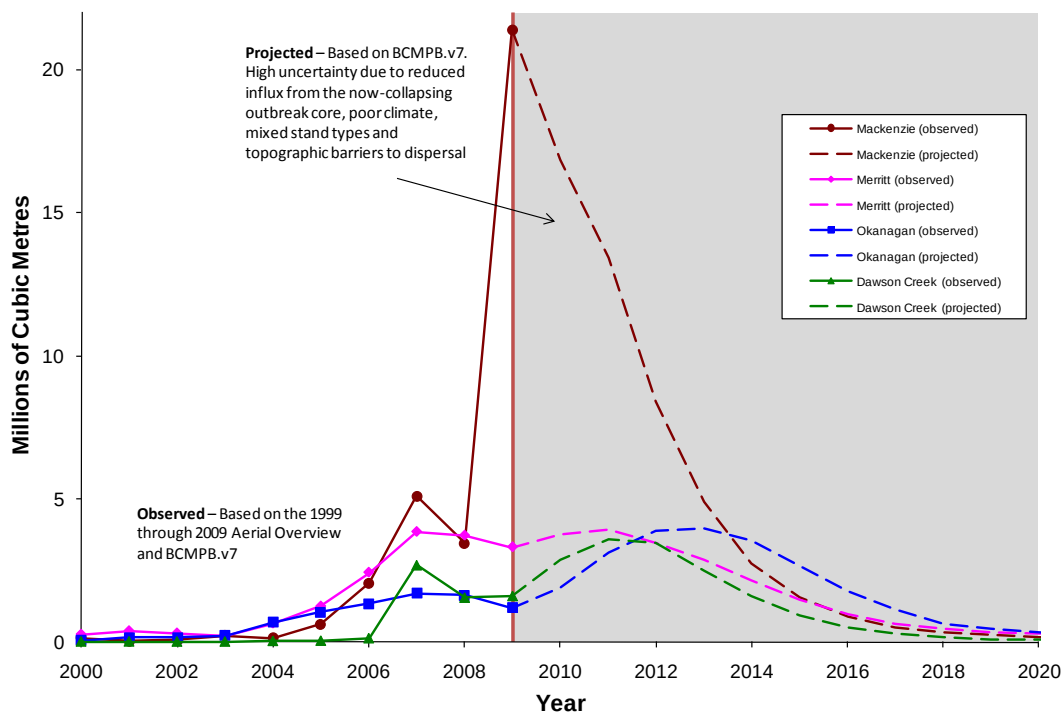


Figure 4. Observed and projected annual volume of mature merchantable pine killed (red-attack) on the Timber Harvesting Land Base for Mackenzie, Merritt, Okanagan, and Dawson Creek Timber Supply Areas. The infestation may not proceed as projected within those units at the periphery of the current infestation. Note the drop in volume killed in 2008 in Mackenzie and Dawson Creek, which is an artifact of the improper aerial overview surveys conducted in these areas in 2008.

¹² Recent detailed MPB population studies in Dawson Creek TSA and west-central Alberta show that external immigration is a key driver of population dynamics in these regions.

Other management units near the periphery of the current outbreak have the same uncertainty on future infestation levels, but these units contain less pine and, therefore, will have less impact on the provincial rate of infestation subsidence.

3.1.3 Changes in 2009 Annual Mortality

It is now estimated that approximately 45 million m³ of mature merchantable pine on the THLB was observed as red-attack during the summer of 2009. This is higher than what was projected last year by BCMPB.v6 (see Figure 2), which projected that approximately 38 million m³ of merchantable pine on the THLB would be observed killed during the summer of 2009.

Lower than anticipated 2009 red-attack was observed in most of the pine units. The units that experienced either higher (Mackenzie TSA, Vanderhoof, Lakes, Ft St James) or marginally lower (Prince George and Dawson Creek) than anticipated amounts of red-attack on the THLB were those units that received incomplete 2008 aerial overview surveys of forest health.

3.2 Cumulative Impact

3.2.1 Observed Cumulative Mortality

It is now estimated that the provincial cumulative volume of mature merchantable pine mortality (red- and grey-attack) from 1999 to 2009 is approximately 630 million m³. This represents approximately 47% of the total provincial mature merchantable pine volume on the THLB at the start of the current outbreak (1.35 billion m³ in year 1999). The majority of that mortality (584 million m³) has occurred in the “pine units” and represents 50% of the mature merchantable pine volume in those units (Table 2).

It is interesting to note that since the start of the current MPB infestation outbreak in 1999 there has been approximately 224 million m³ of mature pine harvested in the province. Of this, an estimated 100 million m³ were in the red- or grey-attack phase according to BCMPB model output. The remaining 124 million m³ of logged mature pine were either live pine or attacked pine that were unsurveyed by the aerial overview. This brings the total mature pine either killed by MPB or logged to approximately 754 million m³, which is approximately 56% of the mature harvestable pine on the THLB at the start of the current MPB infestation outbreak in 1999.

Similarly for the “pine units”, since the start of the current MPB infestation outbreak there has been approximately 207 million m³ of mature pine harvested. Of this, an estimated 93 million m³ were in the red- or grey-attack phase according to BCMPB model output. The remaining 114 million m³ of logged mature pine were either live pine or attacked pine that were not surveyed by the aerial overview. This brings the total mature pine either killed by MPB or logged to approximately 698 million m³, which is approximately 59% of the mature harvestable pine on the THLB in the “pine units” at the start of the current MPB infestation outbreak in 1999.

3.2.2 Projected Cumulative Mortality

Provincially, it is projected that 65% of the total merchantable pine volume on the THLB at the start of the current outbreak will be killed by 2016 if the infestation continues to behave as projected by the model (Table 2). The infestation will have largely subsided by that time and only an additional 2% may be killed by 2020.

Table 2. Cumulative volume (millions of m³) and percentage of mature pine on the THLB in 1999 projected to be killed (red- and grey-attack) in each “pine unit” during selected years.

Pine Unit	Year			
	2009	2010	2016	2020
Quesnel	89.7 (81%)	89.7 (81%)	89.9 (81%)	90.0 (81%)
Lakes	53.1 (75%)	53.4 (75%)	53.9 (76%)	54.1 (76%)
Vanderhoof District	70.8 (73%)	70.9 (73%)	71.1 (73%)	71.2 (73%)
100 Mile House	41.7 (73%)	41.7 (73%)	42.5 (74%)	43.1 (75%)
Williams Lake	86.6 (60%)	87.8 (61%)	91.6 (64%)	93.2 (65%)
Prince George District	46.8 (60%)	47.0 (60%)	48.5 (62%)	49.2 (63%)
Ft St James District	55.0 (50%)	60.1 (55%)	80.2 (73%)	81.4 (74%)
Morice	28.6 (50%)	30.6 (54%)	37.1 (65%)	37.6 (66%)
Kamloops	28.9 (49%)	29.4 (50%)	35.7 (61%)	37.6 (64%)
Arrow	2.3 (30%)	2.6 (33%)	5.2 (66%)	5.6 (71%)
Mackenzie	33.3 (29%)	50.2 (43%)	82.1 (70%)	83.4 (71%)
Robson Valley	1.7 (27%)	2.1 (34%)	3.6 (58%)	3.8 (62%)
Merritt	16.7 (25%)	20.4 (31%)	35.3 (53%)	37.0 (56%)
Lillooet	4.6 (24%)	5.6 (29%)	11.2 (58%)	12.1 (62%)
Golden	1.0 (21%)	1.1 (22%)	2.8 (55%)	3.1 (62%)
Dawson Creek	6.0 (20%)	8.9 (29%)	21.5 (70%)	22.2 (72%)
Kootenay Lake	2.1 (16%)	2.4 (19%)	7.0 (54%)	8.0 (62%)
Okanagan	8.3 (14%)	10.2 (18%)	29.1 (51%)	31.7 (55%)
Invermere	1.6 (14%)	1.9 (16%)	5.7 (49%)	6.4 (55%)
Bulkley	1.5 (12%)	2.5 (19%)	9.3 (71%)	9.6 (73%)
Cranbrook	3.1 (10%)	3.5 (11%)	14.3 (46%)	17.0 (55%)
Boundary	0.7 (5%)	0.9 (6%)	8.4 (56%)	9.5 (63%)
Pine Units Total	584.3 (50%)	622.9 (53%)	786.0 (67%)	806.8 (69%)
Provincial Total	630.0 (47%)	674.6 (50%)	877.4 (65%)	904.8 (67%)

In the “pine units”, it is projected that 67% of the total merchantable pine volume on the THLB at the start of the current outbreak will be killed by 2016 if the infestation continues to behave as projected by the model (Table 2). By 2020, it is projected that 69% of total merchantable pine volume on the THLB in the pine units will be killed.

There is substantial variability in the cumulative percentage of pine killed in 2008, ranging from 81% in Quesnel to 5% in Boundary. However, it is projected there will be much less variability by the time the infestation subsides (81% to 62% in 2020).

Similar to the projections of future annual mortality, however, there is substantial uncertainty regarding the long-term projections of cumulative pine mortality (Figure 5). Again, this uncertainty arises, in part, from the uncertainty around when and how intensely the infestation will peak in areas on the periphery of the current outbreak,

and the degree to which these areas are driven by influx from the now-collapsing core of the outbreak. Outbreaks in peripheral landscapes with marginal climatic suitability, mixed tree types, and larger topographic barriers may either subside faster than expected, or not experience the projected peak annual mortality projected by BCMPB once the central outbreak subsides.

3.2.3 Changes in Projected Cumulative Mortality

It is now projected that the current MPB infestation will kill approximately 65% of the provincial merchantable pine volume by 2016, and that mortality will then slow substantially and the infestation will essentially be over by 2020 with 67% of the pine volume killed (see Figure 5). In 2006, when this project was in only its 3rd year, it was projected that 80% of the provincial merchantable pine volume may be killed by the time the infestation was over. Last year, it was projected that 69% of the provincial merchantable pine volume may be killed once the infestation was essentially over in 2020.

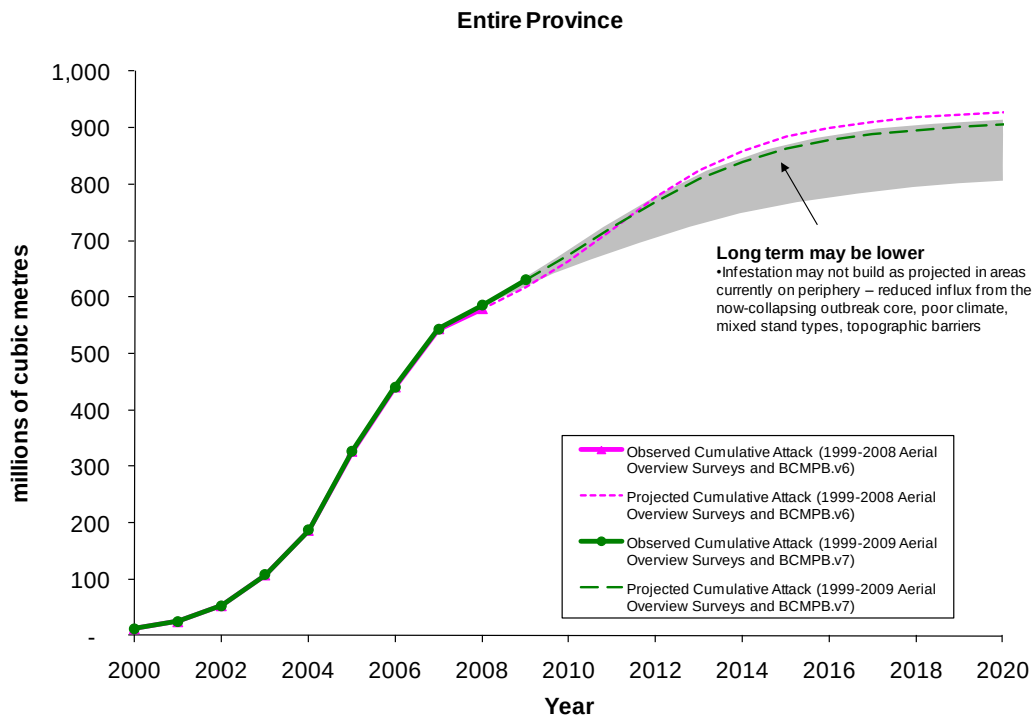


Figure 5. The observed and projected cumulative kill (red- and grey-attack) in the province. The grey area highlights the uncertainty surrounding both the current and long term estimates of volume loss. Also a comparison between results produced last year, which were based on the 1999 to 2008 aerial overviews, and current results, which include the 2009 aerial overview.

This difference (80% projected in Year 3 of the project, to 69% in Year 6, to 67% in current results) highlights the uncertainty surrounding the estimation of cumulative pine volume kill, which arises from a few factors. One is the model's consistent underestimation of how fast the infestation subsides after it has peaked within a management unit, which results in more pine remaining on the landscape than originally projected. Second is the model's consistent overestimation of the amount of pine projected to be killed in the periphery units in the south-east of the province.

Current estimates are that considerably less pine will be killed in these periphery units than initially projected. The third factor affecting the drop in projected kill is the impact of underestimation or overestimation by the Aerial Overview of Forest Health.

It is likely that underestimation or overestimation of the amount of red-attack by the aerial overview surveys has impacted the estimated cumulative percentage of pine volume killed, both provincially and within certain management units. In particular, the provincial estimate of current and future cumulative pine loss has been most likely impacted by the large underestimation of red-attack in the Northern Interior Forest Region aerial overview surveys in 2008.

Although the results of the 2008 aerial overview are exceptional in their underestimation of red-attack, they highlight the impact that underestimation and overestimation of the amount of red-attack by the aerial overview surveys has on projected cumulative pine loss. Consistent over or underestimation of red-attack contributes to considerable uncertainty around the estimates of current and future cumulative pine loss. It is possible that the pine losses estimated by BCMPB will vary significantly from those actually experienced. For example, BCMPB currently estimates that the Prince George Forest District has lost approximately 60% of its mature merchantable pine to the mountain pine beetle. However as reported in the previous BCMPB update report, Ministry staff in the Prince George District estimate the current losses to be between 85% and 90%¹³. This is a significant difference.

As stated earlier, it is for this reason that field sampling or aerial photograph interpretation techniques should be used to collect accurate estimates of cumulative pine loss due to MPB within those management units nearing the end of their infestation (e.g. 100 Mile House, Lakes, Prince George, Quesnel, Vanderhoof).

4 Conclusions and Caveats

The principal conclusions about the infestation are:

- Approximately 630 million m³ (47%) of the merchantable pine volume in the province has likely already been killed (red- and grey-attack), which includes approximately 45 million m³ observed as red-attack in the summer 2009
- The worst year of observed red-attack, at a provincial scale, was 2005.
- The volume of red-attack pine has declined rapidly, at a provincial scale, since 2005.
- The annual volume of red-attack pine is projected to remain mostly constant at around 46 million m³ provincially until 2012 as it moves into those areas on the periphery of the current outbreak that contain significant amounts of pine (Mackenzie, Merritt, Okanagan). However, there is substantial uncertainty around this aspect of the projection, in part due to the inconsistencies in mapping the 2008 aerial overview within Lakes, Mackenzie and Dawson Creek Timber Supply Areas, and Vanderhoof, Fort St. James and Prince George Forest Districts, but also because there still

¹³ John Pousette, pers. comm., April 2009

remains large uncertainty around how the infestation will progress in these periphery landscapes with marginal climatic suitability, mixed tree types, and larger topographic barriers

- After 2012, the infestation will begin to subside rapidly again, and within 8 years it is projected that less than 5 million m³ will be killed annually.
- Approximately 65% of the pine volume in the province will be killed by 2016. The infestation will have largely subsided by that time and only an additional 2% may be killed after 2020. This is significantly less than the 80% mortality projected by Version 3 of the model published in 2006.
- **For those management units nearing the end of their current infestation, field sampling or aerial photograph interpretation techniques should be used to collect accurate estimates of cumulative pine loss due to MPB.**

The main caveats about these conclusions are:

- Current mortality estimates are based entirely on an analysis of the Provincial Aerial Overview of Forest Health. These estimates are essentially unverified. While there is no dispute that the infestation is causing extensive pine mortality provincially, the precise magnitude of the impact is not known. The model undoubtedly both overestimates and underestimates mortality in some areas.
- The results presented assume that the future will resemble the past, and that differences in habitat suitability between regions are captured by factors included in BCMPB. The model produces a projection of what will occur if the infestation continues to progress as it has over the last eight years. It is important to realize that this is not a prediction of what will occur. There is substantial uncertainty about when and how the infestation will subside and eventually end.
- BCMPB does not include past weather effects or try to simulate future weather effects. As a result, the observed annual kill for a given year may vary considerably from the predicted annual kill. This was apparent in the red-attack observed during the summer of 2007 in the Dawson Creek area. In summer 2006, the Dawson Creek pine-unit experienced an unpredicted immigration of mountain pine beetles from the infestation in the central interior. This led to an unpredicted increase in the 2007 observed red-attack. As the outbreak subsides, it may be expected an increased effect of specific weather events on variability in projected outcomes.
- There is now a significant amount of data from central areas where the infestation is subsiding, but there is still minimal information about subsidence in the peripheral areas. The BCMPB model allows some difference between outbreak dynamics in peripheral areas by considering the effect of “long-distance dispersal pressure”, which can reach higher levels in areas with abundant, extensive pine. However, the “dispersal pressure” component may not adequately capture all the differences between central and peripheral areas. In general, it is suspected that many of the differences between projected and observed behaviour arise because the dispersal component of BCMPB does not adequately model the observed spatial structure of the infestation data. BCMPB projections are generally less clumped than observed infestations, causing the model to under-project

intensely infested areas, and over-project light infestations. Adequately understanding and accounting for the infestation's spatial structure is a challenging and rapidly developing area of research. Future modeling effort could likely benefit from insights and analysis techniques currently being developed, but incorporating this research is beyond the scope of the current BCMPB project.

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