Forest Practices Board

Timber Harvesting in Beetle-Affected Areas

Is it meeting government's expectations?

Special Report

FPB/SR/44

March 2014

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Board Commentary

British Columbia is in the midst of a large-scale salvage program, the likes of which has never been seen. There is nothing sustainable about this harvest; this is a one-time activity initiated by the province to recover value from the trees killed by the mountain pine beetle (MPB) epidemic and to speed regeneration of affected areas. Once those trees no longer have any economic value, salvage will stop and the province will need to sustainably manage the harvest of the remaining live trees. The issue, simply put, is that the more live trees that are harvested now, the lower the sustainable harvest level will be after the salvage program is finished.

A 2007 Board report[1] on this issue concluded that the entire increased allowable annual cut (AAC), allocated to managing the effects of the beetle epidemic, had been put to good effect; that is, into harvesting more pine. From 2000 to 2006, the amount of non-pine harvested remained more-or-less the same, while the amount of pine harvested more than doubled.

However, since the 2007 Board report, things have changed. Since 2009, the proportion of pine in the harvest has been decreasing and the proportion of non-pine has been increasing. The Board is concerned that government's projections about the timber supply available after the salvage program ends are based on maintaining a high proportion of pine—more specifically dead pine—in the harvest until then. In discussions with industry foresters, the Board has found general agreement that there is a growing disparity between government's estimate of the amount of salvageable timber and the actual economically viable timber available on the ground.

In light of what appears to be rapidly changing circumstances in areas affected by MPB, it seems prudent for the chief forester to revisit AAC determination in those areas more frequently than has been done in the past and certainly not on the 10-year interval allowed by the recent amendment to the *Forest Act* section 8(1). Decisions can quickly become outdated, particularly as better information about shelf life and the amount of dead pine on the landbase becomes available.

The Board encourages the chief forester to:

- Develop a process of rapid re-evaluation of the AAC in areas where it has been increased to facilitate salvage harvest of dead pine.
- Be consistent in explicitly stating expectations about harvest performance, and, in particular, how performance against those expectations should be measured.

The Board encourages government to:

- Ensure it collects the information needed by the chief forester to measure performance, particularly in areas where there is an expectation that salvage harvesting will continue for the foreseeable future.

[1] Tree Species Harvested In Areas Affected By Mountain Pine Beetles FBP/SR/33.

Executive Summary

Government has told the people of British Columbia that the mountain pine beetle (MPB) epidemic in British Columbia's interior will result in the 'mid-term'[2] timber supply being much lower than was expected prior to the epidemic. Government's projections would be much worse were it not for their expectation that the forest industry will, in the short-term, maximize the harvest of pine trees—in particular, dead pine—and minimize the harvest of non-pine trees, saving those trees for the mid-term.

The Board compared the amount of dead pine and live pine in the harvest against government's general expectation that, "licensees continue to focus harvesting on MPB-impacted pine-leading stands."[3] The Board found that, over the entire MPB affected area, the forest industry has focused its harvesting to meet that general expectation:

- For the last two years, the proportion of dead pine in the harvest has been higher than the proportion reported to be on the landbase. It is difficult to accurately estimate the amount of dead pine in the harvest before that time.
- The proportion of any pine (dead or alive) in the harvest has been greater than the proportion of pine on the landbase since the beginning of the epidemic, around the year 2000.

Notwithstanding these generally positive findings, there are indications that government's specific expectations are not being met in some cases:

- Although the percentage of pine in the harvest increased steadily from 2000 to 2009, it has decreased steadily since then. The Board projects that, if the current trend continues, the percentage of pine in the harvest will be lower than the percentage of pine on the landbase by 2018, which would indicate a loss of focus on meeting government's expectations about the harvest of pine.

  The decrease is likely caused by increasing difficulty in finding economically viable pine stands—stands with high enough volume and close enough to roads and mills. Many of those stands have already been harvested and the quality of the dead pine in the remaining stands is deteriorating rapidly. Therefore, the trend in decreasing pine in the harvest seems likely to continue.

- The Board examined harvest performance against specific expectations, stated at the management unit scale (timber supply area [TSA] or tree farm licence [TFL]) and found that, in some cases, licensees are not meeting those expectations. Notably, the AAC determination for eight management units contain a specified non-pine partition—an expectation about the maximum volume of non-pine species that should be harvested. The first non-pine partitions were established in 2008. In 2009-10,[4] two-thirds of the non-pine partition was harvested. Since then, there has been a consistent year-over-year increase in the proportion harvested. The Board estimates that the non-pine harvest in 2013-14 will be more than 10 percent over the total of the non-pine partitions (9.3 million cubic metres harvested of the total 8.4 million cubic

[2] Typically cited as being 10 to 50 years from now.
[3] Okanagan TSA Allowable Cut Determination, 2012.
[4] Harvest performance is described using government fiscal years (April 1 to March 31) in this report.

metre non-pine partition). There are specific concerns in two of the TSAs where there are non-pine partitions.

- The Prince George TSA has a non-pine partition of 3.5 million cubic metres and just over 100 percent of that partition was harvested during 2011-12 and 2012-13, and the Board estimates that just over 100 percent will be harvested in 2013-14. However, the Prince George TSA also has a specific 'sub-partition' for the maximum volume that should be harvested from spruce-leading stands (875 000 cubic metres). In 2012-13, 125 percent of that partition was harvested and the Board estimates that over 180 percent will be harvested in 2013-14.
- There has been a non-pine partition in place in the Morice TSA since 2008. Almost the entire partition was harvested in 2008-09 and the non-pine harvest has exceeded the partition in each fiscal year since then. In 2012-13, 185 percent of the partition was harvested and the Board estimates that about 200 percent of the partition will be harvested in 2013-14.

The expectations for non-pine harvest were set based on the actual non-pine harvest five to eight years in the past (2006 to 2009). It may be challenging for the forest industry to continue to meet those expectations in the face of the increasing difficulty in finding economically viable pine stands. The non-pine partitions are guidance provided by the chief forester and have no legal effect. The Crown is relying on forest managers to respect the partitions.

The Board notes that government rarely explicitly states how performance against its expectations should be measured and that there are potentially significant problems with the information available to measure performance. This results in considerable, and sometimes unresolved, debate about how to measure performance and about how to interpret the measurements. In this report, the Board has largely relied on the information obtained from government's Harvest Billing System.[5]

[5] http://www.for.gov.bc.ca/hva/hbs/ Government ensures the information is adequate for the primary purposes of timber pricing and billing.

Detailed Report

Introduction

Background

The effects of the mountain pine beetle (MPB) epidemic in British Columbia's interior are expected to have negative implications for timber supply in the period known as the 'mid-term.'[i] Current projections are that, "when beetle-killed pine is no longer salvageable, the province's overall supply of mature timber will be reduced, and 10 to 15 years from now it is forecast to be 20 percent below the pre-infestation levels, a reduction that may last up to 50 years," and that, "in areas with the greatest percentage of pine in the forest, shortages are already being noted and the drop in the harvest levels will likely exceed 20 percent,"[ii] below pre-infestation levels.

These projections are based on various assumptions made by the chief forester during the process of determining the allowable annual cut (AAC). Dire as the projections are, they would be much worse but for, "the assumption that we'll minimize the amount of harvesting of green fibre,"[iii] in the short-term to save this fibre for the mid-term. However, the Board is aware of many anecdotal concerns that the profile of the harvest in MPB-affected areas may not be meeting the assumptions and expectations of government.

The Board reported on aspects of this issue six years ago (November 2007) in a special report titled, *Tree Species Harvested In Areas Affected By Mountain Pine Beetles*.[iv] This report is a follow-up that has a broader geographic scope and examines issues that could not be addressed in 2007 (notably, the amount of dead pine being harvested) and issues that have arisen since 2007 (notably, the application of explicit 'partitions' on the amount of non-pine species that should be harvested).

Objectives

This special report assesses whether the harvest profile in areas affected by the MPB epidemic is consistent with government's expectations. The primary focus is an examination of the amount of live pine harvested, relative to the amount of dead pine and non-pine species, and a comparison of those amounts against expectations, expressed or implied, in the chief forester's determinations for AACs and the public discussion papers that are part of the timber supply review process.[v]

Description of the Beetle-Affected Area

This report focuses on the 28 timber supply areas (TSAs) and tree farm licences (TFLs) identified by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) as, "mountain pine beetle impacted management units,"[vi] hereafter called the 'beetle-affected units.' These units might be better described as 'pine-affected' units, since they were selected by MFLNRO based on having a minimum of 15 percent pine on the timber harvesting landbase in stands with over 150 cubic metres per hectare.

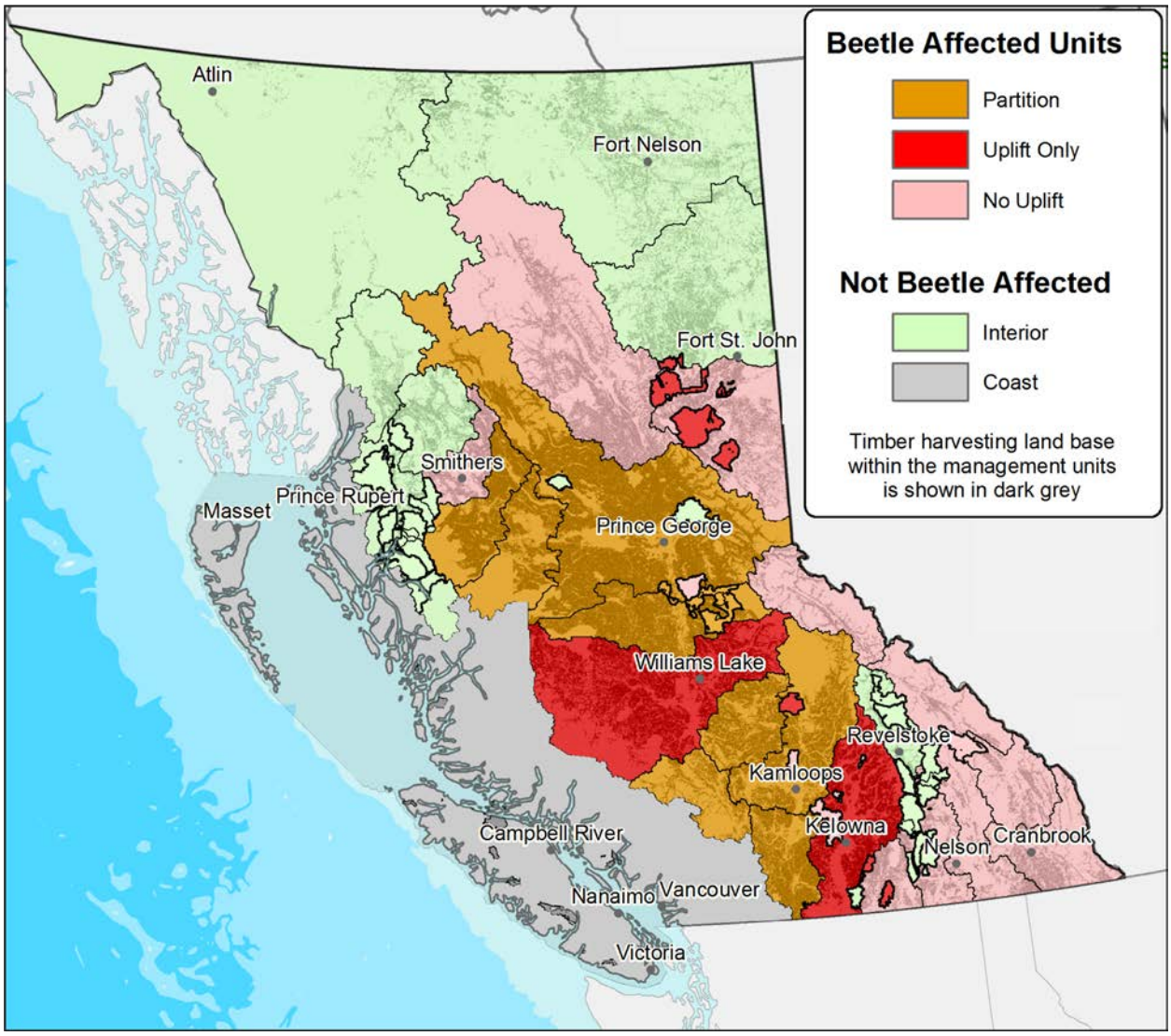

Figure 1. British Columbia's timber supply areas and tree farm licences shown in categories relevant to this special report.

Beetle-affected units cover most of the harvestable forest area in the BC interior. The coast, far north and some management units in the interior wet-belt are not beetle-affected (Figure 1).

In this report, the 28 beetle-affected units are divided into three categories as shown in Figure 2 (see Appendix 1 for details).

Partition

There are nine beetle affected units with relevant partitions[6] to the AAC:

- ***Non-Pine Partition*:** In eight units, the AAC determination specifies a partition for the maximum total volume of non-pine species that should be harvested, "to ensure ongoing sustainability of non-pine species and protection of non-timber values."[vii]
  - In six of those units, the determination also provided an uplift in the AAC; an increase in the AAC to facilitate recovery of value from the dead pine.
- ***Live Tree Partition*:** In the 100 Mile House TSA, the recent determination specifies a maximum volume of live trees that should be harvested.[viii] This unit also has an uplift.

Uplift Only

There are five units where the AAC determination includes an uplift to facilitate recovery of value from the dead pine but not a specified non-pine or live tree partition.

No Uplift No Partition

There are 14 units with neither an uplift, nor a partition.

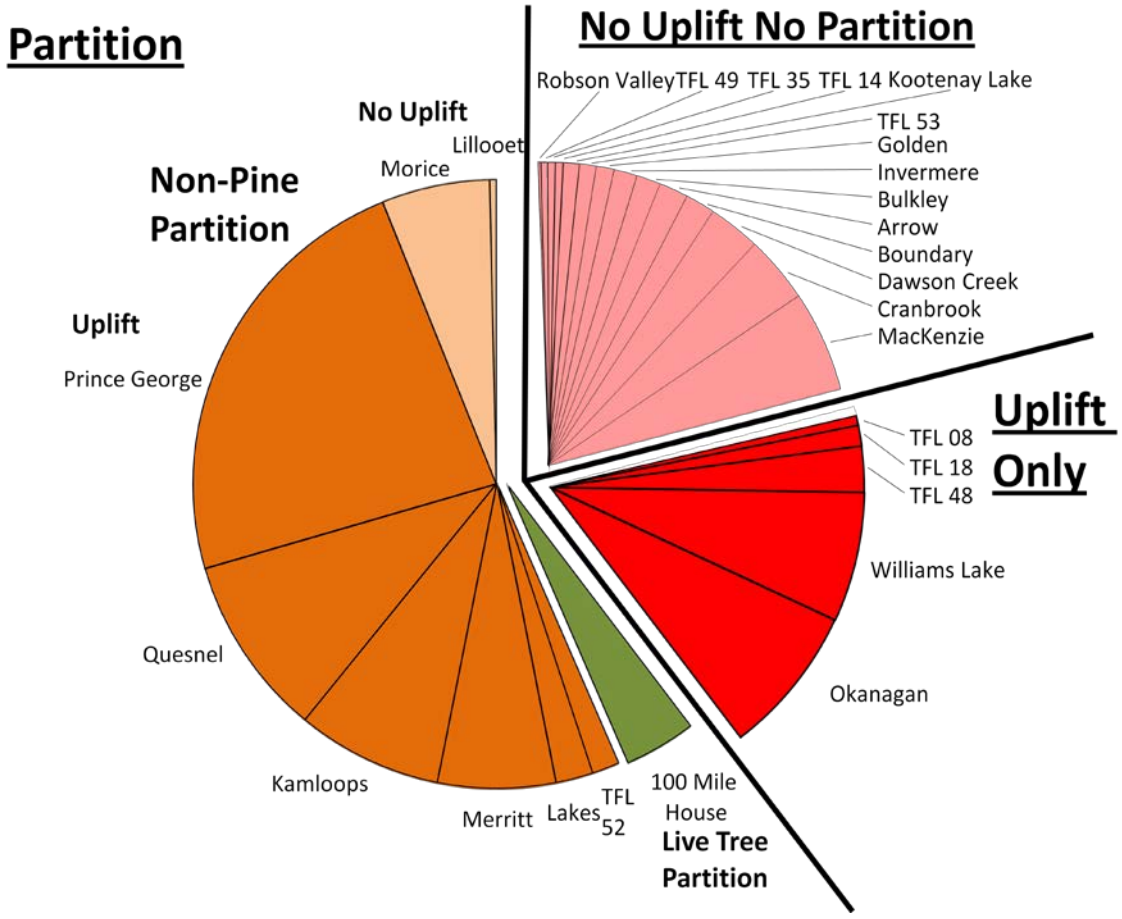

Figure 2. Proportion of the 2012-13 harvest in beetle-affected units by management unit category.

[6] Section 8 (5) of the *Forest Act* enables the chief forester, when determining an AAC, to, "specify that portions of the [AAC] are attributable to . . . . different types of timber or terrain."

In the 2012-13 fiscal year, the total harvest in beetle-affected units was just over 44 million cubic metres (Appendix 2).[7] Well over half of that was harvested in units with a partition (Figure 2).

The remainder of the harvest in beetle-affected units was evenly split among units with an uplift but not a partition, and those with neither an uplift nor a partition (Figure 2).

Harvest in beetle-affected units is dominated by the Prince George TSA, with nearly 25 percent of the total harvest in 2012-13. Fifty-five percent of the total harvest that year occurred in the top five units: Prince George, Quesnel, Kamloops, Okanagan and Williams Lake TSAs (Figure 2, Appendix 2).

Harvest in the beetle-affected units during 2012-13 was 85 percent of the total harvest in the interior (44 of 51 million cubic metres). The other seven million cubic metres was harvested in TSAs and TFLs that were not beetle-affected units (four million) and in community forests and woodlots (three million). The entire interior harvest was about three-quarters of the total provincial harvest (the remainder coming from the coast).

Government's Expectations About Harvest

The chief forester's AAC determinations and associated public discussion papers [ix] contain expectations (either explicit or implied) about the kinds and volumes of trees that should be harvested. The chief forester has expressed the general expectation that, "licensees continue to focus harvesting on MPB-impacted pine-leading stands."[x] In some cases, there are more specific expectations about the proportion of the harvest that should be dead pine. There are also some specific expectations about the proportion of the harvest that should be pine, whether live or dead, and, conversely, the maximum volume of non-pine that should be harvested. The nature of the expectations leads to the three main questions addressed in this report (Table 1).

Table 1. Summary of government's expectations and the resulting questions for this report.

General Expectation	Specific Examples	Question in this Report
Harvest as much dead pine as possible for as long a possible.	In the 100 Mile House TSA: the public discussion paper indicates that 75 percent of the total harvest should be dead pine until 2017.[xi]	How much dead pine is being harvested?
Focus on harvesting pine for as long as possible.	In the Prince George TSA: "the timber supply analysis assumes that 92 percent of the harvest will come from pine-leading stands for as long as possible."[xii]	How much pine is being harvested?
Avoid harvest of non-pine species, to the extent possible, to protect that volume for the mid-term supply.	Eight beetle-affected units have specified 'non-pine partitions' indicating the chief forester's expectation about the total volume of non-pine species that should be harvested (see Appendix 1 for details).	How much of the non-pine partitions is being harvested?

[7] As reported to the MFLNRO Harvest Billing System. In this report the Board reports all harvesting by government fiscal year (April 1 – March 31) primarily to maintain consistency with some other reporting done by the ministry. The fiscal year also provides convenient breaks similar to harvesting seasons.

Measuring Harvest Against Expectations

Government rarely explicitly states how harvest performance should be measured against expectations. However, in two cases, the chief forester's AAC determinations do explicitly state that information in government's Harvest Billing System (HBS) [xiii] should be used to monitor ongoing performance of harvest in the non-pine partitions.[xiv]

The Board used information from HBS throughout this report to estimate the proportion of the harvest that was pine and the absolute volume of the harvest that was non-pine—the non-pine partitions. The Board used HBS data rather than other available sources of information, such as forest cover maps or pre-harvest estimates of the species composition of stands (cruise information[8]), because HBS data is what government uses to develop its harvest expectations (Appendix 4). The AAC determination process, in which the harvest expectations are set, is based on an analysis of current management practices.[xv] Recent[9] actual harvest performance, as identified in HBS, is used as a starting point in that analysis and subsequent analyses examine the implications of meeting (or not meeting) harvest expectations based on that starting point.

Government has also expressed expectations about the proportion of the pine in the harvest that should be dead. With the exception of the most recent AAC determination for the 100 Mile House TSA, there is no indication how these expectations should be measured.[10] The Board used a combination of HBS returns and data obtained from the Electronic Commerce and Appraisal System (ECAS)[xvi] to estimate the amount of dead pine in the harvest. These methods are described more fully in Appendix 3.

There are potentially significant issues in using HBS and ECAS information to measure harvest performance against expectations (see Appendix 4 for details):

- The primary purpose for collecting the information is to calculate stumpage (price) of timber to be harvested (in the case of ECAS), collect revenue and ensure the correct timber volume is being billed accurately and equitably (in the case of HBS). Government ensures the information is adequate for the primary purposes of timber pricing and billing, but neither system is specifically designed to collect information to monitor harvest performance.
- The information used does not represent direct measurements of every tree: all of it is estimates based on various kinds of sample measurements. The estimates contain generally accepted sampling variability.
- Since the beginning of the MPB epidemic there have been significant changes in the timber profile on the landbase, forest harvesting methods and the collection and reporting of information in the system used to measure harvest performance. Most notable are changes in the HBS, which now contains two different kinds of estimates of timber volume.

[8] The systematic measurement of a forested area designed to estimate to a specified degree of accuracy the volume of timber it contains, by evaluating the number and species of trees, their sizes, and conditions. (http://www.for.gov.bc.ca/hfd/library/documents/glossary/Glossary.pdf)

[9] During the period immediately leading up to the closure of the data package used in the analysis, often two years before the determination.

[10] That determination simply states that district staff could monitor the harvest of dead pine using cruise data.

In some cases, the information is an estimate of what was harvested and delivered to mills.[11] In this process all the delivered logs are weighed and the volume and species composition of a sample of those logs are measured. That information is used to estimate the volume and species composition of the logs that were only weighed. [12] Virtually all the information in HBS was this kind of estimate until June 2010, when it became mandatory to use the cruise-based billing process to report harvest in areas severely affected by MPB (more than 35 percent of the cut block is red or grey MPB attacked timber). [xvii] With cruise-based billing, the information reported to HBS is a timber cruise estimate of the volume and species composition of the stand prior to harvest.

In 2012-13, about 44 percent of the volume reported to HBS was a weigh scale estimate of the volume and about 54 percent of the volume was a cruise based estimate of the volume (the remaining two percent was reported as waste). The volume and the tree species composition estimates from these two sources may or may not be comparable depending on the circumstances (see Appendix 4) and this may be important when attempting to measure harvest performance against expectations.

A brief description of the information system and a more detailed discussion of the issues with the information are provided in Appendix 4. The potential implications of these issues on the finding of this report will be discussed, where appropriate, in the remainder of the text.

Given that the situation in beetle-affected units is changing relatively rapidly, the Board thinks that it is important that the most current estimates of harvest performance be made available. For that reason, the Board has, in some cases in this report, estimated harvest performance for the last quarter of government's current fiscal year (January 1, 2014 to March 31, 2014) in order to present results for the entire fiscal year. Fourth quarter estimates for 2013-14 were calculated based on the average, over relevant previous fiscal years, of the ratio between harvest in the fourth quarter and the first three quarters (see Appendix 3 for details of the calculations and Appendix 5 for values used in the projections).

How Much Dead Pine is Being Harvested?

It is difficult to estimate of the amount of dead pine that has been harvested during the entire course of the MPB epidemic, which started around 2000, because there have been changes to the way harvesting has been reported to HBS during that time. Most notably, until April 2006, logs graded 3 or 5 in HBS indicated that the trees were dead when harvested. After 2006, these grades were eliminated and the same logs were primarily reported as grade 4, along with many trees that were alive when harvested. In June 2010, cruise-based billing was introduced, which requires that any cut block with more than 35 percent dead pine be reported to HBS using two billing codes, code 8 for dead and code 7 for alive. The Board used this information, supplemented with some actual cruise data, to estimate the amount of dead pine in the harvest in the recent past.

The Board found that 62 percent of the pine harvested was dead during the two full fiscal years since cruise-based billing became mandatory (2011-12 and 2012-13) (Table 2). MFLNRO estimates that just

[11] or left on site and reported as waste.

[12] This is generally the case, although in some instances all of the delivered logs are measured.

over half the pine on the landbase is dead.[xviii] Combined, these results indicate that over all beetle-affected units there is a substantial focus on harvesting dead pine. There is uncertainty about this conclusion because there is considerable uncertainty about the amount of dead pine on the landbase. The provincial scale estimate, published by MFLNRO, is around half, but there are separate estimates published by MFLNRO for individual management units that are higher[xix] in some cases and lower[xx] in others.

The Board notes that even though 62 percent of the harvested pine was dead, less than 40 percent of the total volume harvested was dead pine because not nearly all of the harvest was pine (Table 2).

The harvest of dead pine shows an expected trend by management unit type (Table 2). The highest proportion of dead pine is in units with a partition and the lowest is in units without an uplift. There is substantial variability among managements in the amount of dead pine being harvested (Appendix 6).

Table 2. Harvested volume of dead pine, all pine and all species (millions of cubic metres) and relevant percentages by management unit type (April 1, 2011 to March, 2013).

Management Unit Type	Volume of Dead Pine	Volume of All Pine	Percent of Pine that is Dead	Total Volume of All Species	Percent of Total Volume that is Dead Pine
Partition	24.3	33.4	73%	51.4	47%
Uplift	6.2	11.3	55%	19.4	32%
No Uplift	3.2	9.3	34%	18.0	18%
All Units	**33.6**	**54.0**	**62%**	**88.8**	**38%**

Three of the public discussion papers, produced by MFLNRO for recent AAC determinations, have presented explicit assumptions about the proportion of dead pine in the harvest in 'Scenario 1' (the base scenario from which sensitivity analyses are conducted). The Board compared these assumptions against the actual harvest (Table 3). For the Quesnel TSA, the harvest was close to the assumptions, but for the Prince George TSA there was somewhat less dead pine being harvested than was assumed in the analysis. In the 100 Mile House TSA, there was a more substantial difference between the assumption in the public discussion paper and the actual harvest (11 percent).

Table 3. Dead pine harvest expectations as specified in public discussion papers compared to actual dead pine harvest (April 1, 2011 to March 31, 2013).

Timber Supply Area	Public Discussion Paper Scenario 1	Actual Harvest
100 Mile House[xxi]	75%	64%
Prince George[xxii]	60%	54%
Quesnel[xxiii]	72%	69%

How Much Pine is Being Harvested?

Detailed information about the trees species composition of the harvest has been recorded consistently in HBS since 1998. The Board used this information to determine how much pine was harvested over the entire course of the outbreak.

In 2001, the chief forester began to increase the AAC to facilitate management of the beetle epidemic (Appendix 1). At that time, there was approximately 2.2 billion cubic metres of wood on the timber harvesting landbase in the beetle-affected units (Table 4).[13] Pine made up less than half that volume.

Since 2001, there have been over 500 million cubic metres of wood harvested, a little less than one-quarter of the total. Sixty percent of that harvest was pine. This indicates an overall focus on pine in the harvest since 2001. Despite this pine focus in the harvest, the percentage of pine on the landbase only dropped from around 46 percent in 2001 to around 41 percent in 2013 (Table 4).

Table 4. Timber volume harvested since 2001 and remaining on the timber harvesting landbase in 2013 by type of tree (in all beetle-affected units).

	Timber Volume (millions of cubic metres)		
Type of Tree	Harvested Since 2001	Remaining on the Landbase in 2013	Total
Pine	330	690	1020
Other Species	200	1000	1200
Total	**530**	**1690**	**2220**

From the beginning of the forest management response to the current epidemic, around the year 2000, until 2005-06 the volume of pine harvested increased more-or-less steadily, while the volume of other species harvested decreased (Figure 3). This occurred during a period of increasing AACs that were initially meant to facilitate efforts to control the epidemic. Beginning in 2004, there were further increases in the AAC in some areas to facilitate salvage of the dead pine (Figure 3). This finding is consistent with the 2007 Board report,[xxiv] which concluded that all of the additional harvest power granted by the increased AACs had been devoted to managing the epidemic.

From 2006-07 to 2009-10, there was a dramatic decrease in the volume harvested, but it increased again in 2010-11 and has remained relatively constant for the last three years. Because of these changes, it is not clear from Figure 3 whether the focus on government's expectations for the pine harvest has been maintained since 2006-07.

[13] Volume on the landbase is based on data from *Monitoring Harvest Activity Across 28 Mountain Pine Beetle Impacted Management Units*; MFLNRO 2013; http://www.for.gov.bc.ca/hts/pubs/MPB_Monitoring_Harvest_2013.pdf. Harvested volumes are the sum of volumes reported to the Harvest Billing System.

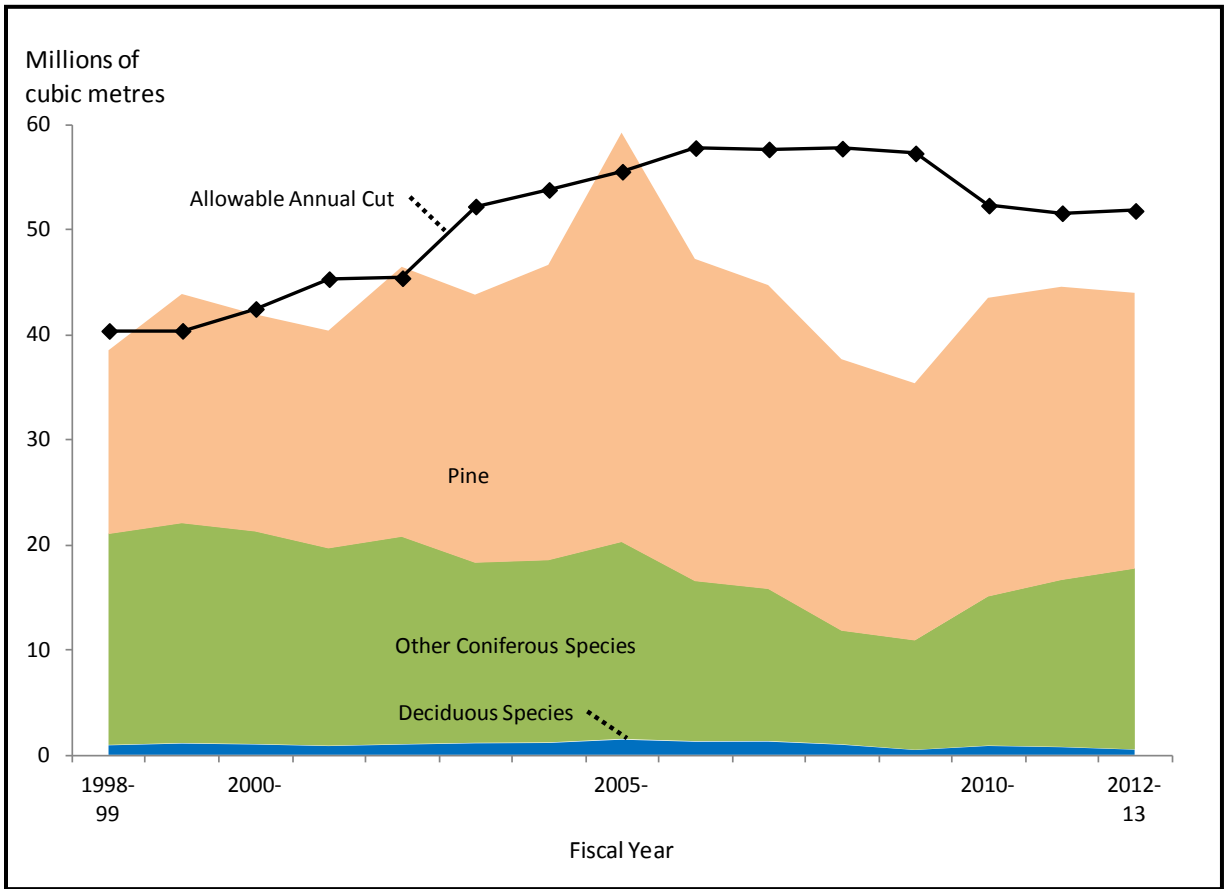

Figure 3. Volume harvested by species type and fiscal year (compared to the allowable annual cut).

What is clear from Figure 3 is that, over the last seven years, there has been a substantial gap between the AAC and the volume harvested, with a total of 23 percent of the AAC not harvested. In the last three fiscal years, the harvest has increased but there is still a 15 percent gap between the AAC and the harvest. Up to 2009-10, the gap between the AAC and the harvest is largely explained by the dramatic decline in housing starts in the United States (beginning in 2006), which resulted in decreased demand for dimensional wood products (e.g., 2X4s and 2X6s). Global markets for wood products began to open up and improve in 2010-11, and the increased demand resulted in increased harvest levels, which have remained reasonably steady at 15 percent below the AAC. The recent gap between the harvest and the AAC is largely due to volumes apportioned to non-replaceable forest licences (NRFL) for which there has either been no commitments (i.e., no licence agreements have been signed) or for which commitments have been made but there has been little or no harvesting. In most cases, these NRFLs were intended to facilitate the harvest of dead pine, much of it for bioenergy, and secondarily for sawn wood products. Log markets did not support the harvesting on many NRFLs (until recently).

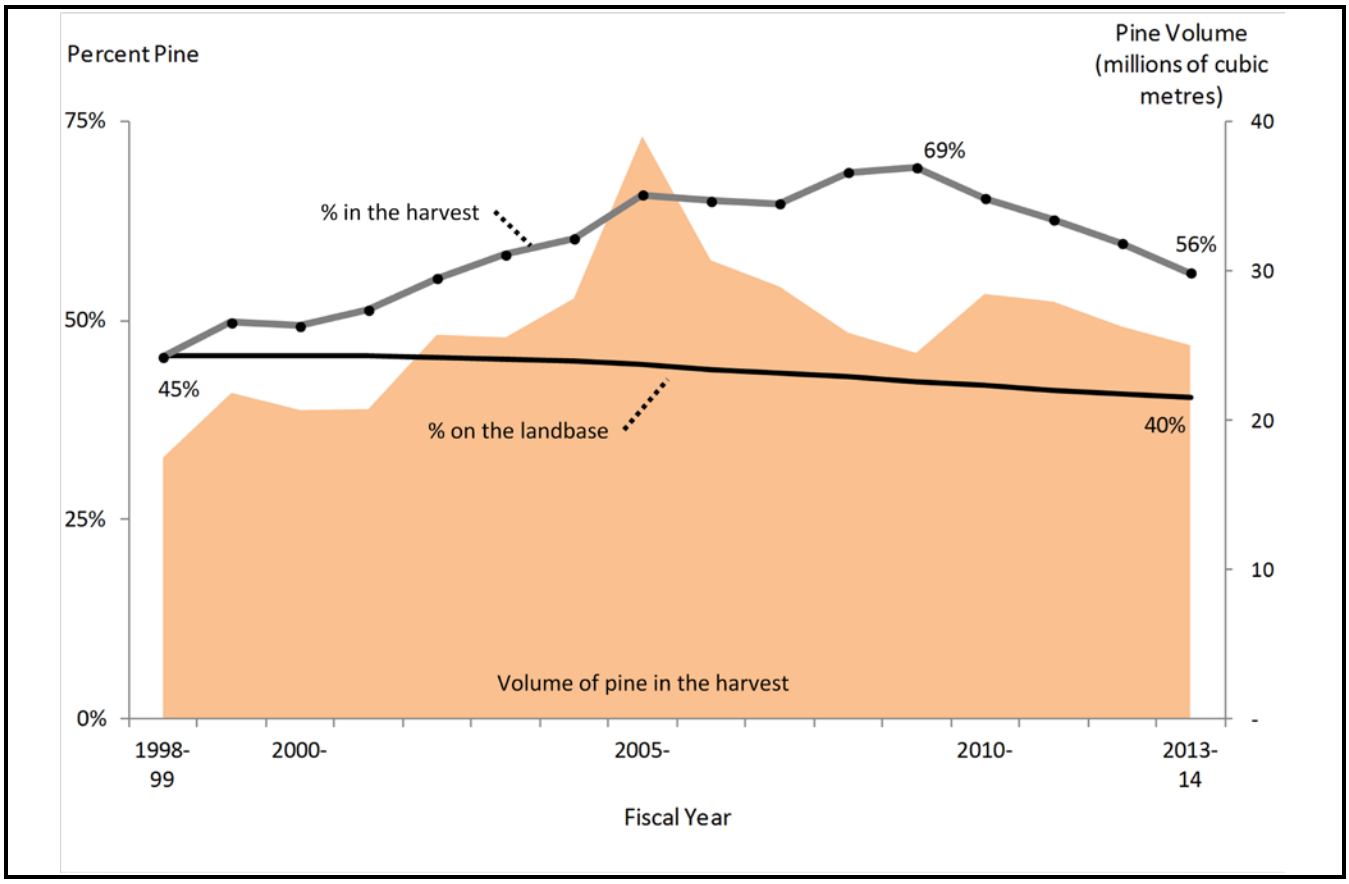

Figure 4. Percent pine and volume of pine in the harvest and percent pine on the landbase by fiscal year (fourth quarter of 2013-14 is estimated).

Figure 4 illustrates that the forest industry has focused its harvest on pine since 1999-00—the proportion of pine in the harvest has been greater than the proportion of pine on the landbase for that entire time. The percentage of pine in the harvest rose more-or-less steadily until 2009-10 when it peaked around 69 percent. Since then, the percentage of pine has decreased steadily and is estimated to be 56 percent in 2013-14.[14] If this trend continues, the percentage of pine in the harvest will be back to the pre-beetle level of 45 percent by 2016-17 and it will be below the percentage of pine on the landbase by 2018-19.

The rate at which the percentage of pine in the harvest is decreasing is a matter of some debate. This is primarily because volumes reported in HBS are the net volumes (the volume that can be made into wood products), but there is an increasing volume of dead pine on the landbase that has deteriorated in quality beyond what can be used to make wood products. This additional gross volume of dead pine can be up to 20 percent higher than the volume reported to HBS through the cruise-based billing process, so it can be argued that the percentage of pine in the harvest is actually higher that what is reported to HBS. The Board estimates that the percentage of pine in the harvest during 2013-14 based on the additional gross volume may be as high as 60 percent, rather than the 56 percent obtained using the data in HBS (Figure 4). Nevertheless, there is a trend in decreasing pine percentages in the harvest.

[14] See Appendices 3 and 5 for details of the projection of the last quarter of 2013-14.

This decreasing trend is dominated by the harvest in the Prince George TSA, where approximately one-quarter of the volume in the beetle-affected units is cut. Another important contributor is the Quesnel TSA, where around 10 percent of the harvest in beetle-affected units is cut. The decline in the percentage of pine in the harvest would have been greater but for the performance in Quesnel, where the percentage has slightly increased from 83 to 85 percent since 2009-10. The variability in the percent pine in the harvest by management unit is shown in Appendix 6.

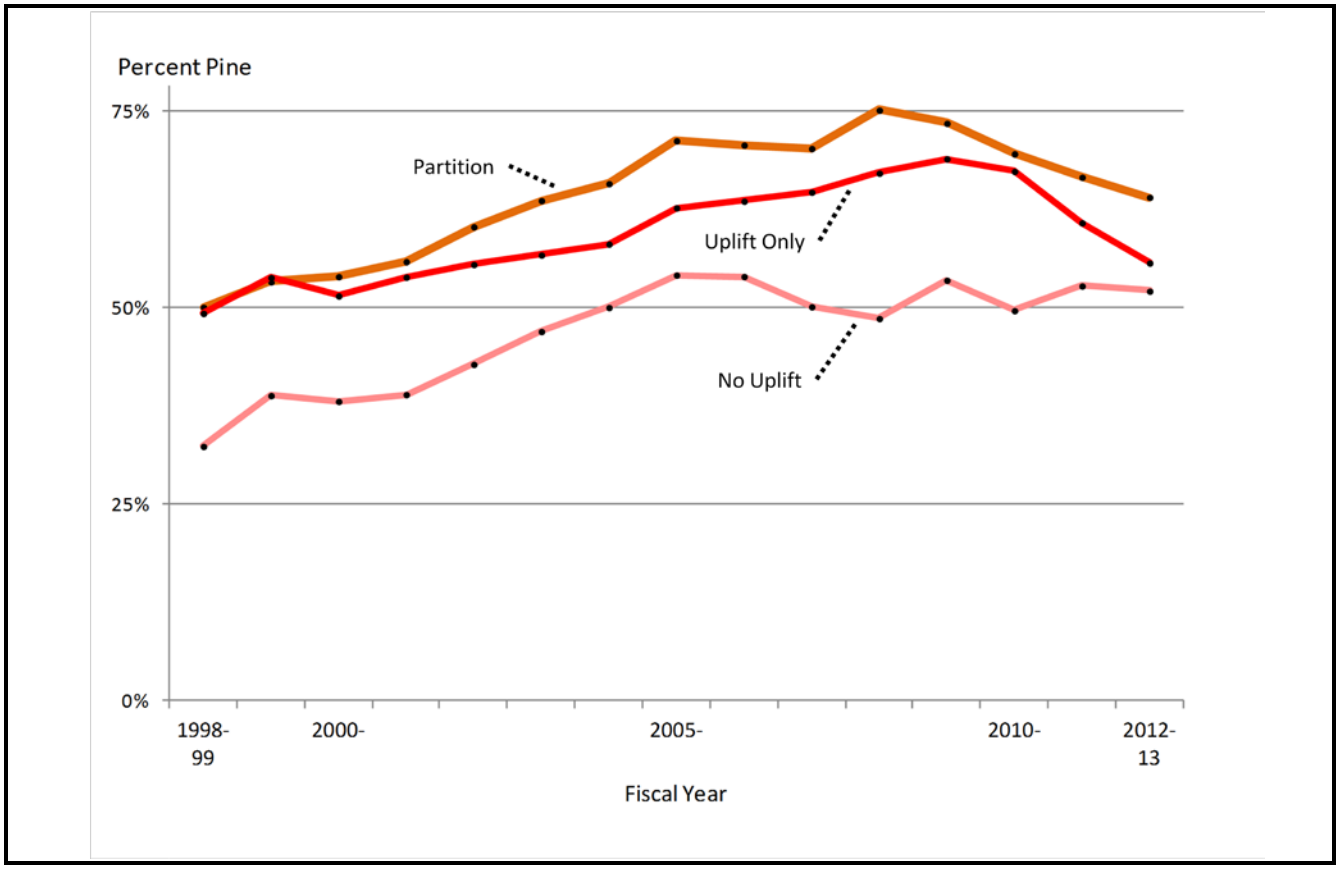

Figure 5. Percent pine in the harvest by management unit type and fiscal year.

The trend over time in the proportion of the pine harvest differs among the different types of units described earlier (Figure 5). The percentage of pine harvested in units with a partition peaked at 75 percent in 2008-09 and has decreased steadily since then. Where there was an uplift, but no partition, the percentage of pine harvested peaked in 2009-10 and has decreased since. Those beetle-affected units with no uplift rose to the challenge of harvesting pine at about the same rate as the units with an uplift, but once 50 percent pine was reached the proportion of pine in the harvest more-or-less stabilized.

The pine harvest in the Prince George TSA, which represents nearly 25 percent of the total harvest in beetle-affected units, was examined in more detail because there is a very specific expectation about the pine harvest in the AAC determination:

> The timber supply analysis assumes that 92 percent of the harvest will come from pine-leading stands for as long as possible … However, if licensees do not continue to focus their harvest on pine-leading stands, the impacts to the mid-term will be severe.[xxv]

The Prince George TSA harvested 92 percent of its volume from pine leading stands[15] in 2007 and 98 percent during 2009, prior to the most recent AAC determination in January 2011.[xxvi]

However, in the first two years after the AAC determination, approximately 80 percent of the volume harvested came from pine leading stands (Table 5). Performance in the first three quarters of the 2013-14 fiscal year indicates that the volume harvested from pine leading stands may now be as low as 71 percent of the total harvest.

Table 5. Timber volume harvested in pine leading stands in the Prince George TSA (millions of cubic metres).

Fiscal Year	Total Volume Harvested	Total Volume in Pine Leading Stands	Pine Leading Stand Percentage
2011-12	10.9	9.0	82%
2012-13	10.3	8.0	78%
2013-14	9.6	6.8	71%

Note: Fourth quarter of 2013-14 is estimated.

It is likely that, over all the beetle-affected management units, the percentage of pine in the harvest is decreasing because:

- The quality of the dead pine is deteriorating rapidly so pine stands are losing their value and it is becoming increasing difficult to find economically viable pine stands.
- For more than a decade much of the harvest in the beetle-affected units has been targeted at pine stands with the highest volume that are closest to roads and mills. As a result, it is becoming increasingly difficult to find pine leading stands with wood quality and volume that are economic to harvest.

[15] HBS does not contain information about the species composition of individual stands. The Board uses the finest resolution in HBS – the timber mark, or cutting permit, as a surrogate. The chief forester uses the same information when setting his expectations and when reporting on performance.

How Much of the Non-Pine Partitions is Being Harvested?

Since 2008, in eight management units, the AAC determination has specified the absolute volume of non-pine species that should be harvested annually (the non-pine partition).[16] Performance in those partitions was assessed using information from HBS. It is important to note that there is no legal requirement on the part of licensees to adhere to the non-pine partitions.[17]

Figure 6 shows the size of the non-pine partitions and performance in those partitions compared to the AAC and total harvest. Performance for each management unit is shown starting in the first full fiscal year after the AAC determination. The fourth quarter of 2013-14 has been estimated (Appendix 5).

The first non-pine partitions were established in 2008. In 2009-10, two-thirds of the total of the non-pine partitions was harvested. Since then, there has been a consistent year-over-year increase in the proportion harvested. The total non-pine partition for all eight units is currently 8.4 million cubic metres. In 2012-13, a total of 9 million cubic metres of non-pine was harvested (107 percent of all the partitions). An estimated 9.3 million cubic metres will likely be harvested in 2013-14 (112 percent of all the partitions).

In Prince George, the non-pine partition is 3.5 million cubic metres. Slightly more non-pine than that was harvested in both 2011-12 and 2012-13 fiscal years[18] and non-pine harvest is projected to about the same in 2013-14. Eighty seven percent of the entire 12.5 million cubic metre AAC was harvested in 2011-12 and that dropped to 82 percent in 2012-13. The total harvest is projected to be only 75 percent of the AAC in 2013-14.

In the Prince George TSA, there is a separate sub-partition for the maximum volume that should be harvested in spruce-leading 'stands'[19] (875 000 cubic metres).[20] During 2011-12 just over half a million cubic metres was harvested. During 2012-13 just over 1.1 million cubic metres was harvested (125 percent of the sub-partition). The Board estimates that the harvest from spruce-leading stands in the Prince George TSA will be over 1.6 million cubic metres during 2013-14 (180 percent of the sub-partition).

[16] The 'live tree' partition in the recent 100 Mile House TSA determination is not included in this analysis, in part because it is conceptually different from the other 'non-pine' partitions, but also because there has not been sufficient time to determine what the performance in the partition has been.

[17] Although it is possible for government to put a legal requirement in place if they choose to do so, the provision of the *Forest Act* enabling this (Part 4, Division 3.01) has not been used. As noted previously, the *Forest Act* Section 8 (5) enables the chief forester to specify a partition when setting the AAC.

[18] This result is consistent with a report produced by the government/industry led PGTSA steering committee.

[19] Measurement of performance in spruce-leading stands has the same issue as measurement of performance in pine-leading stands, as previously discussed; that is, HBS does not contain information about the species composition of individual stands. The Board uses the finest resolution in HBS—the timber mark, or cutting permit—as a surrogate.

[20] This is a part of the total non-pine partition for the Prince George TSA of 3.5 million cubic metres.

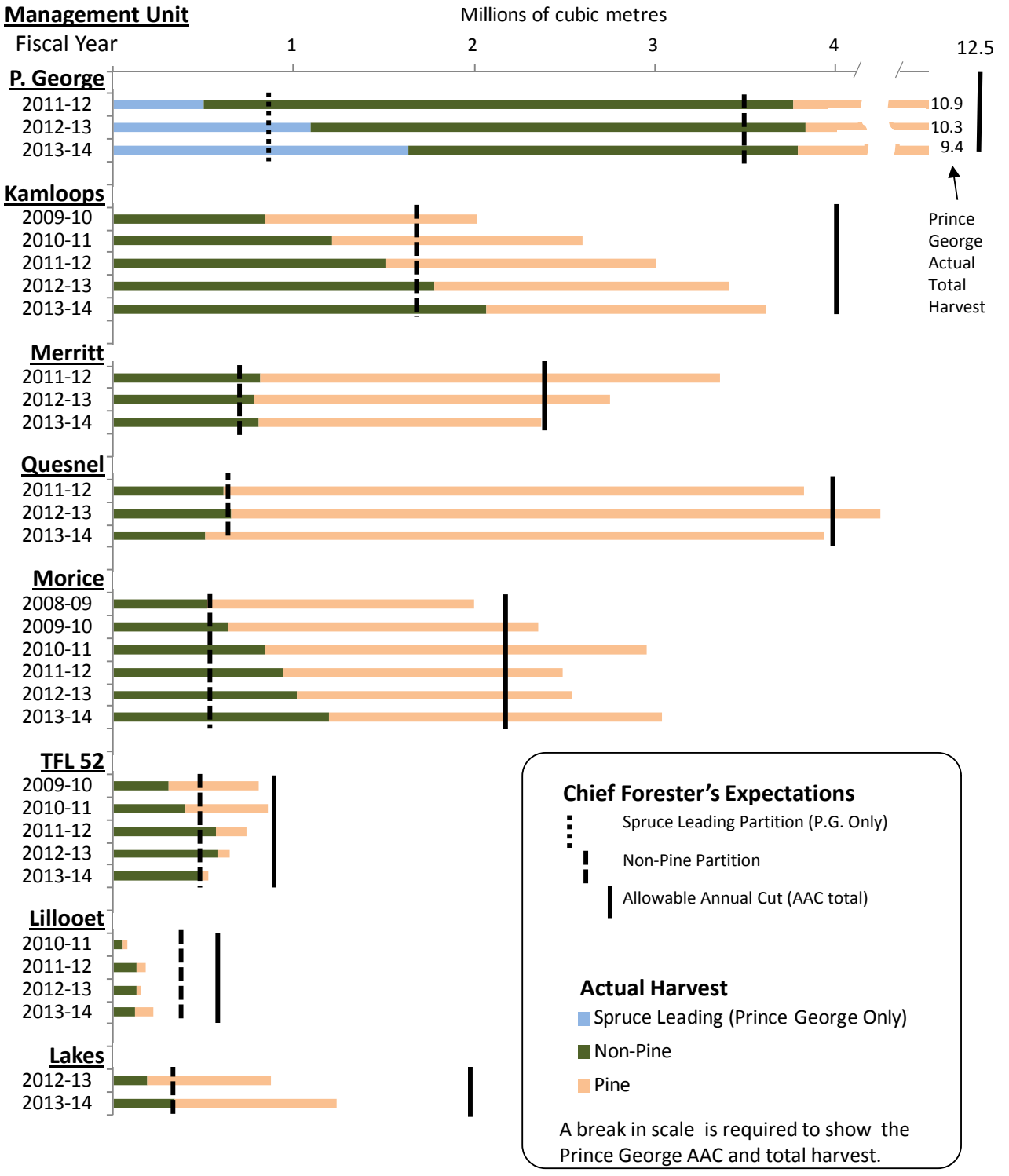

Figure 6. Volumes of non-pine and pine harvested compared to the non-pine partitions and the total AAC (fourth quarter of 2013-14 is estimated).

In the Kamloops TSA, the non-pine harvest has increased steadily over the last four years, along with the proportion of AAC that was cut. Eighty-five percent of the AAC was harvested in 2012-13 and just over 100 percent of the partition was cut. Kamloops is projected to harvest 90 percent of its AAC and over 120 percent of its non-pine partition in 2013-14.

In both Merritt and Quesnel TSAs, the non-pine harvest was approximately equal to the partition during the last two fiscal years and is projected to be the same in 2013-14. In Merritt, the volume of pine harvested has decreased since the non-pine partition has been in place.

During the last four fiscal years, the non-pine harvest in the Morice TSA has exceeded the partition and the total harvest has exceeded the AAC. Licensees harvested 185 percent of the partition in 2012-13. The non-pine harvest is projected to be about 200 percent of the partition in 2013-14. The Board is aware that major licensees in the Morice TSA and the Babine business area of the BC Timber Sales program have developed a plan intended to bring the non-pine harvest within the partition over the next year and a half.

The harvest in TFL 52 (Bowron-Cottonwood) has been below the AAC since the determination in April 2009. Pine salvage on the TFL is all but complete and 90 percent of the total harvest in 2012-13 was non-pine. That amount (575 000 cubic metres) was 115 percent of the partition. In 2013-14 the non-pine harvest in the management unit is projected to be equal to the non-pine partition and, with almost no pine being harvested, less than 60 percent of the AAC is expected to be cut.

In the Lillooet TSA, no more than 35 percent of the partition has been harvested in the last three fiscal years and no more than 32 percent of the AAC was cut.

In the Lakes TSA, there is only one full fiscal year of data (2012-13) showing that neither all of the AAC nor the partition was harvested. Assuming that the harvest in 2012-13 can be used to project the harvest during the third quarter of 2013-14, then over 60 percent of the AAC may be harvested and almost the entire non-pine partition may be harvested.

Conclusions

A general expectation of government, continually expressed by the chief forester, is that in beetle-affected areas, "licensees continue to focus harvesting on MPB-impacted pine-leading stands."[xxvii]

- The Board found that nearly two-thirds of the pine harvested over the last two fiscal years was dead. MFLNRO estimates that just over half the pine on the landbase is dead.[xxviii]
  - This indicates that the forest industry has focused its harvest on dead pine; at least in the recent past.
- The Board found that the proportion of pine in the harvest has been well above the proportion of pine on the landbase since the beginning of the forest management response to the current epidemic, around the year 2000.
  - This indicates that the forest industry has been focusing its harvest on pine during the entire epidemic and its after-effects.

Notwithstanding these positive conclusions compared to the general expectation, there are several trends and indicators in the results that suggest the forest industry is losing its focus on government's specific expectations for the harvest of dead pine and pine.

- Where the Board examined specific expectations about the amount of dead pine in the harvest, the expectations were not being met (Table 3). Arguably, this may be an issue with the expectations rather than the performance. Government's expectations were based on previous harvest performance, but the situation is changing rapidly, resulting in difficulties maintaining that performance. Notably, the quality of the dead pine available for harvest is deteriorating or remains marginally economic.
- The percentage of pine in the harvest rose steadily from 2000-01 to a peak of 69 percent in 2009-10 and has been steadily decreasing ever since. A similar decrease in the percentage of pine in the harvest has been reported by MFLNRO.[xxix] The decrease is likely caused by deterioration in the quality of the dead pine and increasing difficulty in finding economically viable pine stands. Therefore, the trend in decreasing pine in the harvest seems likely to continue. The Board projects that, if the decrease continues at the same rate, the percent of pine in the harvest will be back to pre-beetle levels (45 percent in 1998-99) by 2016-17 and it will be below the percentage of pine on the landbase by 2018-19.

  This trend is evident in, and driven by, the Prince George TSA, which accounts for around one-quarter of the harvest volume in the beetle-affected area. Licensees in the Prince George TSA are harvesting far less pine than was assumed in the analysis leading to the allowable annual cut (AAC) determination—done just a few years ago—and the amount of pine harvested is decreasing. The trend would be stronger but for the notable exception—the Quesnel TSA. It is the second largest unit, by harvest volume, and the percentage of the pine in the harvest there has increased slightly since 2009.

- In eight management units, the chief forester has articulated specific expectations about the maximum amount of non-pine that should be harvested—the non-pine partitions of the AAC. The first non-pine partitions were established in 2008. In 2009-10, two-thirds of the total of the non-pine partitions was harvested. Since then, there has been a consistent year-over-year increase in the proportion of the total that has been harvested. The Board estimates that the non-pine harvest in 2013-14 will be more than 10 percent over the total of the non-pine partitions (9.3 million cubic metres harvested of the total 8.4 million cubic metre non-pine partition). In the Prince George TSA, there is also a specific sub-partition for the maximum volume that should be harvested from spruce-leading stands (875 000 cubic metres).[21] One hundred and twenty five percent of that partition was harvested in 2012-13 and the Board estimates that over 180 percent will be harvested in 2013-14. Comparisons of the non-pine partition against the amount of non-pine in the harvest in any given year must be interpreted with some caution because there is some consensus that the partitions should be adhered to over longer time frames (possibly five years). Nevertheless, in the Morice TSA, more non-pine than the partition has been harvested for each of the last four years and the Board estimates that about 200 percent of the partition will be harvested in 2013-14. In the Kamloops TSA, there has been a four-year trend towards an increasing non-pine harvest and the Board estimates that 120 percent of the partition will be harvested in 2013-14.

  As noted above, the issue may be with government's expectations rather than harvest performance. The expectations represented by the partitions are based on actual performance five to eight years in the past (2006 to 2009). It may be challenging for the forest industry to continue to meet those expectations in the face of the increasing difficulty in finding economically viable pine stands. The Board also notes that these partitions in the AAC are guidance provided by the chief forester and have no legal effect. The Crown is expecting forest managers in their respective management units to conduct harvesting that respects the partitions. Whether this expectation is reasonable seems to be in doubt.

- Over the last seven years, only three-quarters of the AAC has been harvested in the beetle-affected areas. Over the last three years, there was a 15 percent gap between the AAC and the actual harvest. This gap is largely due to volumes apportioned to non-replaceable forest licences for which there has either been no commitments (i.e., no licence agreements have been signed) or for which commitments have been made, but there has been little or no harvesting. In most cases, these NRFL volumes were intended to facilitate the harvest of dead pine, much of it for bioenergy, and secondarily for sawn wood products. Log markets did not support the harvesting on many NRFLs (until recently).

  This gap between the AAC and the actual harvest may be a concern because the timber supply analyses that support the AAC determinations assume the entire AAC will be harvested. If it is not, then the area that will be promptly regenerated after harvesting will be lower than assumed and conclusions about the long-term (and possibly mid-term) timber supply need to be revisited.

[21] This is a part of the total non-pine partition for the Prince George TSA of 3.5 million cubic metres.

However, this concern may be entirely offset because there are other concerns that the area the chief forester assumes will be harvested is too low, in the case of beetle-affected stands. These concerns exist because the volume estimates that support the chief forester's AAC determinations include some beetle-killed wood that is not included in the volumes reported to HBS. The result is that licensees need to harvest more area than expected to achieve the volumes assumed in the AAC determinations. This concern could be resolved if the analysts that support the AAC determination accommodated these differences in volume estimates in their analyses.

This latter concern about the area harvested highlights the issue that there is some considerable debate about how to measure harvest performance against expectations. This is primarily because of differences among timber volumes portrayed in the forest cover map, in the timber cruise, and volumes reported to HBS (see Appendix 4 for details).

The Board concludes that, for the purpose of monitoring harvest performance against the chief forester's expectations, the information in HBS should be the gold standard.[22] It is this information that is used to set expectations and in some cases the chief forester has been explicit that this information should be used to monitor harvest against expectations. The AAC determination is the first step in apportionment. Apportionment is managed through cut control—which is managed through HBS returns—so the chief forester needs to make sure that the right volumes are being used during the timber supply review process; volumes that can be apportioned. For these reasons, the Board relied almost exclusively on the information in HBS to measure performance against expectations. However, HBS contains information from two different sources (scale based and timber cruise based), each estimated in different ways, and each with their unique sampling procedures and generally accepted sampling variability. Using that information to track harvesting expectations should include some reconciliation of the differences. This could be done through special studies or more detailed analyses, and would likely require accepting some general assumptions about the impact of the differences on the use of the information.

[22] The Board notes that government ensures the information is adequate for the primary purposes of timber pricing and billing.

End Notes

Web links last accessed: March 21, 2014

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[i] Special Committee on Timber Supply. 2012. Growing Fibre, Growing Value. page 44. https://www.leg.bc.ca/cmt/39thparl/session-4/timber/reports/PDF/Rpt-TIMBER-39-4-GrowingFibreGrowingValue-2012-08-15.pdf

[ii] *ibid.*; page 1.

[iii] MINUTES SPECIAL COMMITTEE ON TIMBER SUPPLY, Issue No. 9, Tuesday, June 19, 2012 @1125, R. Vossen, Hampton Lumber Mills, Canada, Ltd. http://www.leg.bc.ca/cmt/39thparl/session-4/timber/hansard/F20619a.htm#9:1125;

[iv] Forest Practices Board. 2007. Tree Species Harvested In Areas Affected By Mountain Pine Beetles FPB/SR/33. http://www.fpb.gov.bc.ca/SR33_Tree_Species_Harvested_in_Areas_Affected_by_MPB.pdf

[v] Forest Analysis and Inventory Branch. 2013. Timber Supply Review (TSR) Document Descriptions. MFLNRO http://www.for.gov.bc.ca/hts/tsa/TSR_document_description.pdf

[vi] Forest Analysis and Inventory Branch. 2013. Monitoring Harvest Activity Across 28 Mountain Pine Beetle Impacted Management Units. MFLNRO. http://www.for.gov.bc.ca/hts/pubs/MPB_Monitoring_Harvest_2013.pdf

[vii] Snetsinger, J. 2011. Prince George Timber Supply Area Rationale for Allowable Annual Cut (AAC) Determination. BC Ministry of Forests, Mines and Lands. http://www.for.gov.bc.ca/hts/tsa/tsa24/tsr4/24ts11ra.pdf

[viii] Nichols, D. 2013. 100 Mile House TSA AAC Determination, MFLNRO http://www.for.gov.bc.ca/hts/tsa/tsa23/current_2012/23ts13ra.pdf

[ix] Current Allowable Annual Cut (AAC) for Timber Supply Areas (TSA) http://www.for.gov.bc.ca/hts/aactsa.htm and Current Allowable Annual Cut (AAC) for Tree Farm Licences (TFLs) http://www.for.gov.bc.ca/hts/tfls.htm

[x] Snetsinger, J. 2012. Okanagan AAC Determination. MFLNRO http://www.for.gov.bc.ca/hts/tsa/tsa22/current_2011/22ts12ra.pdf

[xi] Forest Analysis and Inventory Branch. 2013. 100 Mile House TSA Timber Supply Analysis Public Discussion Paper. MFLNRO. http://www.for.gov.bc.ca/hts/tsa/tsa23/current_2012/23ts13pdp.pdf

[xii] *Supra* note vii

[xiii] Timber Pricing Branch, MFLNRO , Harvest Billing System (HBS), http://www.for.gov.bc.ca/hva/hbs/

[xiv] Snetsinger, J. 2010. Merritt AAC Determination. Ministry of Forests Mines and Lands http://www.for.gov.bc.ca/hts/tsa/tsa18/tsr2009/18ts10ra.pdf and Snetsinger, J. 2012. Lakes AAC Determination. MFLNRO http://www.for.gov.bc.ca/hts/tsa/tsa14/current_tsr_2009/14ts11ra.pdf

[xv] e.g. *Supra* note viii

[xvi] Timber Pricing Branch, MFLNRO, Electronic Commerce Appraisal System (ECAS) https://www.for.gov.bc.ca/hva/ecas/

[xvii] Timber Pricing Branch, MFLNRO, Interior Pricing Policy Changes https://www.for.gov.bc.ca/hva/interior-pricing-changes.htm

[xviii] Walton, A. 2013. Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update . . 10. MFLNRO http://www.for.gov.bc.ca/ftp/hre/external/!publish/web/bcmpb/year10/BCMPB.v10.BeetleProjection.Update.pdf

[xix] e.g. Forest Analysis and Inventory Branch. 2013. Mackenzie TSA Timber Supply Analysis Public Discussion Paper. MFLNRO. http://www.for.gov.bc.ca/hts/tsa/tsa16/current_2012/16tspdp13.pdf

[xx] e.g. Forsite Consultants Ltd. 2013. Quesnel TSA – Type 4 Silviculture Strategy Data Package Version 2.0. Resource Practices Branch MFLNRO. http://www.for.gov.bc.ca/hfp/silstrat/Quesnel/Quesnel_Type_4_Data_Package_20130619.pdf

[xxi] *Supra* note xi

[xxii] Forest Analysis and Inventory Branch. 2010. Prince George TSA Timber Supply Analysis Public Discussion Paper. Ministry of Forests and Range http://www.for.gov.bc.ca/hts/tsa/tsa24/tsr4/24ts10pdp.pdf

[xxiii] Forest Analysis and Inventory Branch. 2010. Quesnel TSA Timber Supply Analysis Public Discussion Paper. Ministry of Forests and Range http://www.for.gov.bc.ca/hts/tsa/tsa26/2009_current/26ts10pdp.pdf

[xxiv] *Supra* note iv

[xxv] *Supra* note vii

[xxvi] *Supra* note vi

[xxvii] e.g. *Supra* note x

[xxviii] *Supra* note xviii

[xxix] *Supra* note vi

Appendix 1: Information Required to Categorize Beetle-Affected Management Units

Management Unit Name	First Beetle Uplift	Non-Pine Partition (000's m^3)	Current AAC (000's m^3)	pre-beetle AAC (000's m^3)	% uplift for beetle mgmt	Current AAC Determin-ation Date	Link to Rationale
Arrow TSA			550	550		01-Jul-05	Arrow
Boundary TSA			700	700		**01-Jan-02**	Boundary
Bulkley TSA			852	895		29-Jan-14	Bulkley
Cranbrook TSA			904	871		**01-Nov-05**	Cranbrook
Dawson Creek TSA			1,860	1,733		01-May-03	Dawson
Golden TSA			485	530		03-Jun-10	Golden
Invermere TSA			599	591		**01-Nov-05**	Invermere
Kamloops TSA	2004	1,700	4,000	2,679	149%	01-Jun-08	Kamloops
Kootenay Lake TSA			640	681		12-Aug-10	Kootenay
Lakes TSA	2001	350	2,000	1,500	133%	12-Jul-11	Lakes
Lillooet TSA		400	570	643		01-May-09	Lillooet
MacKenzie TSA			3,050	2,997		**01-Dec-01**	Mackenzie
Robson Valley TSA			536	602		04-Aug-06	Robson
Merritt TSA	2005	720	2,400	1,454	165%	02-Dec-10	Merritt
Morice TSA		550	2,165	1,986		01-Feb-08	Morice
Okanagan TSA	2006		3,100	2,615	119%	29-Feb-12	Okanagan
100 Mile House TSA	2006	See notes	2,000	1,362	147%	07-Nov-13	100 Mile
Prince George TSA	2002	3,500	12,500	9,364	133%	11-Jan-11	PG
Quesnel TSA	2001	650	4,000	2,340	171%	11-Jan-11	Quesnel
Williams Lake TSA	2007		5,770	3,807	152%	18-Apr-07	WilliamsLk
TFL 08 Boundary	2002		186	175	106%	01-Apr-09	TFL 08
TFL 14 Spilli...n			180	160		07-Apr-08	TFL 14
TFL 18 Clearwater	2006		290	176	165%	09-Mar-06	TFL 18
TFL 35 Jamieson Ck	2004		125	126		01-Mar-12	TFL 35
TFL 48 Chetwynd	2007		900	580	155%	25-May-07	TFL 48
TFL 49 Okanagan	2005		330	380		30-Nov-12	TFL 49
TFL 52 Bn.-Cttwd.	2009	500	918	870	106%	01-Apr-09	TFL 52
TFL 53 Naver	2003		219	240		30-Nov-10	TFL 53

Notes:

- *Bold dates in the "Current AAC Determination" indicate there has been a subsequent postponement order.*
- *The AAC in the Williams Lake TSA was increased in 1985 from 2,500,000 to 3,750,000 cubic metres to address the mountain pine beetle epidemic that occurred in the area around that time. In 1996 the AAC was set at 3,807,000 cubic metres.*
- *TFLs 35, 49 and 53 received uplifts in2004, 2005 and 2003, respectively, but the recent determinations returned the AAC to at or below pre-beetle (and fire) levels.*
- *The recent determination for the 100 Mile House TSA specified a partition at 500,000 cubic metres for the total volume of live trees that should be harvested. All other partitions listed are for the total volume of non-pine species that should be harvested.*
- *TFL 14 Spilli...n = Spillimacheen; TFL 52 Bn.-Cttwd.= Bowron Cottonwood*

Appendix 2: Summary of Interior Harvest During 2012-13

Description and Notes for Column Headers in the Following Table

Management Unit

Management Units are listed in decreasing order of the percentage of the total pine harvest in 2012-13.

Management units are the beetle-affected timber supply areas (TSA) and tree farm licences (TFL) as listed in Appendix 1, except:

- The Prince George TSA is divided into the three MFLNRO Districts that make up the TSA, plus the total for the TSA itself.
- NOT affected TSA/TFL is the sum of the values for all those TSAs and TFLs in the Northern or Southern Interior that are not beetle-affects.
- Other (C.F., wd. lot,) is the sum of all interior community forests and woodlots.

TFL 14 Spilli...n = TFL 14 Spillimacheen
TFL 52 Bn.-Cttwd.= TFL 52 Bowron Cottonwood

Harvest (000's m^3)
The four columns under this heading are harvest estimates in thousands of cubic metres.

Pine = all lodgepole pine including dead pine.
Dead Pine = dead lodgepole pine only.
Non-Pine = all species other than lodgepole pine harvested; including deciduous (note relatively high non-pine harvest in Dawson Creek contains significant amounts of aspen harvest).
Total = sum of pine and non-pine.

% of AAC Harvested = harvest in the management unit as a percentage of the AAC for that unit.
% of All Pine Cut = pine harvest as a percentage of the total interior pine harvest.

Pine Harvest % of MU
The three columns under this heading are percentage of the total harvest in the MU in 2012-13.

Pine Cut = percentage of pine in the harvest**.**
Dead Pine = percentage of the pine harvested that was dead.
Dead Pine of Total = percentage of the total harvest that was dead pine.

% of Partition Cut = percentage of the non-pine partition harvested (see Appendix 1 for volumes of the non-pine partitions).

Summary of the BC interior harvest during the 2012-13 fiscal year.

Management Unit	HARVEST (000's m^3) Pine	Dead Pine	Non-Pine	Total	% of AAC Harvested	% of All Pine Cut	PINE HARVEST % of MU Pine Cut	Dead Pine	Dead Pine of Total	% of Partition Cut
PG TSA Ft.St. James	2,565	2,053	1,462	4,028		9	64	80	51	
PG TSA Vanderhoof	2,186	1,972	798	2,984		8	73	90	66	
PG Prince George	1,702	1,437	1,572	3,274		6	52	84	44	
Prince George ALL	6,454	5,463	3,832	10,286	82	23	63	85	53	109
Quesnel TSA	3,592	3,041	654	4,246	106	13	85	85	72	101
Williams Lake TSA	2,054	1,066	880	2,934	51	7	70	52	36	
Merritt TSA	1,964	799	789	2,754	115	7	71	41	29	110
Kamloops TSA	1,622	1,303	1,788	3,411	85	6	48	80	38	105
Morice TSA	1,521	892	1,020	2,541	117	5	60	59	35	185
MacKenzie TSA	1,508	1,196	856	2,365	78	5	64	79	51	
Okanagan TSA	1,362	339	2,031	3,394	109	5	40	25	10	
100 Mile House TSA	1,112	1,032	576	1,688	84	4	66	93	61	
Cranbrook TSA	989	67	583	1,572	174	4	63	7	4	
Dawson Creek TSA	694	308	536	1,229	66	2	56	44	25	
Lakes TSA	680	523	190	870	44	2	78	77	60	54
TFL 48 Chetwynd	558	325	474	1,032	115	2	54	58	32	
Boundary TSA	442	30	261	703	100	2	63	7	4	
Bulkley TSA	360	61	204	565	64	1	64	17	11	
Invermere TSA	237	36	312	549	92	1	43	15	7	
TFL 18 Clearwater	179	142	287	466	161	1	38	79	30	
TFL 14 Spilli...n	135	5	49	184	102	0.5	73	3	2	
Kootenay Lake TSA	115	5	253	367	57	0.4	31	4	1	
TFL 08 Boundary	104	9	115	219	118	0.4	48	9	4	
Arrow TSA	95	21	594	689	125	0.3	14	22	3	
Golden TSA	77	14	347	424	87	0.3	18	18	3	
TFL 52 Bn.-Cttnwd	69	49	575	643	70	0.2	11	71	8	115
TFL 49 Okanagan	69	39	81	149	45	0.2	46	56	26	
TFL 35 Jamieson Ck	69	9	109	178	142	0.2	39	13	5	
TFL 53 Naver	32	11	351	383	175	0.1	8	35	3	
Robson Valley TSA	25	11	25	50	9	0.1	50	46	23	
Lillooet TSA	25	7	130	155	27	0.1	16	30	5	33
Beetle Affected Total	**26,141**	**16,803**	**17,904**	**44,045**	**85**	**94**	**59**	**64**	**38**	**107**
NOT affected TSA/TFL	577		3,427	4,004		2	14			
Other (C.F., wd. lot,)	1,163		1,778	2,940		4	40			
Grand Total	**27,880**		**23,109**	**50,989**		**100**	**55**			

Appendix 3: Description of the Information Sources and Methods

- The Board obtained harvest volumes by tree species from April 1, 1998, to December 31, 2013, from the MFLNRO harvest billing system (HBS).[xxx] The Board used this information to report on the species composition of the harvest (i.e., the percentage of pine and the volume of non-pine in the harvest).
- The Board estimated the volume dead pine harvested from information in HBS and the MFLNRO electronic commerce and appraisal system (ECAS)[xxxi] for the period April 1, 2011, to March 31, 2013. This time period was chosen because it includes the first full fiscal year after the implementation of the requirement to use cruise-based billing for any cutting authority with more than 35 percent pine that was red or grey MPB attack. Dead pine was calculated as the total volume of green, red and grey MPB attack in the cruise summary. Where harvesting was reported to HBS using a:
  - **weigh scale based cutting authority** (normal production and waste): the amount of dead pine was estimated using cruise information in ECAS for the timber mark where it was available. For timber marks where cruise information was not available (about one fifth of the volume) the amount of dead pine was estimated, by management unit, based on the average amounts found in the cruise data for the management unit.
  - **cruise based cutting authority:** the volumes of dead pine as reported to HBS (billing code 8) were used directly and the volume of billing code 7 pine that was green attack (also dead) was calculated based on the percentage of green attack in the cruise information (available in all but a few cases).
- Performance during the fourth quarter of the 2013-14 fiscal year was estimated for the main report (Figure 4, Table 5, and Figure 6). These projections are based on multipliers for the fourth quarter of the fiscal. For each management unit in each relevant year, the multiplier is the fourth quarter volume divided by the first three quarters volume. The average of those multipliers, over all relevant years, is used to estimate the volumes in the fourth quarter of 2013-14. Totals for 2013-14 are then calculated as the actual harvest in the first three quarters, plus the estimate for the fourth quarter. The quantities used in the projections are presented in Appendix 5.
- The proportion of pine on the timber harvesting landbase was obtained (where available) from MFLNRO report titled *Monitoring Harvest Activity Across 28 Mountain Pine Beetle Impacted Management Units*.[xxxii]
- The overall proportion of the dead pine on the landbase was obtained from MFLNRO report titled *Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: . . .1999 through 2012 . . . (year 10)*.[xxxiii]
- Information about the AAC, partitions and the expectations of government were obtained from documents related to the AAC determination process (the rationales for the AAC determination and public discussion papers).[xxxiv]
- Some use was made of the information in the 2007 Board report, *Tree Species Harvested in Areas Affected by Mountain Pine Beetles*.[xxxv]

Appendix 4: Issues Related to the Information

Government has expressed expectations about the trees species composition of the harvest. In some cases those are expressed as the minimum proportion of the harvest that should be pine. However, most commonly the explicit expectations are for the maximum absolute volume of the harvest that should be non-pine – the non-pine partitions. These expectations are based on actual performance as identified in the harvest billing system (HBS)[xxxvi] around the close of the data package for the given allowable annual cut determination as demonstrated below.

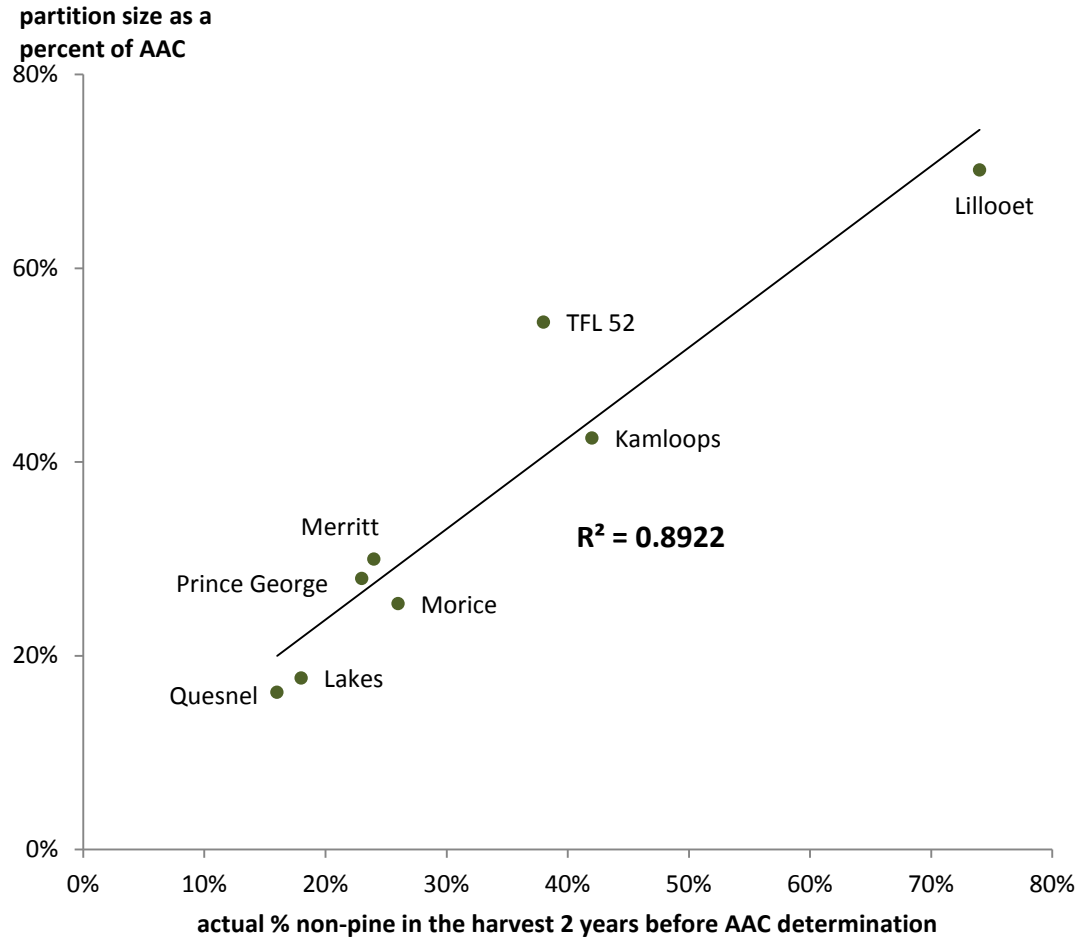

Figure A7. Relationship between actual non-pine harvest, two years before the AAC determination and the determined partition as a percent of the determined AAC.

In the eight TSAs, with non-pine partitions, nearly 90 percent of the variability in the partition size (as a percent of the AAC) can be explained by the non-pine harvest performance two years prior to the AAC determination (Figure A7), as reported by MFLNRO. (http://www.for.gov.bc.ca/hts/pubs/Report-Monitoring%20Harvest_Nov%202012.pdf)

In addition, government has, in some cases, explicitly stated that HBS should be used to monitor ongoing performance.[xxxvii] Therefore, the Board used HBS to measure performance about the tree species composition of the harvest.

Government has also expressed expectations about the proportion of the pine in the harvest that should be dead. With the exception of the most recent AAC determination for the 100 Mile House TSA (November 7, 2013), there is no indication how these expectations should be measured.[23] The Board used a combination of HBS returns and data obtained from the electronic commerce and appraisal system (ECAS)[xxxviii] to estimate the amount of dead pine that is being harvested. These methods and the other information sources and methods used in this report are detailed in Appendix 3.

There are potentially significant issues in using the information in HBS and ECAS to measure harvest performance against expectations. The issues, discussed below in some detail, are of three different types:

- The primary purpose for collecting the information is to calculate stumpage (price) of timber to be harvested (in the case of ECAS), collect revenue and ensure the correct timber volume is being billed accurately and equitably (in the case of HBS). Government ensures that the information is adequate for the primary purposes of timber pricing and billing but neither system is specifically designed to collect information to monitor harvest performance.
- The information used does not represent direct measurements of every tree—all of it is estimates based on various kinds of sample measurements. The estimates contain generally accepted sampling variability.
- Since the beginning of the MPB epidemic there have been significant changes in the timber profile on the landbase, forest harvesting methods and the collection and reporting of information in the system used to measure harvest performance.

Figure A8 is a simplified schematic of the portions of government's information system related to this topic as it stood prior to the most significant change in the system, made on June 1, 2010. The change, and its implications, are discussed below.

[23] The 100 Mile House TSA determination simply states that district staff could monitor the harvest of dead pine using "cruise data."

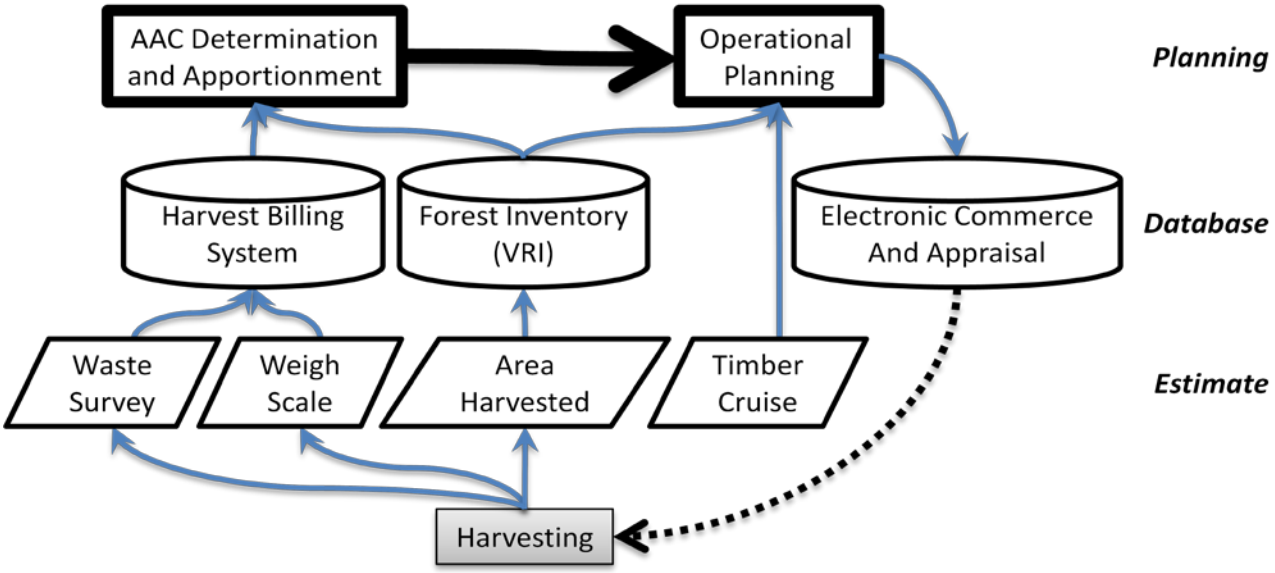

Figure A8. Simplified relationships among planning, database and measurement components of the information system used to assess harvest performance against expectations (note that this figure depicts the main information flow in the system prior to June 1, 2010 when mandatory cruise-based billing for beetle killed cut blocks was implemented).

A brief description of the system prior to June 1, 2010, when mandatory cruise-based billing for beetle killed cutblocks was implemented is:

- An AAC is determined (and subsequently legally apportioned[xxxix]) based on an analysis that uses a wide variety of information, including the forest inventory (a.k.a. Vegetation Resources Inventory[xl]) and HBS databases as input. The results of that process form a significant directive for operational planning.
- Operational planning uses a host of information (much of it about the economics of harvesting) to develop spatially explicit plans of where harvesting will occur. Often an initial step in that process is to consult the forest inventory database to identify likely areas for harvest. Those areas are usually visited to obtain cursory information about the nature of the area (a reconnaissance survey) and then, if deemed suitable, a timber cruise[24] is conducted.
- Some of the information from the cruise is used in the Electronic Commerce and Appraisal System (ECAS) to calculate the stumpage that will be owed when the timber is harvested.
- After the harvesting is complete:
  - The forest inventory is updated with a map of the area harveste.
  - In general, log weigh scaling is used to update HBS with estimates of the volume, species composition and grade (suitability for making wood products) of wood harvested and delivered to the timber processing facility (hereafter the mill). In that process, every logging truck is weighed and the load of logs is assigned to a pre-defined stratum. A

[24] The systematic measurement of a forested area designed to estimate to a specified degree of accuracy the volume of timber it contains, by evaluating the number and species of trees, their sizes, and conditions. (http://www.for.gov.bc.ca/hfd/library/documents/glossary/Glossary.pdf)

sample of the logging truckloads delivered to the mill is scaled[25] to ensure the relationship between weight and volume for each stratum. Note that, in some cases, all of the delivered logs are measured.

- HBS is updated with an estimate of the net merchantable volume left on the site after harvest, also known as waste.

It is important to note that, in theory, the volumes estimated in the forest inventory and the timber cruise (and the waste assessment) are the net merchantable volumes and are directly comparable to the volumes actually delivered to the mills, as measured by the log weigh scaling process. That is, the timber inventory and the timber cruise contain estimates of the volume of the main stem of the tree, excluding stump and top; further reduced for an estimate of the volume that is not deliverable (also known as decay, waste and breakage). In practice, there are several reasons why the three volume estimates may be different and, in general, why the estimates of timber volume in the inventory may be higher than the estimates in the cruise, which may be higher than the volumes estimated by log weigh scaling:

- Pine volumes in the inventory may be overestimated. This is because the inventory contains estimates, including estimates of the species composition of the stand. These estimates are theoretically unbiased (i.e., neither too high nor too low). However, since the beginning of the MPB outbreak, the industry has been focusing their harvest on stands that actually have a high percentage of pine. They use the inventory, in part, to do this. This biased harvesting may have created a bias in the inventory estimates towards overestimating the amount of pine. The Board found that since 2007 an estimate of the proportion of pine harvested based on the forest cover map was seven percent higher than an estimate based on HBS returns (Table A6).
- Where there has been MPB related mortality, pine volumes in the inventory will be higher than in the operational timber cruise because the estimate in the cruise contains a reduction in the volume net down to account dead pine trees that will not be delivered (20 percent for most of the dead pine). This net down is not included in the volume estimates found in the inventory.
- Volumes of all species in the inventory and the cruise may be higher than the volumes estimated by log weigh scaling for two reasons:
  - The factors used to reduce the volume estimate to account for decay waste and breakage are based on broad regional averages published in 1976[xli] and may not adequately reflect current conditions in MPB affected areas.
  - The estimates in the inventory and cruise are based on the assumption that the entire main stem of the tree, less the stump and the top, will be delivered to the mill; that is, whole trees will be loaded on logging trucks. However, recent changes in harvesting technology have resulted in almost all of the wood now going through an initial processing step in the woods. In this so-called 'cut-to-length' system, trees are cut into lengths that can be directly used in the mill. Depending on the log specifications of the mills and the market for pulp logs, this process may result in portions of trees being left on the harvesting site. Theoretically, this volume should be accounted for in the waste assessment, but there is growing concern that the waste assessment procedures may be under-estimating wasted volumes.[xlii]

[25] "To measure or estimate the quantity, expressed as the volume, . . . of products obtained from trees after they are felled." (http://www.for.gov.bc.ca/hfd/library/documents/glossary/Glossary.pdf)

These issues are important in the context of this report for two reasons.

First, as discussed above, the Board has decided that, in this report, harvest performance will be measured against government expectations mainly using the information in HBS. However, the Board did use information in ECAS to estimate the amount of dead pine in the harvest. Additionally, it should be noted that, for the most part AAC determinations are not explicit about how harvest performance should be measured. Because of the issues outlined above there is often considerable, and unresolved, debate among interested parties about how harvest performance should be measured at the management unit scale. For example, the recent AAC determination for the 100 Mile House TSA states that there should be a, "report annually to the chief forester [about] harvest performance within dead stands and within the AAC partition attributable to live tree volume," but there is no specific direction about how this is to be done other than a mention in the text that district staff "indicate they could implement a partition to conserve live trees based on cruise data."[xliii]

Secondly, and most importantly, the system described in Figure A8 underwent a significant change on June 1, 2010. After that time if an area to be harvested contained more than 35 percent red and grey MPB attacked pine, the log scaling and waste assessment processes are no longer used and the area is administered (in HBS) using a cruise-based billing system (also called stand-as-a-whole pricing).[xliv] The data entered into HBS is volumes and species composition estimated in the cruise. That volume is an estimate of what was planned to be harvested and delivered, rather than an estimate of what was actually delivered.

Prior to June 1, 2010, only one percent of the volume in HBS was administered using cruise-based billing. Since then approximately half the total volume (and 70 percent of the pine volume) is administered that way. That is, recently, half the volume in HBS is an estimate of what was actually harvested and delivered, and half the volume is an estimate of what was planned to be harvested. These volumes may not be comparable for the reasons discussed above. This may not be important for the primary purpose of the information system, that is, calculation and collection of stumpage owed, but it may be very important when using the information to measure harvest performance against expectations.

In summary, the primary issues related to the use of HBS and ECAS to track harvest volume in beetle affected units are:

- HBS tracks timber that was actually harvested for scale-based returns, and records what was planned for harvest (but not actually harvested) for cruise-based returns. Therefore, the system cannot be used to report on what was actually harvested—or planned to be harvested—for all areas and volume in beetle affected units.
- ECAS currently records detailed information about the type of timber planned for harvest – including dead and live volume – but it does not track the timber that is actually harvested. Furthermore, ECAS was designed to facilitate appraising stumpage, and not reporting information for tracking harvest plans. Thus, access to information from the system is difficult, and does not include some key data that would be useful in tracking harvest expectations.

The consequence of these issues is that the information systems, in their current form, do not provide easy access to consistent information about harvest in beetle-affected units needed to monitor performance against government expectations. Much of the information needed can be extracted from these systems, but assumptions and approximations must be made to. Modifications to the reporting systems and policy changes related to what information is reported would be required to solve these problems. The Board notes that these issues are unimportant in the context of the primary purpose of the information systems (collecting revenue from timber harvesting and ensuring the correct timber volume is being billed accurately and equitably).

Table A6. Differences between percent pine in the Vegetation Resources Inventory and report to HBS.

	Percent Pine Source		
Management Unit	**VRI**	**HBS**	**Difference**
100Mile House TSA	82%	75%	8%
Arrow TSA	30%	24%	6%
Boundary TSA	61%	54%	7%
Bulkley TSA	61%	61%	0%
Cranbrook TSA	67%	70%	-3%
Dawson Creek TSA	41%	36%	4%
Golden TSA	33%	34%	-1%
Invermere TSA	60%	58%	2%
Kamloops TSA DKA	58%	55%	2%
Kootenay Lake TSA	45%	44%	1%
Lakes TSA	81%	78%	3%
Lillooet TSA	33%	30%	3%
MacKenzie TSA	72%	66%	7%
Merritt TSA	79%	75%	4%
Morice TSA	75%	68%	7%
Okanagan TSA	61%	51%	10%
Prince George DJA	73%	68%	5%
Prince George DPG	72%	63%	9%
Prince George DVA	84%	79%	5%
Quesnel TSA	86%	83%	4%
Robson Valley TSA	58%	41%	17%
Williams Lake TSA	78%	71%	7%
All TSAs	**72%**	**66%**	**7%**

Harvest polygons (reported to RESULTS) for the period 2007 to 2012 were intersected with the Vegetation Resources Inventory (VRI) from 2007. Percentage pine was calculated and compared to estimates obtained from HBS.

Appendix 5: The Fourth Quarter of 2013-14 Projections

See Appendix 3 for methods. Multipliers are shown for each year and the average multiplier used to estimate the fourth quarter are shown.

Projection of Percent Pine in the Harvest (Figure 4)

Fiscal Year	Fiscal Part (Quarter)	Total Volumes for all Beetle-Affected Units		Multipliers	
		Pine	Total	Pine	Total
2009-10	1st, 2nd and 3rd	15,275,641	21,745,986		
	4th	9,232,482	13,684,491	0.60	0.63
2010-11	1st, 2nd and 3rd	18,747,258	28,188,511		
	4th	9,713,646	15,381,169	0.52	0.55
2011-12	1st, 2nd and 3rd	19,284,299	30,066,915		
	4th	8,661,767	14,557,592	0.45	0.48
2012-13	1st, 2nd and 3rd	17,706,455	29,213,535		
	4th	8,576,354	14,830,983	0.48	0.51
2013-14	1st, 2nd and 3rd	16,530,984	28,997,204		
	4th Quarter Estimate	8,497,150	15,707,714	0.51	0.54
Total 2013-14		**25,028,134**	**44,704,918**		
Percent pine 2013-14		*56%*			

Projection of Percent Pine Leading in the Prince George TSA Harvest (Table 5)

Time Period	Fiscal Part (Quarter)	Volume		Second Half Multipliers	
		Total Volume	Pine Leading Mark Volume	Total Volume	Pine Leading
2010-11	1st, 2nd and 3rd	6,217,592	5,456,571	0.61	0.50
	4th	3,806,695	2,705,607		
2011-12	1st, 2nd and 3rd	7,613,415	6,345,256	0.44	0.42
	4th	3,323,280	2,636,218		
2012-13	1st, 2nd and 3rd	6,642,246	5,322,881	0.55	0.50
	4th	3,643,615	2,641,721		
2013-14	1st, 2nd and 3rd	6,278,769	4,644,060		
	4th Quarter Estimate	3,343,027	2,178,996	0.53	0.47
2013-14	Full Year Estimate	9,621,796	6,823,056		
	Pine Leading	0.71			

Projection of Harvest in the Non-Pine Partitions (Figure 6)

Fourth quarter estimators applied to each management unit are shown in yellow highlight.

MU Name	Fiscal Year	Fiscal Part (Quarter)	Non-Pine Volume	Total Volume	Non-Pine Multiplier	Total Volume Muliplier
Kamloops TSA	**2009-10**	1st, 2nd and 3rd	545,382	1,183,986	0.54	0.70
		4th	294,600	832,756		
	2010-11	1st, 2nd and 3rd	788,359	1,639,133	0.54	0.59
		4th	423,464	960,799		
	2011-12	1st, 2nd and 3rd	946,735	1,906,657	0.59	0.57
		4th	557,289	1,094,709		
	2012-13	1st, 2nd and 3rd	1,286,068	2,530,614	0.38	0.35
		4th	489,562	879,909		
	2013-14	1st, 2nd and 3rd	1,367,198	2,328,539	0.51	0.55
		4th Q Estimate	699,537	1,287,315		
Lakes TSA	**2012-13**	1st, 2nd and 3rd	106,155	520,718	0.79	0.67
		4th	84,103	349,408		
	2013-14	1st, 2nd and 3rd	192,139	738,694	0.79	0.67
		4th Q Estimate	152,225	495,671		
Lillooet TSA	**2010-11**	1st, 2nd and 3rd	36,402	53,542	0.55	0.42
		4th	20,104	22,640		
	2011-12	1st, 2nd and 3rd	98,817	151,766	0.31	0.22
		4th	30,910	32,661		
	2012-13	1st, 2nd and 3rd	104,927	128,104	0.23	0.21
		4th	23,984	26,733		
	2013-14	1st, 2nd and 3rd	91,977	172,429	0.36	0.28
		4th Q Estimate	33,530	48,666		
Merritt TSA	**2011-12**	1st, 2nd and 3rd	525,680	2,297,710	0.54	0.46
		4th	285,336	1,060,410		
	2012-13	1st, 2nd and 3rd	495,896	1,723,247	0.57	0.60
		4th	281,383	1,030,582		
	2013-14	1st, 2nd and 3rd	519,136	1,548,699	0.56	0.53
		4th Q Estimate	288,177	820,465		
Morice TSA	**2008-09**	1st, 2nd and 3rd	280,429	1,099,349	0.86	0.82
		4th	240,141	898,883		
	2009-10	1st, 2nd and 3rd	313,117	1,173,113	1.04	1.01
		4th	325,740	1,182,099		
	2010-11	1st, 2nd and 3rd	439,250	1,811,082	0.91	0.63
		4th	399,482	1,139,679		
	2011-12	1st, 2nd and 3rd	589,139	1,654,918	0.59	0.50
		4th	350,522	831,412		
	2012-13	1st, 2nd and 3rd	640,318	1,632,268	0.59	0.56
		4th	379,845	908,727		
	2013-14	1st, 2nd and 3rd	662,282	1,782,625	0.80	0.70
		4th Q Estimate	529,071	1,252,724		
Prince George TSA	**2011-12**	1st, 2nd and 3rd	2,563,800	7,613,415	0.47	0.44
		4th	1,198,390	3,323,280		
	2012-13	1st, 2nd and 3rd	2,357,197	6,642,246	0.63	0.55
		4th	1,474,877	3,643,615		
	2013-14	1st, 2nd and 3rd	2,452,960	6,278,769	0.55	0.49
		4th Q Estimate	1,340,688	3,092,466		

MU Name	Fiscal Year	Fiscal Part (Quarter)	Non-Pine Volume	Total Volume	Non-Pine Multiplier	Total Volume Muliplier
Quesnel TSA	**2011-12**	1st, 2nd and 3rd	400,258	2,495,839	0.52	0.53
		4th	208,142	1,331,121		
	2012-13	1st, 2nd and 3rd	421,457	2,880,122	0.55	0.47
		4th	232,250	1,365,716		
	2013-14	1st, 2nd and 3rd	333,196	2,615,312	0.54	0.50
		4th Q Estimate	178,441	1,317,493		
TFL 52 Bowron-Cottonwood	**2009-10**	1st, 2nd and 3rd	180,035	415,761	0.69	0.94
		4th	125,100	389,437		
	2010-11	1st, 2nd and 3rd	235,681	559,982	0.70	0.53
		4th	164,642	296,244		
	2011-12	1st, 2nd and 3rd	321,143	451,023	0.78	0.63
		4th	251,077	285,624		
	2012-13	1st, 2nd and 3rd	282,463	337,155	1.03	0.91
		4th	292,258	306,334		
	2013-14	1st, 2nd and 3rd	275,677	299,683	0.80	0.75
		4th Q Estimate	221,227	225,329		

Appendix 6: Management Unit Scale Variability

Harvest since the 2007 Board report was examined in more detail to determine whether there has been a consistent focus among management units on harvesting pine. With one exception, the proportion of the pine in harvest in all beetle-affected TSAs[26] has been greater than expected based on the proportion of pine that is available on the landbase (Figure A9). This indicates a focus on pine harvest. As might be expected, this result is stronger and less variable for management units where there has been an AAC uplift, which have more explicit expectations about the amount of pine that should be harvested. This result is consistent with the findings in the 2007 Board report.

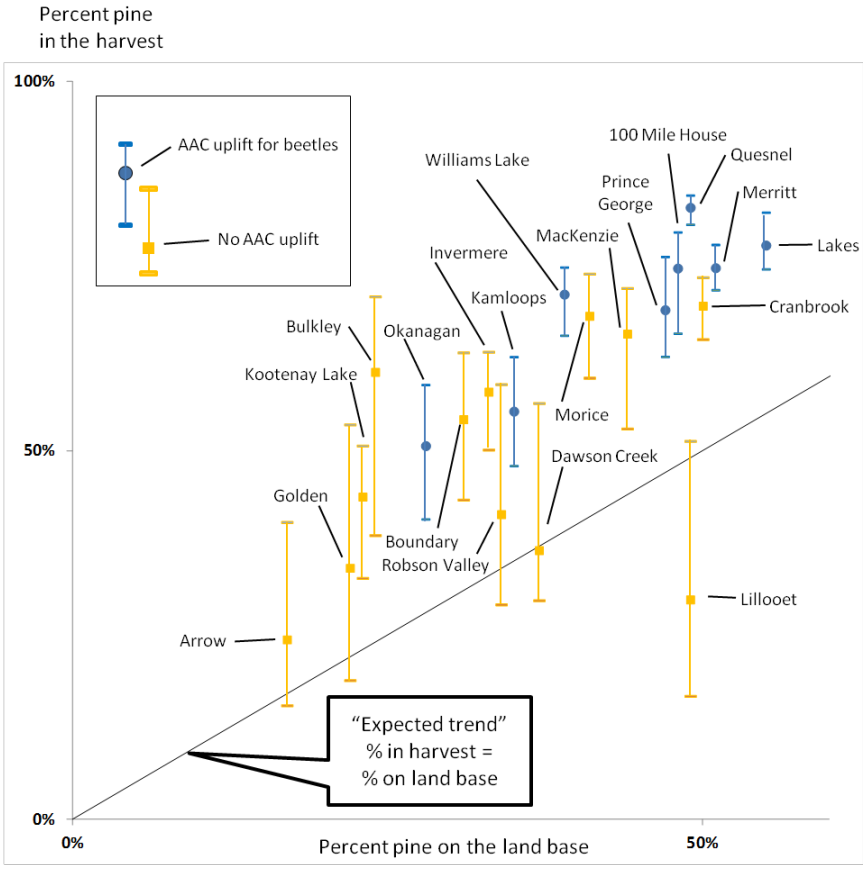

Figure A9. Average, minimum and maximum percent pine in the harvest since 2006-07 compared to the percent pine on the landbase in 2011 (as reported by MFLNRO).

The proportion of dead pine in the harvest was compared to the proportion of the dead pine on the landbase (Figure A10). As in Figure A9, a focus on harvesting dead pine would result in a management unit being above the line—that is the percentage of dead pine in the harvest should be greater than the percentage of dead pine on the landbase. This expectation is stronger for units that have an uplift in place to facilitate management of the outbreak. Although a number of units are below the line in Figure A10, the result overall the beetle-affected units is that there has been a focus on dead pine in the harvest because the units with very large dead pine harvest are predominantly above the line (Kamloops, Mackenzie, Prince George (all districts), 100 Mile House and Quesnel).

[26] TFLs are not included in this analysis because MFLNRO provides limited information about the volume of pine remaining on the landbase in TFLs in 2011.

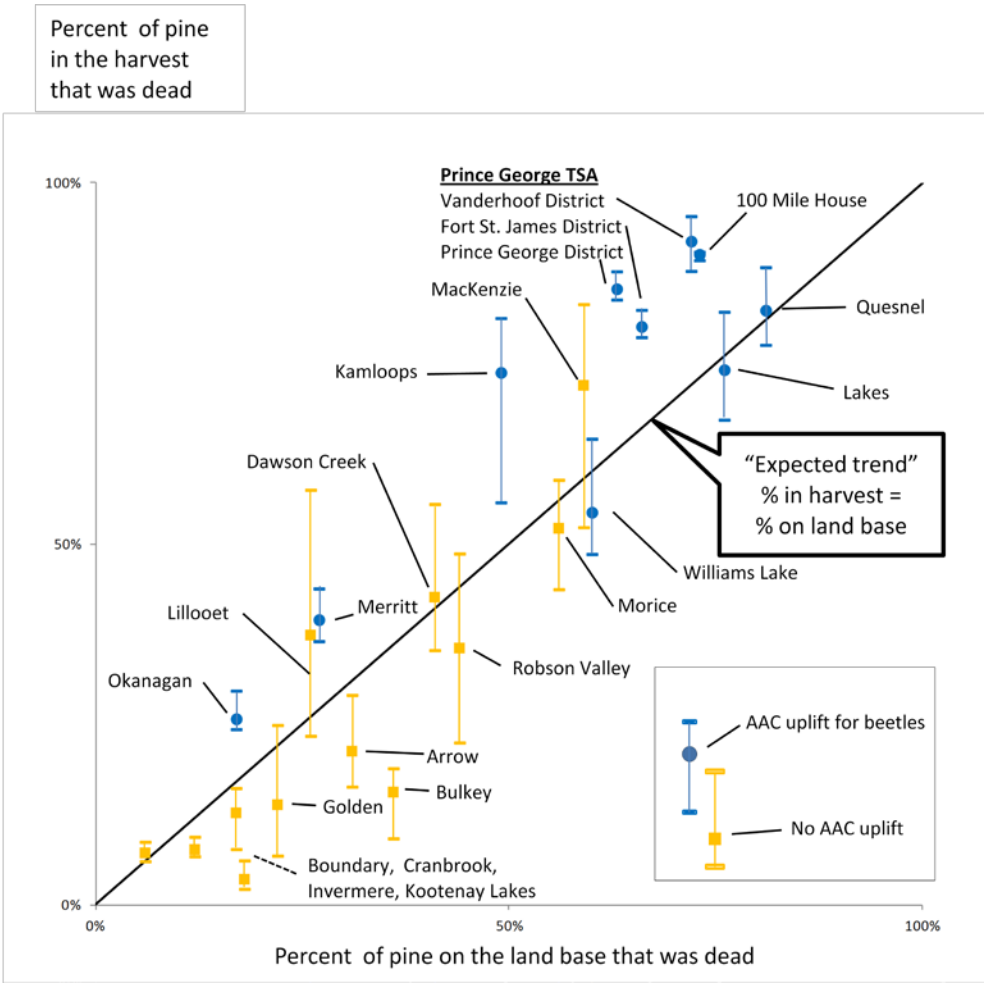

Figure A10. Average, minimum and maximum percent of the dead pine in the harvest during 2011-12 and 2012-2013 compared to the percent of dead pine on the landbase in 2012 as reported by MFLNRO http://www.for.gov.bc.ca/hre/bcmpb/

End Notes for the Appendices

Web links last accessed March 21, 2014

[xxx] Timber Pricing Branch, MFLNRO , Harvest Billing System (HBS), http://www.for.gov.bc.ca/hva/hbs/

[xxxi] Timber Pricing Branch, MFLNRO, Electronic Commerce Appraisal System (ECAS) https://www.for.gov.bc.ca/hva/ecas/

[xxxii] Forest Analysis and Inventory Branch. 2012. Monitoring Harvest Activity Across 28 Mountain Pine Beetle Impacted Management Units. MFLNRO. http://www.for.gov.bc.ca/hts/pubs/Report-Monitoring%20Harvest_Nov%202012.pdf

[xxxiii] Walton, A. 2013. Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: Update . . 10. MFLNRO http://www.for.gov.bc.ca/ftp/hre/external/!publish/web/bcmpb/year10/BCMPB.v10.BeetleProjection.Update.pdf

[xxxiv] Current Allowable Annual Cut (AAC) for Timber Supply Areas (TSA) http://www.for.gov.bc.ca/hts/aactsa.htm and Current Allowable Annual Cut (AAC) for Tree Farm Licences (TFLs) http://www.for.gov.bc.ca/hts/tfls.htm

[xxxv] Forest Practices Board. 2007. Tree Species Harvested In Areas Affected By Mountain Pine Beetles FPB/SR/33. http://www.fpb.gov.bc.ca/SR33_Tree_Species_Harvested_in_Areas_Affected_by_MPB.pdf

[xxxvi] Supra note xxx

[xxxvii] For example Snetsinger, J. 2010. Merritt AAC Determination. Ministry of Forests Mines and Lands http://www.for.gov.bc.ca/hts/tsa/tsa18/tsr2009/18ts10ra.pdf.

[xxxviii] Supra note xxxi

[xxxix] Timber Tenures Branch, MFLNRO, AAC, Apportionment and Commitment Reports http://www.for.gov.bc.ca/hth/timber-tenures/apportionment/index.htm

[xl] Forest Analysis and Inventory Branch, MFLNRO, Vegetation Resources Inventory http://www.for.gov.bc.ca/hts/vri/

[xli] Forest Inventory Division, BC Forest Service. 1976. Metric diameter class decay, waste and breakage factors for all forest inventory zones. http://www.for.gov.bc.ca/hfd/library/documents/Bib37749.pdf

[xlii] Most recently Nichols, D. 2013. 100 Mile House TSA AAC Determination, MFLNRO http://www.for.gov.bc.ca/hts/tsa/tsa23/current_2012/23ts13ra.pdf at page 19, but see also Forest Practices Board. 2010. Measuring wood waste in BC. Complaint Investigation 080870. FPB/IRC/170 http://www.fpb.gov.bc.ca/WorkArea/DownloadAsset.aspx?id=5499

[xliii] Nichols, D. 2013. 100 Mile House TSA AAC Determination, MFLNRO at page 25 and page 36. http://www.for.gov.bc.ca/hts/tsa/tsa23/current_2012/23ts13ra.pdf

[xliv] Friesen, B. 2010. Memo to all interior licensees regarding planned changes to the interior market pricing system (MPS) http://www.for.gov.bc.ca/ftp/hva/external/!publish/web/InfoPaper/Proposed-Interior-Pricing-Policy.pdf

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