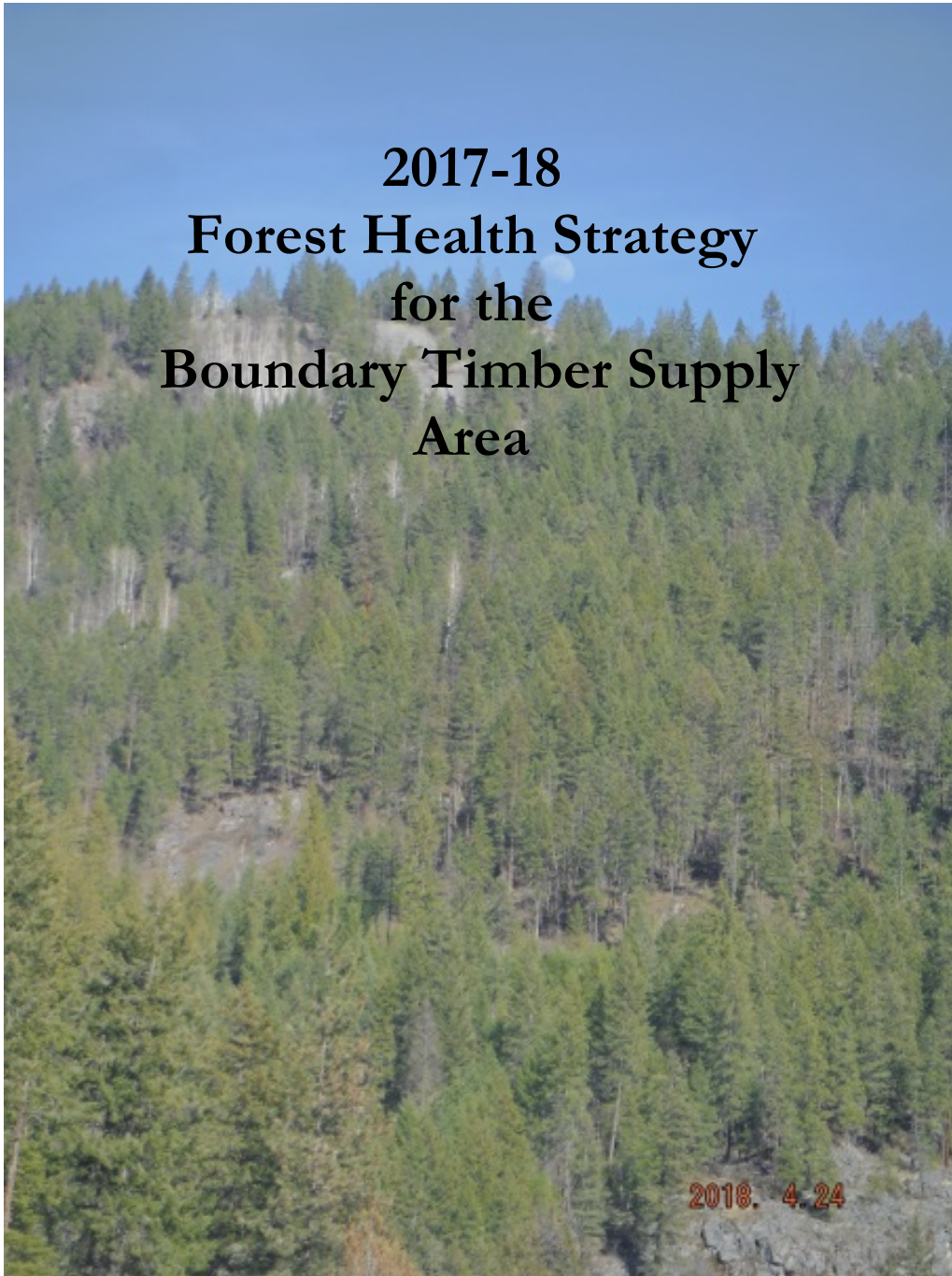


2017-18 Forest Health Strategy for the Boundary Timber Supply Area



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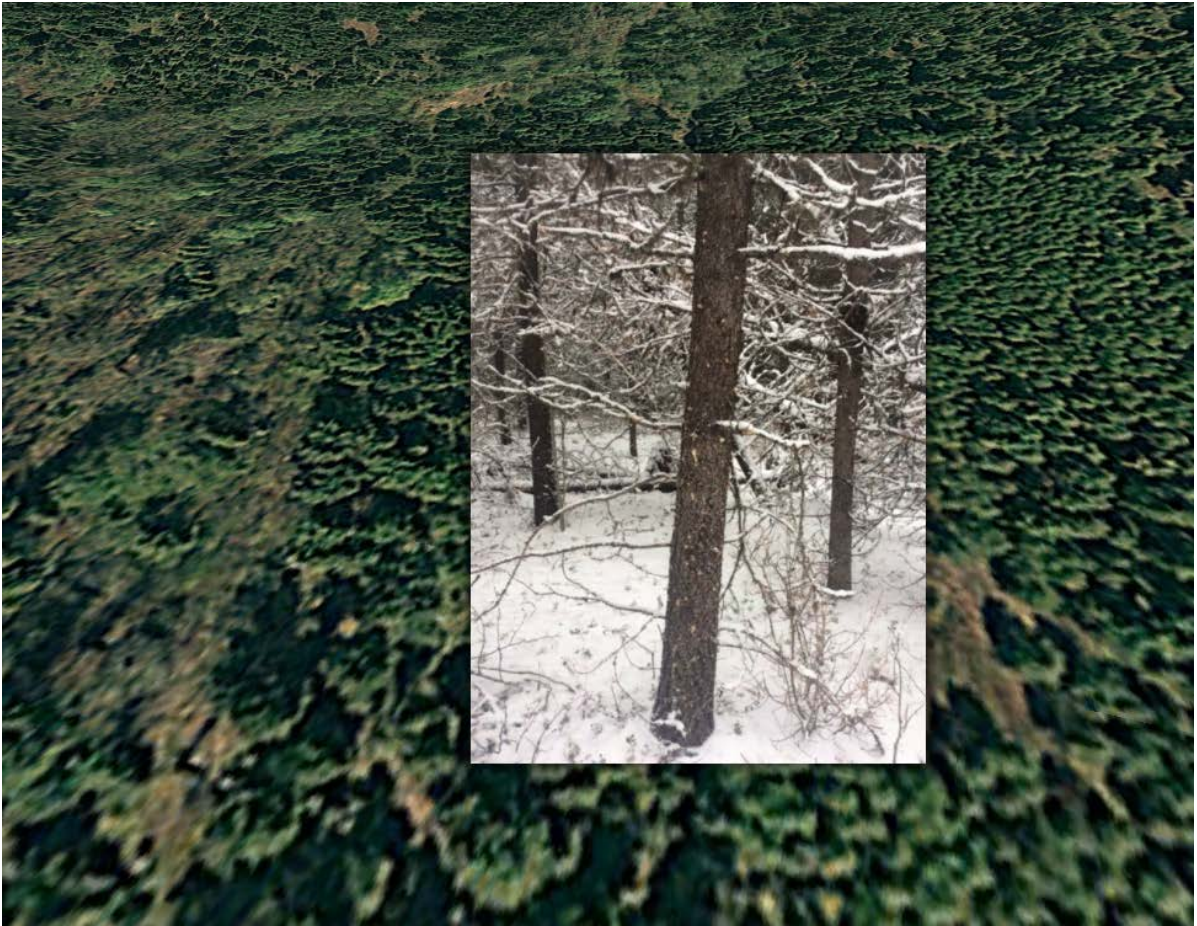
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May 15, 2018

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28 May 2018

Date



Young Pli , approximately 40 years old, IBM attack in Gilpin area

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1. Goal

The goal of this Forest Health Strategy is to serve as a resource for directing forest health management and for communicating hazards or other relevant information on major pests in the Boundary Timber Supply Area (TSA). It provides some of the tools necessary to improve sustainability and resiliency of forested ecosystems by identifying strategies and tactics to minimize losses from damaging insects, diseases and abiotic disturbances.

2. Objectives

The overall objective is to minimize timber losses and the hazard and risk from forest health factors by:

- maintaining a detection program for forest health agents over the land base;
- assessing the potential risks and impact of the identified forest health agents on resource values and timber supply;
- identifying prevention and suppression strategies and tactics for major pests;
- implementing ecologically sound, economically feasible and socially acceptable mitigating strategies and tactics to address forest health agents while considering constraints and limitations placed on the land base;
- encouraging and fostering knowledge sharing on forest health agents amongst Boundary TSA forest stakeholders, primarily forest tenure Licensees;
- evaluating management practices for the purposes of adaptive management; and
- provide strategic direction for management activities.

2.1 Provincial Forest Health Mandate

The goal of the Provincial Forest Health Program is to manage pests to meet forest management objectives. The provincial government's three key forest health strategic objectives are to:

- 1. Pest impacts are monitored and assessed**
The evaluation of pest impacts on forest resource values is supported by forest health monitoring and assessments.
- 2. Practices are adapted to accommodate known forest health risks**
Forest practices are modified to minimize the impacts of forest health factors based on the best available information.
- 3. Resources are protected**
Forest resources are protected from pest damage through appropriately applied direct management actions.

Additional information on the Provincial Forest Health Program can be found at:

<https://www.for.gov.bc.ca/hfp/health/index.htm#first>

3. Boundary TSA description

The Boundary Timber Supply Area (TSA) lies in the southeastern part of the province, and is part of the Selkirk Resource District. The TSA covers 580,000 hectares (ha) with about 288,000 considered to be available for timber harvesting. Biogeoclimatic zones include Interior Cedar Hemlock (ICH), Engelmann Spruce-Subalpine Fir (ESSF), Montane Spruce (MS), Interior Douglas fir (IDF) and Ponderosa pine (PP). Forests are dominated by Lodgepole pine, Douglas-fir, Western larch, Spruce, and Sub-alpine fir. While the external perimeter of the TSA includes Tree Farm Licence 8, Granby Provincial Park and Gladstone Provincial Park, these units are not included in the TSA area or

Timber Supply review. Important non timber values include domestic water, forest recreation, scenic, mule deer winter range and habitat for a threatened grizzly bear population. The last TSR determination concluded that non recovered losses due to forest health factors and growth losses due to Armillaria root disease are important factors driving allowable annual cut calculations.

The main communities in the TSA are Grand Forks, Christina Lake, Greenwood, Midway and Rock Creek.

Table 1: Total Volume (m³) by Species Composition for Boundary TSA, over 60 yrs old as of March 2017. Does not include TFL8, Parks or private land.

Species	Leading Species Total Volume m ³	2nd Species Total Volume m ³	3rd Species Total Volume m ³	4th Species Total Volume m ³	Total Volume	Volume %
PLI	10,696,155	2,408,930	1,637,893	150,430	14,893,408	29.7%
FDI	9,192,607	1,824,258	634,120	69,889	11,720,874	23.4%
LW	6,493,664	4,341,490	762,555	114,394	11,712,103	23.4%
SX	2,998,305	2,229,012	474,530	123,106	5,824,953	11.6%
BL	2,310,305	992,873	237,939	69,051	3,610,168	7.2%
CW	350,762	185,458	71,811	26,222	634,253	1.3%
HW	355,239	95,712	32,418	12,315	495,684	1.0%
AT	145,467	90,692	40,606	29,879	306,644	0.6%
ACT	217,506	43,673	23,399	13,686	298,264	0.6%
PY	64,726	114,946	67,243	17,220	264,135	0.5%
PW	38,187	52,828	93,845	59,056	243,916	0.5%
EP	26,997	15,351	17,281	9,491	69,120	0.1%
PA	2,695	9,257	9,021	0	20,973	0.0%
Totals					50,094,495	

The following BMUs contain area in both TFL 8 and in the Boundary TSA.

TFL8 BMUs
B01 – South Kettle (portion)
B07 – Boundary South (portion)
B08 – Beaverdell North (portion)

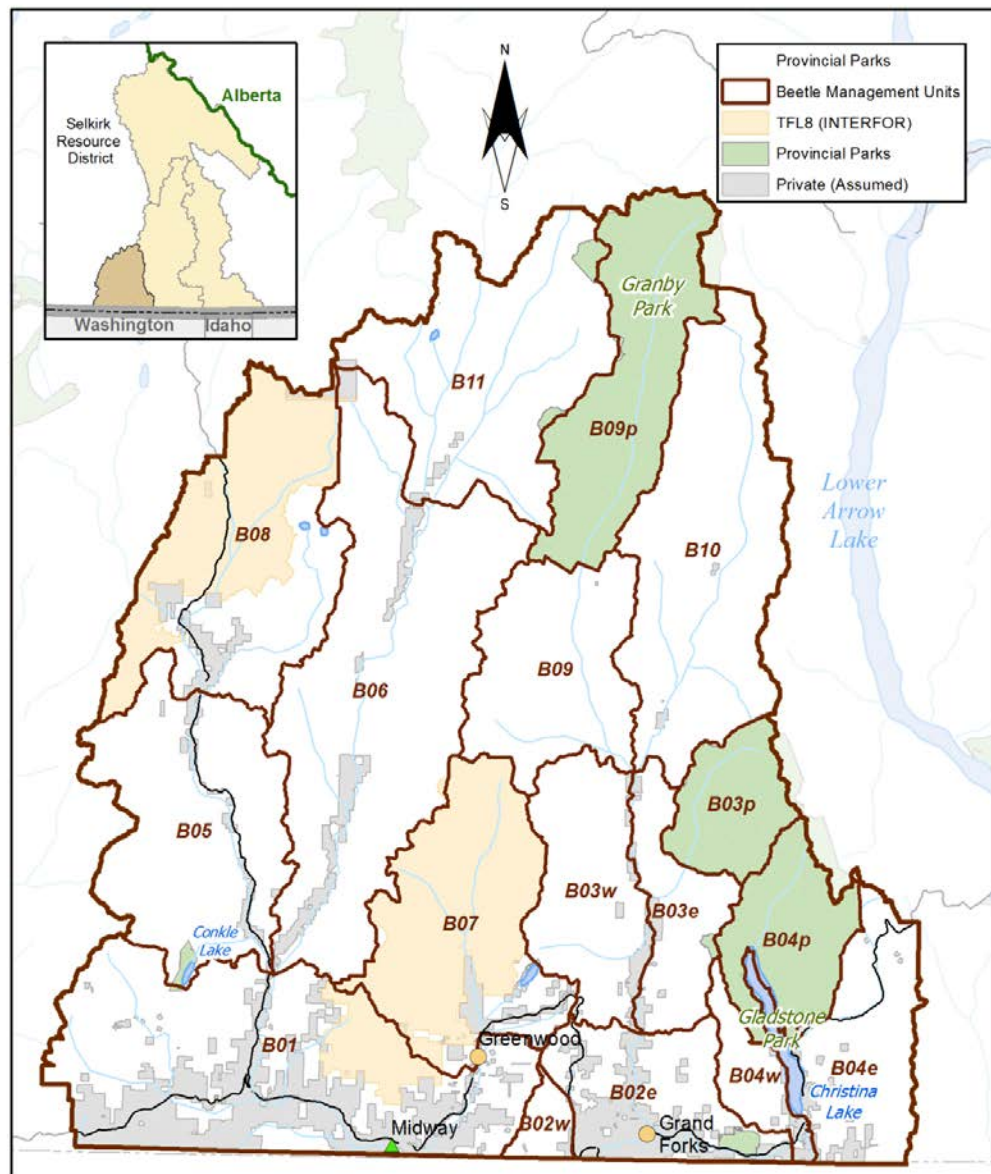
The following 14 BMUs are fully included in the Boundary TSA:

BMU #	BMU Name	BMU #	BMU Name
B01	South Kettle (portion)	B05	Beaverdell South
B02e	Grand Forks East	B06	Kettle River
B02w	Grand Forks West	B07	Boundary South (portion)
B03e	Mid Granby East	B08	Beaverdell North (portion)
B03w	Mid Granby West	B09	Upper Granby
B04e	Christina East	B10	Burrell Creek
B04w	Christina West	B11	Rendell Creek

Comprehensive descriptions of the Boundary TSA are included in the following documents:

- Boundary TSA Website <http://www.for.gov.bc.ca/hts/tsa/tsa02/>
 - Information Report
 - Analysis Report
 - Rational for Allowable Annual Cut Determination.
- Kootenay-Boundary Land Use Plan

<https://www.for.gov.bc.ca/tasb/slrp/pdf/LRMP/Kootenay%20Boundary%20Land%20Use%20Plan%20Implementation%20Strategy.pdf>



Map 1: Boundary TSA showing BMUs, TFL8, Parks and Private Land.

3.1. Previous Forest Health Strategies in the Boundary TSA

The last forest health strategy update was completed in 2017. Since 2005, there have been annual updates to Beetle Management Strategies (BMUs) based on annual aerial overview mapping, detailed mapping, ground surveys and other local information.

4. TSA Priority Ranking of Forest Health Agents

The priority forest health agents have been ranked following the Provincial Forest Health Strategy (Table 2). Rankings were based on the following factors:

- The collective knowledge of the regional and district forest health specialists, forest managers, licensees and contractors.
- Historic recorded occurrence patterns.
- Known or suspected impacts to forest resource values, based on the knowledge of local forest professional and regional forest health specialists.
- Availability of operational detection and treatment methods.
- Costs and benefits of applying detailed detection and treatment activities.
- Overall level of knowledge about the hazard and risk zones.
- Distribution of pest and current incidence levels.

The rankings are somewhat subjective, so an additional approach is to consider what the impact of the forest health factor would be equivalent to in terms of area. This approach provides a useful perspective to the rankings and generally applies as follows:

- Very High: a forest health factor that has the predicted potential to result in damage equivalent to the loss of >400 ha per year
- High: loss of 200 – 400 ha per year
- Moderate: loss of 100 – 200 ha per year
- Low: loss of 50 – 100 ha per year
- Very Low: very little or no known damage (<50 ha per year)

Note: some abiotic injuries (i.e. flooding) are not ranked, as the severity can change with each event. Also note that not all forest health factors are ranked, only the more significant pests within the TSA. The following table covers the major forest health agents which can potentially impact the timber supply.

Table 2: Ranking of Forest Health agents by potential impact on forest management activities in the Boundary TSA				
	Very High	High	Moderate	Low
Defoliators	Western Spruce Budworm			Aspen Serpentine Leaf Miner, Balsam Woolly Adelgid
Diseases	Armillaria root disease		Hard pine rusts (Western gall rust, Stalactiform blister rust & Comandra blister rust, Larch Needle Blight, White Pine Blister Rust	Dwarf mistletoe (pine and larch) Black Stain root disease
Insects	Mountain pine, Douglas-fir, Spruce & Western balsam bark beetles			Western pine beetle Spruce weevil

Mammals		Bear & other animals		
Abiotic Factors	Fire		Drought, Windthrow	

5. Description of the Priority Forest Health agent status

The following table provides an overview of the activity status of some of the priority forest health agents which were reported during the 2017 provincial overview survey.

Table 3: Selected summary of 2016 & 2017 Boundary TSA significant Forest Health damaging agents

Forest health agents	2016 Affected Area(ha) & # of trees in spots	2017 Affected Area(ha) (includes # of trees in spots)	Trend	Current Impact on Timber Supply	TSA Priority
Mountain pine bark beetle	16,980 ha/ 3701	1277 ha	Decreased significantly	High	1
Douglas-fir bark beetle	442 ha/ 1470	995 ha	Increased significantly	High	1
Western Spruce Budworm	1694 ha	0 ha	Decreased significantly	Nil	2
Western balsam bark beetle	3619 ha/ 179	542 ha	Decreased Significantly	Moderate	3
Fire	370 ha	2309 ha	Increased significantly	High	2
Spruce bark beetle	27.6 ha/ 0	0 ha	Decreasing	Nil	3
Animal(Bear)	112	243 ha	Increasing	High	3
Aspen Serpentine Leaf Miner	387 ha	398 ha	Increasing slightly	Low	NA
Pine Needle Cast & other Pine foliar diseases	369 ha	7684 ha	Increasing significantly	Moderate	3
Larch Needle Blight	0 ha	519 ha	Increasing	Very Low	
Drought	20 ha	0 ha	No change	Very Low	3
Post Burn Mortality	18 ha	137 ha	Increasing	Very Low	3
Western Pine Beetle	11.4 ha/ 30	0 ha	Decreasing	Nil	3
Windthrow	0 ha	0 ha	No change	NA	1

5.1. Mountain Pine beetle –IBM (*Dendroctonus ponderosae*)

The mapped polygon area of current mountain pine beetle infestation has decreased significantly in 2017 compared to 2016 levels, only 7.5% of the 2016 area. The cause of this significant drop is unknown, presumably it is not weather (cold) related as the winter did not have killing cold temperatures. The decline may be related to lack of food source due to many years of repeated

attack and past focus of harvesting larger diameter unattacked Lodgepole pine stands by Licensees. There may also be the possibility the attack levels were not detected due to wet weather over the spring and at time of flight in early summer many trees had not yet turned red. The 2018 flight should confirm if this significant drop is in fact the case.

Mountain pine beetle has been active in the Boundary TSA since 2002 and may have peaked but remains a significant cause of tree mortality and non-recoverable losses if not harvested immediately. Volume losses based on the AOS data (TSA only) from last 3 years show a declining trend from 77,072 m³ to 55,214 m³ to 58,038 m³ from 2015 to 2017 respectively. There are 117,752 ha, out of a total of 659,000 ha, of susceptible (>33 rating) forest types to Mountain pine beetle in the Boundary TSA based on a 2014 BMU analysis and Lodgepole Pine is the dominant tree species in this TSA, representing 29.7% of volume over the age of 60 (exclusive of TFL8, parks and private land).

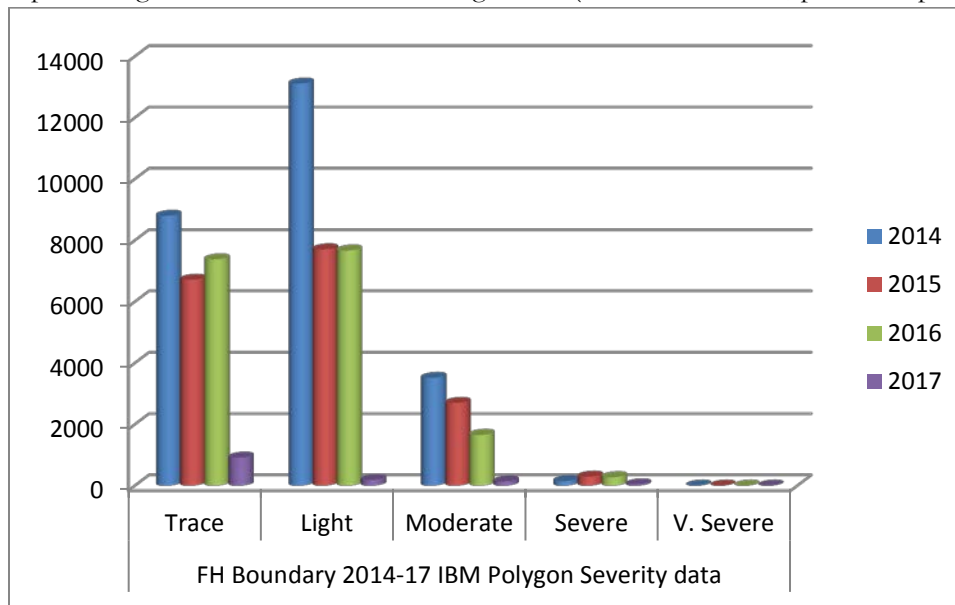


Figure 1 Boundary TSA: 2014-2017 MPB polygon area by severity class.

Harvest levels of Pli by Boundary TSA Forest Licensees have not been adequate to reduce IBM attack levels and likely not reducing non-recoverable losses significantly. Over the past several years Boundary TSA licensees/BC Timber Sales have harvested Lodgepole pine stands as a high percentage of their harvest but the recent trend for 2013-2016 shows declining Pli harvest both in absolute amounts and as a percentage of the total harvest. Pli volume as a % of billed volume represented 47.7% in 2014, 38.2% in 2015 and only 34.2% in 2016. The average annual harvest level over 2013-2016 has been 960,000 m³/ year, somewhat above the total AAC on the TSA, TFL and CFA combined AACs of 886,000 m³.

Table 4: Mountain Pine Beetle attacked area 2014 – 2017 compared to area harvested and planned to be harvested.

	2014-17 IBM AOS Polygon % Harvest Area			
Year	Total AOS Polygon Area – ha.	Harvested as of Winter 2017-18	Planned Harvest as of Winter 2017-18	Total Current and Future Harvest %
2014	25575.4	12.4%	4.1%	16.5%
2015	17363.7	10.5%	3.6%	14.1%
2016	16980.3	8.9%	3.2%	12.1%
2017	1248.9	6.4%	4.4%	10.8%

The table above is a summary of the annual 2014 to 2017 AOS IBM polygons across the entire TSA and the harvest to date and planned harvest. Values are significantly below target of 50% for a Holding strategy for BMUs.

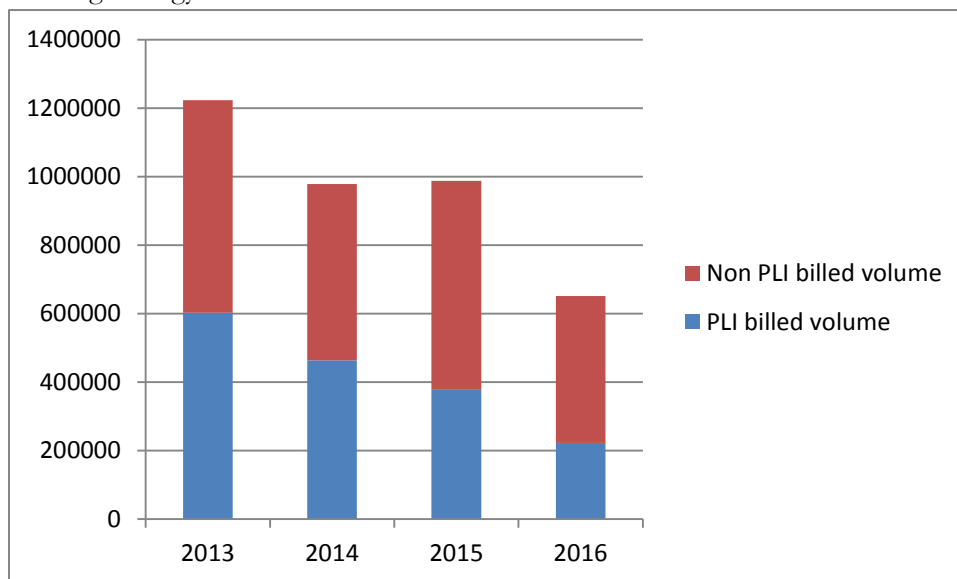


Figure 2: 2013-2016 billed volume (m3) for Boundary TSA (includes TFL 8 and WB CFA).

Future Trends

The BC MPB projection of the Current Mountain Pine Beetle Outbreak estimates that less pine will be killed than originally thought but the impact on Boundary TSA is still significant and projects that IBM attack will continue to increase for Boundary TSA. <http://www.for.gov.bc.ca/hre/bcmpb/>

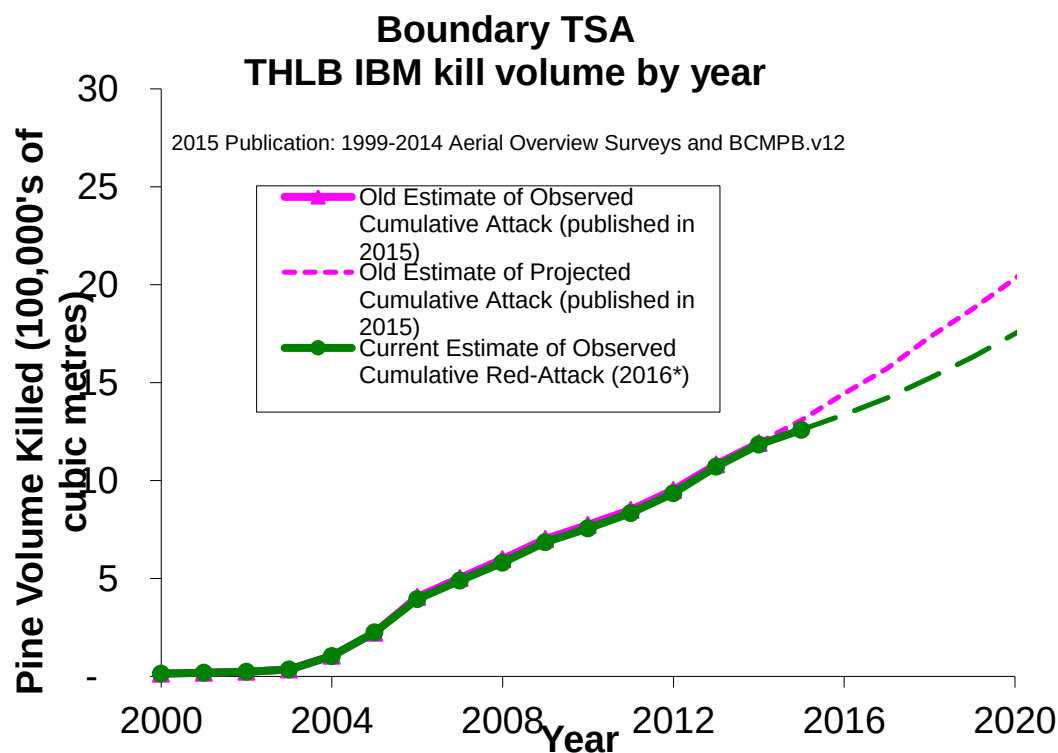


Figure 3: BCMPB V13 IBM pine kill volume projection shows a decreased kill projection rate over previous year. Last update was based on 2015 data

The current model still projects that the annual volume of Pli killed will continue to rise over the next 9 years to over 150,000 cubic meters in 2024. From 1999 to 2024 the projection is that 15% of the total Pli volume will have been killed by IBM, down from 19% in 2016's projection. The total Pli volume killed from 1999 to 2015 from Mountain Pine Beetle has been calculated at 1,259,280 cubic metres based on the Aerial Overview Survey data.

One Licencee reported – “MPB in juvenile (30-40 year) lodgepole pine stands in the Gilpin area is the most concerning Forest Health issue for me. I haven't seen it spread in strictly young stands like these before.” DSE assessment of a sample of previously spaced and or pruned Pli stands found evidence of IBM attack in these stands.

5.2. Douglas-fir beetle –IBD (*Dendroctonus pseudotsugae*)

The Douglas-fir beetle population has more than doubled from last year. The infested area has increased to 995 ha in 2017 from 442 ha in 2016. There have been additional anecdotal reports of active IBD from some of the Woodlot Licensees as well. The area covered by the 2017 detailed IBD flight detection found significantly more attack in the portion of the TSA flown with **438 spots** detected and **2009 red trees** tallied, 2016 detailed flight tallied **422 spots** and a total of **2030 red trees**. The detailed flights for both years did not tally single red trees, only 2 or more and flew outside of TFL8 and Parks in southern portions of the TSA. The detailed flight shows a much higher incidence than the Overview survey highlighting how significant IBD is at this time. Attack levels are increasing over previous years. Exact are flown in each of 2016 and 2017 may have varied somewhat.

Douglas-fir is a common and the second most predominant species, 23.4% of the volume over age 60, in this TSA and is of an age and diameter to be susceptible to the beetle. There are 60,270 ha of susceptible (>20 rating) forest types to Douglas-fir beetle in the Boundary TSA based on a 2014 BMU analysis. Proactive management of Douglas-fir beetle and Douglas-fir leading stands remains a high priority for the Boundary TSA given this species' higher wood value. Trap trees and/ or funnel trap programs and monitoring post-harvest slash and monitoring blowdown in recently harvested blocks and removing or burning any slash would be considered good practice to minimize future losses.

Table 5: Douglas-fir Beetle attacked area 2014 – 2017 compared to area harvested and planned to be harvested.

Year	2014-17 IBD AOS Polygon % Harvest Area			Total Current and Future Harvest %
	Total AOS Polygon Area – ha.	Harvested as of Winter 2017-18	Planned Harvest as of Winter 2017-18	
2014	50.1	15.6%	0.0%	15.6%
2015	259.8	12.1%	43.4%	53.5%
2016	441.9	13.1%	13.7%	26.7%
2017	807.3	9.3%	3.8%	13.1%

The table above is a summary of the annual 2014 to 2017 IBD AOS polygons across the entire TSA and the harvest to date and planned harvest. There appears to be a delay in planning and implementing harvest of beetle attacked areas and a shortened timeframe would assist in control of IBD and ideally use trap trees for control as well.

The Bark Beetle Guidebook is an additional source to guide treatments (a revised publication should be available this year). In recent years, a small amount of IBD attacked trees and blowdown have been salvaged through the District Small Scale Salvage Program, reducing potential non recoverable losses to a small degree.

Winter snow damage on mature stems and possible subsequent IBD concerns were noted by 1 Woodlot Licence holder.

5.3. Spruce bark beetle -IBS(*Dendroctonus rufipennis*)

No Spruce bark beetle was identified in the aerial overview mapping, down from the 28 ha in 2016. Spruce blowdown or Bark beetle attack, when identified, is a high priority for harvest and treatment. There are 51,496 ha of susceptible (>20 rating) forest types to Spruce beetle in the Boundary TSA based on a 2014 BMU analysis. The Bark Beetle Guidebook will guide treatments. Link is as follows: <http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/beetle/betletoc.htm>

5.4. Windthrow-NW

No windthrow was observed for 2017 for the second year in a row. It has remained low the last 5 years but it is a concern especially when located in Douglas-fir and Spruce types. Instances of blowdown associated with very small patches or individual trees occurs undetected by the AOS survey. Historically, Spruce bark beetle and Douglas-fir beetle outbreaks have been closely associated to windthrow events. Prompt removal of Spruce and Douglas-fir windthrow trees are imperative to avoid the buildup of these two bark beetles. The direct impact of windthrow on the TSA is usually minimal however, the indirect impact in the form of bark beetle outbreak, can be significant.

5.5. Armillaria Root Disease –DRA (*Armillaria ostoyae*)

Management of Armillaria in the TSA is recommended to follow the “Armillaria root disease management guideline for the Nelson Forest Region” Technical report TR-014, March 1998 and the BC Root Disease Management Guide (in press). Stocking Standards for Free Growing Stands are contained in each licensee’s Forest Stewardship Plan and have been developed to address this disease. Harvested ICH stands of a suitable nature should be considered for stump removal treatments post-harvest to reduce DRA levels. Treatment of stands other than the ICH should be assessed for DRA levels or only after discussions with FLNRO Regional Pathologist. Because deciduous brush thinning can promote spread of Armillaria, such action should be applied carefully. Options might include earlier treatment to maintain conifer crop tree growth vigour when competing deciduous broadleaves have a less extensive root network.

Young plantations with Armillaria tend to suffer a distinct early wave of mortality due to young roots contacting infected stump systems. Mortality usually peaks between 9 and 16 years after planting. Thus, applying free-growing surveys after this time period would provide the most useful information on plantation success. A later FG survey than typical is recommended for areas with known Armillaria, such as ICH sites.

One major licensee reported 79.7 ha of stump removal for 2017, no other Licensees have recorded any treatment to date in RESULTS for 2017. This is significantly down from 2016 when the same Licensee completed 678.9 ha’s of stump removal and one Woodlot completed 2.3 ha. No other Licensees appear to be conducting stump removal treatments even though a significant portion of Boundary is covered by ICH BEC subzones that are considered highly susceptible to DRA and treatment levels seem to be low.

A new root disease guidebook has recently been published and a copy has been placed on the FTP site at the following link:

<https://www.for.gov.bc.ca/ftp/DAB/external/!publish/Forest%20Health/>

5.6. Western Balsam bark beetle-IBB (*Dryocoetes confuses*)

There are large areas of subalpine fir leading forest stands in the Boundary TSA that are susceptible to western balsam bark beetle. Western balsam bark beetle has been chronically causing mortality over many years. Attack levels have decreased significantly in 2017 to 542 ha compared to 3619 ha in 2016. Direct control action on that insect is very difficult due to its attack dynamics and the scattered distribution of the stands.

5.7. Western pine beetle-IBW (*Dendroctonus brevicomis*)

Western pine beetle has been identified in the Boundary TSA in the past and appears to be present in low levels in the extensive Py stands along the main valleys especially on private land. No IBW was mapped in 2017 compared to 13 ha in 2016. Management of Py blowdown is an important component of IBW control.

5.8. Larch Dwarf mistletoe-DML (*Arceuthobium laricis*) & Lodgepole Pine Dwarf mistletoe-DMP (*Arceuthobium americanum*)

The larch and lodgepole pine Dwarf mistletoes may be causing losses in volume in some parts of the TSA. No recent field data to verify level of impact or occurrence. The impact on the TSA is negligible. Refer to the Dwarf Mistletoe Guidebook for management strategy and tactics

<http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/dwarf/dwarftoc.htm>

5.9. Larch needle cast-DFM (*Meria laricis*) and blight-DFH(*Hypodermella laricis*)

In 2017, 519 ha of Larch needle cast were mapped representing a significant increase from 0 ha in 2016. The disease is associated with cool damp spring and early summer conditions and this last year saw wetter conditions throughout the spring season. These diseases infect Western larch of all ages. Defoliation by these diseases may cause minor growth reduction in large trees and young trees may be killed. Occurrence is variable from year to year. Negligible impact on the TSA is expected at this point and no management is proposed except continuous monitoring of the occurrence.

5.10. Black Stain Root Disease-DRB (*Leptographium wageneri*)

Black Stain root disease has caused some mortality of lodgepole pine and was noted in past monitoring and can be associated with Ips beetle. The impact on TSA is not considered significant and no management actions are planned.

5.11. Lophodermella (Pine) Needle Cast -DFL (*Lophodermella concolor*) and Dothistroma Needle Blight – DFS (*Dothistroma septosporum*)

A total of 7684 ha of Lophodermella Needle Cast and Dothistroma Needle Blight was mapped in 2017 up from 369 ha in 2016. This represents a very significant increase from past observations and is a point of concern. The impact on the TSA can be significant in local areas, especially on regenerating plantations. Careful consideration should be given to species selection in higher risk areas such as the ICH BEC zone. Licencees may want to give consideration to timing of Free Growing surveys for high percentage Plt plantations in high risk areas to ensure these diseases are detected. One strategy could be to at least do a sample of surveys earlier in the season.

5.12. Hard pine rusts: Western gall rust-DSG (*Endocronartium harknessii*), Stalactiform blister rust-DSS (*Cronartium coleosporioides*), Comandra blister rust-DSC (*Cronartium comandra*)

The hard pine rusts have been a minor concern in the Boundary TSA in the past and often found in pine plantations. Low levels of Western Gall Rust were noted on post Free Growing Stand Development Monitoring plots completed from 2008-2011. Stocking Standards should be modified to ensure stands are not declared free growing without the stand being old enough or tall enough to more fully express the potential problem with these diseases, especially in ICH sites where Pli is planted or regenerated. Where possible, a mix of species is highly recommended to be planted or regenerated naturally.

One Licencee reports of note was the presence of incidental levels of commandra rust, which I haven't seen at all for a decade or more.

5.13 Western Spruce Budworm –IDW (*Choristoneura occidentalis*)

The population of IDW appears to have crashed in 2017 with 0 ha detected in overview survey compared to 1694 ha detected in 2016. Detection, prediction and treatment of defoliators remain the responsibility of the Kootenay Boundary Regional staff. More specific information on the defoliator program can be obtained from them and in the Defoliator Management Guidebook (1995) <http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/defoliat/defoltoc.htm>.

Forest tenure holders should give thought to appropriate silviculture systems to manage for this pest where other management constraints allow. This would include limiting the amount of single tree selection harvesting or heavy retention systems where trying to regenerate a younger layer under an established canopy. Multi-layered multi-aged stands are especially vulnerable to damage by IDW.

5.14 Deciduous Pests

The only pest in this category was Aspen serpentine leaf miner with 398 ha of area noted in 2017, up slightly from 387 ha in 2016. The impact of this pest on the TSA is not deemed to be significant. No management is planned. As per Chief Forester direction, deciduous species should not be included in stocking standards. Chronic damage impacting deciduous species in the Boundary and other adjacent TSAs over the last many years, possibly related to climate change or weather patterns, supports this recommendation.

5.15 Bear-AB and other Animal Damage

Bear damage was mapped at 243 ha for 2017, showing an increase in area from 112 ha in 2016. During FREP SDM sampling (2009-2013) bear damage and possibly other animals were found to be killing and damaging young Pli trees by stripping their bark and the damage levels are likely significantly higher than can be mapped by the overview survey. Potential solutions to managing animal damage and in particular bear damage might include high species diversity at time of planting, less Pli, and perhaps higher establishment density as well. Consideration should be given to avoiding or careful consideration of spacing, pruning and fertilizing.

A 2017 District project assessing spaced and/ or pruned Pli stands found that Bear damage was significant and one of the 2 leading mortality agents, especially in Pli stands that were both spaced and pruned.

5.16 Birch Decline

Paper Birch (*Betula papyrifera*) decline has been widespread throughout the Southern Interior region of the province. Characterized by crown die-back, most mature birch appear susceptible. The spatial distribution patterns and actual causation remain poorly understood. A variety of agents have been observed including bronze birch borer (*Agrius anxius*), non-native birch leaf miners (*Fenusa pusilla*

and *Profenusa thomsoni*), *Fomes fomentarius*, *Cryptosporella tomentella*, *Armillaria ostoyae* and *Cerrena unicolor*. All are possible agents that could be contributing to birch decline. Climatic perturbations may be a pre-disposing factor – and are currently under investigation using dendrochronology methods.

The decline of birch can accelerate the impacts of *Armillaria* within mixed conifer-broadleaf stands. A particularly important aspect of forest health relates to birch's resistance and tolerance of *Armillaria* root disease. In fact, the roots of deciduous trees often provide a barrier to disease spread, thus protecting neighbouring conifers such as Douglas-fir and lodgepole pine from infection. When birch are harvested, thinned or killed by other causes, the *Armillaria* fungus is able to quickly spread along dead birch roots and transfer to conifers. Overall, the incidence accelerates. Thus, careful consideration should be given in regards to thinning birch and other deciduous brush. One potential action is to consider treatments when the deciduous is younger and smaller with a less developed root network that would come into greater contact than if older and larger.

5.17 Whitebark Pine Decline

Whitebark pine (*P. albicaulis*) often occurs within harvest units at elevations above 1600 meters. About half of all whitebark pine in the Boundary TSA is dead or dying. The causes are primarily white pine blister rust and mountain pine beetle. To a lesser extent, the exclusion of fire has favoured its less fire-hardy competitors. As a result, this tree species was placed on the federal endangered species list in 2012. Whitebark pine is valuable to grizzly bears and many other wildlife for its very large seeds.

The cutting or damaging of whitebark pine should be strictly avoided. Whitebark pine stands, especially those with many healthy cone-bearing trees are good candidates for wildlife tree reserves, Old Growth Management Areas, and Wildlife Habitat Areas for grizzly bears. In harvest areas, the thinning of competing trees can promote whitebark pine survivorship by reducing competition and providing seed regeneration habitat.

5.18 Hot Droughts

The frequency and intensity of drought combined with higher summer temperatures appears to be increasing in the southern interior of BC. As a result, trees become stressed, especially young regeneration and overstocked (high density) mature stands. A total of 0 ha were mapped as drought in 2017 compared to 20 ha for 2016. Although 2017 experienced a record high hot drought, mortality may not become evident until 2018. Impacted trees often don't die until a year or two post hot drought. The hot droughts of 2003 and 2007 are implicated in the timing of deaths of *Armillaria* infected regeneration on the Knappen Creek Stump Removal Trial. Often, trees do not die until the growing season following the drought. In a report to the Chief Forester, Axelson and Ebata (2015) predict the following impacts:

- Bark beetles of various species populations will increase.
- Plantation pests such as spruce weevil or lodgepole pine terminal weevil will increase.
- Defoliator activity could increase. Decline syndromes already being experienced in aspen and birch, they will continue or will become accelerated.
- Root diseases impacts will accelerate.

One Licencee reported - 2017 was a bad year for drought. "We lost some older plantations (5-12 year old), particularly in the low-lying valley bottoms along the Kettle River, where coarse soils completely dried out. The worst suffering spp in this age group was the planted Pli. We also experienced some mortality to new (1-3 year old) plantations, across all species."

6. Management objectives for priority forest health agents

6.1. Management objectives for bark beetles (IBM, IBD and IBS)

The following are the management objectives, **in order of priority**, to be implemented for the three main bark beetles in the Boundary TSA: mountain pine beetles, Douglas-fir beetle and spruce beetle. Any reference to “bark beetles” in the following management objective refers to the three bark beetles listed above.

1. **Sanitation and salvage harvesting of beetle killed areas where economically feasible, especially moderate or higher severity IBM, IBD and IBS attacked polygons and larger Light attack polygons identified by the Aerial Overview Survey or other surveys. Limit the amount of unsalvageable losses due to bark beetles. Target a minimum of 50% of these areas identified as an attack polygon in the last 12 months to maintain current holding action strategy IBM within BMUs. And 80% of the area to maintain the suppression strategy for IBD and IBS.**
2. Prioritize the forest management to higher hazard forest stands by harvesting or reducing the susceptibility of stands to bark beetles.
3. Maintain the annual IBM/ IBD/ IBS affected volumes to no greater than the one year of the current AAC, 700,000 m³.

Definitions:

Sanitation harvesting: harvesting operations specifically designed to maximize the extraction of currently infested or infected stands in order to reduce the damage caused by forest pests and to prevent their spread, e.g. bark beetles.

Salvage Harvesting: harvesting operations primarily designed to recover timber damaged or degraded by fire, an old insect attack, wind, or disease before the potential wood products become un-merchantable. Control of forest health factors such as bark beetles is incidental and is not the primary objective of salvage logging.

6.2 Harvesting Treatments

Harvesting is to be considered the preferred treatment for all infestations where it is operationally feasible. Treatment may include a single harvest regime or combination of harvest regimes ranging from large cut blocks, to single tree selection or small patch where appropriate.

The treatment goal is to remove as much, if not all of the current attack prior to the next beetle flight period. Within the Suppression Zone action plans must contemplate harvest before the next flight period. If this is not achievable, or the likelihood of pre-flight harvest is low, then these areas should be tabled as opportunities for other Licencees by at least April 1st of the following year.

Direct single tree treatments are not to be considered an alternative for harvest where the recovery of otherwise lost timber values and sanitation of beetles, i.e. removal of trees with brood can be attained. Where resources are insufficient to address the removal of all infestations prior to the next beetle flight, consideration must be given to minimizing block sizes and/or harvesting only those portions of the block that are infested this should be considered a short-term strategy until resources permit the removal of logical openings.

It is imperative the operational planning requirements are scheduled accordingly and where necessary to meet tight time frames. If necessary, expedited approvals should be requested and are appropriate where infestations are identified post-flight and where harvest is planned to take place prior to the next beetle flight.

Licencees should consider a small-scale sanitation program as required to meet overall objectives. Sanitation is defined as the removal of infested material prior to beetle flight. Sanitation is to be used, where necessary, to balance resource allocations to optimize the effectiveness of harvesting and single tree treatment strategies and maximize the recovery of otherwise lost timber values.

Sanitation should also be considered where landscape level disturbances and impacts dictate a light footprint approach and where a minimum of one truck load (40 m³) of operable timber can be recovered, within reasonable skid distance (400 metres) of established logging truck access; the objective is to remove all infested trees prior to the next beetle flight. Only under exceptional circumstances where the methods cannot be applied should these sites be baited and held over flight.

If it is determined that harvesting prior to the next beetle flight is impossible, then consideration should be given to expanding the harvest area to include the area baited, as well as sufficient susceptible host.

6.3 Hauling and Milling Guidelines

The following guidelines should be considered when areas surrounding the mill site are in or near urban areas, or in areas not yet affected by bark beetles.

In recognition of the potential for bark beetles to fly from milling facilities into adjacent areas the following guidelines apply during the period of July 1 to September 15:

- Manage -spring break up inventories of infested timber for priority processing prior to the above-noted period;
- Keep mill inventories and deliveries of bark beetle infested wood at a minimal operational level to meet business needs;
- Mill profile requirements permitting, prioritize processing beetle- infested sources over uninfested sources.
- Establish funnel traps (especially for IBD) in and around log yards, log decks and log booms to assist in monitoring bark beetle flight and to serve as a control measure. Traps should be monitored at least weekly and contents destroyed.

In recognition of the potential for bark beetles to fly from infested cut blocks (standing trees or decks) to adjacent timber, the following guidelines apply:

- In Salvage BMU's, no special considerations
- In Suppression and Holding BMU's:
 - For infested cut blocks that are not harvested/hailed prior to beetle flight, consider baiting in an attempt to minimize spread. Licensees should, where practical, plan operations that avoid leaving decks of infested timber on site.
 - Communication of business needs/expectation for awareness between licensee and DSE prior to spring break-up/next beetle flight is required.

In recognition of the potential for bark beetles to fly from trucks during transport the following guidelines apply:

- Inform truck drivers when they are hauling green attack loads and that the beetle flight period extends from July 1st to Sept. 15th.

- Inform truck drivers that extended delays along the way can result in bark beetles flying from the load into the adjacent forest land base.
- When practical, hauling of beetle infested logs should be as direct as possible from the cutting area to the mill.

6.4 Pheromone Placement

Pheromone placement is to occur in **infested stands only**, where beetle control activities cannot be implemented until after the next flight and in mop up operations around harvested and treated infestations. In the case of larger blocks with isolated concentrations of attack, only the infested portions of the block should be baited.

The use of pheromone baits must always be followed by actions to remove or eradicate the concentrated beetle populations. All pheromone placement plans should be shared at operational beetle planning meetings, including scheduling follow-up treatments and responsibilities.

Pheromone placement can be implemented throughout the spectrum of treatment strategies including fall and burn. Pheromones should not be placed in operable areas where population levels are extremely high and increasing, or in inoperable areas where population levels are endemic and declining.

The responsibility to carry out follow-up treatments to remove or eradicate concentrated beetle populations resulting from baiting lies solely with the placement agency (Section 41 of the Forest Planning and Practices Regulation (FPPR)). Follow-up actions must be carried out prior to the subsequent beetle flight unless specifically exempted by the District Manager (Section 91 of the FPPR).

Licensees, excluding TSL holders not operating under a cutting permit authority, should consider pheromone bait placement in unharvested portions of beetle infested blocks prior to biological beetle flight times where due to unforeseen circumstance the Licensee will not be able to complete harvest prior to the beetle flight.

All pheromone placement activities must be carried out in a manner which allows for future identification and location of baited trees. Baited trees must be marked conspicuously in the field using flagging, and the placement agency must be identified at each bait site. Maps identifying all baited areas should be provided to the District by September 15th each year. Detailed guidance and protocols on the use of pheromones is provided in “Strategies and Tactics for Managing the Mountain Pine Beetle”, developed for the B.C. Forest Service by Lorraine MacLauchlan and J. E. Brooks (http://www.for.gov.bc.ca/ftp/HFP/external/!publish/MPB_booklet/).

6.5 Roles and Responsibilities

Detailed bark beetle surveys are carried out to determine the nature and extent of bark beetle infestations within the area of the plan. Specific areas requiring surveys are identified from aerial overview maps and previously known infestations.

If significant risks to forest resources are identified from surveys, actions to reduce risks are identified and reported within bark beetle survey reports and shared with the appropriate licensee. The responsibility to carry out these actions or measures is the responsibility of the licensee.

1. Responsibilities are assigned in this matrix according to funding source. Although there are allowances for some activities under the appraisal system, the responsibilities assigned include the implementation and funding of these activities.
2. In the event that a Forest Licencee must carry out activities within the operating area of another Forest Licencee, the responsibility for bark beetle management activities post-harvest are to be negotiated in advance.
3. Where special management areas have been identified such as areas of interest for the Protected Areas Strategy, the responsibilities identified in this matrix may be amended to address specific management guidelines for these areas.

DSE Forest Health Responsibility Matrix

DISTRICT RESPONSIBILITIES	REGIONAL RESPONSIBILITIES
Prepare an annual Boundary TSA Forest Health Strategy when time and funding permits	Conduct annual aerial overview surveys and provide digital data to districts to produce overview maps and to distribute to DSE clients
Info sharing at TSA Steering Committee meetings and directly to Forest Licensees and other clients	Produce and distribute the Provincial annual forest health overview surveys
Conduct detailed aerial and ground surveys within the Boundary TSA where deemed appropriate	Conduct aerial treatments for defoliators (ex. spruce budworm Bt spraying) Conduct defoliator monitoring
Produce maps from the aerial surveys and provide ground survey information and maps to Licensees and clients	Provide overwinter mortality estimates of bark beetles

Within DSE, Forest Licensees have a responsibility to track, monitor and treat forest health factors. The following table covers the responsibilities for Licensees and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

ACTIVITY	FLNRORD	LICENSEES
Monitor and evaluate forest health activities (Utilize the best current information to detect and manage forest health factors)	X	
Conduct treatment of defoliator outbreaks (FLNRORD regional responsibility)	X	
Develop annual reports of bark beetle activities for the Province	X	
Conduct bark beetle treatments when required by the Forest Health Strategy	X	X
Maintain and share records of collected survey information	X	
Conduct ground surveys when required to verify incidence and severity of forest health pests	X	X
Conduct aerial overview forest health surveys and report on results (FLNRORD region)	X	
Conduct detailed aerial surveys focusing on suppression beetle management units	X	
Submission of survey and treatment data to FLNRORD		X

7. Provincial Ranking and BMU Strategy for IBM and IBD

Ranking for the two bark beetles with the highest potential impact on the TSA will be covered in this section: Mountain pine beetle and Douglas-fir beetle. The two ranking tables below follow the methodology outline in the Provincial Bark Beetle Strategy and also include the strategy for each BMU.

7.1. Table 6: Mountain pine beetle ranking

BMU#	BMU Name	Susceptibility	Provincial Ranking	BMU-Strategy
B01	South Kettle	High	4	Salvage
B02e	Grand Forks E	Low	7	Salvage
B02w	Grand Forks W	High	4	Salvage
B03e	Mid Granby E	High	4	Salvage
B03w	Mid Granby W	High	1	Salvage
B04e	Christina E	High	4	Salvage
B04w	Christina W	Low	6	Salvage
B05	Beaverdell S	High	4	Salvage
B06	Main Kettle River	High	1	Salvage
B07	Boundary S	Low	8	Salvage
B08	Beaverdell N	High	1	Salvage
B09	Upper Granby	High	4	Salvage
B10	Burrell	High	3	Salvage
B11	Rendell	High	4	Salvage

If the MPB infestation declines sufficiently at some point, it may be appropriate to re-designate some BMUs as suppression or holding, however at this time all the BMUs have been changed to Salvage designation for a BMU strategy as harvest levels over the last many years had not achieved the minimum harvest area of 50% for holding strategy.

7.2 Table 7: Douglas-fir beetle ranking

BMU#	BMU Name	Susceptibility	Provincial Ranking	BMU Strategy
B01	South Kettle	High	3	Suppression
B02e	Grand Forks E	High	3	Suppression
B02w	Grand Forks W	High	3	Suppression
B03e	Mid Granby E	High	3	Suppression
B03w	Mid Granby W	High	3	Suppression
B04e	Christina E	High	3	Suppression
B04w	Christina W	High	3	Suppression
B05	Beaverdell S	High	3	Suppression
B06	Main Kettle River	High	3	Suppression
B07	Boundary S	Moderate	3	Suppression
B08	Beaverdell N	Low	8	Suppression
B09	Upper Granby	Low	8	Suppression
B10	Burrell	Low	8	Suppression
B11	Rendell	Low	8	Suppression

Note: No ground based data is available to accurately rate the #green as attack levels for 2017

8. Proposed activities to manage IBM and IBD

8.1. Mountain pine beetle

8.1.1. Harvesting

Timber harvesting in infested (1st priority) and red/grey attack (2nd priority) and un-infested stands (3rd priority) with high hazard and/ or infestation is critical to meeting holding strategy objectives and reducing non-recoverable losses. Failure to address these losses continues to impact future timber supply determinations negatively. Due to insufficient funds to single tree treat the entire area and a lack of coordinated harvesting of Beetle infested stands in BMUs previously designated with a Suppression strategy all Suppression BMUs have been downgraded to Salvage as of 2017-18.

8.1.2. Pheromone Use

No planned pheromone use by DSE at this time but it is covered by the Southern Interior Region Pest Management Plan http://www.for.gov.bc.ca/rsi/ForestHealth/PDF/PMP_2013-2017_FH_Southern_Interior_Feb_19_2013.pdf.

8.1.3. Single tree treatment

Given previous holding strategy no treatments were carried out in 2017 and none planned for future at this time.

8.1.4. Detailed Flight and Ground Surveys

Given 2017 holding strategy no detailed flights were completed in 2017 and future detailed flights for IBM are not planned with current Salvage designation of all BMUs. Fall and Burn treatments would be ineffective without adequate harvesting support given the past and current high beetle populations. If IBM populations remain low throughout the next few years, then re-evaluating suppression strategies and resuming ground treatments may be an option with adequate harvesting support.

8.2. Douglas-fir beetle

8.2.1. Harvesting

The overall strategy for Douglas-fir beetle (IBD) management is that of suppression/monitor through the use of one or a combination of the following:

1. Trap trees;
2. Antiaggregation pheromones (MCH);
3. Traps trees and (MCH); and
4. Clean harvesting practices.

Timber harvesting in infested (1st priority) and red/grey attack (2nd priority) and un-infested stands (3rd priority) with high hazard and/ or infestation is critical to meeting suppression strategy objectives and reducing non-recoverable losses. A combination of sanitation and salvage harvesting for Douglas-fir beetle suppression should be carried out in areas of current-attack in order to reduce the existing population and inhibit the infestation expansion. Failure to address these losses continues to impact future timber supply determinations negatively.

Trap trees are highly recommended as an effective tool to reduce overall beetle population levels in any IBD areas or Douglas-fir stands and complete a post-harvest mop-up where necessary. Baited funnel traps and MCH anti-aggregant may be used where conditions are appropriate, primarily but not limited to near larger fires from previous years.

8.2.2. Pheromone Use

Pheromone use is planned for use with IBD funnel trapping projects only at this time under Land Based Investment Funding works through Selkirk resource District and is covered by the Southern Interior Region Pest Management Plan. At this time, DSE plans to deploy about 25-30 funnel trap sites in West Boundary area for IBD which is similar to 2017 activities. Unaware if any other licencees are planning any funnel trapping within Boundary at this time.

http://www.for.gov.bc.ca/rsi/ForestHealth/PDF/PMP_2013-2017_FH_Southern_Interior_Feb_19_2013.pdf.

8.2.3. Single tree treatment and other treatments

No planned single tree treatments at this time. Funnel trapping currently planned for the Rock Creek / West Boundary Area.

8.2.4. Detailed Flight and Ground Surveys

The current plan for 2018-19 is to complete a heli detail survey, budget allowing, of as much of the Boundary TSA (excludes TFL and CFA areas) as possible within high/ moderate Douglas-fir BMU areas. A limited number of ground surveys may be completed. Detailed mapping flights were completed for Douglas-fir bark beetle in portions of the TSA in 2017.

9. Priority Activities in non-suppression BMUs

With the Timber Supply Review completed, the following projects were part of previous FH strategies:

- Non recovered (unsalvaged) loss estimate - completed 2011
- Growth losses in post Free Growing stands – 29 SDM samples completed 2009 – 2011
- Completed a small sample of Pli plantations in 2017 that were spaced and or pruned to assess FH damage, primarily IBM and AB.

Other potential projects:

- IBD funnel trapping where deemed necessary for control.
- Ground survey sampling of IBD

10. 2018-19 Fiscal Year Tactical Plan

The tactical plan will be to continue to monitor forest health agents through the aerial overview survey and IBD detailed survey of selected areas and IBS as it presents itself. District IBD funnel trapping around the Rock Creek Fire and other selected areas is also planned for 2018. Forest Licencees have been encouraged to consider their own funnel trapping programs and trap tree programs for IBD. The focus will continue on TSA Licencees meetings to address IBM, IBD & IBS impacted areas through harvesting to reduce non-recoverable losses and attempt to limit the spread of the various bark beetles. No planned single tree treatments at this time.

11. Stocking Standards

While there are some recommendations within current stocking standards for forest health agents, the risk to Lodgepole pine (Pli) on ICH sites may be inadequately dealt with to date. Consideration should be given to increasing the minimum free growing height for Pli by up to 50% and/ or perhaps increasing the target and minimum density by 200 to 400 sph for stands regenerated to a

high percentage (>60%) of Pli in the ICH subzones. Significant concerns relating to rusts, bear damage and other damaging agents exist for this species especially when stands are declared at such a young age due to the fast growing nature of this species. Evidence for this includes FREP SDM surveys within Boundary TSA as well as other SDM surveys in adjacent TSAs and continued research by Alex Woods and David Coates.

Licensees and prescribing foresters need to be cognizant of climate change and how this can impact future timber supply through stocking recommendations and forest health issues that may have greater, lesser or different impacts in the future as a result of climate change.

An additional consideration to professionals completing Free Growing declarations is the age at which plantations are allowed to undergo Free Growing evaluation. The average FG declaration age is 9 years in the South Area. However, Armillaria root disease, the primary agent of mortality in a substantial number of plantations, does not typically spread until 12-16 years. Thus, FG evaluations prior to 16 years of age risk underestimating stand mortality. New Stocking Standards for Selkirk District based on newly developed BEC incorporates some Forest health concerns from previous standards

12. Non-Recoverable Losses Section (fire, wind, pests, total current AAC comparisons)

	THLB Volume (m3) killed and not harvested as of 2017							
	Forest Health Factors							
Year	IBM	IBD	IBB	IBS	IBW	Fire	Drought	Totals
1999	5,352	700	4,470	-	-	-	3,318	13,840
2000	2,832	3,193	17,327	-	-	-	1,576	24,928
2001	2,867	3,102	731	-	-	-	-	6,700
2002	3,218	1,729	-	-	-	-	-	4,947
2003	7,549	1,606	331	-	-	113	617	10,216
2004	55,704	-	2,887	-	-	293	1,345	60,229
2005	83,631	2,255	19,793	-	-	419	-	106,098
2006	115,357	576	4,961	-	-	-	-	120,894
2007	78,751	463	1,619	-	-	10,066	-	90,899
2008	84,570	198	3,683	-	-	-	-	88,451
2009	81,346	38	971	-	-	139	-	82,494
2010	59,022	-	435	-	-	-	-	59,457
2011	62,474	-	37	-	-	160	-	62,671
2012	82,156	80	134	-	-	61	-	82,431
2013	107,697	77	149	-	-	86	-	108,009
2014	90,846	135	452	-	-	36	-	91,469
2015	60,647	227	447	-	-	34,086	-	95,407
2016	47,778	858	2,162	4	14	95	125	51,036
2017	53,298	1,602	94	-	14	39,781	-	94,789
Totals	1,085,095	16,839	60,683	4	28	85,335	6,981	1,254,965

This table presents the estimated forest volume killed in the Timber Harvesting Land Base (TSA only, excludes TFL8) by selected Aerial Overview Forest Health Factors, as well as the amount of that

killed volume that has been either harvested or not harvested as of the year 2017. The estimates are only for Timber Supply Area and do not include TFL8. The AAC from 1999 to 2016 was 700,000 m³ and was reduced as of October, 2016 to 670,142 m³ for the issuance of West Boundary Community Forest Agreement. Over the 19 years reported in this table the volume lost represents just over 9% of the AAC.

13. Information Links

Report: 2017 Overview of Forest Health in the Southern Interior Region

<http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/aerial-overview-surveys/summary-reports>

The above report is based on spatial data found at the location below for 2016 Annual Overview Survey.

Provincial Forest Health Strategy 2013-2017

<http://www.for.gov.bc.ca/hfp/health/Strategy/Forest%20Health%20Strategy.pdf>

Provincial Bark Beetle Management Technical Implementation Guidelines (formerly Bark Beetle strategy)

<https://www.for.gov.bc.ca/hfp/health/fhdata/bbstrategy.htm>

Spatial Data:

Bark Beetle Hazard Ratings

https://www.for.gov.bc.ca/rsi/foresthealth/hazard_rating.htm

2017 and earlier Annual Overview Surveys. (fixed wing based aerial mapping of all visible forest pests).

http://www.for.gov.bc.ca/ftp/HFP/external/lpublish/Aerial_Overview/

2017 and earlier Detailed Mapping (Helicopter based aerial mapping of Beetle Management Units with a Douglas-fir beetle strategy of suppression.)

Available upon request from District Forest Health Staff



Example of foliar disease during height of breakout in spring then later in season, Kamloops Area