MINISTRY OF FORESTS, LANDS, NATURAL RESOURCE OPERATIONS AND RURAL DEVELOPMENT

Selkirk Natural Resource District

Boundary TSA

Forest Health Strategy 2019-20

Updated by:

Dean Christianson, RPF#3331
Stewardship Forester
Selkirk Natural Resource District
July 30, 2020

Approved by:

Tara DeCourcy, RPF
District Manager
Selkirk Natural Resource District

Date: 30 Aug 2020

Young Pli drought damage 2018

2018 Ips Attack in Lynch Creek blowdown

Cover Page: June 24, 2018 blowdown

Table of Content

1. Goal 5
2. Objectives 5
3. Boundary TSA description 6
3.1. Previous Forest Health Strategies in the Boundary TSA 8
4. TSA Priority Ranking of Forest Health Agents 8
5. Description of the Priority Forest Health agent status 9
5.1. Mountain Pine beetle –IBM (*Dendroctonus ponderosae*) 10
5.2. Douglas-fir beetle –IBD (*Dendroctonus pseudotsugae)* 11
5.3. Spruce bark beetle –IBS (*Dendroctonus rufipennis*) 12
5.4. Windthrow-NW 12
5.5. Armillaria Root Disease –DRA (*Armillaria ostoyae*) 12
5.6. Western Balsam bark beetle-IBB (*Dryocoetes confuses*) 13
5.7. Western pine beetle-IBW (*Dendroctonus brevicomis*) 13
5.8. Dwarf mistletoe: Larch -DML (*Arceuthobium laricis*), Lodgepole Pine-DMP (*Arceuthobium americanum*), & Douglas-fir-DMF (*Arceuthobium douglasii)* 13
5.9. Larch needle cast-DFM (*Meria laricis*) and blight-DFH(*Hypodermella laricis*) 13
5.10. Black Stain Root Disease-DRB (*Leptographium wageneri*) 13
5.11. Lophodermella (Pine) Needle Cast -DFL (*Lophodermella concolor*) and Dothistroma Needle Blight – DFS (*Dothistroma septosporum*) 13
5.12. Hard pine rusts: Western gall rust-DSG (*Endocronartium harknessii*), Stalactiform blister rust-DSS (*Cronartium coleosporioides*), Comandra blister rust-DSC (*Cronartium comandra*) 13
5.13 Western Spruce Budworm –IDW (*Choristoneura occidentalis*) 14
5.15 Deciduous Pests 15
5.16 Bear-AB and other Animal Damage 15
5.17 Birch Decline 15
5.18 Whitebark Pine ecline 16
5.19 Hot Droughts 16
5.20 Fire and Post Fire Mortality NF/ NPB 17
5.21 White Pine Blister Rust DSB (Cronatiumribicola) 17
5.22 Invasive Species – Gypsy moth (*Lymantria dispar dispar*) 17
5.23 Invasive Species – Balsam woolly adelgid (*Adelges piceae*) 18
6. Management objectives for priority forest health agents 18
6.1. Management objectives for bark beetles (IBM, IBD and IBS) 18
6.5 Roles and Responsibilities 21
7. Provincial Ranking and BMU Strategy for IBM and IBD 22
Table 6: Mountain pine beetle BMU ranking and strategies 22
8. Proposed activities to manage IBM and IBD 23
8.1. Mountain pine beetle 23
8.1.1. Harvesting 23
8.1.2. Pheromone Use 23
8.1.3. Single tree treatment 24
8.1.4. Detailed Flight and Ground Surveys 24
8.2. Douglas-fir beetle 24
8.2.1. Harvesting 24
8.2.2. Pheromone Use 24
8.2.3. Single tree treatment and other treatments 25
8.2.4. Detailed Flight and Ground Surveys 25
9. Priority Activities in non-suppression BMUs 25
10. 2020-21 Fiscal Year Tactical Plan 25
11. Stocking Standards 25
12. Non-Recoverable Losses Section – Boundary TSA (fire, wind, pests, total current AAC comparisons) 26
13. Information Links 27

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) including area-based tenures - TFLs, CFAs and Woodlots. 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. The Provincial Forest Health Strategy guides government's forest health program to achieve the goals of:

- maintaining and improving the productivity of British Columbia's forests
- extending the supply of the remaining timber resource
- protecting other forest resource values

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://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health

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. Management units include: Boundary TSA, Tree Farm Licence 8, West Boundary Community Forest, 34 Woodlots and Gladstone and Granby Provincial Parks. 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 (m^3) by Species Composition for Boundary TSA, over 60 years 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	Specie 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	69051	**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	9491	**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

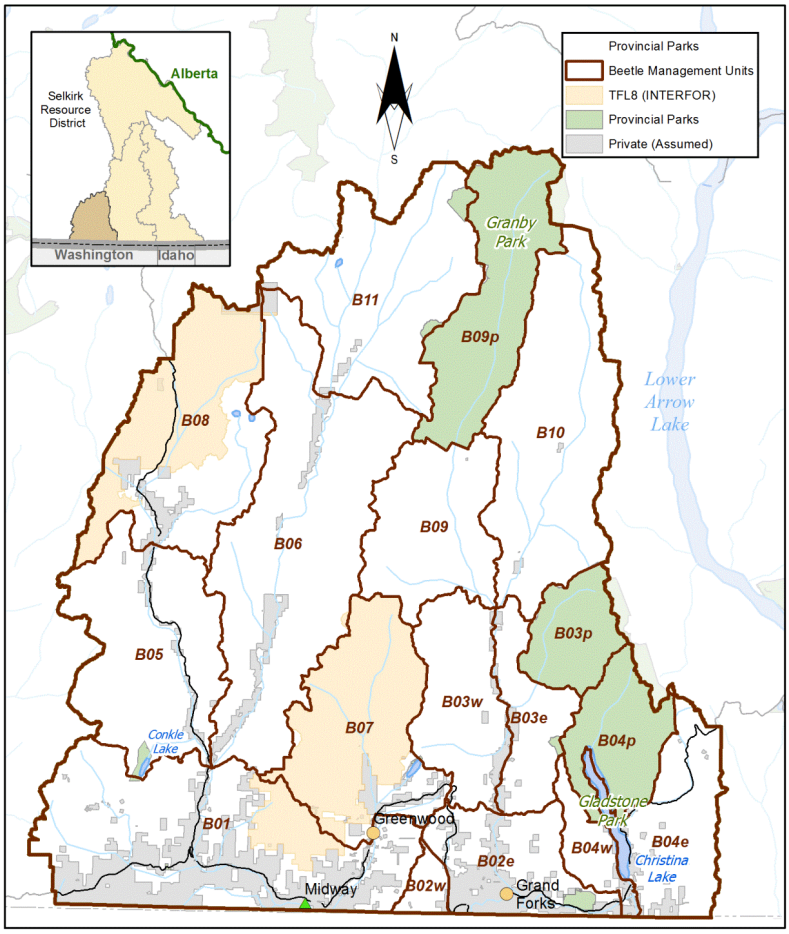


Figure 1: Boundary TSA showing BMUs, TFL8, Parks and Private Land.

3.1. Previous Forest Health Strategies in the Boundary TSA

The last forest health strategy update was completed in 2019. Since 2005, there have 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:

Ranking	***Predicted potential damage loss per year (ha)***
Very High	>400
High	200-400
Moderate	100-200
Low	50-100
Very Low	<50

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	Douglas-fir tussock moth		Aspen Serpentine Leaf Miner Birch Leaf Miner
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**			Western pine beetle Spruce weevil Balsam Wooly Adelgid

	bark beetles			
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 2019 provincial overview survey.

Table 3: Selected summary of 2018 & 2019 Boundary TSA significant Forest Health damaging agents

Forest health agents	2018 Affected Area(ha) (includes # of trees in spots)	2019 Affected Area(ha) (includes # of trees in spots)	Trend	Current Impact on Timber Supply	TSA Priority
Drought	**25,802**	**4,874**	**Decreased significantly**	**Very High**	**1**
Douglas-fir bark beetle	**512**	**1127**	**Increased significantly**	**Very High**	**1**
Mountain pine bark beetle	**748**	**910**	**Increased slightly**	**High**	**1**
Western balsam bark beetle	**1876**	**1683**	Decreased Slightly	Low	3
Post Burn Mortality	0	295	Increasing	Low	3
Fire	**655**	12	Decreased significantly	Very Low	2
Windthrow	**777**	0	Decreased significantly	Very Low	2
Western Spruce Budworm	**2291**	67	Decreased significantly	Very Low	3
Spruce bark beetle	18	0	Slight Decrease	Very Low	3
Animal (Bear)	299	325	Increased Slightly	High	3
Aspen Serpentine Leaf Miner	157	454	Increased slightly	Very Low	
Pine Needle Cast & other Pine foliar diseases	0	0	Static	Very Low	3
Larch Needle Blight	233	25	Decreasing	Very Low	
Western Pine Beetle	2	2	Static	Nil	

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

The mapped polygon area of current mountain pine beetle infestation has increased somewhat in 2019 compared to 2018. 2019 attack was primarily in the Trace and Light severity classes but also has minor occurrence in Moderate and Severe classes. Mountain pine beetle has been active in the Boundary TSA since 2002 and has peaked and is declining significantly 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 53,935 m3 to 581 m3 to 1,613 m3 from 2017 to 2019 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).

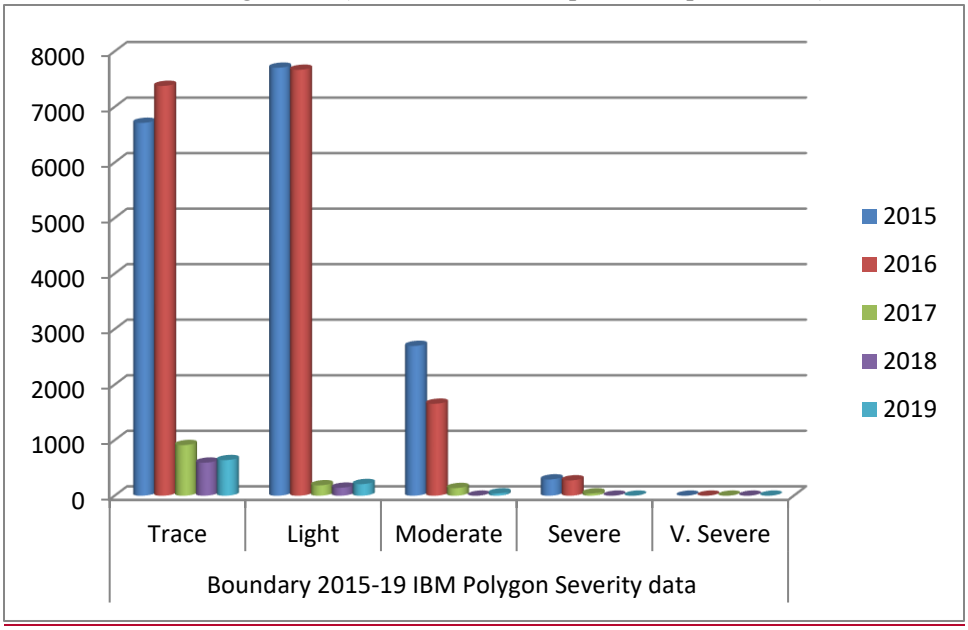


Figure 2 Boundary TSA: 2015-2019 MPB polygon area by severity class.

Harvest levels of IBM attacked Pli by Boundary TSA Forest Licensees have not been significant to reduce IBM attack levels with 7,895 m3 of the 2017 attack showing as harvested and no harvesting of either the 2018 or 2019 attack to date. Over the past several years Boundary TSA licensees/BC Timber Sales have harvested unattacked Lodgepole pine stands as a high percentage of their harvest.

Table 4: Mountain Pine Beetle attacked area 2017 – 2019 compared to area harvested and planned to be harvested in Operable THLB.

2017-19 IBM AOS Polygon % Harvest Area – Operable THLB (includes TFL8 and other Area based tenures)				
Year	THLB AOS Polygon Area – ha.	Area Harvested as of Winter 2019-20	Area Planned Harvest as of Winter 2019-20	**Total Current and Future Harvest %**
2017	648.0	24.1	54.5	12.1%
2018	398.1	39.8	63.3	25.9%
2019	517.5	0	1.5	0.3%

Table 4 is a summary of the annual 2017 to 2019 AOS IBM polygons across the entire TSA and the harvest to date and planned harvest. Values are significantly below targets to reduce beetle

expansion. There appears to be a delay in planning and implementing harvest of beetle attacked areas and a shortened timeframe would assist in control of IBM.

Future Trends

The "BC MPB projection of the Current Mountain Pine Beetle Outbreak" previously estimated that less pine will be killed than originally thought but the impact on Boundary TSA is still significant and had projected that IBM attack will continue to increase for Boundary TSA.

The 2015 IBM Model still projected 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. However, IBM attack crashed significantly after 2017 for the past 2 years and these projections have not been realized to date. The total Pli volume killed from 1999 to 2019 from Mountain Pine Beetle has been calculated at 1,681,230 cubic metres based on the Aerial Overview Survey data within the Crown Forest Land Base.

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

The Douglas-fir beetle population increased by more than two-fold from last year. The infested area is up to 1127 ha in 2019 from 512 ha in 2018. There have been additional anecdotal reports of active IBD from some of the Woodlot Licensees as well. The area covered by the 2019 detailed IBD flight found **315** spots with **1673** red trees tallied compared to **251** spots and **1737** red trees tallied in 2018, **438** spots and **2009** red trees in 2017, and **422** spots and **2030** red trees in 2016. The detailed flights for the last 3 years did not tally single or pairs of red trees, only 3 or more and flew outside of TFL8 and Parks in southern portions of the TSA. The detailed flight shows a higher incidence than the Overview survey highlighting the significance of IBD. Attack levels are similar from year to year. The exact area flown has varied somewhat from year to year.

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 2017 – 2019 compared to area harvested and planned to be harvested.

2017-19 IBD AOS Polygon % Harvest Area – Operable THLB (includes TFL8 and other Area based tenures)				
Year	THLB AOS Polygon Area – ha	Area Harvested as of Winter 2019-20	Area Planned Harvest as of Winter 2019-20	**Total Current and Future Harvest %**
2017	759.7	0.6	130.0	17.2%
2018	418.9	0	31.0	7.4%
2019	829.1	1.3	80.8	9.9%

Table 5 is a summary of the annual 2017 to 2019 IBD AOS polygons in the operable THLB 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.

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

0 ha of Spruce bark beetle was identified in 2019. This is down from 18 ha in 2018 and 0 ha in 2017. 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 identified from the AOS in 2019 compared to the 777 ha of windthrow observed in 2018 which was a result of a significant storm on June 24, 2018, mostly centered just north of Grand Forks. 76.2 ha of the area is mostly planned or harvested as of winter 2019 on crown land or about 16% of the operable area. Anecdotal reports suggest harvesting has taken place on at least some private lands as well. Instances of blowdown associated with very small patches or individual trees occur 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 and other root diseases in the TSA is recommended to follow the "Managing Root Disease in BC" guide published by FLNRORD (2018). 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.

Interfor reported 373.9 ha of stump removal for 2019, no other Licencees have recorded any treatment to date in RESULTS for 2019 as of January 2020. No other Licencees 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. Sub-alpine fir represents 7.2% of the total volume (m^3) by species composition, over 60 years old as of March 2017 for the Boundary TSA, not including TFL8, Parks or private land. Western balsam bark beetle has been chronically causing mortality over many years. Attack levels have decreased slightly in 2019 to 1683 ha from 1876 ha in 2018. All the attack is within Trace Severity polygons or spots and most of the area is within non-THLB – Parks & inoperable ground. 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. 2.0 ha of IBW was mapped in 2019 (spots), compared to 2 ha in 2018 (spots). Management of Py blowdown is an important component of IBW control.

5.8. Dwarf mistletoe: Larch -DML (*Arceuthobium laricis*), Lodgepole Pine-DMP (*Arceuthobium americanum*), & Douglas-fir-DMF (*Arceuthobium douglasii)*

Dwarf mistletoes are causing losses in volume in some parts of the TSA. However, there is no recent field data to verify level of impact or occurrence. Refer to the new land management handbook, "Dwarf Mistletoe Management in BC" for guidance.

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

In 2019, 25 ha of Larch needle cast were mapped representing a significant decrease from 233 ha in 2018. 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 in 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 known to be 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 Pli 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 Lodgepole 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. None of these diseases were detected in the 2018 or 2019 flights but due to the timing of the flight it is possible they would be undetected. 2017 had a special flight covering part of the Boundary TSA earlier in spring resulting in significant levels detected.

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

Western spruce budworm reduces incremental growth and can kill trees after multiple years of defoliation. The population of IDW have decreased significantly in 2019 to 66 ha compared to 2,291 ha of attack in light and moderate severity classes in 2018. This compares to 0 ha detected in overview survey in 2017. The last major outbreak was in 2012 at 43,064 ha. Detection, prediction and treatment of defoliators remain the responsibility of the Kootenay Boundary Regional staff. Egg mass surveys have been conducted in the fall in the Boundary TSA at 18 sites over the last couple of years. These surveys provide an estimate of the defoliator population thus predicted defoliation for the next season. Egg mass surveys conducted in 2019 indicate that defoliation will be nil in 9 sites, light in 8 sites and moderate in only 1 site. 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 regnerate a younger layer under an established canopy. Multi-layered multi-aged stands are especially vulnerable to damage by IDW.

5.14 Douglas-fir tussock moth – IDT (*Orgyia pseudotsugata*)

Douglas-fir tussock moth feeds on the needles of Douglas-fir, true fir and spruce and population can errupt cyclically with outbreaks occurring approximately every 10 to 12 years. Severe defoliation can result in tree mortality, top-kill or weakened trees, making them susceptible to bark beetle attack. The caterpillars' hairs, cast of laval skins, egg masses, cocoons and female moths can also cause a serious human and other animal health risk which can cause an allergic reaction called tussockosis. The symtoms of tussockosis range from itching, skin rashes, and eye irritation to anaplyaxis in extreme cases depending on the severity of the outbreak, degree of exposure and sensitivity of the individual.

Douglas-fir tussock moth has had a long history in the Boundary TSA with recorded outbreaks as far back as 1929 in the Kettle Valley and near Grand Forks. A small outbreak (20 ha) was observed at the Christina Lake Golf Course in 1981, with additional moths trapped around Christina Lake, Eholt and Rock Creek. By 1983 2,275 ha of light to severe defoliation between Johnstone Creek, Rock Creek and Midway, and north towards Westbridge was recorded with the population collasping in 1984. This was the last major outbreak recorded in the Boundary TSA. Again in 1991, populations around Christina Lake started to increase with the population collasping in 1994. The most recent notable defoliation occurred near Rock Creek in 2008 where a small patch of Douglas-fir was severely defolated. Tussock moth has most likely been at very lows levels throughout low elevation IDF stands in the south. However, changing climatic conditions have allowed this insect to reach outbreak levels in geographic locations where in the past it could not.

In 2019, no incidence was recorded from the aerial overview surveys. Annual trapping with pheromones at permanent sample sites (PSPs) has been conducted by the Minstry since 2009 to

provide trends in populations and for predicting imminent defoliation. As well, three-tree beatings are conducted annually at PSPs to determine species richness and abundance. In 2019, following two years of positive beatings for Douglas-fir tussok moth, no larvae were observed at any of the nine PSPs. Overall, an average of 5 moths per 6-trap cluster were caught in 2019, an increase from 2018, indicating defoliation may occur in the next few years. Similar to 2018, defoliation of blue spruce was noted in Rock Creek, east to Greenwood and Midway; all on private property. As well, some single-tree epizootics were observed. Highest numbers of pheromone trap catches were observed at Johnstone Creek Road, which light defoliation occurred on mature trees and moderate defoliation on understory.

Successful management of Douglas-fir tussock moth depends on carefully monitoring populations within high-hazard stands during the non-outbreak and building phases. Long-term management strategies include stand-manipulation such as conversion to alternative species, promotion of species mixes, stand-structure manipulation such as harvesting and thinning. Once the outbreak begins, viable treatment options exist where management objectives warrant. The preferred treatment is the application of the biological insecticide *Bacillus thuringiensis* var. *Kurstaki* (*Btk*).

5.15 Deciduous Pests

The only pest in this category was Aspen serpentine leaf miner with 454 ha of Light severity area noted in 2019, up from 157 ha of Moderate severity in 2018. 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.

5.16 Bear-AB and other Animal Damage

Bear damage was mapped at 325 ha of Light and Moderate severity mortality in 2019 compared to 299 ha for 2018. 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, bear damage in particular 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.

5.17 Birch Decline

During 2000-2007 paper birch (*Betula papyrifera*) decline was 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 (*Agrilus anxius*), non-native birch leaf miners (*Fenusa pussila* 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, but no definitive research has concluded.

In 2019, wide scale birch leaf "browning" and mining were noted May through June, in the Kootenay Boundary and Thompson Okanagana Regions in the south, and Omineca Region in the north, throughout the range of paper birch, Betula papyrifera. Larval collections were made mid-June

throughout the beginning of July from thirthenn sites (nine in the Thompson Okanagan; three in the Kootenay Boundary Region; and one in the Omineca) and genomic DNA sequencing was conducted confirming the pest species to be *Lyonetia prunifoliella* for all 13 sites. This damage was previously thought to be a complex of birch leafminers (*Fenusa pusilla* and *Profenusa thomsoni*), (Hymenoptera: Tenthredinidae), but now we know that at least some of the damage is caused by *Lyonetia prunifoliella*

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.

5.18 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 lessor 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 suvivorship by reducing competition and providing seed regeneration habitat.

5.19 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. 2019 saw a reduction of observed drought with 4,874 ha observed mostly in Light and Moderate severity. This is a significant drop from 2018 where a total of 25,802 ha of Light , Moderate and Severe mortality was detected. 2019 growing season weather was not as hot and dry as the previous 2 years. Sub-lethal effects of drought are often not well ducomented so often go undetected. 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.

Significant plantation losses of all ages were experienced by Licencees in 2017. Drought kill of multiple-age class Douglas-fir and lodgepole pine was evident in early 2019 in the Beaverdell area.

Recommendations to manage drought include:

- careful species selection and mix (more drought resistant) and higher density at time of planting,
- obstacle planting and leave trees to shade young planted trees,
- additional monitoring plantation post drought,
- consider time of planting moisture retention fertilizer paks.

5.20 Fire and Post Fire Mortality NF/ NPB

2019 did not record any wildfires of note note in Boudnary so the total hectares was zero. However, 295 ha of Post Fire Mortality was noted from previous years' fires. Havest of these areas is highly recommended if ecnomoical to reduce NRLs and IBD and IBS population growth.

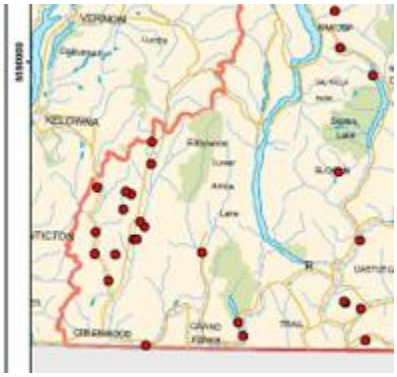
5.21 White Pine Blister Rust DSB (*Cronatium ribicola*)

White Pine blister rust is an introduced pathogen which has caused extensive mortality of western white pine and whitebark pine within the Boundary TSA. On the neighbouring Arrow TSA, SDM sampling found 35.5% of Layers 1, 2, 3 Pw being dead or unacceptable. The availability of disease-resistant white pine makes it possible to ensure this valuable timber species is restored. Disease resistant white pine should be promoted as a reforestation species on appropriate sites. Based on successfully yielding approximately 65% survivorship of white pine, a similar rust-resistance effort should continue to be supported for whitebark pine, which is occasionally harvested, federally endangered, and especially valuable for wildlife. Forest Licencees are encouraged to consider planting rust resistant Pw seedlots.

5.21 Invasive Species – Gypsy moth (*Lymantria dispar dispar*)

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD), Canadian Food Inspection Agency (CFIA), and Canadian Forest Service (CFS) cooperatively monitor for the occurrence of European gypsy moth, *Lymantria dispar dispar* at approximately 5,000 sites provincially. 72 sites are monitored by the Region annually at various high-risk areas including forest recreation sites, campgrounds, and rest stops (Figure 2). In 2018, three moths were trapped at a site near Castlegar. A delamination grid of an additional 43 traps per square mile were deployed in 2019, with a total of 13 moths caught in 5 traps (one trap caught 9 moths, and 4 traps caught singles). In late October, the Regional Entomologist and CFIA personnel ground surveyed the area within a 500-meter radius of the "positive traps" but no egg masses were located. A spray program using *Btk* is planned for 167 ha in May-June to eradicate the Gypsy moth from the area.

Figure 1. Kootenay Boundary Regional Gypsy moth pheromone trap placements.



5.22 Invasive Species – Balsam woolly adelgid (*Adelges piceae*)

Balsam woolly adelgid was accidentally introduced to North America from Europe around 1900 and into Canada in 1910. Adelgids are inconspicuous, aphid-like pests that appear as a white, woolly mass about 1mm long on the bark. Due to their small size they can be easily overlooked. Despite this size, they are an extremely destructive pest that can kill a tree after several years of heavy feeding, with sub-alpine firs (*Abies lasiocarpa*) being the most susceptible. BWA injects toxic saliva into its host plant when feeding, thus inhibiting bud formation and causing tree decline such as yellowing of the needles, premature needle loss, swelling of branch nodes and terminal buds.

Ministry of Agriculture (AGRI) and the Ministry of Forests Lands and Natural Resource Operations and Rural Development (FLNRORD) conducted an occurrence survey for balsam woolly adelgid (BWA) throughout the interior of BC from 2014 to 2018. The objective of the survey was to determine the northern and eastern limits of the current spread of BWA, sampling the primary susceptible tree species, sub-alpine fir from 1,000 to 1,600-meter elevation ranges. It should be noted that much of the province is inaccessible and it is possible that BWA may in fact occur in many of the areas where it was not positively identified. BWA has been confirmed in the Boundary TSA. BWA appears to have spread naturally from Washington State forests via wind, birds, and animals and likely from transportation of trees within BC from infested to non-infested areas.

In 2018, areas in the Kootenays that were sampled included; Kalso, Salmo, Creston, Cranbrook, Kimberley, Fernie, Invermere, Golden, Roger's Pass, Glacier National Park and Revelstoke. Any potential samples located were sent to the Canadian National Collection of Insects, Arachnids and Nematodes in Ottawa for identification via the CFIA office in Kelowna. No positive samples were found in the 2018 sampling and even areas with plenty of woolly tuffs did not contain adelgids as they had already been preyed upon.

Table 1. Balsam woolly adelgid occurrence sampling results, 2016-2018 in the Kootenay Boundary Region.

Location	Result of sampling (positive, negative)	Sample Year
Christian Valley, Barth and Sandrift FSRs	Positive	2017
Jewel Lake Provincial Park	Positive (most heavily infested area found)	2017
Boundary Mt. Roderick DHU Road	Negative	2017
Phoenix Ski area/ Gibbs Creek FSR	Positive (gouting in understory trees)	2017
Rossland Cascade FSR	Positive	2017

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 m^3.

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 m^3) 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 April 1 to September 15 (Beetle species dependent):

- 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/hauled 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 staff prior to spring break-up/next beetle flight is recommended.

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 April 1st to Sept. 15th (beetle species dependent).
- 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 licencee. The responsibility to carry out these actions or measures is the responsibility of the licencee.

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 Licencees 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 Btk 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***	***LICENCEES***
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.

Table 6: Mountain pine beetle BMU ranking and strategies

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 these strategies should be reassessed and possibly reassigned to 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.

Table 7: Douglas-fir beetle BMU ranking and strategies

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

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 were 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 2018 and none planned for future at this time.

8.1.4. Detailed Flight and Ground Surveys

Given 2018 holding strategy no detailed flights were completed in 2019 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. Sanitation Harvesting;
2. Clean harvesting practices;
3. Trap trees;
4. Anti-aggregation pheromones (MCH);
5. Funnel trapping.

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 (Enhanced lures and MCH) 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 20 funnel trap sites in Southwest Boundary area and 25-30 funnel trap sites in Grand Forks and north area for IBD. Some funnel trapping is also planned by a few other licencees within Boundary at this time. http://www.for.gov.bc.ca/rsi/ForestHealth/PDF/PMP_2013-2017_FH_Southern_Interior_Feb_19_2013.pdf.

2019 IBD District funded funnel trapping in SW Boundary resulted in over 995,000 IBD captured on 20 sites. 2018 trapping captured 920,000 Douglas-fir bark beetles captured on 26 sites. This is a significant increase over 2017 when over 585,000 beetles were captured in approximately the same area. 2019 Funnel trapping around Grand Forks and North around the 2018 windthrow areas captured 748,000 IBD over 30 sites.

8.2.3. Single tree treatment and other treatments

No single tree treatments are planned at this time. Funnel trapping currently planned for the Rock Creek / Southwest Boundary Area and the 2018 blowdown area north of Grand Forks.

8.2.4. Detailed Flight and Ground Surveys

The 2019-20 plan is to consider a heli detail survey of a small part of Boundary TSA (excludes TFL and CFA areas) as possible within high/ moderate Douglas-fir BMU areas depending on priorities within the rest of Selkirk District and budget allowing. Detailed mapping flights were completed for Douglas-fir bark beetle in portions of the TSA in 2019.

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 projects:

- IBD funnel trapping where deemed necessary for control.

10. 2020-21 Fiscal Year Tactical Plan

The tactical plan will be to continue to monitor forest health agents through the aerial overview survey and possibly IBD detailed survey of selected areas and IBS as it presents itself. District IBD funnel trapping around the Rock Creek Fire/ SW Boundary and the windthrow areas north of Grand Forks is planned for 2020. 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 and discussions to address IBM, IBD, IBS, NW and ND 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. Georeferenced maps of Boundary TSA showing Fire, IBD, IBS & IBM 2017-2019 polygons and spots and detailed spots for 2019 are available on the Selkirk District Forest Health FTP location.

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 Free growing 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. The 2018 drought damage was a significant mortality loss and possibly a good indicator of selecting species more drought resistant on sites than in the past.

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 – Boundary TSA (fire, wind, pests, total current AAC comparisons)

Table 8 presents the estimated forest volume killed in the Timber Harvesting Land Base (TSA only, excludes TFL8 and other non-TSA areas) by selected Aerial Overview Forest Health Factors, as well as the amount of that killed volume that has not been harvested as of the year 2019. The AAC from 1996 to present is 700,000 m3 annually.

Table 8: 1999-2019 Non-recoverable losses not harvested within the Boundary Timber Supply Area Timber Harvesting Land Base

THLB Volume (m3) killed and not harvested as of 2019									
	Forest Health Factors							**Volume Killed & Harvested**	
Year	**IBM**	**IBD**	**IBB**	**Fire**	**Drought**	**Wind throw**	**Totals**	**M³**	**% of Total Killed**
1999	5,184	425	3956	-	3,070	-	12,635	5,567	31%
2000	2,742	2,344	17,294	-	1,301	-	23,681	4,948	17%
2001	2,808	2,651	759	-	-	827	6,218	2,087	26%
2002	2,955	1,708	-	-	-	-	4,663	996	18%
2003	7,023	1,615	331	120	617	-	9,706	4,541	32%
2004	52,556	-	2,785	293	1,345	-	56,979	15,276	21%
2005	77,153	2,293	18,816	419	-	-	98,681	28,981	23%
2006	110,759	700	4,443	-	-	-	115,902	39,751	26%
2007	73,354	296	1,559	7,346	-	-	82,555	21,890	21%
2008	80,627	105	3,393	-	-	-	84,125	18,421	18%
2009	75,942	38	830	139	-	467	76,949	20,557	21%
2010	53,504	-	342	-	-	344	53,846	16,618	24%
2011	57,363	-	37	328	-	-	57,728	20,911	27%
2012	74,419	80	133	61	-	54	74,693	25,018	25%
2013	98,939	77	129	86	-	372	99,231	27,052	21%
2014	82,024	135	349	36	-	-	82,544	21,754	21%
2015	54,425	236	416	23,718	-	-	78,795	22,750	22%
2016	42,086	777	1,643	86	125	-	44,717	9,008	17%
2017	46,040	1,768	95	37,876	-	-	85,779	8,336	9%
2018	581	3,080	435	8,322	132,275	9,363	144,693	3,025	2%

2019	**1,613**	**1,801**	**210**	**-**	**23,838**	**-**	**27,462**	-	0%
Totals	**1,002,097**	**20,129**	**57,955**	**78,830**	**146,869**	**11,427**	**1,407,416**	**317,487**	19%
Change from previous year	-83,576	+322	-1,566	-16,724	+15,702		-85,799		

2019 NRLs are the lowest recorded since 2003. 2018 had the highest Non-recoverable losses on record in the last 21 years and represents over 20% of the current AAC for Boundary TSA, 90% of which has been attributed to drought. Over the 21 years reported in this table the volume lost represents just under 10% of the AAC and harvested killed volume is less than 50% of a single year's AAC. The reduction in losses from the 2018 data is presumably due to harvesting of previously damaged areas, changes in TSA THLB boundaries and/ or refinements in data analysis.

13. Information Links

Report: 2019 Overview of Forest Health Conditions in Southern British Columbia

https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/aerial-overview-surveys/summary-reports

Provincial Forest Health Strategy 2013-2017

https://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

2019 and earlier Annual Overview Surveys. (fixed wing based aerial mapping of all visible forest pests).

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

2019 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 or at following FTP location:
https://www.for.gov.bc.ca/ftp/DAB/external/!publish/Forest%20Health/Detailed%20and%20Aerial%20Overview%20flight%20data/