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

Selkirk Natural Resource District

Arrow & Cascadia TSAs
Forest Health Strategy 2019-20

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July 10, 2020

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July 23, 2020
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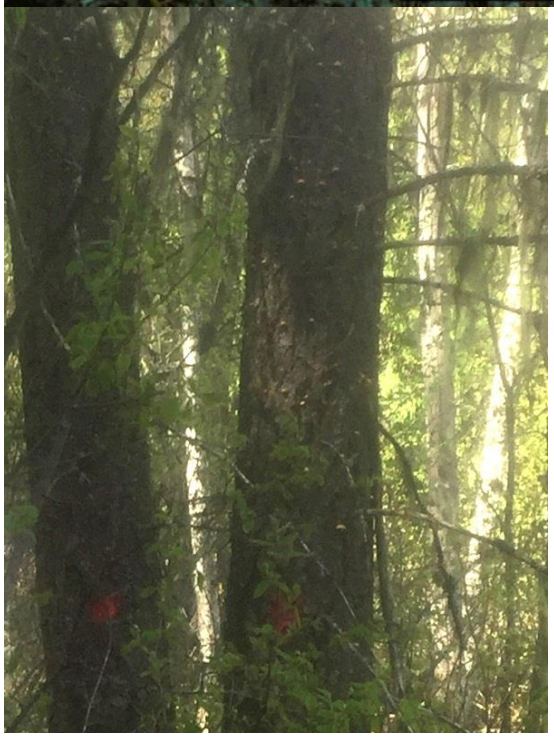
IBD photos



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IBD funnel trapping 2018

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 Arrow Timber Supply Area (TSA) including Cascadia TSA and other area based tenures with Arrow TSA including 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 Arrow TSA forest stakeholders, primarily forest tenure Licencees;
- 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 strategic forest health 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. Arrow TSA Description

The Arrow Timber Supply Area (TSA) lies in the West Kootenay area in the southeastern part of the province and is part of the Selkirk Resource District. The TSA covers 605,640 hectares (ha). Management units include: Arrow TSA, Cascadia TSA, Tree Farm Licences 23 and 3, Nakusp & Slocan Community Forests, 13 Woodlots, Valhalla Provincial Park, Goat Range Provincial Park and Kokanee Glacier Provincial Park. The main communities in the TSA are Trail, Castlegar, Nakusp, and Rossland.

Table 1: Total Volume (m^3) by Species Composition for Arrow TSA & Cascadia TSA (Arrow portion only), over 60 yrs old as of March 2017. Does not include TFL23, TFL3, 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	Species Volume %
Douglas-fir	31,698,997	6,290,003	2,410,938	668,909	**41,068,847**	**23%**
Spruce	18,528,073	11,138,496	2,558,841	810,917	**33,036,327**	**19%**
Sub-alpine fir	18,800,427	7,010,059	1,270,867	511,714	**27,593,067**	**16%**
Hemlock	15,999,729	4,938,916	1,524,271	427,340	**22,890,255**	**13%**
Western Larch	10,328,008	6,223,060	2,192,461	1,010,460	**19,753,989**	**11%**
Lodgepole Pine	8,628,481	3,561,558	2,711,306	826,721	**15,728,066**	**9%**
Western Red Cedar	3,782,947	3,708,368	1,392,592	513,490	**9,397,397**	**5%**
Trembling Aspen	1,005,684	518,703	341,914	289,943	**2,156,244**	**1%**
Paper Birch	659,882	402,395	302,540	240073	**1,604,890**	**1%**
Western White Pine	100,613	226,512	461,905	388,508	**1,177,539**	**1%**
Cottonwood	408,752	134,827	100,817	82,834	**727,230**	**0%**
Grand fir	322,361	127,722	89,330	67,191	**606,604**	**0%**
Ponderosa pine	109,087	364,952	81,998	47,305	**603,343**	**0%**
Whitebark pine	21,928	130,177	98,702	12497	**263,304**	**0%**
Alpine Larch	138	1,738	1,441	1,881	**5,197**	**0%**
Totals	**110,395,109**	**44,777,486**	**15,539,922**	**5,899,783**	**176,612,300**	

The inventory data indicates that many of the stands in the Arrow TSA are approaching age and diameter thresholds which will make them more susceptible to attack from insects such as bark beetles.

The TSA is situated in the Interior Wet Belt, and its forests are among the most productive in the B.C. interior. Major biogeoclimatic zones include the Interior Cedar Hemlock, Engelmann Spruce-Sub-alpine Fir, and Alpine Tundra zones. A few small areas in the Lower Arrow Lakes are classified as Interior Douglas-fir zone. The dominant tree species (10% or greater) are Douglas-fir, Spruce, Sub-alpine fir, Western Hemlock and Western larch. Minor species found in the TSA include Lodgepole pine, Western red cedar, Western white pine, Grand fir, Ponderosa pine, Whitebark pine

and Broadleaf species. As a result of fires at the turn of the century, only 16 percent of all stands are over 140 years. The majority of the stands in the TSA are between 60 and 120 years of age.

The following 22 Beetle Management Units (BMUs) are included in the Arrow TSA, See map for locations:

Table 2: Arrow, Cascadia TSA and TFLs 3 & 23 BMUs

BMU #	BMU Name	BMU #	BMU Name
N501	Sheep	N514	Perry
N502	Rossland	N515	Lemon
N503	Bear	N519	Eagle
N504	Pend Oreille	N520	Whatsan
N505	Stagleap	N521	Woden
N506	Erie	N522	Caribou
N507	Glade	N523	Hills
N508	Blueberry	N524	Idaho
N509	Dog	N525	Wilson
N511	Cayuse	N528	Kuskanax
N512	Ladybird	N530	Trout(partial)
N513	Pedro	N531	Fish

TFLs' & Cascadia TSA BMUs		
N510 – Johnston	N518 – Gladstone	N530-Trout (partial)
N511- Cayuse	N521-Woden (partial)	
N514 - Perry	N526 – Vipond	
N516 – Hoder	N527 – Fosthall	
N517 – Koch	N529 – Halfway	

The Arrow TSA is characterized by steep, mountainous terrain in the north, with gentler terrain and wider valleys and trenches in the south. Approximately half of the TSA is productive forest land. A significant portion of the productive forest land area is unavailable for timber harvesting for various reasons, including: operability, environmental sensitivity, unstable soils and steep slopes, non-merchantable forest types. Consequently, approximately 202,000 hectares, or 27 percent, of the Arrow TSA's total land base is considered available for timber harvesting under current management practices. Additional operable land has also been removed as a result of the Caribou GAR order. Ungulate Winter Range, Old Growth Management Areas and Connectivity Corridors are additional resource constraints are placed on the land base. All the above land use values and constraints make management of forest health agents in the Arrow TSA challenging.

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

Arrow TSA Website http://www.for.gov.bc.ca/hts/tsa/tsa01/

- 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

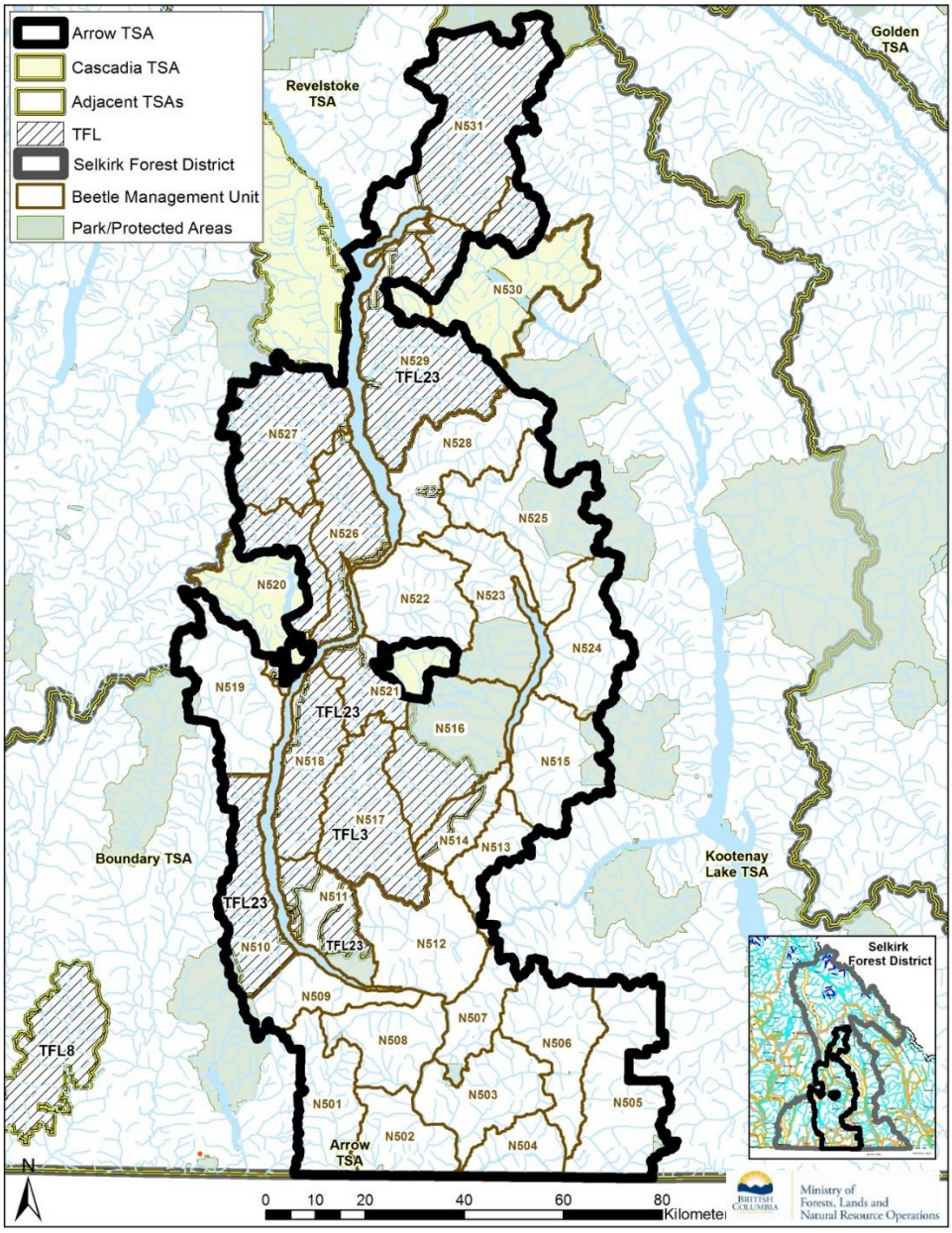


Figure 1: Arrow TSA showing, TFLs (includes Cascadia TSA) and Parks.

3.1. Previous Forest Health Strategies in the Arrow TSA

The last full forest health strategy was completed in 2018-19. Since 2005, there have been annual updates to BMU strategies based on annual aerial overview mapping, detailed mapping, ground reconnaissance and other local information. No BMU updates have taken place in Arrow for at least the last 9 or more years.

4. TSA Priority Ranking of Forest Health Agents

The priority forest health agents have been ranked following the Provincial Forest Health Strategy (Table 3). 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 two TSAs. Table 3 covers the major forest health agents which can potentially impact the timber supply.

Table 3: Ranking of Forest Health agents by potential impact on forest management activities in the Arrow TSA

	Very High	**High**	**Moderate**	**Low**
Defoliators		Western Spruce Budworm	Western hemlock looper	Aspen Serpentine Leaf Miner
Diseases	Armillaria root disease		White pine blister rust	Dothistroma, Hard Pine Rusts (Western gall rust, Stalactiform & Comandra blister rusts)
Insects	**Douglas-fir beetle, Spruce beetle Mountain pine beetle Western balsam bark beetle**			Spruce weevil Balsam Wooly Adelgid
Mammals		Bear & other animals		
Abiotic Factors	**Fire**	Windthrow Drought		

5. Description of the Priority Forest Health agent status

Table 4 provides an overview of the activity status of some of the priority forest health agents which were reported during the 2017 and 2018 provincial overview surveys. Note that spot tree counts have been incorporated into the severe category of damage based on a fraction of a hectare per spot. Forest Health agents listed as priority 1's should be the focus of Forest Licencees with any significant areas of this in their Licence or operating areas.

Table 4: Selected Summary of 2018 & 2019 Arrow TSA significant Forest Health damaging agents

Forest health agents	2019 Affected Area (ha)	2018 Affected Area (ha)	Trend	Current Impact on Timber Supply	TSA Priority
Douglas-fir beetle	**2395**	**2656**	**Slight Decrease**	**Very High**	**1**
Mountain pine beetle	**1072**	**598**	**Significant Increase**	**High**	**1**
Western balsam bark beetle	**7183**	**5140**	Significant Increase	**Very High**	**2**
Spruce bark beetle	428	207	Significant Increase	Moderate	1
Western Hemlock Looper	548	0	Significant Increase	High	2
Drought	205	**1902**	**Significant Decrease**	**Moderate**	**2**
Fire & Post Fire	131	**19,435**	Significant Decrease	Low	1
Windthrow	11	412	Significant Decrease	Low	2
Animal damage (Bear)	210	423	Slight Decrease	Low	3
Dothistroma Needle Blight	156	ND	Slight Increase	Low	3
Larch needle blight / cast	93	1181	Significant decrease	Nil	n/a
Aspen Serpentine Leaf Miner	12,255	13,729	Slight Decrease	Low	n/a
Birch Leaf Miner	701	374	Significant Increase	Very Low	n/a
Western Pine Beetle	43	0	Increasing	Very Low	n/a
Cedar Flagging	568	0	Increasing	Low	n/a
Flooding & Slides	27	36	Slight Decrease	Very Low	n/a

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

The area of current mountain pine beetle infestation has increased by approximately 2/3's from 2018. More than 80% of the area affected was surveyed as Light and Moderate severity. The attack is generally scattered throughout the TSA with a small concentration north of Hwy 6 near summit Lake. Mountain pine beetle has been active in the Arrow TSA since 2002 and activity has been generally declining since 2006 likely due to much of the concentrated Pli stands having been already attacked and/or harvested but increases have been observed over the last few years.

Prior to 2010 Arrow TSA licencees and adjacent TFL holders had aggressively responded to the beetle population with targeted harvesting and have significantly reduced the area of susceptible pine on operable terrain. **Continued harvest of susceptible stands** and any identified polygons of

attack to reduce non recoverable losses is the recommended strategy. Table 4 below shows recent harvest of IBM polygons is non-existent in last 3 years and negligible area planned to harvest. As of 2015 just over 30% of the THLB Pli volume was estimated to have been killed by IBM in Arrow.

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 TFLs 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	299.6	0.0	0.0	**0.0%**
2018	326.6	0.0	5.2	**1.6%**
2019	462.1	0.0	4.0	**0.0%**

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

The Douglas-fir beetle population decreased slightly from 2018 to 2019 by approximately ten percent but remains the potentially most significant FH factor impacting timber supply in 2019. Most of the polygon's area total was in the Light and Moderate attack severity classes, with a smaller amount in both Trace and Severe. Areas of more concentrated attack in 2018 include the Fruitvale, Salmo, South of Fauqier, Arrow Park Area and Beaton Arm areas but IBD is scattered throughout the TSA as well.

There are 142,885 ha of susceptible (>20 rating) forest types to Douglas-fir beetle in the Arrow TSA based on a 2014 BMU analysis and Douglas-fir is one of the dominant tree species in this TSA. In addition, inventory data indicates many of the stands in the Arrow TSA are approaching age and diameter threshold which will make them more susceptible to attack from bark beetles. The Douglas-fir beetle has the potential to significantly impact the Arrow TSA. Therefore, the management of Douglas-fir beetle and Douglas-fir leading stands remain a priority for the Arrow TSA. **Trap tree and/ or funnel trap programs and monitoring post harvest slash and monitoring blowdown in recently harvested blocks and removing or burning any slash are recommended beneficial practices to minimize future losses.** Additional good practice includes harvesting fired damaged trees and adjacent stressed trees to reduce IBD population increases. This may be even more important for small tenure holders – Woodlots primarily and Community Forests.

Forest Licencee plans and harvest of IBD attacked areas from 2017-2019 is shown in Table 5. Only a very small area has been planned for harvest and no areas have been harvested to date. Response is currently too minimal and slow to effectively reduce IBD populations through harvesting actions. **Licencee response in suppression BMUs should be targeting harvest of at least 70% of the previous year's attack within 1 to 2 years.**

Table 5: Douglas-fir beetle attacked area 2017-2019 compared to area harvested and planned to be harvested in Operable THLB

2017-19 IBD AOS Polygon % Harvest Area – Operable THLB (includes TFLs 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	985.8	0.0	21.1	**2.1%**
2018	1872.4	0.0	24.6	**1.3%**
2019	1462.5	0.0	27.4	**1.9%**

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

Spruce beetle appears to be expanding and has doubled from 207 hectares in 2018 to 429 ha in 2019 and most of the area has been assessed as Light and Moderate severity with smaller amounts in both Trace and Severe. 159 hectares (approximately 1/3 of the 2019 area) is in the operable land base and most of this is within Low severity. 110.0 hectares of Area with Moderate and Trace severity is within Valhalla Provincial Park. There are 86,200 ha of susceptible (>20 rating) forest types to Spruce beetle in the Arrow TSA based on a 2014 BMU analysis. **Spruce blowdown when identified is a high priority for treatment / harvest**. The Bark Beetle Guidebook will guide treatments. Link is as follows:
http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/beetle/betletoc.htm

Forest Licencee plans, and harvest of IBS attacked areas from 2017-2019 is shown in Table 6. None of the area has been harvested to date and no areas planned for future harvest. Rapid harvest response to any IBS outbreaks on operable THLB area is critical to reduce losses and IBS populations. **Licencee response in suppression BMUs should be targeting harvest of at least 70% of the previous year's attack within 1 to 2 years. It is recommended that Forest Licencees target harvesting any IBS as a priority to limit any spread.**

Table 6: Spruce Beetle attacked area 2017–2019 compared to area harvested and planned to be harvested in Operable THLB.

2017-19 IBS AOS Polygon % Harvest Area - Operable THLB (includes TFLs and other Area based tenures)				
Year	THLB AOS Polygon Area -ha	Area Harvested as of Winter 2018-19	Area Planned Harvest as of Winter 2018-19	**Total Current and Future Harvest %**
2017	36.8	0	0	**0.0%**
2018	20.3	0	0	**0.0%**
2019	159.4	0	0	**0.0%**

5.4. Windthrow NW

Only a small amount of windthrow was observed in 2019 for a total of 11 ha. A significant drop from the 2018 total of 412 ha. Negligible windthrow from 2018 has been harvested or planned to harvest to date. Windthrow is a major concern especially when located in Douglas-fir and spruce dominated stand types. Historically, spruce bark beetle and Douglas-fir beetle outbreaks have been closely associated with 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 in usually minimal however, the indirect impact in the form of bark beetle outbreak, can be serious if not managed in a timely fashion.

Table 7: Windthrow affected area 2018–2019 compared to area harvested and planned to be harvested in Operable THLB.

2018-19 NW AOS Polygon % Harvest Area Operable THLB (includes TFLs and other Area based tenures)				
Year	THLB AOS Polygon Area -ha	Area Harvested as of Winter 2018-19	Area Planned Harvest as of Winter 2018-19	**Total Current and Future Harvest %**
2018	333.7	1.9	3.9	**1.7%**
2019	3.4	0	0	**0%**

5.5. Western Balsam bark beetle IBB (*Dryocoetes confuses*)

There are large areas of subalpine fir leading forest stands in the Arrow TSA that are susceptible to western balsam bark beetle. Sub-alpine fir represents 16% of the total volume (m^3) by species composition, over 60 years old as of March 2017 for the Arrow TSA, not including TFLs, Parks or private land. Western balsam bark beetle has been chronically causing mortality over many years. In 2019 there was a significant increase to 7,183 ha from 5,139 ha in 2018. Attack severity for 2019 was primarily Trace with a smaller amount of Light severity. Some of the observed attack could be drought due to extremely dry drought years in 2017 & 2018. Direct control action on that insect is very difficult due to its attack dynamics and the scattered distribution of the stands. Licencees should be considering impacted areas for potential harvest.

5.6. Amillaria Root Disease DRA (*Armillaria ostoyae*)

Armillaria (DRA) root disease has been identified throughout the Arrow TSA. Recent FREP SDM surveys have been finding DRA as well. Arrow TSA SDM plots DRA incidence ranges from 0% to 3.5% for Layers 1, 2, and 3 throughout the various BECs sampled.

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 vigor 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 437.2 ha of stump removal for 2019 in TFL23. No other Licencee recorded stump removal for 2019 as of January 2020. Few Licencees appear to be conducting stump removal treatments even though a significant portion of Arrow is covered by ICH BEC subzones that are considered highly susceptible to DRA.

A 2016 analysis of information from RESULTS indicated that the average amount of stump removal is less than 35 hectares per year over a 10 plus year timeframe within the Arrow TSA (TFLs and other area based tenures excluded). This number seems far too low given the high % of ICH stands and it is **recommended that all Licencees should be considering stump removal treatments in high risk areas where feasible.**

5.7 Laminated Root Disease

This disease, caused by *Phellinus sulphurascens*, primarily infects Douglas-fir, grand fir, subalpine fir, and mountain hemlock. A separate laminated root disease (*Phellinus weirii*)is known to cause butt rot on western red-cedar but is not known to be a major mortality agent. The incidence of *P. sulphurascens* can be especially impacting on second & third-growth Douglas-fir plantations. Windthrow, decay, and mortality can be locally significant, especially in moist ICH subzones. Douglas-fir bark beetle may prefer infected trees. Management 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.

5.8 Fire and Post Fire

Fire damaged area is detected based on previous year's fire season and post fire damage is additional noted mortality in subsequent years. Fire damaged stands should be considered for immediate salvage to reduce future damaging agents such as Douglas-fir bark beetle and to reduce non-recoverable losses. Harvest within a year of damage is recommended for wood quality and reduction of other pests. Fire affected area was down significantly in 2019 with 0 ha burned and 131 ha of post fire mortality compared to 19,435 ha in 2018.

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

2019 saw a significant decrease to 93 ha affected in comparison to 1181 ha infected by these two larch foliage diseases in 2018. 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. Area affected varies annually. No significant impact on the TSA is expected at this point and no management is proposed except continuous monitoring of the occurrence. These diseases are reliant on extended cool wet conditions in spring to early summer seasons.

5.9 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 are of moderate concern in the Arrow TSA. They are restricted to lodgepole and ponderosa pine. Some low levels have been noted in completed FREP Stand Development Monitoring plots within the Arrow TSA. The loss impact on the TSA is unclear but will impact the future rotation to some degree with timber mortality and quality losses. Free Growing surveys and declarations 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.

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

Both Lophodermella and Dothistroma were not detected in previous years. They typically affect young pine stands and can cause serious defoliation typically during moist summer years. Growth reductions and mortality may result after repeated epidemics. Both are often associated with over planting of Lodgepole pine in ICH sites or planting offsite seedlots. Where possible, a mix of species is highly recommended to be planted or regenerated naturally. 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 Dwarf mistletoe: Larch -DML (*Arceuthobium laricis*), Lodgepole Pine-DMP (*Arceuthobium americanum*), and 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.

5.13 Various broadleaf deciduous diseases and pests

Changes observed in deciduous pests and diseases - Aspen leaf miner to 12,225 ha from 13,729 ha & Birch leaf miner to 701 ha from 375 ha. The impact of these pests and diseases on the TSA is not significant. No management is planned. As per Chief Forester direction, deciduous species should not be included in stocking standards. Chronic damage has been impacting deciduous species in the Arrow TSA over the last many years, possibly related to climate change or weather patterns, supports this recommendation.

5.14 Bear-AB and other Animal Damage

Bear damage has halved to 210 ha of Light attack. Damage was also noted in the FREP SDM surveys, primarily on Lodgepole pine but also on other species. Most mortality appears to be on younger single trees but to be detected on the AOS it would be significant damage within an opening or strata. 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.

5.15 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 was not detected for a third year after three previous years in a row of noted attack. 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 which attempt to regenerate a younger layer under an established canopy. Future managment may include a spray program by the Province if the outbreak is significant enough and funds available.

5.16 Western Hemlock Looper IDL (*Lambdina fiscellaria lugubrosa)*

Looper was detected for the first time in 6 years in 2019 within Light, Moderate and Severe severity classes. Area of attack was noted in northeast of Nakusp. The current management strategy is to monitor and if necessary, consider spraying with Btk. Monitoring is through the aerial overview survey and ground sampling carried out at the Regional level. While not significant at this time, a prolonged outbreak would impact short term timber supply of host species. The preferred host of the looper is western hemlock followed by interior spruce, Douglas-fir and western red cedar and it is found primarily in mature and over mature hemlock and hemlock-cedar stands.

5.17 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 Arrow TSA. On the neighbouring Kootenay Lake TSA, it

is the #1 insect/disease factor in stands younger than 40 years (SDM). Arrow SDM sample 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.

5.18 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 Arrow region 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 species for its very large seeds.

The cutting or damaging of whitebark pine should be strictly avoided. Whitebark pine stands, especially those with many cone-bearing trees and in good health, 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.

5.19 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.

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, 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 before in regards to thinning birch and other deciduous brush. Early treatments may be an option to reduce DRA issues before root spread on deciduous becomes too large.

5.20 Hot Droughts NDM

No area was observed as drought kill in 2019. It was mapped at 1902 ha in 2018 in the Light,. Moderate and Severe severity classes. 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. Impacted trees often don't die until a year or two post hot drought. Sub-lethal effects of drought are often not well ducomented so often go undetected 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. 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.

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 3). An Open House was held in Castlegar January 23, 2020 to inform the public.

Figure 2. Kootenay Boundary Regional Gypsy moth pheromone trap placements.

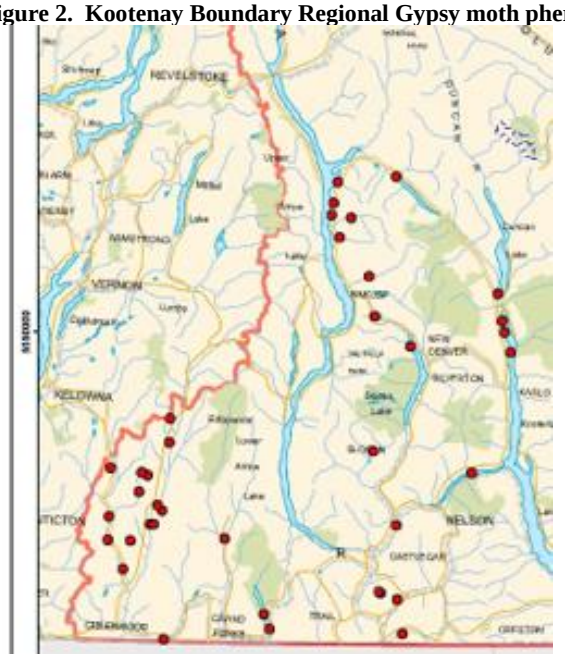
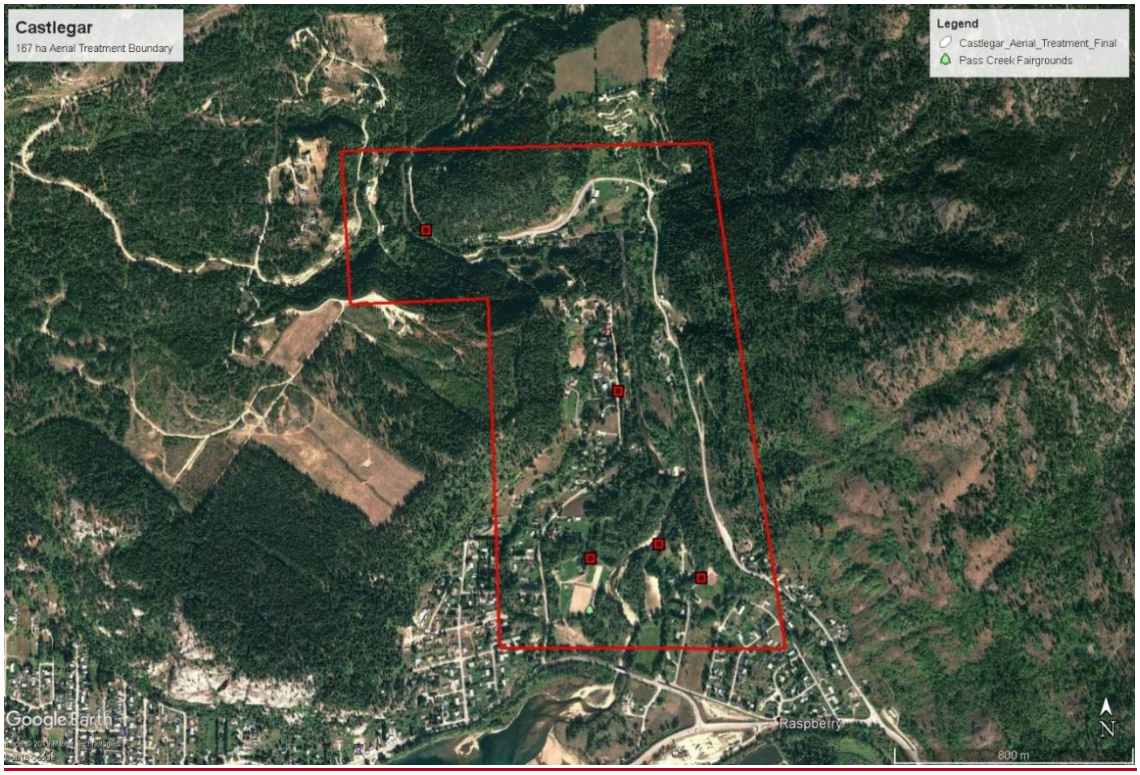


Figure 3. 2019 Castlegar Gypsy moth positive traps and 2020 spray boundary.



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 Arrow TSA specifically - Trail, Rossland, Upper Arrow Lake and Lower Arrow Lake areas. 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.

The northern spread appears to be contained below a line that runs approximately from Mica Creek, to Blue River, to Wells Gray Provincial Park and Quesnel.

Table 8: Balsam woolly adelgid occurrence sampling results, 2016-2018 in the Kootenay Boundary Region – Arrow TSA.

Location	Result of sampling (positive, negative)	Sample Year
New Denver/ Kalso Pass (Hwy 6)	negative	2018
Archibald FSR (near Salmo)	Negative	2018
Rossland Cascade FSR	Positive	2017

6 Management objectives for priority forest health agents

6.1 Integrated Forest Health Management objectives

The following principle for management objective commonly known as "Integrated Forest Health Management" will be followed for all the priority forest health agents in the Arrow TSA:

1. Know the landbase and resource management objectives;
2. Manage from an ecological perspective;
3. Don't make the situation worse;
4. Practice adaptive management.

The Integrated Forest Health Management is a system that, in the context of specific resource management objectives and knowledge of the associated environment and the biology of the forest health agent and host species, applies all suitable techniques and methods to maintain forest health agent populations at levels below those causing unacceptable damage or mitigates such damage.

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

The following are the management objectives to be implemented for the three main bark beetles in the Arrow TSA: mountain pine beetles, Douglas-fir beetle and spruce bark 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 harvesting a minimum of 80% of the area to maintain the suppression strategy for IBD and IBS and 50% of the IBM attacked stands to maintain the current holding action suppression strategy within 24 months of the AOS flight.**
2. Prioritize the forest management to higher hazard forest stands by harvesting or reducing the susceptibility of stands to bark beetles.
3. Limit the amount of non-recoverable losses due to bark beetles;

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.

6.3 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.

6.4 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 for mountain pine beetle and April 1 through August 31 for Douglas-fir beetle and May 15 through July 15 for spruce beetle:

- 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 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 1 to Sept. 15 for mountain pine beetle and April 1 through August 31 for Douglas-fir beetle and May 15 through July 15 for spruce beetle:
• 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.

6.5 Pheromone Placement

Pheromone placement is to occur in or immediately adjacent to **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/*).

6.6 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. If 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 Arrow 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 Arrow 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 Selkirk Resource District (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 outlined in the Provincial Bark Beetle Strategy and also include the bark beetle Strategy for each BMU.

Table 9: Mountain pine beetle BMU ranking and strategies

BMU #	BMU Name	# green attack	Susceptibility	Provincial Ranking	BMU Strategy
501	Sheep	Unknown	High	1	Hold
502	Rossland	Unknown	High	1	Hold
503	Bear	Unknown	High	2	Hold
504	Pend Oreille	Unknown	Low	3	Hold
505	Stagleap	Unknown	High	4	Hold
506	Erie	Unknown	High	1	Hold
507	Glade	Unknown	High	4	Hold
508	Blueberry	Unknown	High	4	Hold
509	Dog	Unknown	High	4	Hold
511	Cayuse	Unknown	High	1	Hold
512	Ladybird	Unknown	High	4	Hold
513	Pedro	Unknown	High	1	Salvage
514	Perry	Unknown	High	1	Salvage
515	Lemon	Unknown	High	1	Hold
516	HoderTFL3	Unknown	Not Available		Hold
517	KochTFL3	Unknown	Not Available		Hold

518	GladstoneTFL23	Unknown	Not Available		Hold
519	Eagle	Unknown	High	1	Hold
520	Whatsan	Unknown	Low	8	Hold
521	Woden	Unknown	High	1	Salvage
522	Caribou	Unknown	High	1	Hold
523	Hills	Unknown	High	3	Hold
524	Idaho	Unknown	High	3	Hold
525	Wilson	Unknown	Low	8	Hold
526	VipondTFL23	Unknown	Not Available		Hold
527	FosthallTFL23	Unknown	Not Available		Hold
528	Kuskanax	Unknown	High	3	Hold
529	HalfwayTFL23	Unknown	Not Available		Hold
530	Trout	Unknown	Low	8	Hold
531	Fish	Unknown	Low	8	Hold

Table 10: Douglas-fir beetle BMU ranking and strategies

BMU #	BMU Name	# green attack	Susceptibility	Provincial Ranking	BMU Strategy
501	Sheep	Unknown	High	1	Suppression
502	Rossland	Unknown	High	3	Suppression
503	Bear	Unknown	High	3	Suppression
504	Pend Oreille	Unknown	High	3	Suppression
505	Stagleap	Unknown	High	3	Suppression
506	Erie	Unknown	High	3	Suppression
507	Glade	Unknown	High	3	Suppression
508	Blueberry	Unknown	High	3	Suppression
509	Dog	Unknown	High	3	Suppression
510	JohnstonTFL23	Unknown	Not Available		Suppression
511	Cayuse	Unknown	High	3	Suppression
512	Ladybird	Unknown	High	1	Suppression
513	Pedro	Unknown	High	3	Suppression
514	Perry	Unknown	High	3	Suppression
515	Lemon	Unknown	High	3	Suppression
516	HoderTFL3	Unknown	Not Available		Suppression
517	KochTFL3	Unknown	Not Available		Suppression
518	GladstoneTFL23	Unknown	Not Available		Suppression
519	Eagle	Unknown	High	3	Suppression
520	Whatsan	Unknown	Low	8	Suppression
521	Woden	Unknown	Low	8	Suppression
522	Caribou	Unknown	High	3	Suppression
523	Hills	Unknown	High	3	Suppression
524	Idaho	Unknown	High	3	Suppression
525	Wilson	Unknown	High	3	Suppression
526	VipondTFL23	Unknown	Not Available		Suppression
527	FosthallTFL23	Unknown	Not Available		Suppression

528	Kuskanax	Unknown	High	3	Suppression
529	HalfwayTFL23	Unknown	Not Available		Suppression
530	Trout	Unknown	Low	8	Suppression
531	Fish	Unknown	Low	8	Suppression

8 Recommended activities to manage IBM, IBD and IBS

8.1 Mountain pine beetle

8.1.1 Harvesting

Harvesting is the most efficient short-term method of managing IBM populations with the intent to prevent timber loss. 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 reducing non-recoverable losses. Failure to address these losses will impact future timber supply determinations negatively. In order to reduce mid-term timber supply impacts harvesting should be targeted at infested stands with significant hazard where feasible.

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 and other treatments

No planned single tree treatments at this time.

8.1.4 Detailed Flight and Ground Surveys

None planned at this time. With no suppression BMUs, no active management by the District has been occurring or is planned including detailed surveys, pheromone use or single tree treatments. **Licencees should be targeting any moderate or higher severity attacked areas for harvest within 12 months or less from date of detection.**

8.2 Douglas-fir beetle

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 practises;
3. Trap trees;
4. Anti-aggregation pheromones (MCH);
5. Funnel trapping.

8.2.1 Harvesting

Timber harvesting in infested (1st priority) and red/grey attack (2nd priority) and un-infested stands (3rd priority) with high hazard and stress factors such as nearby windthrow, fire damage for example 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.

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.
http://www.for.gov.bc.ca/rsi/ForestHealth/PDF/PMP_2013-2017_FH_Southern_Interior_Feb_19_2013.pdf.
DSE contracts deployed 29 funnel trap sites in southern Arrow for IBD which was an increase from 2017 due to the 2017 fires and this resulted in almost 1.1 million Douglas-fir bark beetles captured. BCTS and some Licencees also massed trapped IBD in funnel traps whose numbers are currently not available. This is a significant increase over 2018 when over 118,000 beetles were captured on 10 sites.

8.2.3 Single tree treatment and other treatments

No completed or planned single tree treatments at this time.

8.2.4 Detailed Flight and Ground Surveys

The plan for 2020-21 is to complete a heli detail survey, budget allowing, of selected higher incident and risk areas in Arrow TSA (excludes TFL and CFA areas). Area flown will likely be significantly less than the last several years. Detailed mapping flights were completed for Douglas-fir bark beetle in portions of the TSA in 2019. Ground surveys were not completed in 2019 and are not planned at this time for 2020.

8.3 Spruce beetle

The overall strategy for Spruce beetle (IBS) management is that of suppression/monitor through the use of one or a combination of the following:

1. Trap trees;
2. Clean harvesting practices.

8.2.1 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 suppression strategy objectives and reducing non-recoverable losses. A combination of sanitation and salvage harvesting for Spruce 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 IBS areas or Spruce stands and complete a post-harvest mop-up where necessary.

8.3.2 Pheromone Use

No planned use of pheromones is planned at this time for IBS management.

8.3.3 Single tree treatment and other treatments

No planned single tree treatments at this time.

8.3.4 Detailed Flight and Ground Surveys

The current plan for 2020-21 is to consider a heli detail survey of known higher incident areas for IBS, budget allowing, in Arrow TSA (excludes TFL and CFA areas). No Ground surveys currently planned for 2020 or completed in 2019.

9 Priority Activities in BMUs

The following projects are planned:

- Ongoing detailed monitoring (primarily detailed flights) in higher priority areas.
- Ongoing discussions with Licencees regarding active IBM, IBD and IBS population and fire damage and windthrow in their operating areas and targeting these areas for immediate harvest.
- Ongoing Funnel Trapping for IBD in selected areas.
- Encouraging Forest Licencees to consider their own funnel trap and trap tree programs.

10 2020-21 Fiscal Year Tactical Plan

The tactical plan will be to continue to monitor forest health agents through the overview survey and IBD / IBS detailed survey in selected areas of suppression units. Selkirk District is currently implementing a funnel trap program for IBD in several areas of south Arrow TSA. Additional opportunities for funnel trapping will be considered on an annual basis based on current attack levels, funding and site feasibility. The primary focus of the funnel trap program is to reduce IBD populations in areas of high risk such as areas of recent fire, blowdown or high IBD incidence.

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, Fire and blowdown 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

Forest health concerns can be a factor in species selection and other aspects of stocking standards. Significant concerns relating to Pli in the ICH in particular 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 Arrow TSA as well as other SDM surveys in adjacent TSAs and continued research by Alex Woods and David Coates. New BEC and corresponding stocking standards have addressed some of the Pli in ICH concerns.

Licencees 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 (FG) declarations is the age at which plantations are allowed to undergo FG 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. Several other Pli damaging and mortality agents often express themselves at an older age then 9 years and are an added risk factor for future timber supply with early FG declarations.

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

The estimated forest volume killed by selected Forest Health Factor and not harvested in the Timber Harvesting Land Base (TSA only, excludes TFL3&23), as well as the amount of that killed volume that has been either harvested by the year 2019 is shown by year in Table 11. 2019 NRLs are the lowest since 2016. Over the 21 years reported in this table the volume lost represents 14.7% of the AAC for that time period or the equivalent of over 3 years of the current AAC in the 21 years. The killed volume harvested percentages show significant drops in recent years, notably 2011 to present, compared to the 1999 to 2008 timeframe. IBD losses are now estimated to be larger than IBM losses for each of the last four years. The largest recorded NRLs to fire were in 2018 and significant drought losses of 6,772 m3 were very significant as the third highest NRL Forest Health Factor for 2018. The lower NRLs in 2019 are due no fires recorded causing significant volume losses.

Table 11: 1999-2019 THLB volume killed by selected Forest Health factors and not harvested and total killed volume harvested

Annual Volume (m3) Killed on the THLB and Not Harvested as of 2019 – Arrow TSA								**Volume Killed & Harvested**	
	Forest Health Factors								
Year	**IBM**	**IBD**	**IBB**	**IBS**	**Fire**	**Drought**	**Totals***	**m3**	**% of Total Killed**
1999	29,379	127	4,483	0	0	-	33,989	18,597	35.4%
2000	28,287	6,858	1,864	0	0	-	37,009	15,828	30.4%
2001	16,221	3,546	743	0	0	-	20,510	8,694	29.8%
2002	26,307	1,081	0	0	0	-	27,388	10,219	27.2%
2003	44,488	676	7,333	0	0	13	5,423	24,998	31.1%
2004	190,148	271	4,175	0	0	-	194,594	57,587	22.8%
2005	250,331	483	4,542	0	5,530	-	260,999	66,247	20.2%
2006	273,478	511	9,321	0	2,234	-	285,545	73,598	20.5%
2007	100,915	0	5,029	0	134,775	-	240,719	37,006	13.3%
2008	116,605	121	1,817	0	20,102	-	138,645	35,250	20.3%
2009	61,721	177	2,546	0	14,919	-	79,363	13,057	14.1%
2010	28,336	0	2,052	0	167	-	30,555	4,635	13.2%
2011	11,917	631	275	0	0	-	12,823	1,532	10.7%
2012	6,849	1,043	331	0	450	-	8,673	1,078	11.1%
2013	4,571	2,814	750	0	5,774	-	13,909	1,292	8.5%
2014	4,156	3,421	758	0	3,273	-	11,773	1,004	7.9%
2015	4,011	1,048	775	0	6,570	-	12,404	1,462	10.5%
2016	3,848	4,892	2,268	0	958	-	11,966	748	5.9%
2017	6,211	11,401	682	350	4,504	-	23,148	2,075	8.2%
2018	582	14,428	906	137	181,092	6,772	203,917	5,779	2.8%
2019	219	13,301	1,395	504	0	167	15,586	-	0.0%
Totals	**1,208,580**	**66,830**	**52,045**	**991**	**380,349**	**6,952**	**1,718,938**	**380,686**	**18.1%**
Change from previous year	-28,566	+14,342	-1525	+559	+7,948	+447	+2,361	-41,268	

*Includes other FH Factors not included in the table

The 21-year average 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.

The historical Arrow TSA AAC from 1999 to present is listed in Table 12. Total NRLs over the last 21 years represent over 3 years of AAC for Arrow TSA.

Table 12: Historical Arrow TSA AAC

Year	Volume m3
1999-2001	619,000
2002-2007	550,000
2008-2011	584,000
2012-2015	535,700
2016-2017	505,853
2018-Present	500,000
21 Year Total	11,647,506

13 Conclusion

This Forest Health Strategy provides strategic direction for the licensees and FLNRORD in the Selkirk Natural Resource District – Arrow TSA. Specific practices conducted by each licensee should fall within the strategic direction provided within this document. There are significant concerns on the spread and ongoing non-recoverable losses as a result of the 4 bark beetles –, Douglas-fir Beetle, Mountain Pine Beetle, Western Balsam Beetle and Spruce Beetle and fire damaged stands and the necessity to address these through harvest and other active management tools to reduce NRLs in the present and future.

Periodic review of the Forest Health Strategy will allow adaptive management principles to be used. The plan is to review it on an annual basis will ensure forest managers regularly turn their minds to other potential sources of damage or risk to the forest.

The active co-operation of licensees and FLNRORD staff working together to promote and manage healthy forests through diversity, early detection of forest health issues, and direct action as required, will ensure a sound and sustainable industry.

14 Information Links

Report: 2019 Overview of Forest Health Conditions in Southern British Columbia
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/2019_south_area_forest_health_conditions_report.pdf

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

2018 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/

2017-19 Maps of IBD, IBS and IBM for the area are available on the FTP site at

https://www.for.gov.bc.ca/ftp/DAB/external/!publish/Forest%20Health/Detailed%20and%20Aerial%20Overview%20flight%20data/2018%20data/AerialOverviewSurvey%202016-2018%20IBM%20IBD%20NW%20NF%20GERefPDF%20maps/

Additional maps and data are available on the Branch FTP site at
https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/