MINISTRY OF FORESTS

Selkirk Natural Resource District

Arrow & Cascadia TSAs
Forest Health Strategy 2023-24

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Wood Borer attack


Cover Photo- Erin McLeod

Table of Contents

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 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 Arrow TSA and area-based tenure forestry licence stakeholders;
- 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. **Forest Health Factors are detected and assessed.**
   New and recurring disturbances caused by forest health factors are detected, and assessments of risk and impact to forest resource values are provided.
2. **Practices are adapted to accommodate known forest health risks.**
   Evidence-based information is used to develop recommendations and modify forest management practices to mitigate the impacts of forest health factors.
3. **Resources are protected.**
   Forest resource values are protected from forest health factor damage through appropriately applied direct management actions including treatment and monitoring. This includes the support and implementation of proactive management activities.

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) in the THLB by Species Composition for Arrow TSA & Cascadia TSA (Arrow portion only), over 60 years old & >17.5 cm diameter for all non-Pli species, >12.5cm for Pine species as of February, 2021. Does not include TFL23, TFL3, Parks or private land.

Species	Leading Species Total Volume m3	2nd Species Total Volume m3	3rd Species Total Volume m3	4th Species Total Volume m3	5th Species Total Volume m3	Total Volume	Species Volume %
Douglas-fir	8,752,786	1,845,879	690,256	166,846	34,196	**11,489,964**	**27.8%**
Larch	4,372,745	2,067,767	680,231	243,205	50,661	**7,414,609**	**17.9%**
Spruce	3,407,359	1,782,716	472,337	212,823	44,016	**5,919,251**	**14.3%**
Lodgepole pine	2,814,911	1,258,120	860,972	266,063	80,173	**5,280,238**	**12.8%**
Sub-alpine fir	2,352,934	1,150,832	280,987	111,161	32,871	**3,928,785**	**9.5%**
Hemlock	2,551,568	860,726	329,341	138,455	35,509	**3,915,598**	**9.5%**
Cedar	595,030	607,675	290,859	137,467	34,867	**1,665,898**	**4.0%**
Aspen	21,334	190,833	126,928	102,803	30,653	**472,551**	**1.1%**
Birch	19,099	130,041	107,803	90,151	25,121	**372,216**	**0.9%**
White Pine	21,077	68,639	105,615	98,981	54,909	**349,221**	**0.8%**
Grand fir	182,313	67,443	42,982	31,108	10,824	**334,670**	**0.8%**
Cottonwood	25,594	36,658	23,882	27,214	10,081	**123,428**	**0.3%**
Ponderosa pine	20,563	40,331	15,039	7,877	447	**84,257**	**0.2%**
Whitebark pine	1,387	11,559	11,166	1,265	NULL	**25,377**	**0.1%**
Total						**41,376,064**	

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, Western larch, Spruce, and Lodgepole pine. Minor species found in the TSA include Sub-alpine fir, Western hemlock, 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
  https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/timber-supply-review-and-allowable-annual-cut/allowable-annual-cut-timber-supply-areas/arrow-tsa
  - Analysis Report
  - Information Report
  - Rational for Allowable Annual Cut Determination

- Kootenay-Boundary Land Use Plan
  https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/kootenay-boundary/kootenay-boundary-rlup

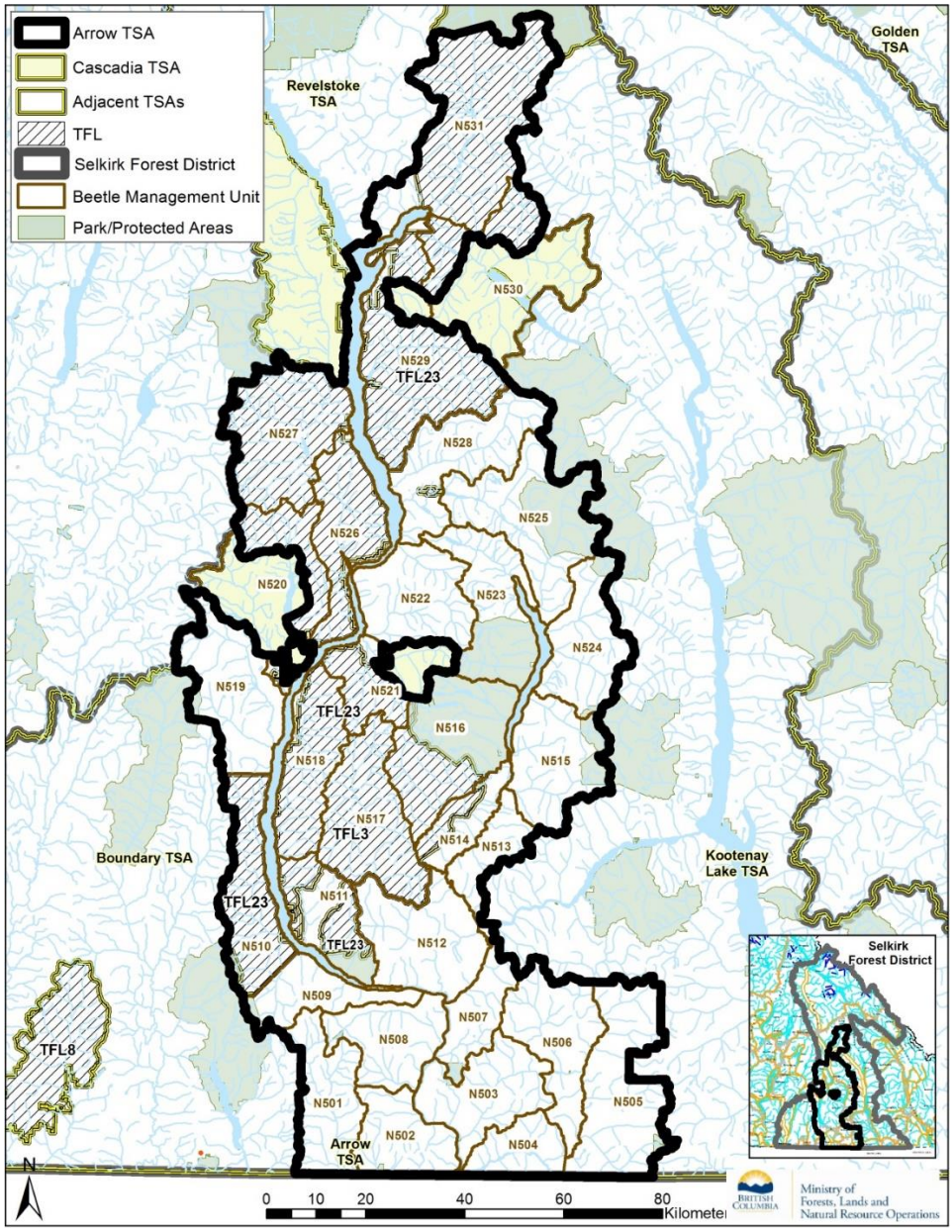

Figure 1: Arrow TSA showing, TFLs (includes Cascadia TSA) and Parks.

3.1. Previous Forest Health Strategies in the Arrow TSA

The last full forest health strategy was completed in 2023. 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 13 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, Black Army Cutworm
Diseases	Armillaria root disease	White pine blister rust		Dothistroma, Lophodermella, Hard pine rusts (Western gall rust, Stalactiform blister rust, Comandra blister rust)
Insects	**Douglas-fir beetle, Spruce beetle, Mountain pine beetle, Western balsam bark beetle**			Spruce weevil, Balsam Woolly Adelgid, Western Bark Beetle
Mammals			Bear	Deer, Moose, other animals
Abiotic Factors	**Fire**	Windthrow, Drought		Snow damage

5. Description of the Priority Forest Health agent status and tactics

Table 4 provides an overview of the activity status of some of the priority forest health agents which were reported during the 2022 and 2023 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 these in their Licence or operating areas.

Table 4: Selected Summary of 2022 & 2023 Arrow TSA significant Forest Health damaging agents

Forest Health Agents	2023 Affected Area (ha)	2022 Affected Area (ha)	Trend	Current Impact on Timber Supply	TSA Priority
Fire & Post Fire	3,117	748	Very Significant Increase	Very High	**1**
Douglas-fir beetle	1,174	5,355	Significant Decrease	Very High	**1**
Western balsam bark beetle	2,261	1,295	Significant Increase	Very High	2
Western Hemlock Looper	585	6,511	Significant Decrease	High	2
Mountain pine beetle	454	90	Significant Increase	High	2
Cedar Flagging	11,144	3,130	Significant Increase	High	3
Drought	28	0	Significant Decrease	Very Low	2
Windthrow	28	6	Significant Decrease	Very Low	2
Slides	18	0	Slight Increase	Very low	3
Spruce bark beetle	218	0	Slight Decrease	Moderate	2
Larch needle blight / cast	356	301	Slight Increase	Nil	n/a
Aspen Serpentine Leaf Miner	2,969	76	Significant Increase	Low	n/a
Western Pine Beetle	0	1	Not detected	Very Low	n/a

5.1 BARK BEETLES

Douglas-fir beetle IBD (*Dendroctonus pseudotsugae*)

The Douglas-fir beetle population decreased significantly from 5335 ha in 2022 to 1174 ha in 2023. Most of the polygon area total was spread across Light and Trace attack severity classes with about 10% in the Moderate category. IBD attack is common throughout the TSA, maybe more so in the southern half, in valley bottoms where there is susceptible Fdi and likely slightly concentrated where trees have been stressed from fire damage, windthrow and/ or drought. There are 142,885 ha of susceptible (>20 rating) forest types to Douglas-fir beetle in the Arrow TSA based on a 2021 BMU analysis and Douglas-fir is one of the dominant tree species in this TSA at almost 28% of the over 60 years of age volume. 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. 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 remains negligible over the last many years. 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.**

A small Area of the Arrow TSA was detailed flown for IBD, east side of lower Slocan River valley and small area north of the Pend D'Oreille River, a total of 46 spots were noted and 253 red trees tallied (see Figure 2).

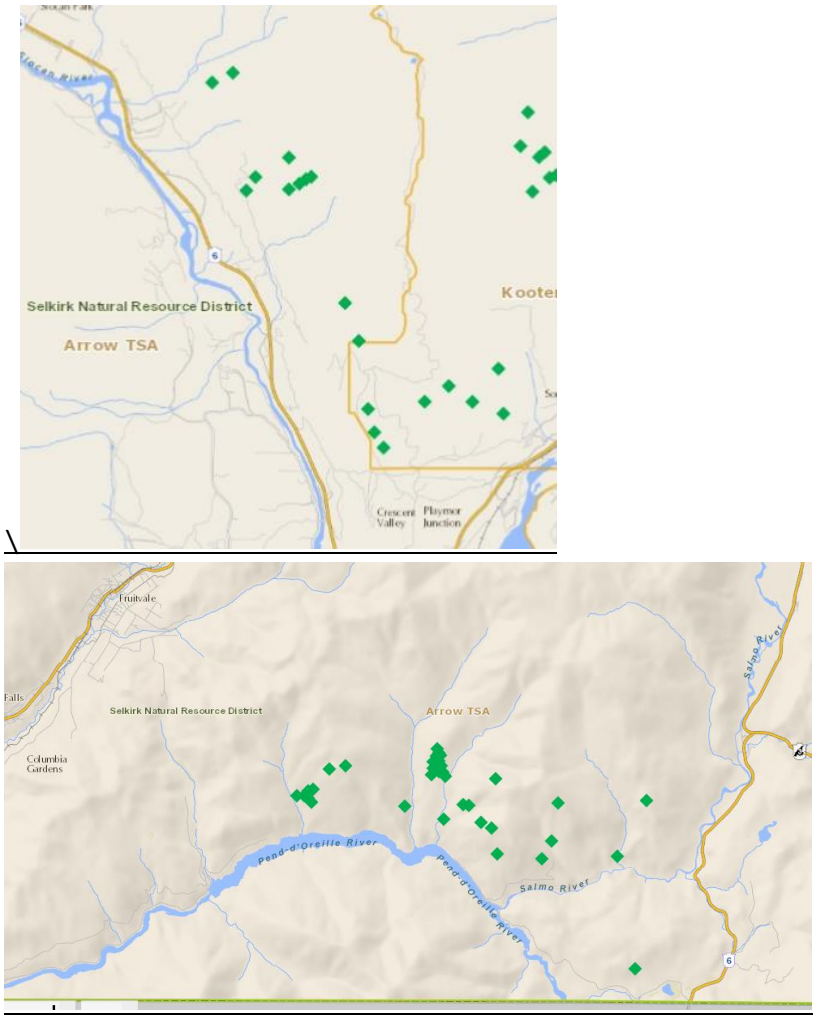

Figure 2. 2023 IBD Detailed flight results in Arrow TSA.

Information on managing IBD post fire can be found here:

DFB_Post-fire information_Nov 28_2017.pdf (gov.bc.ca)

Mountain Pine beetle IBM (*Dendroctonus ponderosae*)

The area of current mountain pine beetle infestation has increased to 454 ha in 2023 from 90 ha in 2022. Severity across this area was noted primarily in Light and Trace severity classes and just over 10% in Moderate. The attack is concentrated near north end of Slocan Lake to Nakusp above Hwy 6 mostly in inoperable terrain. 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.

Continued harvest of susceptible stands and any identified polygons of attack to reduce non recoverable losses is the recommended strategy. Negligible harvest of IBM affected areas has been

recorded in recent years. As of 2015 just over 30% of the THLB Pli volume was estimated to have been killed by IBM in Arrow.

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 9.5% of the total volume (m^3) by species composition, over 60 years old as of 2021 for the Arrow TSA, not including TFLs, Parks or private land. Western balsam bark beetle has been chronically causing mortality over many years. In 2023 there was a significant increase to 2261 ha compared to 1295 ha in 2022. Attack severity for 2022 was in Light and Trace severity classes. 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 especially Moderate attack or higher.

Spruce bark beetle IBS (*Dendroctonus rufipennis*)

Spruce beetle was observed at 218 ha in 2023 and 0 ha in 2022. IBS was observed in the area to the north and west of Urd Peak , SE of Burton. There are 86,200 ha of susceptible (>20 rating) forest types to Spruce beetle in the Arrow TSA based on a 2014 BMU analysis and the Arrow/ Cascadia TSAs have 14.3% Spruce over age of 60. **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

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.**

5.2 DEFOLIATORS

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 again for sixth year in a row. 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.

Western Hemlock Looper IDL (*Lambdina fiscellaria lugubrosa*)

Looper affected area decreased significantly in 2022 to 585 ha from 6511 ha in 2022 within Moderate and Light severity classes. Areas of attack noted include several polygons in several drainages around Nakusp (Bremne Ck, Kuskanax Drainage north to St Leaon Creek) and Trout Lake to Beaton area. No spray program is currently planned for Arrow TSA. 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. 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. **Licencees should consider harvesting heavily affected stands where possible.**

Larch casebearer – IDC (*Coleophora laricella*)

Larch casebearer was not observed in 2023 or 2022. Larch trees are relatively resistant to the effects of defoliation. However, after 5 years of severe defoliation, annual terminal and radial growth may be seriously affected.

Black army cutworm IDA *(Actebia fennica)*

Black army cutworm was a major pest in the 1980's associated with prescribed burns and with increased wildlife activity and tight timelines for reforestation increased monitoring is required to ensure this defoliator does not impact recently planted areas. Larvae actively feed April through June on a variety of hosts causing "shot-hole" type defoliation. Included in the host preference is a variety of shrubs and herbaceous plants as well as western larch, Douglas-fir, Engelmann/hybrid spruce and lodgepole pine. At low populations black army cutworm feeds on it's preferred hosts of shrubs and herbaceous plants as well as larch, but at moderate and outbreak populations feeding switches to conifer seedlings such as Douglas-fir, Engelmann/ hybrid spruce and lodgepole pine. Seedling mortality can occur as quickly as a single year dependant on black army cutworm population density. Most seedlings can sustain moderate defoliation (i.e. less than 60%) with limited impact on their growth or survival. Moister sites also recover quicker, whereas drier sites experience greater affects of reduced height growth and mortality because of reduced root growth from moisture stress.

Wildfire timing is critical to determine if black army cutworm populations might increase post fire. For early season fires, from April through June, IDA populations are expected to increase the following spring and for late season fires, occurring July through October, IDA populations can increase as early as the following summer.

High risk sites such as burned openings are the preferred egg laying areas. The more severe the burn (i.e. no to little vegetation remaining) the following year leads to the highest levels of defoliation on natural or planted conifer seedlings. ESSF, MS, SBS, ICH and IDF BEC zones are the highest risk areas, especially the drought-prone sites in the drier subzones.

Management strategies for black army cutworm include.

1. Conducting spring surveys on the natural vegetation to determine presence of IDA.
2. Conducting adult pheromone monitoring in the summer (July 1 – September 15th) annually one to three years post fire using baited multi-pher or unitraps.
3. Depending on population levels avoid spring planting or delay planting for one to three years following a burn.

Predicted defoliation risk the following year using multi-pher traps can be categorized as low for <350 moths/ trap, moderate >350-1200 moth per trap and high >1200 moths per trap.

Traps should be placed at least 200 meters apart, well within the burn area, away from stand edges, with a vapona strip placed inside, check and empty traps weekly, place traps at 0.5 to 1 m height on south-facing slopes, in a line across prevailing winds if possible.

Kootenay Boundary Region has been monitoring black army cutworm in various locations since 2018 using multi-pher traps.

5.3 OTHER INSECTS

Spruce Weevil -IWS (*Pissodes strobi*)

Spruce weevil is an insect that will repeatedly attack and damage the leader of spruce trees, causing poor form and reduced growth. It is not typically noted by the AOS. Spruce weevil is currently a medium to low priority issue overall, but in plantations that contain a large proportion of spruce seedlings; it is a medium to high priority. Risk increases with increasing growth degree days so lower elevation planting of spruce is at greater risk of attack and severe plantation damage. One strategy for this insect is to ensure that there is a good species mix on the site, consider Sx seedlot selection carefully and maintain a relatively high planting density.

Wood Borers

In June 2021, a heat dome event occurred setting record temperatures throughout southern BC and into the US. As a result of these high temperatures and combined moisture stress trees expereinced siginifcant stress. In the spring of 2023 a significant number of mature Douglas-fir and to a lesser extent, lodgepole pine and western larch, displayed symptoms of attack by larger woodborers as the bark was stripped by woodpeckers, in many cases from crown to duff within a week or so. Woodborers are not usually primary tree killers but when trees are severely stressed they often attack and overcome weakened trees.

Figure 4. Douglas-fir trees infested and killed by larger woodborers and stripped of their bark by woodpeckers (Loon Lake, BC near Grassmere, April 2023).

5.4 DISEASES

Amillaria 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 MoF (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 may be considered for stump removal treatments post-harvest to reduce DRA levels. Because deciduous brush thinning can promote spread of Armillaria, such action should be applied cautiously.

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 90.6 ha of stump removal for 2023 in TFL23 and their forest Licence over 6 blocks in Arrow TSA. No other Licencee recorded stump removal for 2023. 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.

This number seems far too low given the high % of ICH stands and it is recommended that all Licencees consider stump removal treatment and other silviculture options in high risk areas where feasible.

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 MoF (2018). Stocking Standards for Free Growing Stands are contained in each licensee's Forest Stewardship Plan and have been developed to address this disease.

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

2023 saw a slight increase to 356 ha affected in comparison to 301 ha infected by these two larch foliage diseases in 2022. 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.

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 were noted in completed FREP Stand Development Monitoring plots within the Arrow TSA many years ago. 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.

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

Dothistroma was not detected in 2021 or 2022. These needle diseases 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 for Licencees could be to at least do a sample of surveys earlier in the season.**

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.

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 the level of impact or occurrence. Refer to the new land management handbook, "Dwarf Mistletoe Management in BC" for guidance.

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.

Specific guidelines for retaining whitebark pine are provided by the Ministry of Forests with the link below:
Natural Resource Best Management Practices - Province of British Columbia (gov.bc.ca)

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 is harvested, or killed by other causes, the Armillaria fungus can quickly spread along dead birch roots and transfer to conifers. Overall, the incidence accelerates. Thus, careful consideration should be given regarding thinning birch and other deciduous brush. Early treatments may be an option to reduce DRA issues before root spread on deciduous becomes too large.

5.5 Deciduous Pests

Various broadleaf deciduous diseases and pests

Changes observed in deciduous pests and diseases - Aspen leaf miner to 2969 ha from 76 ha & Birch leaf miner undetected at 0 ha two years in a row. The impact of these pests and diseases on the TSA is not thought to be significant. No management is planned. 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.

5.6 Abiotic and Animal Damage

Windthrow NW

Observed windthrow was similar significantly in 2023 at 28 ha compared to 22 ha in 2022. There was just a single polygon observed and located south of Burton above Burton (Trout) Ck. 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.

Fire NB and Post Fire NBP

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. Harvesting within a year of damage is recommended for wood quality and reduction of other pests. Fire affected area was significantly higher in 2023 compared to 2022 with an estimated 3117 ha burned in 2022 with the largest fire at 876.3 ha fully in one of the Arrow management Units. Most of the area burned was in TFL23 and Arrow and Cascadia TSAs and north and east of Nakusp. No Post Fire mortality was observed for 2023.

Hot Droughts NDM

No area was observed as drought kill in 2022 or 2023. Given the Heat dome in 2021 it was expected that some level of drought damage could be observed in 2022. However,. This damage was noted throughout the Koch Ck drainage and 1 polygon in Ladybird and appears to be observed exclusively on Western Red Cedar. 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.

Drought Foliage Damage NDF

A significant amount of area was observed for Cedar Flagging in 2022 - 3,130 ha. Drought foliage damage was noted for a total of 1,227 ha in 2021. Most of the area affected in 2022 was spread relatively evenly across Light, Moderate and Severe severity classes. NE was noted primarily in the Trout Lake and Lardeau Creek area. Cedar flagging is typically a result of hot, dry weather and drought conditions from current and previous years.

Bear-AB and other Animal Damage

No bear damage was observed for the last two years. 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.

5.7 Invasive Species

Spongy Moth (*Lymantria dispar dispar*)

The Ministry of Forests (MoF), Canadian Food Inspection Agency (CFIA), and Canadian Forest Service (CFS) cooperatively monitor for the occurrence of European spongy 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 3). No confirmed adult moths were caught in the Arrow TSA in 2023, therefore no treatment is scheduled.

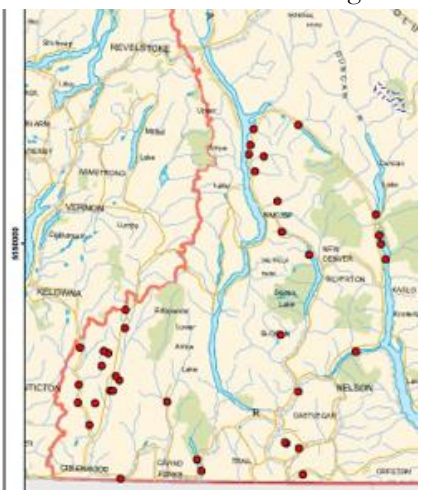

Figure 3. Kootenay Boundary Regional Spongy moth pheromone trap placements.

Balsam woolly adelgid - IAB (*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.

IAB has been confirmed in the Arrow TSA and 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.

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, 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 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.

ACTIVITY	***MoF***	***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 (MoF 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 (MoF region)	***X***	
Conduct detailed aerial surveys focusing on suppression beetle management units	***X***	
Submission of survey and treatment data to MoF		***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. Table 5 below follows the methodology outlined in the Provincial Bark Beetle Strategy and also includes the bark beetle Strategy for each BMU.

Table 5: Mountain pine beetle and Douglas-fir beetle BMU ranking and strategies

BMU #	**BMU Name**	**IBM**			**IBD**		
		Susceptibility	Provincial Ranking	BMU Strategy	Susceptibility	Provincial Ranking	BMU Strategy
501	Sheep	High	1	Reactive	High	1	Targeted
502	Rossland	High	1	Reactive	High	3	Targeted
503	Bear	High	2	Reactive	High	3	Targeted
504	Pend Oreille	Low	3	Reactive	High	3	Targeted
505	Stagleap	High	4	Reactive	High	3	Targeted
506	Erie	High	1	Reactive	High	3	Targeted
507	Glade	High	4	Reactive	High	3	Targeted
508	Blueberry	High	4	Reactive	High	3	Targeted
509	Dog	High	4	Reactive	High	3	Targeted
511	Cayuse	High	1	Reactive	Not Available		Targeted
512	Ladybird	High	4	Reactive	High	3	Targeted
513	Pedro	High	1	Salvage	High	1	Targeted
514	Perry	High	1	Salvage	High	3	Targeted
515	Lemon	High	1	Reactive	High	3	Targeted
516	HoderTFL3	Not Available		Reactive	High	3	Targeted
517	KochTFL3	Not Available		Reactive	Not Available		Targeted
518	GladstoneTFL23	Not Available		Reactive	Not Available		Targeted
519	Eagle	High	1	Reactive	Not Available		Targeted
520	Whatsan	Low	8	Reactive	High	3	Targeted
521	Woden	High	1	Salvage	Low	8	Targeted
522	Caribou	High	1	Reactive	Low	8	Targeted
523	Hills	High	3	Reactive	High	3	Targeted
524	Idaho	High	3	Reactive	High	3	Targeted
525	Wilson	Low	8	Reactive	High	3	Targeted
526	VipondTFL23	Not Available		Reactive	High	3	Targeted

527	FosthallTFL23	Not Available		Reactive	Not Available		Targeted
528	Kuskanax	High	3	Reactive	Not Available		Targeted
529	HalfwayTFL23	Not Available		Reactive	High	3	Targeted
530	Trout	Low	8	Reactive	Not Available		Targeted
531	Fish	Low	8	Reactive	Low	8	Targeted

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.

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/southern-interior-program/pmp_forest_health_southern_interior_sep_6_2017.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

No planned IBM activities 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.
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/southern-interior-program/pmp_forest_health_southern_interior_sep_6_2017.pdf
DSE contracts deployed 45 funnel trap sites in southern Arrow for IBD and this resulted in almost 1.1 million Douglas-fir bark beetles captured. IBD Funnel trap capture numbers by Licencee is listed in Table 6. Over 2.5 million captured by all participating Licencees and Government and potentially saving over 1,511 new attacked trees. This compares to 3.3 million in 2023 and 3.4 million in 2022. The current population trend based on trap numbers and AOS observations appears to be one of slow decline.

TABLE 6: ARROW IBD Funnel trapping - 2023

Licencee	# of Sites	# of IBD
District	45	1,093,836
BCTS North	11	196,350
BCTS South	??	15,386
ATCO	9	122,679
NACFOR		Data Not supplied
Interfor	8	742.231
Stella-Jones	3	196,000
W0405		Data Not supplied
SIFCO		Data Not supplied
W1856		Data Not supplied
Monticola Private lands	15	155,180
W0408	4	46,624
Totals	**95**	**2,568,286+**

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 2024-25 is to consider heli detail survey in very high priority areas, budget allowing, of selected higher incident and risk areas in Arrow TSA (excludes TFL and CFA areas). Detailed mapping flights were completed for Douglas-fir bark beetle in 2 smaller areas TSA in 2023. Ground surveys were not completed in 2023 and are not planned at this time for 2024.

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 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 2024-25 is not to detail fly any IBS for 2024 as AOS detection levels are extremely low and in Parks or inoperable areas. No Ground surveys currently planned for 2023 or completed in the last many years.

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 and coordinating with participating Licencees.
- Encouraging Forest Licencees to consider their own funnel trap and trap tree programs.

10 2024-25 Fiscal Year Tactical Plan

The tactical plan will be to continue to monitor forest health agents through the overview survey and IBD 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 currently.

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 than 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)

Non-recoverable losses (NRLs), or unsalvaged losses, are the amount of volume lost annually to damaging agents that is not harvested. This represents losses above and beyond those already accounted for in existing growth and yield models, often as a result of unpredictable events. These losses can be both incremental losses (e.g. defoliation, defect) and mortality. NRLs are generally subtracted from yield projections.

Fir the second year in a row the NRL data has not been supplied by Branch staff. 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 7. 2019 NRLs were 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. 2020 losses are likely a bit higher due to the fires and higher IBD but offset somewhat due to lower attack levels in other FH factors. There is no 2020-23 update to this table as it was not supplied at the time of this report preparation.

Table 7: 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 &**

	Forest Health Factors							Harvested	
Year	IBM	IBD	IBB	IBS	Fire	Drought	Totals*	m3	% of Total Killed
1999-2009	1,137,880	13,851	41,853	0	177,560	13	1,324,184	361,081	21.4%
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%**

*Includes other FH Factors not included in the table

The historical Arrow TSA AAC from 1999 to present is listed in Table 9. Total NRLs over the 21 years represents over 3 years of AAC for Arrow TSA.

Table 9: Historical Arrow TSA AAC

Year	Annual 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
24 Year Total	13,647,506

13 Summary Comments

This Forest Health Strategy provides strategic direction for the licensees and Ministry of Forests 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, Western Balsam Beetle, Spruce Beetle Mountain Pine 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. Active IBD management is highly recommended in any areas of moderate or higher hazard Douglas-fir risk. Recent Wildfire losses, Western Hemlock Looper and Drought are also significant factors in the last few years that are recommended for attention by Licencees, whether for harvest, or reforestation regimes or both. New this last year are wood borers as a primary mortality agent. Wood Borers attack has seen a significant rise based on ground observations and at times was mistaken for IBD from the air.

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 licencees and MoF 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.

Please contact Dean Christianson, Stewardship Forester – forest Health if any issues or questions related to Forest Health within the District. Dean. Christianson@gov.bc.ca or 778-364-1145.

14 Information Links

Report: BC Southern Interior FH Conditions for 2023

2023_southern_interior_fh_report_feb_15_2024_final.pdf (gov.bc.ca)

Provincial Forest Health Strategy 2023-2026

fh_strategic_plan_2023_final.pdf (gov.bc.ca)

Provincial Bark Beetle Management Technical Implementation Guidelines (formerly Bark Beetle strategy
https://www.for.gov.bc.ca/hfp/health/fhdata/bbstrategy.htm

Natural Resource Climate Change Applied Science

Applied Science - Province of British Columbia (gov.bc.ca)

Spatial Data:
Bark Beetle Hazard Ratings
https://www.for.gov.bc.ca/rsi/foresthealth/hazard_rating.htm

2022 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/

2022 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/

2019-21 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%20GEOrefPDF%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/