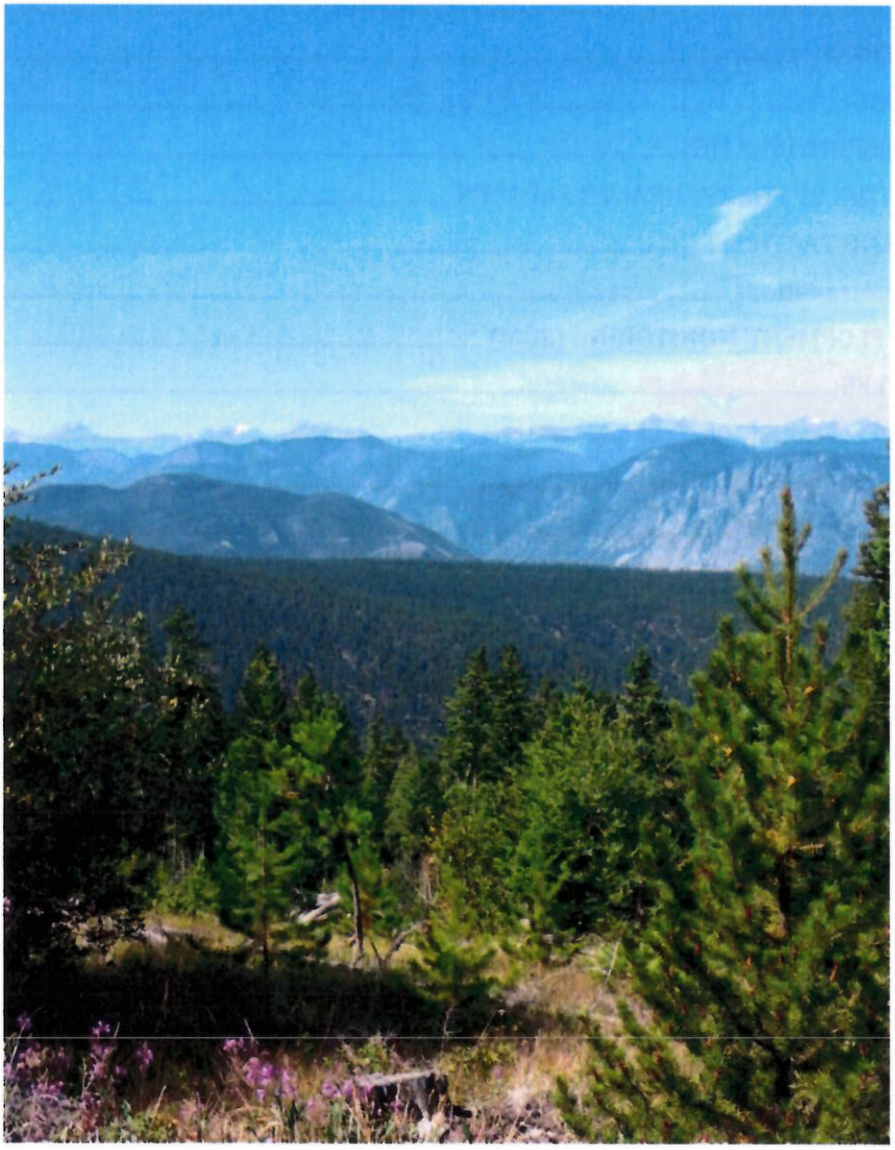
2016-2017

FOREST HEALTH STRATEGY

CASCADES NATURAL RESOURCE DISTRICT



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INTRODUCTION

The Cascades Forest District Forest Health Strategy is intended to guide management of forest health concerns on Crown land within the Merritt and Lillooet Timber Supply Areas (TSA). The annual update will outline the current status of forest health factors and the key strategies and tactics to address them. The intent of this document is to provide guidance to operational planners, reviewing agencies and approval authorities. By providing basic acceptable approaches to forest health management this document simplifies the planning and approval for forest health treatments. Forest health activities are subject to financial constraints and targets that may not be met due to fluctuating economic conditions. It is expected that proposals that vary from the agreed-upon direction will include a rationale to clarify the appropriateness of the proposal.

PRIORITY FOREST HEALTH ISSUES

The current, high priority forest health issue in both TSAs is bark beetle. More specifically, Douglas fir and spruce beetle in the Merritt TSA and Douglas fir and mountain pine beetle in the Lillooet TSA.

The use of aerial overview surveys will continue to be the base method for detection and monitoring. The information gathered from the flights will be used to prioritize areas for ground surveys and treatments and all information will be shared with local stakeholders. A coordinated approach between the Licensees and District will be promoted to implement targeted treatments such as trap trees and harvesting.

CHANGES OF NOTE

- Combined TSAs
- Updated Beetle Management Units (BMUs)
- Aligned Lillooet BMU's with Landscape Units
- Updated status of priority pests
- Updated non-recoverable losses to reflect TSR 5 review
- Included a section on Stand Development Monitoring (SDM)
- Added climate change section

GOALS AND OBJECTIVES

The goal of the Cascades Forest Health Strategy is to protect the forest resources from damaging agents that threaten the resources immediate and long-term sustainability. This strategy will strive to align itself with the provincial forest health strategy (2013-2016) goals which are as follows:

1. The evaluation of pest impacts on forest resource values is supported by forest health monitoring and assessments.
2. Forest practices are modified to minimize the impacts of forest health factors based on the best available information.
3. Forest resources are protected from pest damage through appropriately applied direct management actions.

To successfully attain these goals, a number of objectives must also be identified and achieved. These objectives mirror those identified at the provincial level and are as follows:

- Maintain a detection program for damaging agents. This program includes standardized incidence surveys, reports, records and continuous improvement or evolution of methods.
- Assess current and future stand and landscape level hazard and risk from priority pests including the impacts of forest management practices on resource values.
- Identify significant pest risks to resource values and identify appropriate management strategies and tactics, while considering constraints imposed by other resource management agencies.
- Implement strategies and tactics according to scientifically sound practices. This includes implementing strategies and tactics in a timely manner for unforeseen occurrences or outbreaks.
- Evaluate results of practices over the short and long-term and modify accordingly. This includes monitoring practices, identifying information gaps and applying research to revise and improve practices as required.

Cascades Forest District consists of the Merritt and the Lillooet Timber Supply Areas (TSA). Mountainous terrain and steep river valleys dominate both TSAs. In Merritt, the Cascade Mountains dominate the western portion of the TSA, while the dry, flat Thompson Plateau dominates the eastern portion. Over 5% of the TSA is very dry grasslands with sagebrush and open-growing Ponderosa Pine. In Lillooet, the geography results in great variation of climate and vegetation complexes. The western portion experiences predominately wet coastal conditions, while the eastern portion has dry interior conditions.

Timber Harvesting Landbase (THLB)

Of the Cascades Forest District land base, various designations apply and forest health management objectives, responsibilities and potential control activities differ depending on the land designation. The following tables show the breakdown of the landbase:

Table 1. Merritt TSA Landbase Profile

	Merritt		Lillooet	
Landbase Designation	**Area (ha)**	**% Total Area**	**Area (ha)**	**%Total Area**
Parks & Protected areas	17,311	1.5%	258,054	22.9%
Community forest	12,925	1.1%	23,182	2.1%
Woodlots	14,291	1.3%	8,048	0.7%
Private, Indian Reserve	192,355	17.0%	46,244	4.1%
THLB	717,665	63.4%	230,709	20.5%
TSA total	**1,131,178**	--	**1,125,128**	--

*The hectares quoted in the above table are based on a new analysis by District GIS specialist July 2016

Private Land Owners / Woodlots/Community Forests

This Forest Health Strategy is intended to guide management of crown land within the Cascades Forest District. For private land owners, woodlot licensees and Community Forests, forest health responsibilities are limited; however, it would be in the best interest of such holders to consider and implement this forest health strategy as it applies. Generally, the results of aerial surveys are available to all land-based operators as and when the information is collected and summarized.

Biogeoclimatic Zones

The landscape across BC is classified according to the Biogeoclimatic Ecosystem Classification (BEC) system using vegetation, soils and climate. Dominant climatic climax vegetation is utilized to name each BEC zone. These zones are used frequently in forest management to help determine hazard ratings for forest health factors.

Table 2. Biogeoclimatic Zones in the Merritt and Lillooet TSA.

	Merritt		Lillooet	
	Area (ha)	**% total area**	**Area (ha)**	**% total area**
Interior Douglas fir (IDF)	530,217	46.8	288,495	25.7
Montane spruce (MS)	330,632	29.2	147,734	13.2
Engelmann spruce subalpine fire (ESSF)	191,403	16.9	513,811	45.8
Ponderosa Pine (PP)	28,323	2.5	38,294	3.4
Bunchgrass (BG)	46,282	4.1	15,283	1.4
Coastal Western Hemlock (CWH)	2,934	0.3	2,210	0.2
Interior Mountain-heather Alpine(IMA)	1,197	0.1	111,242	9.9
Mountain hemlock (MH)	174	<0.1		
Boreal Altai Fescue Alpine (BAFA)			4.944	0.4

CLIMATE CHANGE

There is a growing body of evidence that global climate change has contributed to increased incidence and severity of a number of forest health factors (Woods et al., 2010). Current climate projections for the Thompson Okanagan (TO) Region suggest that the region could see an increase in mean annual temperatures, more precipitation in the form of rain in the winter months, less precipitation in the summer, and a diminished snowpack at lower elevations. The forests in the drier Douglas-fir and ponderosa ecosystems may shift to more grasslands and experience frequent and lengthy periods of drought. This shift to a drier climate will put stress on the forests and they will become more vulnerable to fire and insect attacks.

Here are some highlights from the TO Climate Action Plan with regard to forest health:

- Drought, fire and insects expected to be primary disturbance agents
- Armillaria root rot will likely decrease in drier ecozones and increase in the transitional
- Drought will impact grasslands
- Fire size, frequency and intensity will increase; expect more full crown fires
- Spruce beetle may increase throughout the region in the short-term
- Forested ecosystems in the region are already undergoing massive shifts in structure due to the mortality of lodgepole pine (Pli) caused by the mountain pine beetle
- Douglas fir (Fdi) will likely experience increased mortality from the tussock moth and Douglas fir bark beetle
- Drought is expected to increase mortality in Pli, Fdi, balsam (Bl), spruce (S) and trembling aspen (At)
- Insects detrimental to forest resources are projected to increase substantially in dry and transitional dry subzones

Refer to the following links for information when considering adapting harvesting and silvicultural practices for climate change:

Chief Forester memo
https://www.for.gov.bc.ca/hfp/silviculture/Guidance%20for%20assessing%20FSP%20stocking%20standards%20June%2021%202012.pdf

ADM memo
https://www.for.gov.bc.ca/hfp/silviculture/Consideration%20of%20Climate%20Change%20Memo.pdf

Thompson Okanagan Climate Action Plan
https://www.for.gov.bc.ca/ftp/dcs/external/!publish/FSP_Renewals%202016/FSP%20Supporting%20Information/TORegionClimateActionPlan_16March2016_v8.0.pdf

Adapting forest and range management to climate change in the Thompson-Okanagan Region: considerations for planners and practitioners
http://professionalbiology.com/pdfs/ThomOka150529.pdf

Table 3. General forest health obligations

Activity	District	Region/Branch	Forest Licensees**
Prepare an annual Forest Health Strategy	X		
Define performance measures for specific strategies and tactics		X	
Conduct annual aerial overview survey on all provincial forests and report on results		X	
Conduct detailed aerial surveys of suppression beetle management units	X		
Conduct ground surveys as required to quantify incidence and intensity of damaging agents.	X		X
Conduct aerial treatment of defoliator outbreaks		X	
Conduct mortality estimates of bark beetle		X	
Conduct bark beetle treatments when required	X		X*
Conduct SDM monitoring as part of the provincial Resource Stewardship Monitoring program	X		
Maintain a record of collected survey information	X	X	
Provide annual reporting of bark beetle activities to the Province and Licensees	X		
Annually update Beetle Management Units designations	X		
Monitor and treat, if necessary, introductions of non-native potentially harmful organisms		X	
Identify knowledge gaps and provide information and training	X	X	
Monitor and evaluate forest health activities to attain adaptive management	X		

* Includes pheromone baiting, trap tree felling, and salvage/sanitation harvesting.

**The individual forest licensees within the Merritt TSA are still obligated to record and evaluate the occurrence of detected forest health factors for Forest Stewardship Plans and operational plans, as well as conduct ground surveys and timber reconnaissance in efforts to develop salvage/sanitation harvest plans and treatments

PRIORITY LISTING OF FOREST HEALTH FACTORS

The priority forest health pests have been ranked using the criteria from the Provincial Forest Health Strategy. Rankings were based on the following factors:

- known impacts to forest resource values,
- availability of operational detection and treatment methods,
- costs and benefits of applying detailed detection and treatment activities,
- overall level of knowledge of the hazards and risks and
- distribution and incidence levels of the pests.

Table 4. Cascades Forest District Priority Ranking of Forest Health Pests

Very High	High	Medium	Low	Very Low
Douglas-fir Beetle	Mountain pine beetle	Cattle	Balsam Bark Beetle	Aspen leaf miner
Spruce Bark Beetle	Western Spruce Budworm	Tomentosus Root Rot	Balsam Woolly Adelgid	Vole
Armillaria Root Disease	Lodgepole pine Dwarf Mistletoe		White pine blister rust	
Phellinus(laminated) Root Disease	Comandra and gall stem rusts		Douglas-fir Tussock moth	
			Conifer foliar diseases	

Below is a list of forest health agents, their current status, and comparison with historical levels for those agents identified in the annual provincial overview flight.

Table 5 – historical listing of forest health agents

MERRITT TSA (hectares by year)	2011	2012	2013	2014	2015
BARK BEETLES					
IBM (Mountain pine beetle)	32,869	8911	3546	1284	638
IBS (Spruce beetle)	384	872	868	1043	722
IBB (Balsam bark beetle)	3206	9217	10,353	11,409	15,871
IBD (Douglas fir beetle)	94	83	92	274	394
DEFOLIATORS					
ID6 (Aspen leaf miner)		119	2049	631	106
IDU (Satin moth)	11	60	19	60	55
IDW (Western spruce budworm)	35,931	91,295	1678	186	271
IDT (Douglas fir tussock moth)	97				
DISEASES					
DFL (Lophodermella needle cast)			181	391	
DFS (Dothistroma)		42			
DFO (Lophodermium needle cast)			62		
ANIMALS					
AB (bear)				45	43
OTHER					
NB (fire)	120	756	182	1396	8
NCA (Aspen decline)	270	2845	1580	803	
NW (windthrow)			101	39	
NAV (avalanche)					8

LILLOOET TSA (hectares by year)	2011	2012	2013	2014	2015
BARK BEETLES					
IBM (Mountain pine beetle)	9360	4930	4912	4462	5834
IBS (Spruce beetle)	83	660	290	1203	3126
IBB (Western balsam beetle)	1274	1601	2625	11,240	13,211
IBD (Douglas fir beetle)	607	408	528	1945	2092
DEFOLIATORS					
ID6 (Aspen leaf miner)			505		
IDU (Satin moth)	24			9	
IDW (Western spruce budworm)	16,488	34,443	1660	53	
IDT (Douglas fir tussock moth)	1555	124			
IDI (Pine sheathminer)			40		
ANIMALS					
AB (bear)				9	
OTHER					
NB (fire)	16	251	135	1493	2330
ND (drought)				6	
NF (flooding)		5	18		
NCA (Aspen decline)		91	110	54	
NS (slide)	22	10			
NW (windthrow)	4	40			14
NY (snow/ice)		36			
NAV (avalanche)		10			

SEDA RECOMMENDATIONS

Stand Establishment Decision Aids

Stand Establishment Decision Aids (SEDAs) exist for forest health factors that affect both the Merritt and Lillooet TSAs. These SEDAs are available for download at Stand Establishment Decision Aids (SEDAs) | FORREX. The forest health SEDAs that reference ecosystems from this TSA (and therefore may be of interest) are:

1. ***Southern Interior Forest Region Forest Health SEDA – volume 6, issue 1***
2. ***Spruce Weevil and Western Spruce Budworm SEDA – volume 7, issue 3***
3. ***British Columbia's Forests: White Pine Blister Rust SEDA – volume 10, issue 1***
4. ***British Columbia's Southern Interior Forests: Armillaria Root disease SEDA – volume 9, issue 2***
5. ***Laminated Root Rot SEDA – volume 7, issue 3***
6. ***Hemlock Dwarf Mistletoe SEDA – volume 5, issue 1***
7. ***Cariboo Forest Region SEDA: Part 1 and 2, volume 2, issue 1 and 2***

Although our ecosystems are not mentioned in the ***Southern Interior Forest Region Forest Health SEDA*** for Spruce Weevil (aka White Pine Weevil); this pest has been noted in the Merritt TSA. Consideration should be given to this forest health agent, especially as we favor planting increased quantities of genetically improved spruce in our TSAs.

Several of these SEDAs are from the Coast and Cariboo in name, but due to the transitional ecosystems in our TSAs, some of the pest information applies. It is recommended that you monitor the Forrex webpage as new SEDAs are published from time to time and may be applicable to either TSA.

Where a SEDA identifies that there is a high hazard from a specified forest health factor in a given ecosystem, and the ranking of that forest health factor in the forest health strategy is high or very high, it may be more appropriate to follow the management recommendations given in the SEDA. For your convenience and to help inform delegated decision makers (when reviewing proposed FSP stocking standards), those high hazard and high rank intersections are presented below.

- Western spruce budworm is noted as high hazard in the Southern Interior Region (SIR) Forest Health SEDA. When operating in the IDF xh1, xh2, and dk1 BEC subzones and variants, the following regeneration and establishment considerations are suggested: promote species mixtures and consider converting stands to non-host species (i.e. lodgepole pine and ponderosa pine). Further harvest and plantation maintenance considerations are made in the SEDA.
- Armillaria root disease is noted as high hazard, in the Armillaria Root Disease SEDA, when operating in any of our BEC zones except the PP. If Armillaria is detected within a

block strong consideration should be given to the recommendations contained within the SEDA.

- Lodgepole pine dwarf mistletoe is noted as high hazard in the Cariboo Forest Region Part 1 Forest Health SEDA. When operating in the IDF dk1 and ESSF dc2 consideration should be given to the recommendations contained within the SEDA, including removal of residual lodgepole pine over 50cm tall.
- Commandra Blister Rust is speculated (limited or conflicting data) at moderate to high hazard in the SIR Forest Health SEDA. When operating in the ESSF dc2, IDF dk1, dk2, and MS dm2 consideration should be given to the recommendations contained within the SEDA, including increased stocking density to offset rust caused mortality. This may be of lesser or greater importance based on whether or not plantations and stands in the geographic area have had a history of or exhibit signs of current rust infections or if large amounts of the alternate hosts are noted.

STAND DEVELOPMENT MONITORING (SDM)

The Stand Development Monitoring (SDM) protocol has been designed to assess the health and productivity of young stands between the ages of 15 and 40 years. SDM collects and provides introductory analysis of data in five specific areas: stand density (total, well-spaced (WS) and free-growing (FG) stems per hectare), stand species composition, pest incidence, tree volume and site index. SDM data can be used for a variety of purposes in tracking how stand attributes change in managed forests. It is also one of the few monitoring programs that looks at post-free growing stands and will be essential to monitor the effects of climate change.

The cross-disciplinary nature of SDM data with links to silviculture, inventory, forest health and growth and yield, allows for a broad examination of current forest management practice in BC. The opportunity exists for data from SDM to be used by licensees to meet some of the requirements of sustainable forest management certification. SDM data can ultimately be used to support revision of standards associated with current practices. Such adaptive management techniques will be essential under a changing environment. Given its direct tie to management practices through the use of operational silviculture records, SDM is uniquely positioned to provide a benchmark measure on which to base a systematic approach of adaptive management for many silvicultural practices.

Thirty-four polygons were sampled between 2011 and 2013 from randomly selected cutblocks in the Merritt TSA. The data is summarized below:

• Leading pathogen: gall rust	• Gall rust occurs more frequently in MS and IDF BEC zones than other zones, with the MS being infected twice as much as the IDF
• Leading insect: Pine terminal weevil	• Layer 1 and Layer 2 Pli is the tree species most affected by forest health factors
• Leading animal: porcupine	• Pli makes up the bulk of the crop trees for the next rotation

• Leading abiotic: snow press	• 9 of 34 stands sampled have changed leading species between the time of the FG survey and the SDM survey
• Unacceptable forking caused by unknown trauma is prevalent in all BEC zones, with Fdi experiencing twice the incidence than Bl and Pli	

Currently the SDM protocol is undergoing a revision to address technical concerns so that the data may be used in the TSR and to allow greater data compatibility between SDM and Young Stand Monitoring

SDM2.0 will be operational in 2017.

OVERVIEW

Bark Beetles in the Cascades Forest District

The data quoted in this strategy stems from the 2015 Provincial aerial overview fixed wing survey. Although this data is not as accurate as the detailed aerial GPS survey data that drives the suppression activities, it has several advantages. The survey is cost efficient, covers all forested areas within the TSA, flags areas of interest that require detailed flights and ground-truthing, includes all forest health factors visible from the air, and employs consistent methodology throughout the province year after year.
As shown in Tables 7 and 8 and Figures 1 and 2 below, four bark beetle species have been recorded as active in the Merritt and Lillooet TSAs, with Douglas fir beetle and Balsam bark beetle both on the rise.

Table 6 Historical Bark Beetle infestations in Merritt TSA

	Total area of Infestation (hectares)				
Bark Beetle	**2011**	**2012**	**2013**	**2014**	**2015**
Douglas fir Beetle	94	83	92	274	394
Spruce beetle	384	872	868	1043	722
Balsam beetle	3206	9217	10,353	11,409	15,871
Mountain pine beetle	82,869	8911	3546	1284	638

Table 7 Historical Bark Beetle Infestations in Lillooet TSA

	Total area of Infestation (hectares)				
Bark Beetle	**2011**	**2012**	**2013**	**2014**	**2015**
Douglas fir beetle	607	408	528	1945	2092
Spruce beetle	83	660	290	1203	3120
Balsam beetle	1274	1601	2625	11,240	13,190
Mountain pine beetle	9360	4930	4912	4462	4894

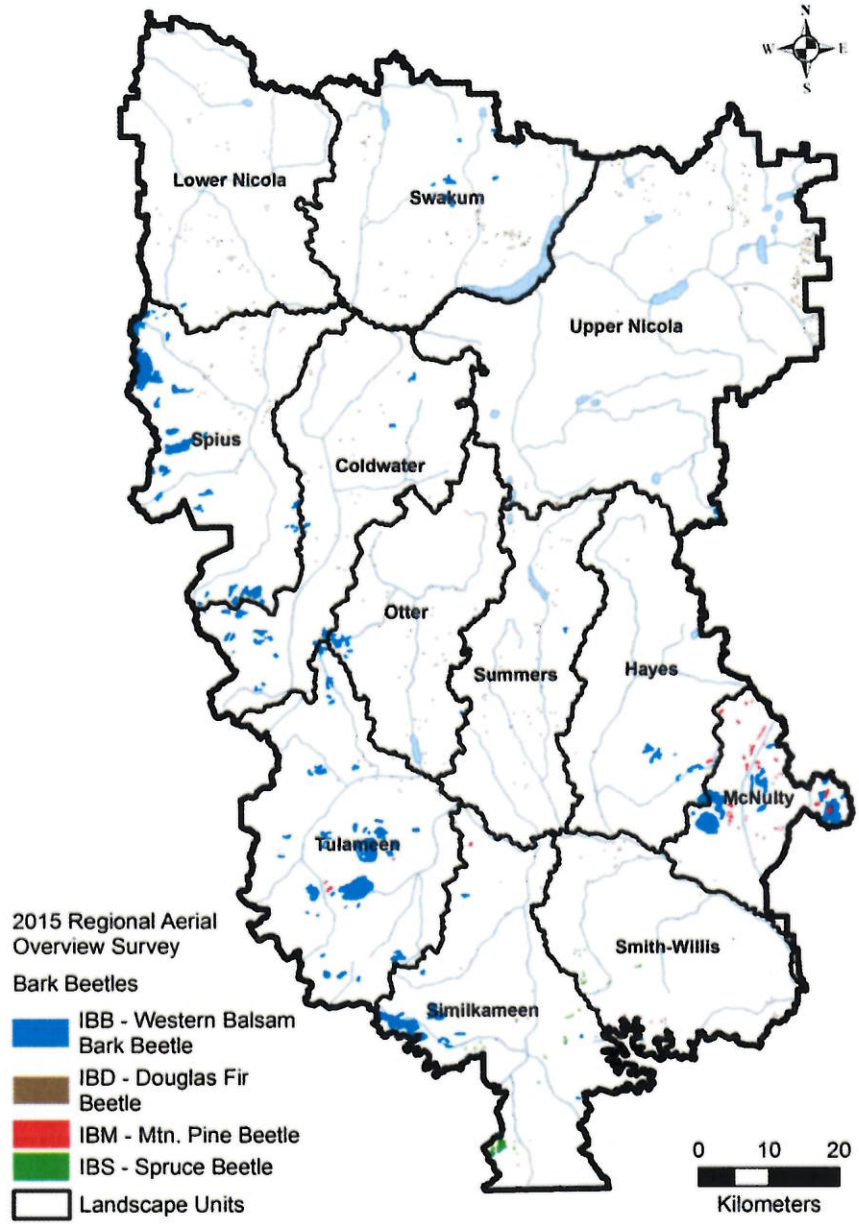

Figure 1 General overview of beetle within Merritt BMUs in 2015

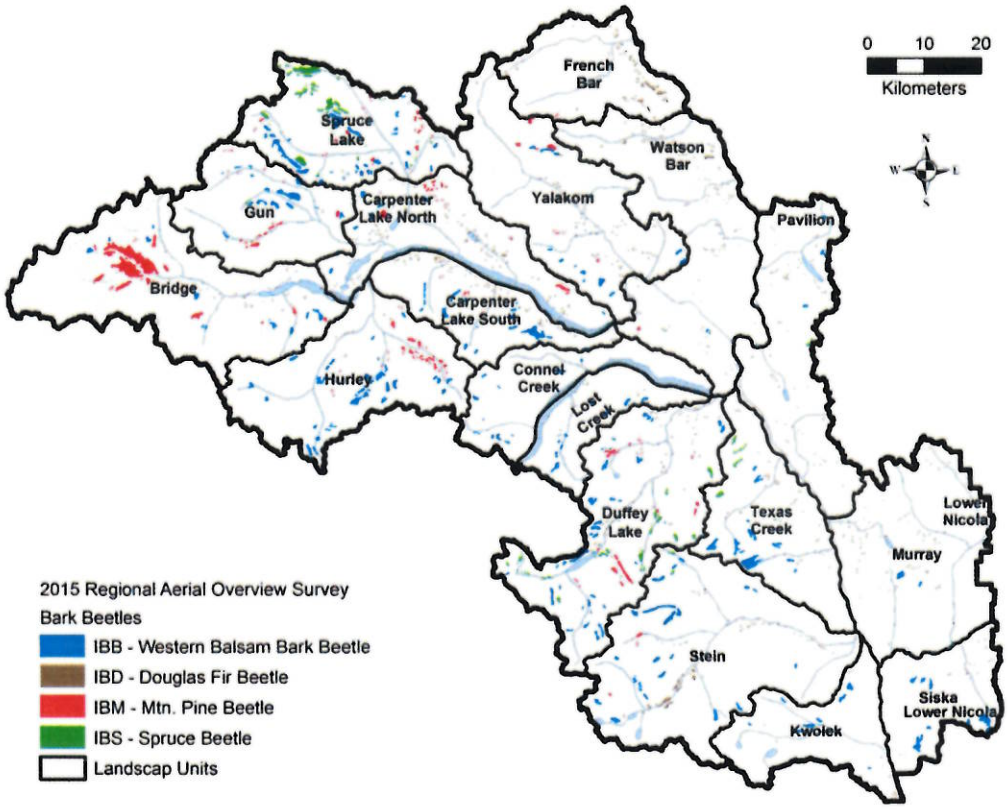

Figure 2 General overview of beetle within Lillooet BMUs in 2015

A Beetle Management Unit (BMU) is a planning and reporting unit for operational beetle management. The strategy assigned to the Unit must be feasible and appropriate so as to achieve favorable results. BMU strategies are revised annually based on the most recent annual overview survey and strategies are evaluated and reassigned if the objective is not attainable. The BMU performance measures (i.e., % of known infestations treated prior to beetle flight per year) are the strategic targets that, if met, will achieve the desired beetle management objectives. The consequence of failure is a downgrading of the BMU strategy to a less intensive objective. It is imperative that strategies are selected with a realistic understanding of the capacity for treatment and failing to do so would result in a waste of valuable resources that could have been allocated to areas where success would be more probable. The following objectives and strategies from the Provincial Bark Beetle Management Technical Implementation Guidelines are used by the Cascades Forest District to assign BMU designations:

Strategy	Objective/Performance Measure
Prevention/Suppression	Objective is to reduce populations and maintain them at a relatively low level. Target is to treat >80% of known infestation centers in each year. All harvest and treatment is directed at green attacked trees
Holding Action	Objective is to maintain the infestation to a relatively static level by treating ~50-70% of known infestations in each year. That is, the level of harvest and/or treatment is equal to the rate of infestation expansion. Harvesting should be concentrated in green attacked trees.
Salvage	Objective is to salvage for value recovery as the highest priority. Indications are that holding the infestation static will fail due to influx of populations from heavily infested BMUs in proximity. Emphasis is more to retrieve values at risk and maximize Crown revenues by directing harvest towards killed stands prior to significant degrade.
Monitor	Objective is to only record the change in attack level with no beetle management being attempted.

Below are the 2015 BMU designations for Merritt and Lillooet TSAs:

Table 8 BMU areas and strategy designations in the Merritt TSA

Merritt TSA	2015-2016 BMU strategy		
BMU	**IBM**	**IBD**	**IBS**
Coldwater	Suppression	Suppression	Suppression
Hayes	Suppression	Suppression	Suppression
Lower Nicola	Suppression	Suppression	Suppression
McNulty	Suppression	Suppression	Suppression
Otter	Suppression	Suppression	Suppression
Similkameen	Suppression	Suppression	Suppression
Smith-Willis	Suppression	Suppression	Suppression
Spius	Suppression	Suppression	Suppression
Summers	Suppression	Suppression	Suppression
Swakum	Suppression	Suppression	Suppression
Tulameen	Suppression	Suppression	Suppression
Upper Nicola	Suppression	Suppression	Suppression

Table 9 BMU areas and strategy designations in the Lillooet TSA

Lillooet TSA	2015-2016 BMU strategy		
BMU	**IBM**	**IBD**	**IBS**
Bridge	salvage	suppression	salvage
Carpenter Lake North	salvage	suppression	salvage
Carpenter Lake South	salvage	suppression	salvage
Connel Creek	salvage	suppression	salvage
Duffey Lake	salvage	suppression	salvage
French Bar	salvage	holding	suppression
Gun	monitor	monitor	monitor
Hurley	salvage	suppression	salvage
Kwoiek	salvage	suppression	salvage
Lost Creek	salvage	suppression	salvage
Murray	salvage	suppression	monitor
Pavilion	salvage	suppression	monitor
Siska	salvage	suppression	monitor
Stein (Park)	monitor	monitor	monitor
Spruce Lake	monitor	monitor	monitor
Texas Creek	salvage	suppression	salvage
Watson Bar	salvage	holding	suppression
Yalakom	salvage	suppression	suppression

BLANKET SALVAGE PERMIT

The provincial Emergency Bark Beetle Management Area (EBBMA) zonations were repealed July 3, 2014 as the pine beetle emergency is over. However, the tools made available by that policy such as blanket salvage permits and comparative cruising will still be available. Refer to the latest Interior Appraisal Manual update for the applicable conditions. District guidelines for a blanket salvage permit application are available on the Cascades Natural Resource District website.

NON-RECOVERABLE LOSSES

When determining the Allowable Annual Cut for the Merritt TSA, the Chief Forester must take into consideration the "abnormal infestations in and devastations of, and major salvage programs planned for timber in the area" (Sec. 8(8)(e) of the Forest Act). Standing timber volume that is destroyed by natural causes (such as bark beetles) and is not salvaged is referred to as a non-recoverable loss (NRL). An NRL estimate calculated for a timber supply review is presented as the average annual unsalvaged loss of timber volume projected throughout the planning period, occurring within the timber harvesting land base. The TSR analysis considers this value as how much timber volume was projected to be there, but will in fact not be there when that point in time is reached.

Other losses, such as Douglas-fir bark beetle and Western balsam bark beetle, are accounted for in the Operational Adjustment Factors (OAFs). Losses due to mountain Pine beetle are accounted for in yield curve reductions based on the shelf-life assumptions.

In an effort to address the magnitude of pine volume killed, the MFLNRO continues TSA-wide aerial surveys to identify beetle infestations. This information is then provided to forest licensees, woodlots and small scale salvage loggers for harvesting consideration. In addition, the MFLNRO places a priority on working with First Nations, local communities and forest licensees in both TSAs to find solutions to the key constraints and challenges that will allow access to and the harvesting of timber that at present cannot be harvested.

Table 10. Historical listing of Non-recoverable losses

Merritt

	YEAR	TOTAL (m3/yr)	INSECTS (m3)	WIND (m3)	FIRE (m3)	OTHER (m3)
TSR1	1996	116,910	52,630	18,565	38,715	7,000
TSR2	2000	143,626	93,841	18,565	31,220	
TSR3	2005	143,626	93,841	18,565	31,220	
TSR4	2010	74,785	25,000	18,565	31,220	
TSR5	2015	47,000	7,000	18,000	22,000	

Lillooet TSA

	YEAR	TOTAL (m3/yr)	INSECTS (m3)	WIND (m3)	FIRE (m3)	OTHER (m3)
	2012	16,700	10,700	5,000	5,000	7,000

TIMELINES

The following table provides general guidelines for Douglas fir and spruce bark beetle management practices.

Table 11 Douglas fir and spruce bark beetle timelines

Stage	S	O	N	D	J	F	M	A	M	J	J	A
Provincial overview flight											■	
Local detailed flight	■											■
Ground walk-thru and probing	■	■	■	■								
Trap tree removal or burning	■	■	■	■	■	■	■					
Log deck removal	■	■	■	■	■	■	■					
Potential beetle flight window									■	■	■	
Trap tree falling			■	■	■	■	■	■				

INTEGRATED SILVICULTURE STRATEGY

The Integrated Silviculture Strategy is currently being developed. ISS will result in harvesting and silviculture retention strategies that will incorporate forest health considerations.
BC MFLNRO Silviculture Strategies Site

MOUNTAIN PINE BEETLE (DENDROCTONUS PONDEROSAE)

The priority ranking for mountain pine beetle in the Cascades Forest District has been down-graded from **very high** to **high**. It remains high as there is still the need to capture the dead standing trees before they lose value in the Merritt TSA and to address green attack in the Lillooet TSA.

The table below shows the severity level of red attack in both TSAs. Merritt has not experienced such low levels of attack in over a decade.

Table 12 Area of mountain pine beetle by severity class by TSA

	Trace <1% (ha)	Light 1-10% (ha)	Moderate 10-30% (ha)	Severe 30-50% (ha)	Very severe >50%(ha)	Total (ha)
Merritt	142	476	20	8		646
Lillooet	421	3,182	2,075	157	16	5,851

Merritt TSA

With the release of the Timber Supply Review (TSR) 5 determination for the Merritt TSA on March 30, 2016, the Chief Forester has expectations for harvest performance in all stand profiles assumed to contribute to the timber supply on the licensees. This includes ungulate winter range, dry belt fir and low volume stands (150-200 m3/ha). From a forest health perspective, the salvage of dead volume associated with past insect infestations or other events is a priority. Licensees are to continue harvesting active infestations of mountain pine beetle as the District cannot afford another outbreak of bark beetles, as well salvaging grey attack.

Lillooet TSA

The mountain pine beetle continues to be a high priority pest for the Lillooet TSA. Although the beetle peaked in 2008, there is a static population that needs to be addressed with harvesting operations. The following harvesting priorities (in order of importance) will be followed where practical to maximize the beetle management effort with the goal to eliminate as many adult beetles and brood as possible and minimize un-salvaged losses over the long term:

1. Stands that are heavily-infested with bark beetles (high numbers of beetle-infested trees in patches/polygons) and having existing or high potential for spread and damage (outbreak).
2. Stands that are infested with bark beetles in a scattered spot ("salt-and-pepper") pattern and having existing or high potential for spread and damage (building).

3. Timber that has blown down, been damaged or killed by fire, forest pests, or other similar factors before the wood significantly deteriorates (salvage).
4. Stands at moderate-high susceptibility of being damaged by forest pests (stand susceptibility reduction).
5. Oldest, declining timber (stands that have reached culmination age) on most productive timber sites, exclusive of Old Growth Management Areas's or other stands identified as important for wildlife habitat.
6. Other timber.

Management tactic: regular harvest, salvage harvest, detailed aerial monitoring

Secondary Stand Structure

Early in 2009 the District Manager received a request from a licensee to be exempted from the newly implemented Secondary Stand Structure section of the Forest Planning and Practices Regulation. Based on sound rationale and a cooperative process involving the proponent licensee, District and Branch Forest Service staff, the district manager approved the exemption. This allowed the proponent licensee to follow the TSA group's management goals of harvesting active leading edge beetle infestations. This also allowed the licensee to save administrative and field costs and not be restricted by the 30% green attack at time of harvest rule.

MPB Attack in Young Stands

In the years following TSR 4, the amount of MPB infestation within young stands was dramatically less than originally projected at the time of TSR 4. An analysis of young pine impacts using provincial aerial overview survey data indicates that 588.5 hectares of the 39,464 hectares (1.5%) of pine leading age class 2 and 3 stands within the THLB had severe and very severe impact levels, and are therefore assumed to be dead.

A summary of the young stand monitoring completed for the Merritt TSA (MFLNR 2015) found that 12.4% of the lodgepole pine trees per hectare and 12.8% of the lodgepole pine basal area was affected by insect attack. There was also significant damage from other forest health agents. This report recommends that forest health specialists and growth and yield specialists should review and analyze the severity data to determine potential impacts.

The TSR 2015 technical report (MFLNR 2015) indicates that growth and yield impacts of MPB were not modelled for managed stands (i.e. less than 30 years).

Source: Draft Integrated Silviculture Strategy for the Merritt TSA, November 25, 2015

Table 13. Hectares of Young Pine impacts from provincial aerial overview survey

Attack year[1,2]	Trace <1% (ha)	Low 1-10% (ha)	Mod 11-30% (ha)	Severe 30-50% (ha)	Very Severe >51% (ha)
2005	202.7	515.6	227.3	33.2	2.0
2006	79.2	175.0	642.0	175.0	2.4
2007	0	726.9	371.4	280.6	18.6
2008	243.1	849.0	681.4	59.0	0
2009	82.5	639.3	247.7	14.6	0
2010	122.4	520.8	8.4	1.2	1.4
2011	0	33.7	0	0.5	0
2012	0	0	0	0	0
2013	0	0	0	0	0
Total	**729.9**	**3,460.3**	**2,178.2**	**564.1**	**24.4**

[1] 2005 and 2006 were obtained by intersecting aerial overview data and VRI pine leading, age class 2 and 3.
[2] 2007 to 2013 were obtained from notations within the provincial aerial overview survey.

Source: Martin Ponsioen, April 16, 2014

DOUGLAS FIR BEETLE (DENDROCTONUS PSEUDOTSUGAE)

Douglas-fir beetle (Dendroctonus pseudotsugae) is an important pest of mature Douglas-fir in BC. At low population levels, the beetle infests scattered, stressed trees and windthrow. However, Douglas-fir beetle (IBD) populations can quickly build under favourable conditions, at which time significant numbers of healthy trees can be killed. Drought, fire, root disease or significant windthrow/breakage from ice and snow are often the precipitators of outbreaks.

Currently we are experiencing an increasing population of beetle across both TSAs. With the hot, dry weather in the summer of 2015, the conditions were favourable for 2 beetle flights to occur, one in May and then another in June. The area in Tables 6 and 7 may under-report the size of the infestation as the overview mapping flight was conducted prior to the second flight of beetle. Expect multiple flights per season to become more common as climate change creates more favorable conditions for the life cycle of beetle populations.

Hazard rating mapping was updated for both TSAs in 2014 based on the Shore and Safranyik model which considers age, host basal area, stand density and elevation. The hazard rating of stands is intended to identify those stands that are highly susceptible to bark beetle attack, not an indication of the current beetle population. Also known as susceptibility mapping, this planning tool will be used to direct detailed detection efforts, ground surveys and planned treatments.

Table 14. Susceptibility ratings for Douglas fir beetle

	Merritt		Lillooet	
Hazard rating	**Area (ha)**	**% landbase**	**Area (ha)**	**% landbase**
Very low (0-5%)	93,694	8.3	40,314	3.5
Low (6-20%)	156,131	13.8	89,964	8.0
Low-medium (21-40%)	56,790	5.0	77,807	6.9
Medium (41-60%)	56,419	5.0	30,117	2.7
High (61-80%)	47,797	4.2	37,716	3.4
Very high (81-100%)	22,501	2.0	47,711	4.2

Management Tactic: currently all BMUs in the Merritt TSA have been designated with the 'suppression' strategy. Activities would include small patch removal, single tree removal, and trap trees, and fall & burn in very limited cases. In the Lillooet TSA, the BMU strategies range from 'suppression' to 'holding' and 'monitor'. Holding and monitor activities would include detailed aerial flights, ground probe surveys and walkthroughs to gather solid data regarding the population.

Sanitation and control tactics must take into consideration the regulations for Ungulate Winter Range (UWR), OGMA, requirements, and dry-belt fir challenges. Use trap trees to direct infestations away from sensitive areas.

SPRUCE BEETLE (DENDROCTONUS RUFIPENNIS)

The spruce beetle (Dendroctonus rufipennis) is the most destructive agent of mature spruce in BC. At low population levels, the spruce beetle (IBS) prefers to infest weakened trees and downed host material. If a significant amount of a preferred food source such as windfall or breakage from ice or snow is available, populations can build to the point of outbreak, where beetles then move into healthy trees.

In the Merritt TSA, the current outbreak was identified in early spring of 2009, in the areas to the south and east of the Similkameen River. Since then, the beetle has crossed the river and moved west and then north into the Copper River drainage. In the Lillooet TSA, the spruce beetle is concentrating in the Spruce Lake and Duffy BMUs. Spruce beetle populations are expected to increase with the warming trend of climate change. Expect to see this two year cycle beetle morph into a one year cycle thereby doubling the number of beetle that attacks.

Hazard rating mapping was updated for both TSAs in 2014 based on the Shore and Safranyik model which considers age, host basal area, stand density and elevation. The hazard rating of stands is intended to identify those stands that are highly susceptible to bark beetle attack, not an indication of the current beetle population. Also known as susceptibility mapping, this planning tool will be used to direct detailed detection efforts, ground surveys and planned treatments.

Table 15. Susceptibility ratings for spruce bark beetle

	Merritt		Lillooet	
Hazard rating	**Area (ha)**	**% landbase**	**Area (ha)**	**% landbase**
Very low (0-5%)	49,083	4.3	16,052	1.4
Low (6-20%)	157,188	13.9	108,332	9.6
Low-medium (21-40%)	108,034	9.6	97,133	8.6
Medium (41-60%)	38,220	3.4	18,502	1.6
High (61-80%)	6,605	0.1	2,596	0.2
Very high (81-100%)	511	<0.1	203	<0.1

Management Tactic: currently all BMUs in the Merritt TSA are in 'suppression'. Activities will include small patch removal, single tree removal, trap trees/pheromone baiting and fall & burn in limited cases. In the Lillooet TSA, the BMUs range of strategies depends on a variety of operational and social limitations. Primary activities at this time will include aerial overview flights and ground walkthroughs to gather definitive information. In both TSAs, the optimal management tactic is to prevent the build-up of the spruce beetle populations with prompt salvage of spruce blowdown and to consider wind direction, topographic features and edge feathering in cutblock design and layout.

For harvesting scenarios, use trap trees to direct beetle away from sensitive areas such as WHA and OGMA.

WESTERN BALSAM BARK BEETLE (DRYOCOETES CONFUSUS)

Western balsam bark beetle is the most significant damaging agent of its primary host, mature sub-alpine fir (Abies lasiocarpa). This bark beetle and an associated pathogenic fungus can be responsible for significant tree mortality in high elevation ecosystems. Research shows that the driest and coldest ESSF subzones are sustaining the highest levels of attack. This is due to the fact the host trees are already stressed on these harsh sites and when combined with climatic changes, such as more frequent and prolonged drought periods, sub-alpine fir becomes more susceptible to beetle attack.

Management tactic: manage sub-alpine fir stands on a 70-100 year rotation.

Reference:
https://www.researchgate.net/publication/283154074_Quantification_of_Dryocoetes_confusus-caused_mortality_in_subalpine_fir_forests_of_southern_British_Columbia

WESTERN PINE BEETLE (DENDROCTONUS BREVICOMIS)

This bark beetle, which only attacks ponderosa pine, is less commonly found in the either Merritt or Lillooet TSAs. It's a one-year cycle beetle which can sometimes populate two generations of beetle in one season. It is often mistaken for mountain pine beetle or other secondary beetles such as Ips spp. Expect this beetle to increase in population as drought stress becomes more common due to climate change.

Management tactic: Monitor ponderosa pine stands for beetle activity. Focus on stands damaged by fire or other injury or disease.

MSMA (MONOSODIUM METHANEARSENATE)

The use of MSMA in the Cascades Forest District ceased in 2004. MFLNR has made the decision that it will no longer use this chemical and that existing stock will be disposed of. A policy was developed in light of Forest Practices Board audit that outlines management practices for the legacy MSMA-treated trees left in the forests. The main intent of the policy is to develop a provincial database that will detail the locations of legacy trees; that outlines a reporting system for when legacy trees are encountered; and states that legacy trees are to be left standing and conspicuously marked when found during license development. More information can be found at Treatment of trees with MSMA for bark beetle control

DEFOLIATORS

Western spruce budworm (Choristoneura occidentalis)

This high ranking pest is the primary defoliator of concern for interior Douglas-fir in the Cascades Forest District. Outbreaks of this budworm cause significant damage through larval feeding on the foliage, resulting in reduced seed production due to damaged cones, growth loss, topkill, stem deformities and even mortality, particularly in the understory. The IDF BEC zone, which covers almost half of the Merritt TSA and a quarter of the Lillooet TSA, is a high hazard zone for western spruce budworm in Douglas-fir stands, particularly the IDFdk (dry, cool) and IDFxh (very dry, hot) subzones.
Due to a rigorous spray program, a sharp decline in populations has occurred starting in 2014. No defoliation from budworm was found in the Lillooet TSA in 2015.

Area defoliated (hectares)

TSA	2012	2013	2014	2015
Merritt	91,295	1678	186	271
Lillooet	34,443	1660	53	0
District total	**126,238**	**3,338**	**239**	**271**

Management Tactic: When operating in the IDF xh1, xh2 and dk1, consider reforesting with a variety of species or converting stands to a non-host species (i.e. lodgepole pine and ponderosa pine). The Regional Entomologist will continue with monitoring and implementing the Bacillus thuringiensis kurstaki (Btk) spray program as and where needed. Refer to FPC Defoliator Management Guidebook for more information:

Defoliator Management Guidebook: Table of Contents

Douglas-fir tussock moth (Orgyia pseudotsugata)

This defoliator ranks low to very low as a priority pest in both TSAs. Since the larvae consume both old and new foliage, one year's defoliation can result in top kill and mortality. If mature trees survive the defoliation, the resulting stress can put them at high risk of attack by the Douglas-fir bark beetle. The potential exists for an outbreak, particularly in the IDFxh2 subzone. For the 3rd year in a row, no tussock moth defoliation was detected during the aerial overview survey. However, outbreaks tend to be cyclical, and of short duration, and the next build is expected to occur between 2017-2019.

Management Tactic: continue to monitor; consider reforesting with a non-host species if possible. The Regional Entomologist will carry out an aerial spray program with Nuclear polyhedrosis virus (NPV) as and when required. Due to Tussokosis, an allergic reaction to the hair of the caterpillar, priority treatment areas are those near human populations.

Other Defoliators

Aspen Serpentine Leaf Miner (Phyllocnistis populiella) is found throughout both TSAs and is increasing in incidence and severity. The mining from this pest causes foliage discoloration and premature leaf drop which can lead to reduced tree growth, branch dieback and even tree mortality in severe cases.

Satin Moth (Leucoma salicis) is on the decline in both TSAs. In 2015, it was mapped in small scattered patches in the Spius Landscape Unit within the Merritt TSA. Satin moth feeds on cottonwood and aspen leaves and repeated severe defoliation can result in reduced radial growth, topkill and tree mortality.

Management Tactic: As with the other defoliators listed above, the defoliation program is primarily the responsibility of the Regional office in Kamloops. Continue to monitor is the best option at this time.

FOREST HEALTH OF YOUNG STANDS

A variety of forest health factors are found within young stands such as **spruce weevil *(Pissodes strobi),* pine terminal weevil *(Pissodes terminalis),* Warren's root collar weevil *(Hylobius warreni)*** and **balsam woolly adelgid (Adelges picae)** to name a few. At this time, these factors contribute to minor losses in stands and are not compromising future timber supply.

Management tactic: continue to monitor through silviculture surveys and report in RESULTS. Refer to the appropriate Forest Practices Code Guidebooks and SEDA publications for appropriate treatment regimes.

Balsam Woolly Adelgid (Adelges piceae)

Cascades Forest District is in the quarantine area mandated by the Balsam Woolly Adelgid Regulation under the Plant Protection Act. At this time, there are no operational forestry treatments in place other than reporting to RESULTS. For more information, refer to this link:

Balsam Woolly Adelgid - Province of British Columbia

ROOT DISEASE

Landscape level field surveys for root disease were conducted in the Cascades Forest District between 2007 and 2009. The sample population consisted of 30 randomly selected stands occurring in the Interior Douglas-fir (IDF) biogeoclimatic zone where Douglas-fir was a leading component. Of the 25 stands sampled across the IDF, incidence of **Laminated root rot** (DRL) was found in 44% of the stands and **Armillaria root rot** (DRA) was found in 32%
Remaining work includes analyses of TSA-level incidence and tree growth data associated with sampled PSPs to determine stand level losses, or a first approximation operational adjustment factor (OAF), for DRL/DRA, which can be incorporated into Timber Supply Reviews.

Armillaria root disease (Armillaria ostoyae)

This root disease occurs throughout the Merritt TSA, with the highest hazard biogeoclimatic zones being the IDF and MS, which cover more than two-thirds of the TSA. Douglas fir, western hemlock, subalpine fir and spruce are the tree species with the highest susceptibility; lodgepole pine is moderately susceptible. Armillaria root disease can cause growth loss and minor butt rot in diseased trees; however mortality and reforestation issues are the greatest cause of loss. Infected trees are predisposed to bark beetle attack and blowdown. According to projected climate change models, incidence is projected to decline in drier subzones but increase in transitional subzones.

Management Tactic: for best management practices, refer to the Stand Establishment Decision Aid (SEDA) report – 'Armillaria Root Disease Stand Establishment Decision Aid'

http://www.forrex.org/sites/default/files/publications/jem_archive/ISS48/vol9_no2_art7.pdf

Stumping is the most common and effective treatment for Armillaria. Stumps and large roots may harbor inoculum which could Best management guidelines will be developed for the District.

Laminated root rot (Phellinus weirii)

Laminated root rot is a forest health factor of concern primarily for Douglas-fir in the IDF biogeoclimatic zone. Infections can result in extensive butt rot and mortality can occur at all ages. Very often Phellinus is found on the same site as Armillaria which can make planning complicated.

Management Tactic: On a local level, more training and education will be available to improve the identification of root diseases. Correct identification has an impact on all aspects of the cycle from selecting the harvest system to site prep to reforestation.

Root Disease Management Guidebook

STEM DISEASES

Comandra blister rust (Cronartium comandrae)
Western gall rust (Endocronartium harknessii),
Stalactiform blister rust (Cronartium coleosporioides),
White pine blister rust (Cronartium ribicola)

Lodgepole pine, ponderosa pine and white pine are the host species susceptible to these rusts. Although these rusts can be found on trees of all ages, young trees are the most susceptible to serious damage including reduced tree growth, defects and mortality. Due to the ubiquitous nature of western gall rust, it is found throughout the Merritt and Lillooet TSAs and is the most frequently occurring of all the stem rusts.

Management Tactic: Management strategies include the correct identification of the rust in young stands, and based on the intensity levels present, developing treatments to ensure stands achieve free growing status.

Using stocking densities that account for projected incidence levels or mortality and applying treatments such as pruning and removal of the infected stems, and the planting of blister rust-resistant stock are reasonable tactics for managing these rusts.

FOLIAR DISEASES

Hendersonia (Hendersonia pinicola)
Elytroderma needle disease (Elytroderma deformans)
Pine needle cast (Lophodermella concolor).

Elytroderma needle disease is most common on ponderosa pine and Lophodermella on lodgepole pine. Hendersonia is often found in association with Lophodermella. All infections can cause severe defoliation, resulting in growth reductions and occasionally mortality.

Management tactic: continue to monitor and report thru aerial and ground surveys.

Dothistroma Needle Blight (Mycosphaerella pini)

Dothistroma is not common in either TSA, but should be monitored as this disease can spread rapidly given favourable climatic conditions. In 2012, 42 ha were identified in the Tulameen operating area along the Podunk FSR.

Management tactic: continue to monitor and report.

For more information, refer to SEDA report:

http://www.forrex.org/sites/default/files/pages/files/vol10_no1_art1.pdf

DWARF MISTLETOE

There are 2 species of dwarf mistletoe in the Cascades Forest District: **Lodgepole pine dwarf mistletoe** (*Arceuthobium americanum*) and **Douglas fir dwarf mistletoe** (*Arceuthobium douglasii*). Lodgepole pine mistletoe is prevalent throughout the majority of mature lodgepole pine stands with the IDF and MS biogeoclimatic zones being high hazard areas. Incidence of Douglas fir mistletoe is minor in both TSAs. Heavily infected trees suffer reduced height and diameter growth, structural weakness leading to breakage, and occasional mortality. This disease can have significant impact in regenerating stands. Incidence and intensity of dwarf mistletoe has increased with fire exclusion practices.

Management Tactic: To reduce and minimize the spread of the parasite into regenerated stands of lodgepole pine and Douglas fir, infected stems greater than 50 cm in height need to be eradicated following harvesting by cutting and slashing. Plant non-host tree species within 15 metres of mistletoe infected trees.

Dwarf Mistletoe Management Guidebook

ABIOTIC

Drought

Over the past few years, drought has significantly impacted seedling establishment. All species have been affected and there was widespread drought damage to young stands in the Merritt TSA. All young stands should be monitored for health factors that could arise from drought stress and mortality. There was a significant period of drought during the summer of 2015 which may have impacted new plantations.

Wildfire

Areas of damaged timber associated with wildfires, specifically Douglas-fir and spruce, will be monitored for infestation by bark beetles through aerial survey, ground reconnaissance and pheromone monitoring traps (if warranted), with subsequent treatment of beetle-infested trees through targeted trap tree and salvage/sanitation harvesting programs, where operationally feasible. Monitoring of recent fire damaged timber will be conducted in 2016 to monitor Douglas Fir Beetle and Spruce Beetle activity.

Animal Damage

Various animals cause damage to certain tree species in the Merritt TSA on a localized or cyclical basis. Damage to seedlings and saplings by **voles** (Microtus spp.) during winter feeding is cyclical and localized, but can be extensive and significant in a given plantation. **Cattle damage** due to

feeding, trampling and rubbing is common in heavy grazing areas. Damage from **black bear** is usually contained to particular drainages where bears have learned the behavior of removing large strips of bark on the lower bole of trees. Animal damage is addressed only on a block by block basis when damage is sufficient that it interferes with the obligation to produce free growing stands. The potential for this problem must be considered in relevant operational plans.

Management Tactic: monitor plantations where and when known events occur. Prepare to react operationally with increased densities, alternate tree species, cattle movement management, hydration fertilizer packets, and other innovative ideas.

TACTICAL PLAN 2016-2017

- conduct detailed aerial flights in Merritt and Lillooet TSAs. Target spruce bark beetle, Douglas fir beetle, foliar disease in the Homestead/Shrimpton area, dothistroma on Podunk, squirrel in Wolf-Belgie, and MPB in young stands near Gwyneth lake
- implement Douglas fir beetle probing contracts to collect green:red ratios to support licensee harvest operations
- look for western pine beetle on ponderosa pine around recent fire perimeters

REFERENCE LINKS

Provincial Bark Beetle Management Technical Implementation Guidelines
https://www.for.gov.bc.ca/hfp/health/fhdata/ProvBBStrategy.pdf

Aerial overview survey maps ,spatial files and reports
Aerial Overview Survey Data Files - Province of British Columbia

Southern Interior Forest Region – Pest Management Plan
BCFS Southern Interior Forest Health Program Home Page

Southern Interior Forest Region – 2015 Annual report
http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/aerial-overview-survey-documents/2015-fh-bc-overview.pdf

Climate Change
Climate Change - Province of British Columbia

Thompson Okanagan Climate Action Plan
https://www.for.gov.bc.ca/ftp/dcs/external/!publish/FSP_Renewals%202016/FSP%20Supporting%20Information/TORegionClimateActionPlan_16March2016_v8.0.pdf