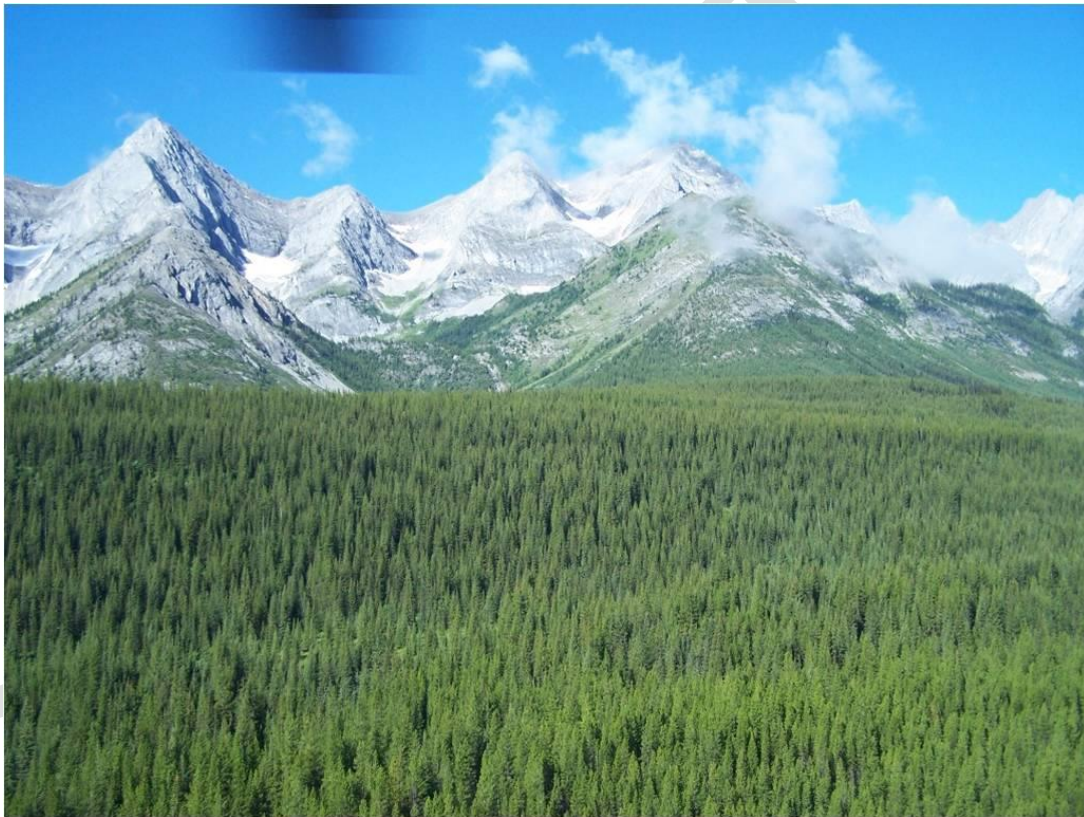


CRANBROOK TSA FOREST HEALTH STRATEGY 2019



Updated by Liz Goyette, RFT RMNRD in consultation, and with contributions from
Marnie Duthie-Holt, Forest Entomologist for Kootenay Boundary Region
Todd Blewett, RPF Resource Stewardship Forester RMRD

DISTRICT MANAGER APPROVAL

Ray Morello, RPF

DATE

CONTENTS

1.0	INTRODUCTION	5
2.0	AREA OF INFLUENCE.....	6
3.0	FIRST NATIONS.....	7
4.0	FOREST HEALTH FACTOR RANKING.....	7
5.0	CURRENT FOREST HEALTH CONDITIONS.....	8
5.1	BARK BEETLES	10
5.1.1	<i>Mountain Pine Beetle (IBM)</i>	10
5.1.2	<i>Spruce Bark Beetle (IBS)</i>	11
5.1.3	<i>Douglas –Fir Beetle (IBD)</i>	12
5.1.4	<i>Western Balsam Bark Beetle (IBB)</i>	13
5.2	ARMILLARIA ROOT DISEASE (DRA)	13
5.3	Western Gall Rust (DSG)	14
5.4	Wildfire Damage (NW)	14
5.5	Drought (ND)	14
5.6	WHITEBARK PINE CONCERNS	14
5.7	PESTS OF YOUNG STANDS	15
5.8	INVASIVE PESTS.....	15
6.0	NON-RECOVERABLE LOSS.....	19
7.0	STOCKING STANDARDS	20
8.0	CLIMATE CHANGE IMPACTS AND CUMULATIVE EFFECTS	21
9.0	BARK BEETLE MANAGEMENT STRATEGIES.....	22
10.0	BARK BEETLE TACTICS.....	27
10.1	HAZARD RATING	27
10.2	DETAILED AERIAL AND GROUND SURVEYS.....	30

10.3	HARVESTING TREATMENT	30
10.4	HAULING AND MILLING GUIDELINES.....	31
10.5	PHEROMONE PLACEMENT	31
10.6	SINGLE TREE DISPOSAL	33
10.7	OVERWINTERING MORTALITY ASSESSMENT	33
11.0	BARK BEETLE TACTICAL PLAN	34
11.1	PRIORITIZATION OF SUPPRESSION UNITS	34
11.2	PROPOSED ACTIVITIES AND BUDGET FOR SINGLE TREE TREATMENT	37
11.0	REFERENCES.....	38

Table 1 - CRANBROOK TSA FOREST HEALTH FACTOR RANKING	8
Table 2 - CRANBROOK TSA 1999-2018 AERIAL OVERVIEW SURVEY RESULTS	9
Table 3- CRANBROOK TSA NON-RECOVERABLE LOSSES	20
Table 4 - CRANBROOK TSA 2019 BARK BEETLE MANAGEMENT STRATEGIES	24
Table 5 - CRANBROOK TSA HECTARES SUSCEPTIBLE TO BARK BEETLE ATTACK BY BMU	29
Table 6 - CRANBROOK TSA IBM SUPPRESSION UNIT PROVINCIAL PRIORITY RANKING	35
Table 7 - CRANBROOK TSA IBS SUPPRESSION UNIT PROVINCIAL PRIORITY RANKING	36
Table 8 - CRANBROOK TSA IBD SUPPRESSION UNIT PROVINCIAL PRIORITY RANKING	36
Table 9 - CRANBROOK TSA 2019/20 PROPOSED BUDGET FOR BARK BEETLE MANAGEMENT	38

Figure 1 - CRANBROOK TSA 1978-2018 AERIAL OVERVIEW RESULTS OF IBM ATTACK	11
Figure 2 - CRANBROOK TSA 1988-2018 AERIAL OVERVIEW RESULTS OF IBD ATTACK	12
Figure 3 - 2018 KOOTENAY BOUNDARY REGION GYPSY MOTH TRAP PLACEMENTS	17
Figure 4 - BALSAM WOOLLY ADELGID INCIDENCE IN BC	19
Figure 5- CRANBROOK TSA 2019 MOUNTAIN PINE BEETLE MANAGEMENT UNITS	25
Figure 6 - CRANBROOK TSA 2019 SPRUCE BARK BEETLE MANAGEMENT UNITS	26
Figure 7 - CRANBROOK TSA 2019 DOUGLAS-FIR BEETLE MANAGEMENT UNITS	27

1.0 INTRODUCTION

The goal of the Forest Health Strategy is to provide information on damaging insects, diseases and abiotic disturbances that have the potential for significant impact and/or occur frequently within the Cranbrook Timber Supply Area (TSA), and identify strategies and tactics to address them. The Forest Health Strategy also provides gives strategic direction for operational plans and serves to prioritise forest health investments in the TSA.

The intent is to minimize timber losses and improve forest resiliency by realizing the following objectives:

- maintenance of a detection program for forest health agents across the land base and assessing the associated risk and impact on resource values and timber supply;
- promotion of knowledge sharing on priority forest health issues amongst ministry staff, forest licensees, First Nations and stakeholders;
- implementation of mitigating forest health management strategies and tactics according to scientifically sound best practices, while considering constraints and limitations imposed by other resource management imperatives;
- provision of forest health related operational planning and investment guidance;
- tracking and evaluating results of forest health management practices for the purpose of adaptive management.

The Cranbrook Forest Health Strategy goal and objectives are in accordance with the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) Provincial Forest Health Strategy 2019-2021 mandate to ensure:

- Forest Health Factors are detected and assessed;
- Practices are adapted to accommodate known forest health risk; and
- Resource values are protected

The Provincial Forest Health Strategy is available for reference at the following link:

https://gwww.nrs.gov.bc.ca/flnrord/resource-practices/forest-health?pl=mb-flnr-forest_health

Forest Health Management in the TSA will take into consideration other resource values and be guided by:

- Identifying and prioritizing Forest Health Factors significance;
- Practising adaptive management by reviewing and revising treatments and tactics in response to scientific and/or technological advances;
- Expert advisement from FLNRORD Resource Practices Branch and Regional and Provincial Forest Health Specialists;
- Promoting diverse species and age mosaics and managing form an ecological perspective;
- Encouraging harvest focused on susceptible, high risk forest types;
- Reducing spread and/or not exacerbating the situation;
- Support timely approvals for harvest of damaged timber in order to recover value to the greatest extent possible;

- Kootenay Boundary Land Use Plans
<https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/kootenay-boundary/kootenay-boundary-rlup>;
- British Columbia's Mountain Pine Beetle Action Plan 2006-201
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/mountain-pine-beetle/mountain_pine_beetle_action_plan_2006.pdf;
- Chief Forester Guidance:
December 2005 Guidance on Landscape and Stand Level Structural Retention in Large Scale MPB Operations
<https://www.for.gov.bc.ca/hfd/library/documents/bib95960.pdf>
- Cranbrook TSA Rational for Allowable Annual Cut (AAC)
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stewardship/forest-analysis-inventory/tsr-annual-allowable-cut/cranbrook_tsa_rationale_2017.pdf;
- Forest and Range Practices Act bulletins
<https://www.for.gov.bc.ca/hth/frpa-admin/frpa-implementation/bulletins.htm>;
- Current Government Actions Regulation (GAR) Orders:
<https://www.for.gov.bc.ca/hth/frpa-admin/frpa-implementation/gar.htm>;

2.0 AREA OF INFLUENCE

The Cranbrook TSA covers 1,484,998 hectares and is bounded by the Skookumchuck Valley to the north, the Canada–U.S. border to the south, the Alberta border to the east, and the southern Purcell Mountains height-of-land to the west. Three major physiographic regions characterize the varied terrain of the Cranbrook TSA: the Rocky Mountains in the east, the Purcell Mountains in the west, and the Rocky Mountain trench in the middle.

The Cranbrook TSA includes the cities of Cranbrook, Kimberley and Fernie, and the smaller communities of Sparwood and Elkford. Small, unincorporated communities and a number of rural residences are dispersed throughout the area. Population in the area from the 2016 Census¹ was reported at 43,532.

The area of Crown Forest Management Land Base (CFMLB) is 782,474 hectares. This excludes areas under area-based tenures, private land, areas not managed by the Crown for timber supply, non-productive land, and existing roads. After further reduction for area not suitable or available for timber harvesting as a result of ecological, economic or social considerations, the current Timber Harvesting Land Base (THLB) is 351,773 hectares. Approximately 60% of the THLB timber volume is dominated by lodgepole pine, with the remaining volume made up by 14% Douglas-fir, 12% larch, 10% spruce and 4% balsam.

The Cranbrook TSA contains six biogeoclimatic zones as follows, an indication of the climatic and biological diversity in this area:

¹ <http://www.rdek.bc.ca/departments/planning/census/>

- Ponderosa Pine Zone - occurs at low elevations (700 to 900 metres) in very dry valleys of the Rocky Mountain Trench;
- Interior Douglas-fir Zone - occurs in the Rocky Mountain Trench, generally between the Ponderosa Pine Zone and the Montane Spruce Zone (between 800 and 1200 metres);
- Montane Spruce Zone - found at mid-elevations, often between the Interior Douglas-fir Zone and the Engelmann Spruce-Subalpine Fir Zone (between 1200 and 1600 metres).
- Interior Cedar-Hemlock Zone occurs at low to middle elevations (700 to 1500 metres) in the wetter portions of the Purcell and Rocky Mountains.
- Engelmann Spruce-Subalpine Fir Zone - the uppermost forested zone, lying below the Alpine Tundra from 1600 to 2000 metres.
- Alpine Tundra Zone - above the Engelmann Spruce-Subalpine Fir Zone, and is by definition treeless (although stunted trees are common at lower elevations) as it is dominated by rock, ice and grassy meadows.

3.0 FIRST NATIONS

The member bands of two First Nation Councils have territories that encompass areas within the Cranbrook TSA: the Ktunaxa Nation Council (KNC) and the Shuswap Nation Tribal Council (SNTC).

Two Ktunaxa communities lie within the Cranbrook TSA. The ?Aq'am community located 15 kilometres northeast of Cranbrook, and the Tobacco Plains Indian Band 60 kilometres southeast of Cranbrook at Grasmere.

The Shuswap Indian Band community is located 80 kilometres north of the Cranbrook TSA at Invermere.

4.0 FOREST HEALTH FACTOR RANKING

Forest Health Factors impacting the Cranbrook TSA have been compiled and ranked in terms of priority in Table 1 below. Ranking is based on the following factors: known impacts to forest resource values, overall knowledge of the hazards and risks of each FHF, availability of operational detection and treatment methods, costs and benefits of applying detailed detection and treatment activities, and the collective knowledge of the Regional/District Forest Health Specialists.

Management strategies for Forest Health Factors with a ranking of High or Very High will be addressed in this document. Those with a Medium, Low or Very Low ranking will be monitored using the Provincial aerial overview surveys, silviculture surveys and pest incidence surveys where possible. If these factors threaten a specific value they should be managed accordingly.

Table 1 - CRANBROOK TSA FOREST HEALTH FACTOR RANKING

Very High	High	Medium	Low	Very Low
Mountain pine beetle	Douglas-fir beetle	Western spruce budworm	Western false hemlock	Laminated root rot
	Spruce bark beetle	Laminated Root Rot	looper	White pine blister rust
	Western balsam Bark Beetle	Tomentosus root rot	Spruce weevil	Dothistroma needle blight
	Armillaria root disease	Pine needle cast	Blackheaded budworm	Atropellis canker
	Western gall rust	Northern pitch twig moth	2 year cycle budworm	Blackstain root disease
	Wildfire	Stalactiform blister rust	Comandra blister rust	Warren's root collar weevil
	Drought	Drought Mortality	Lodgepole pine dwarf mistletoe	Lodgepole pine terminal weevil
		Windthrow	Larch dwarf mistletoe	Tent caterpillar
		Bear damage	Larch needle cast and blight	Satin Moth
			Aspen & Birch Leaf Miners	Flooding
			Sequoia pitch moth	Avalanche
			Ips beetle	Winter drying
			Fir engraver beetle	Porcupine damage
			Black army cutworm	Vole damage
			Rhizina root rot	

5.0 CURRENT FOREST HEALTH CONDITIONS

Forest Health Factors (FHF) in the Cranbrook TSA range from incidences that cause minor harm to those which cause landscape level timber losses. The most significant tree mortality over the course of the last 20 years has been the result of mountain pine beetle and wildfire activity. Mortality due to balsam, Douglas-fir and spruce bark beetle activity, and windthrow events have also occurred. Defoliators, needle diseases and abiotic incidents have reduced growth and caused some tree mortality. Other notable FHF's that are more difficult to accurately track and map (due to visibility issues) include Armillaria root disease and Western gall rust

Notably, mountain pine beetle activity has decline across the TSA. However, continuing patterns of drought stress and significant wind events have caused localised outbreaks of balsam, Douglas-fir and spruce bark beetles, as well as unprecedented wildfire activity.

The foundation for monitoring forest health conditions in BC is the provincial Aerial Overview Survey² (AOS). It is an annual event that captures the location and severity of visible forest health conditions.

Results of the AOS for the Cranbrook TSA are summarized in the following Table 2.

² <https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/aerial-overview-surveys>

CRANBROOK TSA FOREST HEALTH STRATEGY 2019

Table 2 - CRANBROOK TSA 1999-2018 AERIAL OVERVIEW SURVEY RESULTS

Type of impact: 1=quality, 2=growth reduction, 3=young tree mortality, 4=mature tree mortality

	Forest Health Factor	Hectares Affected 2018	Cumulative Hectares Affected '99-18	Type of Impact	% of THLB stands led by host species
BARK BEETLES	Mountain Pine Beetle	938	254,058	4	49
	Spruce Bark Beetle	896	8,851	4	9
	Douglas-Fir Beetle	136	4,618	4	19
	Western Balsam Bark Beetle	6,140	58,666	4	9
	Western Pine Beetle	8	330	4	1
DEFOLIATORS	Western Spruce Budworm	0	11,682	3,4	19
	Aspen Leaf Miner	1,437	12,527	2,3	<1
	Western False Hemlock Looper	0	2,673	2,3	19
	Birch Leaf Miner	145	891	2,3	<1
	Satin Moth	0	608	2,3,4	<1
	Tent Caterpillar	0	648	2,3	<1
DISEASE	Larch Needle Cast/Blight	437	52,177	2,3	14
	Pine Needle Cast	0	5,772	2,3	49
	Dothistroma Needle Blight	186	248	2,3	49
ABIOTIC	Wildfire	16,063	135,525	1,2,3,4	100
	Drought Mortality	4,964	4,964	3,4	100
	Post Burn Mortality	411	666	3,4	100
	Bear Damage	196	904	3,4	100
	Catastrophic Blowdown	47	118,090	3,4	100
	Snow (Avalanche)	29	564	3,4	100
	Flooding	7	134	3,4	100
	Winter Drying (Red Belt)	0	3,850	2,3,4	100

The Rocky Mountain Natural Resource District (comprised of Cranbrook and Invermere TSAs) 2018 Aerial Overview Survey Map can be downloaded for viewing from the following link:

https://www.for.gov.bc.ca/ftp/RSI/external/!publish/Aerial_overview_surveys/2018/printable%20georeferenced%20poster%20sized%20maps%20by%20TSA/2018%20Cranbrook+Invermere%20TSA%20overview%20survey%20wall%20map%2034X44%20Portrait.pdf

5.1 BARK BEETLES

In British Columbia bark beetles are considered the most destructive agent to mature forests as they have caused widespread mortality throughout mature forests. Of the most significant concern are; mountain pine, spruce, western balsam and Douglas-fir beetles.

5.1.1 MOUNTAIN PINE BEETLE (IBM)

District Status: Static

Mountain pine beetle is well known in BC for a massive outbreak that began in the late 1990's. The epidemic lasted 15 years and resulted in the loss of millions of hectares of pine forest. Provincially, populations have been on the decline for the last few years, as a result of unfavourable weather conditions and a declining abundance of host material.

Mountain pine beetle has historically influenced the landscape in the TSA, and continues to be a concern in relation to environmental and economic impacts. Currently 174,218 hectares of pine in the TSA are rated as moderate to highly susceptible to IBM attack. Three outbreaks have occurred in the TSA in the last forty years. The largest and latest outbreak ran from 2002 to 2011, and peaked at 43,810 hectares of infestation in 2005.

For the past six years the population has remained at a low level. The 2018 Provincial Aerial Overview Survey indicates that 938 hectares have been attacked. The population decline is attributed to a combination of the following:

- temperature fluctuations and volatile winds during the summer of 2008 resulted in a less concentrated flight period, thus current attack tended to be dispersed in scattered single tree or small pocket versus large contiguous patches;
- pine targeted harvest operations focused on large concentrations of current attack and susceptible stands at high risk for spread;
- an uplift to the Allowable Annual Cut (AAC) focused on infested and high risk stands to address management of unprecedented levels of infestation;
- falling and burning of infested stems in key locales;

The following graph indicates the number of hectares attacked by IBM in the TSA as detected by the Aerial Overview Survey:

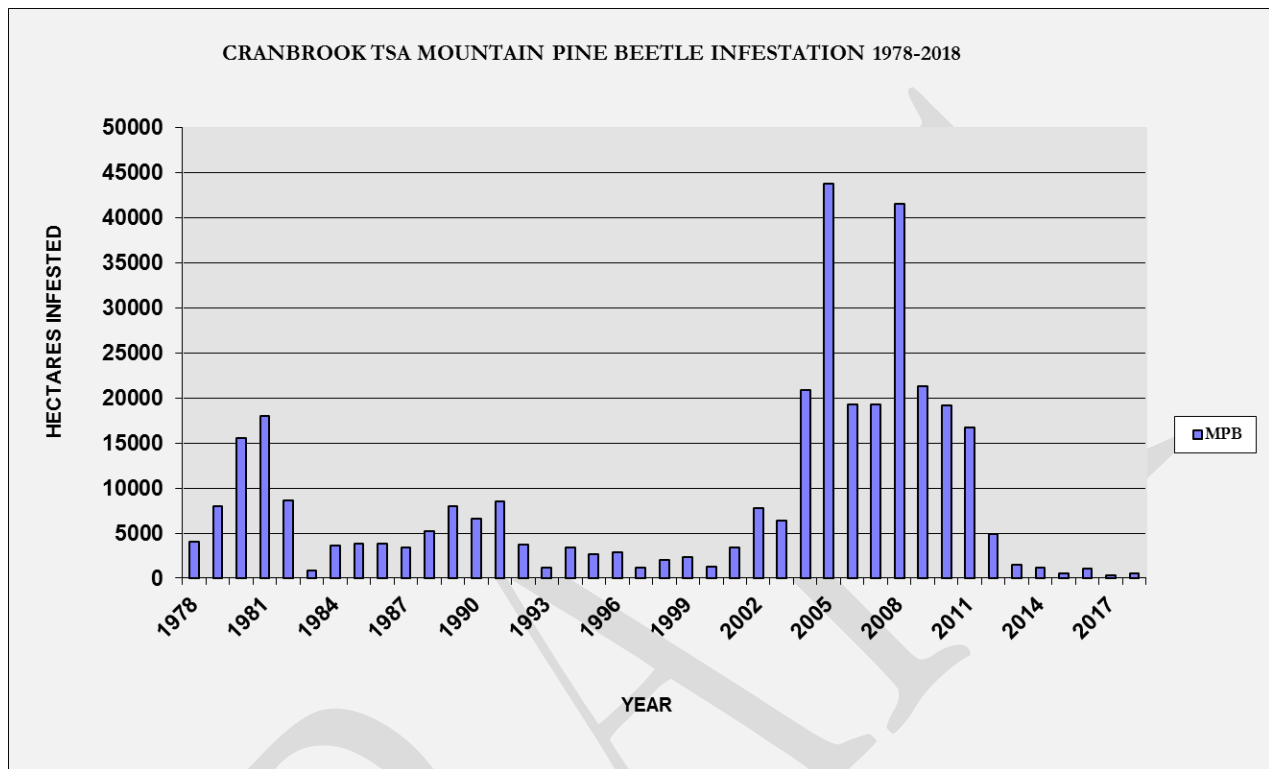


Figure 1 - CRANBROOK TSA 1978-2018 AERIAL OVERVIEW RESULTS OF IBM ATTACK

5.1.2 SPRUCE BARK BEETLE (IBS)

District Status: Decreasing

The spruce beetle is the leading damaging agent of mature spruce in BC. At low population levels, IBS prefers to infest weakened and downed spruce trees. If a significant amount of wind, snow or drought damage, occurs in host stands, populations can quickly increase and spread into healthy trees.

Within the TSA, 38,283 hectares are rated as moderate to highly susceptible to IBS attack. The majority of these stands are located in the Elk, Flathead and St. Mary River Valleys.

A localised IBS outbreak began in Elk Lakes Provincial Park and the upper Elk Valley in 2012 as a result of significant wind events. The population peaked in 2015 at 3,286 ha of infestation. In 2018 the Aerial Overview Survey recorded mortality on 896 hectares within the THLB in the upper Elk Valley, and 772 hectares in Elk Lakes Provincial Park.

It is difficult to capture spruce beetle outbreaks from the air as trees are slow to exhibit a change in crown colour as they expire. As a result, infestations can easily be underestimated during the Aerial Overview Survey.

5.1.3 DOUGLAS –FIR BEETLE (IBD)

District Status: Increasing

Although IBD prefers to infest weakened and downed host material; stress factors such as fire, drought, root disease and windthrow play key roles in the development of infestations.

Douglas-fir beetle has historically influenced the TSA landscape, although to a lesser degree than mountain pine beetle. The TSA contains 38,103 hectares rated moderate to highly susceptible to IBD attack.

The 2018 AOS results indicate that IBD infestation covers 703 ha. Infestation levels have been building over the last 5 years, with the largest concentrations located along steep slopes in Sand and Wildhorse Creek, and the drainages within the Galton Mountain Range.

The following graph depicts the number of hectares attacked by IBD in the TSA as detected by the Aerial Overview Survey.

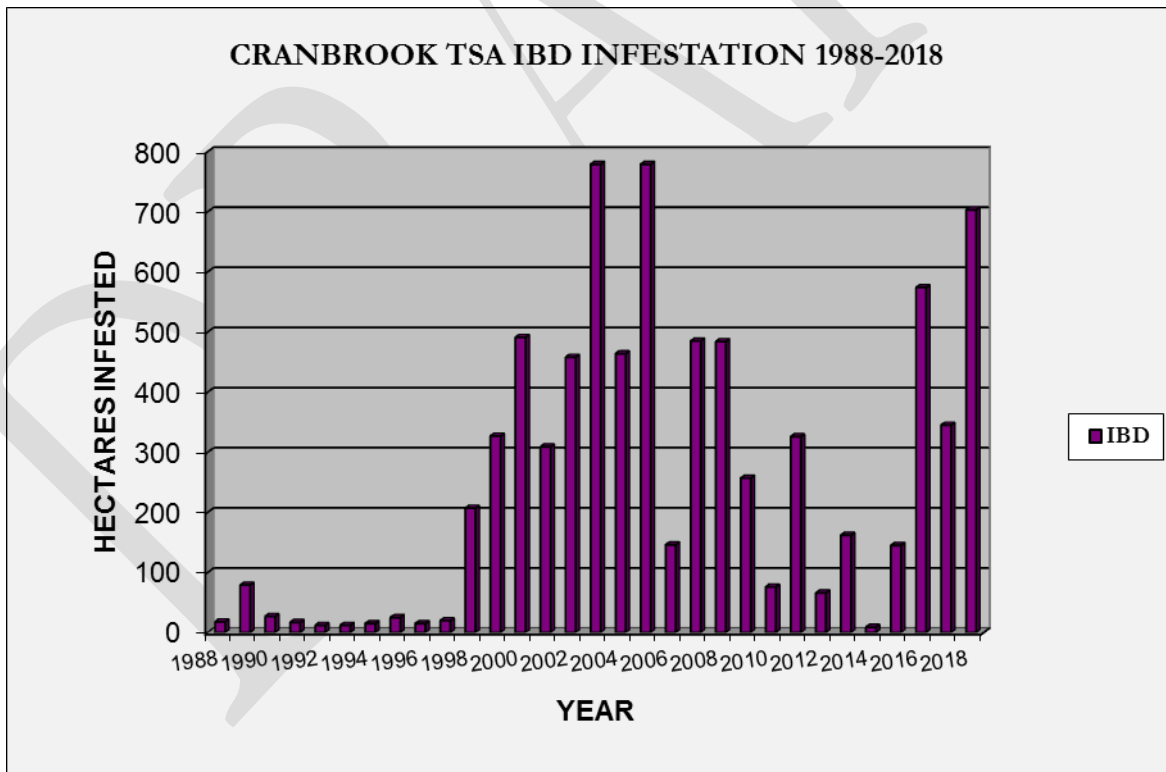


Figure 2 - CRANBROOK TSA 1988-2018 AERIAL OVERVIEW RESULTS OF IBD ATTACK

5.1.4 WESTERN BALSAM BARK BEETLE (IBB)

District Status: Increasing

The western balsam bark beetle causes scattered mortality across large areas of subalpine fir stands in British Columbia. In recent years, IBB incidence and mortality rates across the province have significantly increased.

In the Cranbrook TSA IBB can be found throughout high-elevation stands with 6,140 hectares of mortality mapped in 2018, many of which are located outside of the THLB. As a result, this beetle has not historically ranked as being economically and/or ecologically important. However; the scale of damage merits further examination, as currently the only management occurring is where western balsam bark beetle can be salvage harvested concurrent with other forest health factors, such as spruce beetle.

5.2 ARMILLARIA ROOT DISEASE (DRA)

District Status: Increasing

Armillaria ostoyae is the most common disease in the Cranbrook TSA, particularly in the Interior Cedar Hemlock and Interior Douglas-fir biogeoclimatic zones. It causes considerable mortality in immature stands when roots of healthy trees grow into contact with DRA inoculum. Infected second growth stands tend to suffer a distinct wave of mortality that peaks 12 years post stand establishment. Growth loss occurs when repeated non-lethal infections occur on the roots of older trees. Trees with the disease are also more susceptible to attack by other pathogens or insects.

Armillaria is challenging to manage because it can be difficult to identify in the field, spread is exacerbated by partial cutting and thinning (Morrison et al. 2001)³, and given extensive calcareous and fine textured soils in the TSA, traditional management such as stumping and push-over harvesting may not be possible due to unacceptable levels of associated soil disturbance (Kishchuk et al. 1999⁴, Curran et al. 2000⁵).

Details for DRA detection and management strategies are available in the BC Root Disease Management Guidebook, available at the following link:

<https://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Forest%20Health%20References/RootDiseaseGuidebook%E2%80%9393May2018.pdf>

A Stand Establishment Decision Aid (SEDA) is available for DRA in the southern interior of BC, and can be found at [https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest Health/SEDAs/vol9_no2_art7-Armillaria%202008.pdf](https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest%20Health/SEDAs/vol9_no2_art7-Armillaria%202008.pdf). The SEDA provides detailed information on hazard and risk, as well as a decision matrix/flowchart.

³ Morrison, D.J., Pellow, K.W., Nemec, F.L., Norris D.J., and Semenoff, P. 2001. Effects of Selective Cutting on the Epidemiology of Armillaria Root Disease in the Southern Interior of British Columbia. Canadian Journal of Forest Research. 31:59-70

⁴ Kishchuk, B., Maynard, D., and Curran, M. 1999. Calcareous Soils. Technology Transfer Note Number 15. Pacific Forestry Centre, Canadian Forest Service. Victoria, BC

⁵ Curran, M., Saceniels, K., and Begin, E. 2000. Effects of Harvest Season and Root Rot Treatment on Sensitive Soils in the Rocky Mountains: trail establishment. Extension Note EN-49. Nelson Forest Region, BC MOF. Nelson, BC.

5.3 WESTERN GALL RUST (DSG)

District Status: Increasing

Pine stem rusts are fungal diseases that occur on pine trees and often require an alternate herbaceous host to complete its life cycle. Western gall rust (DSG) is a fungal disease and is the most common stem rust in BC.

In the Cranbrook TSA, western gall rust (DSG) is a major concern in terms of causing wood quality issues, growth reduction and in some cases mortality rates in managed stands. Concerns for achieving free growing status are beginning to arise in some locales.

Information on detection and management of DSG is contained in British Columbia's Southern Interior Forests Forest Health Stand Establishment Decision Aids available at

https://www.for.gov.bc.ca/ftp/HFP/external/publish/Forest_Health/SEDAs/SI%20Forest%20Health%20SEDA%202005.pdf.

5.4 WILDFIRE DAMAGE (NW)

District Status: Increased frequency and severity predicted

The 2017 wildfire season was the most extensive on record in British Columbia's history. A number of vast fires significantly impacted social, economic and environmental elements across the province.

In 2017 wildfire impacted 41,083 hectares in the TSA, with the largest fires occurring in Lamb Creek, Quinn Creek, Linklater, Lodgepole, Soowa Mountain, and the Flathead Valley. In 2018 fire consumed 16,063 hectares, with large fire located in Meachen Creek, Lost Dog, the Elk Valley and Sage Creek. Additional mortality is expected to increase substantially in 2019 and beyond, as a result of impacts from the 2017/18 wildfires. Areas where fires occur will be monitored for increase in bark beetle activity.

5.5 DROUGHT (ND)

District Status: Increased frequency and severity predicted

The summer of 2017 was one of the driest on record in the Cranbrook TSA. The summer of 2018 was a continued prolonged period of drought; as a result associated mortality is expected to increase exponentially in 2019. There is also high potential for sub-lethal effects including top kill, flagging and secondary insects to be attracted to stressed trees and can cause further incremental growth loss or mortality. Thus, sites mapped for drought will be monitored closely, with particular attention extended to locations in the vicinity of where bark beetle suppression efforts are occurring.

5.6 WHITEBARK PINE CONCERNS

Blue-listed species at risk

Whitebark pine is a high elevation conifer that is considered the foundation to ecosystem function on many alpine and subalpine sites, as it can play a key role in retaining water and snow on localised sites and a substantial number of flora and fauna depend upon its presence. It is generally considered to be short and slow growing species, but at lower elevations it can attain commercial dimensions.

Whitebark pine is threatened range-wide mainly due to white pine blister rust, mountain pine beetle, fire and fire suppression, and climate change. Impacts are often compounded as these factors frequently interact.

Measures to actively manage this species at risk should be addressed in a licensee's Forest Steward Plan in order to maintain and promote whitebark pine within managed stands wherever possible. For more detailed information the publication *Silvicultural Options for the Endangered Whitebark Pine* can be found here: http://www.fgcouncil.bc.ca/Whitebark_Pine_Silviculture_2013.pdf

5.7 PESTS OF YOUNG STANDS

Stand Establishment Decision Aids (SEDAs) exist for forest health factors that can impact young stands in this TSA, as follows:

- Southern Interior Forest Region Forest Health SEDAs for Blackstain Root Disease, Comandra Blister Rust, Western Gall Rust, Western Spruce Budworm, and White Pine Blister Rust
- White Pine Blister Rust
- Armillaria Root disease

SEDAs are posted for reference at <http://www.forrex.org/tools/sedas/>.

To assist forest practitioners in selecting stands for spacing, the publication "*Field Guidelines for the Selection of Stands for Spacing (Interior)*" can be consulted at the following link:

<https://www.for.gov.bc.ca/hfp/publications/00021/FS448b%2020120329.pdf>

These guidelines incorporate biological, forest health and financial factors that can influence the ensuing development, yield and value of a spaced stand.

The Forest and Range Effectiveness Evaluation Program (FREP) has established a provincial Stand Development Monitoring (SDM) protocol for annually assessing the health of young managed stands on a random sampling of sites. The data collected provides a retrospective on the silviculture practices that were utilized on the site, and the state of FHF activity. Detailed information on the FREP SDM Protocol can be found on the following FREP website: <https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/integrated-resource-monitoring/forest-range-evaluation-program>

5.8 INVASIVE PESTS

Invasive forest pests threaten the health of forest ecosystems and include insects and diseases that have accidentally been introduced or have migrated into British Columbia. Two that are of particular concern to B.C.'s economy are gypsy moth and the balsam woolly adelgid.

The gypsy moth is native to Europe, North Africa, and Asia. The European gypsy moth was introduced in eastern North America in the mid 1800's and is now well-established in the northeastern states, and parts of Ontario and Quebec. Gypsy moths consume the leaves of trees and shrubs in their caterpillar stage and threaten extensive damage to B.C.'s environment and economy for forestry products and fruit producers. There is a constant threat that both strains could become established here. In 1991 egg masses and adult male Asian gypsy moths were found in B.C.'s lower mainland.

The Canadian Food Inspection Agency and FLNRORD run an annual gypsy moth trapping program whereby pheromone traps are placed across the province in high risk areas and major transportation corridors to detect the presence of male moths that may have been brought into B.C. Eradication treatments are implemented where necessary. The most common treatment is to spray with the biological insecticide Btk. In 2018, 55 moths were caught in 22 different locations, primarily in the Lower Mainland/ Fraser Valley and southern Vancouver Island and one unusual find near Castlegar. The following map in Figure 3 shows the location of pheromone traps placed in the Kootenay-Boundary Region in 2018.

More information on the Gypsy Moth in North America can be found at the following link:

<https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/invasive-forest-pests/gypsy-moth>

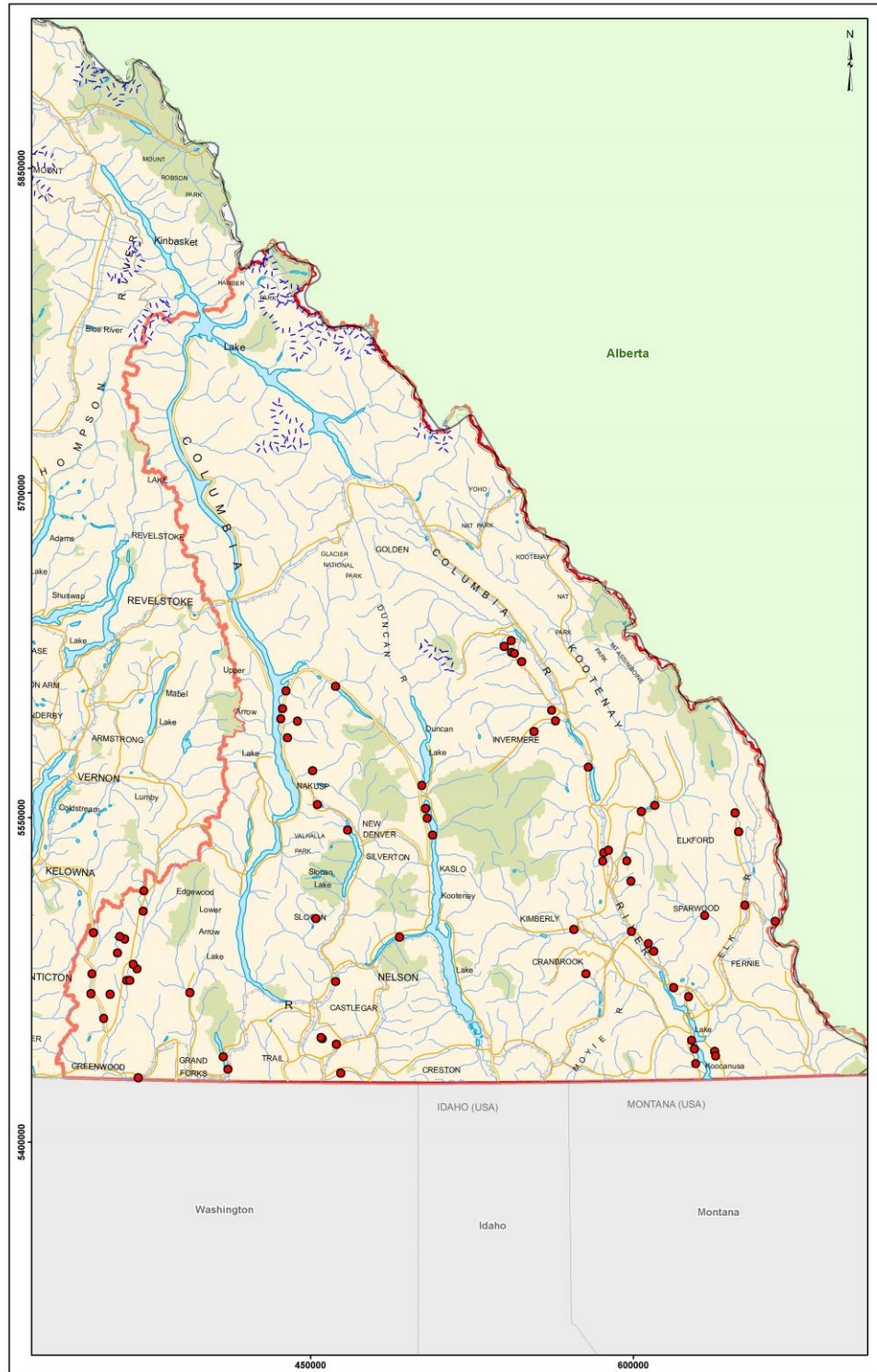


Figure 3 - 2018 KOOTENAY BOUNDARY REGION GYPSY MOTH TRAP PLACEMENTS

The balsam woolly adelgid (BWA) was accidentally introduced to North America from Europe. It is an aphid-like insect that feeds exclusively on true firs (*Abies* species), and appears on the tree bark as woolly, white masses about 1 mm long. It can kill a tree after several years of heavy feeding. Significant risk of spreading this insect is posed by the movement of true firs for reforestation purposes, or use as Christmas or ornamental trees.

Control of BWA consists of removal and disposal of infested trees, as currently there are no naturally occurring biological control agents. The following map in Figure 4 depicts recorded BWA incidence in BC. Further information on BWA can be sourced at the following link:

<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/nursery-and-ornamentals/balsam-woolly-adelgid>

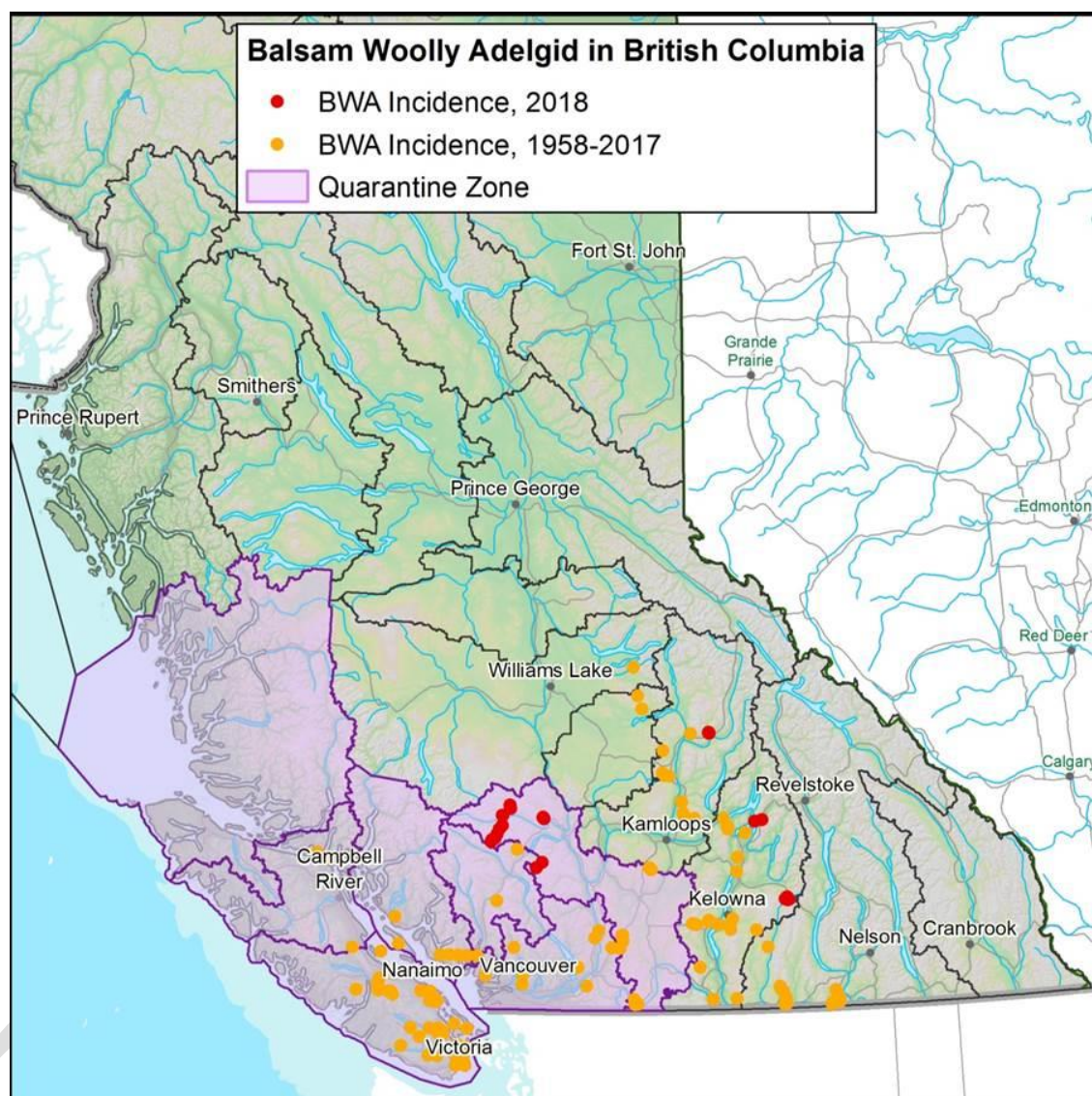


Figure 4 - BALSAM WOOLLY ADELGID INCIDENCE IN BC

6.0 NON-RECOVERABLE LOSS

Non-recoverable loss (NRL) is the volume of timber that is destroyed or damaged due to forest health factor activity on the timber harvesting land base that are not recovered by timber harvesting operations. During the analysis of timber supply, catastrophic levels of loss are accounted for by deducting an average annual NRL from harvest projection calculations.

The following Table 3 lists average annual NRL estimations for catastrophic level FHF events that have occurred in the Cranbrook TSA. They are based on a 10-year averaging period derived from data provided by Adrian Walton, (FLNRORD Research Landscape Ecologist, Forest Analysis and Inventory Branch) as part of a provincial estimate of NRLs in each TSA for input into Timber Supply Review Allowable Annual Cut data

packages.

Table 3- CRANBROOK TSA NON-RECOVERABLE LOSSES

Casual Factor	Average Annual Non-recoverable Volume Loss m ³
Mountain Pine beetle	35,500
Douglas-fir beetle	1,519
Spruce bark beetle	192
Balsam bark beetle	2,315
Western Pine Beetle	112
Wildfire	7,792
Flooding	305
Fir engraver beetle	132
TSA total	47,867

Volume losses attributed to non-catastrophic FHF occurrences are considered as part of a natural process that occurs over time, and is accounted for within the growth and yield models utilized for timber supply analysis.

7.0 STOCKING STANDARDS

In British Columbia, Stocking Standards are a required component of forest stewardship plans (FSP) under the Forest and Range Practices Act (FRPA), as follows:

“Stocking Standards means the tree stocking standards that apply when (a) establishing a free growing stand or (b) meeting the requirements of Forest Planning and Practices Regulation (FPPR) section 44 - covers commercial thinning, intermediate cuts and harvesting for special forest products”.

Reforestation decisions involve choosing suitable species and stocking levels, and achieving prompt and effective establishment. These resulting decisions impact stand structure, forest biodiversity, forest health, rotation length and future utilization.

To aid forest practitioners in creating healthy and valuable stands, a training module entitled *Stocking Standards Review 2011 – Decisions that Last a Lifetime* is available for reference at:

<http://www.for.gov.bc.ca/ftp/his/external/!publish/results/training/Stocking-Standards.pdf>

The *Tree Species Selection Tool* was developed in 2012, as a means of providing forest practitioners with the best available science-based tree species selection related information for a given geographical location:

<http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/tree-species-selection>

Resources Practices Branch published updates to the *Reference Guide for FDP Stocking Standards (2014): Climate-Change related Stocking Standards* available at:

http://www.for.gov.bc.ca/hfp/silviculture/Stocking_stds/2014_FDP_SS_update.pdf

Fire management stocking standards are intended to be used in specific circumstances and locations to achieve specific fire management objectives. The latest *Fire Management Stocking Standards Guidance Document* released 12 February 2016 is available at

<https://www.for.gov.bc.ca/hfp/silviculture/Fire%20Management%20Stocking%20Standards%20Guidance%20%20Document%20March%202016.pdf>;

Localized Stocking Standards have been developed and referenced in licensee Forest Stewardship Plans. *Rocky Mountain District Forest Stewardship Plan Stocking Standards Version 4.1* and *Rocky Mountain District Partial Cutting Stocking Standards* can be found at the following links:

https://www.for.gov.bc.ca/ftp/drm/external/!publish/web/Silviculture/BECv11_RMNRD_FSP_SS_w_footnotes.pdf

<https://www.for.gov.bc.ca/ftp/DRM/external/!publish/Web/Silviculture/V2RMFDpartcutstds.pdf>

8.0 CLIMATE CHANGE IMPACTS AND CUMULATIVE EFFECTS

Strong scientific evidence indicates that climate change will significantly affect the ecosystems of BC's. The climate in BC has become warmer and wetter over the last century, with winter warming the most. Snow packs have decreased, while extreme rainfall and dry conditions have increased. In-depth information is available at the links that follow:

The provincial climate change strategy

https://www.for.gov.bc.ca/het/climate/strategy/climate_change_strat_2015-20.pdf.

Climate Change and Adaptation in B.C. Forests <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/natural-resources-climate-change>

For the southern regions of BC, expectations are that warming will continue, and summer precipitation will decrease. Natural disturbance dynamics will likely change to include increased fire and drought in southern, and more frequent and extensive mortality due to bark beetles, defoliators and diseases.

On February 27, 2012 the Chief Forester released the *Forest Stewardship Action Plan for Climate Change Adaptation 2012-2017*, located at:

http://www.for.gov.bc.ca/ftp/HFP/external/!publish/ClimateChange/Adaptation/MFLNR_CCAadaptation_Action_Plan_2012_final.pdf.

The plan "...sets out a new and emerging policy direction and framework for which new policies, guidance and tools will be developed to support forest managers and decision makers in adapting their practices over the next five years and beyond." and challenges BC forest managers to incorporate adaptation to climate change into forest stewardship practices. Three main goals from the Action Plan are to:

1. Foster Resilient Forests
2. Maintain Future Options and Benefits
3. Build Adaptive Capacity

In keeping with the above goals, and to provide best available information at the Regional level, the following recently published document is available for reference *Adapting natural resource management to climate change in the Kootenay Boundary Region: Considerations for practitioners and Government staff* <https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/regional-extension-notes/kbren160222.pdf>

British Columbia's cumulative effects framework is a set of policies, procedures and decision-support tools that helps identify and manage cumulative effects consistently and transparently across British Columbia's natural resource sector. The publication *Cumulative Effects Framework Engagement overview* is available at: http://www2.gov.bc.ca/assets/gov/environment/natural_resource-stewardship/cumulative-effects/phase_2_engagement_overview_april_27_final.pdf

To define transparent and consistent methods for assessing and reporting on conditions and trends across the province, standard value assessment protocols are being developed for aquatic ecosystems, forest biodiversity, grizzly bear, moose and old growth forest. Interim assessment protocols that have been approved are posted for review at: [Values - Province of British Columbia](#)

9.0 BARK BEETLE MANAGEMENT STRATEGIES

Specific management strategies are provided for bark beetles ranked Very High or High as to their potential to impact forest management activities and values in the Cranbrook TSA. In order to limit tree mortality, these insects are considered as the top priority for implementation of treatment activities.

Treatment activities and monitoring responsibilities reside with FLNRORD Regional/or District Forest Health Specialists, unless the forest health issue affects preparation of site plans, free growing obligations, or licensees address the issue voluntarily or undertake activities eligible for Land Base Investment Branch funding.

Bark beetles pose a major threat to land management objectives as large-scale mortality has a negative impact on timber and non-timber resources. Effective management techniques are required to mitigate and prevent losses.

Bark beetle management objectives in the Cranbrook TSA are to reduce population spread and minimize revenue loss and impacts to other resource values.

There are 38 landscape units in the Cranbrook TSA. Each individual landscape unit is considered a Beetle Management Unit (BMU) for planning and reporting purposes. These units provide a means for resource allocation and monitoring, determining effectiveness of treatments, evaluating level of damage to timber and impacts on other resources. An annual review of each BMU occurs to assign appropriate management strategies and treatment tactics in accordance with the approach and guidance provided by the Provincial Bark Beetle Strategy⁶ and Provincial Bark Beetle Management Technical Guidelines⁷. There are four possible management strategies for a BMU, as follows:

1. Suppression – to reduce populations address all current attack within two years (80-100% brood kill targeted per year). The intent is to drive bark beetle populations down and stop the spread via focused harvest and single tree treatments. Single tree treatment funds are only allocated to BMUs with a Suppression designation.
2. Holding - maintain beetle populations at a static level that can be dealt with under current AAC by addressing 50-80% of current attack. Therefore; the level of harvest and/or treatment is equal to the rate of expansion.
3. Salvage – the priority is to salvage previously attacked timber to minimise value loss. This is relevant in areas where suppression or holding actions are no longer feasible.
4. Monitor - no action required beyond monitoring and reporting.

The following table presents Beetle Management Unit strategies for the TSA. To provide geographic perspective on the location of BMUs, individual bark beetle species reference maps also follow.

⁶ <https://www.for.gov.bc.ca/hfp/health/fhdata/bbstrategy.htm>

⁷ https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/bark_beetle_management_technical_guidelines.pdf

Table 4 - CRANBROOK TSA 2019 BARK BEETLE MANAGEMENT STRATEGIES

BMU	BMU Name	IBM Management Designation	IBS Management Designation	IBD Management Designation
C01	Moyie Lake	Suppression	Holding	Holding
C02	Perry-Moyie	Suppression	Suppression	Holding
C03	Lamb Creek	Holding	Holding	Holding
C04	Hellroaring-Meachen	Holding	Suppression	Holding
C05	Redding Creek	Holding	Suppression	Holding
C06	Upper St. Mary	Holding	Suppression	Holding
C07	White Creek	Holding	Holding	Holding
C08	Kimberley Watershed	Suppression	Suppression	Suppression
C09	Yahk River	Suppression	Suppression	Holding
C10	Bloom-Caven	Suppression	Holding	Suppression
C11	Teepee Creek	Suppression	Suppression	Suppression
C12	Cranbrook Watershed	Suppression	Holding	Suppression
C13	Galton Range	Suppression	Holding	Suppression
C14	Wigwam River	Suppression	Suppression	Holding
C15	Lodgepole-Bighorn	Suppression	Holding	Suppression
C16	West Flathead	Suppression	Suppression	Holding
C17	Upper Flathead	Suppression	Suppression	Holding
C18	East Flathead	Suppression	Suppression	Holding
C19	Corbin Creek	Suppression	Holding	Holding
C20	Alexander-Line	Suppression	Holding	Holding
C21	Fording River	Holding	Suppression	Holding
C22	Upper Elk	Suppression	Holding	Holding
C23	West Elk	Suppression	Holding	Suppression
C24	Lower Elk	Suppression	Suppression	Holding
C25	Sand Creek	Holding	Suppression	Holding
C26	Iron-Sulphur	Suppression	Suppression	Holding
C27	Upper Bull	Suppression	Suppression	Holding
C28	Galbraith-Dibble	Suppression	Holding	Holding
C29	Wildhorse-Steeple	Holding	Holding	Holding
C30	Cranbrook	Suppression	Holding	Suppression
C31	Lost Dog	Suppression	Holding	Holding
C32	St. Mary Prairie-HaHa Lake	Holding	Holding	Suppression
C33	Wasa-Picture Valley	Holding	Holding	Suppression
C34	Jaffray-Baynes Lake	Suppression	Holding	Suppression
C35	Tobacco Plains	Holding	Holding	Holding
C36	Mayook-Wardner	Suppression	Holding	Suppression
C37	Linklater Englishman	Suppression	Holding	Suppression
C38	East Elk	Holding	Suppression	Holding

CRANBROOK TSA FOREST HEALTH STRATEGY 2019

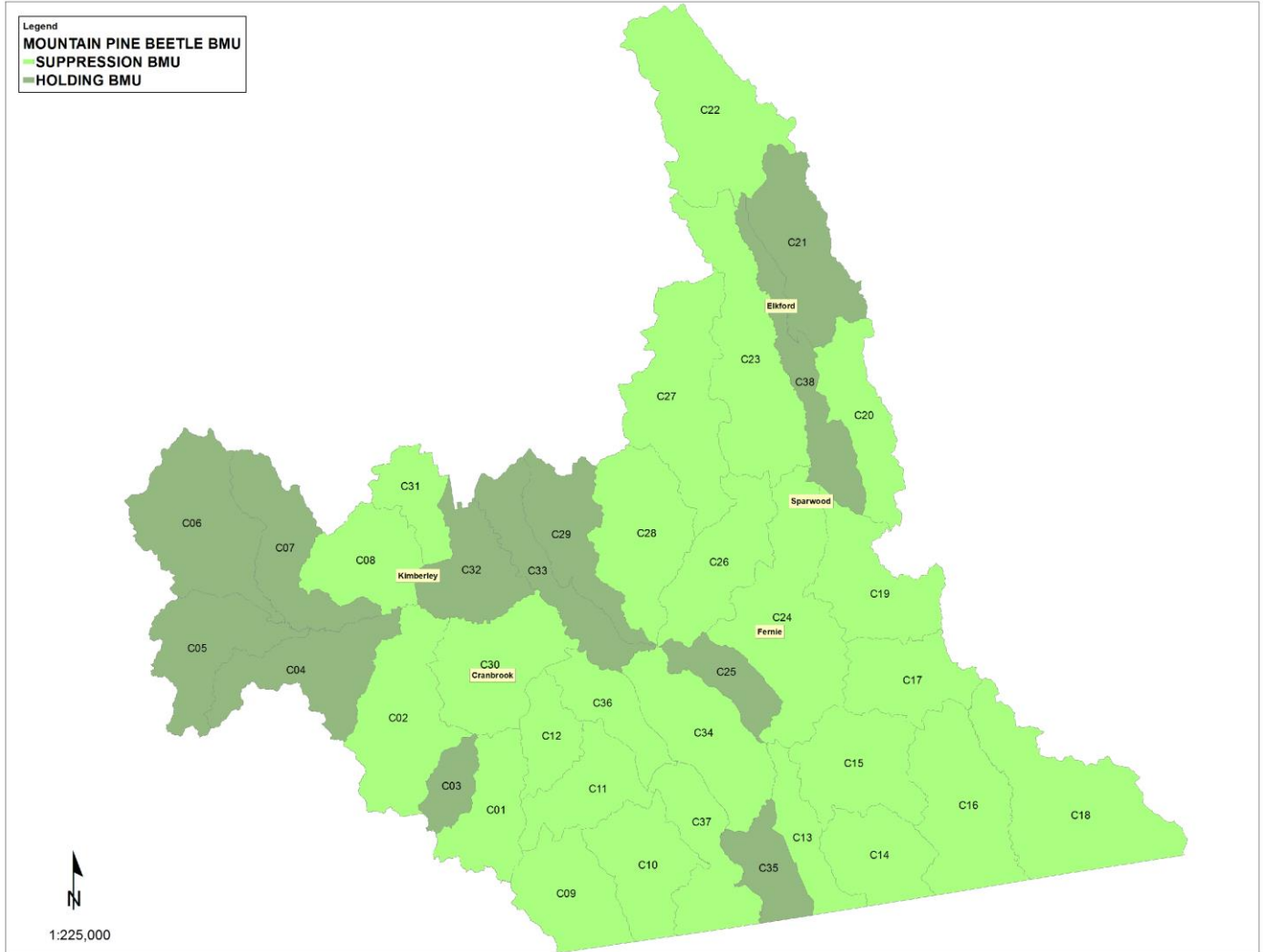


Figure 5- CRANBROOK TSA 2019 MOUNTAIN PINE BEETLE MANAGEMENT UNITS

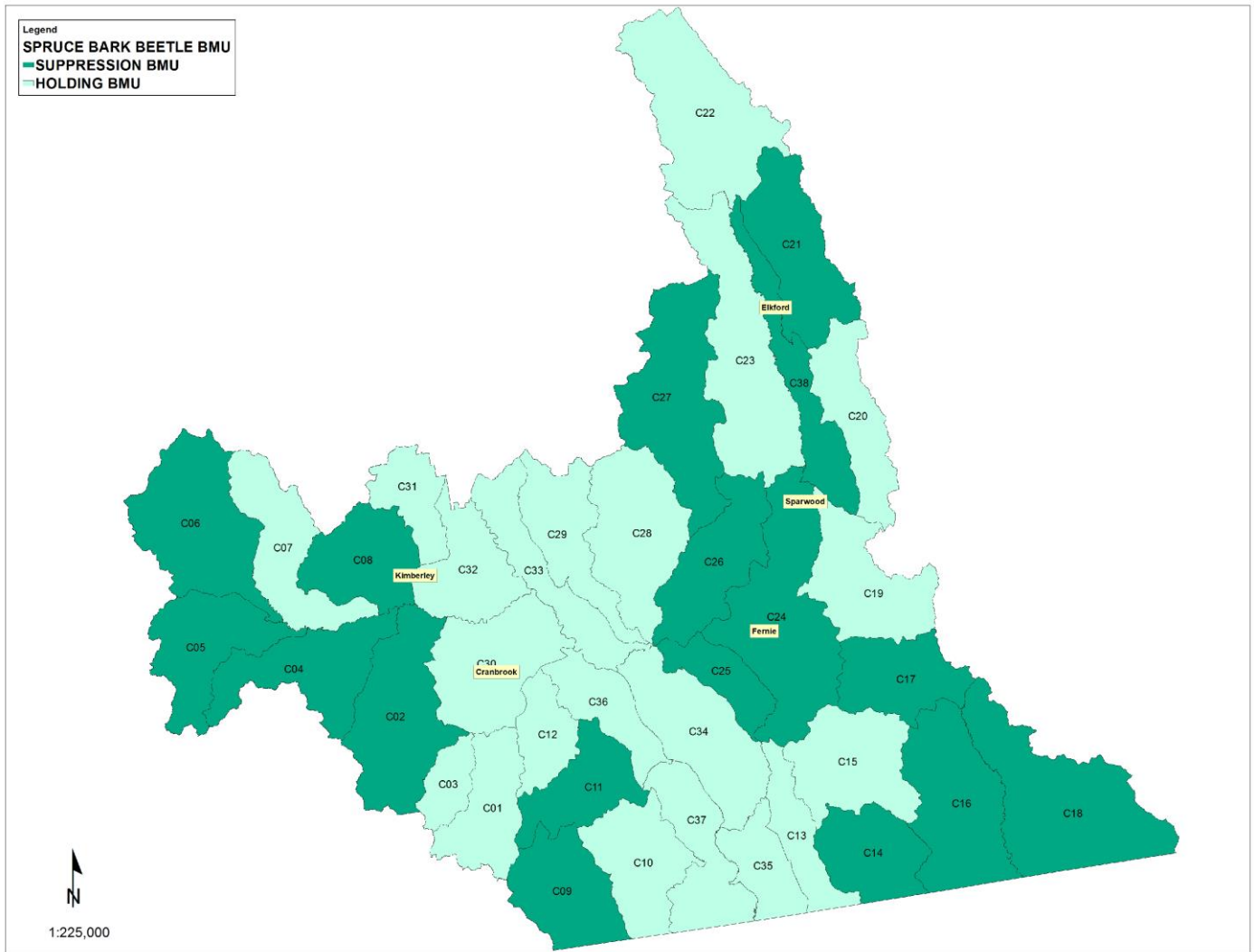


Figure 6 - CRANBROOK TSA 2019 SPRUCE BARK BEETLE MANAGEMENT UNITS

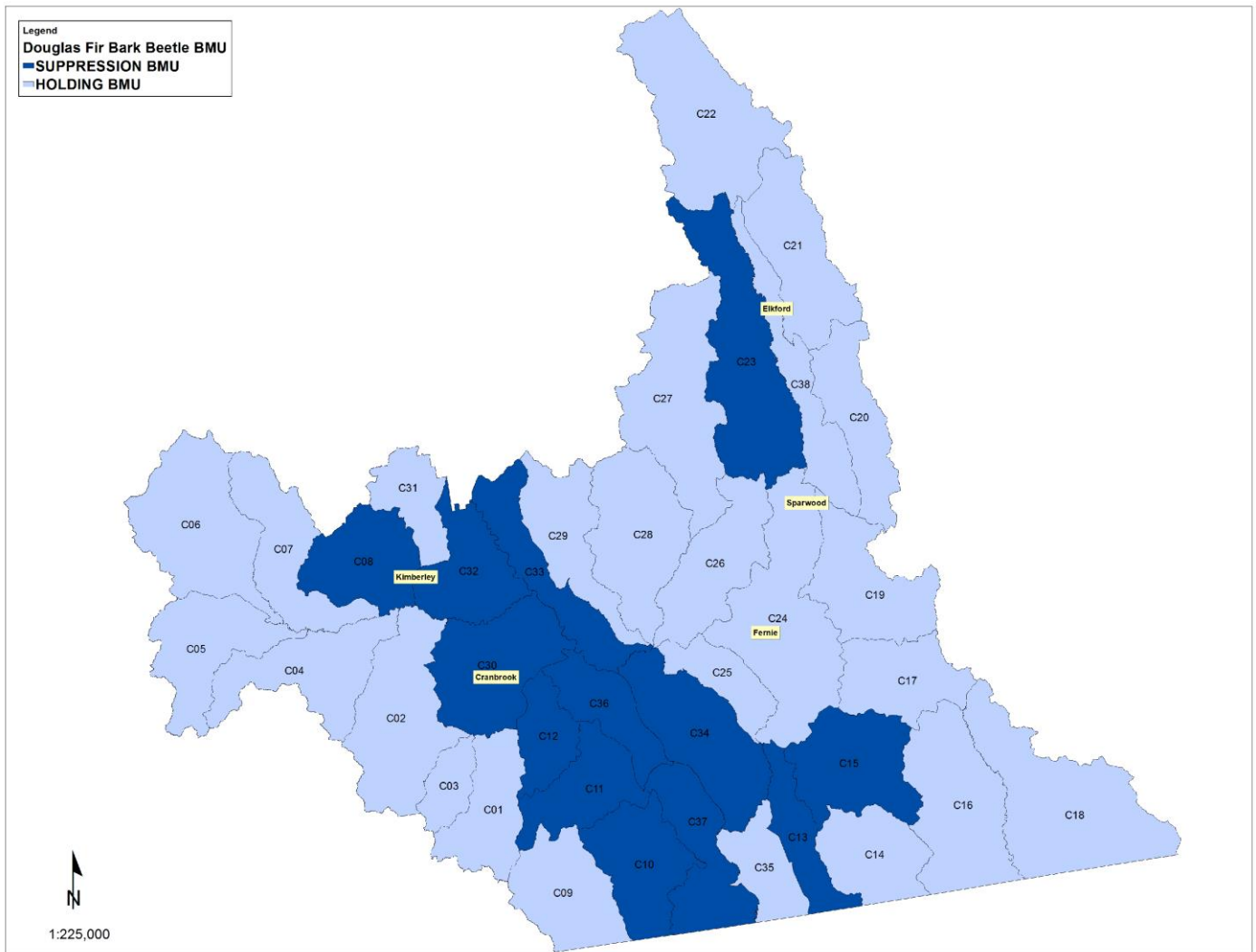


Figure 7 - CRANBROOK TSA 2019 DOUGLAS-FIR BEETLE MANAGEMENT UNITS

10.0 BARK BEETLE TACTICS

An appropriate combination of actions and treatments must be applied to specific infestations or areas within a BMU to accomplish the management objectives. Treatments will have to be repeated each year the strategy remains in place, unless there have been significant changes to reduce susceptibility of the timber, or the risk of subsequent infestation has abated.

10.1 HAZARD RATING

Stand level priority ranking systems, such as hazard (susceptibility) and risk analysis are key decision making tools that aid in assessing potential impacts of insect outbreaks, and developing management plans. Hazard

rating considers stand age, host basal area, stand density, and elevation; and, identifies stands where high volume losses can be expected should a beetle outbreak arise. Susceptibility ratings range from 0-100 and provide a relative indicator of the level loss a stand of timber would experience in the event of a particular bark beetle infestation.

Hazard ratings for IBM⁸, IBD⁹ and IBS¹⁰ were updated in 2013 for the Cranbrook TSA using the most current methodology. Specifics on the amount of moderate to high hazard host material available in each BMU are provided in the following table:

⁸ Decision support systems. 2006. Shore, T.L.; Riel, W.G.; Safranyik, L.; Fall, A. Pages 193-230 (Chapter 8) in L. Safranyik and W.R. Wilson, editors. The mountain pine beetle: a synthesis of biology, management, and impacts on lodgepole pine. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia. 304 p.

⁹ A Susceptibility and Risk Rating System for the Douglas-fir Beetle in British Columbia. Draft version 10, April 2001. T.L. Shore and L. Safranyik. Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.

¹⁰ A Susceptibility and Risk Rating System for the Spruce Beetle *Dendroctonus rufipennis*. DRAFT Version 10, August 4, 2005. L. Safranyik and T.L. Shore, Canadian Forest Service, Pacific Forestry Centre.

Table 5 - CRANBROOK TSA HECTARES SUSCEPTIBLE TO BARK BEETLE ATTACK BY BMU

BMU	BMU Name	IBM Moderate to High Hazard Hectares	IBS Moderate to High Hazard Hectares	IBD Moderate to High Hazard Hectares
C01	Moyie Lake	8,889	739	302
C02	Perry-Moyie	7,258	2,336	878
C03	Lamb Creek	675	362	110
C04	Hellroaring-Meachen	1,688	2,237	183
C05	Redding Creek	4,144	1,222	68
C06	Upper St. Mary	2,833	1,924	57
C07	White Creek	1,853	814	168
C08	Kimberley Watershed	7,233	1,315	408
C09	Yahk River	9,400	1,423	84
C10	Bloom-Caven	8,833	798	1,301
C11	Teepee Creek	5,498	1,050	185
C12	Cranbrook Watershed	7,952	602	83
C13	Galton Range	3,696	113	2,932
C14	Wigwam River	8,137	918	242
C15	Lodgepole-Bighorn	4,017	878	2,150
C16	West Flathead	8,964	1,907	396
C17	Upper Flathead	6,325	1,907	76
C18	East Flathead	11,436	1,549	312
C19	Corbin Creek	2,408	149	0
C20	Alexander-Line	2,029	545	72
C21	Fording River	717	903	7
C22	Upper Elk	4,705	900	5
C23	West Elk	4,597	3,476	1,000
C24	Lower Elk	3,872	2,267	158
C25	Sand Creek	1,658	1,069	971
C26	Iron-Sulphur	6,799	923	854
C27	Upper Bull	5,636	1,971	526
C28	Galbraith-Dibble	5,089	719	439
C29	Wildhorse-Steeple	1,040	719	1,479
C30	Cranbrook	4,339	526	1,968
C31	Lost Dog	6,897	445	3
C32	St. Mary Prairie-HaHa Lake	1,716	242	1,294
C33	Wasa-Picture Valley	1,824	259	2,794
C34	Jaffray-Baynes Lake	4,162	199	996
C35	Tobacco Plains	186	12	713
C36	Mayook-Wardner	3,415	246	1667
C37	Linklater Englishman	3,750	518	3044
C38	East Elk	551	102	0
TOTAL HECTARES		174,218	38,283	27,925

10.2 DETAILED AERIAL AND GROUND SURVEYS

Detailed aerial surveys commence in mid to late summer to coincide with tree crown fade in the previous year's attacked trees, as funding permits. The attacked trees are GPS located to serve as a guide to direct ground survey works.

Ground surveys are conducted post beetle flight (usually from early September to mid-November) to obtain data on the level of current attack, and the amount of susceptible host timber remaining. The information collected is used to delineate infested areas and to facilitate planning and operational treatment decisions. Ground survey information should only be considered accurate and applicable for the current beetle flight period. Typically surveys will provide details on the state of the infestation, stand and site information, management options, and GPS or sketch mapped locations of beetle attacked stems.

The detailed and Regional aerial overview flight data, coupled with hazard rating, form the basis for allocating management resources and responsibilities.

The District Forest Health Specialist is responsible for implementing survey work in Suppression BMU's in areas not under cutting permit.

Reconnaissance surveys should be undertaken in the absence of aerial overview data. This is important where blocks have not been harvested pre-flight and there is a potential for spread into adjacent stands requiring further amendments to existing blocks.

As an accelerated planning process is required to facilitate successful treatment outcomes, aerial and ground survey information collected by the Regional and/or District Forest Health specialist will be shared with licensees as soon as practicable.

10.3 HARVESTING TREATMENT

The preferred removal method of bark beetle infested timber is via expedited sanitation harvesting, whenever economically and environmentally feasible. These operations focus on timely extraction of currently infested trees in order to limit beetle population spread and recover timber value before the wood value degrades. This may require a combination of harvest regimes ranging from single tree host removal to small patch or large cut blocks. Targeted sanitation harvest treatments are vital in BMU's with a suppression management designation

In order to limit timber volume loss, salvage harvesting operations are to be directed at recovering concentrations of damaged timber before the wood quality declines and becomes non-merchantable.

Harvesting of high hazard timber is appropriate in either uninfested or lightly infested management units, if harvesting capacity is in excess of that required to deal with other active infestations.

10.4 HAULING AND MILLING GUIDELINES

For awareness, communication of business needs/expectation is required between licensee and Regional and/or District Forest Health Specialists prior to an upcoming bark beetle flight period.

The following guidelines should be considered during peak beetle flights from July 1 to September 15th annually:

1. In locations where mill sites are in or near urban areas, or in areas not yet affected by bark beetles:
 - Manage inventories of infested timber for priority processing over non-infested sources.
 - Keep mill inventories and deliveries of infested wood at a minimal operational level
 - Establish Lindgren funnel traps in and around log yards, log decks assist in monitoring bark beetle flight and to serve as a control measure.
2. In Suppression and Holding BMU's:
 - For infested cut blocks that are not harvested/hailed prior to beetle flight, consider baiting in an attempt to minimize spread. Licensees should, where practical, plan operations that avoid leaving decks of infested timber on site.
 - Communication of business needs/expectation for awareness between licensees and the Regional and/or District Forest Health Specialist
 - Restrict hauling of current attack loads through non-infested host corridors
 - Hauling of infested logs should be as direct as possible from the cutting area to the mill
 - Inform truck drivers that extended delays along the way can result in bark beetles flying from the load into adjacent host material.

10.5 PHEROMONE PLACEMENT

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

1. **Grid/spot baiting** - aggregation pheromones to contain and concentrate populations prior to harvesting. (has been used operationally in B.C. for IBM since 1984)
 - Use when attack levels low and dispersed throughout proposed harvest block
 - Commitment to follow up treatment
 - 50 m by 50 m grid bait (emergent beetles cannot fly out of the grid without coming within 25 m of a baited tree, and beetles can also be attracted from up to 75 m away).
 - Contain and concentrate beetles within stand prior to sanitation harvests
 - Cutblock boundary is laid out around the grid, and all host trees/ infested trees are harvested sometime before beetle flight in the following year. Beetles are transported to a mill and killed in a debarker.
2. **Trapping** - to monitor or suppress populations with a contingency plan must be in place to treat any spillover attack that may occur in adjacent host material.
 - Monitor time and magnitude of beetle flights
 - Mop up tool after sanitation harvesting
 - Population control – capture large numbers of beetles
 - MP3 multiple funnel trap clusters spaced 5-10m apart
3. **Anti-aggregants** (verbenone/MCH) – to deter attack
 - Repels and disperses beetles
 - Used for high-value trees
 - Protects healthy standing and uninfested windthrow and protects damaged or stressed residual trees.
 - Use as push-pull with aggregants/trap trees
 - Timing & population levels important
 - Benefits: one entry, fairly cheap to buy
 - Works best with small infestations (avoid in larger sites where may be ineffective or risky) and to treat sites after sanitation harvesting to disperse beetles in stumps, debris, tops, etc.

4. “**Push-pull**” tactic - use of both aggregation and anti-aggregation pheromones

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).

Maps identifying all baited areas should be provided to the District Forest Health Specialist by September 15th each year.

Detailed information on pheromone use can be located at the following link:

<https://semiochemical.com/wp-content/uploads/2017/03/Tree-bait-bulletin.pdf>

10.6 SINGLE TREE DISPOSAL

Single tree disposal is used to remove infested trees in lightly infested areas or scattered on the periphery of larger infestations and in locations where other resource constraints limit treatment options (I.E. Parks, Recreation Sites, watersheds, riparian areas). Infested stems are felled, bucked (or debarked), piled and burned so that all infested bark is well scorched. A thorough survey of an affected stand is required to ensure all infested stems have been marked for removal.

10.7 OVERWINTERING MORTALITY ASSESSMENT

Overwintering mortality assessments are conducted during the spring (usually March). Beetle population trends can then be determined using the following protocol:

- Slabs of bark are taken on the north and south side of currently attacked trees/site to yield a 15 cm x 15 cm bark samples
- Sample 10 trees/site > 20 cm in DBH. Do not sample adjacent to openings or road edges
- Collect location, tree number, DBH, aspect, elevation, date sampled, site number, top of sample, tree species
- Avoid water or fuel exposure, samples stored in breathable material (burlap, paperbag) for 5 days or quicker or assessed on site
- Random sampling with woodpeckered trees is acceptable. Provide an estimate of percentage of woodpecker activity.
- Record number of live and dead larvae (or other life stages) and adults
- Record number of entry holes (= indicator of attack)

- Number of dead larvae, pupae, and adults are not included in calculations of r-values (just overwintering mortality assessments)
- Calculate the R-value (avg. no. progeny per sample/ avg. no. entrance holes) and record the population interpretation for the site:

R-value	Population Interpretation
0-2.5	Decreasing
2.6-4.0	Static
>4.1	Increasing

11.0 BARK BEETLE TACTICAL PLAN

The Tactical Plan prioritizes the treatment sequence of individual BMU's, details planned detection and single tree treatment activities and their associated cost estimates.

11.1 PRIORTIZATION OF SUPPRESSION UNITS

In order to prioritize treatment and allocate resources, Suppression BMU's have been ranked in order of importance for bark beetles of concern in the TSA as detailed in the tables below. The order of ranking follows the method documented in the Provincial Bark Beetle Management Technical Guidelines, available for reference at: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/bark_beetle_management_technical_guidelines.pdf

CRANBROOK TSA FOREST HEALTH STRATEGY 2019

Table 6 - CRANBROOK TSA IBM SUPPRESSION UNIT PROVINCIAL PRIORITY RANKING

BMU	BMU Name	Number of Current Attack	AOS Infested Spots	Ranking of Susceptible Area Remaining	Provincial Priority Ranking	IBM Mod-High Hazard Hectares	IBM 2018 AOS Infested Hectares	Provincial Park	PARK IBM Mod-High Hazard Hectares	PARK IBM 2018 AOS Infested Hectares
C08	Kimberley Watershed	High	Low	High	1	7,233	132.00			
C30	Cranbrook	High	Low	High	1	4,339	47.00			
C12	Cranbrook Watershed	High	Low	High	1	7,952	23.00			
C01	Moyie Lake	Low	Low	High	3	8,889	100.00	Moyie Lake	40	0.00
C02	Perry-Moyie	Low	Low	High	3	7,258	0.00			
C09	Yahk River	Low	Low	High	3	9,400	33.00	Gilnockie	679	0.00
C10	Bloom-Caven	Low	Low	High	3	8,833	17.00			
C11	Teepee Creek	Low	Low	High	3	5,498	52.00			
C13	Galton Range	Low	Low	High	3	3,696	0.00			
C14	Wigwam River	Low	Low	High	3	8,137	41.00			
C15	Lodgepole-Bighorn	Low	Low	High	3	4,017	40.00			
C16	West Flathead	Low	Low	High	3	8,964	0.25			
C17	Upper Flathead	Low	Low	High	3	6,325	0.00			
C18	East Flathead	Low	Low	High	3	11,436	0.00	Akamina-Kishinena	651	0.00
C19	Corbin Creek	Low	Low	High	3	2,408	0.00			
C20	Alexander-Line	Low	Low	High	3	2,029	0.00	Crowsnest		
C23	West Elk	Low	Low	High	3	4,597	0.00			
C24	Lower Elk	Low	Low	High	3	3,872	0.00	Mount Fernie Elk Valley Morrissey	-	0.00
C26	Iron-Sulphur	Low	Low	High	3	6,799	0.00			
C27	Upper Bull	Low	Low	High	3	5,636	16.00			
C28	Galbraith-Dibble	Low	Low	High	3	5,089	0.00	Top Of The World	-	0.00
C31	Lost Dog	Low	Low	High	3	6,897	67.00			
C34	Jaffray-Baynes Lake	Low	Low	High	3	4,162	0.00	Kikomun Creek	41	0.00
C36	Mayook-Wardner	Low	Low	High	3	3,415	54.00			
TOTALS						150,629	639.25			

CRANBROOK TSA FOREST HEALTH STRATEGY 2019

Table 7 - CRANBROOK TSA IBS SUPPRESSION UNIT PROVINCIAL PRIORITY RANKING

BMU	BMU Name	Number of Current Attack	AOS Infested Spots	Ranking of Susceptible Area Remaining	Provincial Priority Ranking	IBS Mod-High Hazard Hectares	IBS 2018 AOS Infested Hectares	Provincial Park	PARK IBS Mod-High Hazard Hectares	PARK IBS 2018 AOS Infested Hectares
C02	Perry	Low	Low	High	3	2336	0.00			
C24	Lower Elk	Low	Low	High	3	2267	0.00			
C04	Hellroaring	Low	Low	High	3	2237	0.00			
C06	Upper St Mary	Low	Low	High	3	1924	0.00	Purcell Wilderness	68	14.00
C16	West Flathead	Low	Low	High	3	1907	0.00			
C17	Upper Flathead	Low	Low	High	3	1907	0.00			
C18	East Flathead	Low	Low	High	3	1549	0.00	Akamina-Kishinena	428	0.00
C09	Yahk River	Low	Low	High	3	1423	0.00			
C08	Kimberley Watershed	Low	Low	High	3	1315	0.00			
C05	Redding	Low	Low	High	3	1222	0.00			
C11	Teepee	Low	Low	High	3	1050	0.00			
C25	Sand Creek	High	High	High	4	1069	0.00			
C27	Upper Bull	Low	Low	Low	8	1971	0.00			
C26	Iron-Sulphur	Low	Low	Low	8	923	0.00			
C14	Wigwam	Low	Low	Low	8	918	0.00			
C21	Fording	Low	Low	Low	8	903	19.70			
C38	East Elk	Low	Low	Low	8	102	17.80			
TOTALS						25,022	37.50			

Table 8 - CRANBROOK TSA IBD SUPPRESSION UNIT PROVINCIAL PRIORITY RANKING

BMU	BMU Name	Number of Current Attack	AOS Infested Spots	Ranking of Susceptible Area Remaining	Provincial Priority Ranking	IBD Mod-High Hazard Hectares	IBD 2018 AOS Infested Hectares	Provincial Park	PARK IBD Mod-High Hazard Hectares	PARK IBD 2018 AOS Infested Hectares
C37	Linklater	Low	Low	High	1	3044	57.70			
C13	Galtons	Low	Low	High	1	2932	112.40			
C33	Wasa	Low	Low	High	1	2794	0.00	Wasa	23	0.00
C15	Lodgepole	Low	Low	High	1	2150	11.60			
C30	Cranbrook Watershed	Low	Low	High	1	1968	13.80			
C36	Mayook	Low	Low	High	1	1667	78.10			
C10	Bloom	Low	Low	High	1	1301	8.50			
C23	West Elk	Low	Low	High	1	1000	0.50			
C34	Jaffray	Low	Low	Low	8	996	36.90			
C08	Kimberley Watershed	Low	Low	Low	8	408	0.25			
C11	Teepee	Low	Low	Low	8	185	25.50			
C12	Cranbrook Watershed	Low	Low	Low	8	83	0.00			
TOTALS						19,822	345.25			

11.2 PROPOSED ACTIVITIES AND BUDGET FOR SINGLE TREE TREATMENT

All single tree treatments are to be carried out in Suppression BMUs only. Activities will be led by the Rocky Mountain Natural Resource District Forest Health Specialist and/or Regional Forest Entomologist in a collaborative management effort between licensees, First Nations, stakeholders, private land holders and other concerned government agencies. Other management efforts that will form an integral part of an effective beetle management program will include timely sanitation harvest of current attack, as well as larger block removal of infested or high risk stands.

Proposed single tree treatment activities in the Cranbrook TSA for 2013/14 include:

1. Detailed aerial surveys of all red attack identified in the MFLNRO Aerial Overview Surveys, including inoperable stands.
2. Ground surveys of detailed survey sites, and moderate to high susceptible stands in areas where risk of spread is identified as high.
3. Funnel Trap Monitoring and Mortality Surveys.
4. Lethal Funnel Trap baiting for Douglas Fir Beetle
5. Single Tree Disposal (Fall and Burn or Fall and Peel)
6. Overwintering mortality assessments
7. Pheromone Baiting for anti-aggregation in high value stands, or for mop-up following single tree disposal.
8. Tracking of treatment activities, and annual update of the TSA Forest Health Strategy.

The budget request detailed in the following tables identifies intended treatment activities and funding requests based on best estimates using historic survey and treatment data, and local knowledge. As a result, the following Table 9 will be utilised as a starting point and revision will occur periodically during the course of program delivery: when funding allocations are assigned, as updated survey data becomes available, and when ongoing assessments of management strategy targets are conducted. Implementation of treatments is subject to funding, as allocated by FLNRD's Resource Stewardship Division.

Table 9 - CRANBROOK TSA 2019/20 PROPOSED BUDGET FOR BARK BEETLE MANAGEMENT

ACTIVITY	IBM		IBD/IBS		TOTAL	TOTAL \$
Detailed Aerial Surveys Hectares	98,902	\$20,030.80	155,152	\$31,423.11	254,054 Ha	\$51,453.91
Ground Survey Hectares	89	\$19,231.34	132	\$36,714.37	221 Ha	\$55,945.71
Funnel Trapping Sites	0	0	34	\$38,716.77	34 Sites	\$38,716.77
Trap Trees	0	0	330	\$106,762.11	330 Trees	\$106,762.11
Fall and Burn Trees	1217	\$170,216.56	122	\$40,691.98	122 Trees	\$210,908.54
TOTAL		\$209,478.70		\$254,308.34		\$463,787.04

11.0 REFERENCES

Ministry of Forests, Lands, Natural Resource Operations and Rural Development Provincial Bark Beetle Management Technical Implementation Guidelines <http://www.for.gov.bc.ca/hfp/health/fhdata/bbstrategy.htm>

British Columbia Ministry of Forests, Lands Natural Resource Operations and Rural Development. TSA Forest Health Strategy Template <http://www.for.gov.bc.ca/hfp/health/fhdata/template.htm>

Wildfire Service Wildfire History Reports <http://bcwildfire.ca/History/firelocations.htm>

Henigman, J., Ebata, T., Allen, E., Westfall, J., and Pollard, A. 2001. Field Guide to Forest Damage in BC. Joint Publication Number 17. Canadian Forest Service and BC Ministry of Forests.