Williams Lake Timber Supply Area
Forest Health Strategy
2022/2023

BRITISH COLUMBIA
Ministry of Forests

Endorsed By:

Harold Stolar, RFT
District Manager
Cariboo-Chilcotin Natural Resource District

Prepared by: Nicole Dolighan, RPF

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Foreword

The purpose of the Williams Lake TSA Forest Health Strategy 2022/2023 is to promote cooperative forest management between operational planners, First Nations, reviewing agencies, and approval authorities of forest health risks, issues, and best management practices.

Updates of Note 2022/2023:

- Beetle Management Unit Maps with Corresponding Strategies.
    - All strategies will be updated in 2023 to follow new provincial guidelines and definitions.
    - BMU shapes are found here: 2022-2023 BMU Shapes
- Priority of *Forest Health Factors in the Williams Lake TSA (Table 2)*.
- The 2022/2023 Aerial Overview Flight dataset was not yet available for this updated Forest Health Strategy but will be made available once completed.
- The BC Government Forest Health website has been updated and can be accessed here: BC Government Forest Health Website
- Root Disease guidebook 2018 is available here: Managing Root Disease in BC

Forest Health Factors to note for the coming field season are:

- The Cariboo experienced low wildfire activity during the 2022 fire season with a total of 228 wildfires in the Cariboo Fire Centre, totalling 788 hectares burned.
- Douglas-fir beetle (IBD) – Total area affected by IBD reduced from 41,575 ha in 2021 to 12,333 ha in 2022.
    - IBD flight was late in the spring due to cold April and May.
    - Wood borer presence has been noted in IBD attacked trees, areas with green Douglas-fir blowdown, and surrounding wildfire perimeters.
- Drought – 2022 was once again one of the driest summers on record in the district, and it is anticipated that more drought stress and mortality will become evident throughout 2023. There is also a potential for secondary insects to be attracted to stressed tress, causing further mortality.
    - Continued bark beetle mitigation strategies on all harvest activities is crucial to maintaining IBD populations below epidemic levels.
- Western spruce budworm – Levels of defoliation observed in the Pablo Creek/Sheep Creek area of the Fraser River Valley have decreased over the past year, most likely due to late spring weather events, predators, and parasites.
    - Egg mass sampling was conducted in the fall of 2022 with areas of predicted moderate to high potential defoliation the following summer are recommended for a BtK treatment program in 2023.

- Western hemlock looper – 2021 spray program around Quesnel Lake was conducted. Preliminary results showcase a positive result from the treatments.
- Flooding – No major flooding events occurred in 2022 in the Cariboo, however, past events remain evident with some tree mortality and stress.

For more information on pests and diseases in the Williams Lake TSA review the 2021 Overview of Forest Health Conditions in British Columbia

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1. Introduction

This strategy recommends actions to address forest health issues in the Williams Lake Timber Supply Area (WLTSA) also known as the Cariboo-Chilcotin Natural Resource District. It is one of the largest Timber Supply Areas (TSAs) in the province, covering approximately 4.93 million hectares. There are three general landscape types: the Chilcotin Plateau, the central portion of the TSA and the eastern portion of the TSA. The Chilcotin Plateau, located west of the Fraser River, is characterized by a drier climate with extensive lodgepole pine forests and some Douglas-fir. The central portion of the TSA, located both east and west of the Fraser River, has mixed-species forests primarily Douglas-fir and lodgepole pine as well as a large portion of dry-belt Douglas-fir stands. The eastern portion of the TSA increases in elevation and moisture to forests of spruce, pine, western redcedar, western hemlock and subalpine fir.

The intent of this document is to provide guidance and information to operational planners, First Nations, reviewing agencies and approval authorities on forest health risks, issues and best management practices. It outlines the current status of forest health factors and key strategies and actions to minimize losses from damaging agents. The objective is to enhance ecosystem health by improving forest resiliency and sustainability. By providing acceptable approaches to forest health management this document attempts to simplify the planning and approval process for forest health treatments.

2. Guiding Principles

The WLTSA strategy and Forest Professionals[1] are to be consistent with all relevant legislation and planning guidance including:

- Chief Forester guidance in the Williams Lake TSA Rational for Allowable Annual Cut (AAC) Determination (February 25, 2015);
- Chief Forester Post –Natural Disturbance Forest Retention Guidance (2017 Wildfires)
- Regional Manager Post-Wildfire Salvage guidance to Licensees
- Cariboo Region Delegated Decision Makers Post-Wildfire Salvage Expectations for Land Use Designations in Cariboo Region
- Chief Forester Guidance on Landscape- and Stand-level Structural Retention in Large-Scale Mountain Pine Beetle Salvage Operations (December 2005); and
- Cariboo-Chilcotin Land Use Plan (CCLUP), Government Actions Regulation (GAR) Orders pertaining to Ungulate Winter Range (#U-5-001, U-5-002 and U-5-003),

[1] Forest Professionals are Registered Professional Foresters, Registered Forest Technologists, Special Permit and Limited License Holders, Accredited Timber Cruisers, Accredited Timber Evaluators and Silvicultural Accredited Surveyors. Forest professionals ensure that the forests are managed sustainably. (http://abcfp.ca/)

and associated strategies;
Order for Shallow/Moderate Snowpack MDWRs
Order for Transition/Deep Snowpack MDWRs

- Mule Deer Winter Range exemptions for wildfire impacted stands
- CCLUP Regional Biodiversity Conservation Strategy and Updates;

3. Forest Health Objectives

- Identify beetle management strategies for each Beetle Management Unit (BMU). The 2022/2023 BMU strategy maps are found in Appendix 2. No changes were made to IBM and IBS strategies for 2022-2023. *All strategies will be updated in 2023 to reflect new Provincial standards and definitions.*
- Provide updated strategic guidance for the ongoing forest health management in the WLTSA.
- Identify treatment strategies for forest health management.
- Facilitate co-operative planning between First Nations, multidisciplinary government branches, and licensees.
- Establish short- and long-term harvest guidelines to best address opportunities, given the current pest incidences and infestation levels.
- Focus on proactive forest resiliency through various partnerships.
- Facilitate the development of scientifically and ecologically sound operational plans and practices.
- In conjunction with the various licensees and MoF, identify areas of responsibility for beetle management. This includes where there may be opportunities for Indigenous Nations and small tenure holders to assist in salvage/suppression efforts.

4. Roles and Responsibilities

- Licensees, First Nations, and MoF will collaboratively undertake implementation of this strategy primarily through the WLTSA Forest Health Committee.
- Meetings of this committee will be held on an as-needed basis to discuss the implementation and effectiveness of this strategy. An outline of meeting topics, dates and actions are shown in Table 1.
- Bark beetle treatment planning (detailed aerial surveys, probing, pheromone placement, single tree removal/disposal, trap tree placement/removal and larger scale treatments such as sanitation harvesting) is a continuous process involving the collaborative effort of licensees, First Nations, and MoF in WLTSA Forest Health Committee.

Table 1: Implementation schedule for Forest Health meetings

Topic	Meeting Dates	Actions
Planning	June - October	• Aerial overview and detailed flight information • Updated BMU strategies and boundaries • Identify areas of responsibility and planned activities based on infestation levels and company capacity • Communicate proactive/reactive forest health resiliency projects planned in the district • MoF report on IBD treatments and monitoring evaluations
Implementation	August - March	• Discussion of planned and implemented beetle treatments, proactive management, and collaborative projects • Update on spruce budworm treatments of the previous year (if applicable), and egg mass sampling and treatment strategy • WLTSA Forest Health Strategy in draft
Monitoring & Evaluation	January – June	• Licensee summary submission of Douglas-fir beetle treatment type and location • Evaluation of treatments and monitoring results with recommendations for future planning • Update on western spruce budworm treatment plans and target areas • Final version of WLTSA Forest Health Strategy endorsed and released

5. Priority Forest Health Factors in the WLTSA

The priority status of forest health agents is derived from the MoF annual aerial overview survey, from regional forest health specialists, district and branch forest health staff, and reports from licensees.

Within the WLTSA pest species are prioritised according to:

- distribution of pest and current incidence levels,
- available susceptible host species,

- landscape level hazard and risk information,
- known or suspected impacts on forest resource values,
- impact to the timber harvest land base,
- availability of operational detection and treatment methods, and
- costs and benefits of applying detailed detection and treatment activities.

Table 2: Priority of the Forest Health Factors within the WLTSA

High	Moderate	Low
Douglas-fir Beetle	Armillaria Root Disease	Western Balsam Bark Beetle
Western Spruce Budworm	Tomentosus Root Disease	Forest Tent Caterpillar
Spruce Beetle	Laminated Root Disease	Aspen Serpentine Leaf Miner
Gypsy Moth	Western Gall Rust	Black Army Cutworm
Douglas-fir Tussock Moth	Comandra Blister Rust	Lodgepole Pine Terminal Weevil
Wildfire	Lodgepole Pine Dwarf Mistletoe	Warren Root Collar Weevil
	Post-wildfire Damage	Stalactiform Blister Rust
	Elytroderma Needle Cast	Atropellis Canker
	White Pine Weevil	Lophodermella Needle Cast
	Two Year Cycle Budworm	Pine Needle Sheathminer
	Drought Damage	Flood Damage
	Windthrow	Bear Damage
	Mountain Pine Beetle	Winter Desiccation
	Western Hemlock Looper	Balsam Woolly Adelgid

6. Forest Health Factors and Management Directions

Table 3 highlights a comparison of the major Forest Health Factors (FHF) in the Williams Lake TSA as recorded in the Aerial Overview Survey from 2020-2022.

Table 3. Comparison of FHF from the 2020-2022 AOS Surveys.

Forest Health Factor (FHF)	2020 (Total Area)	2021 (Total Area)	2022 (Total Area)
IBB – Western balsam bark beetle	49,835.76	44,824.15	24,613.13
IBD – Douglas-fir bark beetle	57,081.89	41,574.53	12,333.51
IBM – Mountain pine bark beetle	38,715.54	35,530.48	32,918.22
IBS – Spruce bark beetle	11,984.51	10,498.56	2,447.47
ID6 – Aspen leaf miner	8,656.03	69,990.45	10,385.32
IDL – Western hemlock looper	25,407.94	10,074.26	1,984.91
IDT – Douglas-fir tussock moth	27.98	394.09	68.32
IDW – Western spruce budworm	10,273.61	36,349.49	72,571.21
NB - Fire	99.06	26,881.27	0
NF - Flooding	7,006.67	3,432.12	1,724.46

The most notable changes are the reduced beetle populations from 2020 to present, however, Mountain pine bark beetle (IBM) continues to remain relatively static. Western spruce budworm (IDW) continues to increase substantially, emphasizing the need for further forest management initiatives.

Definitions

The following definitions, from the *Provincial Bark Beetle Management Technical Implementation Guidelines, Spring 2003*, are used for the purposes of this document. A new Provincial Bark Beetle Management Technical Guide is currently being developed.

Bark Beetles

The goal of bark beetle management is to minimize the spread of bark beetles and the loss of crown timber and to protect non-timber resource values. The bark beetle hazard maps were updated in 2019 for the WLTSA.

Beetle Management Unit (BMU): is a planning and reporting unit for operational beetle management. Its purpose is to facilitate the implementation of beetle management activities. BMUs have been established by the District with input from First Nations and licensees to prioritize bark beetle management at the landscape level.

Beetle Management Strategies: The following are strategies that may be employed within BMUs. An assigned strategy is based on the level of outbreak in an area and the estimated effectiveness of selected treatments in achieving stated objectives. These

strategies have been updated to replace the previous BMU classifications (Suppression/Holding/Salvage/Monitor), and will be implemented in 2023.

Proactive: The use of proactive management tactics and is applied where beetle populations are in the endemic population phase. The key goal of the Proactive strategy is to prevent beetle populations from expanding to unmanageable levels.

Targeted: The use of aggressive pest reduction tactics on beetle populations that are in the incipient population phase and is applied where pest populations are building but can still be effectively reduced before more widespread infestation occurs.

Reactive: The use of tactics in response to pest populations that are in the epidemic population phase. The goal of the Reactive strategy is to reduce and mitigate widespread bark beetle-caused host tree mortality.

Salvage: Focus on the harvesting of mostly dead or dying trees and stands to minimize timber value losses in widespread infestations and is applied where management efforts would be ineffective in reducing beetle populations and subsequent levels of damage. The Salvage strategy is most suited for beetle populations that are nearing the end of the epidemic phase or in the post-epidemic phase. The goal is to recover timber value, to regenerate impacted areas and to reduce fire risk to promote future resilient forests.

No Action: The No Action strategy is applied to designated areas where:

- Natural disturbances are left unmanaged
- Management efforts would be ineffective in substantially reducing beetle populations and impacts
- There is no short-term possibility of salvaging dead timber
- Access cannot be put in place before substantial merchantable degradation of the dead material (economically constrained areas)
- Non-timber values or other management constraints such as wilderness areas, Parks or ecological reserves, culturally significant areas, supersedes that of timber or wood products

Areas designated as no action should be large enough to allow for the full range of ecosystem processes through time.

Douglas-fir Beetle (IBD) *Dendroctonus pseudotsugae*

Douglas-fir beetle is causing significant damage to forests in the WLTSA and is currently at outbreak levels. During outbreaks Douglas-fir beetle can kill large numbers of healthy trees over extensive areas. Outbreaks can alter ungulate winter range (MDWR), affect the preservation of Old Growth Management Areas (OGMAs), watershed management,

recreation, and aesthetic values. Areas with increased beetle activity include Meldrum Creek, Mackin Creek, Dog Creek, and Chimney Lake.

It is also worth noting that Wildfire Risk Reduction projects predominately occur within the Interior Douglas-fir (IDF) biogeoclimatic zones within the Cariboo-Chilcotin District, resulting in more open forest stands. These openings can create windthrow, therefore monitoring sites post-harvest activities is important for early detection of Douglas-fir beetle.

An important mandate within the Ministry of Forests is the reintroduction of prescribed and cultural burning on the landscape. The majority of these burns occur in fire-maintained ecosystems such as open grasslands, and Douglas-fir forest types. Post-burn monitoring of these sites is important to ensure scorched trees do not increase Douglas-fir beetle populations.

Detailed helicopter-GPS surveys are conducted annually in heavily IBD impacted areas of the WLTSA that are good candidates for operational treatments. This bark beetle survey provides accurate GPS coordinates of infestation points and polygons of spatially continuous infestations. Due to the survey timing, current green attack was not yet detectable in the 2022 detailed flight.

Stand management for Douglas-fir beetle:

- Follow Best Practices for Managing Douglas-fir Beetle:
  - Introduction and Biology
  - Management Strategies and Tactics
  - Landscape and Stand Level Planning
  - Douglas-fir Beetle and Wildfire
- Sanitation harvest activities within constrained areas (OGMAs, RRZs, etc…) must be consistent with the CCLUP and applicable Update Notes. These are ecologically sensitive areas and it is imperative that any activity in these areas is consistent with current biodiversity guidance and special care and attention is given to harvesting practices.

WLTSA Strategy: "Suppression" for some Douglas-fir dominated areas (see Appendix 2 for specifics), and "Salvage" for other non-currently infested areas.
Note: these strategies will be updated to reflect new BMU classifications.

Spruce Beetle (IBS) *Dendroctonus rufipennis*

Spruce stands are generally located in moist to wet ecosystems which result in faster decay and a short "shelf-life" of one to three years. Many spruce-leading stands have a high site index and if these stands are not harvested and re-forested promptly it could result in significant long-term losses in productivity. High site index stands should be

prioritized for salvage of dead trees and suppression of infestation centres with an aim to balance forest health and mid-term timber supply. Wind felled spruce is an excellent habitat for spruce beetles and blowdown centres should be carefully monitored to ensure populations are dealt with before they start increasing and attacking standing healthy spruce.

Spruce beetle is difficult to detect in overview surveys but they are still a useful tool in identifying general trends in beetle population levels. Attack declined in 2018, with most areas classified as trace or light. The areas to watch are Quesnel Lake and Horsefly Lake in the east, and Big Creek and Churn Creek in the south.

Although infestations appear to be declining, spruce beetle continues to be a species of great concern due to its chronic spread, the difficulty distinguishing between green and red attack, and the short "shelf-life" due to ecotypes where the beetle is located. The main treatments for spruce beetle are trap tree deployment and salvage harvest. It is important to note that spruce beetles overwinter in stumps or the duff when present in standing trees. Therefore, it is critical to include trap trees pre- and post-harvest in conjunction with sanitation harvest. Poor access, steep ground, and other economic challenges have led to very little harvesting of infested spruce.

WLTSA Strategy: "Monitor" for the majority of the WLTSA and "Holding" for some areas (see Appendix 2 for specifics).
Note: these strategies will be updated to reflect new BMU classifications.

Mountain Pine Beetle (IBM) *Dendroctonus ponderosae*

In the AAC Rationale for Williams Lake TSA the Chief Forester directs licensees "to continue to focus harvesting as much as possible on mountain pine beetle-impacted pine-leading stands in the Williams Lake TSA; and to harvest no more than their share of the AAC partition attributable to live tree volume." This strategy should be followed while managing current and future forest values in context of sustainability. Mountain pine beetle has been identified in areas of the southwestern portion of the Williams Lake TSA, specifically surrounding Ts'il?os Park.

Overall Objective: Salvage affected pine stands in a manner that will:

- maximize the economic value obtained from the killed trees,
- extend the salvage term (i.e. harvest those stands with the most dead wood), and
- expedite the restoration of impacted stands to the harvesting land base.

High Priority for Salvage (Unconstrained Landbase)

- Stands with at least 70 percent pine with high percentages of beetle-infested or killed stems
- Stands located west of the Fraser River

- Low volume stands (<100 cubic metres/ha)
- Pure pine stands with little or no advanced regeneration (especially high site index) to expedite stand recovery. (i.e. Ideal candidate areas for stand rehabilitation)
- Areas where shelf-life is considered short (i.e. wetter BEC zones)

Moderate Priority Salvage (Unconstrained Landbase):

- Areas where shelf-life is considered short
- >50% Pine by Volume
- >30% beetle attack (Red green and grey combined)
- High/Moderate Susceptibility

Low Priority Salvage (Unconstrained and constrained areas)

- Mixed Stands (< 50% pine)
- Maximize harvest of infested pine through selective harvest.
- Prescriptions should target pine removal rather than clearcut, where residual stands can be maintained in a wind firm condition to target the maximum volume of infested pine and to encourage natural regeneration of non-pine (climax) species especially where advanced regen exists in understory. Where more than one beetle species has infested mixed stand, then the rational should be explicit.
- OGMA's, MDWR's, Riparian and other constrained areas in accordance with higher level plan guidelines, Land Use Orders and GAR orders.
- High amount of advanced regeneration
- Stands with suitable secondary structure (see Appendix 4 for definition)

The following table provides guidance to the placement of salvage areas on the landbase. It serves as guidance for salvage planning, but other values as listed above, should also be considered and rationalized in harvesting proposals.

Table 4: Priority for pine salvage based on stand characteristics and level of beetle kill (Modified from McLennan 2003) (Eng 2004).

	Percentage of pine killed (Green, Red and Grey attack)				
Percentage of stand volume that is pine	<30%	30-50%	51-70%	>70% West of the Fraser River	>70% East of the Fraser River
<30%	No	No	No	No	No
30-50%	No	No	No	Low	Low
51-70%	Low	Low	Low	High	Moderate
>70%	Low	Moderate	Moderate	High	Moderate

WLTSA Strategy: All BMUs within the WLTSA have been identified as "salvage" strategy (Appendix 2) for Mountain Pine Beetle

Western Balsam Bark Beetle (IBB) *Dryocetes confusus*

Stand management for western balsam bark beetle:

- To prevent high in-stand losses from IBB, manage to younger ages (i.e. harvest at 80 yrs) once >100 yrs very susceptible to attack.
- Monitor blowdown in stands particularly around edges.
- Trap trees can be used for IBB (much the same as for spruce beetle, Douglas-fir beetle) – although the timing is not as well know (fall vs. spring felling).
- Stands can be baited prior to harvest to contain as many beetles in the proposed block as possible.
- Stands should be hazard rated and managed (planned for harvest & regeneration) based upon:
    - species (>50% Bl)
    - age (older stands higher risk)
    - BEC – ESSF highest hazard in that most Bl is found in this ecosystem but Bl in the MS & SBS is very susceptible to attack because it is drought stressed more frequently and thus becomes easier to attack.
    - The ESSFdv and ESSFxc are highest hazard, followed by ESSFwc, mw, cv and dc.
    - elevation
    - current and past beetle attack

WLTSA Strategy: "Monitor" with no treatments planned.
Note: these strategies will be updated to reflect new BMU classifications.

Defoliators

Defoliators, such as the western spruce budworm and 2-year cycle budworm, impact all age classes of their preferred hosts and can substantially impact growth and productivity and wood quality. Severe defoliation by these insects can result in mortality, especially in younger age classes, and have negative impacts on other stewardship values on the land base (e.g., ungulate ranges).

Western Spruce Budworm (IDW) *Choristoneura freemani*

Severe defoliation of mature stands does not typically result in mortality in the first year but stresses the trees reducing wood quality and quantity and may predispose Douglas-fir to attack by Douglas-fir beetle. When a mature stand is infested, understory mortality can be very significant. As a result of this understory mortality and Douglas-fir beetle mortality NSR stands are created.

Ministry of Forests conducts aerial treatments using *Bacillus thuringiensis* var. *kurstaki* (B.t.k.) in areas of predicted moderate to severe defoliation by western spruce budworm. Detailed monitoring is conducted each year to determine population dynamics. Egg mass sampling occurs September to October to determine if threshold

values are met to initiate a treatment program. Bud mining surveys are then conducted the following spring to estimate population levels and timing of Btk applications. Further collaboration between District leads and Region staff is needed to identify infestation areas that could be selected for proactive forest management tools such as spacing or thinning treatments for long term forest resiliency.

This pest is of high significance as it not only has the potential to cause mortality after four or more years of repeated defoliation, and growth loss in the current growing stock, but also stresses the trees, potentially increasing future vulnerability to bark beetle attack and furthering potential losses to mid-term timber supply.

Silviculture strategies:

- Plant higher densities to increase resilience in stands decreasing the overall susceptibility to severe and sustained western spruce budworm defoliation events.
- Thin dense understories to remove early instar food source

WLTSA Strategy: Identify areas for revitalization projects in conjunction with an aerial spray program. A combination of permanent sample areas as well as supplemental sample areas are monitored in order to track larval development, predict populations levels, and tree defoliation.

Spongy Moth (IDM) *Lymantria dispar*

Spongy moth is an invasive non-native species which has not become established in the WLTSA. This insect defoliates deciduous trees and has over 300 known hosts. Introduction to an area could occur from recreational and other vehicles traveling in or from infested areas carrying pupae or eggs. No known cases of spongy moth within the WLTSA has occurred in the last 5 years.

WLTSA Strategy: Monitor using a trapping program in conjunction with District and Regional staff and the CFIA. Early detection of this defoliator is critical for eradication treatments.

Douglas-fir Tussock Moth (IDT) *Orgyia pseudotsugata*

Douglas-fir tussock moth has the potential to cause significant mortality; although, top-kill, growth reduction, and secondary insects and fungal attacks may also occur. All ages of Douglas-fir are susceptible. Outbreaks typically occur every 10- 12 years and can last around 4 years.

The outbreak in 2019 was significant as it is the furthest north that IDT has ever been recorded. This outbreak is centered in the Fraser River valley, near the community of Dog Creek.

WLTSA Strategy: Monitor in conjunction with an aerial treatment program. Detailed monitoring through annual trap deployment at the identified sites is ongoing to track larval development, populations levels, and tree defoliation.

Two Year Cycle Budworm (IDB) *Choristoneura biennis*.

In the interior wet belt two-year cycle budworm defoliates true firs and spruce species during "on" years (in the WLTSA this occurs during even years). This pest has the potential to create significant damage in the eastern portion of the WLTSA, with infestations covering over a million hectares recorded for the Cariboo during previous outbreaks. Potentially, plantations could suffer significant damage from this insect, and severe defoliation may predispose trees to attack by western balsam bark beetle or spruce beetle.

WLTSA Strategy: Monitor with no treatments planned.

Western Hemlock Looper (IDL) *Lambdina fiscellaria lugubrosa*

The western hemlock looper is a very destructive insect that defoliates western hemlock, western red cedar, Douglas-fir, and spruce species. Tree mortality can occur in the first year of an infestation and populations can remain high for 1 to 4 years. Outbreaks can occur every 6 to 8 years when populations once again build to outbreak levels. Historically outbreaks have been restricted to around Quesnel Lake. The last time populations were high in this TSA was 2020, so would not expect populations to increase again until 2028.
UPDATE: Severe defoliation was observed around Quesnel and Horsefly Lakes in 2020. There also was also large number of moths observed around Williams Lake and Dog Creek/Alkali Lake, but with little to no visible defoliation.

WLTSA Strategy: Monitor in conjunction with an aerial spray treatment. Detailed monitoring at the identified sites in order to track larval development, populations levels, and tree defoliation will be conducted.

Forest Tent Caterpillar (IDF) *Malacosoma disstria*

One or more years of severe defoliation may result in top-kill, branch mortality, reduced radial growth and if the infestation persists, occasional mortality. Many of the infested stands are also infested with aspen serpentine leaf miner.

WLTSA Strategy: Monitor with no treatments planned.

Aspen Serpentine Leaf Miner (ID6) *Phyllocnistis populiella*

Leaf miners tunnel between the epidermal layer of the leaf, reducing the leaf's photosynthetic capacity. Outbreaks of this insect are common in western North America. Short (1 or 2 year) outbreaks do not normally have major long-term impacts on tree growth; however, this insect has been active for several years in areas around the Williams Lake TSA. The majority of sites affected in 2018 were classified as moderate to severe.

WLTSA Strategy: Monitor with no treatments planned.

Black Army Cutworm (IDA) *Actebia fennica*

In the absence of herbaceous plants and shrubs black army cutworm (IDA) will defoliate coniferous seedlings. Monitoring of IDA took place in 2018 due to the large area affected by wildfires in 2017. Populations were found to be low, but planting sites that are devoid of all vegetation should be avoided for 1-2 years after the wildfire.
BAC Management:

- Identify high risk sites:
    - Burned openings, south or west facing slopes are preferred for egg laying
    - Severe burns decreases natural vegetation which leads to higher risk of plantation defoliation
    - ESSF, MS, SBS, ICH, and IDF
    - Drought-prone sites
- Delay planting for 1 – 2 years post-fire event
- Avoid spring planting
- Survey for IDA damage on natural vegetation in the spring
- Pheromone monitoring

WLTSA Strategy: Monitor with no treatments planned.

Pine Needle Sheathminer (IDI) *Zelleria haimbachi*

The pine needle sheathminer generally attacks juvenile to immature pine stands. Up to 100% of the new growth may be destroyed resulting in growth reduction.

WLTSA Strategy: Monitor with no treatments planned.

Balsam Woolly Adelgid (IAB) *Adelges piceae*

Balsam woolly adelgid generally attacks all true firs, subalpine fir being the most susceptible and amabilis and grand fir being less susceptible. Damage includes swelling and distortion at buds and leader resulting in stunted growth, poor timber quality and tree death. This species was also introduced from Europe.

During a survey conducted in 2017 to determine the spread of IAB northward in BC, light infestation of IAB was found along the Horsefly River.
There is no large-scale treatment that can feasibly be employed for mature stands.

WLTSA Strategy: Monitor with no treatments planned.

Weevils

White Pine Weevil (IWS) (*Pissodes strobi)*: Priority = Moderate
Lodgepole Pine terminal Weevil (IWP) (Pissodes terminalis): Priority = Low
Warren's Root Collar Weevil (IWW) (*Hylobius warren)*: Priority =Low

White pine weevil and lodgepole pine terminal weevil can cause significant forking damage in young stands. Most of the mortality occurs in the first 10 years. The ICH and parts of the SBSdw1 are at high risk for white pine weevil. Warren Root Collar weevil can cause scattered mortality in young stands.

Silviculture strategies:

- Plant alternate species or species mixes.
- Leave non-target species; for example do not brush aspen.
- Plant higher densities.
- Plant genetically resistant stock for terminal weevil.

WLTSA Strategy: Monitor individual affected stands.

Diseases

Root Diseases
The old FPC Root Disease Guidebook (1996) has been updated to a new guidance document called "Managing Root Disease in British Columbia". The updated and revised root disease website is also now available.

Armillaria Root Disease (DRA) *Armillaria ostoyae*

Armillaria root disease causes mortality in a wide range of conifers and deciduous trees and increases the susceptibility of infected trees to bark beetles and other pests.

Douglas-fir, true firs, and spruce are highly susceptible to Armillaria root disease, western hemlock exhibits medium to high susceptibility, pines are moderately susceptible, and western red cedar and deciduous species have a lower susceptibility. Western larch also appears to be less susceptible to Armillaria after age twenty to forty.

Preharvest assessments for Armillaria root disease should be conducted as part of the site plan in all south facing ICH and SBSdw1 subzones and where root disease has been identified as part of the SP walkthrough in other subzones. South facing low elevation aspects within the SBSdw1 and ICH have the greatest hazard, such as areas around Horsefly Lake and Quesnel Lake. These root diseases are absent or extremely rare on the Chilcotin Plateau east of Tatlayoko Lake. Some helicopter and ground traversed root rot shapefiles are available on the FTP Government Site.

Management Strategies for Armillaria includes planting a mixture of less susceptible species or stumping where appropriate (refer to root disease management guidebook). Default stocking standards are not appropriate for root rot areas.

Tomentosus Root Disease (DRT) *Inonotus tomentosus*

Spruce is the primary host for Tomentosus root disease, with lodgepole pine exhibiting medium susceptibility. Infection can occur via spores, or from root to root contact between trees and stumps. Tomentosus root disease often goes undetected and can cause considerable growth loss in mature spruce stands. Tomentosus is high hazard in the drier SBS subzones and ICH. The presence of Tomentosus is easily determined by looking for advanced honeycomb decay in blowdown prior to harvest. Where spruce is prescribed for planting in stands to be harvested with a significant spruce component, a post-harvest stump assessment is recommended to identify the extent and location of Tomentosus within the stand.

Management strategies include avoidance planting and regenerating with a species other than spruce.

Laminated Root Rot (DRL) *Inonotus sulphurascens*

Laminated root rot is primarily a disease of Douglas-fir. It is most prevalent on warm south facing slopes in the ICH and SBSdw1. It forms discrete root rot centres or openings with associated windthrown and dead standing trees. Windthrown trees generally fall in random directions, have characteristic root balls, and laminar decay. Conduct preharvest assessments for laminated and armillaria root disease as part of the silviculture prescription in all ICH and SBS subzones and where root disease identified as part of the SP walkthrough in other subzones. Some helicopter and ground traversed root rot shapefiles are available on the RSM ftp site. South facing low elevation aspects

within the SBSdw1 and ICH have the greatest hazard. These root diseases are absent or extremely rare on the Chilcotin Plateau east of Tatlayoko Lake.

Management Strategies for Laminated include planting a mixture of less susceptible species (pines and cedar) or stumping where appropriate (refer to root disease management guidebook).

Root Rot silviculture Strategy:

- Free growing assessments should be conducted after age 12 in high hazard root rot BEC zones. Root diseases are difficult to detect before age 12.
- Plant tolerant or resistant species
- Root Rot centres are more easily identified and mapped before harvest

Stem Rusts of Pine

Comandra Blister Rust (DSC) *Cronartium comandrae*
Stalactiform Blister Rust (DSS) *Cronartium coleosporioides*
Western Gall Rust (DSG) *Endocronartium harknessii*

DSS, DSC, and DSG all occur within the WLTSA. These pests are particularly important in young pine stands (<25 years of age). Comandra and stalactiform rust can only infect lodgepole pine from spores produced on the alternate host plant. These spores are typically only transmitted over short distances. The frequency of alternate plant hosts present on a site is likely an important risk factor for the Cronartium stem rusts. Western gall rust is the most common forest health factor affecting young lodgepole pine stands and does not require an alternate host.

<u>WLTSA Silviculture strategy:</u>

- Where pine is a preferred species, minimum stocking should be increased to 2000sph to offset mortality due to rust.
- Plant alternate species where possible to minimize the risk of losses.
- Before considering spacing it is important to conduct pest surveys and to consider the impact of forest pests on final stocking levels. Delay free growing assessment to after 15 years in high hazard stands. Contact your regional forest specialist for hazard maps based on RESULTS data.

Atropellis Canker (DSA) *Atropellis piniphila*

Produces cankers with abundant sap on the main stem. Unlike dwarf mistletoe or stem rusts these cankers are not associated with squirrel feeding. Most infections occur on bark at 14-40 years of age. Infections much more common in high density pine stands

and on the north side of the stem. When spacing pine stands older than 14 years old, space from north to south to aid in selection of disease-free trees.

WLTSA Strategy: Manage to an appropriate stocking level to reduce the likelihood of infection and carefully assess stands before undertaking pre-commercial spacing operations.

Dwarf Mistletoe

Lodgepole Pine Dwarf Mistletoe (DMP) *Arceuthobium americanum*
Priority = Moderate

There are high incidences of lodgepole pine dwarf mistletoe in the SBPSxc where lodgepole pine is the only preferred species. The disease is caused by a parasitic plant and spread occurs from infected residual trees. Removal of all infected residual stems over 2m is the best way of reducing future infection. Preliminary modelling suggests that sanitation down to 0.5m may not be necessary if stands are being managed on short rotations. Lodgepole pine dwarf mistletoe hazard within the SBPSxc and IDFdk3 is very high. Refer to the new Land Management Handbook 73 for additional management information. Pre harvest stratification of blocks to identify post-harvest sanitation treatment areas is recommended.

WLTSA Harvest Systems Strategy:

- Minimize the amount of dwarf mistletoe infected edges when laying out cut blocks and make use of natural barriers whenever possible (e.g. roads, non lodgepole pine timber type, water bodies, etc.).
- Avoid leaving wildlife tree patches and leave strips infected with dwarf mistletoe within or adjacent to the block whenever possible especially along road right of ways.
- Stands or portions of stands which are infested should be treated following harvest by removal of all residual lodgepole pine over 2m in height. Residuals will generally have dwarf mistletoe plants unless they were shaded prior to harvesting. On average it takes four years between infection and the first appearance of plants.

Needle Casts

Elytroderma Needle Cast (DFE) *Elytroderma deformans*

Elytroderma needle cast is easily recognized and well documented on Ponderosa pine but often goes misdiagnosed on Lodgepole pine. It is unique from other foliage disease in its ability to infect and persist in shoots where it can cause severe stunting and

brooming. Elytroderma displays similar symptoms to Lophodermella but it can be distinguished by the fruiting bodies and stunting that it causes. Elytroderma is widespread in the IDF and SBPS, with wet low-lying areas adjacent to swamps or lakes generally having a higher incidence. Mean Impact on stand volume in the IDFdk3 has been estimated to be 2% by age 40. Elytroderma causes irregular stem growth and large upturned branches that result in large, elongated knots and reduced lumber quality even in trees with low disease severity. Conversion of mixed Fd/Pl stands to Pl plantations is not recommended within the IDFdk because of the impacts of this disease. Where clearcutting is practiced in mixed IDF forest types, maintain a component of Douglas-fir residuals and include Douglas-fir in the planting mix. An assessment for Elytroderma is recommended before spacing in lodgepole pine stands (especially in repressed pine stands).

WLTSA Silviculture Strategy:

- Increase regeneration densities to 2000sph offset potential losses and damage from Elytroderma.
- Manage for alternate species where appropriate for the site especially in low lying areas adjacent to riparian areas.
- Dwarf mistletoe sanitation treatments can effectively remove infected advanced regen.
- Avoid using planting stock from higher elevations or drier locations than the area to be planted.

Lophodermella Needle Cast (DFL) *Lophodrmella concolor*

When conditions are optimal (wet springs and summers), needle cast can infect large tracts of pine forest, particularly plantations. The long-term impact of this foliar disease is not completely understood, although permanent sample plots in affected plantations show significant growth reduction and mortality. This agent should be closely monitored, mapped, and the impact on plantations carefully recorded (esp. in the IDF & SBPS). Conditions were optimal in 2018 for high intensity infections in 2020.

WLTSA Strategy: Plant a diversity of species at the stand and landscape level

Dothistroma Needle Blight (DFS) *Dothistroma septosporum*

Dothistrom as a needle blight of pines that affects all ages of needles, particularly in the lower crown. It causes crown lift and can result in significant growth loss and even mortality when infection occurs in multiple years. Dothistroma is considered high hazard on lodgepole pine in the ICH, particularly in low lying areas adjacent to riparian areas. Limit the planting of lodgepole pine in the ICH except where needed to reduce the spread of root disease.

WLTSA Strategy: Avoid planting lodgepole pine in the ICH except where needed to reduce the spread of root disease

Abiotic Injuries

Wildfire Damage and Post-Wildfire Mortality

The 2017 wildfires were the most extensive on record in BC's history with the Cariboo Region being the most severely impacted. These large wildfire affected areas impact social, economic and environmental factors which all must be considered when determining a treatment for an area.
Post-wildfire mortality as a result of the 2017 wildfires should have peaked in 2018.

WLTSA Strategy: The following Provincial guidelines are provided for land managers to determine best practices when managing post-disturbance forests.

- Chief Forester Post –Natural Disturbance Forest Retention Guidance (2017 Wildfires)
- Regional Manager Post-Wildfire Salvage guidance to Licensees
- Cariboo Region Delegated Decision Makers Post-Wildfire Salvage Expectations for Land Use Designations in Cariboo Region
- Best Practices for Managing Douglas-fir Beetle - Douglas-fir Beetle and Wildfire
- Mule Deer Winter Range exemptions for wildfire impacted stands

Drought Damage

We are experiencing more frequent and unpredictable summers in terms of dry, hot conditions. The 2021 heat spell resulted in some of the hottest days ever recorded in the district, and 2022 had high temperatures for sustained days throughout August. It is anticipated that more drought stress and mortality will become evident throughout 2023. Major heat stress has been observed through discolouration of needles, and extensive dropping of needles throughout the late summer and fall months.

There is also a potential for secondary insects to be attracted to drought stressed trees and cause further mortality. Sites mapped for drought should be monitored closely and if located in suppression zones subject to ground checks.

WLTSA Strategy: Monitor closely for Douglas-fir beetle in impacted mature Douglas-fir stands. Plant drought resistant species. Minimize soil compaction resulting from harvesting activities and avoid harvesting areas with shallow soils. Avoid redirecting historical water flows as a consequence of road or ditch construction.

Windthrow

The occurrence of windthrow can contribute to the maintenance and build-up of local spruce and Douglas-fir beetle populations.

Windthrow patches of Douglas-fir and spruce should be addressed promptly to minimize the expansion of beetle populations. It may be appropriate in some areas to leave blown-down trees on the ground until after the beetle flight and utilize them as trap trees. Windthrown trees should be removed prior to the beetle flight of the following year so that attacked blowdown does not contribute to increases in beetle attack.

WLTSA Strategy: Allow windthrow to act as trap trees through summer and harvest before April 1st to prevent bark beetle population build-up. Alternative strategies are to use MCH, trap trees and/or fall and burn.

Flooding Damage

Flooding was extensive in 2019, 2020 and 2021. Sites mapped for flooding should be monitored closely when they are detected because the trees become stressed making them more susceptible to bark beetle infestations. Areas of flooding should therefore be subject to ground checks if they are located in suppression zones.

WLTSA Strategy: Strategies are to use MCH, trap trees or fall and burn to combat associated IBD infestations.

Bear Damage

This damage has been occurring in lodgepole pine plantations in the eastern Cariboo and has been ongoing for several years.

WLTSA Strategy: No treatments planned at this time.

7. Bark Beetle Management

The Aerial Overview Survey (AOS) is conducted annually over 80-90% of the province provides a way to track changes in various visible forest health agents. The graphs in Appendix 1 are based on AOS data from 1999-2022 showing the total area impacted by each bark beetle.

Follow guidance provided by Best Practices for Managing Douglas-fir Beetle:

- Introduction and Biology

- Management Strategies and Tactics
- Landscape and Stand Level Planning
- Douglas-fir Beetle and Wildfire

Bark beetle hazard maps identify stands that are highly susceptible to bark beetle because of their stand characteristics.
Detailed survey data from 2022 is available through the FTP site. The overview aerial survey data for 2021 is linked, with the 2022 data to be sent out as soon as it is available.

Mule Deer Winter Range (MDWR) and Bark Beetles
Follow Government Actions Regulation (GAR) orders pertaining to ungulate winter range (#U-5-001, U-5-002, and U-5003):

- Ungulate Winter Ranges Cariboo Chilcotin Land Use Plan, Shallow and Moderate Snowpack
- Ungulate Winter Ranges Cariboo Chilcotin Land Use Plan, Transition and Deep Snowpack

  - Use existing access only.
  - Trees selected for trap trees should be ones that would be harvested in a regular MDWR entry
  - Trap trees should not be located on ridge lines or topographic breaks.
  - Trap trees should be mark-to-cut and fallers should be instructed clearly as to what the goals are and should be supervised appropriately.
  - Trap tree sites must be accurately mapped with trees removed prior to next beetle flight without damage to the surrounding stand.
  - Trap tree sites in MDWRs would be followed up with a second treatment (eg., trap trees, anti-aggregation pheromone baiting (MCH))
  - All infested Douglas-fir trees, stumps, and debris associated with sanitation harvest must be treated and/or removed from the site prior to beetle flight.

Old Growth Management Areas (OGMAs) and Bark Beetles
In many areas, OGMAs contain the only representation of old forests in a landscape/BEC zone. The qualities present in the OGMAs (large, old trees) are also attractive for bark beetles. To minimize the impact on OGMAs the following precautions will be taken:

- Be consistent with the Land Use Objectives for the Cariboo-Chilcotin Land Use Plan, Biodiversity Updates, and approved Forest Stewardship Plans (FSPs).
- Identify OGMAs of major concern for annual bark beetle monitoring
- Susceptible stands outside OGMAs will aid in prioritizing OGMA treatments
- Where infestations occur inside OGMAs, if appropriate, locate an intensive trap tree program outside the boundary to draw beetles out of the OGMA

- Consider using MCH on Douglas-fir where it could be of benefit to protect healthy stands inside OGMAs which may be provided and/or placed by MoF
- All infested Douglas-fir trees, stumps, and debris associated with sanitation harvest must be treated and/or removed from the site prior to beetle flight.

8. Non-Recoverable Losses

Non-recoverable losses account for the average volume lost each year due to natural causes, such as pests, fire and wind, that are not recovered or salvaged. The WLTSA Rationale for AAC Determination assumed a total of 149,553 cubic metres per year. Since this time a new tool for estimating NRL has been developed using the provincial aerial overview survey data. The salvage areas are netted out of the mapped mortality resulting in a rough estimate of unsalvaged volumes. This spreadsheet is posted on the FTP site at https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/NRLs/ The most recent NRL estimates for the WLTSA are provided in Table 4.

Table 5: Summary of estimated non-recoverable losses (unsalvaged) by damaging agent 2009-2019

Year	Douglas-fir beetle (m3/yr)	Drought (m3/yr)	Fire (m3/yr)	Flood (m3/yr)	Mountain Pine Beetle (m3/yr)	Spruce beetle (m3/yr)	Western Balsam Bark Beetle (m3/yr)	Total (m3/yr)
2009	60,160	0	514,717	0	1,506,064	87,598	208	2,168,747
2010	4,416	0	557,308	124	135,053	122,556	9,74	819,540
2011	5,799	0	944	297	35,835	10,933	2,299	56,107
2012	25,238	0	6,888	6,136	30,346	85,204	9,813	163,625
2013	2,602	0	1,283	4,593	8,368	17,536	2,116	36,498
2014	34,531	36	7,266	6,812	5,746	1,950	3,426	59,768
2015	36,200	21,123	39,082	1,490	7,462	4,274	615	110,246
2016	121,996	7,915	1,332	1,821	20,615	18,884	5,647	178,210
2017	169,823	0	2,866,697	388	18,761	36,488	2,609	3,094,766
2018	91,476	1,076	173,832	3,698	19,483	1,447	8,151	299,163
2019	36,268	6,410	0	2,060	12,686	3,492	1,819	62,735

9. Reducing the Impacts of Climate Change

There is a growing body of evidence that global climate change has contributed to increased incidence and severity of several forest health factors (Woods et al., 2010). Therefore, adapting natural resource management to climate change is necessary to ensure forests are productive and ecosystems are resilient.

The Cariboo Region Extension Note on Adapting Natural Resource Management to Climate Change includes climate change projections; projected impacts of climate change to ecosystems; and adaptation strategies for natural resource management.

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

The choice of silviculture strategies and/or harvesting systems can be an important consideration in establishing a healthy future stand. These strategies need to be considered in the context of integrated resource management.

Some silvicultural strategies and harvesting systems are listed below to help minimize the impact from forest pests and mitigate the risks associated with climate change:

- Treat the site prior to planting. For obligate parasites that have short distance spread (dwarf mistletoes) or site specific pests (some root rots), site treatment such as sanitation spacing or stumping can be an effective method of reducing losses from disease.
- Planting within two years of slash burning may increase the risk of black army cut worm or Rhizina root disease in certain areas.
- Before considering spacing it is important to conduct pest surveys and to consider the impact of forest pests on final stocking levels. In some instances, it is preferable to delay spacing until the final impact of forest pests can be more accurately assessed.
- The Ministry of Forests has modified their seed transfer standards to climate based seed transfer to mitigate the impacts of climate change.
- Partial harvest systems are generally not recommended in stands with root disease or dwarf mistletoe but may be beneficial for regenerating well stocked stands with greater structural and species diversity and may provide some mitigation against growing season frosts and other weather events.

10. Key TSR Issues

In February 2015 a new Annual Allowable Cut Determination for the WLTSA was published. In this document MoF staff, other agencies and licensees (as appropriate) are directed by the Chief Forester to undertake or support specific tasks and studies. The key tasks and studies that relate to this strategy are noted below. These projects are important to help reduce the risk and uncertainty associated with factors that affect the timber supply in the Williams Lake TSA.

Short-term considerations:

1. Licensees are to continue to focus harvesting as much as possible on mountain pine beetle-impacted pine-leading stands in the Williams Lake TSA; and to harvest no more than their share of the AAC partition attributable to live tree volume.
2. District staff are to monitor the following and report semi-annually to the chief forester:
    a. harvest performance within MPB-killed pine-leading stands and the volume attributable to live trees within those stands; and
    b. harvest contribution from non-pine leading stands.

Mid-term timber supply considerations:

1. *Low productivity sites*: Staff are to explore opportunities (eg., rehabilitation and bioenergy) for the use of some of the low productivity sites before the next determination
2. *Mule deer winter range*: Staff are to address MDWR issues including meeting minimum basal area targets relative to current or projected stand conditions; incentives for non-clearcut harvesting approaches given higher administrative and planning costs; and addressing poor forest health conditions that may be exacerbated by lack of management before the next determination so that this factor can be better considered. There is also a need for a standard Cariboo region-wide approach to modelling winter range requirements stemming from an order under the Government Actions Regulation.
3. *Douglas-fir stands*: Staff are to explore innovative ways (such as use of LiDAR) to improve the inventory, including growth and yield, of Interior Douglas-fir stands given their contribution to mid-term timber supply.
4. *Wildfire Risk Reduction*: Staff are to explore how WRR projects will be taken into account during the AAC determination if the purpose of these forests is minimal basal area retention.

Other considerations:

1. *Climate change*: Staff are to try and understand projected climate change impacts in the TSA so that this important consideration can be factored into the next determination.

11. Web Links for Resources

Cariboo Region Forest Health Strategies and Data

Guide to identifying Douglas-fir beetle attack from ground assessments
https://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Forest%20Health%20Presentations/Douglas-fir_beetle_signs.pdf

2015 updated Seral Analysis. This analysis is based on the 2015 VRI data.
Report:
ftp://ftp.geobc.gov.bc.ca/publish/Regional/WilliamsLake/forest/seral/seral_2015/report/
Maps:
ftp://ftp.geobc.gov.bc.ca/publish/Regional/WilliamsLake/forest/seral/seral_2015/maps/

Root Rot shape files
https://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Root%20Rot%20Shapefiles/

Biodiversity Committee Updates

Cariboo-Chilcotin Land Use Plan. 2006. An Integrated Strategy for Management of Biodiversity and Bark Beetles in Douglas-fir and Spruce Stands. Update Note #7b.
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/cariboo-region/cariboochilcotin-rlup/update_note_7b.pdf

Land Use Order
Objectives for wildlife tree retention, OGMAs, Critical Fish Habitat, Lakes, Riparian Reserve Zones, Grasslands, High Value Moose Wetlands, and Grizzly Bear.
ftp://ftp.geobc.gov.bc.ca/publish/Regional/WilliamsLake/Cariboo-Chilcotin_LUOR_Order/legal_order_document/CaribooChilcotinLUO_May2011.pdf

MDWR Management Strategies
Management Strategy for Mule Deer Winter Ranges in the Cariboo-Chilcotin Part 1a:
Management Plan for Shallow and Moderate Snowpack Zones. 2007. R.J. Dawson, H.M. Armleder, B. Bings, and D. Peel.

Management Strategy for Mule Deer Winter Ranges in the Cariboo-Chilcotin Part 1b: Management Plan for Transition and Deep Snowpack Zones. 2006. R.J. Dawson, H.M. Armleder, B. Bings, and D. Peel.

General Wildlife Measures

Order for Shallow/Moderate Snowpack MDWRs:
http://www.env.gov.bc.ca/wld/documents/wha/Amendment_ShallowModerate_Feb07_Ord.pdf

Order for Transition/Deep Snowpack MDWRs:
http://www.env.gov.bc.ca/wld/documents/wha/Amendment_TransDeep_Feb07_ord.pdf

Individual MDWR Long-term Objectives Maps, Overview TSA MDWR maps, Snowpack Zones map:
http://www.env.gov.bc.ca/esd/distdata/ecosystems/mdwr/

Information Notes:

Mule Deer Winter Range Strategy Committee. 2014. Regional mule deer winter range strategy. Information Note #1. Guidance for fire damaged stands.

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/cariboo-region/cariboochilcotin-rlup/fire_damaged_stands.pdf

Mule Deer Winter Range Strategy Committee. 2014. Regional mule deer winter range strategy. Information Note #2. Guidance for MDWR General Wildlife Measure Exemption Requests for Salvage of Insect-killed Douglas-fir.

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/cariboo-region/cariboochilcotin-rlup/mule_deer_winter_range_wildfire_exemption_request.pdf

Frost Hazard Guide and Extension Note

Steen, O.A.S., R. Stathers, and R. Coupé. 1990. Identification and management of summer frost prone sites in the Cariboo Forest Region. For. Can. and B.C. Min. For., Victoria, B.C. FRDA Rep. 157. 23 pp.
http://www.for.gov.bc.ca/hfd/pubs/Docs/Frr/Frr157.htm
https://www.for.gov.bc.ca/rsi/research/cextnotes/extnot05.pdf

Ecora Resource Group Ltd. 2012. Drought risk and frost hazard mapping for the Williams Lake TSA. And Frost Hazard Workbook (Excel). (maps available upon request).

https://www.for.gov.bc.ca/ftp/DCC/external/!publish/Frost%20Hazard/Report%20and%20tools/

General Forest Health Information

Provincial Aerial Overview Survey
https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/

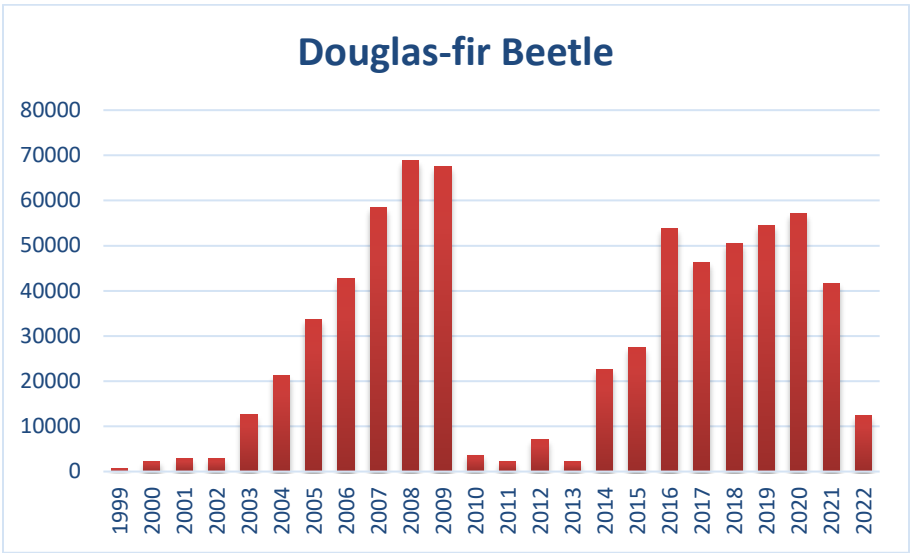
RESULTS Incidence Maps
https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/RESULTS%20incidence%20maps/

12. References

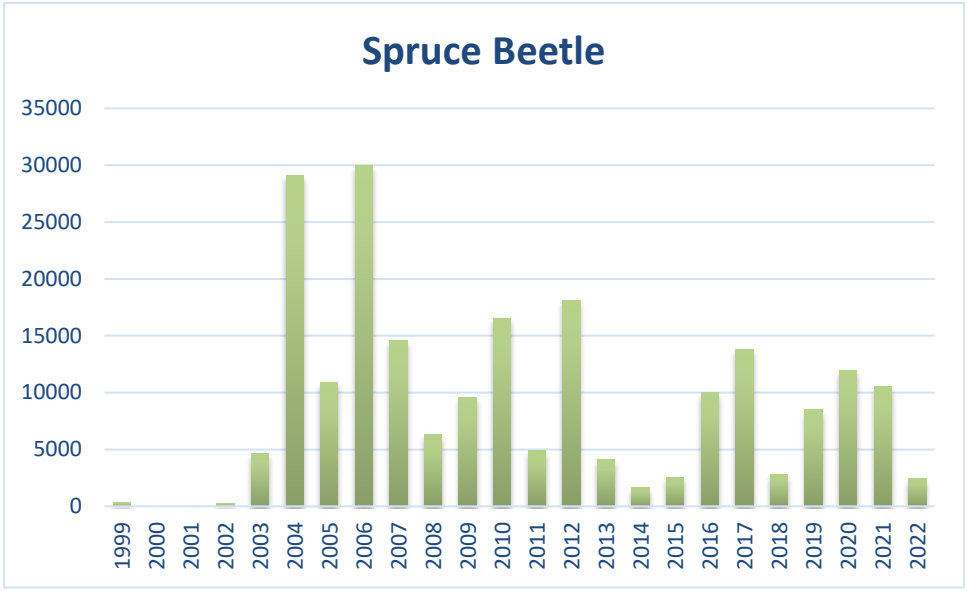
Woods, A.J. et al. 2010. Forest health and climate change: a British Columbia perspective. Forestry Chronicle 86(4): 412-417.

Appendix 1: Bark Beetle Population Trends 1999-2022

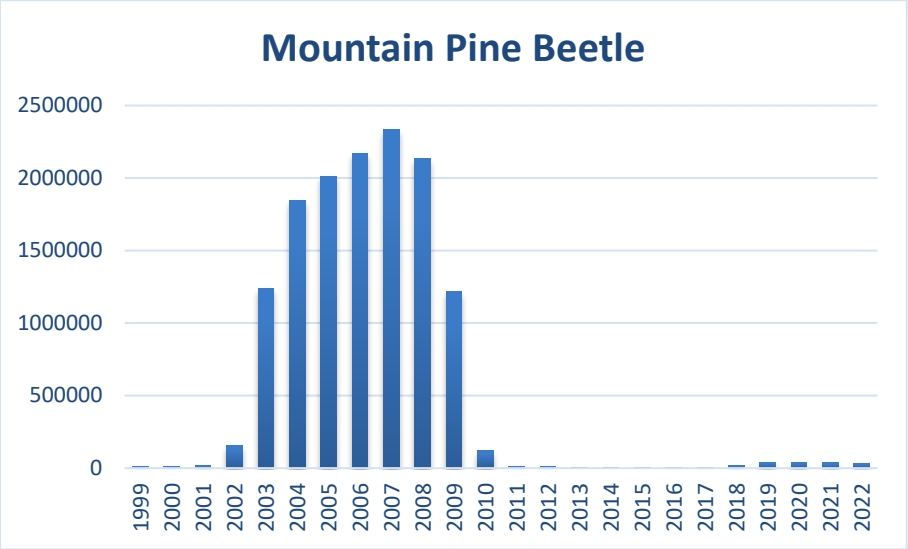
Area affected (ha) by Douglas-fir Beetle: 1999 – 2022



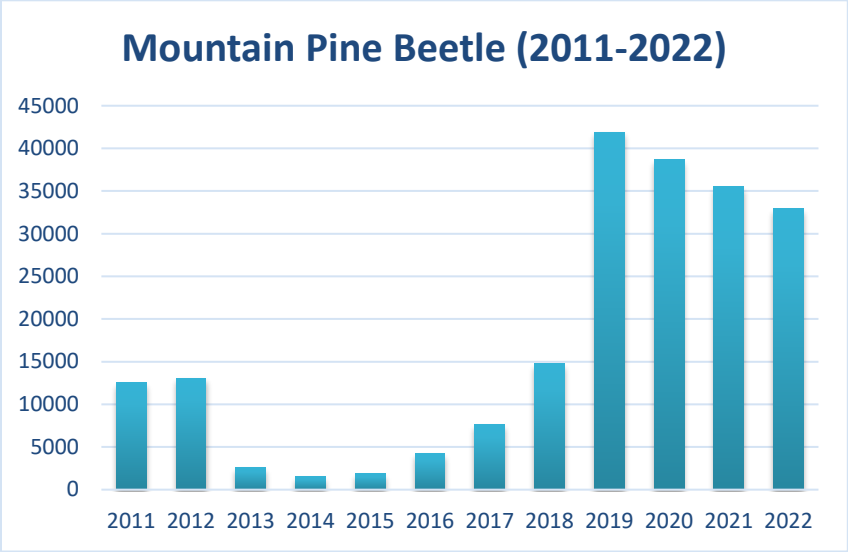
Area (ha) affected by Spruce Beetle: 1999 – 2022



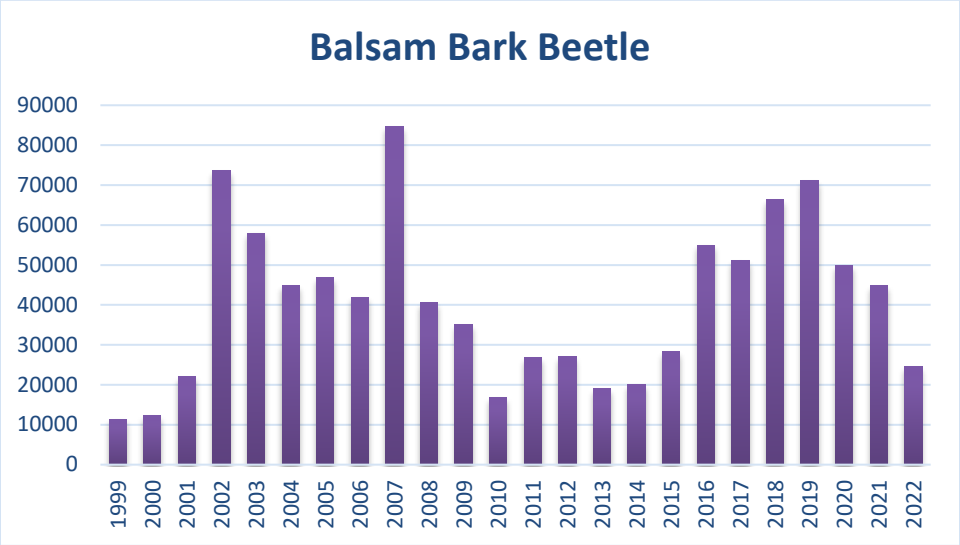
Area (ha) affected by Mountain Pine Beetle: 1999 – 2022



Area (ha) affected by Mountain Pine Beetle: 2011 – 2022

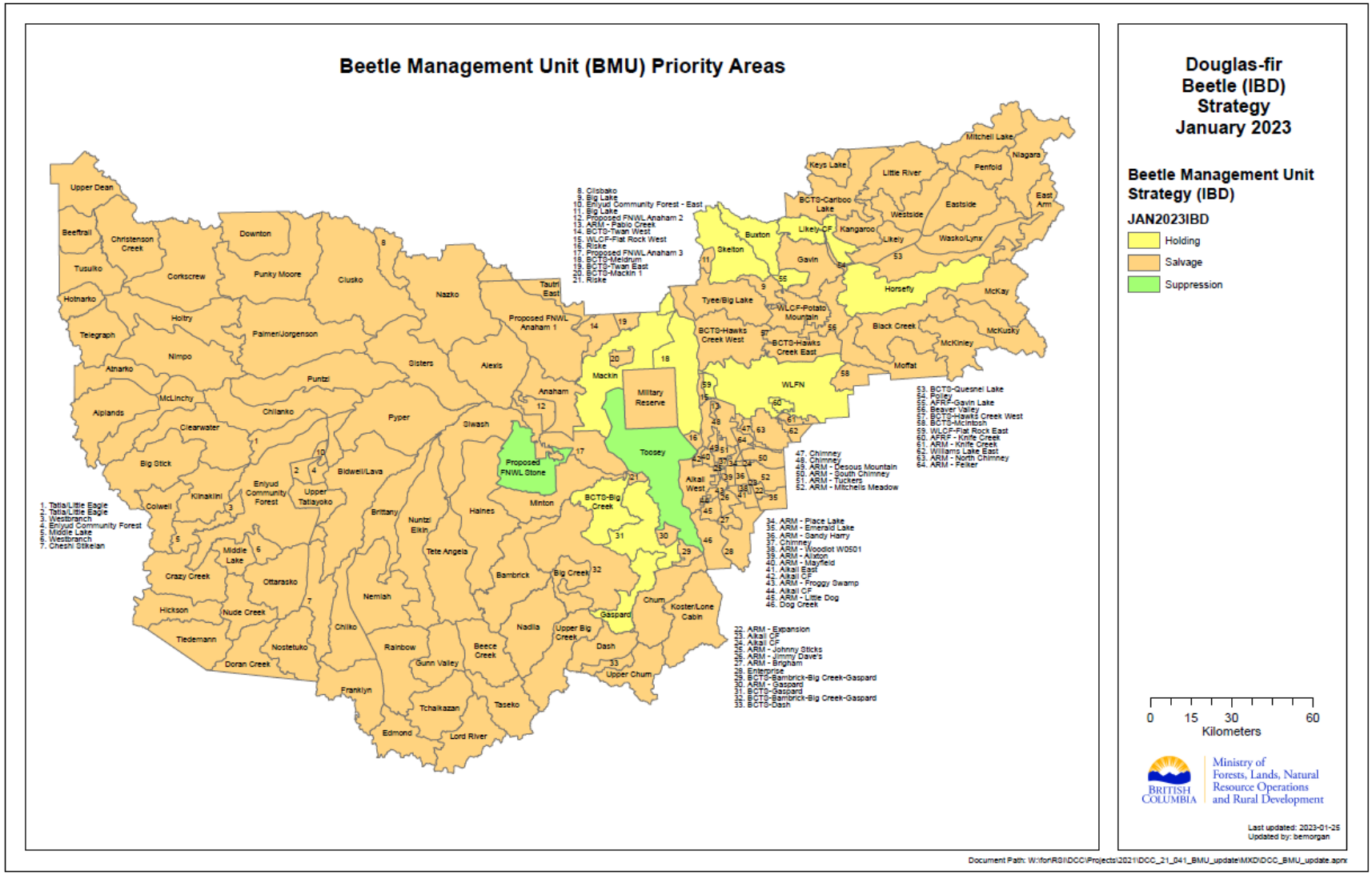


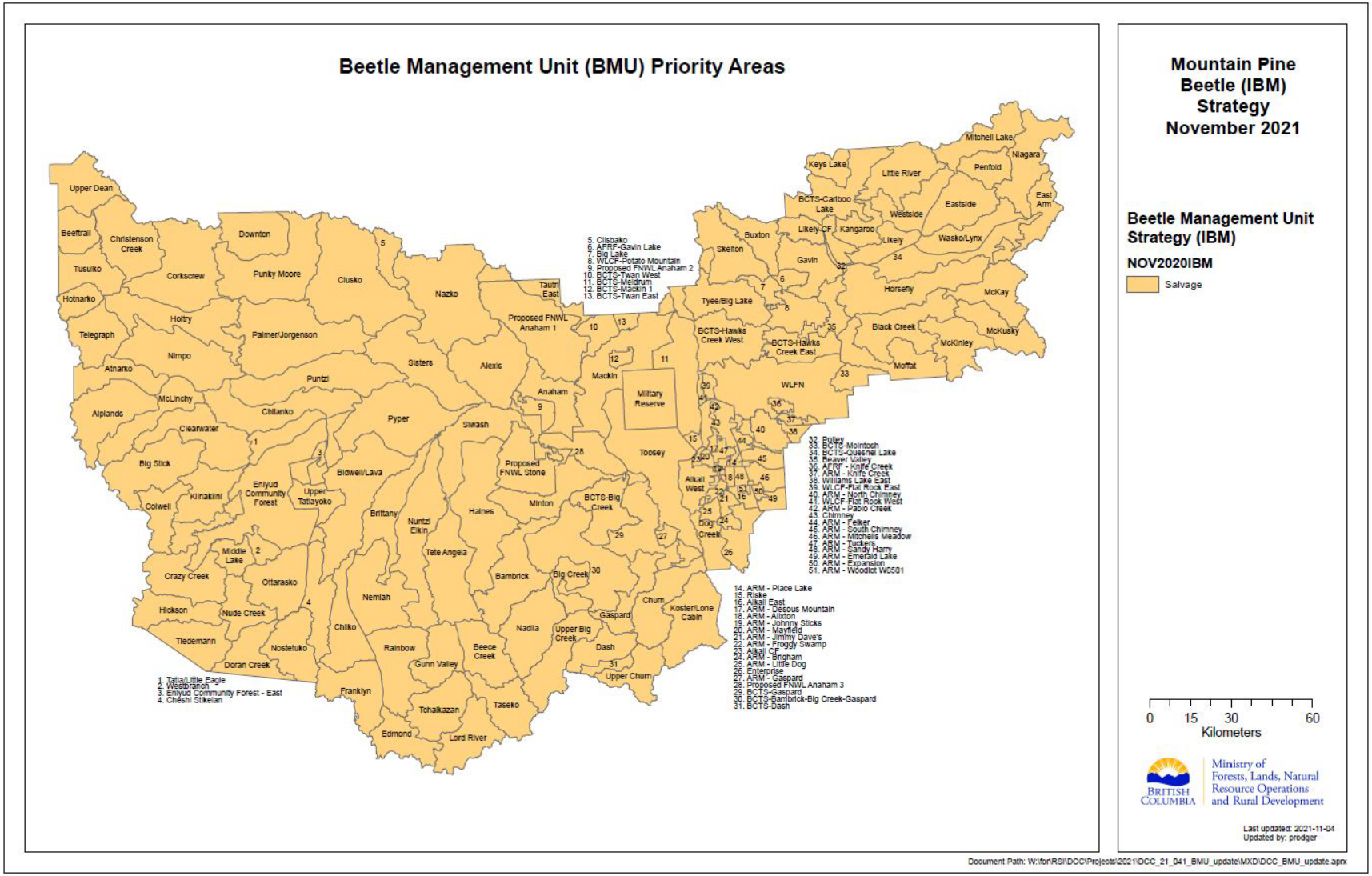
Area (ha) affected by Western Balsam Bark Beetle: 1999 – 2022



Appendix 2:

Beetle Management Units and WLTSA Strategies


Beetle Management Unit (BMU) Priority Areas
Douglas-fir Beetle (IBD) Strategy January 2023
Beetle Management Unit Strategy (IBD)
JAN2023IBD
Holding
Salvage
Suppression
0 15 30 60
Kilometers
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
BRITISH COLUMBIA
Last updated: 2023-01-25
Updated by: bemorgan
Document Path: W:\for\RSI\DCC\Projects\2021\DCC_21_041_BMU_update\MXD\DCC_BMU_update.aprx


Beetle Management Unit (BMU) Priority Areas
Upper Dean
Beetrail
Christenson Creek
Tusulko
Hotnarko
Telegraph
Atnarko
Aiplands
Big Stick
Colwell
Crazy Creek
Hickson
Tiedemann
Doran Creek
Nostetuko
Corkscrew
Holtry
Nimpo
McLinchy
Clearwater
Kilnaklini
Middle Lake
Ottarasko
Nude Creek
Downton
Punky Moore
Palmer/Jorgenson
Puntzi
Chilanko
Enlyud Community Forest
Upper Tatlayoko
Bidwell/Lava
Clusko
Pyper
Sisters
Nazko
Alexis
Siwash
Brittany
Nuntzi Elkin
Haines
Tete Angela
Nemiah
Chilko
Rainbow
Gunn Valley
Franklyn
Tchaikazan
Edmond
Lord River
Taseko
Beece Creek
Nadila
Bambrick
Minton
Proposed FNWL Stone
Proposed FNWL Anaham 1
Tautri East
Anaham
Mackin
Military Reserve
Toosey
BCTS-Big Creek
Big Creek
Upper Big Creek
Gaspard
Dash
Upper Churn
Churn
Koster/Lone Cabin
Dog Creek
Alkali West
Skelton
Buxton
Tyee/Big Lake
BCTS-Hawks Creek West
BCTS-Hawks Creek East
WLFN
Gavin
Likely CF
Kangaroo
Likely
Westside
Eastside
BCTS-Cariboo Lake
Keys Lake
Little River
Mitchell Lake
Niagara
Penfold
East Arm
Wasko/Lynx
Horsefly
McKay
Black Creek
McKinley
McKusky
Moffat
1. Tatla/Little Eagle
2. Westbranch
3. Enlyud Community Forest - East
4. Chéshi Stikelan
5. Clisbako
6. AFRF-Gavin Lake
7. Big Lake
8. WLCF-Potato Mountain
9. Proposed FNWL Anaham 2
10. BCTS-Twan West
11. BCTS-Meldrum
12. BCTS-Mackin 1
13. BCTS-Twan East
14. ARM - Place Lake
15. Riske
16. Alkali East
17. ARM - Desous Mountain
18. ARM - Alkton
19. ARM - Johnny Sticks
20. ARM - Mayfield
21. ARM - Jimmy Dave's
22. ARM - Froggy Swamp
23. Alkali CF
24. ARM - Brigham
25. ARM - Little Dog
26. Enterprise
27. ARM - Gaspard
28. Proposed FNWL Anaham 3
29. BCTS-Gaspard
30. BCTS-Bambrick-Big Creek-Gaspard
31. BCTS-Dash
32. Polley
33. BCTS-McIntosh
34. BCTS-Quesnel Lake
35. Beaver Valley
36. AFRF - Knife Creek
37. ARM - Knife Creek
38. Williams Lake East
39. WLCF-Flat Rock East
40. ARM - North Chimney
41. WLCF-Flat Rock West
42. ARM - Pablo Creek
43. Chimney
44. ARM - Felker
45. ARM - South Chimney
46. ARM - Mitchells Meadow
47. ARM - Tuckers
48. ARM - Sandy Harry
49. ARM - Emerald Lake
50. ARM - Expansion
51. ARM - Woodlot Wd501
Mountain Pine Beetle (IBM) Strategy November 2021
Beetle Management Unit Strategy (IBM)
NOV2020IBM
Salvage
0 15 30 60
Kilometers
BRITISH COLUMBIA
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Last updated: 2021-11-04
Updated by: prodger
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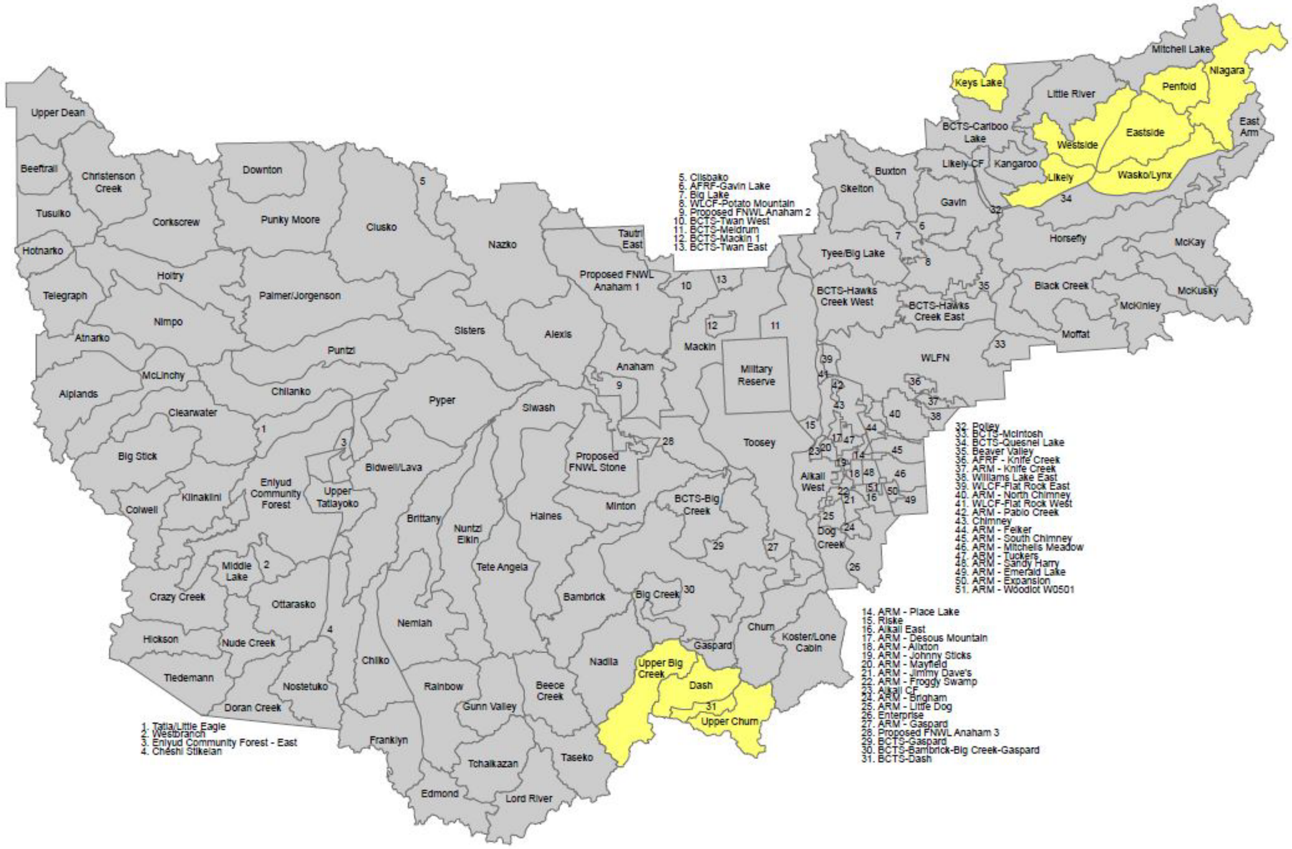
Beetle Management Unit (BMU) Priority Areas


Upper Dean
Beefirail
Christenson Creek
Tusulko
Corkscrew
Downton
Punky Moore
Clusko
Hotnarko
Holtry
Palmer/Jorgenson
Telegraph
Nimpo
Atnarko
Puntzi
Sisters
Nazko
Alexis
Tautri East
Proposed FNWL Anaham 1
Mackin
Anaham
Military Reserve
McLinchy
Alplands
Chilanko
Pyper
Siwash
Clearwater
Big Stick
Enlyud Community Forest
Upper Tatlayoko
Bidwell/Lava
Proposed FNWL Stone
Toosey
Klinaklini
Colwell
Brittany
Nuntzi Elkin
Haines
Minton
BCTS-Big Creek
Tete Angela
Middle Lake
Crazy Creek
Ottarasko
Bambrick
Big Creek
Nemiah
Chum
Koster/Lone Cabin
Hickson
Nude Creek
Chilko
Nadila
Upper Big Creek
Gaspard
Dash
Tiedemann
Nostetuko
Rainbow
Beece Creek
Doran Creek
Gunn Valley
Upper Churn
Franklyn
Taseko
Tchaikazan
Edmond
Lord River
Skelton
Buxton
Tyee/Big Lake
BCTS-Hawks Creek West
BCTS-Hawks Creek East
WLFN
Alkali West
Dog Creek
Keys Lake
BCTS-Cariboo Lake
Likely CF
Kangaroo
Gavin
Little River
Westside
Likely
Eastside
Wasko/Lynx
Penfold
Niagara
Mitchell Lake
East Arm
Horsefly
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47. ARM - Tuckers
48. ARM - Sandy Harry
49. ARM - Emerald Lake
50. ARM - Expansion
51. ARM - Woodlot W0501
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Spruce Beetle (IBS) Strategy December 2021

Beetle Management Unit Strategy (IBS)

NOV2020IBS

- Holding
- Monitor

0 15 30 60
Kilometers

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