Quesnel Natural Resource District
Forest Health Strategy

2024

BRITISH COLUMBIA | Ministry of Forests

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Executive Summary

The purpose of the 2024 Quesnel Natural Resource District Forest Health Strategy is to provide current forest health conditions and risks within the Quesnel District and review information from the Annual Overview Survey (AOS) for forest health factors. It also provides best management practices to meet overarching legislation, regulation, and higher-level plans to incorporate strategies and tactics developed in conjunction with scientific research, local licensees, and First Nations.

This strategy does not account for every forest health factor present in the Quesnel District, it focuses on the health issues that cause the most damage and those with effective management strategies. Practitioners that notice a forest health agent of concern are asked to contact the Quesnel Natural Resource District stewardship staff. This document will be updated as required.

Forest Health Factors to Note for the 2024 Field Season:

- **Drought** associated stress was reported over large areas of the Quesnel Forest District in 2023. Drought stress decreases the health and resiliency of forests and may lead to a sharp increase of bark beetles or other forest health factors in coming years.

- **Douglas-fir beetle** – Based on AOS data, field observation and anecdotal evidence it appears that the populations continue to be low through 2023. Manage proactively for these insects.

- **Spruce Beetle** – There is a decrease in outbreak area compared with 2022. The decrease may be explained partially by the way AOS data is collected (ie, fewer large polygons of "trace" status), an actual decreased bark beetle activity year over year, one-year vs two-year life cycles and climate.

- **Western balsam bark beetle** – outbreaks continue to occur in the Quesnel district. Most activity is concentrated in high elevation forests and is generally lightly dispersed over large areas. It is most common southeast of Wells but is found across the district.

- **Western spruce budworm** (IDW) has been reported along the Fraser River near Margeurite and Castlerock. This represents the northernmost extent of this defoliator. Consider this insect when working in IDF forests or at low elevations.

- **Wood Borers** are increasingly observed in mature Douglas-fir and may be contributing to tree mortality. They are not known to infest healthy vigorous trees.

- **Other forest health factors** such as root diseases, foliar diseases, stem rusts and defoliating insects appear to be exhibiting endemic levels. They are of local concern and where they occur, site specific management is deemed most suitable.

Updates of Note 2024:

- **The Stand Health and Growth Monitoring (SHAGM)** project has been developed by Alex Woods, the research pathologist based in Smithers, as a tool to collect critical information on mid rotation plantations. This is a large data blind spot for BC interior forests, with large implications for improved practices and value monitoring. The SHAGM objective is to collect data on forest health, stand volume, and important FN values over a large sample population using a standardized mid-rotation assessment that can be collected by multiple parties and that can be compared to the current standardized yield projection for stands aged 20-40 years. The intent is to integrate forest health, forest yield and FN value data from the outset and avoid the trap of information silos. This protocol can address the question of which forest health agents are having the greatest current volume impact. It can also provide a snapshot of how well the stand is currently adhering to the expected yield trajectory, considering the forest health agents present. To learn how to become involved with this program reach out to Quesnel district Stewardship staff or your regional forest health specialist.
- A **provincial bark beetle portal** is being created by the provincial director for bark beetle response, Jeane Robert. This portal will give a provincial overview of bark beetle data and response information giving a fantastic resource for bark beetle management in BC. Expect this portal to be live by the end of 2024.
- **Updated Beetle Management Unit Strategies** – new strategies and definitions

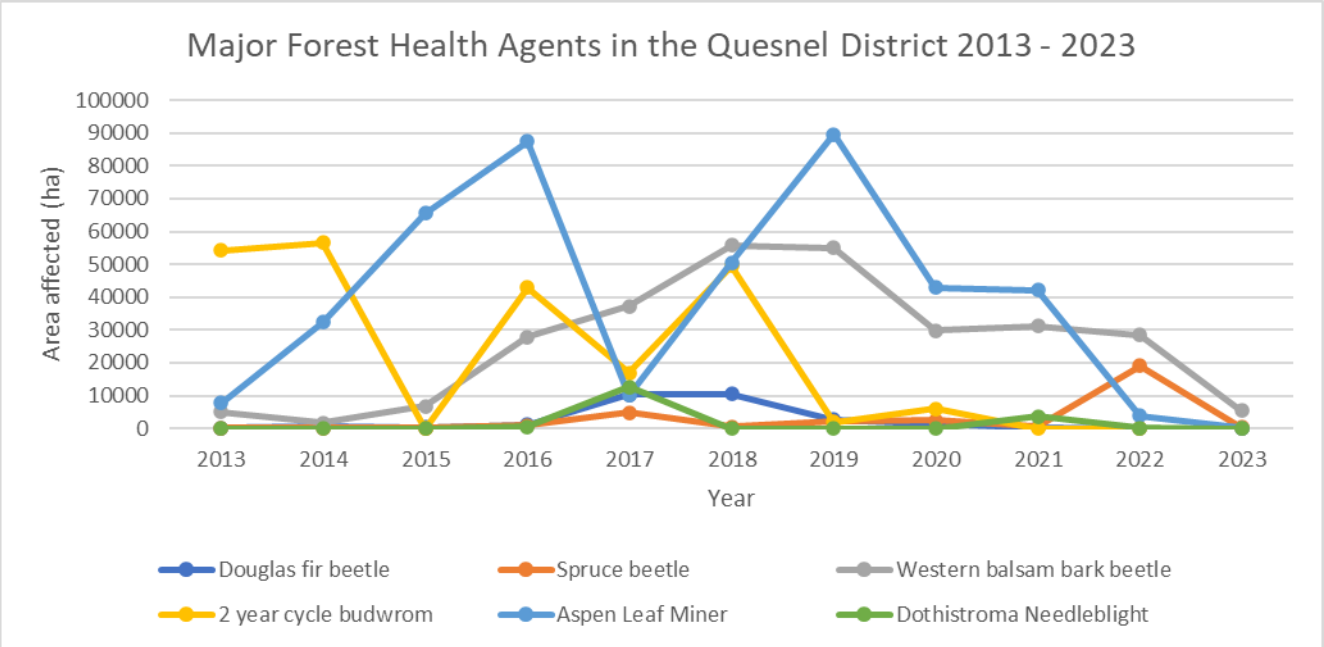

Figure 1. Graph of select forest heath agents in the Quesnel District from 2013 to 2023

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1.0 Introduction

This District Forest Health Strategy was created utilizing the guidance of the Provincial Forest Health Strategic Plan 2023-2026.

The purpose of this document is to outline the vision for forest health stewardship in the district. It also establishes bark beetle management objectives and specific strategies for various forest health factors, and the status and extent of priority forest health agents in the Quesnel district. Its focus is twofold: managing the priority forest health agents of the district and emphasizing the importance of proactive management to improve forest resilience. More details on proactive management as well as other strategies can be found in section 6 of this document.

Although Douglas-fir beetle is present in very low levels coming into 2024, and areas of spruce beetle concern are limited in area, Douglas-fir and spruce beetles continue to be priority forest health agents,. Another forest health agent of note is the western balsam bark beetle. It has a different attack pattern from the other major bark beetle species, being more dispersed both over distance and time which makes it more challenging to manage. It also occurs largely in difficult, constrained high elevation terrain. However, the area affected by this beetle has been on the rise while other beetle species shifted to a more endemic pattern in the last 2-3 years. This beetle may be difficult to manage, but it should receive attention given the large amount of area affected and the elevated rates of mortality.

Useful Links and Information:

- Provincial Forest Health Website (includes links to the various aerial overview surveys, guidebooks, legislation, strategies): https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health
- Windthrow Management Handbook: https://a100.gov.bc.ca/pub/eirs/lookupDocument.do?fromStatic=true&repository=BDP&documentId=13130
- Dwarf Mistletoe Management Guidebook: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/dwarf_mistletoe_management_guidebook.pdf

- Root Disease Guidebook: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/root-disease-docs/rootdiseaseguidebookjune2018_4.pdf
- Root Disease Website: https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/root-diseases
- Frost-Prone Site Identification and Guidance: https://www.for.gov.bc.ca/hfd/pubs/Docs/Frr/FRR157.pdf https://www.for.gov.bc.ca/rsi/research/cextnotes/extnot05.pdf
- Reforesting Dry and Drought-Prone Sites: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/reforesting_dry_sites_in_the_thompson_okanagan_natural_resource_region_brochure_final.pdf

1.1 Natural Resource District Responsibilities and Activities

The Quesnel Natural Resource District Stewardship staff remain the point of contact for forest health concerns and planning. Staff conduct forest health monitoring and treatments both independently and with collaboration from stakeholders and First Nations. Responsibilities of District staff include:

- Acting as a point of contact and facilitator for licensees, First Nations and other stakeholders when coordinating forest health treatments
- Determining and establishing Beetle Management Units (BMUs) in coordination with licensees, First Nations and other stakeholders
- Disseminating regional information such as aerial overview surveys, beetle and other forest health agent mapping, spray programs, etc.
- Acting as subject matter experts for operational forest health and as conduits to access information from other subject matter experts when required

District Stewardship staff work with regional staff to plan detailed overview flights and share forest health information. Stewardship staff also coordinate targeted ground-truthing using the results of overview and detailed flights to determine the extent of the forest health factor and plan follow-up treatments.

Stewardship staff conduct field visits to known or reported locations where forest health agents have become a concern. Through these field visits district staff aim to familiarize themselves with forest health damage in the district and provide better insight for how to manage them in the future.

2.0 Major Forest Health Agents

Bark Beetles

- Douglas-fir beetle (*Dendroctonus pseudotsugae*), IBD
- Spruce beetle (*Dendroctonus rufipennis*), IBS
- Western balsam bark beetle (*Dryocoetes confusus*), IBB

Defoliators

- Two-Year cycle budworm (*Choristoneura biennis*), IDB
- Western spruce budworm *(Choristoneura freemani),* IDW
- Aspen serpentine leafminer (*Phyllocnistis populiella*), ID6

Root Disease

- Armillaria root disease (*Armillaria oystoyae*), DRA
- Tomentosus root disease (*Inonotus tomentosus*), DRT
- Laminated root disease (*Coniferiporia sulphurascens*), DRL

Stem and Branch Diseases

- Lodgepole pine dwarf mistletoe (*Arceuthobium americanum*), DMP
- Western gall rust (*Endocronartium harknessii*), DSG
- Stalactiform blister rust (*Cronartium coleosporioides*), DSS
- Atropellis canker (*Atropellis piniphila*), DSA
- Commandra blister rust (*Cronartium comandrae*), DSC

Weevils

- White pine weevil (*Pissodes strobi*), IWS
- Lodgepole pine terminal weevil (*Pissodes terminalis*), IWP
- Warren's root collar weevil (*Hylobius warreni*), IWW

Foliar Diseases

- Dothistroma needle blight (*Dothistroma septosporum*), DFS
- Elytroderma needle cast (*Elytroderma deformans*), DFE
- Lophodermella needle cast (*Lophodermella concolor*), DFL
- Aspen Poplar leaf and twig blight (*Venturia macularis*), DLV

Abiotic Injuries

- Wildfire, NB
- Aspen decline, NCA
- Drought, ND
- Frost, NG
- Animal damage, A
- Windthrow, NW
- Flooding, NF

3.0 Ranking of Forest Health Factors by Importance

Forest health factors (FHFs) in the Quesnel district are considered to have been at low population levels during 2023, thus rankings for 2024 would be modest and of relatively equal concern. No factors are pre-eminent in the AOS data, therefore, they will be evenly weighed. Until a scenario arises where one FHF is more significant compared to others, no rankings shall be applied. Currently it is more important to assess FHFs on a situational basis (from the stand to landscape level) than on a ranking list applied to a district.

Bark beetles usually receive more focus because of the potential to cause widespread mortality in mature trees over the course of a few seasons, and our ability to apply effective treatments. Because beetle populations in the Quesnel district are relatively light coming in to 2024 there is a good chance to proactively manage bark beetles and apply some attention to other forest health factors.

4.0 Status of Priority Forest Health Agents

The data presented in the sections below is sourced from the Provincial Aerial Overview Survey Reports available here. Important to note is that areas presented include the total of trace, light, moderate, and severe polygons. For better information on the severity of infestation or natural disturbance, refer to the site above.

Due to low populations of most forest health agents in the Quesnel district over 2023, there is no single pathogen or insect of focus for 2024. However, due to the potential for rapid population build up and damage to the forest from the perspectives of multiple values, bark beetles are of primary interest for monitoring and management.

Severity:	Percentage of Trees in Polygon Impacted:
Trace	<1%
Low	1-10%
Moderate	11-29%
Severe	30-49%
Very Severe	>50%

4.1 Bark Beetles

4.1.1 Douglas-fir Beetle *(Dendroctonus pseudostugae)*

Douglas-fir beetle (IBD) throughout the district has been identified as *proactive* for all BMU's. *(Refer to pages 15-16 for definitions of BMU strategies)*

Results from the Douglas-fir beetle funnel trapping program in the Quesnel district over the last few years has shown a decrease in beetles captured. This aligns with AOS data as well as anecdotal information that all point to the reduction of Douglas-fir beetle activity in the region over 2022/23.

The possible reasons for the continual decline are many, including temperature anomalies such as a rapid switch from warm temperatures in October of 2022 to extreme cold by early December of that year. Rapid early season temperature changes have strong negative effects on larval populations. It is also possible that elevated beetle populations from 2016-19 allowed for a growth in the populations of the beetle's natural pathogens and predators, leading to a collapse. Most likely, it is a combination of multiple factors.

IBD continues to simmer along the Fraser River valley, as well as along the Blackwater river valley. Scattered attack has been particularly noted between the Blackwater Crossing and Batnuni Crossing.

Timber Area (Ha) affected by Douglas-fir Beetle

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Area (ha)	548	301	1194	10320	10501	2686	1423	375	6	**12**

(Provincial Overview Report): These areas, in hectares, are all estimates of recorded trace, low, moderate and high infestations collected during the provincial aerial overview survey. The survey records all red trees, but not new infestations. So, as the reds turn into greys the infestation area decreases.)

4.1.2 Spruce Beetle *(Dendroctonus rufipennis)*

Spruce beetle (IBS) throughout the district has been identified as *proactive* for all BMU's. *(refer to pages 15-16 for definitions of BMU strategies)*

Spruce beetle was quiet in 2023 compared to 2022. Most of the IBS polygons in the survey are identified as "low" or "trace", meaning light levels of attack were noted over a given area. spruce beetle remains a medium priority due to its extent, ability to rapidly build populations, and the importance of healthy spruce to many different forest values.

Timber Area (Ha) affected by Spruce Beetle

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Area (ha)	241	111	964	4836	509	2140	2400	579	19088	**326**

(Provincial Overview Report): These areas, in hectares, are all estimates of recorded trace, low, moderate and high infestations collected during the provincial aerial overview survey. The survey records all red trees, but not new infestations. So, as the reds turn into greys the infestation area decreases.)

4.1.3 Western Balsam Bark Beetle *(Dryocoetes confusus)*

Western balsam bark beetle (IBB) throughout the District has been identified as *proactive* for all BMU's. *(refer to pages 15-16 for definitions of BMU strategies)*

The Quesnel District has elevated levels of IBB attack, beginning from 2016. Large areas are identified in the AOS due to a dispersed attack pattern. Polygons are identified as "low" or "trace" attack over large swaths of forest where attack is scattered throughout.

Western balsam bark beetle is difficult to manage for due to this dispersed attack, with activity smouldering through a location over many years. Management strategies such as targeting infested clusters or baiting insects into trap trees can be less effective on IBB compared to other bark beetles. Operationally the best strategy is to grid bait a planned harvest unit with pheromone attractants, or to cut trap trees within a harvest area so long as the trees can be removed before the next flight. This is particularly effective if the targeted stand already has some level of attack and has a high amount of suitable host trees. Stands with less than 400sph of Bl often show reduced levels of attack and would be therefore less effective at harvesting infested trees.

Timber Area (Ha) affected by Western Balsam Bark Beetle

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Area (ha)	1,632	6,838	27,824	37,161	55,885	54,988	29,757	31,136	28,433	**5,415**

(Provincial Overview Report): These areas, in hectares, are all estimates of recorded trace, low, moderate and high infestations collected during the provincial aerial overview survey. The survey records all red trees, but not new infestations. So, as the reds turn into greys the infestation area decreases.)

4.2 Defoliators

4.2.1 Two-Year Cycle Budworm

Two-year cycle budworm is consistently seen in the Quesnel district and attacks spruce and subalpine fir. There were no areas of attack identified in the 2023 AOS. It does not often cause tree mortality, but heavy or repeated infestations can cause stress and weaken trees making them more susceptible to other insects or pathogens. Populations of note within the Quesnel district for this insect have previously been observed in the upper Swift River, Bald Mountain, Beaver Pass, and Mount Tom areas.

4.2.2 Western Spruce Budworm

Western spruce budworm is not consistently observed within the Quesnel Forest District, but it has been observed in 2023 as well as several other years in the past. With a changing climate it is only expected to become more common. Contrary to its name, this insect mainly feeds on Douglas-fir. It primarily targets new foliage during the spring. After successive years of feeding, it can potentially cause tree mortality. This insect is primarily managed through aerial application of the insecticide *Bacillus thuringiensis kurstaki* (Btk).

4.2.3 Spongy (Formerly Gypsy) Moth (*Lymantria dispar*)

Spongy moth is an invasive insect that defoliates primarily deciduous trees. Populations have not become established in the Quesnel TSA, but through a partnership with the Canadian Food Inspection Agency, a trapping program is in place at recreation sites throughout the TSA to catch any potential introduced individuals. Spongy moths are known to lay their egg masses on recreation vehicles and trailers, so it is anticipated that any incipient infestation would occur at these sites.

4.2.4 Other Defoliators

Other defoliators have been of lesser concern; however, aspen serpentine leaf miner (*Phyllocnistis populiella*) continues to be a major health factor in trembling aspen and has been responsible for considerable defoliation of that species throughout the Quesnel TSA. The leaf miner itself does not usually cause enough damage to a tree to cause mortality, but it can reduce photosynthetic capacity by up to 75%. This in turn weakens the trees' ability to fend off or recover from other pathogens. These cumulative effects do have the ability to kill the tree. There is no planned treatment to address aspen serpentine leaf miner.

Western spruce budworm and Douglas-fir tussock moth were included in the table below to keep them in the minds of forest workers of this district. Western spruce budworm is uncommon in the Quesnel TSA but has been noted over a significant area in 2023. It is a major forest health agent in Williams Lake and 100 Mile House but is infrequently successful in establishing this far north. As climates change it can be expected this insect will have more opportunity to establish in Quesnel.

The same concept applies to Douglas-fir tussock moth. It is only just beginning to establish in Williams Lake and 100 Mile House, so it is a future consideration for Quesnel. Any suspected sightings of Douglas-fir tussock moth or western spruce budworm should be reported to Quesnel District Stewardship staff.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Two Year Cycle Budworm	56,611	0	42,867	17,021	49,589	1,897	6,093	0	0	**0**
Western Spruce Budworm	265	0	0	0	0	0	0	0	0	**1,211**
Douglas-fir Tussock Moth	0	0	0	0	0	0	0	0	0	**0**
Pine Needle Sheathminer	312	1,055	3,921	2,106	1,802	751	0	0	0	**0**
Aspen Serpentine Leafminer	32,458	65,576	87,544	10,123	50,547	89,687	42,891	42,128	3768	**159**
Western Hemlock Looper	0	0	0	0	0	0	0	357	0	**0**

*All units are hectares

4.3 Foliar Diseases

Dothistroma needle blight has historically been the most damaging foliar disease in the Quesnel Natural Resource District TSA. No treatments are currently planned to address this disease, see section 6.5 for more details on treatment options.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Venturia Blight	0	10	394	0	34	0.5	13	0	0	**0**
Dothistroma Needle Blight	0	0	500	12,705	36	0	0	3702	72	**0**
Lophodermella Needle Cast	0	0	0	0	0	0	0	220	0	**0**

*All units are hectares

(2023 Overview of Forest Health Conditions in Southern British Columbia): Areas include the total of trace, low, moderate and severe polygons

4.4 Animal Damage

The animal damage seen in the Quesnel district is often expressed as the removal of bark and cambium or tramping of seedlings. Bear damage is the most common issue seen in the AOS, but it is quite small in scope. Bear damage is most commonly the peeling of bark at or near the root collar of a tree, with strips of peeled bark extending up the trunk. This can either be seen in separate strips or the complete girdling of a stem. Bears will often do this in spring to eat the cambium as an early season food source. Porcupine damage is similar, though it is usually higher up the stem and the teeth marks are more chisel like.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Porcupine	0	0	0	0	0	0	0	0.5	0	**0**
Bear	0	156	28	19	39	1.75	5.5	4.75	0	**0**

*All units are hectares

(2023 Overview of Forest Health Conditions in Southern British Columbia): Areas include the total of trace, low, moderate and severe polygons

4.5 Abiotic and Other Damage

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	**2023**
Wildfire	16,225	170	428	310,325	55,308	177	0	12,385	0	**22,759**
Post-Wildfire	214	397	1,093	0	2,201	16,227	11,641	2,191	405	**9**
Drought	0	66	20	38	68	0	1.5	1,617	0	**2,678**
Cedar Flagging	0	0	0	0	0	4,804	6,817	0	0	**1,612**
Aspen Decline	0	0	240	0	296	0	19	12	0	**0**
Flooding	97	23	4	119	86	120	326	52	74	**40**
Hail	0	0	0	0	0	0	0	0	0	**0**
Shoot/Bud Frost Kill	0	0	0	0	0	0	0	0	0	**0**
Windthrow	16	41	0	0	0	0	672	47	0	**0**
Avalanche/slide	26	15	0	0	0	0	23	0.5	0	**0**

*All units are hectares

(2023 Overview of Forest Health Conditions in Southern British Columbia): Areas include the total of trace, low, moderate and severe polygons

5.0 Management Objectives

The Quesnel Forest Health Strategy will follow the specific management objectives for forest health factors as per the Provincial Bark Beetle Strategy. The beetle strategy is currently being updated and is expected to be available later in 2024. The updated version may suggest different management objectives or a new direction of focus.
The 2019 – 2022 management objectives were to:

- Minimize the loss of timber value
- Minimize the loss of Crown revenue
- Minimize the spread of bark beetles

Bark beetles are a natural component of forest ecosystems in British Columbia, and at most times are present at low or endemic levels. Currently within the Quesnel district only the western balsam bark beetle has increased in population size to a landscape level disturbance, with the other bark beetles exhibiting low population level disturbance. With adequate resources, beetle populations can be monitored and managed to meet the above objectives. This strategic plan provides direction to deploy resources to where it is most appropriate to mitigate the rate of spread.

6.0 Specific Strategies

For priority forest health agents, the Quesnel Forest Health Strategy will follow the specific strategies and tactics outlined in the Forest Practices Code Guidebooks, Provincial Bark Beetle Strategy, guidance documents, and focus on areas identified by the Quesnel Natural Resource District Detailed Aerial Survey Maps.

6.1 Bark Beetles

6.1.1 Beetle Management Units

A Beetle Management Unit (BMU) is a planning and reporting unit for operational beetle management. Its purpose is to identify an area of concern, establish the appropriate beetle management objectives, and to facilitate the implementation of those beetle management activities. Resource management objectives will be consistent throughout each BMU. Additionally, strategies will be evaluated for compatibility with adjacent BMUs. BMUs have been created within the District for prioritising each bark beetle species.

A priority rating will be given to all beetle management units based on timber types, resource values, adjacent infestations, and past investments. This priority rating then needs to be further evaluated to consider shelf life, species composition and amount of infestation to better inform the management strategy to be used.

6.1.3 Beetle Management Unit Establishment

Currently, most BMU boundaries for the District follow the boundaries of Landscape Units. However, upon the discovery of an active infestation BMU boundaries can be modified to reflect the management strategy best suited for the area. Modification of existing or the creation of new BMU boundaries is authorized by the District Manager with the input from District Stewardship staff and any proponent licensee(s), First Nation(s) or other stakeholder(s). Information used to inform the creation/modification of BMUs include, but is not limited to, overview flight data, beetle probe findings, and stand susceptibility (i.e. bark beetle hazard mapping).

6.1.4 Beetle Management Unit Strategies

The following five strategies for each of the Quesnel BMU's will be implemented. These strategies are selected based on the level of outbreak in an area and the estimated effectiveness of selected treatments in achieving stated objectives. The BMU's will be re-evaluated as new aerial survey information is received. Revised strategies for each of the BMU's will be adjusted at that time.

These strategies are relatively new and replaced the old set of "Monitoring, Suppression, Holding, and Salvage". The new strategies are roughly analogous to the old ones, but there are key differences.

1. **Proactive**

Use proactive management tactics where beetle populations are in an endemic population phase. The key goal of the Proactive strategy is to prevent beetle populations from expanding to unmanageable levels. Operationally this can be seen as knowing where the beetles are and tailoring treatments to these specific locations. This strategy is roughly similar the old "monitoring" strategy.

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2. **Targeted**

Use aggressive reduction tactics on beetle populations in the incipient or building population phases but can still be effectively reduced before more widespread infestation occurs. "Targeted" is similar to the old "Holding" strategy.

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3. **Reactive**

The use of tactics in response to beetle 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. "Reactive" is similar to the old "Suppression" strategy.

4. **Salvage**

Salvage focuses harvest on stands containing mostly dead or dying trees to minimize timber value losses in widespread infestations. It 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 promote more resilient forests.

5. **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.

6.1.5 Beetle Attack Analysis/Susceptibility Maps

Beetle Hazard Mapping reflects the susceptibility of stands to beetle infestation based on factors such as tree age, elevation, species composition, landscape constraints, current infestation levels, and is calculated from information in the Ministry of Forests' digital inventory ("FIP") files. These maps are updated periodically by the MoF to reflect the changing land base as stands grow and age into higher susceptibility classes as well as the removal of stands due to harvesting and other disturbances i.e. wildfire.

6.1.6 Aerial Surveys

The provincial aerial overview survey is carried out via fixed-wing aircraft each year to determine the spread of bark beetles and other forest health agents within the district. These results are shared to interested parties by district stewardship staff or by request. The aerial overview survey can be used to inform a more detailed overview survey using rotary-winged aircraft at lower altitudes to further refine the impacted areas.

6.1.7 Probing

Beetle probing is the ground-truthing method used to further refine the infested area provided from flight data. Probing can also identify current (green) attack while aerial surveys cannot.

The extent of active infestation is important for determining the appropriate course of action, especially in constrained areas (i.e. OGMAs) as per the Biodiversity Guidelines.

6.1.8 Harvesting

Harvesting is a viable control to physically remove and destroy beetle populations. A distinction should be made between Sanitation and Salvage. Sanitation is the removal of currently infested trees and requires timely identification of infested stems via ground-truthing. Salvage harvesting is the removal of already killed timber to recover economic value and to hasten regeneration of the infested stand. These definitions are especially important when operating in constrained areas. Review *Regional Biodiversity Conservation Strategy Update Note 7b: An Integrated Strategy for Management of Biodiversity and Bark Beetles in Douglas-fir and Spruce Stands* for more information regarding this.

Small Patch or Selective:

Small patch harvesting is a viable control option for small, scattered patch infestations of bark beetles. All small patch harvesting should be followed by a mop-up procedure.

Selective harvesting (single tree mark-to-cut, shelterwood etc.) should consider windfirmness of retained stems (see windthrow management guidance below) as well as the susceptibility of those retained stems to infestation due to age, tree health, size etc. Careful harvesting should minimize the amount of damage to residual stems from equipment impacts or rub trees. Those trees damaged during harvest should be removed or left as a trap tree if a follow-up treatment is prescribed since stressed or damaged trees can act as an attractant to bark beetles. Residual slash and slash piles can attract beetles and lead to the retained stems becoming infested. Management options include clean harvesting and slash removal concurrent with harvesting or by deploying MCH on the retained stems for 2-3 years post-harvest once the attractant slash has decomposed or has been disposed of.

Clearcutting:

Clearcutting of large polygons is a common control for heavy concentration of bark beetle infestation, and wherever possible should be used in conjunction with a strategy to concentrate beetle populations into the planned harvest areas. Strategies include trap tree falling, road right-of-way falling (trap trees), or semiochemical baiting (chemicals that can either attract or repel insects). Timing of harvest should be planned to occur prior to the next beetle flight (can begin in early May), or once the strategy being used to concentrate beetle populations has been completed.

6.1.9 Minimizing Windthrow:

Most bark beetles are highly attracted to large, windthrown stems. Beetle infestations often begin after windthrow events where suitable host trees are killed by windthrow and act as nurseries for beetle broods. Adult beetles emerge from the windthrown trees in large populations and move to mass attack adjacent healthy trees.

Cutblock design should consider windthrow risk based on a host of factors (soils, stand characteristics, topography, known prevailing winds and meteorological conditions etc.). If a

proposed cutblock is assessed as being susceptible to windthrow, the following strategies should be employed to mitigate possible damage:

Clearcutting:

- Wind-facing boundaries should be located on sites that are least risk (deep, well-drained soils with tree species known for deep rooting and good crown form)
- Use natural landscape boundaries to create windfirm edges (rock bluffs, previously disturbed edges, bogs etc.)
- Boundaries should be relatively uniform and smooth – avoid sharp corners or indentations that are exposed to wind
- Boundaries may require "feathering" on sites that are at higher risk. This involves removing more vulnerable stems along the boundary edge and retaining the more windfirm stems to protect the downwind adjacent stand. No more than 15-20% of stems should be removed.

Selective Cutting and Thinning:

- Select high windthrow hazard areas and trees as the removal portion of the harvest plan, especially in group selection or strip-cut methods
- Avoid locating selective cuts adjacent to existing clearcuts or vice-vera. It will take some time for retained stems to become completely windfirm once adjacent stems have been harvested, so exposing them to full-force wind immediately post-harvest is poor practice
- Residual trees should be selected as the retention cohort (sound, well-rooted veterans, good taper and relatively small, open crowns)
- Inter-tree spacing of residuals should not exceed ½ tree length
- Early spacing on high windthrow hazard sites will encourage strong rooting while trees are flexible and before they are tall enough to be susceptible
- Several light-mid intensity treatments rather than one heavy treatment generally produce a more resilient forest
- Allow several years between treatments to allow the residual stand to adapt to the new wind condition
- Avoid damaging root systems of retained stems during harvesting and skidding activities

In all instances, it is good practice is to place 3-methylcyclohex-2en-1-one (MCH) along cutblock boundaries and on residual stems post-harvest prior to beetle flight in anticipation of possible windthrow. This will prevent infestation of windthrown stems that can result in populations able to mass-attack adjacent timber. MCH is effective on both Douglas-fir and spruce beetle.

Funnel traps or pheromone trap trees can also be used to concentrate bark beetles into an area before harvesting, so long as harvesting is not delayed or deferred into late spring or summer.

Where Douglas-fir and spruce are reserved singly or as wildlife tree patches, consider the above recommendations to maximize wind firmness. Retained stems and reserve areas should have post-harvest inspections conducted to ensure the wind firmness goals were met, and if there is blowdown these trees should be salvaged to prevent the concentration of bark beetles. For more information on managing windthrow, see the *Windthrow Handbook for British Columbia Forests*.

6.1.10 Post-Harvest Mop-Up

For Douglas-fir and spruce beetle control, slash and felled trees which may be present after harvesting should be minimized, piled and burned or cut into lengths less than 1m, to prevent population build-up or survival in that material. If the original harvest was to treat a bark beetle infestation, leaving trap trees in easily accessible areas post-harvest is a good clean-up tool to capture any beetles emerging from logging slash and stumps and to capture beetles from adjacent stands attracted to the smell of logging slash. See the "Conventional Trap Trees" section for more information on trap trees.

6.1.11 Conventional Trap Trees

This tactic is used to control most bark beetles and takes advantage of the fact that bark beetles prefer downed material over standing trees. Trees are felled in easily accessible locations for removal after the next beetle flight. Trap trees should be felled at a ratio of one trap tree per every 4 known currently infested trees in the target stand. Trap trees should not be pruned nor felled into sunlit openings since this dries out the cambium and is less attractive to beetles. Trees should be felled in March or April to lie on top of accumulated snow and be in place for beetle emergence. They should be removed that same year in late fall or early winter (October /November) so they are easy to locate and remove without too much accumulated snow or ice. Waiting until spring is possible but more operationally challenging to achieve before beetles emerge (it is best practice to assume beetles fully infest trap trees after 1 season). Beetle emergence for spruce beetle and balsam beetle is near May 15th and Douglas-fir beetle is near Apr 15th, dates vary by site and weather.

Trap trees can be useful for managing bark beetles in inoperable and constrained areas such as OGMAs and MDWR. Trees are felled outside of the inoperable/constrained area and left for a season to "pull" beetles out of the stand in question. Another good tactic is to pre-fall trap trees in a planned cutblock. These can be dispersed throughout the block or be comprised of road rights-of-way. The pre-felled trap trees will attract beetles into the area to be cut, and then subsequent harvest and milling of timber will destroy any beetle brood.

It should be noted that often trap trees will create a "spillover" effect where beetles are attracted to the trap trees but will also attack adjacent trees. Trap trees should be planned to account for possible spillover (harvest) or felled in areas with other tree species that are not susceptible to the beetle in question.

Note that the Forest Planning and Practices Regulation (FPPR) section 41 states:

"An agreement holder or a timber sales manager who uses trap trees or pheromones to concentrate insect populations must ensure that the insect brood is destroyed before the insects emerge."

Whenever trap trees or semiochemical lures are mentioned in this document, this regulation must be considered and adhered to.

6.1.12 Funnel Trapping

Funnel trapping can be an effective control tactic if used in the correct circumstances. The semiochemical lures are an even more powerful attractant than trap trees. One drawback to funnel traps is that they need to be monitored constantly; possibly even twice a week during peak beetle flight periods. This makes them labour intensive, especially in isolated areas. Since the semiochemical lures are so powerful the spill over effect can be even greater than that of trap trees, so funnel traps should be placed in areas with no susceptible timber such as open clearcuts or deciduous types. MCH can be used to try and push insects away from adjacent timber and into trap systems.

Funnel traps are excellent tools around mill yards since beetles will already be attracted to log decks stored there and they will be easily accessible. If those working in and around log yards notice insect attack on the trees surrounding the yard they are encouraged to reach out to district stewardship staff to discuss setting up funnel traps.

Having some funnel traps with Ambrosia beetle lures around mill yards can increase timber and log quality. Ambrosia beetles burrow deeply into the core of felled timber and leave unsightly dark pinholes, thus deteriorating the log quality.

6.1.13 Delivery and Milling Restrictions

All timber infested with bark beetles must be delivered to the mill and debarked between the following time periods:

Douglas-fir	Aug 30th to April 15th.
Spruce	Aug 15th to May 15th
Subalpine Fir	Sept 1st to May 15th
Lodgepole Pine	August 30th to June 1st

The mill must be advised of the beetle infested wood. Exemption maybe given to these restrictions if it is determined that these beetles have entered the tree in the present year and will not emerge until the following spring.

Though not specific to Quesnel, the Omineca Spruce Beetle Hauling and Storage Plan provides valuable information on this topic.

6.1.14 Douglas-fir Beetle-Specific Control Tactics

The following control techniques will be deployed by the Ministry's District or regional forest health program when adequate resources are available and possibly in conjunction with major licensees, BC Timber Sales (BCTS), or Small Scale Salvage (SSS).

1. Using information from detailed aerial survey, locate red attack and perform detailed ground surveys collecting data on amount of current attack.
2. Prioritize control techniques by amount of current attack and location to access.

   General Guidelines:

   a. 1-10 current attack trees:
      - deploy MCH and funnel traps
      - if access is good, harvesting may be considered.

   b. >10 current attack trees:
      - harvest current attack and access trees only,
      - Deploy MCH and funnel traps
      - Deploy MCH on its own in remote locations

   c. >100 concentrated current attack (i.e. in 1-2 ha area)
      - develop cutblock encompassing current attack trees.
      - follow up with trap trees, outside boundary.

3. Harvested bark beetle areas should have a follow-up treatment such as MCH or trap trees before the next beetle flight to control residual beetles in stumps and slash.

4. Control efforts in OGMAs must be done in accordance with the Regional Biodiversity Conservation Strategy (Update #7b) and Cariboo Chilcotin Land Use Plan (CCLUP). The level of beetle control activity may be limited by position of BMU boundaries. In such instances, Quesnel Natural Resource District staff should be engaged to determine whether BMU boundaries can be altered to respond appropriately.

5. Control efforts, in MDWR, must be done in accordance with the Ministry of environment, General Wildlife Measures (GAR).

6. Cutting authorities being planned by major licensees and BCTS in Douglas-fir beetle infested areas should incorporate pre-felling trees on roads and landings prior to beetle flight to concentrate beetle populations into harvest area.

7. Additional post-harvest treatments are described in the post-harvest Mop-Up and Trap Trees sections.

6.1.15 Spruce Beetle & Western Balsam Bark Beetle-Specific Control Tactics

The following control techniques will be deployed by the ministry's district or regional forest health program when adequate resources are available and possibility in conjunction with the major licensee, BCTS or SSS.

1. Use information from detailed aerial survey to locate infestation centres and outer boundaries of infestations, conduct field checks to confirm beetle activity.
2. Prioritize control techniques by amount of current attack and location to access.

   General Guidelines:

   a. Small infestation site, less than 1 hectare in size and isolated:

      - The infested trees are to be removed by harvesting.
      - If infested trees cannot be removed before the beetle flight the following year because of harvesting conditions, a trap tree program is to be utilized.

The above-mentioned control techniques will be deployed by the Ministry's district forest health program and possibility in conjunction with the major licensee BCTS or SSS.

   b. Larger infestation areas, greater than 1 hectare in size:

      - Harvested under a Forest Stewardship plan.
      - Cutting authorities being planned by major licensees and BCTS in spruce beetle infestation areas should incorporate the use of trap trees, by pre-felling roads and landings.
      - Alternatively, bait with attractant semiochemicals in a grid pattern to concentrate beetle populations. Areas grid baited must be assured of harvest within one year. Under the Forest and Range Practices Act (FRPA), FPPR Sec 41, it states that an agreement holder or a timber sales manager who uses trap trees or pheromones to concentrate insect populations must ensure that the insect brood is destroyed before the insects emerge.
      - It is very important to follow up post-harvest with a trap tree program for one or two years to contain beetles coming out of stumps.

6.2 Weevils

Warren's Root Collar Weevil (*Hylobius warreni*) Pine and Spruce
Lodgepole Pine Terminal Weevil (*Pissodes terminalis*) Pine
White Pine Weevil (*Pissodes strobi*)

Weevils can cause considerable damage in young plantations, leading to degraded timber quality (terminal weevils, *Pissodes* sp.) and mortality (root collar weevil).

- increase stocking density to offset losses. *Pissodes* sp. Prefer open grown, vigorous trees, so increasing stocking may reduce stand susceptibility.

- Diversify species mix.
- Studies have shown that as proximity to existing weevil populations and duff depth increases, root collar weevil populations increase. Consider this when planting in areas of known root collar weevil presence.

6.3 Defoliators

6.3.1 Two-Year Cycle Budworm *(Choristoneura biennis)*

Two-year cycle budworm remains an endemic health factor for spruce and subalpine fir forests in the Quesnel TSA. There is currently no planned control or management for this insect. However, the principles for western spruce budworm generally apply. Establishing a mosaic landscape to prevent establishment, use of Btk an effective spot treatment. Btk is a bacterium that affects all lepidopterans.

6.3.2 Serpentine Aspen Leaf Miner *(Phyllocnistis populiella)*

Aspen is not a common commercial species, but it does comprise an important role for other values within the forest of the Quesnel district. There are currently no plans to manage for leaf miner. Contact insecticides are not an effective management tool as the larvae are protected within the leaf.

6.4 Root Disease Control Tactics

Armillaria Rood Disease (*Armillaria ostoyae*)
Tomentosus Root Disease (*Inonotus tomentosus*)
Laminated Root Rot (*Coniferiporia sulphurascens*)

Generally, Armillaria is restricted to a few scattered small areas in the Quesnel district. This root disease is spread by root contact. Incidences of very small Armillaria spots have been reported in a few areas in the district (500 Road, Ernst Road and Deep Creek). Tomentosus is found throughout the district, particularly in spruce stands.

Upon identification of root disease within areas of planned development, it is requested that interested parties contact District Stewardship staff to discuss management options, and collaboration is required to be authorized to claim appraisal allowances (stumping). Some tactics to manage for root disease include:

- Reforesting using species that are less susceptible to the root disease of concern and utilizing species mixes, including hardwoods.
- Avoiding planting adjacent to stumps. If the stump is infected, placing a new seedling directly beside it provides the fungus with fresh inoculum potential. This treatment is effective when dealing with *Tomentosus* root disease, but ineffective when dealing with *Armillaria* root disease.

- Post-harvest stumping. The ripped stumps should be replaced in the cavity they were removed from upside-down to allow the roots to dry. Any large roots or stump sections that break off while stumping should be dug out.
- Pushover harvesting. Additional protective armouring may be required on equipment.
- Delaying reforestation. Immediately planting post-harvest provides root disease with fresh inoculum potential.

These basic tactics have been drawn from the guidance document *Managing Root Disease in British Columbia*. It replaces previous FPC Root Disease Guidebook (1996) and is intended to help forest professionals and practitioners navigate the challenges of operating in areas impacted by root disease by providing science-based survey and treatment options that are applied consistently across the province. Additionally, an updated and revised root disease website is also now available. Please consult these resources for further information, or contact the local District Stewardship staff for assistance.

6.5 Foliar Disease Control Tactics

6.5.1 Elytroderma Needle Cast (*Elytroderma deformans*)

Elytroderma infects lodgepole and ponderosa pine, especially near moist sites such as lowlands and near lakes. Some control tactics include:

- Clearcut harvest of all host species and subsequent slashing of understorey. This prevents the future planted stand from becoming infested.
- Avoid replanting host species near moist sites. Select non-host species for these sites.

6.5.2 Lophodermella Needle Cast (*Lophodermella concolor*)

Lophodermella is a needle cast that can infect large tracts of pine forests during wet springs and summers, with symptoms being displayed the following May/June. It can cause severe defoliation and even mortality in the event of repeated epidemics. The only strategies to manage for lophodermella is to avoid monocultures of lodgepole pine and to plant a diversity of species of preferably resistant stock wherever possible, and to promote airflow through stands by thinning or pruning (density management).

6.5.3 Dothistroma Needle Blight (*Dothistroma septosporum*)

Dothistroma, or red band needle blight, infects pine species and is similar to lophodermella by requiring moist conditions to thrive. Like lophodermella, the only strategies to manage for dothistroma is to avoid monocultures of lodgepole pine and to plant a diversity of species of preferably resistant stock wherever possible, and to promote airflow through stands by thinning or pruning (density management).

6.6 Dwarf Mistletoe Control Tactics

The most common dwarf mistletoe found in the Quesnel Natural Resource District is Lodgepole Pine Dwarf Mistletoe (*Arceuthobium americanum*). Though not detected through aerial overview surveys, mistletoe is widespread in lodgepole pine plantations and mature stands throughout the TSA. Common tactics to manage dwarf mistletoe include:

- Developing cutblocks with "clean" edges i.e. harvest boundary follows non host species timber type or a physical boundary like a road. This prevents re-infection of the stand to be planted.
- Clearcut harvest of all host species and subsequent slashing of host understorey. This prevents the future planted stand from becoming infested.
- Consider mistletoe areas for prescribed fire
- Selection harvesting can open the canopy and increase the light entering the stand. Mistletoe that was latent prior to the selective cut can be "activated" and increase. If using a selection harvest system, removal of all host species is recommended and retain stems of non-host species.

The *Dwarf Mistletoe Management Guidebook* is available online and contains additional information and strategies to manage not only for Lodgepole Pine Dwarf Mistletoe, but other varieties of dwarf mistletoe as well.

6.7 Stem Rusts of Pine

Comandra Blister Rust (*Cronartium comandrae*)
Stalactiform Blister Rust (*Cronartium coleosporoides*)
Western Gall Rust (*Endocronartium harknesii*)

Many rust fungi require an alternate host to complete their life cycles. Comandra blister rust's alternate host is pale comandra (*Comandra umbellata*), and stalactiform blister rust's alternate hosts are the paintbrushes (*Castilleja* sp.) and cow wheat (*Melampyrum lineare*). Western gall rust does not have an alternate host. Some control tactics to consider:

- avoid harvest in areas of known instances of rusts with alternate hosts present (where applicable). There is hazard mapping available to determine if the stand in question is at-risk
- Increase stocking to offset growth losses
- Diversify species mix. Spore transmission from alternate hosts is very short-distance, consider this when determining spacing between pine and other species when planting
- Consider broadcast burning where rusts have historically been an issue

High concentrations of stem rusts have been reported in the vicinity of Nyland Lake and Beavermouth, as well as in the Ramsey Creek, Udy creek and Snaking River areas.

6.8 Atropellis Canker (*Atropellis piniphila*)

Atropellis canker infects pine and can be more problematic on drier sites and on stems that survive wildfire. High density stands are also at greater risk.

- Diversify species mix
- Decrease pine component when fill planting. If pine is the only acceptable species, reduce stocking density to avoid spread of infection

6.9 Abiotic Damage

6.9.1 Frost Damage

The Quesnel Natural Resource District is prone to late spring and early summer frosts which can damage the young buds and shoots of vegetation, especially on freshly planted stock and seedlings. Some strategies to mitigate frost hazard include:

- Using shrubs and deciduous trees as thermal cover, or low density conifers for a nurse crop
- If clearcutting, include strategic retention of mature trees, stubs, or clumps of advanced regen to shelter seedlings. Utilize obstacle planting as much as possible
- Stratification of frost-prone sites for a different treatment (no harvest, different species mix etc. These areas tend to be in the low spots in rolling terrain i.e. “bowls”)
- Site preparation to create raised planting sites
- Selective harvesting (shelterwood)

Some useful guidance can be found in the *Identification and Management of Summer Frost-prone Sites in the Cariboo Forest Region* handbook, as well as the bulletin of the same title.

6.9.2 Drought

Compared to other locations in the province, Quesnel district has not historically had major issues with drought. Drought does occur though, particularly further south and to the west in rain shadows, or on south exposures. As the climate changes drought events may occur more frequently, last longer, and be more damaging than in the past. When operating in dry ecosystems consider drought as part of forest planning. Some common tactics include:

- Stratification of harvest areas and NAR to avoid areas expected to be problematic to reforest due to drought
- Site preparation that focuses on providing shade, moisture pooling, and reducing vegetative competition for water (i.e., deep-ripping)
- Migration of more drought-tolerant species where acceptable i.e. Ponderosa pine
- Using the Climate-Based Seed Transfer tool to select for seed that may be more well-adapted to drought and heat stress as well as larger planting stock. Select species based on the future conditions they may be facing, not on ease of establishment
- Selective harvesting

- If clearcutting, include strategic retention for shelter of seedlings including stubs. Utilize obstacle planting as much as possible to provide shade for seedlings
- Planting as soon as possible after snowmelt in the spring to give seedlings the most time to establish before the peak of summer heat

The *Reforesting Dry Sites in the Thompson Okanagan Natural Resource Region* handbook has recently been developed to assist in reforesting these sites. Though developed for the Thompson Okanagan Region, the principles outlined in this handbook are applicable to our area.

6.9.3 Wildfire

Wildfire is a forest health issue and should be considered at all planning levels. When planning development, the future potential of wildfire throughout the rotation of the stand and where that stand sits within the landscape should be accounted for to better ensure a long-term stable timber supply. Some of these principles may include:

- Plan development over a landscape scale and establish a patchy matrix of age classes, species types, density classes etc. This patchiness can break up the fuel matrix in the event of a future wildfire which may ease in suppression efforts. This includes retention and road network development. Best practice in volume-based license areas is to coordinate with other tenure holders and government to manage for fire on this large scale
- Maintain permanent access structures (mainlines, major crossings) for ease of access.
- Reintroduction of broadcast burning and other prescribed fire post-harvest as a site preparation and fuel reduction tool.
- Select species based on the future conditions they may be facing, not on ease of establishment. Select species that are fire-resistant as well as those that are resistant to other forest health concerns in that area.
- Adopt deciduous species into stocking standards as fire-resistant species.
- Selective harvesting that minimizes fuel loading of stands.
- Density management i.e., juvenile spacing and pre-commercial thinning.
- Monitor the edge of recently burned areas for bark beetle activity.

7.0 Reporting to the Chief Forester:

In the Quesnel TSA, Rationale for Allowable Annual Cut (AAC) determination (page 37), the Chief Forester states: “I encourage FLNR staff to monitor whether young stands are meeting minimum stocking standards given the impact of the various forest health issues.”

To fulfil the requirements of this request, the District will continue to carry out Stand Development Monitoring surveys on young stands in the TSA to determine impacts of forest health agents.

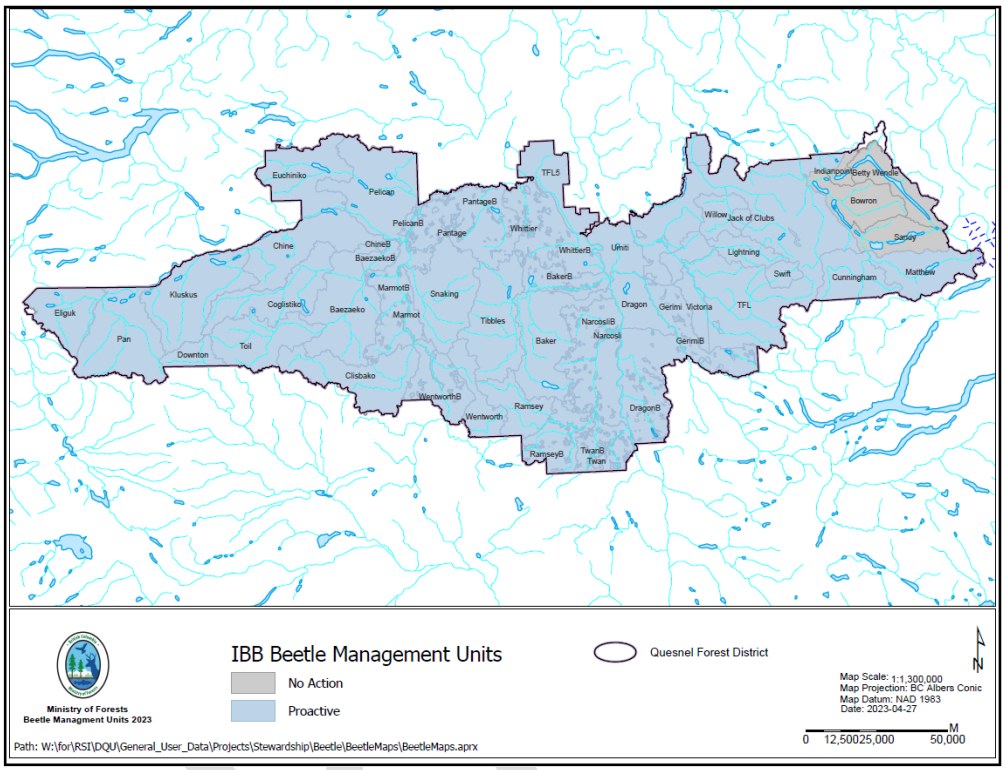
Appendix 1: Quesnel Natural Resouce District Beetle Management Units (BMU)

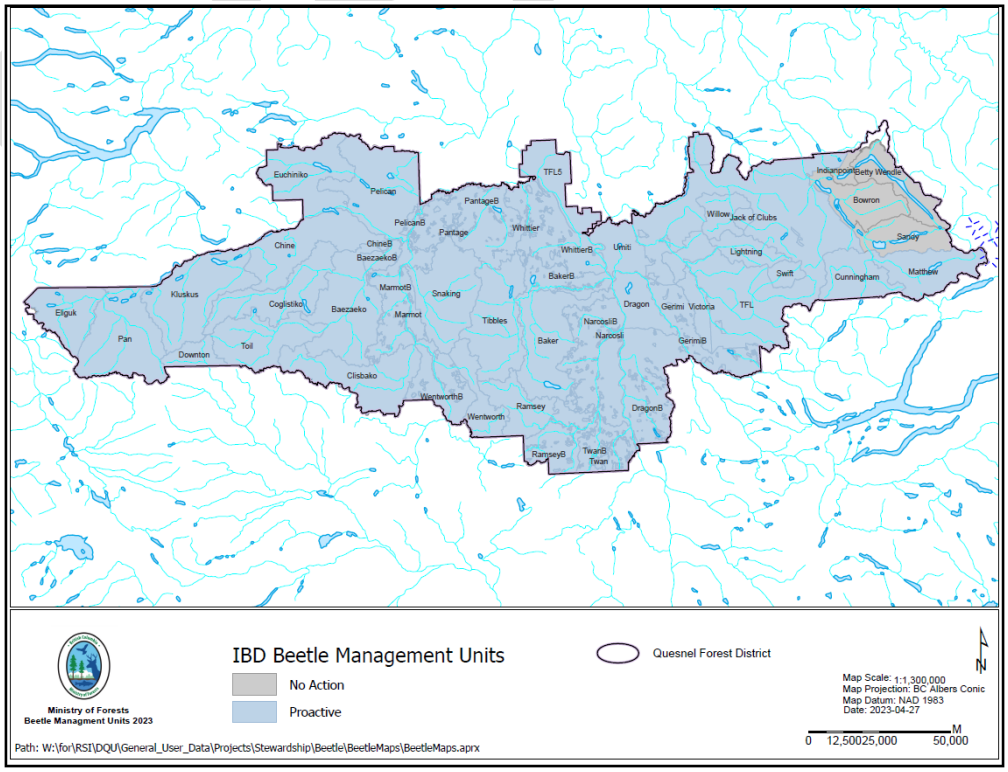
All Bark Beetles (IBD, IBS, IBB, IBM)

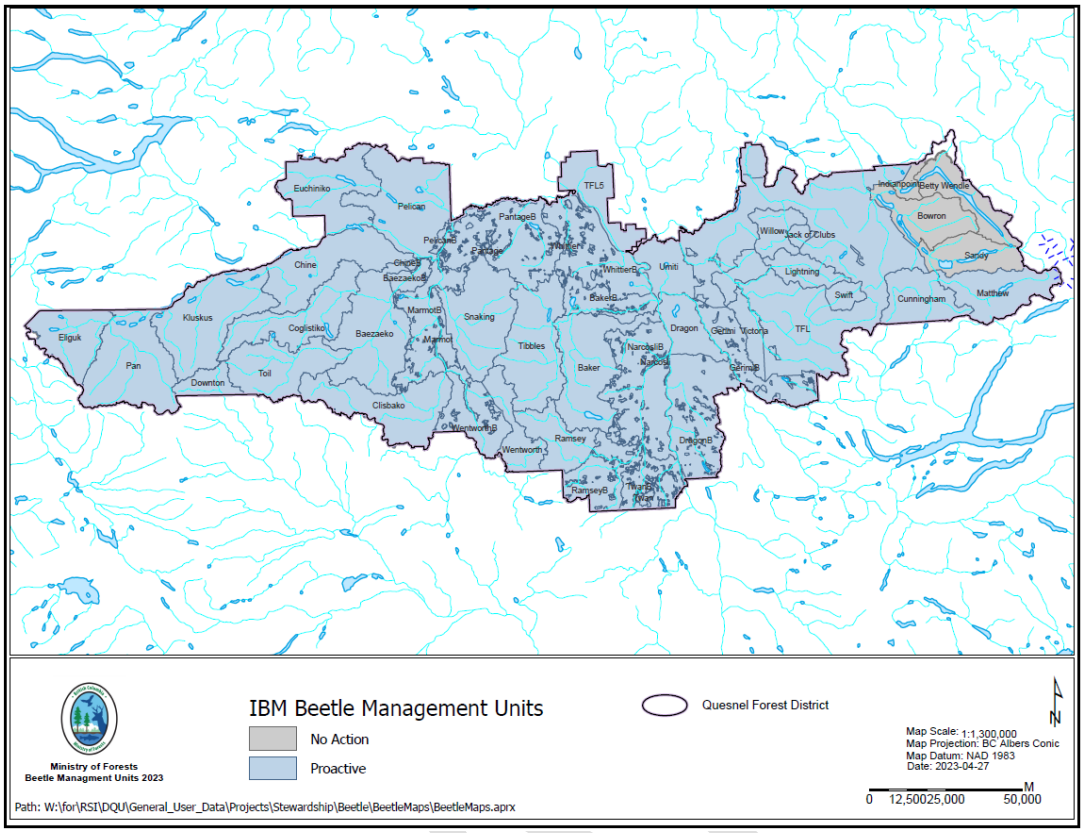
BMU	STRATEGY
Betty Wendle	No Action
Bowron	No Action
Indianpoint	No Action
Sandy	No Action
All other BMUs	Proactive

Appendix 2: Quesnel Natural Resouce District Beetle Management Unit Maps

These maps were drawn in 2023 but remain valid for 2024.



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Willow
Jack of Clubs
Lightning
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Cunningham
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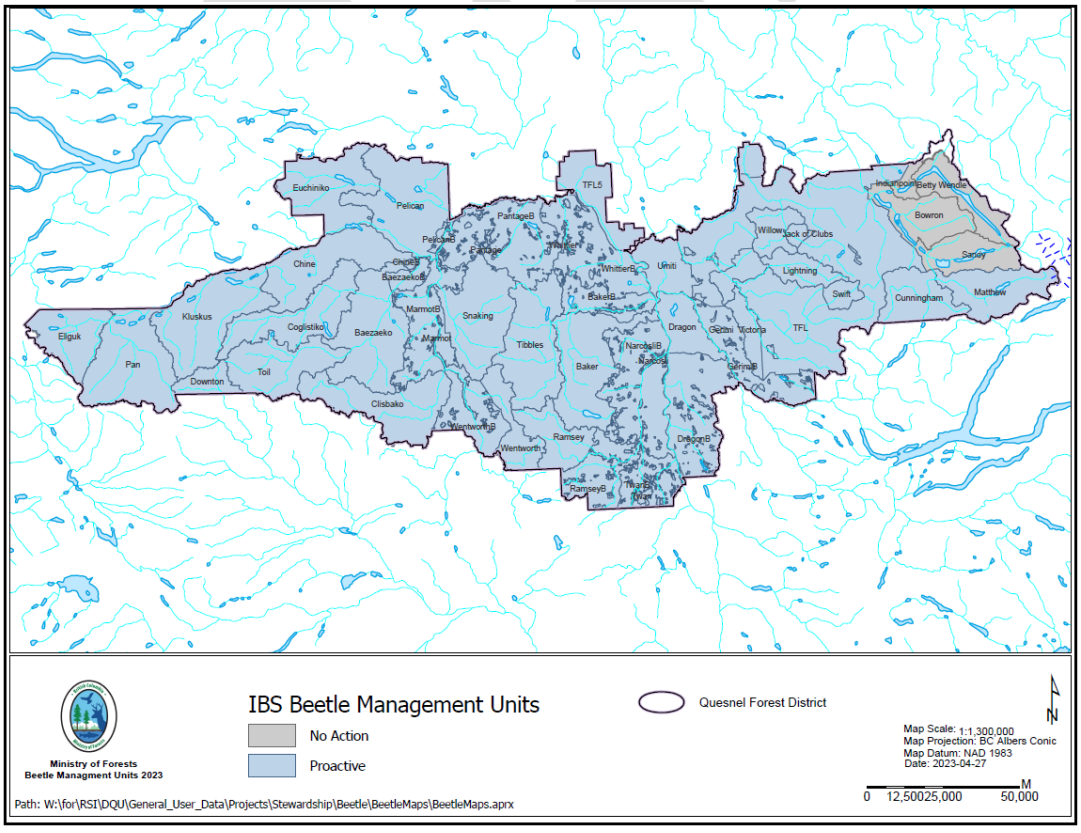
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