

NORTHEAST REGION

FORT NELSON, FORT SAINT JOHN, AND DAWSON CREEK TIMBER SUPPLY AREAS

FOREST HEALTH STRATEGY 2017-2018

BC MINISTRY OF FORESTS, LANDS, NATURAL RESOURCE OPERATIONS AND RURAL DEVELOPMENT



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ACKNOWLEDGMENTS

This strategy was written by Jeanne Robert, Regional Forest Entomologist, and Jewel Yurkewich, Regional Forest Pathologist at the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) for the Omineca and Northeast Regions. All unattributed pictures in this document were taken by either Jeanne or Jewel.



We would like to thank our sources of input and information including FLNRORD staff from the Fort Nelson and Peace Districts as well as local licensees and consultants. The collaborative effort was instrumental in the successful revision of this annual strategy.

Front cover photo – snowy mountains near Chetwynd, BC.

Above photo – Jewel (left) and Jeanne (right) participating in the Douglas fir beetle course held in Quesnel; photo credit: Leo Rankin.

1 MISSION STATEMENT

The Northeast Forest Health Strategy provides a framework to co-ordinate and guide forest health activities within the Northeast Region. It is aligned with and driven by the mission statement of the [Provincial Forest Health Strategy](#) to:

“Provide science-based, economically rationalized best management practices and implement treatment programs that prevent or mitigate the impacts of forest health agents.”

1.1 INTRODUCTION

The Northeast Forest Health Strategy provides a framework to coordinate and guide forest health activities within the TSAs of the Northeast Region while ensuring consistency with the existing legislative objectives, the provincial forest health strategies and guidelines, and the Omineca Forest Health Strategy. The strategy aims to:

- incorporate the principles of Integrated Forest Health Management in order to effectively mitigate the risks and impacts of priority pests and pathogens on resource objectives;
- provide guidance in the form of best practices for managing priority pests and pathogens;
- summarize the current knowledge with regards to the impact of forest health factors on timber supply; and
- provide ecologically sound, scientific techniques for the protection and enhancement of resource values.

The Forest Health Strategy establishes a proactive approach that emphasizes the early detection of forest health problems, promptly implements scientifically sound solutions, and ensures that expenditures of resources are necessary, efficient, and cost effective.

Integrated Forest Health Management (IFHM)

IFHM is a variant of the internationally recognized approach to pest management known as Integrated Pest Management (IPM).

The principles of IPM have been modified within a forestry context to produce the principles of IFHM. These principles can be summed up briefly as:

- know the land-base and resource management objectives;
- manage from an ecological perspective;
- maintain or improve the current forest health situation; and
- practice adaptive management

1.2 SCOPE OF THE FOREST HEALTH STRATEGY

This strategy applies to the Northeast Region, which contains three Timber Supply Areas (TSAs). The TSAs are located in the north central interior of BC and include: Fort Nelson, Fort Saint John, and Dawson Creek (Figure 1). Together they cover approximately 16.7 million hectares and combined, current annual allowable cut (AAC) is 5.6 million m³/year. For more information on the AAC by TSA and effective dates, please see: <https://www.for.gov.bc.ca/hts/aactsa.htm>



FIGURE 1 - THE NORTHEAST REGION.

1.3 OVERVIEW OF TIMBER SUPPLY AREAS

FORT NELSON TSA

The Fort Nelson TSA covers approximately 9.8 million hectares and extends from the Alberta border in the east and up to the Yukon border to the north (Figure 2). The Fort Nelson Natural Resource District administers the TSA. The current AAC is 1,625,000 m³/year (effective as of November 2006).

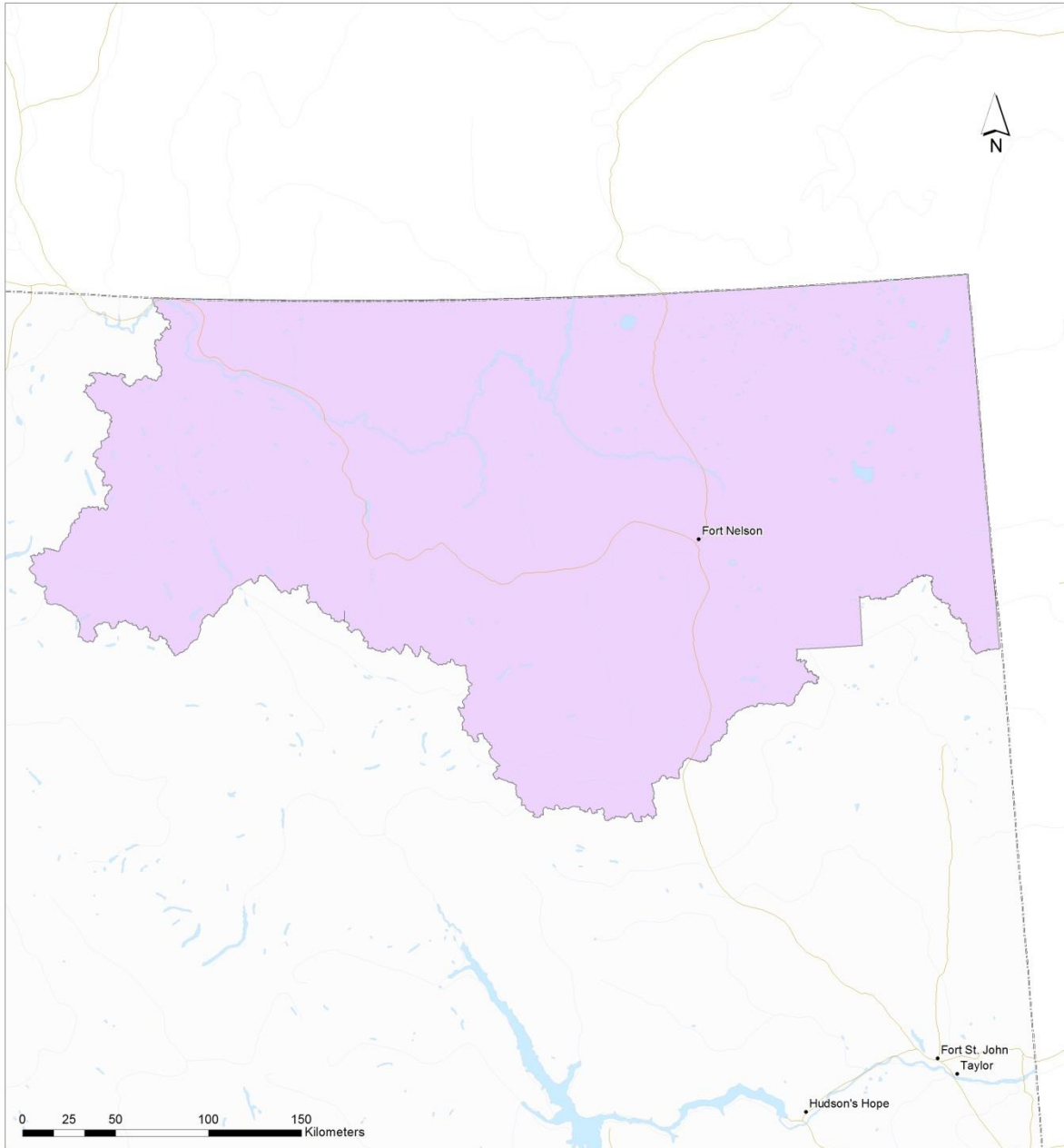


FIGURE 2 – THE FORT NELSON TSA.

FORT SAINT JOHN TSA

The Fort Saint John TSA is located in northeastern BC, south of the Fort Nelson TSA. Fort Saint John TSA covers approximately 4.6 million hectares (Figure 3) and is administered from the Peace Natural Resource District. The current AAC is 2,115,000 m³/year (effective as of December 2007).

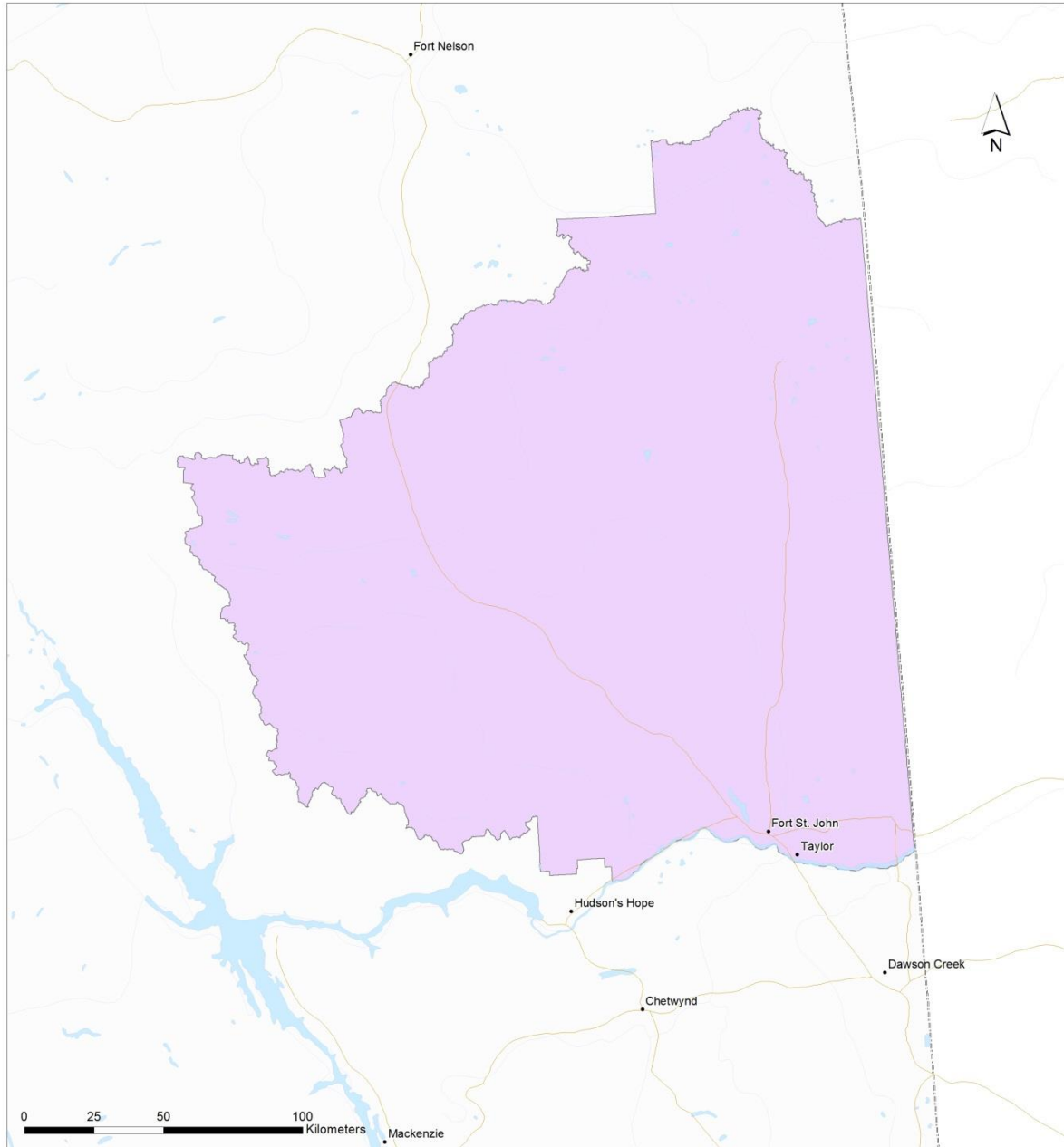


FIGURE 3 – THE FORT SAINT JOHN TSA.

DAWSON CREEK TSA

The Dawson Creek TSA is located northeastern BC (Figure 4), south of the Fort Saint John TSA and east of the Mackenzie TSA. The total area is approximately 2.3 million ha and the current AAC is 1,860,000 m³/yr (effective as of October 2014). This TSA is administered from the Peace Natural Resource District office, which is located in Dawson Creek.



FIGURE 4 – THE DAWSON CREEK TSA.

2 NORTHEAST PEST ALERT!

New or noteworthy pests and pathogens in the Northeast Region.

The **Northeast Pest Alert** highlights new or unusual forest health issues. This includes invasive species with a potential for expansion or lesser known pests and pathogens of interest to forest professionals and the general public in the Northeast region. We will also use the pest alert to request samples or sighting of rare or new pests and pathogens.

2.1 ENDEMIC INSECTS AND PATHOGENS

2.1.1 “DIESEL ROT”

There have been several anecdotal reports of a brown stain/rot (yet to be formally identified) occurring in the both healthy and beetle-killed spruce trees coming into mills within the Prince George TSA, Omineca Region (Figure 5). **At this time it is not known whether the discoloration is associated with reduced wood quality or if the causal agent modifies the wood structure; more information is required in order to determine the relevance of this discoloration.** This year, we will attempt to identify the rot and search for information on its prevalence and life history, if available. If forest professionals in the Northeast are encountering “diesel rot” in their operating areas, please do not hesitate to contact Jewel Yurkewich, Regional Pathologist (Jewel.Yurkewich@gov.bc.ca), or Jeanne Robert, Regional Entomologist (Jeanne.Robert@gov.bc.ca) to pass on information regarding the location of “diesel rot” or to submit samples from boards containing the rot. Physical samples of the rot are needed in order to facilitate identification.



FIGURE 5 – AN EXAMPLE OF “DIESEL ROT” IN A NEWLY CUT SPRUCE BOARDS, “DIESEL ROT” IS A CURRENTLY UNIDENTIFIED STAIN ENCOUNTERED DURING THE MILLING OF BOTH HEALTHY AND SPRUCE BEETLE-KILLED TREES. PHOTO CREDIT: CANADIAN FOREST PRODUCTS LTD.

2.1.2 UNKNOWN *POPULUS* SPP. FOLIAR DISEASE – FORT NELSON

In the 2016 Aerial Overview Survey (AOS), surveyors mapped an unknown foliar disease in the area around Fort Nelson (Figure 6); the disease appeared to be concentrated in upland stands, on cottonwood leaves (*Populus balsamifera*). The samples were examined but the results were inconclusive due to the presence of multiple fungal species, and therefore it was difficult to determine the identity of the primary pathogen. However, cottonwood leaf rust (*Melampsora occidentalis*) was positively identified. Please refer to the 2016 AOS Summary Report for more details. In order to facilitate accurate identification in the years to follow, the best samples should be collected in late July (when the leaves begin to turn 'blotchy brown') through August (as the leaves grow progressively discoloured). If you are working in an area with similar symptoms please contact Jewel Yurkewich, Regional Pathologist (Jewel.Yurkewich@gov.bc.ca) to determine if you should collect samples. If you do collect samples, they can simply be placed in paper bags, labeled with the date and mailed to Jewel Yurkewich, Regional Pathologist, or Jeanne Robert, Regional Entomologist (jeanne.Robert@gov.bc.ca).

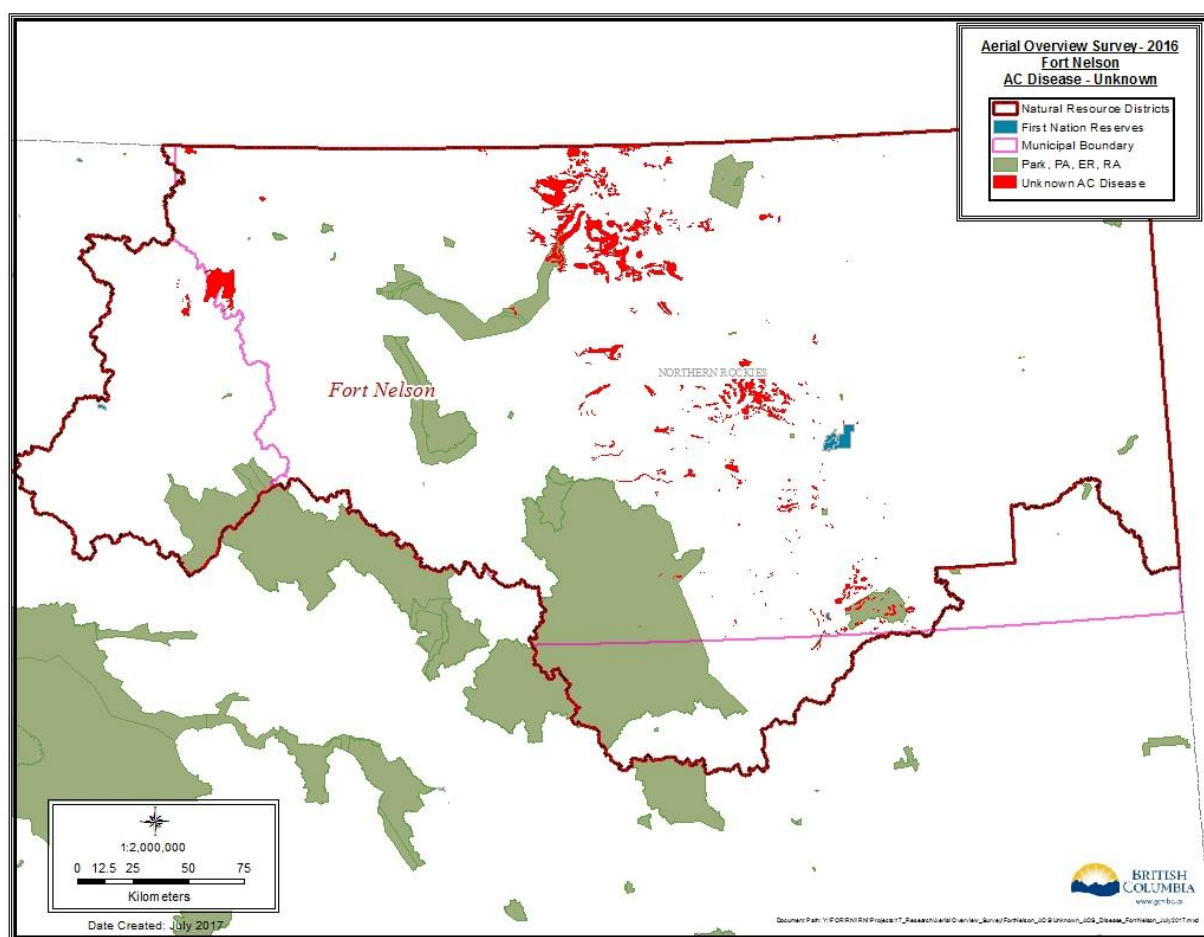


FIGURE 6 – 2016 AERIAL OVERVIEW SURVEY DATA SHOWING THE GENERAL LOCATIONS OF THE UNKNOWN COTTONWOOD FOLIAR DISEASE.

2.2 INVASIVE INSECTS AND PATHOGENS

For information on invasive plants for this region, please see <http://nwipc.org/>.

For information on additional invasive pests, please see:

<http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/invasive-pests-and-biosecurity>

2.2.1 WHITE PINE BLISTER RUST (*CRONARTIUM RIBICOLA*)

White pine blister rust is an invasive pathogen that primarily affects Western white pine (*Pinus monticola*) and whitebark pine (*Pinus albicaulis*); however, this pathogen is responsible for the decline of several 5-needle pines in North America. Whitebark pine only occurs at high-elevation, subalpine locations and several locations in the Omineca Region represent the most northern tips of its distribution. The significance of whitebark pine infection is primarily the ecological and social implications, with emphasis on wildlife cover and food, watershed protection, ecological succession, subalpine biodiversity, and for its visually aesthetic and recreational considerations (Tomback et al. 2001). Whitebark pine is threatened by its susceptibility to white pine blister rust.

Last summer the Sidney Williams Whitebark Pine Assessments 2016 project was underway. Alana Clason and Bonnie Hooge worked to establish permanent transects to complement the initial field work conducted by Stefan Zeglen in 2002, and to assess the health and productivity of the pines. The overall objectives of the project were to:

- 1) Evaluate the health of the candidate screening trees;
- 2) Establish long-term white pine blister rust monitoring transects; and
- 3) Determine the potential cone crop for 2017.

The continuation of the project was funded by the Landbase Investment Strategy (LBIS) and is focused on monitoring the cone production of infected pines for seed collection and resistance screening purposes. A summary report, *Sidney Williams Whitebark Pine Assessments 2016*, was prepared by Alana Clason and is available through Kevin Hoekstra, Senior Ecosystems Biologist (Kevin.Hoekstra@gov.bc.ca). The work on white pine blister rust continues this upcoming summer with further investigation of tree health, population dynamics, and microsite conditions conducive to infection and tree mortality.

In addition to the field work, many experts are gathering in Jasper National Park to host the Whitebark Pine Ecosystem Foundation 2017 Science and Management Meeting in September. For more information please visit: <http://www.whitebarkpine.ca/>

The publication completed by Stefan Zeglen, Regional Forest Pathologist - West and South Coast (Stefan.Zeglen@gov.ba.ca) can be found at: <http://www.nrcresearchpress.com/doi/pdf/10.1139/x02-049>

A tactical plan exists for managing whitebark pine in the Omineca and can be found here: http://www.whitebarkpine.ca/uploads/4/4/1/8/4418310/wbp_management_in_omineca.pdf

A Forest Health Stand Establishment decision Aid (SEDA) for white pine blister rust was developed for the Southern Interior Forest Region. The SEDA is available at: https://www.for.gov.bc.ca/ftp/DSQ/external/!publish/forest%20health/SEDA_WPBlisterRust.pdf

3 INTERPRETING THE NORTHEAST FOREST HEALTH STRATEGY

This Forest Health Strategy has been developed using information and input from experienced personnel with knowledge and insight into the priority pests (e.g. bark beetles) and/or pathogens (e.g. rusts) for each TSA. Forest health factors are prioritized within each TSA using this information and input. For the priority pests and pathogens, specific proactive and reactive measures are incorporated whenever possible.

Proactive forest health measures require an awareness of potential problems, an ability to analyze hazard and risk for damaging agents and stand types, “pest-aware” silviculture and harvesting practices, use of cost/benefit analyses, knowledge of existing management techniques, and the willingness to explore new ideas and technologies. Proactive forest health measures help to moderate extreme pest cycles, reduce future pest outbreaks, and ensure the sustainability of forest resources.

Reactive measures are an unavoidable part of the forest health program due to the relatively unpredictable nature of existing and new forest damaging agents. Reactive forest health measures focus on the suppression of expanding pest outbreaks using short-term direct control methods with the intent of lowering pest populations and preserving resource values.

Our goal is to develop pest or pathogen-specific strategies that contain both proactive and reactive activities. The specific strategies are designed to help practitioners and tenure holders respond to forest health situations in a timely and appropriate manner.

3.1 MANAGEMENT UNIT BOUNDARIES AND DESIGNATIONS

Management unit boundaries for bark beetles were established in each of the TSAs as a basis for developing consistent pest-specific strategies within each area. These Beetle Management Unit (BMU) boundaries were based on existing Landscape Units. Management units do not exist for all priority forest health factors due to population dynamics, ephemeral expression of signs and symptoms, knowledge gaps, issues of accessibility or limitations of current monitoring programs (i.e., forest health factors that are undetectable from the height of the Aerial Overview Survey [AOS]).

Currently, mountain pine beetle (pest code: IBM) and spruce beetle (IBS) are the forest health factors that have been assigned a management strategy in the Northeast using BMUs. Although BMUs are designated independently, it is important to recognize that units are not isolated, and therefore may influence adjacent units. Furthermore, the strategy selected for a unit must be compatible and logical with those of adjacent units and with the overall integrated resource use plans for the TSA (detailed information on assigning strategy designations to beetle management units is in Appendix 1).

3.2 RANKING OF FOREST HEALTH FACTORS

To allocate resources effectively, forest health factors relative to the Fort Nelson, Fort Saint John and Dawson Creek TSAs have been ranked by merging online survey results with local experience and knowledge; the ranking includes both major bark beetles, and other priority insects and pathogens. Additional information considered in order to validate the rankings included:

- known or suspected impacts on forest resource values;
- distribution of pest and current incidence levels;
- resources required to obtain missing information necessary for management; and
- overall level of knowledge about the hazard and risk zones.

As this strategy is evaluated and revised annually, the 2017 rankings represent a unified direction for forest health management in the Northeast Region. As additional information and analyses regarding the impacts become available, the information will be integrated into the rankings and development of the management strategies reflected in the annual Forest Health Strategy.

There are four tables, the first contains the ranking from high importance to low importance of forest pests in the Northeast, the second contains the rankings for forest pathogens, the third contains the rankings of abiotic and animal damage, and the fourth contains a ranking of declines and complexes (forest health issues with more than one pest or pathogen causing symptoms). For example, more information on aspen decline can be found here: <https://cfs.nrcan.gc.ca/projects/124>.

TABLE 1 – RANKING OF ECOLOGICAL AND ECONOMIC IMPORTANCE OF COMMON FOREST PESTS OCCURRING IN THE NORTHEAST REGION.

Pest	High importance	Moderate importance	Low importance
Major Bark Beetles:			
Mountain pine beetle		☒	
Spruce beetle		☒	
Western balsam bark beetle			*research needed
Other pests:			
Aspen leaf miner		☒	
Birch leaf miner			☒
Bruce spanworm			☒
Conifer aphids / adelgids			☒
Forest tent caterpillar			☒
Hemlock looper			☒
Large aspen tortrix			☒
Pine needle sheath miner			☒
Sawfly damage			☒
Satin moth			☒
Spruce/white pine weevil			☒
Two-year cycle budworm			☒
Warren root collar weevil			☒

***research needed:** the full extent of the potential economic or ecological impact of this pest or pathogen requires more research.

TABLE 2 – RANKING OF ECOLOGICAL AND ECONOMIC IMPORTANCE OF COMMON FOREST PATHOGENS OCCURRING IN THE NORTHEAST REGION.

Pathogen	High importance	Moderate importance	Low importance
Rusts:			
Comandra blister rust		☒	
Stalactiform blister rust		☒	
Western gall rust		☒	
White pine blister rust			☒
Blight:			
Dothistroma (red band)			☒
Venturia spp.			☒
Other pathogens:			
Tomentosus root rot			☒

TABLE 3 – RANKING OF ECOLOGICAL AND ECONOMIC IMPORTANCE OF ANIMAL DAMAGE OCCURING IN THE NORTHEAST REGION.

Animal and Abiotic damage	High importance	Moderate importance	Low importance
Animal:			
Moose			☒
Hares / rabbits			☒
Abiotic:			
Drought			*monitor
Frost			☒
Snow press			☒
Windthrow		☒	

***monitor:** although this pest is of low importance in the Omineca, there is potential for an increase of spread within the next year or two and so the population should be carefully monitored

TABLE 4 – RANKING OF DECLINES AND COMPLEXES (FOREST HEALTH ISSUE WITH MORE THAN ONE PEST OR PATHOGEN CAUSING SYMPTOMS) IN THE NORTHEAST REGION.

Decline / complex	High importance	Moderate importance	Low importance
Cedar flagging			☒
Aspen/birch/cedar decline			☒

4 MAJOR BARK BEETLES IN THE NORTHEAST

Although mountain pine beetle populations continue to decline in British Columbia, projected climate change data combined with several consecutive years of favourable weather conditions, indicate that bark beetles will continue to be a high priority issue for forest health management for the foreseeable future.

Climate change, weather, and bark beetles: Regular bark beetle outbreaks are a normal occurrence in the pine and spruce-dominated forests in the Northeast region, but recent changing climate and weather patterns have resulted in very good conditions for bark beetle populations to increase beyond the historical range and severity. This region shows a general trend towards warmer weather and decreased annual precipitation since 1910 (Foord 2016). Throughout the northeast since 1910, annual precipitation has decreased more than 15% on average, and the average minimum temperature has increased 2.8°C. In addition, the number of degree days and frost-free days are projected to increase into the future (Foord 2016). These trends mean that bark beetle overwintering mortality due to early winter cold snaps may no longer be a strong natural population control. High overwintering beetle survival due to warmer winters, longer beetle development times due to an extended growing season, and stressed host trees due to decreased precipitation favour the development of multiple robust bark beetle populations throughout the region that are difficult to control.

The impact of bark beetles: The impact from mountain pine beetle and spruce beetle, and western balsam bark beetle are not limited to timber loss. There are also significant impacts on carbon sequestration, recreation, fish and wildlife, watershed management, range, landscape and aesthetics, cultural heritage, and other resource values. Bark beetle suppression strategies have been developed and implemented with due consideration for these other resource values while sustaining a strong economic approach rooted in providing a long-term supply of fiber to local mills. The goal of bark beetle management must be to minimize the spread of bark beetles, to minimize the loss of crown timber, and to protect non-timber resource values.

4.1 MOUNTAIN PINE BEETLE (*DENDROCTONUS PONDEROSAE*)



Mountain pine beetle continues to decline in the Northeast after the unprecedented 2007 peak outbreak covering 10 million hectares in BC. For the Northeast region, the population dropped from 178,987 hectares in 2015 to 36,088 hectares in 2016. At the tail end of an unprecedented outbreak, there is little short term action that can be applied beyond the continued salvage of beetle-killed pine where it is economically feasible and ecologically reasonable. The general strategy for mountain pine beetle should be longer term planning of pine-dominated forests while keeping in mind other forest health factors (for example, please see blights [Section 5.3], mistletoe [Section 5.7], and rusts [Section 5.8-5.10]). **Re-planting of mountain pine beetle-killed stands must be conducted with foresight for prevention of future outbreaks in mind.** In the long term, this insect population is only temporarily reduced, and given climate predictions for this region, a population outbreak will likely recur when the host population recovers.

The mountain pine beetle is now established in Alberta. Overwintering data in Alberta from 2016 indicates that populations are continuing to increase in a large proportion of the infested area in Alberta. This illustrates the remarkable adaptability and tenacity of bark beetles and highlights the impact of recent weather patterns that allowed mountain pine beetle to thrive in an area outside its historical range using a novel host species (Jack pine, *Pinus banksiana*) (Cullingham 2011). Mountain pine beetle has also now established in southwest Saskatchewan.

FORT NELSON TSA

The mountain pine beetle population continued to decline in the Fort Nelson TSA (15,039 hectares in 2016). The current attack is concentrated on the southern border with the Fort Saint John TSA. The majority of the TSA is therefore in the “monitor” strategy (Figure 7).

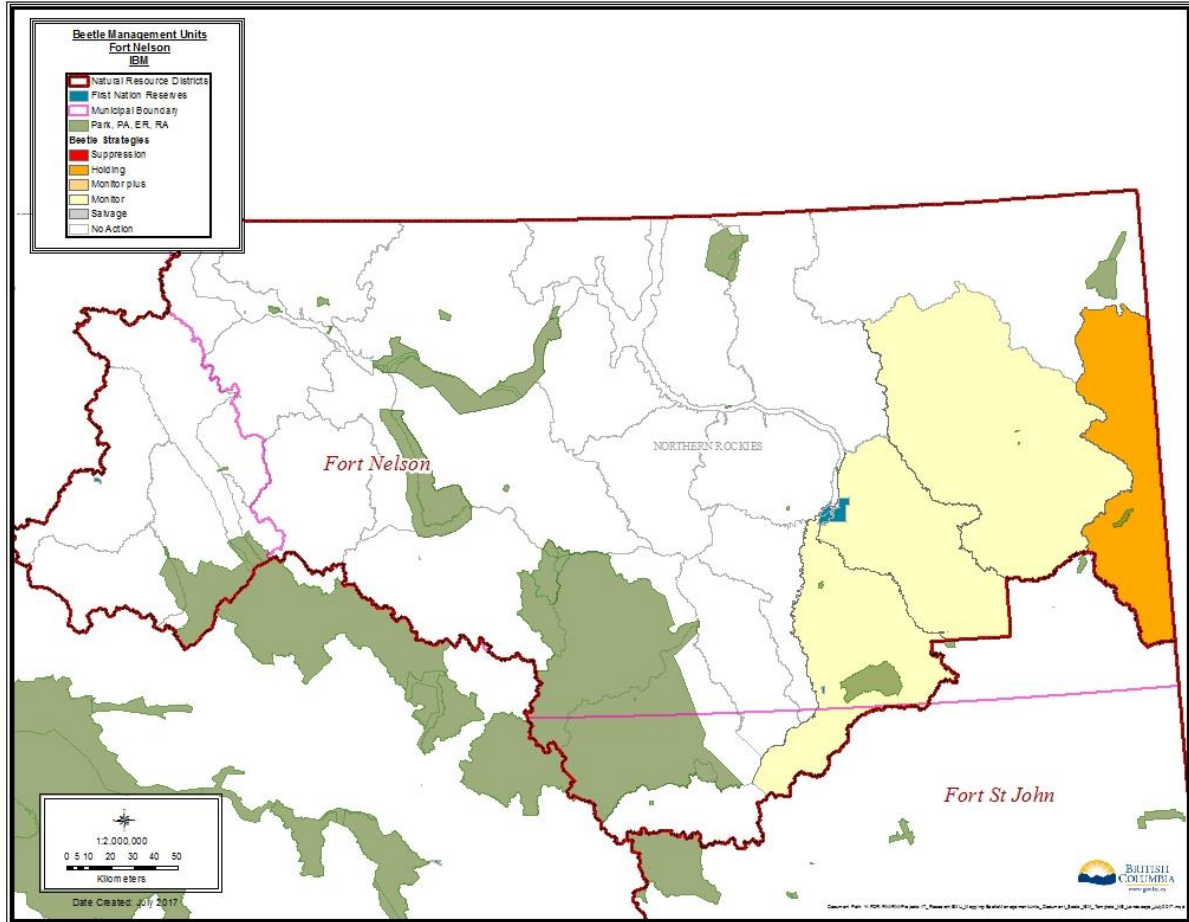


FIGURE 7 – FORT NELSON TSA FOREST HEALTH STRATEGY FOR MOUNTAIN PINE BEETLE.

FORT SAINT JOHN TSA

Mountain pine beetle populations dropped precipitously in the Fort Saint John TSA – there was a total of 2,282 hectares mapped in 2016. We will continue to monitor the population during the Annual Aerial Overview survey, but the small and light infestation put mountain pine beetle on the back burner for this year in the Fort Saint John TSA. The predominant strategy in the Fort Saint John TSA should be “monitor” or “no action” (Figure 8).

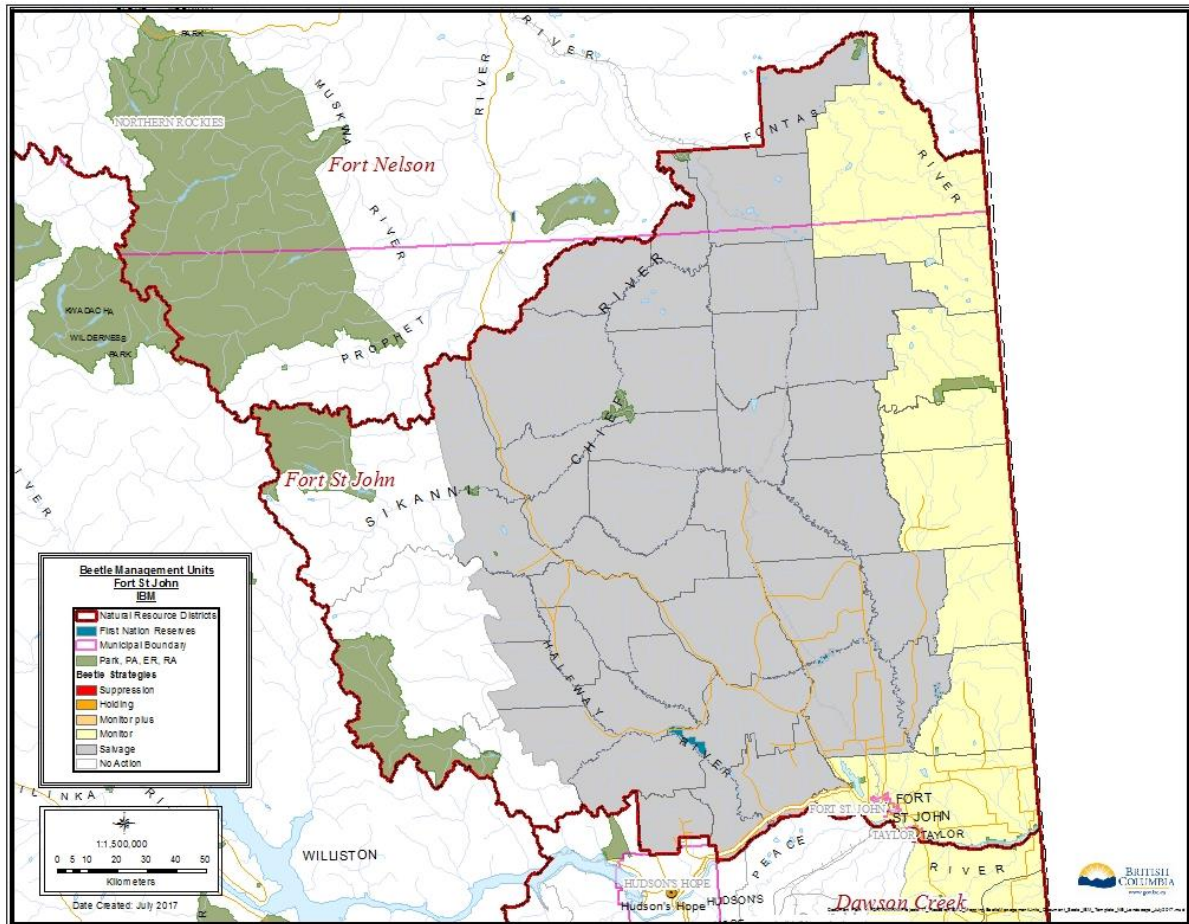


FIGURE 8 – FORT SAINT JOHN TSA FOREST HEALTH STRATEGY FOR MOUNTAIN PINE BEETLE.

DAWSON CREEK TSA

In 2016, 18,766 hectares of mountain pine beetle mortality was mapped in the Dawson Creek TSA. Although this is the highest level of mountain pine beetle infestation in the Northeast Region for 2016, the infested areas were designated light to moderately severe. Only 30 hectares showed a severe infestation. Ongoing efforts to reduce the population of mountain pine beetle should be continued where practicable, and the strategy for most of the mountain pine beetle management units are “monitor” or “no action” (Figure 9).

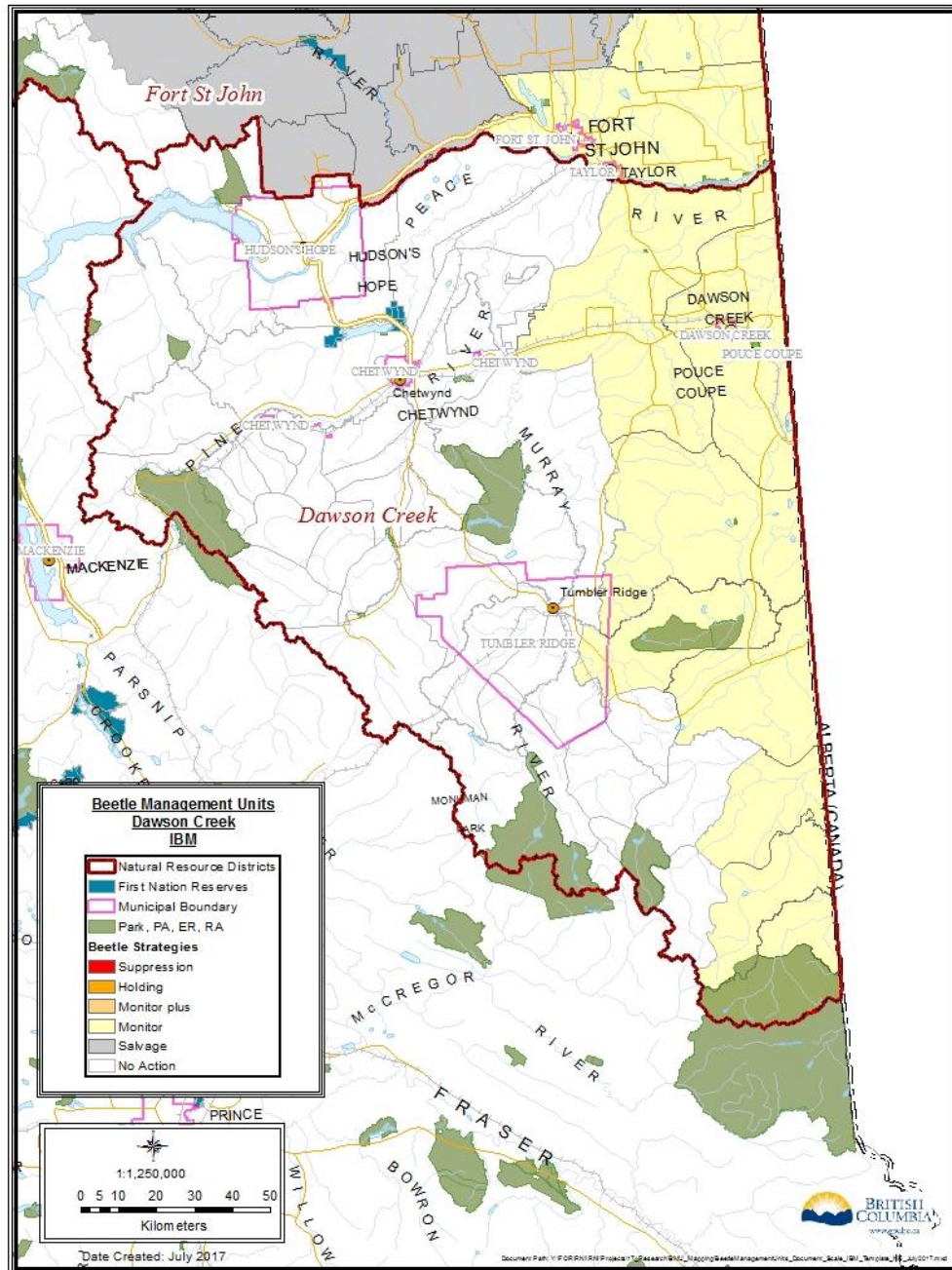


FIGURE 9 – DAWSON CREEK TSA FOREST HEALTH STRATEGY FOR MOUNTAIN PINE BEETLE.

4.2 SPRUCE BEETLE (*DENDROCTONUS RUFIPENNIS*)



Outbreak in the Omineca – implications for the Northeast: Warmer spring and summer temperatures in the Prince George and Mackenzie TSAs since 2014, combined with reduced precipitation and windthrow events have culminated in a 218,406 hectare outbreak of spruce beetle in the Omineca region in 2016. Overwintering brood success data from the outbreak area suggests that beetles are shifting from the more common two-year life cycle to a one-year cycle and showing sufficient overwintering brood survival for a population increase in 2017. Because of the size of the current outbreak, as well as the increase in the intensity of attack in the infested areas, spruce beetle populations should be carefully monitored in Northeast region throughout 2017 to track both the size of the infestation as well as any shift from a two-year life cycle to a one-year life cycle within the beetle population.

Tools: A wide range of tools have been developed to mitigate spruce beetle damage. Some of the available tactics include: overview and detailed aerial and ground surveys; single tree treatments of conventional trap trees; fall and burn; fall and peel; pheromone baiting; sanitation/salvage harvesting; hazard and risk rating; and high hazard host removal. In addition, a spruce beetle working group for the Northeast was formed with licensees in order to coordinate the response to the spruce beetle outbreak. Anne Marie Fonda (AnneMarie.Fonda@gov.bc.ca), Stewardship Specialist, is the spruce beetle contact for the Northeast working group.

Additional information on provincial spruce beetle management initiatives can be found here: <http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/spruce-beetle/omineca-spruce-beetle>

The above link contains maps showing the extent of the current outbreak in Prince George and Mackenzie districts and provides links to guidance documents for beneficial management practices, trap tree use, and hauling and milling restrictions. This website will be updated as new information and guidance becomes available.



Working Together - British Columbia's Spruce Beetle Mitigation Strategy:

Heather Wiebe was appointed as the Spruce Beetle Project Manager in February 2016 in order to coordinate a consistent and effective response to the current spruce beetle outbreak from licensee and government representatives in the Omineca and Northeast Regions. In 2017, Heather Wiebe is moving on to other projects, but John Huybers, Prince George District Manager (John.Huybers@gov.bc.ca), is taking over as the Spruce Beetle Project Lead.

Training A spruce beetle probing course using these guidelines is offered by UNBC continuing studies in Prince George (see: <http://www.unbc.ca/continuing-studies/courses>). This is a practical course designed for forest consulting personnel who intend to conduct ground detection surveys for spruce beetle. It will be instructed by Robert Hodgkinson (FLNRORD Forest Entomologist Emeritus: Robert.Hodgkinson@gov.bc.ca).

Should the outbreak population continue to increase and spread in the Northeast, trained and experienced beetle-probing professionals are a key resource for timely and effective monitoring of infestations. In order to avoid a shortfall of qualified beetle probing surveyors, we strongly encourage consulting professionals, licensees, and government employees involved in on-the-ground spruce beetle management to complete the training course this year.

The general provincial spruce beetle management strategy can be found here:

http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/4805dc_ominecasprucebeetlestrategy_web.pdf

The communication and management response included the formation of a public advisory committee to provide input into developing and implementing a spruce beetle management plan. For more information please contact Jeanne Robert, Regional Entomologist (Jeanne.Robert@gov.bc.ca) or John Huybers, Spruce Beetle Project Lead (John.Huybers@gov.bc.ca).

FORT NELSON TSA

The Fort Nelson TSA did not have a large area mapped for spruce beetle in 2016. There was a total of 3,904 hectares of track and light attack in the TSA. Because of the outbreak to the south in Omineca and reported spruce beetle outbreaks occurring in Alaska in 2016, the populations throughout the Northeast region should be carefully monitored this year (Figure 10).

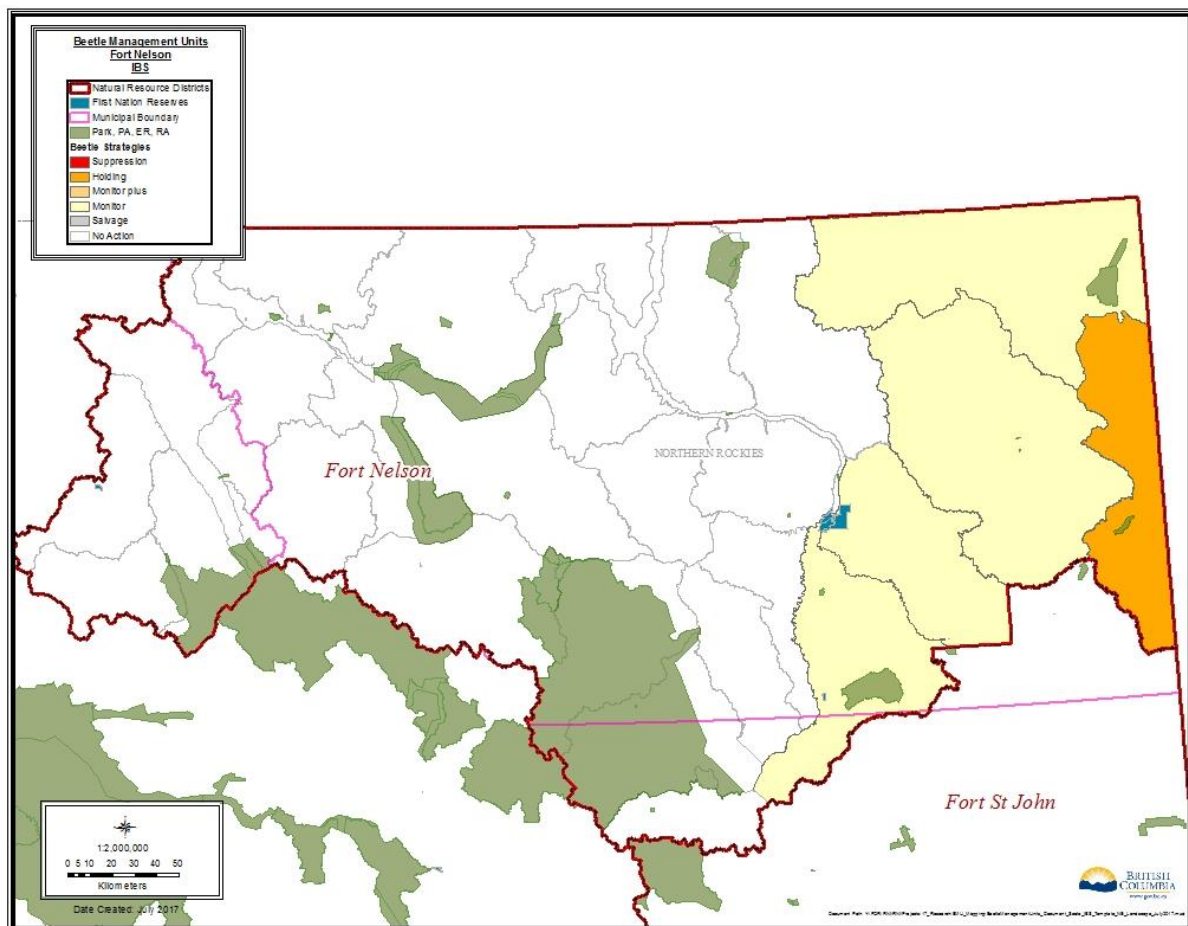


FIGURE 10 – FORT NELSON TSA FOREST HEALTH STRATEGY FOR SPRUCE BEETLE.

FORT SAINT JOHN TSA

The Fort Saint John TSA did not have a large area mapped for spruce beetle in 2016, where there was only 1,930 hectares of attack. Because of the outbreak to the south in Omineca and reported spruce beetle outbreaks occurring in Alaska in 2016, the populations throughout the Northeast region should be carefully monitored this year (Figure 11).

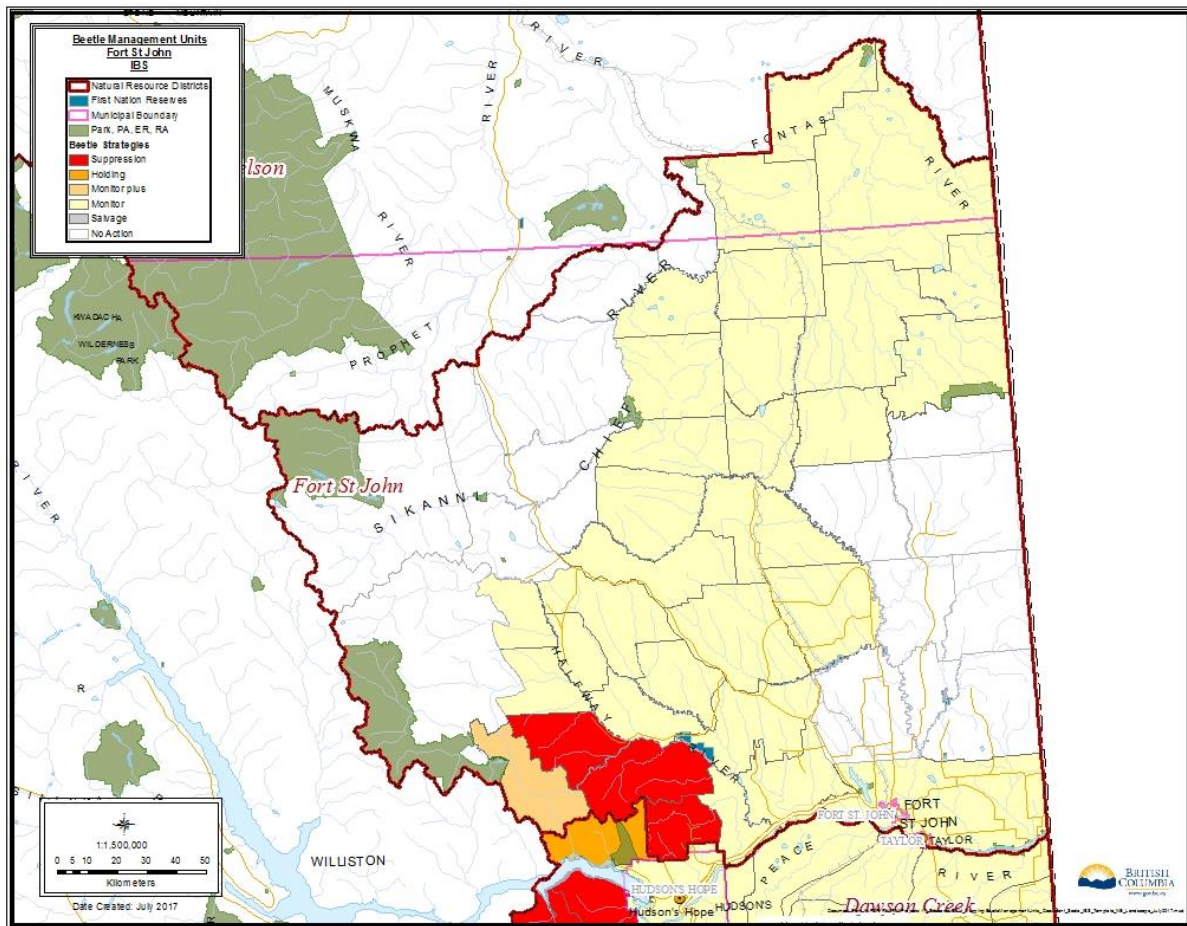


FIGURE 11 – FORT SAINT JOHN TSA FOREST HEALTH STRATEGY FOR SPRUCE BEETLE.

DAWSON CREEK TSA

The Dawson Creek TSA sustained the highest amount of spruce beetle attack in the Northeast region, with 4,408 hectares mapped in 2016. The majority of the infested area is directly adjacent to the Mackenzie TSA and is likely a result of increased population pressure from the outbreak center there. The beetle management units to the south and west of the Dawson Creek TSA are therefore predominantly labeled “suppression” and the rest of the TSA should be carefully monitored to identify any early infestations in standing healthy trees (Figure 12).

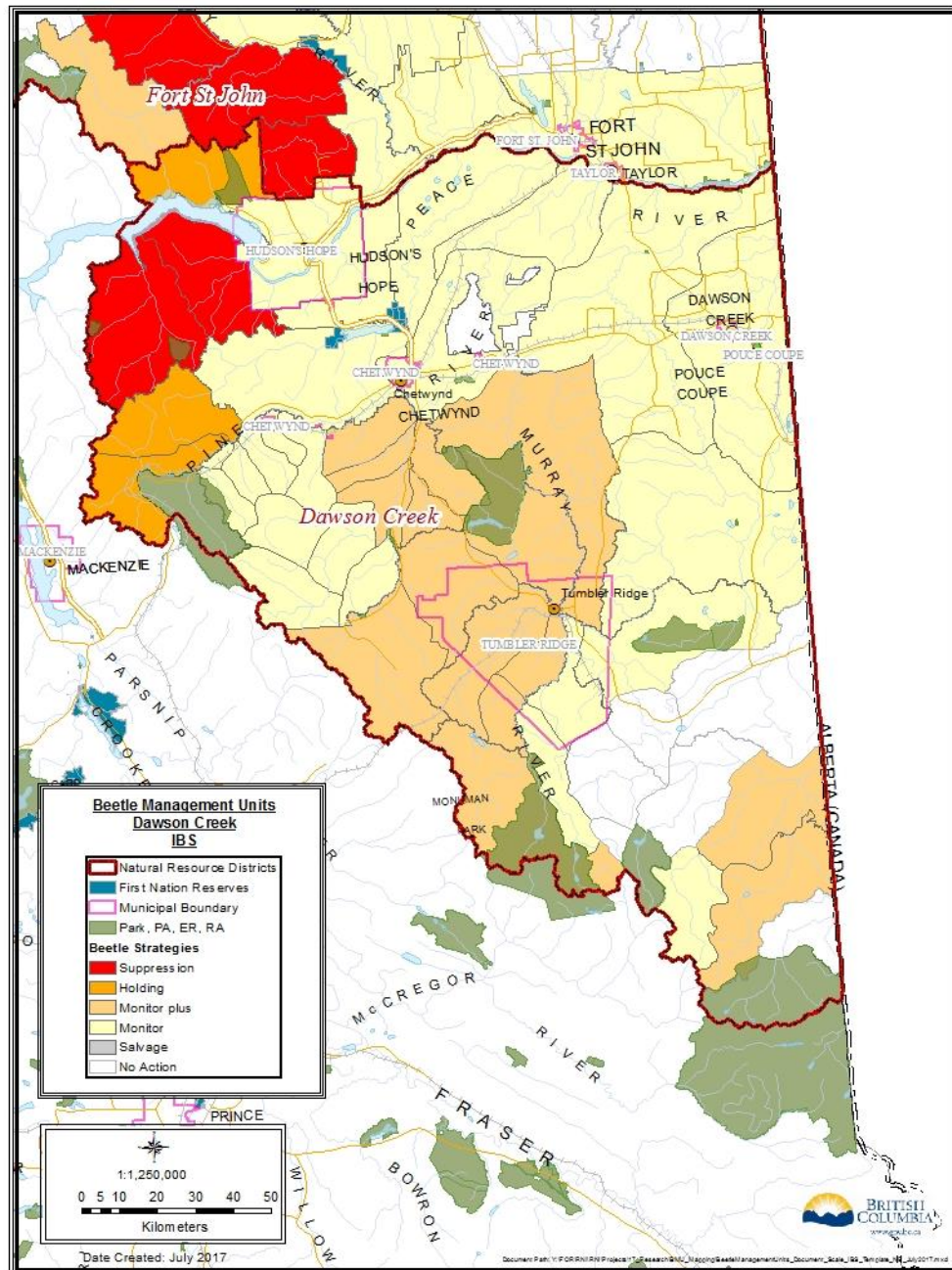


FIGURE 12 – DAWSON CREEK TSA FOREST HEALTH STRATEGY FOR SPRUCE BEETLE.

4.3 WESTERN BALSAM BARK BEETLE (*DRYOCETES CONFUSUS*)

Western balsam bark beetle causes significant mortality of sub-alpine fir throughout British Columbia. The provincial infestation area for western balsam bark beetle increased in 2016 to **over 3.2 million hectares**. In the Northeast region, the infestation area for western balsam bark beetle was relatively constant between 2015 and 2016 (227,605 hectares in 2016). This was the exception in the province where most regions showed substantial increases in western balsam bark beetle mortality. The majority of the damage occurred in the adjacent Omineca region with over 1.4 million hectares damaged. Careful monitoring of population trends is recommended in the Northeast.

Although western balsam bark beetle does not historically rank highly for economic and ecological importance in regional forest health strategies, the scale of the provincial and regional damage, along with the significant increase in affected area, warrants further investigation. Difficulties with management arise from the scattered nature of attack over susceptible host types, and the low level of management currently employed against the bark beetle. Infested areas can be salvaged where feasible, especially where western balsam bark beetle is concurrent with other forest health factors, such as spruce beetle. Stands scheduled for harvest could be proactively baited with aggregation pheromones to help concentrate beetles in the stands scheduled to be harvested within a defined timeframe.

5 OTHER PRIORITY INSECTS AND PATHOGENS IN THE NORTHEAST

This section of the strategy is intended to provide information and context around the management of priority insects and pathogens that are not accurately represented by the Aerial Overview Survey (AOS) and those that may pose management challenges that are complicated and not easily resolved by increasing financial investment. In most cases, the management of these insects and pathogens requires improved data collection procedure, further research, and a site-specific approach that incorporates ecological linkages and a climate change lens. TSA-specific information is presented for some of the pests where our monitoring efforts (AOS, detailed surveys, on-site data collection) have captured clear differences. In cases where such differences have not been captured, the knowledge gaps and best management practices have been identified; this provides an opportunity to engage in constructive conversation with the district staff, licensees, tenure holders, and the public regarding how to improve the management of forest pests or mitigate the impacts within the Northeast region.

5.1 TWO-YEAR CYCLE BUDWORM (*CHORISTONEURA BIENNIS*)

Two-year cycle budworm is a major insect defoliator of interior spruce (*Picea engelmannii* X *P. glauca*) and subalpine fir (*Abies lasiocarpa*) in central BC. The provincial infested area increased significantly to 160,143 hectares in 2016, but no budworm was identified in the Northeast region. The two-year cycle budworm's economic and ecological importance was therefore ranked low in the Northeast for 2017-2018.

5.2 ASPEN LEAF MINER (*PHYLLOCNISTIS POPULIELLA*)

The sheer size of the area infested by aspen leaf miner (1,226,265 hectares in BC) elevates this pest to moderate in the forest health factor rankings (Table 1), although the total provincial area is down to about half of the peak in 2014. The infestation area in the Northeast increased to 222,158 hectares in 2016.

Although aspen (*Populus tremuloides*) can generally tolerate repeated defoliation over several years, the combination of widespread infestation of aspen leaf miner, infestation by large aspen tortrix (Section 5.3), infection by *Venturia* blight (Section 5.5), and/or drought may contribute to a general aspen decline. Continued research in to the potential impact of aspen leaf miner is priority for 2017-2018.

5.3 LARGE ASPEN TORTRIX (*CHORISTONEURA CONFLICTANA*)

There were no significant populations of large aspen tortrix recorded in the Northeast region mapped in the 2016 aerial overview survey. These defoliators are not expected to cause significant damage on aspen or secondary host species (including balsam, poplar, birch, and willow) in 2017-2018 since outbreaks are short-lived (Cerezke 1992), and no infestation areas were mapped.

5.4 RED BAND NEEDLE BLIGHT (*DOTHISTROMA SEPTOSPORUM*)

Epidemic levels of *Dothistroma* needle blight can develop rapidly and the severity and extent of the damage cannot be predicted. *Dothistroma* needle blight in young lodgepole pine plantations should be seen as a warning of the potential risk that foliar diseases might pose, particularly when species diversity is not maintained. In 2016, the AOS captured 5,559ha of pine infected by *Dothistroma* in the Omineca. Although, *Dothistroma* was not reported in the Northeast, it is important to monitor pine plantations for this pathogen.

It is important to note that the AOS does not align with the most easily detected window of expression (early to late spring before the buds flush) for red band needle blight but improvements are being made. Therefore it is important to monitor stands in the early spring, and record and report the location of infected stands to Jewel Yurkewich, Regional Pathologist (Jewel.Yurkewich@gov.bc.ca).

Currently, the provincial team of pathologists are working together to develop a monitoring programme focused on foliar pathogens. The methodology is designed to supplement the AOS and to provide additional, systematic details about the progression of foliar pathogens in targeted areas over time. More information will be available following the 2017 field season.

5.5 ASPEN, POPLAR LEAF AND TWIG BLIGHT (*VENTURIA SPP.*)

In BC, the incidence of *Venturia* blight quadrupled to 55,049 ha from 13,636 ha last year. Although the majority of the infection was found on trembling aspen in the Skeena region, monitoring these pathogens is still important in the Northeast as they reflect the changing growing conditions in adjacent areas. According to the 2016 AOS Summary, impact in the Northeast region totaled 4,188 ha with the majority (3,655ha) occurring in the Fort Nelson TSA.

When moist weather conditions prevail during the previous and current growing season, *Venturia* can kill most shoots in aspen stands regenerating by sprouting. Repeated infection results in stem deformity and growth reduction. These diseases are most severe in young stands and have the greatest impact in intensively managed plantations. However, the area reported as infected by *Venturia* in the AOS is dominantly composed of mature stands with infected crowns.

5.6 TOMENTOSUS ROOT DISEASE (*ONNIA TOMENTOSA*)

Tomentosus (*Onnia tomentosa* = *Inonotus tomentosus*) has been found to have inconsistent above ground symptoms and its distribution is not captured by the AOS or other details surveys. The location of specific disease centers requires local, expert knowledge and proper documentation. If an area is impacted by tomentosus or is suspected of having high hazard rating please send the location and stand descriptors to Jewel Yurkewich, Regional Pathologist (Jewel.Yurkewich@gov.bc.ca). This information will be used to develop a database for areas impacted by tomentosus that can be used for both management and research applications.

Infected trees may appear healthy, but often have extensive butt cull and reduced annual increment growth. The distribution of infection ranges from scattered individual trees to defined centers dependent on the presence of host species. The fungus spreads from tree to tree at points of root contact; consequently, diseased trees occur in groups and mortality results in stand openings. Windthrow may occur before the death of an infected tree. Fruiting bodies on, or around a tree, indicate that three or more meters of rot may be present in the base of the stem. Tomentosus root rot can be a serious problem in second-growth stands as the stumps of infected trees provide an inoculum source for spread up to 20 years post-harvest.

The FPC Root Disease Management Guidebook is currently under revision and is scheduled to become available to practitioners in 2018. This revision covers best practices, and the strategies and tactics for managing tomentosus. For more information refer to the Stand Establishment Decision Aid (SEDA) for tomentosus: <http://jem.forrex.org/index.php/jem/article/view/562>.

5.7 LODGEPOLE PINE DWARF MISTLETOE (*ARCEUTHOBIUM AMERICANUM*)



Lodgepole pine dwarf mistletoe, a parasitic plant which causes swelling of tree stems and irregular branching patterns, is one of the most damaging disease agents in mature lodgepole pine in north central BC. This disease agent causes suppressed growth, decreased wood quality, and increased tree mortality (Hawksworth & Dooling 1984; Ramsfield et al. 2002). Older trees with well-developed, vigorous crowns may not show appreciable effects from the parasite for years after initial infection. However, as the parasite spreads through the crown, the tree's growth slows; eventually the crown dies and then the tree. Insects, particularly secondary bark beetles, frequently invade heavily infected trees and kill them. Dwarf mistletoe also reduces the seed production of the host trees and can cause commercially unacceptable deformities such as cankers and knots (Hawksworth & Dooling 1984).

Although the mountain pine beetle epidemic eliminated the majority of overstory host across a broad area in the north, it is important to consider how we will manage mistletoe in the regenerating stands. The rate of spread has been reduced considerably since lateral spread from advanced regeneration is not as effective as mistletoe rains from the overstory; however, the survival of mistletoe in the understory will allow the pest to perpetuate and persist into the future. **Thus, it is crucial that we identify the stands at risk and that the age class is monitored to ensure that we are managing proactively rather than reactively. This entails designing site preparation treatments with mistletoe in mind and not leaving unnecessary seed trees or retention patches where mistletoe is evident.**

In order to detect and quantify mistletoe experienced forest health surveyors can use a walkthrough survey or the formal Hawksworth survey. The Dwarf Mistletoe Management Guidebook provides guidance on how to

deal with mistletoe infection within both clearcut and partial-cut harvesting systems, and for pre-commercial and commercial thinning in young stands. The Hawksworth six-class dwarf mistletoe rating system survey is also explained within the guidebook. This guidebook can be found at the following website:
<http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/dwarf/dwarftoc.htm>.

To increase our understanding of stand tending options, a mistletoe sanitation trial is currently underway in the Cariboo Region (conducted by David Rusch, Regional Forest Pathologist for the Cariboo & Thompson Okanagan Regions, David.Rusch@gov.bc.ca). Through this research and continued application of local knowledge, the best management practices for lodgepole pine dwarf mistletoe will be revised and adapted to better suit our current growing stock.

Mistletoe was not incorporated into the online Forest Health Survey that we distributed earlier this year. However, it should be considered as moderate importance because it can be expected that as pine stands mature the importance of this parasitic plant will increase to moderate-high importance for management.

5.8 WESTERN GALL RUST (*ENDOCRONARTIUM HARKNESSII*)

The distribution of western gall rust is widespread throughout the province of BC, as well as in the east (Ziller 1974). At this time, no additional information can be presented due to the need for data mining and subsequent summarization of the RESULTS database in order to estimate the relative impact of western gall rust in the Northeast.

Western gall rust is the most common rust of young lodgepole pine. Western gall rust does not require an alternate host to complete its lifecycle, and therefore infection occurs directly from pine to pine. Infection occurs through the spread of spores which are capable of traveling hundreds of kilometers. When local environmental conditions are suitable for spore spread the resultant infection occurs in a fairly uniform to random pattern. Infection from western gall rust is highest in young stands, with approximately 90% of the susceptible trees becoming infected by age ten on most sites. Western gall rust seldom kills older trees, but can kill young trees with main stem infections.



Free growing surveys conducted as early as age 15 should capture 90% of infection on high risk sites. Main stem galls are generally lethal when infection occurs at a very young age, with mortality typically leveling off somewhat by age 20 to 25. Stem deformities persisting into late rotation may result in breakage, cull, and volume loss depending on the severity of infection.

Variation in genetic predisposition is strongest in western gall rust, compared to other stem rusts. Natural resistance to western gall rust has been incorporated into the BC Tree Improvement Program. The main source of resistant seed is from select Orchards, and from a new orchard established in 2010 for the sole purpose of reforesting high risk sites with gall rust resistant material.

5.9 STALACTIFORM BLISTER RUST (*CRONARTIUM COLEOSPORIOIDES*)



Stalactiform blister rust can be locally abundant, but is not widespread. Alternate hosts for stalactiform blister rust include members of the Orobanchaceae family. Most notable are common red paintbrush (*Castilleja* spp.), cow wheat (*Melanpyrum lineare*), and yellow rattlebox, (*Rhinanthus minor* L.). These plants are common on disturbed sites and distributed by contaminated equipment. Significant mortality can occur on sites with moderate to high levels of alternate hosts, particularly if trees are infected at a very young age.

For operational purposes, if stalactiform blister rust is found in a mature stand a walkthrough should be conducted to determine the relative severity, spatial distribution and prevalence of the disease onsite. Please see the [Pine Stem Rust Management Guidebook](#) for details pertaining to the walkthrough. If the walkthrough provides considerable evidence for classifying the site as “moderate-high hazard”, considerations such as modified planting density or species composition must be made in the site plan prior to harvest. If the area of interest has already been harvested and stalactiform blister rust is identified as prevalent onsite after regeneration takes place, it is important to visit the site regularly to monitor the mortality rate. If the disease is found in an area for the first time, please contact Jewel Yurkewich, Regional Pathologist (Jewel.Yurkewich@gov.bc.ca).

5.10 COMANDRA BLISTER RUST (*CRONARTIUM COMANDRAE*)



Comandra blister rust is a persistent and lethal stem rust of lodgepole pine. It girdles and kills young trees rapidly and can occur at very high levels locally. Since spread by spores from the alternate host to pine is typically over a short range, infection is highly clustered and generally corresponds to the distribution of the alternate host, *Geocaulon lividum* (Bastard toadflax)*. Risk is several times higher within close proximity (a few meters) to the alternate host. Resistance in lodgepole pine is not believed to be common, although resistance screening holds potential for identification of resistant families.

For operational purposes, if comandra blister rust is found in a mature stand a walkthrough should be conducted to determine the relative severity, spatial distribution and prevalence of the disease onsite. Please see the [Pine Stem Rust Management Guidebook](#) for details pertaining to the walkthrough. If the walkthrough provides considerable evidence for classifying the site as “moderate hazard”, considerations such as modified planting density or species composition must be made in the site plan prior to harvest. If the area of interest has already been harvested and comandra is identified as prevalent onsite after regeneration takes place, it is important to visit the site regularly to monitor the mortality rate.

Keep in mind that the majority of mortality on moderate-high hazard sites is most likely to occur in the first 5 years. If the disease is found in an isolated area for the first time, please Jewel Yurkewich, Regional Pathologist (Jewel.Yurkewich@gov.bc.ca).

***Please note: throughout the distribution of comandra blister rust in North America there are two documented alternate hosts. In the Northeast Region the most likely alternate host is *Geocaulon lividum*, whereas further south and in the United States *Comandra umbellata* may participate in the pathogen’s lifecycle. Therefore using the scientific name will minimize confusion and promote better understanding; refer to [E-Flora BC](#) for updated common and scientific names.**

5.11 SPRUCE/WHITE PINE WEEVIL (*PISSODES TERMINALIS*)



The spruce weevil is a low impact pest in the Northeast Region, affecting the growth and development of younger interior spruce. Repeated weevil attacks to the leading shoots of young interior spruce trees can result in suppressed height growth and stem deformities. Planting genetically resistant seedlings, appropriate provenances, and mixtures of different species, as well as the use of nurse crops, can help reduce the damage from this pest. Characteristics of susceptible stands include open, sunlit, fast-growing stands of interior spruce, 8–30 years of age, 0.5–12 m tall, with terminal diameters of 5 mm or more. Denser stands have slightly lower attack rates and subsequent damage results in fewer

deformities. Spruce plantations are at risk if adjacent stands have been heavily attacked. For more information, please see the terminal weevil guidebook:

<https://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/weevil/we-toc.htm>.

5.12 LODGPOLE PINE TERMINAL WEEVIL (*PISSODES STROBI*)

This weevil has the potential to set back plantations severely by attacking at least two years of growth and potentially reducing timber quality by creating “shepherd’s crooks” in the juvenile trees. Localized areas have high occurrences; therefore monitoring this pest in areas of known infestations is essential in 2017-2018, but this pest was not identified as a priority forest health factor in the Omineca as a whole. For more information, please see the terminal weevil guidebook:

<https://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/weevil/we-toc.htm>.

5.13 WARREN ROOT COLLAR WEEVIL (*HYLOBIUS WARRENI*)



Warren root collar weevil is an ever-present concern in regenerating stands but, in general, the economic and ecological impact associated with this insect is relatively low.

Warren root collar weevil attacks lodgepole pine, Engelmann spruce, and white spruce. Usually trees over two cm in diameter at the root collar are attacked. The weevil may exist in

mature stands and may subsequently attack the plantations with random mortality of single or groups of trees, especially if an adjacent mature stand has been recently harvested (Klingenberg et al. 2010). Mixed species planting will reduce the damage impacts from this insect.

6 ADDITIONAL INFORMATION

6.1 AERIAL OVERVIEW SURVEY DATA ACCESS

The current and historical data from the annual aerial overview surveys (AOS) can be found on the official forest health website from the BC government:

<http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/aerial-overview-surveys>

6.2 CONTACTS

TABLE 5 – REGIONAL CONTACTS

Name (Last, First)	Title	Email	Telephone
Bevington, Alex	Research Earth Scientist	Alexandre.Bevington@gov.bc.ca	250-561-3460
Geertsema, Marten	Research Geomorphologist	Marten.Geertsema@gov.bc.ca	250-561-3473
Miller, Brendan	Research Soil Scientist	Brendan.Miller@gov.bc.ca	250-561-3474
Rex, John	Research Hydrologist	John.Rex@gov.bc.ca	250-561-3464
Robert, Jeanne	Regional Entomologist	jeanne.Robert@gov.bc.ca	250-561-3461
Rogers, Bruce	Research Ecologist	Bruce.Rogers@gov.bc.ca	250-561-3471
Foord, Vanessa	Regional Research Climatologist	Vanessa.Foord@gov.bc.ca	250-561-3459
Yurkewich, Jewel	Regional Pathologist	Jewel.Yurkewich@gov.bc.ca	778-693-3029

TABLE 6 – FLNRORD CONTACTS FOR SPRUCE BEETLE MANAGEMENT

Name (Last, First)	Title	Expertise / role in forest health	Email	Telephone
Charlston, Alena	Stewardship Forester	Prince George TSA spruce beetle lead and working group coordinator	Alena.Charlston@gov.bc.ca	250-614-7495
Fonda, Anne Marie	Stewardship Specialist	Northeast Region spruce beetle lead and working group coordinator	AnneMarie.Fonda@gov.bc.ca	250-784-1290
Hancock, Darin	Resource Manager	Mackenzie TSA spruce beetle lead and working group coordinator	Darin.Hancock@gov.bc.ca	250-997-2204
Huybers, John	Prince George District Manager	Spruce Beetle Project Lead	John.Huybers@gov.bc.ca	250-614-7442
Robert, Jeanne	Regional Entomologist	Omineca and Northeast Region scientific expertise in forest entomology	jeanne.Robert@gov.bc.ca	250-561-3461

6.3 ADDITIONAL INFORMATION AND LINKS

Bark Beetle Management Guidebook: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/bark_beetle_management_guidebook.pdf

Field guide to Forest Damage in British Columbia: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/land/forest-health-docs/field_guide_to_forest_damage_in_bc_web.pdf

Northwest Invasive Plant Council (NWIPC): <http://nwipc.org/>

Provincial Forest Health Strategy:
<https://www.for.gov.bc.ca/hfp/health/strategy/Forest%20Health%20Strategy.pdf>

Previous Regional/District Forest Health Strategies:
https://www.for.gov.bc.ca/hfp/health/TSA_strategies.htm

7 ABBREVIATIONS

AAC - Allowable Annual Cut

BEC – Biogeoclimate zones

BMU - Beetle Management Unit

CFS - Canadian Forest Service

FPC - Forest Practices Code

IFHM - Integrated Forest Health Management

IPM - Integrated Pest Management

NRFL - Non-Renewable Forest License

NWIPC - Northwest Invasive Plant Council

PSP - Permanent Sample Plots

SEDA - Stand Establishment Decision Aid

SOP - Standard Operating Procedure

TSA - Timber Supply Area

UNBC - University of Northern British Columbia

8 REFERENCES

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APPENDIX I BEETLE MANAGEMENT CONTROL STRATEGIES

Beetle management unit (BMU) strategies are broad approaches that have specific objectives. The strategy chosen for a BMU should remain in place for as long as objectives are being met, or until additional resources become available to allow a more aggressive strategy to be implemented. Situations change from year to year, and so strategies are reassessed annually. Control strategies are also subject to review and modification based on changes in infestation levels, access, and other higher level plans. A yearly review will include an assessment of the success of the plan and how it may be improved in order to better meet the goals and objectives stipulated.

There are seven broad strategies that can be used to address bark beetle infestations in a BMU. The strategies include: prevention/ suppression, holding action, holding plus, salvage, monitor, undesignated, and protected areas/ecological reserves. Selection of the relevant strategy is based upon the forest health issues in the area, the stated integrated resource management objectives, and the expected impact of beetle activity in adjacent management areas.

The **suppression/prevention** is the most aggressive strategy. It is selected when the infestation status requires aggressive direct control actions. This strategy is best applied in areas that are lightly infested, and resources for direct control or harvesting and milling capacities equal or exceed the amount of infestation. The intent of the strategy is to reduce or keep the outbreak to a size and distribution that can be handled within “normal resource capability”.

Holding is defined by vigorous directed harvesting and limited single tree treatments designed to, at least, prevent further population increases. The primary management activity will be directed harvesting (large and small blocks) of currently infested stands; containment baiting would be utilized wherever appropriate. Only limited use of direct control methods such as single tree treatments would be contemplated.

Salvage is applied to areas where management efforts would be ineffective for substantially reducing the beetle populations and subsequent levels of damage. Such areas have extensive outbreaks covering a large proportion of susceptible stands. The objective, in this strategy, is to salvage affected stands and minimize timber value loss. This strategy may also apply to areas with a low economic valuation of host trees – that is, where control is not worth the investment of resources to remove the infestation.

Monitor is the strategy applied to areas where management efforts would be ineffective for substantially reducing the beetle population and subsequent levels of damage, or where there is no short-term (less than five years) possibility of salvaging dead timber. This may be due to management constraints such as in Wilderness areas, Parks, or Ecological Reserves, or because access cannot be put in place before substantial merchantable degradation of the dead material occurs.

Monitoring plus is the strategy where management efforts would be effective for substantially reducing beetle populations (i.e. still early in an outbreak), but current access to the infestation area is limited. Therefore, the unit will be monitored with the intention of accessing the infestation within 5 years as access infrastructure is planned and implemented.

No Action are units that have not been assigned a strategy because no forest health factors have been identified for treatment.

Park, Protected Areas, and Ecological Reserves require a description for the protected area polygons on FLNRORD strategic beetle plans and maps. The bark beetle management strategies (e.g. suppression, holding, etc.), do not fit with the mandate BC Parks has to manage these areas. Therefore, a separate category was established to provide direction and management for protected areas and ecological reserves. Beetle management in protected areas uses a different set of values. Planning for beetle management in protected area will occur through co-operation between Ministry of Environment (MoE) and FLNRORD. The control

tactics available for use in BC Parks include allowing natural processes to prevail (i.e. do nothing), pheromone baits and traps, individual tree fall and burn on site, large-scale prescribed burn, and skid piles and burn on-site with low impact machinery. Commercial logging and road building is strictly prohibited in protected areas as directed through the Park Act.

The other resource management zones, which include Multi-Value Areas, Resource Development Areas, Special Management Areas and Settlement/Agriculture Areas, do not restrict strategy selection. However, they may restrict tactic selection.

Selecting the appropriate strategy or combination of strategies for a given area is based on a number of factors. Some of those factors include:

- beetle species and stand hazard;
- extent and distribution of the current and historical beetle infestations;
- expected impact of the beetle within the local and surrounding areas;
- land use objectives and non-timber resource values within the area; and
- stage of the beetle outbreak, strategies in adjacent landscape units, and accessibility.

APPENDIX II TACTICS FOR MANAGING BARK BEETLES

Tactics are treatments applied to specific areas or infestations within a BMU. The appropriate combination of tactics must be selected for each strategy to accomplish the stated objectives. Rarely will a single treatment be sufficient to deal with a particular infestation. Normally, a combination of treatments will be necessary. Furthermore, most treatments will have to be repeated annually while the strategy remains in place. Until the composition of the forest has substantial modifications, the susceptibility, and often the risk of subsequent infestation will be similar from year to year. Relevant tactics are described below.

Detection: Infestation presence and intensity was, and will continue to be, assessed with overview flights, detailed flight surveys, and ground detection surveys, which may include walkthrough reconnaissance surveys and/or detailed probe surveys.

Prediction: Hazard and risk ratings and green to red ratio calculations will be used to predict the size and location of both present and future populations. Over-wintering mortality studies and Lindgren funnel traps may be used to predict the size and location of future populations.

Harvesting: Harvesting may be divided into three categories: sanitation, salvage, and high hazard host removal. This includes both small patch and single tree selection in suppression/prevention

Single Tree Treatment: This includes fall and burn or fall and peel for IBM, IBD and IBS.

Baiting and Trap Trees: Aggregation semiochemicals or the intentional creation of patches of preferred host will be used to contain and concentrate beetle populations in areas where harvesting or other treatments are planned and access is available. All baits will be global positioning system (GPS) located and mapped for follow-up treatment.

Hauling Restrictions and Yard Management: These restrictions are generally not required if trucks do not stop between the logging site and the destination and if the infested logs are watered, debarked, or processed promptly. The main goal of yard management is the prompt processing or manufacturing of delivered logs during beetle flight. Pheromone traps (primarily to monitor flight) and watering of log decks may also be employed.

Access Development: Access planning and development is important for the short and long term management of bark beetles in high value or high hazard stands.

Reduction of Stand Susceptibility/Prevention: Silvicultural treatments, including species and age class manipulation on a landscape level with the reduction of large, continuous areas of mature and over-mature forest types, may be used to reduce the level of future damage to the forests. This treatment regime requires a long-term focus and can be considered one of the most effective long-term proactive tactics.

The following tables list the tactics for major bark beetles, mountain pine beetle and spruce beetle, with critical dates:

Tactics for MOUNTAIN PINE BEETLE with critical dates for each designated BMU strategy: Suppression (Supr.), Holding (Hold.), Salvage (Salv.), and Monitoring or Monitoring Plus (Mon.).

Tactics	BMU Strategy	Critical Dates
1. Survey / Assessment		
Timing of adult flight	Supr. Hold. Salv. Mon.	June 15 to September 15
Infestation intensity rating	Supr. Hold. Salv. Mon.	Any time
Hazard rating	Supr. Hold. Salv. Mon.	Any time
Risk rating	Supr. Hold. Salv. Mon.	Any time
Overview and detailed aerial		July 15 to September 15

Tactics	BMU Strategy	Critical Dates
sketch mapping	Supr. Hold. Salv.	August 1 to September 15
Aerial photography	Supr. Hold. Salv.	April 1
Ground probe or walkthrough	Supr. Hold. Salv.	Oct - May
2. Harvesting		
Sanitation	Supr. Hold.	Any time
Salvage	Salv.	Any time
High hazard host removal	Supr. Hold.	Any time
Harvest priority rating system	Supr. Hold. Salv.	Any time
3. Single Tree Treatments (STT)		
Fall and burn	Supr. Hold.	October 15 to May 1
Verbenone	Supr.	April 1 to May 15
Debarking	Supr. Hold.	Prior to flight
Small patch / single tree selection	Supr. Hold.	Any time
4. Bait Use		
Containment	Supr. Hold.	May 1 to June 30
Monitoring	Supr. Hold.	July 1 to August 15
Prior and follow-up to STT	Supr. Hold.	Treatment to June 30
5. Hauling Restrictions		
	Supr. Hold.	June 15 to September 15, or as per the Regional Guidelines
6. Access Development		
	Supr. Hold. Salv. Mon.	Any time
7. Beetle Proofing		
	Supr. Hold. Salv. Mon.	Any time
8. Silvicultural Treatments		
Long-term species manipulation	Supr. Hold. Salv. Mon.	Any time
Age class mosaic manipulation	Supr. Hold. Salv. Mon.	Any time

Tactics for SPRUCE BEETLE with critical dates for each designated BMU strategy: Suppression (Supr.), Holding (Hold.), Salvage (Salv.), and Monitoring or Monitoring Plus (Mon.).

Tactics	Strategy	Critical Dates
1. Survey / Assessment		
Timing of adult flight	Supr. Hold. Salv. Mon.	May 25 to August 20
Infestation intensity rating	Supr. Hold. Salv. Mon.	Any time
Hazard rating	Supr. Hold. Salv. Mon.	Any time
Risk rating	Supr. Hold. Salv. Mon.	Any time
Overview and detailed aerial sketch mapping (18-24 month delay for faders)		July 15 to October 15
Aerial photography	Supr. Hold. Salv.	August 1 to October 15
Ground probe or walkthrough	Supr. Hold. Salv.	August 20 to May10
2. Harvesting		
Sanitation	Supr. Hold.	Any time
Salvage	Salv.	Any time
High hazard host removal	Supr. Hold.	Any time
Harvest priority rating system	Supr. Hold. Salv.	Any time
3. Single Tree Treatments (STT)		
Fall and burn	Supr. Hold.	October 15 to May 1
Conventional Trap tree - fall	Supr. Hold.	March 1 to April 1
Conventional Trap tree - remove	Supr. Hold.	August 20 to April 30
Debarking	Supr. Hold.	Prior to flight
Small patch / single tree selection	Supr. Hold.	Any time
Helicopter logging	Supr. Hold.	Any time
4. Bait Use		
Containment	Supr. Hold.	May
Funnel Trap Monitoring	Supr. Hold.	May 25 to August 20
Follow-up Prior to STT	Supr. Hold.	August 20
5. Hauling Restrictions	Supr. Hold.	May 1 to August 20, or as per the Regional Guidelines
6. Access Development	Supr. Hold. Salv. Mon.	Any time
7. Beetle Proofing	Supr. Hold. Salv. Mon.	Any time
8. Silvicultural Treatments		
Long-term species manipulation	Supr. Hold. Salv. Mon.	Any time
Age class mosaic manipulation	Supr. Hold. Salv. Mon.	Any time

**APPENDIX III – 2016 AERIAL OVERVIEW SUMMARY OF SELECTED FOREST
PESTS AND PATHOGENS.**

Fort Nelson TSA

	Trace	Light	Moderate	Severe	Very Severe	Total
Bark Beetles						
IBM=Mountain Pine Beetle	12,149	2,766	91	32	-	15,039
IBS=Spruce Beetle	1,877	2,026	-	-	-	3,904
IBB=Western Balsam Bark Beetle	26,852	529	119	56	-	27,557
All Bark Beetles	40,878	5,322	210	88	-	46,500
Defoliators						
ID6=Aspen Leaf Miner	-	22,305	141,139	58,217	-	221,662
IDE=Spruce Budworm	-	250	-	-	-	250
IDN=Birch Leaf Miner	-	1,797	6,427	485	-	8,710
Total Defoliators	-	24,353	147,566	58,702	-	230,623
Diseases						
DF= Unknown Disease	-	-	49,130	-	-	49,130
DLV=Venturia Blight	-	231	3,415	7	-	3,654
Total Diseases	-	231	52,546	7	-	52,785

Fort Saint John TSA

	Trace	Low	Moderate	Severe	Very Severe	Total
Bark Beetles						
IBM=Mountain Pine Beetle	2,096	72	101	10	-	2,281
IBS=Spruce Beetle	1,539	389	-	1	-	1,929
IBB=Western Balsam Bark Beetle	1,516	64	-	7	-	1,588
All Bark Beetles	5,152	526	101	19	-	5,799
Defoliators						
IDN=Birch Leaf Miner	-	212.69	107.80	-	-	320.50
Total Defoliators	-	212	107	-	-	320
Diseases						
DLV=Venturia Blight	-	-	-	1	-	1
Total Diseases	-	-	-	1	-	1

Dawson Creek TSA

	Trace	Low	Moderate	Severe	Very Severe	Total
Bark Beetles						
IBM=Mountain Pine Beetle	6,495	5,675	6,565	29	-	18,766
IBS=Spruce Beetle	2,151	1,706	188	2	-	4,048
IBB=Western Balsam Bark Beetle	123,102	75,266	-	90	-	198,459
All Bark Beetles	131,749	82,648	6,754	122	-	221,274
Defoliators						
ID2=Bruce spanworm	-	72.26	168.64	-	-	240.90
ID6=Aspen Leaf Miner	-	104.62	391.48	-	-	496.10
IDN=Birch Leaf Miner	-	-	342.09	-	-	342.09
Total Defoliators	-	176	902	-	-	1,079
Diseases						
DLV=Venturia Blight	-	245	152	133	-	531
Total Diseases	-	245	152	133	-	531