# Omineca Region

(Prince George, Mackenzie and Robson Valley Timber Supply Areas)

# Forest Health Strategy 2013

B.C. Ministry of Forests, Lands and Natural Resource Operations

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# OMINECA REGION FOREST HEALTH STRATEGY

## 1.0 INTRODUCTION

The purpose of this document is to present a Forest Health Strategy for the Omineca Region (Prince George, Mackenzie and Robson Valley Timber Supply Areas (TSA)), while ensuring consistency with the existing legislative objectives and the provincial forest health strategies and guidelines. Although the previous focus of this forest health strategy document has primarily been on bark beetle activities for the past ten years, which only accounts for a portion of potential activities, this strategy will provide a framework to coordinate and guide future forest health activities within the TSA's of the Omineca Region. The intention of this strategy is to:

1. Incorporate the principles of integrated forest health management to effectively manage the interactions between forest practices and forest health agents impacting on resource objectives,
2. Provide guidance on the best forest health management strategies available,
3. Outline the legal and government policy framework for forest health management in the Region,
4. Delineate the current knowledge with regards to the impact of forest health factors on timber supply, and
5. Apply ecologically sound techniques for the protection and enhancement of resource values,

"Integrated Forest Health Management" (IFHM) is a variant of the internationally recognized approach to pest management known as Integrated Pest Management (IPM)[1]. The principles of IPM have been slightly modified within a forestry context to produce the principles of IFHM. These principles can be summed up briefly as:

1. Know the land-base and resource management objectives;
2. Manage from an ecological perspective;
3. Don't make the situation worse; and
4. Practice adaptive management.

The next phase of the strategy will be to identify and create an action plan clarifying treatment targets and areas of responsibility for each management unit.

## 2.0 BACKGROUND

The implementation of an effective forest health strategy can augment and stabilize the growing stock within a timber supply area (TSA) by increasing the success of regeneration practices, increasing the productivity of immature stands, and decreasing the losses of mature timber. These benefits imply a reduced risk to silviculture investments and a more stable planning environment, both of which are important to the Ministry of Forests, Lands, & Natural Resource Operations (FLNRO) and the timber industry. In addition, ecologically appropriate forest health practices will reduce the risk of wildfire associated with widespread timber mortality, will improve public safety in multiple use areas, and will lower the risk to non-timber resource values. Establishing a proactive approach that emphasizes early detection of forest health problems promptly implements scientifically sound solutions and ensures that expenditures of resources are necessary, efficient and cost effective.

The purpose of the Provincial Forest Health Implementation Strategy (March 2007) is to direct FLNRO staff at all levels on how to implement the forest health program. The implementation strategy bridges the higher level provincial forest health strategy and the Forest Health Program with the regional strategies for the TSA's. The Provincial Forest Health Strategy clearly lists the areas of responsibilities, and the Provincial Bark Beetle Management Technical Implementation Guidelines offer an approach to achieving treatment targets.

[1] Information on IPM is on the Ministry of Environment web site at http://www.env.gov.bc.ca/epd/ipmp/reqs/index.htm

## 3.0 SCOPE OF THE FOREST HEALTH STRATEGY

The Omineca Region contains three of 38 administrative timber management units, established under Section 7 of the British Columbia Forest Act, for which an Allowable Annual Cut (AAC) of timber in British Columbia (BC) is determined. The three TSA's include: Prince George, Mackenzie and Robson Valley. These TSA's are located in the north-central interior of BC and covers approximately 7.5 million hectares (see Figure 1). The current AAC of the TSA's is 16,086,000 $m^3$/year which accounts for 52.8% of the total TSA volume in the Northern Interior of BC.

The Prince George TSA extends from the Alberta border in the east, to the Spatsizi Plateau Wilderness Park in the northwest and Tweedsmuir Provincial Park in the southwest. The Prince George TSA contains eight (8) timber supply blocks (A through H) and three forest districts (Fort St. James, Vanderhoof, and Prince George). The current AAC is 12,500,000 $m^3$/year and it is one of the largest timber management units in the province.

The Mackenzie TSA is located in the north-central interior of BC and covers approximately 6.1 million hectares and is surrounded by six TSA's and forest districts. The current AAC is 3,050,000 m3. The Mackenzie TSA extends just beyond the Rocky Mountains in the east, the Omineca Mountains in the west, the Village of McLeod Lake in the south and beyond the headwaters of the Kechika River in the north. Central to the TSA is the Williston Reservoir.

The Robson Valley TSA is situated in east central British Columbia. The total area including parks is approximately 1.35 million hectares. The current AAC is 536,000 $m^3$/year and the terrain in the TSA is variable. The bottomlands of the Rocky Mountain trench are flat to rolling, while the adjacent mountain ranges are rugged with steep forested slopes and deeply cut side valleys. The diversity of landscape is reflected in a diversity of tree species, including the dominant spruce, balsam and subalpine fir, as well as western red cedar, lodgepole pine, western hemlock and Douglas-fir. Forests in the TSA are dominated by mature and older types

## 4.0 TERM OF THE FOREST HEALTH STRATEGY

This Forest Health Strategy will take effect April 1, 2013 and will not be confined to a fixed term. This strategy will be reviewed and updated annually by the FLNRO.

## 5.0 MANAGEMENT UNIT BOUNDARIES AND DESIGNATIONS

Management unit boundaries were established in each of the TSA's as a basis for developing administrative strategies to deal with forest health factors; specifically for bark beetles in the beetle management unit (BMU). Each unit identifies an area where specific health strategies can be applied. The units selected coincide with established boundaries of other existing management units (e.g. Landscape Units). Each forest health unit is assigned a strategy to identify high priority forest health factors. Currently, mountain pine beetle, spruce beetle, and Douglas-fir beetle are the only forest health factors that have been assigned a management strategy using these units.

It is important not to consider the designation of any one unit in isolation as each unit designation may have an effect on the beetle situation in adjacent units. Therefore, 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 area. Accordingly, strategy designations for adjacent units should, in most cases, be within one level of each other.

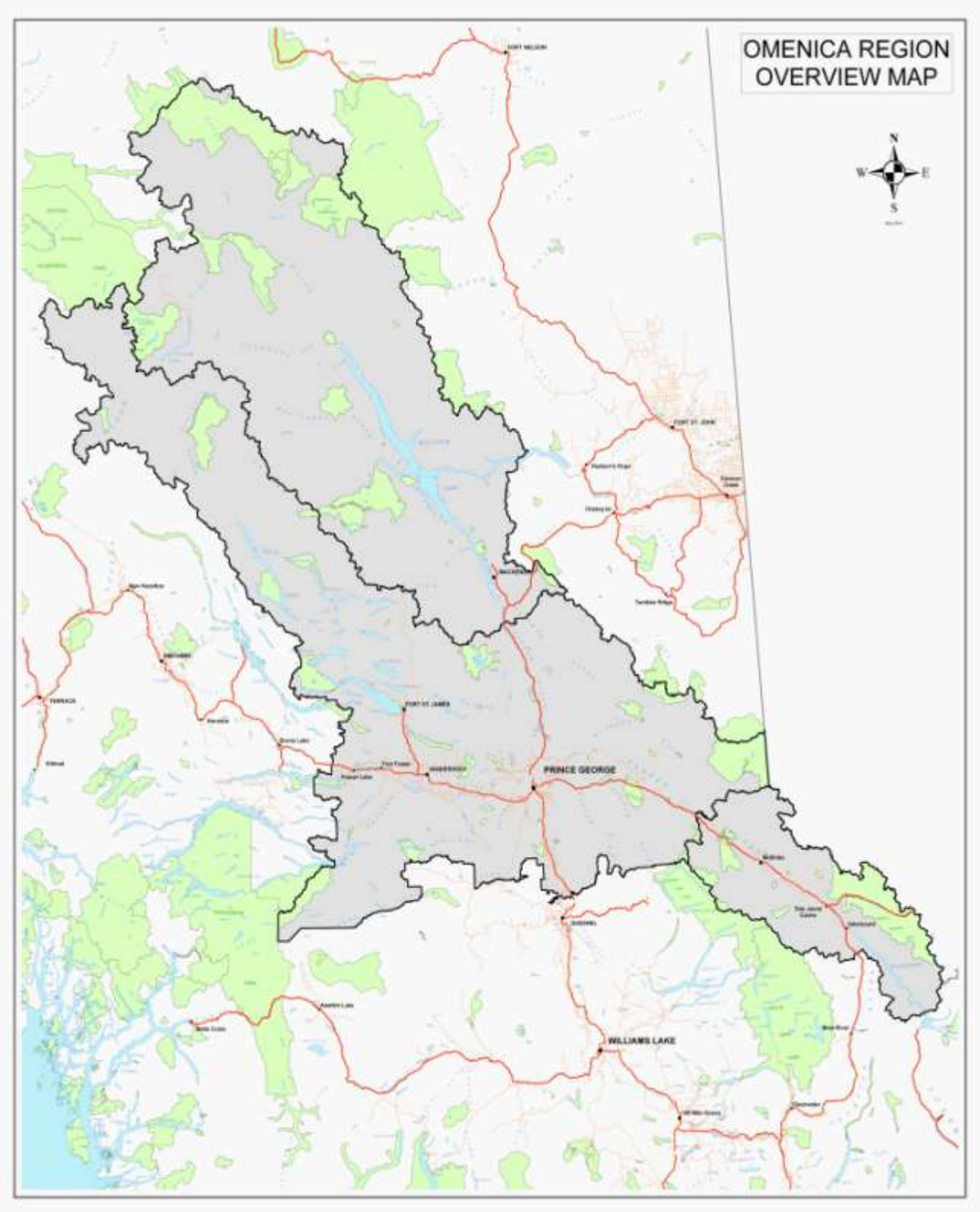



**Figure 1. Key Map of the Omineca Region**

## 5.1 Goal

The provincial forest health strategy provides an overview of forest health direction and activities by the FLNR in BC. It is composed of two parts: the first is a framework outlining the mission, goal and objectives of the program; the second organizes an action plan, identifies roles and responsibilities, and consists of a ranking system to assist in setting priorities. The forest health strategy for the Omenica Region will be consistent with the principles, goals, and objectives that have been outlined in the provincial forest health strategy.

The goal of the forest health program is to manage pests to meet forest management objectives. The provincial government's three key strategic forest health objectives are to:

1. Protect forest resources from pest damage by direct actions when operationally possible and justified;
2. Implement stand establishment activities to minimize the expected impact of known forest pests; and
3. Assess pest impacts on forest values to improve estimates of timber yield from British Columbia's forests and prioritize management interventions.

## 5.2 Program Emphasis Areas

The Forest Health Program is comprised of three emphasis areas: policy support, program delivery, and adaptive management. Each emphasis area is described below with its intended outcome, specific outputs, functions, key objectives and performance measures.

Emphasis 1: Policy support is undertaken to address large scale pest outbreaks, management of exotic pests and interagency efforts. The intended outcome of this emphasis area is that the resource values under the *Forest and Range Practices Act* are protected through the implementation of forest health strategies for each management unit. The chief outputs are forest health strategies at both provincial and management unit levels, the *Mountain Pine Beetle Action Plan* and a provincial invasive plant strategy.

Functions:

- development of provincial, regional and Timber Supply Area forest health strategies;
- participation in interagency efforts;
- support of statutory decision makers (mainly District Managers).

Key Objectives and Performance Measures:

| | |
|---|---|
| **Objective 1**: update forest health strategies | **Performance Measure**: number of completed or updated forest health strategies |
| **Objective 2**: implement legislation, policies, and best management practices in operational plans and practices (e.g. Forest Stewardship Plans and Timber Supply Area bark beetle management tactical plans) | **Performance Measure**: statutory decision-maker level of satisfaction (percent) with forest health support provided |

Emphasis 2: Program Delivery – the intended outcome of this emphasis area is that timber supply areas losses are mitigated and management objectives are attained by the effective delivery of the Forest Health Program. This relates to all of the program drivers. The chief output is the Summary of Forest Health Conditions in British Columbia.

Functions:

- program planning, management and partnering;
- detection, assessment and prediction of pest damage;
- treatment of pest outbreaks and prevention of the establishment of some exotic pests (e.g. gypsy moth and yellow starthistle);
- development of agents for biological control of invasive plants.

Key Objectives and Performance Measures:

| | |
|---|---|
| **Objective 1**: update surveys, assessments and forecasts | **Performance Measure**: percent of Crown forest aerially surveyed to monitor forest health |
| **Objective 2**: implement annual treatment plans | **Performance Measure**: number of hectares treated for native defoliators; percent of exotic pest introductions addressed; percent of mountain pine beetle aggressive emergency management units, parks, and protected areas that achieve treatment targets; percent of beetle management units receiving suppression treatment for species other than mountain pine beetle; percent of at-risk sites treated in parks and protected areas to mitigate impacts of the mountain pine beetle |
| **Objective 3**: implement best management practices | **Performance Measure**: percent of results-based stands monitored that incorporate best management practices for forest health |

Emphasis 3: Adaptive management combines management, research, monitoring and ways to change practices so that management activities are improved based on experience. The intended outcome of this emphasis area is that science-based management be delivered by proficient forest practitioners who know how to best alter practices to meet the expectations of professional reliance. Key outcomes include research papers and reports, training tools, bio-agent guidebooks, and extension materials.

Functions:

- monitoring and evaluation of delivery and treatment regimes;
- facilitation or provision of training and extension activities;
- operational research and monitoring of pest behaviour and populations (natural and managed).

Key Objectives and Performance Measures:

| | |
|---|---|
| **Objective 1**: identify and address priority training and extension needs | **Performance Measure**: number of forest health training and extension events delivered |

## 5.3 Roles and Responsibilities

The following table describes the roles and responsibilities of the various participants in the delivery of forest health activities on provincial forest lands. Resource availability will dictate the level at which these activities are delivered as outlines in Table 1.

**Table 1. Areas of Responsibility for Forest Health Activities**

| Objective | Activity | Government | | Licensees[2] | |
|---|---|---|---|---|---|
| | | MFLNRO | BC Parks[3] | Obl[4] | Enh (LBIS) |
| 1 | (a) Conduct the annual aerial overview survey on all provincial forests | X | | | |
| | (b) Conduct detailed forest health surveys and inventories. | X | X | X | X |
| 2 | (a) Assess pest hazard and risk at multiple scales consistent with management objectives | X | | X | |
| | (b) Develop and refine hazard and risk models | X | | | X |
| 3 | (a) Set priorities for response to forest health issues | X | | X | |
| | (b) Quantify pest impacts at multiple scales | X | X | X | |
| | (c) Monitor managed stands (after free-growing declaration) to determine pest impacts and to report results | X | | | X |
| 4 | (a) Define treatment regimes for control purposes (epidemic pests) and implement them (epidemic and exotic pests) | X | X | X | |
| | (b) Advocate treatment regimes for preventive purposes (endemic pests) | X | | | X |
| 5 | (a) Review forest health FRPA legislation, objectives, and priorities and provide long-term analysis of, and refinement to, management strategies, practices, and policies | X | | | |
| | (b) Develop monitoring framework for forest health | X | | | |
| | (c) Identify indicators and participate in effectiveness evaluation | X | | | |
| | (d) Communicate FRPA training needs for forest health, develop training tools, and provide forest health training related to forest management | X | | | X |
| | (e) Communicate results of trials, inventories, and management policies. | X | | | X |
| | (f) Encourage innovative approaches to forest management that promote forest health. | X | | | X |
| | (g) Design and conduct trials to enable science-based management | X | | | X |
| | (h) Keep current with applied research through participation at workshops and conferences and through liaison with research agencies | X | X | | X |
| | (i) Advocate MFLNRO forest health objectives and priorities to research agencies | X | | | |

## 5.4 Forest Health Implementation Strategy Directives

The FLNRO has identified a number of functions to meet the goals of the Forest Health Program. The following table (2) outlines the functions in the forest health implementation strategy for meeting the intent and obligations. The table is followed by an overview for each function as well as the district and licensees directives in regards to each function. Branch and regional directives can be found within the forest health implementation strategy document.

[2] Individual licensee obligations are described in the FRP Act and Regulations; enhanced activities are eligible for LBIS funding. Obligations for TFL's are established in the approved Management Plan.
[3] Management activities are conducted by MFLNRO Forest Districts on behalf of BC Parks. See MOU in the *Provincial Bark Beetle Technical Implementation Guidelines.*
[4] For individual licensees, this area is limited to the areas with obligations under the approved TFL Management Plan, Forest Development Plan, Forest Stewardship Plan, and Forest Development Units.

**Table 2. Implementation Strategy Function Outline**

| Forest Health Implementation Emphasis Areas | | | | | |
|---|---|---|---|---|---|
| **Function** | **Legislation and Policy support** | **Function** | **Program Delivery** | **Function#** | **Adaptive management** |
| 1 | Develop provincial, regional and TSA strategies | 4 | Conduct Program Planning, Management, and Partnering | 8 | Monitor and Evaluate Treatment Regimes |
| 2 | Participate in Interagency Efforts | 5 | Detect, Assess, and Predict Pest Damage | 9 | Provide or Facilitate Training and Extension Activities |
| 3 | Support Statutory Decision-Makers | 6 | Treat Pest Outbreaks and Prevent the Establishment of Key Exotic Pests | 10 | Conduct Operational Research and Monitoring of Pest Behaviour, and Natural and Managed Populations |
| | | 7 | Manage Endemic Pests and Prevent Establishment of Invasive Plants During Forest Operations | | |

## 5.5 Legislation and Policy Support

**Function 1: Develop provincial, regional and TSA strategies.**

**Overview:** *Describes the FLNRO's forest health program, and provides TSA-level descriptions of forest health issues and recommended responses to translate the provincial objectives to an operational level.*

**Key Objective:** The strategy documents are completed at all levels (provincial to TSA) and signed off by the appropriate level of FLNRO management.

**Roles and Responsibilities**

**Districts:**

- Lead the production and updating of the Timber Supply Area forest health strategy—in particular addressing mature and non-obligatory immature stand impacts or forest health issues—using contractors for data analysis.
- Identify priority research topics in the TSA forest health strategy that are of local interest to research committees through regional specialists or directly to research organizations.
- Consider and incorporate climate change strategies into the TSA forest health strategy using regional specialist advice, and provide input to regional specialists for advising research organizations.
- Bring suspected climate change-related observations to the attention of regional specialists.
- Participate in revisions of species selection guides.
- Review Forest Stewardship Plans, and directly recommend policy change through the policy secretariat.
- Provide feedback into the FRPA Resource Evaluation Program (FREP).

**Licensees:**

- Review the TSA strategies to provide input to the ministry, and incorporate recommendations in Forest Stewardship Plans.

**Function 2: Participate in Interagency Efforts**

**Overview:** *Forest Health issues can be multi-jurisdictional, and solutions require interaction and cooperation with other agencies.*

**Key Objective:** Participate in as many high-priority interagency efforts as possible within time and resource constraints.

**Roles and Responsibilities**
**Districts:**

- Provide input into Best Management Practices for BC Parks within district boundaries.
- Develop rationale notes for identifying key issues, and Best Management Practices for improving forest health-related activities.
- Maintain liaison with other agencies to develop coordinated responses and information exchange for intra- and inter-agency government plans or committees, such as the Spread Control Overview Team.

**Licensees:**

- Provide industry perspective to draft policies and procedures developed by interagency committees.

**Other:**

- First Nations, non-government organizations and the public may be requested for their input into the development of interagency policies or procedures.

**Function 3: Support Statutory Decision-Makers**

**Overview:** *Statutory decision-makers require advice from forest health specialists when making a determination related to forest health.*

**Key Objective:** Provide adequate support to statutory decision makers.

**Roles and Responsibilities**
**Districts**

- Support SDM, immediate supervisor and others about forest health to improve forest management.
- Participate in District Rust Working Group meetings and field sessions
- Support YSM and RESULTs Quality Assurance field activities designed to verify data integrity and build diagnostic capacity in district, licensee, and consultant base.
- Promote workshops, training and other sessions to improve skill set for staff, licensees and others, and make training opportunities available.
- Embed training requirements Learning and Career Development Plans and professional learning plans.

## 5.6 Program Delivery

**Function 4: Conduct Program Planning, Management, and Partnering**

**Overview:** *Ensure forest health budgeting and performance measure reporting are done on time and to specifications.*

**Key Objective:** Have sufficient input into the program planning process and program management meeting or exceeding Ministry standards.

**Roles and Responsibilities**
**Districts**

- Provide feedback to Headquarters re: Land Based Investment Strategy (LIBS) eligibility criteria.
- Provide feedback to regions regarding guidelines and BMPs.
- Set priorities for Beetle Management Unit (BMUs), pest-specific operations, surveys and trials.
- Submit funding proposals based on district priorities.

- Manage forest health contracts.
- Integrate forest health with other ministry initiatives and programs (i.e., Tree Improvement, BC Timber Sales, Forests for Tomorrow, species selection and Small Scale Salvage).

**Function 5: Detect, Assess, and Predict Pest Damage**

**Overview:** *FLNRO is the lead agency in the province to detect, assess and predict the level of damage from forest health factors.*

**Key Objective:** Provide timely and accurate information on pest conditions across the province.

**Roles and Responsibilities**
**Districts:**

- Submit to Headquarters and the region any amendments to standards.
- Provide district feedback to the draft overview map.
- Assist in identifying new infestations from the overview survey.
- Provide logistical support from the district to provide local information for setting up and planning surveys.
- Facilitate the establishment of PSPs.
- Identify abnormal levels of damage and notify regional staff when necessary.
- Participate in the Forest and Range Evaluation Program (FREP) for forest health through feedback for stocking standards and possibly other standards, policies or practices (e.g., cutblock design and wind throw).
- Monitor forest health conditions in natural and managed stands.

**Licensees:**

- Conduct surveys and assessments on behalf of government and as part of their stewardship responsibilities.

**Function 6: Treat Pest Outbreaks and Prevent the Establishment of Key Exotic Pests**

**Overview:** *The FLNRO continues to treat pest outbreaks when necessary and feasible, and prevent the establishment of exotic pests where mandated to do so.*

**Key Objectives:** Provide sufficient response to pest outbreaks in a timely manner, and conduct treatments to prevent the establishment of exotic pests that are well-justified.

**Roles and Responsibilities**
**Districts**

- Liaise and consult with other agencies, particularly with First Nations, licensees, communities, other ministries and stakeholder groups.
- Define treatment regimes in conjunction with the region, e.g., bark beetles and defoliators.
- Provide first response to examine a new infestation.
- Develop and implement contracts to address infestations.
- Conduct proactive, rather than reactive, management where possible.

**Other:**

- Exotic pests, until they become officially established, are the responsibility of the Canadian Food Inspection Agency (CFIA).

**Function 7: Manage Endemic Pests and Prevent Establishment of Invasive Plants During Forest Operations**

**Overview:** *FLNRO provides the best practices and leadership in the management of endemic pests by modifying forestry operations to minimize the impact of potential pests.*

**Key Objective:** Provide the most current science-based best management practices for managing endemic pests and invasive plants.

**Roles and Responsibilities**

**Districts**

- Provide local advice to licensees to implement and develop BMPs within the stewardship mandate, such as local interpretation of more general provincial guide book information and regional guidelines. Examples include prescribed burns, species selection decisions, use of trap trees and stumping. For invasive plants, examples include pro-active re-vegetation after harvesting or road construction, using local or regional native seed sources, reporting of new or spreading infestations, and other aspects of invasive plant management.
- Identify invasive plant locations and update provincial database.

**Licensees:**

- Meet legal obligations to accommodate endemic forest health issues in Forest Stewardship Plans.

**Other:**

- Private land owners may voluntarily or may, in some cases, be required to treat infestations threatening Crown land.
- Detection information and technical advice are provided to the private land owners by the FLNRO.

## 5.7 Adaptive Management

**Function 8: Monitor and Evaluate Treatment Regimes**

**Overview:** *Continuous improvement of legislation, policy and procedures requires a systematic monitoring and evaluation of forest health approaches across the province.*

**Key Objective:** Establish continuous improvement processes for all major forest health functions and activities.

**Roles and Responsibilities**

**Districts**

- Assist in PSP re-measurements set up by region by providing logistical support.
- District roles will be developed when the effectiveness evaluation protocol for forest health is available as a routine evaluation under the FREP.

**Function 9: Provide or Facilitate Training and Extension Activities**

**Overview:** *Key to the success of implementing a functional forest health program is to ensure staff receives the necessary training and information transfer.*

**Key Objective:** Provide sufficient training to permit delivery of program goals.

**Roles and Responsibilities**

**Districts**

- Provide facilitation of ad hoc courses hosted by regional specialists.
- Budget for delivery of a specific number of courses/year.
- Review the updated versions of the Forest Health FPC Guidebooks.
- Facilitate ad hoc courses presented by regional specialists for training ministry and non-ministry staff.
- Participate in regionally sponsored pest ID training courses designed to increase recognition and detection of pests during Free Growing surveys, and YSM plot establishment and reassessment activities, and during Quality Assurance assessment activities of these activities.

**Licensees**

- Attend or send staff, consultants, and contractors to forest health training courses.
- Review drafts of revised Forest Health FPC Guidebooks.

**Other**

- Attend forest health training if relevant.

**Function 10: Conduct Operational Research and Monitoring of Pest Behaviour, and Natural and Managed Populations**

**Overview:**

- *Establish and maintain a network of operational research trials and monitoring plots designed to quantify the impacts and behaviour of pest populations in managed and unmanaged stands.*
- *Revise hazard and risk ratings based on this research and monitoring and other relevant data.*

**Key Objective:** Continue to provide high quality operational research at the regional level.

**Roles and Responsibilities**

**Districts**

- Establish district operational trials.
- Identify problems, issues and potential research questions to branch and regional specialists.
- Assist in locating suitable study sites and with set-up and evaluation where needed.
- Implement a monitoring program on an annual or 5-year cycle, as applicable.
- Maintain data files of monitoring activities.
- Report annually on monitoring activities.
- Prepare budget requests for new and continuing monitoring projects.
- Communicate research results to clients.
- Test or evaluate hazard and risk ratings.

## 5.8 Invasive Plants

The FLNRO is responsible for invasive plant management in provincial forests, section 17 of the *Forest Planning and Practices Regulation* (FPPR) states, "for the purpose of section 47 *[invasive plants]* of the Act, a person who prepares a forest stewardship plan must specify measures in the plan to prevent the introduction or spread of species of plants that are invasive plants under the Invasive Plants Regulation, if the introduction or spread is likely to be the result of the person's forest practices".

Invasive alien plants, also termed "invasive plants" or more generally "weeds", are non-native species that are capable of invading and dominating habitats resulting in environmental, social and economic damage. Infestations of invasive plants can result in reduced biodiversity, loss of wildlife habitat, increased soil erosion and water sedimentation, reduced crop quality and yield and damage to human and animal health. Invasive plants lack natural predators and controls found in their native environments and this allows them to out compete native vegetation for space, nutrients and light resources. Invasive plants reproduce quickly and prolifically, often both vegetatively and by seed. They grow rapidly, have short lifecycles, and are often not palatable to grazing animals or wildlife. Some species like spotted knapweed (*Centaurea stobe biebersteinii* syn. *C. maculosa* and *C. biebersteinii*) release toxins into the soil that inhibit growth of neighbouring species (alleopathy).

### 5.8.1 Objectives

The Invasive Species Strategy for BC was completed in 2012 and is a result of efforts by federal and provincial agencies, as well as community groups and individuals to generate a framework for invasive species management in BC. The Ministry operates within this framework and works in partnership with other government agencies through the Inter-Ministry Invasive Species Working Group (IMISWG), and stakeholders through regional Invasive Plant Committees to effectively manage infestations on crown land. The IMISWG has identified three strategic goals for addressing invasive species, including invasive plants, on Crown land (IMISWG 2013):

- Prevent the establishment of new invasive plant infestations,
- Reduce the socio-economic and environmental impacts of existing invasive species,
- Provide a framework and capacity for the ongoing management of invasive species.

To meet these goals the Ministry has developed 11 management objectives (FLRNO 2012):

1. Prevent the establishment of new invasive plant species through effective early detection and rapid response actions;
2. Promote implementation of preventative measures with stakeholders and clients;
3. Complete and regularly update inventories of legislated and other invasive plant species of interest;
4. Reduce the spread and decrease the density of invasive plant infestations through a variety of methods, including manual and mechanical measures, chemical treatments, and biological control;
5. Restore impacted ecosystems by supporting improved grazing and forest management practices, using available biological control measures, and implementing other cost-effective activities;
6. Participate in international consortia for research and screening of potential biocontrol agents to control priority invasive plant species in BC;
7. Develop biocontrol agents that have been approved for importation and release in BC into operation-ready agents through a process of propagation, limited release, and documentation
8. Monitor and evaluate the value and effectiveness of biocontrol agents released in BC to control invasive plants;
9. Monitor and evaluate ministry invasive plant management activities and ecosystem response to ensure overall program effectiveness, and maintain or improve the efficacy of future treatments;
10. Support, maintain, and enhance the Invasive Alien Plant Program Application (IAPP);
11. Coordinate planning and management activities with other agencies, stakeholders, private landholders, and First Nations through active participation in local invasive plant (weed) committees, or directly as required.

### 5.8.2 Management

The Ministry's Invasive Plant Program is designed to minimize and stop the spread of invasive plants using an Integrated Pest Management (IPM) approach and is implemented in partnership with regional weed committees as well as other land management agencies. An IPM program combines current scientific knowledge, practices, and actions to achieve management objectives. Management of invasive plant infestations involves identification, inventory, treatment, monitoring and adjustment of management strategies based on results and available information (FLNRO 2012). FLNRO is also involved with the development of new biological control agents in order to produce effective, long-term control options for the rehabilitation of heavily infested areas.

To facilitate invasive plant management coordination within BC the Ministry of Forests, Lands and Natural Resource Operations has developed and maintains a database of reported invasive plant infestations and

management activities conducted on these species, the Invasive Alien Plant Program (IAPP). This database has a public mapping component where users can report and view reported invasive plant sites in their area of interest: http://www.for.gov.bc.ca/hra/Plants/application.htm. Information reported through IAPP or the smartphone "Report-A-Weeds" applications for priority invasive species is shared with Ministry Invasive Plant specialists and local weed coordinators to ensure the infestation receives appropriate management. Invasive plant identification and reporting training sessions can be arranged for ministry and private industry staff by contacting the regional invasive plant specialist. For management activities to be added to IAPP, management activities should be reported to the FLNRO Invasive Plant Specialist Denise McLean at 250-614-7433 or denise.mclean@gov.bc.ca.

In the Prince George TSA the Ministry works with two regional invasive plant committees, the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC) and the Northwest Invasive Plant Council (NWIPC). CCIPC and NWIPC are non-profit societies with inclusive memberships, who work with stakeholders to prevent and control the spread of invasive plant species in the central, coastal and northwestern areas of BC. Committee members include agencies, organizations and individuals that carry out or who are interested in invasive plant programs. The majority of the plan area is located within NWIPC operating area. NWIPC coordinates management using a single agency delivery model and is involved in all aspects of invasive plant management including reporting, public education and awareness and treatment. For more information on NWIPC's operating principles, management programs and resources visit www.nwipc.org or call 1-866-44WEEDS.

NWIPC recognizes 77 non-native, invasive species that are present or may become present in its operating area. Other invasive plant species may be present on the landscape but are not currently tracked by the Council. The invasive species list maintained by NWIPC is reviewed annually by its membership. NWIPC uses four invasiveness classifications to describe a species' potential to invade and cause problems should they become established. Species classed as "extremely invasive" being the most aggressive and invasive; in 2013, this included species as knapweeds (spotted, greater, brown and black), common tansy, field scabious, hawkweeds and knotweeds. Examples of "very invasive" species include Canada thistle, diffuse knapweed and oxeye daisy; baby's breath, comfrey and common toadflax are considered "invasive" and species that are "aggressive or under biological control" include St. John's-wort, curled dock and evening primrose (NWIPC 2013).

Treatment and rehabilitation efforts are driven by opportunity for control. Sensitive or important habitats (as designated by stakeholder priorities), infestation size and habitat health impact the opportunity to control or eradicate an infestation. Sites with small infestations threatening un-infested susceptible areas have the highest opportunity for control and sites where high treatment costs (ex. large infestations) will not be offset by significant benefits (ex. habitat is already infested with invasive species

## 6.0 PRINCE GEORGE TSA

The Prince George TSA covers approximately 7.5 million hectares (see Figure 2) extends from the Alberta border in the east, to the Spatsizi Plateau Wilderness Park in the northwest and Tweedsmuir Provincial Park in the southwest. The Prince George TSA contains eight (8) timber supply blocks (A through H) and three forest districts (Fort St. James, Vanderhoof, and Prince George).

### 6.1 Mission Statement for the Prince George TSA

This forest health strategy provides a framework to co-ordinate and guide forest health activities within a relatively large portion of the British Columbia (BC) Interior. While the recent focus of forest health activities has been bark beetle management, this only accounts for a portion of the potential activities as indicated by the following mission statement:

**"The forest health program mitigates pest impacts on provincial forest resource values."**

The forest health program incorporates the principles of integrated pest management to effectively manage interactions between forest practices and damaging agents. It applies ecologically sound techniques to protect and enhance desired resource values (see the four (4) guiding principles in the second paragraph of the Introduction).

A complete forest health program includes both proactive and reactive measures.

Proactive forest health measures require an awareness of potential problems, the ability to analyze hazard and risk for various 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 regulate extremes in pest cycles, reduce future pest risks, and ensure the sustainability of forest resources.

Reactive measures will always be part of a forest health program due to the relatively unpredictable nature of existing and new forest damaging agents. Reactive forest health measures consist of suppressing expanding pest outbreaks using short-term direct control methods with the intent of lowering pest populations and preserving resource values.

An ongoing commitment to adaptive management is essential so that forest practices can improve by learning from past experiences.


**Figure 2. Key Map of the Prince George TSA**

## 6.2 Ranking of Forest Health Factors

To provide an effective allocation of resources, forest health factors relative to the Prince George TSA have been ranked. Ranking includes forest health factors from both the stand management component and the bark beetle suppression component of this forest health strategy.

The ranking of forest factors is based on the following information and considerations:

- The collective knowledge of Regional forest health specialists and local District stewardship staff;
- Known or suspected impacts on forest resource values;
- Costs and benefits of detailed detection and treatment activities;
- Overall level of knowledge about the hazard and risk zones;
- Distribution of pest and current incidence levels; and
- Resources required to-fill knowledge gaps necessary for management of the pest.

It is recognized that more analysis is required to evaluate the impact of current losses of merchantable timber to those losses associated with a reduction of mature harvestable volume at some date in the future. As additional information and analysis regarding the impacts of losses in mature timber becomes known, the information will be included in the ranking of forest health factors. A review of this health factor ranking will be undertaken annually.

Rankings were developed using the collective knowledge of FLNR Branch and Regional forest health specialists for assessing forest health risks at a Provincial level (APPENDIX II). Local (TSA-level) issues may elevate the importance of specific forest health factors. These priorities are reflected in the ranking of forest health factors as presented in this forest health strategy for the Prince George TSA.

The forest health factors in the Prince George TSA have been separated by Forest District and rank as follows:

**Table 3. Ranking of Forest Health Factors in the Fort St. James District**

| ***Very High*** | ***High*** | ***Medium*** | ***Low*** | ***Very Low*** |
|---|---|---|---|---|
| | Two- Year Budworm | Spruce Beetle | Tomentosus Root Disease | Large Aspen Tortrix |
| | Western Balsam Bark Beetle | Mountain Pine Beetle | Lodgepole Pine Dwarf Mistletoe | Serpentine Leaf Miner - aspen |
| | Douglas-Fir Beetle | Engraver Beetles (*Ips Pini)* | White Pine Weevil | Birch Leaf Miner |
| | Stalactiform Blister Rust | Warren's Root Collar Weevil | *Venturia* | Forest Tent Caterpillar |
| | Western Gall Rust | | Red Band Needle Blight – *Dothistroma* | Black Army Cutworm |
| | Comandra Blister Rust | | | |

**Table 4. Ranking of Forest Health Factors in the Prince George District**

| *Very High* | *High* | *Medium* | *Low* | *Very Low* |
|---|---|---|---|---|
| Spruce Beetle | Western Gall Rust | Mountain Pine Beetle | Red Band Needle Blight – *Dothistroma* | Large Aspen Tortrix |
| Douglas-Fir Beetle | Comandra Blister Rust | Two-Year Budworm | Lodgepole Pine Dwarf Mistletoe | Serpentine Leaf Miner on Aspen |
| | Stalactiform Blister Rust | | Engraver Beetles (*Ips pini)* | Forest Tent Caterpillar |
| | | | Tomentosus Root Disease | Birch Leaf Miner |
| | | | Western Balsam Bark Beetle | Satin Moth |
| | | | Spruce Weevil | Black Army Cutworm |

**Table 5. Ranking of Forest Health Factors in the Vanderhoof District**

| *Very High* | *High* | *Medium* | *Low* | *Very Low* |
|---|---|---|---|---|
| Douglas-Fir Beetle | Stalactiform Blister Rust | Spruce Beetle | Mountain Pine Beetle | Western Balsam Bark Beetle |
| | Western Gall Rust | Black Army Cutworm | Tomentosus Root Disease | Large Aspen Tortrix |
| | Comandra Blister Rust | | Lodgepole Pine Dwarf Mistletoe | Red Band Needle Blight – *Dothistroma* |
| | | | Engraver Beetles (*Ips pini)* | Forest Tent Caterpillar |
| | | | *Venturia* | Serpentine Leaf Miner on Aspen |

## 6.3 Stand Management of Non-Bark Beetle Component

The stand management component of this strategy is intended to provide a ranking of non-bark beetle forest health factors in the Prince George TSA. It also provides links to specific tactics to reduce the risk of unacceptable impacts arising from those factors. These tactics will conform largely to strategies addressed by forest health guidebooks or FLNRO guidelines; however, tactics that differ from those presented in guidebooks will be identified and justified.

### 6.3.1 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. In the Prince George TSA, the two-year cycle budworm is causing significant impact on the following:

- Annual increment losses (loss of basal area growth),
- Increased frequency of tree deformities, including forks and crooks,
- Damage to developing cones and buds,
- Reduced height growth due to top kill,
- Reduced host vigor, thus enabling other secondary pests to invade the tree, including:

- Spruce beetle and western balsam bark beetle,
- Wood borers (increased wood decay) and pathogens, and
- Tree mortality in the regeneration, co-dominant, and dominant layers (Duthie-Holt & Setter 1999).

Currently, active management is not being implemented for two-year cycle budworm, except to expedite salvage harvesting based on the prioritization of defoliation levels. Strategic planning to optimize salvage harvesting, will be the most successful approach for recovering timber volumes in defoliated stands.

*Bacillus thuringiensis* subsp. *Kurstaki (Btk)*, a biological insecticide, is the only direct control measure that would be suitable for use and had recently became registered for use against 2-year budworm. Limited use may be justified for localized high value stands that need protection.

### 6.3.2 Dothistroma Needle Blight (*Dothistroma septosporum*) (Red Band)

Dothistroma is a low to medium priority forest health factor in the Prince George TSA though incidence levels should continue to be monitored and their priority reassessed at the annual review stage. A Dothistroma needle blight epidemic 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.

An aerial overview survey has been completed by Regional Forest Pathologist Richard Reich in the Prince George and Fort St. James Districts. A GIS hazard rating system is being developed from the aerial survey results. In general, the SBSvk biogeoclimatic subzone is high risk, the SBSwk is moderate, and all other subzone/variants are rated low. Areas in close proximity to rivers and flat to concave/toe of slope landforms are at highest risk. Slopes greater than 10% are low risk.

### 6.3.3 Ips Beetle (*Ips pini)*

*Ips pini* beetles usually attack weakened, dying, or recently felled trees and fresh logging debris. Large numbers of *Ips pini* may build up when natural events such as ice storms, wildfires, and droughts create large amounts of pine suitable for the breeding of these beetles. Historically, *Ips pini* bark beetles can increase in numbers to a minor extent. They should be dealt with by salvaging blowdown and harvesting infested trees where located. *Ips pini* attacked and killed up to 20% of some young pine plantations in the Bowron-Willow drainages of the Prince George District in 2006 (Hodges, pers. Com.). Therefore, no thinning, pruning or fertilization of younger pine stands should be undertaken in the Prince George TSA until the MPB and any lagging *Ips pini* populations have subsided.

### 6.3.4 Aspen, Poplar Leaf and Twig Blight (*Venturia spp.*)

In B.C., *Venturia* has been reported on aspen. These fungi are widely distributed throughout the range of their hosts in B.C. When moist weather conditions prevail during the 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.

### 6.3.5 Tomentosus Root Disease (*Onnia tomentosa)*

*Onnia tomentosa* primarily infects spruce species, but also is found on lodgepole pine and to a lesser degree on most other conifers in BC. It is found most frequently in spruce-pine forests in central and northern British Columbia, and at correspondingly higher elevations in southern B.C.

Infected trees may appear healthy, but often have extensive butt cull and reduced annual increment growth. The fungus spreads from tree to tree at points of root contact; consequently, diseased trees occur in groups and mortality results in "stand openings." Wind throw may occur before the death of an infected tree. Fruiting bodies on, or around a tree, indicate that one to three metres 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.

Two similar species of *Onnia* are found in B.C., O*. tomentosa* and O*. circinatus*, which is more prevalent on lodgepole pine. It is difficult to differentiate between the two, particularly when fruiting bodies (basidiocarps) are not present. Basidiocarps of O*. tomentosa* are smaller and thinner, and are usually found in groups. Basidiocarps of O*. circinatus* are larger, thicker, and tend to be found individually. O*. circinatus* is more commonly found on pine than spruce. Setal characteristics are a good diagnostic feature but must be examined under a microscope. Advanced stages of decay in the butt may be confused with decay pitting caused by *Phellinus pini.*

The strategies and tactics for Tomentosus root disease management outlined in the FPC Root Disease Management Guidebook should be followed. The Tomentosus SEDA is now available on the web at the following location: http://jem.forrex.org/index.php/jem/article/viewFile/562/489.

### 6.3.6 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, reduced seed crop production, 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).

The mountain pine beetle epidemic has eliminated the overstory host across a broad area in the north. This has very effectively sanitized much of the mistletoe from the overstory. Survival of mistletoe in the understory will maintain the pest, but its spread will be reduced considerably since lateral spread from advanced regeneration is not as effective as mistletoe rain from the overstory.

### 6.3.7 Pine Stem Rusts

Collectively, the pine stem rusts cause more losses than any other pest in young stands. A hazard and risk rating system is currently in development to help identify localized areas of concern.

#### 6.3.7.1 Western Gall Rust (*Endocronartium harknessii)*

Western gall rust (WGR) is the most common rust of young lodgepole pine in the PGTSA accounting for approximately 70% of all rust infection. Infection is caused by long distance spread spores that can travel hundreds of kilometers, resulting in an extensive regional spore cloud. As a result, when local conditions are suitable, stand level infection occurs in a fairly uniform pattern on high risk sites. Infection is spread from pine to pine, since WGR does not require an alternate host. Variation in lodgepole pine's genetic predisposition to infection by WGR is very high. Considerably less variation occurs within the comandra and stalactiform blister rust pathosystems. Selection for natural resistance to WGR is well documented and has been incorporated into the BC Tree Improvement Program. The main source of resistant seed is from select Orchards, such as the Bulkley #228, and from a new orchard established in 2010 for the sole purpose of reforesting high risk sites with gall rust resistant material. Infection from WGR is highest in young stands, with approximately 90% of the susceptible trees becoming infected by age ten on most sites. 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.

WGR damage on mature trees is not as significant, since most infections in mid to late rotation occur on branches and branch galls do not result in serious growth losses (Ziller 1974). As well, this disease seldom kills older trees, but can kill young trees with main stem infections. Heavily infected trees are generally stunted or malformed, predisposing these trees to breakage in high winds or under heavy snow loads (Ziller 1974).

The distribution of WGR is widespread throughout the province of BC, as well as in the east (Ziller 1974). On average it occurs at low to moderate levels in the Prince George TSA, but may be as high as 60% stem infection locally.

#### 6.6.7.2 Stalactiform Blister Rust (*Cronartium coleosporioides)*

Stalactiform blister rust (SBR) can be locally abundant, but is not widespread. Alternate hosts for SBR 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 can be tracked in on equipment. Recent research indicates that yellow rattlebox, may be a very prominent alternate host. Significant mortality can occur on sites with moderate to high levels of alternate hosts, particularly if trees are infected at a very young age. Currently, pre and post-harvest monitoring is occurring.

#### 6.3.7.3 Comandra Blister Rust (*Cronartium comandrae)*

Comandra blister rust (CBR) is a very damaging stem rust of lodgepole pine. It girdles and kills young trees rapidly and can occur at very high levels locally. Since spread from the alternate host to pine is by short range spores, infection is highly clustered and generally corresponds to the distribution of the alternate host, Bastard Toadflax (*Geocaulon lividum)*. 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. Impact can be serious, especially where stocking is insufficient to compensate for mortality, therefore overstocking is recommended on high risk xeric sites. Species mixes are recommended on mesic and moister sites.

Projected rust levels can be estimated using a three step approach (source: Richard Reich):

1. Infection is largely a function of weather, with elevation determining the general hazard. In the SBS biogeoclimatic zone, risk is assessed as
    a. High: (greater than 20%) at less than 800m,
    b. Moderate: from 800-1200m, and
    c. Low: above 1200m.

    Incidence rarely exceeds 5% in the ESSF of the Omineca Region probably due to low night time temperatures, and typically lower levels of the alternate host.
2. At the site level, the presence of CBR's alternate host, Bastard Toadflax can dramatically increase risk. Distribution and percent cover are key factors to assess during a pre-harvest recce prior to developing a prescription
3. The incidence of rust in adjacent young stands is also a key factor when interpreting the overall risk posed by elevation and alternate host abundance

At this time, there is a lack of reliable data for the incidence of CBR in specific ecosystems. Additional information may be found in the Mackenzie TSA Rust Management Strategy regarding treatment options and hazard for related ecosystems.

### 6.3.8 Large Aspen Tortrix (Choristoneura conflictana)

Increased populations of large aspen tortrix were recorded in the Prince George TSA via the aerial overview survey conducted in 2004. However, the affected area subsided to 45 hectares in 2009 and 0 hectares in 2010/11 from the 429,526 hectares reported in 2004. These defoliators are not expected to cause significant damage on aspen or secondary host species, (including balsam, poplar, birch, and willow) since outbreaks tend to be short-lived, lasting only 2 to 3 years in any one location (Cerezke 1992).

Tortrix feeding may cause partial or complete defoliation of trees for 1 to 3 years, resulting in reduced tree vigor and stem growth and occasionally killing the treetop and upper branches. Tree mortality rarely occurs directly from larval feeding, because aspen trees usually re-foliate within 4 to 6 weeks after feeding is complete (Cerezke 1992). For an individual stand, defoliation may only persist for one year due to the movement of the population.

Control of the large aspen tortrix is usually unnecessary because of the short duration of outbreak periods and because many natural biological agents combine to help keep populations in check (Cerezke 1992).

### 6.3.9 Spruce/White Pine Weevil (*Pissodes strobi)*

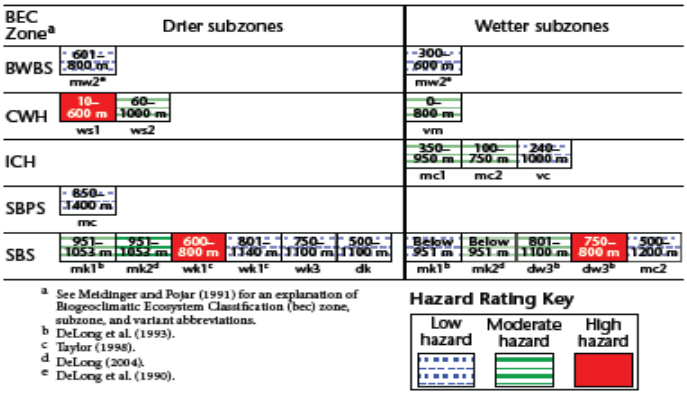
The spruce weevil is a low to moderate pest in the Omineca Region, affecting the growth and development of interior spruce. Repeated weevil attacks to the leading shoots of young interior spruce trees can result in suppressed height growth and stem deformities. Planting genetically resistant seedlings, 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.

- On warmer sites, high hazard exists where heat accumulation exceeds 820 degree days per year above a 7.2°C threshold. Medium-hazard sites receive 785–820 degree days. Weevil development is incomplete with less than 720 degree days.
- Spruce plantations are at risk if adjacent stands have been heavily attacked.

**Table 6. Spruce/White Pine Weevil Hazard Ratings**



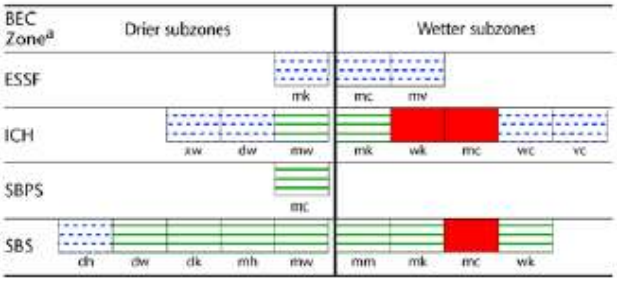

Source: Hodgkinson, R., K. White, and A. Stock. 2011. British Columbia's Northern Interior Forest Region: Spruce/White Pine Weevil Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 11(3):51–54 http://jem.forrex.org/index.php/jem/article/view/16/47

### 6.3.10 Warren Root Collar Weevil (*Hylobius warreni)*

Warren root collar weevil is an ever-present concern in regenerating stands. The impact associated with this insect has been considered low in the past. This insect is receiving more notice as the Prince George TSA is experiencing increased pressure to have a strong midterm timber supply.

Warren root collar weevil attacks lodgepole pine, Engelmann spruce and white spruce. Usually trees over 2 cm in diameter at the root collar are attacked. The weevil may exist in mature stands and may subsequently attack the plantation with random mortality of single or groups of trees. There may also be a correlation between occurrence of Tomentosus root disease and Warren's root collar weevil.

**Table 7. Warren Root Collar Weevil Hazard Ratings[1]**




[1] Ratings are based on expert opinion, known insect biology, and current climatic conditions. If a biogeoclimatic unit is not listed, root collar weevil is not considered to be a significant hazard.

Source: McCulloch, L., B. Aukema, K. White, and M. Klingenberg. 2009. British Columbia's northern interior forests: Warren Root Collar Weevil Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 10(2):105–107 http://www.forrex.org/publications/jem/ISS51/vol10_no2_art8.pdf

### 6.3.11 Lodgpole Pine Terminal Weevil (*Pissodes terminalis)*

The lodgepole pine terminal weevil attacks lodgepole pine trees 1.5 to 10m in height. This weevil has the potential to impact plantation by attacking at least two (2) years of growth and potentially reducing timber quality by creating "Shepherd's crooks" in the juvenile trees. Plantations tend to get spot infestations making their ground detection relatively easy.

Increasing planting densities and mixed stocking can mitigate damage by this pest and should be given serious consideration as these stands will be required for the anticipated midterm timber supply shortfall. Localized areas have high occurrences; therefore monitoring this pest will be essential.

### 6.3.12 Bark Beetle Management Component

The bark beetle suppression component of the Prince George TSA Forest Health Strategy addresses the significant bark beetle problem occurring within the Prince George TSA. The impact from mountain pine beetle, spruce beetle, and western balsam bark beetle are not limited to timber loss. There are also significant impacts on 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 fibre to local mills.

The bark beetle suppression component of the Prince George TSA Forest Health Strategy will provide tactical guidance to forest managers in their attempts to minimize the spread of bark beetles, and minimize the loss of crown timber and other non-timber resource values.

#### 6.3.12.3 Mountain Pine Beetle (*Dendroctonus ponderosae*)

Mountain pine beetle was the top forest health priority in the Prince George TSA, because of the nature of its rapid rate-of-spread and population growth when a suitable host was present. However, the infested area has declined significantly in the Prince George TSA from peak 2007 levels of over 1,700,000 ha to 2013 levels of 321,854 ha.

Mountain pine beetle attack in the Prince George District continued to decline in 2012. Most of the mature pine in this district is dead and the local beetle population was very low. However, it is suspected that some beetles were brought in during high wind events from the large infestations to the north, as most of the scattered attacks occurred is in the northern half of the district. The majority of the trees killed were suppressed understory trees in old attacked stands and young trees in managed stands.

The declining beetle population that remains in the remnant pine of the Vanderhoof and Prince George Districts was reflected in a decrease to the amount of affected this year. Most of the affected hectares were scattered along the northern edge of the district and mortality was very low in the trace and light severity categories.

Mountain pine beetle management in the Prince George and Vanderhoof Districts has generally transitioned from aggressive to salvage. The Fort St. James District, while also salvage, continues to apply a wider range of beetle management strategies. Tools to combat the infestation include: overview and detailed aerial and ground surveys: single tree treatments such as fall and burn, and fall and peel; pheromone baiting; sanitation/salvage harvesting; hazard and risk rating; and high hazard host removal.

Strategies proposed for mountain pine beetle have been directed at the mature timber types, with the exception of rehabilitation of immature stands through the Forests for Tomorrow program, which has been operational in the Prince George District for several years. Additional strategies and tactics are currently being developed to address the infestation in immature pine stands. A risk or susceptibility ranking needs to be created to provide focus on stands that may be at risk or more susceptible.

Regional entomologists and district staff started seeing beetle attack in young stands in 2005. Spaced stands seemed to be the first hit, probably because they had larger stem diameters. Research projects, including those by Southern Interior Forest Region (SIR) entomologist Lorraine MacLauchlan and University of Northern BC (UNBC's) Chris Hawkins, began investigating attack in young stands. They found that stems 10 cm in diameter at breast height (DBH) were attacked, and observed that mortality in stems down to 12 cm DBH and brood development and success in stems as low as 17 cm DBH.

To investigate the extent of MPB on over 280,000 ha of pine leading stands aged 15-60 years in the crown forest land base, Prince George District staff, spearheaded by Jeff Burrows, Stewardship Officer, carried out an extensive detailed aerial survey of immature stands (mostly age class 2 managed stands) in 2007 and 2008 as part of data collection for Timber Supply Review #4 for the Prince George TSA. Over 150,000 ha of identified susceptible pine were sampled by flying approximately 48,500 ha of age class 1, 2 and 3 pine stands. An average of 29%, or approximately 14,000 ha, had been attacked, with attack ranges from 10% in the Fort St. James District to 25% in the Vanderhoof District and 46% in the Prince George District. (Source: Prince George Timber Supply Area Timber Supply Review Data Package November 2008).

The 2010 Provincial aerial overview survey noted significant fresh MPB attack on immature plantations throughout the Prince George TSA.

Special Note regarding Forests for Tomorrow Program (FFT) in the Prince George District: In pine beetle killed spaced stands, snowshoe hare browsing is a significant problem to under planted seedlings as hare populations build up to what appeared to be a peak around 2010. Observations indicate that under planted seedlings are at greatest risk from browsing on moister sites that have developed a secondary brush layer. This will necessitate site preparation of these higher risk stands if we expect to successfully plant them. (Gord Dow, R.P.F., former Regional Silviculture Specialist, FLNRO, personal comments, March, 2008).

#### 6.3.12.4 Spruce Beetle (*Dendroctonus rufipennis*)

Historically, spruce beetle has been a problem for the Prince George TSA with the last major incident occurring in the late 1980's to early 1990's. Recent blowdown in the Willow Valley affecting spruce beetle populations in high value mid-term timber supply has elevated this forest health factor ranking in the Prince George District (source: Jeff Burrows). Although current population levels are relatively static but again may be building in some districts, this pest has caused management difficulties in the past and a wide range of tools have been developed to deal with it. 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.

#### 6.3.12.5 Western Balsam Bark Beetle (*Dryocetes confusus*)

Western balsam bark beetle causes significant mortality of subalpine fir in BC. However, populations of Western balsam bark beetle are often not recorded accurately during aerial overview surveys. Difficulties with management arise from the scattered nature of attack over susceptible host types, and the low level of management currently employed against this bark beetle. Variations in surveys may account for large discrepancies in damage recorded throughout the aerial overview surveys in the last five years.

Despite the large incidence of this pest, it is not managed extensively in the Prince George TSA. Areas will be salvaged where feasible to address infestations, especially where western balsam bark beetle is concurrent with two-year cycle spruce budworm outbreaks, and it is realized that the damage caused by this pest may potentially affect future TSR and AAC determinations.

#### 6.3.12.6 Douglas-fir Beetle (*Dendroctonus pseudotsugae*)

Douglas-fir beetles successfully attack trees that have been weakened by stress. These agents of stress can be abiotic (e.g. drought and fire) or biotic (e.g. overstocking causing competition, diseases, insect attack, etc.). Root diseases are heavily implicated in predisposing trees to bark beetle attack. The presence of Armallaria root disease is indicative of advanced stand degeneration, but laminated root rot is also a predisposing factor. Dwarf mistletoe also weakens trees and reduces growth. Douglas-fir beetles will breed in trees that have been felled by wind or injured by fire. Insect defoliators such as Douglas-fir tussock moth and western spruce budworm can severely weaken trees and predispose them to attack. Logging damage on residual trees can also predispose trees to attack.

This is the most significant bark beetle of Douglas-fir throughout its range. Direct control (e.g., felling, spraying, etc.) has been used infrequently because of high cost. It is possible to prevent damage by removing windthrown trees that may permit a large population of beetles to develop. Attaching capsules of MCH, a Douglas-fir beetle repellant, to their boles, can also protect trees.

Ongoing current infestations, i.e. in the past 2-3 years, have led to increases in the small scale salvage and funnel trap programs in the Prince George District. However, this current attack is not deemed significant to timber supply as most of the attack is focused on larger veterans, not thrifty mature timber. (Source: Jeff Burrows).

The felling and treatment of trap trees from 2010 to 2013 in the Vanderhoof District has significantly decreased the current infestations (Source: Nathan Voth)

### 6.4 Assigning Control Strategies

Beetle management control 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. However, situations change from year to year calling for strategies to be reassessed on an annual basis.

There are six (6) broad strategies that can be used to address bark beetle infestations in a BMU. The strategies include the following:

- Prevention/Suppression,
- Holding action,
- 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 management tactics of these strategies for bark beetles has been included as APPENDIX IX.

FLNR will work together with other agencies (e.g. past Forestry Canada Federal MPB Initiative) to ensure that funding is only allocated to control activities on private land within suppression BMU's.

A detailed description of the control strategies is included as APPENDIX IX

Selection of a management option depends on a technical and ecological evaluation, as well as protected area size and relation of the infestation to neighbouring forest lands. Treatment method is determined through joint decision-making with the MFLNRO that takes into consideration protected area values.

**Table 8. Provincial Control Strategies and Associated Objectives for Beetle Population Removal**

| Strategy | Percent of current infestation to treat (target) | Comments |
|---|---|---|
| **Suppression/Prevention** | ≥80 | Address all current attack within 2 years, stand proofing, other actions. The intent is to "control" the outbreak in that area and stop spread. |
| **Holding Action** | 50-79 | Address the largest proportion of the new infested material, at least close to the rate of expansion. The intent is to reduce beetle populations to levels that can be dealt with annually. |
| **Salvage** | <50 | The priority is to salvage timber previously attacked to minimize value loss. Relevant in areas where suppression or holding actions are no longer appropriate or feasible. |
| **Monitor/Undesignated and Protected Areas** | 0 | No action is required beyond monitoring and recording. This is most appropriate in Parks and Ecological Reserves and in inoperable areas where the outbreak has peaked, salvage is not possible, and there is no chance for any mitigation of further loss. |

Control strategies are 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.

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.

BMU's cannot be considered in isolation as each will have an effect on the adjacent ones. Therefore, the strategy selected for a BMU must be compatible with those declared in adjacent units.

It is important to note that MSMA (monosodium methanearsenate) is no longer available for use and any future considerations for using an active ingredient similar to that of MSMA must conform to the Integrated Pest Management Act and its regulations *(Memorandum, Management of MSMA- treated trees in British Columbia, FLNRO, July 25th, 2007, file 18818-01).* Table 9 outlines the parameters for allowable adjacent control strategies.

**Table 9. Adjacent BMU Control Strategy Evaluation**

| Assigned Strategy/Adjacent Strategies | Suppression / Prevention | Holding Action | Salvage | Monitor, Undesignated, Parks, Protected Areas and Ecological Reserves |
|---|---|---|---|---|
| **Prevention /Suppression** | X | X | | |
| **Holding Action** | X | X | X | |
| **Salvage** | | X | X | X |
| **Monitor, Undesignated, Parks, Protected Areas and Ecological Reserves** | | | X | X |

Specific details related to each BMU and their adjacent control strategies are allocated in the report by BMU found in APPENDIX I.

## 6.5 Invasive Plants

### 6.5.1 Treatment Efforts

#### 6.5.1.1 Fort St. James District

Treatment and inventory efforts are driven by land holder and stakeholder management strategies. Current treatment efforts in the Fort St. James District are summarized in Table 10.

**Table 10. Treatment effort on crown land during 2012, in the Fort St. James District**

| Species | Mechanical Treatments | Chemical Treatments | Total Treatments | Total Area Treated (ha) |
|---|---|---|---|---|
| Field scabious (KNAU ARV) | 2 | 0 | 2 | 0.0003 |
| Hawkweed species (HIER SPP) | 1 | 0 | 1 | 0.0055 |
| Mountain bluet (CENT MON) | 1 | 0 | 1 | 0.0003 |
| Nodding thistle (CARD NUT) | 1 | 0 | 1 | 0.0025 |
| Oxeye daisy (LEUC VUL) | 1 | 0 | 1 | 0.0025 |
| Spotted knapweed (CENT BIE) | 3 | 3 | 6 | 1.0742 |
| **Total** | **9** | **3** | **12** | **1.0853** |

Treatment data extracted from IAPP May 2013

#### 6.5.1.2 Prince George District

2011 marked the first recorded infestations of tansy ragwort and blueweed in the Prince George District however it appears both species have been present in the District for some time.

Treatment and inventory efforts are driven by land holder and stakeholder management strategies. Current treatment and inventory efforts in the Prince George District are summarized in Tables 11 and 12.

**Table 11. Treatment effort during 2012 in the Prince George District**

| Species | Mechanical Treatment | Chemical Treatment | Total Treatments | Total Area Treated (ha) |
|---|---|---|---|---|
| Baby's breath (GYPS PAN) | 1 | 0 | 1 | 0.0001 |
| Bladder campion (SILE VUL) | 1 | 0 | 1 | 0.0001 |
| Blueweed (ECHI VULI) | 2 | 1 | 3 | 0.1110 |
| Burdock species (ARCT SPP) | 1 | 0 | 1 | 0.0020 |
| Chicory (CICH INT) | 0 | 1 | 1 | 0.0200 |
| Common comfrey (SYMP OFF) | 3 | 0 | 3 | 0.0026 |
| Common tansy (TANA VUL) | 59 | 77 | 136 | 0.6068 |
| Cypress spurge (EUPH CYP) | 1 | 0 | 1 | 0.0001 |
| Dalmatian toadflax (LINA DAL) | 5 | 1 | 6 | 0.0066 |
| Diffuse knapweed (CENT DIF) | 0 | 1 | 1 | 0.0300 |
| Field scabious (KNAU ARV) | 0 | 2 | 2 | 0.0830 |
| Hawkweed species (HIER SPP) | 0 | 1 | 1 | 0.0170 |
| Leafy spurge (EUPH ESU) | 2 | 0 | 2 | 0.0005 |
| Marsh plume thistle/Marsh thistle (CIRS PAL) | 15 | 53 | 68 | 2.5622 |
| Meadow knapweed (CENT DEB) | 1 | 1 | 2 | 0.0101 |
| Mountain bluet (CENT MON) | 10 | 8 | 18 | 0.1271 |
| Mullein (VERB THA) | 0 | 1 | 1 | 0.0330 |
| Nodding thistle (CARD NUT) | 0 | 2 | 2 | 0.0350 |
| Oxeye daisy (LEUC VUL) | 1 | 2 | 3 | 0.0520 |
| Policeman's helmet / Himalayan balsam (IMPA GLA) | 2 | 0 | 2 | 0.0105 |
| Queen Anne's lace / wild carrot (DAUC CAR) | 1 | 0 | 1 | 0.0045 |
| Scentless chamomile (MATR PER) | 1 | 0 | 1 | 0.4000 |
| Spotted knapweed (CENT BIE) | 24 | 14 | 38 | 0.1769 |
| **Total** | **130** | **165** | **295** | **4.2911** |

Treatment data extracted from IAPP May 2013

**Table 12. Selected invasive species inventoried on Prince George FLNR jurisdiction in 2012 without treatment**

| Species | Number of Sites | Area Inventoried (ha) |
|---|---|---|
| Canada thistle (CIRS ARV) | 0 | 0 |
| Common tansy (TANA VUL) | 1 | 0.0005 |
| Leafy spurge (EUPH ESU) | 0 | 0 |
| Marsh plume thistle/Marsh thistle (CIRS PAL) | 37 | 19.8421 |
| Mountain bluet (CENT MON) | 0 | 0 |
| Orange hawkweed (HIER AUR) | 32 | 2.7717 |
| **Total** | **72** | **22.6143** |

Inventory data extracted from IAPP May 2013

#### 6.5.1.3 Vanderhoof District

Treatment and inventory efforts are driven by land holder and stakeholder management strategies. Current treatment and inventory efforts in the Vanderhoof District are summarized in Tables 13 and 14.

**Table 13. Treatment effort during 2012 in the Vanderhoof District**

| Species | Mechanical Treatments | Chemical Treatments | Total Treatments | Total Area Treated (ha) |
|---|---|---|---|---|
| Brown knapweed (CENT JAC) | 6 | 0 | 6 | 0.0385 |
| Bull thistle (CIRS VUL) | 3 | 0 | 3 | 0.0304 |
| Burdock species (ARCT SPP) | 1 | 0 | 1 | 0.0001 |
| Canada thistle (CIRS ARV) | 4 | 8 | 12 | 1.1807 |
| Common tansy (TANA VUL) | 65 | 8 | 73 | 3.9909 |
| Dalmatian toadflax (LINA DAL) | 1 | 0 | 1 | 0.005 |
| Field scabious (KNAU ARV) | 76 | 13 | 89 | 1.1229 |
| Leafy spurge (EUPH ESU) | 2 | 0 | 2 | 0.0017 |
| Meadow knapweed (CENT DEB) | 2 | 0 | 2 | 0.0153 |
| Mountain bluet (CENT MON) | 5 | 2 | 7 | 0.0169 |
| Orange hawkweed (HIER AUR) | 1 | 0 | 1 | 0.0001 |
| Spotted knapweed (CENT BIE) | 22 | 0 | 22 | 0.1295 |
| St. John's wort/Saint John's wort/ Goatweed (HYPE PER) | 1 | 0 | 1 | 0.0035 |
| **Total** | **189** | **31** | **220** | **6.5355** |

Treatment data extracted from IAPP May 2013

**Table 14. Selected invasive species inventoried on Vanderhoof FLNR jurisdiction in 2012 without treatment**

| Species | Number of Sites | Area Inventoried (ha) |
|---|---|---|
| Common tansy (TANA VUL) | 1 | 0.0003 |
| Mountain bluet (CENT MON) | 0 | 0 |
| Orange hawkweed (HIER AUR) | 4 | 1.515 |
| Spotted knapweed (CENT BIE) | 0 | 0 |
| Yellow hawkweed (HIER PRA) | 3 | 2.2000 |
| **Total** | **8** | **3.7153** |

Inventory data extracted from IAPP May 2013

## 7.0 MACKENZIE TSA FOREST HEALTH STRATEGY

The Mackenzie TSA is one of 37 administrative timber management units, established under Section 7 of the British Columbia Forest Act, for which an Allowable Annual Cut (AAC) of timber in British Columbia (BC) is determined. It is located in the north-central interior of BC and covers approximately 6.1 million hectares (see Figure 3) and is surrounded by six TSA's and forest districts. The current AAC is 3,050,000 m3. The Mackenzie TSA extends just beyond the Rocky Mountains in the east, the Omineca Mountains in the west, the Village of McLeod Lake in the south and beyond the headwaters of the Kechika River in the north. Central to the TSA is the Williston Reservoir.

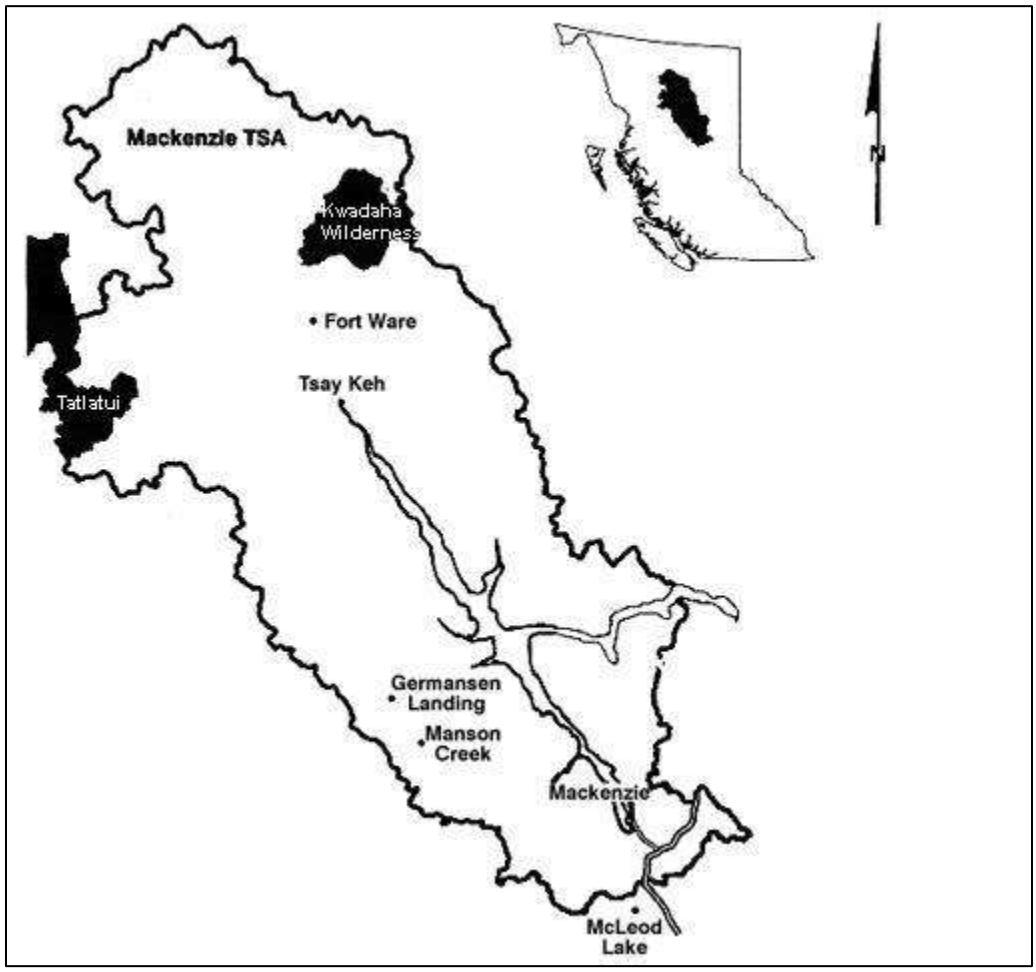



**Figure 3. Key Map of the Mackenzie TSA**

### 7.1 Mission Statement for the Mackenzie TSA

This forest health strategy provides a framework to co-ordinate and guide forest health activities within a relatively large portion of the British Columbia (BC) Interior. While the recent focus of forest health activities has been bark beetle management, this only accounts for a portion of the potential activities as indicated by the following mission statement:

**"The forest health program mitigates pest impacts on provincial forest resource values."**

The forest health program incorporates the principles of integrated pest management to effectively manage interactions between forest practices and damaging agents. It applies ecologically sound techniques to protect and enhance desired resource values (see the four (4) guiding principles in the second paragraph of the Introduction).

A complete forest health program includes both proactive and reactive measures.

Proactive forest health measures require an awareness of potential problems, the ability to analyze hazard and risk for various 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 regulate extremes in pest cycles, reduce future pest risks, and ensure the sustainability of forest resources.

Reactive measures will always be part of a forest health program due to the relatively unpredictable nature of existing and new forest damaging agents. Reactive forest health measures consist of suppressing expanding pest outbreaks using short-term direct control methods with the intent of lowering pest populations and preserving resource values.

An ongoing commitment to adaptive management is essential so that forest practices can improve by learning from past experiences.

## 7.2 Ranking of Forest Health Factors

To provide an effective allocation of resources, forest health factors relative to the Mackenzie TSA have been ranked. Ranking includes forest health factors from both the stand management component and the bark beetle suppression component of this forest health strategy.

The ranking of forest factors is based on the following information and considerations:

- The collective knowledge of Regional forest health specialists and local District stewardship staff
- Known or suspected impacts on forest resource values
- Costs and benefits of detailed detection and treatment activities
- Overall level of knowledge about the hazard and risk zones
- Distribution of pest and current incidence levels; and
- Resources required filling knowledge gaps necessary for management of the pest

It is recognized that more analysis is required to evaluate the impact of current losses of merchantable timber to those losses associated with a reduction of mature harvestable volume at some date in the future. As additional information and analysis regarding the impacts of losses in mature timber becomes known, the information will be included in the ranking of forest health factors. A review of this health factor ranking will be undertaken annually.

Rankings were developed using the collective knowledge of FLNR Branch and Regional forest health specialists for assessing forest health risks at a Provincial level (APPENDIX II). Local (TSA-level) issues may elevate the importance of specific forest health factors. These priorities are reflected in the ranking of forest health factors as presented in this forest health strategy for the Mackenzie TSA.

The forest health factors in the Mackenzie TSA have been ranked as follows in Table 15:

**Table 15. Ranking of Forest Health Factors in the Mackenzie TSA**

| *Very High* | *High* | *Medium* | *Low* | *Very Low* |
|---|---|---|---|---|
| | Mountain Pine Beetle | Spruce Beetle | Tomentosus Root Disease | Forest Tent Caterpillar |
| | Western Balsam Bark Beetle | Two-year Cycle Budworm | Lodgepole Pine Dwarf Mistletoe | Serpentine Leaf Miner - aspen |
| | Comandra Blister Rust | Engraver Beetles *Ips Pini* | White Pine Weevil | Birch Leaf Miner |
| | Stalactiform Blister Rust | Warren's Root Collar Weevil | Venturia | Lodgepole Pine Terminal Weevil |
| | Western Gall Rust | | Red Band Needle Blight – Dothistroma | Spruce Leader Weevil |

## 7.3 Stand Management of Non-Bark Beetle Component

The stand management component of this strategy is intended to provide a ranking of non-bark beetle forest health factors in the Mackenzie TSA. It also provides links to specific tactics to reduce the risk of unacceptable impacts arising from those factors. These tactics will conform largely to strategies addressed by forest health guidebooks or MFLNRO guidelines; however, tactics that differ from those presented in guidebooks will be identified and justified.

### 7.3.1 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 two-year cycle budworm is causing significant impact on the following:

- Annual increment losses (loss of basal area growth)
- Increased frequency of tree deformities, including forks and crooks
- Damage to developing cones and buds
- Reduced height growth due to top kill
- Reduced host vigor, thus enabling other secondary pests to invade the tree, including
    - Spruce beetle and western balsam bark beetle
    - Wood borers (increased wood decay) and pathogens, and
    - Tree mortality in the regeneration, co-dominant, and dominant layers (Duthie-Holt & Setter 1999)

Currently, active management is not being implemented for two-year cycle budworm, except to expedite salvage harvesting based on the prioritization of defoliation levels. Strategic planning to optimize salvage harvesting, will be the most successful approach for recovering timber volumes in defoliated stands.

*Bacillus thuringiensis* subsp. *Kurstaki (Btk)*, a biological insecticide, is the only direct control measure that would be suitable for use and had recently became registered for use against 2-year budworm. Limited use may be justified for localized high value stands that need protection.

### 7.3.2 Dothistroma Needle Blight (*Dothistroma septosporum*) (Red Band)

Dothistroma is a low to medium priority forest health factor in the Mackenzie TSA though incidence levels should continue to be monitored and their priority reassessed at the annual review stage. A Dothistroma needle blight epidemic 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.

An aerial overview survey has been completed by Regional Forest Pathologist Richard Reich in the Prince George and Fort St. James Districts. A GIS hazard rating system is being developed from the aerial survey results. In general, the SBSvk biogeoclimatic subzone is high risk, the SBSwk is moderate, and everything else is low. Areas in close proximity to rivers and flat to concave/toe of slope landforms are at highest risk. Slopes greater than 10% are low risk.

### 7.3.3 Ips Beetle (*Ips pini)*

*Ips pini* beetles usually attack weakened, dying, or recently felled trees and fresh logging debris. Large numbers of *Ips pini* may build up when natural events such as ice storms, wildfires, and droughts create large amounts of pine suitable for the breeding of these beetles. Historically, *Ips pini* bark beetles can increase in numbers to a minor extent. They should be dealt with by salvaging blowdown and harvesting infested trees where located.

### 7.3.4 Aspen, Poplar Leaf and Twig Blight (*Venturia spp.*)

In B.C., *Venturia* has been reported on aspen. These fungi are widely distributed throughout the range of their hosts in B.C. When moist weather conditions prevail during the growing season, *Venturia* can kill most shoots in aspen stands regenerating by sprouting. Repeated infection results in stem deformity and growth reduction.

### 7.3.5 Tomentosus Root Disease (*Onnia tomentosa)*

*Onnia tomentosa* primarily infects spruce species, but also is found on lodgepole pine and to a lesser degree on most other conifers in BC. It is found most frequently in spruce-pine forests in central and northern British Columbia, and at correspondingly higher elevations in southern B.C.

Infected trees may appear healthy, but often have extensive butt cull and reduced annual increment growth. The fungus spreads from tree to tree at points of root contact; consequently, diseased trees occur in groups and mortality results in “stand openings.” Wind throw may occur before the death of an infected tree. Fruiting bodies on, or around a tree, indicate that one to three metres 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.

Two similar species of *Onnia* are found in B.C., O*. tomentosa* and O*. circinatus*, which is more prevalent on lodgepole pine. It is difficult to differentiate between the two, particularly when fruiting bodies (basidiocarps) are not present. Basidiocarps of O*. tomentosa* are smaller and thinner, and are usually found in groups. Basidiocarps of O*. circinatus* are larger, thicker, and tend to be found individually. O*. circinatus* is more commonly found on pine than spruce. Setal characteristics are a good diagnostic feature but must be examined under a microscope. Advanced stages of decay in the butt may be confused with decay pitting caused by *Phellinus pini.*

The strategies and tactics for Tomentosus root disease management outlined in the FPC Root Disease Management Guidebook should be followed. The Tomentosus SEDA is now available on the web at the following location: http://jem.forrex.org/index.php/jem/article/viewFile/562/489.

### 7.3.6 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, reduced seed crop production, 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).

The mountain pine beetle epidemic has eliminated the overstory host across a broad area in the north. This has very effectively sanitized much of the mistletoe from the overstory. Survival of mistletoe in the understory will maintain the pest, but its spread will be reduced considerably since lateral spread from advanced regeneration is not as effective as mistletoe rain from the overstory.

## 7.4 Pine Stem Rusts

Collectively, the pine stem rusts cause more losses than any other pest in young stands. A hazard and risk rating system is currently in development to help identify localized areas of concern.

### 7.4.1 Western Gall Rust (*Endocronartium harknessii)*

Western gall rust (DSG) is the most common rust of young lodgepole pine. Infection is caused by long distance spread spores that travel hundreds of kilometers, resulting in a regional spore cloud. As a result, when local conditions are suitable, infection occurs in a fairly uniform to random pattern. Infection is pine to pine, since WGR does not have an alternate host. Variation in genetic predisposition is strongest in WGR, compared to the blister rusts. Selection for natural resistance holds great promise, and is being incorporated into the tree breeding program. Impact from WGR is highest in young stands, with new stem infection largely subsiding by age ten. Main stem galls are generally lethal on young trees, but a portion may persist into late rotation.

WGR damage on mature trees is not significant, since most infections occur on branches and branch galls do not result in serious growth losses (Ziller 1974). As well, this disease seldom kills older trees, but can kill young trees with main stem infections. Heavily infected trees are generally stunted or malformed, predisposing these trees to breakage in high winds or under heavy snow loads (Ziller 1974). The distribution of WGR is widespread throughout the province of BC, as well as in the east (Ziller 1974).

### 7.4.2 Stalactiform Blister Rust (Cronartium coleosporioides)

Stalactiform blister rust (DSS) can be locally abundant, but is not widespread. Alternate hosts for SBR include members of the figwort 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 can be tracked in on equipment. Recent research indicates that yellow rattlebox, may be a very prominent alternate host. Significant mortality can occur on sites with moderate to high levels of alternate hosts, particularly if trees are infected at a very young age. Currently, pre and post-harvest monitoring is occurring.

### 7.4.3 Comandra Blister Rust (*Cronartium comandrae)*

Comandra blister rust (DSC) is a very damaging stem rust of lodgepole pine. It girdles and kills young trees rapidly and can occur at very high levels locally. Since spread from the alternate host to pine is by short range spores, infection is highly clustered and generally corresponds to the distribution of the alternate host, Bastard Toadflax (*Geocaulon lividum)*. 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 screening holds potential. Impact can be serious, especially where stocking is insufficent to compensate for mortality, therefore overstocking is recommended on high risk xeric sites. Species mixes are recommended on mesic and moister sites.

Projected rust levels can be estimated using a three step approach (source: Richard Reich):

1. Infection is largely a function of weather, with elevation determining the general hazard. In the SBS biogeoclimatic zone, risk is assessed as
    a. High: (greater than 20%) at less than 800m,
    b. Moderate: from 800-1200m, and
    c. Low: above 1200m.

    Incidence rarely exceeds 5% in the ESSF probably due to low night time temperatures
2. At the site level, the presence of CBR's alternate host, Bastard Toadflax can dramatically increase risk. Distribution and percent cover are key factors to assess during a preharvest recce prior to developing a prescription
3. The incidence of rust in adjacent young stands is also a key factor when interpreting the overall risk posed by elevation and alternate host abundance

At this time, there is a lack of reliable data for the incidence of CBR in specific ecosystems. Additional information may be found in the Mackenzie TSA Rust Management Strategy regarding treatment options and hazard for related ecosystems. A rust management strategy and a Standard Operating Procedure (SOP) for ground detection were developed for the Mackenzie TSA by the Mackenzie Rust Working Group in 2006. Members of this working group include: private industry and District and Regional levels of Ministry of Forests and Range. The control measures from the SOP are focused on promoting a greater awareness of rusts and associated alternate hosts, reforesting to higher densities and planting non-susceptible species where ecologically appropriate. To control rusts, infected trees and branches can be removed during the spacing of young stands. For mature forests infested stands can be harvested first to minimize the spread of spores from old blisters

## 7.5 Large Aspen Tortrix (Choristoneura conflictana)

No are no significant populations of large aspen tortrix recorded in the Mackenzie TSA via the aerial overview survey. These defoliators are not expected to cause significant damage on aspen or secondary host species, (including balsam, poplar, birch, and willow) since outbreaks tend to be short-lived, lasting only 2 to 3 years in any one location (Cerezke 1992).

Tortrix feeding may cause partial or complete defoliation of trees for 1 to 3 years, resulting in reduced tree vigor and stem growth and occasionally killing the treetop and upper branches. Tree mortality rarely occurs directly

from larval feeding, because aspen trees usually re-foliate within 4 to 6 weeks after feeding is complete (Cerezke 1992). For an individual stand, defoliation may only persist for one year due to the movement of the population.

Control of the large aspen tortrix is usually unnecessary because of the short duration of outbreak periods and because many natural biological agents combine to help keep populations in check (Cerezke 1992).

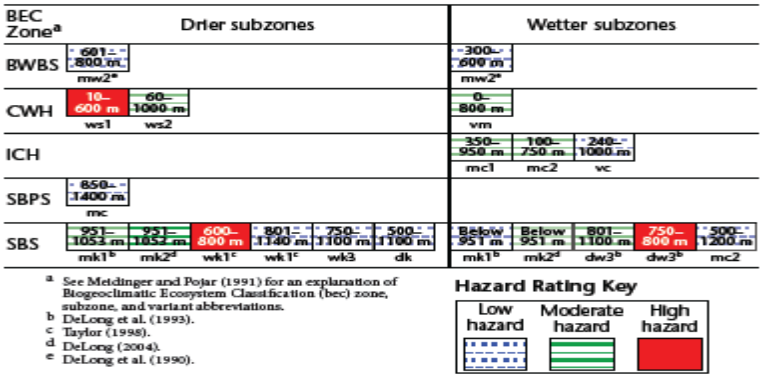
## 7.6 Spruce/White Pine Weevil (*Pissodes strobi)*

The spruce weevil is a major pest in the Northern Interior Forest Region, affecting the growth and development of 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 2 cm or more. Denser stands have slightly lower attack rates and subsequent damage results in fewer deformities.
- On warmer sites, high hazard exists where heat accumulation exceeds 820 degree days per year above a 7.2°C threshold. Medium-hazard sites receive 785–820 degree days. Weevil development is incomplete with less than 720 degree days.
- Spruce plantations are at risk if adjacent stands have been heavily attacked.

**Table 16. Spruce/White Pine Weevil Hazard Ratings**



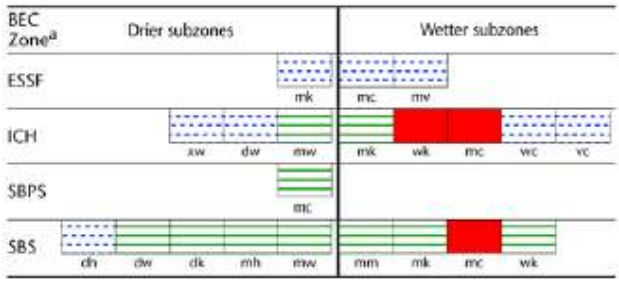

Source: Hodgkinson, R., K. White, and A. Stock. 2011. British Columbia's Northern Interior Forest Region: Spruce/White Pine Weevil Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 11(3):51–54 http://jem.forrex.org/index.php/jem/article/view/16/47

## 7.7 Warren Root Collar Weevil (*Hylobius warreni)*

Warren root collar weevil is an ever-present concern in regenerating stands. The impact associated with this insect has been considered low in the past.

Warren root collar weevil attacks lodgepole pine, Engelmann spruce and white spruce. Usually trees over 2cm in diameter at the root collar are attacked. The weevil may exist in mature stands and may subsequently attack the plantation with random mortality of single or groups of trees. There may also be a correlation between occurrence of Tomentosus root disease and Warren's root collar weevil.

**Table 17. Warren Root Collar Weevil Hazard Ratings.**




[a] See Meidinger and Pojar (1991) for an explanation of Biogeoclimatic Ecosystem Classification (BEC) zone, subzone, and variant abbreviations.

**Hazard Rating Key**

| Low hazard | Moderate hazard | High hazard |
|---|---|---|

[1] Ratings are based on expert opinion, known insect biology, and current climatic conditions. If a biogeoclimatic unit is not listed, root collar weevil is not considered to be a significant hazard.

Source: McCulloch, L., B. Aukema, K. White, and M. Klingenberg. 2009. British Columbia's northern interior forests: Warren Root Collar Weevil Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 10(2):105–107 http://www.forrex.org/publications/jem/ISS51/vol10_no2_art8.pdf

## 7.8 Lodgpole Pine Terminal Weevil (*Pissodes terminalis)*

This weevil has the potential to set back plantations severely by attacking at least two (2) years of growth and potentially reducing timber quality by creating "Shepherd's crooks" in the juvenile trees. Several strategies are available to mitigate damage by this pest and should be given serious consideration as these stands will be required for the anticipated midterm timber supply shortfall. Localized areas have high occurrences; therefore monitoring this pest will be essential.

## 7.9 Bark Beetle Management Component

The bark beetle suppression component of the Mackenzie TSA Forest Health Strategy addressed the significant bark beetle problem occurring within the Mackenzie TSA. The impact from mountain pine beetle, spruce beetle, and western balsam bark beetle are not limited to timber loss. There are also significant impacts on recreation, fish and wildlife, watershed management, range, landscape and aesthetics, cultural heritage, and other resource values.

### 7.9.1 Mountain Pine Beetle (*Dendroctonus ponderosae*)

Mountain pine beetle populations continue to expand in the northern half of the TSA predominantly within the trench area where lodgepole pine is a leading or major component of the stands. Management in the Mackenzie TSA has generally transitioned from aggressive to salvage.

Strategies proposed for mountain pine beetle have been directed at the mature timber types, with the exception of rehabilitation of immature stands through the Forests for Tomorrow program, which has been operational in the Mackenzie TSA for several years. Additional strategies and tactics are currently being developed to address the infestation in immature pine stands. A risk or susceptibility ranking needs to be created to provide focus on stands that may be at risk or more susceptible.

### 7.9.2 Spruce Beetle (*Dendroctonus rufipennis*)

Spruce beetle attack mature spruce trees and cause extensive mortality. Historical outbreaks have often been associated with windthrow or poor forest sanitation practices (Humphreys and Safranyik 1993). Spruce beetle has been a problem in the Mackenzie TSA with the last major outbreak occurring in 1991 (Ministry of Forests and Range 2007). Currently there are two small infestations of spruce beetle other endemic populations in the TSA. There was a major wind storm in November 2010 that blew down approximately 300,000 $m^3$of widely scattered spruce and will likely contribute to these recent flare-ups. BMU's containing the spruce blow down will be assigned a suppression strategy.

The spruce beetle life cycle usually requires two (2) years to complete. When population numbers are small, beetles can be found in weakened and downed trees. As population levels increase to outbreak proportions, beetles make use of healthy standing trees. Eggs are laid within a tunnel system in the inner bark (phloem layer). Once the larvae have hatched they feed on the inner bark. Larval feeding girdles the conductive tissues and severs the tree's supply of water and nutrients which can result in the death of the tree. If they complete a one (1) year life cycle the new adults and can leave the tree to attack new hosts the following year. If completing a multi-year life cycle, many immature adults move to the base of the trunk of the host tree to over winter (Humphreys and Safranyik 1993, MFR 2001).

This pest has had extensive impacts on the forest industry in the past and some of the methods used to manage it are overview and detailed aerial and ground surveys, single tree treatments of fall and burn, conventional trap trees, fall and peel, pheromone baiting, sanitation/salvage harvesting, hazard and risk rating and high hazard host removal (MFR 2007).

### 7.9.3 Western Balsam Bark Beetle (*Dryocetes confusus*)

Western balsam bark beetle causes significant mortality of Sub-alpine fir in BC. However, populations of western balsam bark beetle are often not recorded accurately during aerial overview surveys. Difficulties with management arise from the scattered nature of attack over susceptible host types, and the low level of management currently employed against this bark beetle. These variants in surveys may account for large discrepancies in damage recorded throughout the aerial overview surveys in the last five years.

Despite the large incidence of this pest, it is not managed extensively in the Mackenzie TSA. Areas will be salvaged where feasible to address infestations, especially where western balsam bark beetle is concurrent with two-year cycle spruce budworm outbreaks, and it is realized that the damage caused by this pest may potentially affect future TSR and AAC determinations.

### 7.9.4 Lodgepole Pine Beetle (*Dendroctonus murryanae*)

This bark beetle is not considered an aggressive pest. It normally attacks only weakened mature lodgepole pine trees, stumps, or windfall and on standing trees it concentrates its feeding efforts to the lower bole and root crown. Only a few pairs of beetles will be found in an attacked tree and it usually requires several generations for the damage to be severe enough to kill the tree. It takes one year to complete its life cycle. (Ministry of Forests and Range 2001).

In the past five years there has been no recorded incidence of lodgepole pine beetle but it is sometimes misidentified as mountain pine beetle and both beetles can be found in the same area. The incidence of lodgepole pine beetle recorded in the Mackenzie TSA in 2005 (when surveys were carried out for mountain pine beetle) was 23% in the Clearwater, Lower Ospika and Collins-Davis BMUs. It was

recommended to increase surveys for lodgepole pine beetle to gain a better understanding of its population and dynamics in the Mackenzie TSA (Ministry of Forests and Range 2007).

## 7.10 Assigning Control Strategies

Beetle management control 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. However, situations change from year to year calling for strategies to be reassessed on an annual basis.

There are six (6) broad strategies that can be used to address bark beetle infestations in a BMU. The strategies include the following:

- Prevention/Suppression,
- Holding action,
- 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 management tactics of these strategies for bark beetles has been included as APPENDIX IX.

FLNR will work together with other agencies (e.g. Canadian Forest Service – Federal MPB Initiative) to ensure that funding is only allocated to control activities on private land within suppression BMU's.

A detailed description of the control strategies is included as APPENDIX IX.

**Table 18. Provincial Control Strategies and Associated Objectives for Beetle Population Removal**

| Strategy | Percent of current infestation to treat (target) | Comments |
|---|---|---|
| **Suppression/Prevention** | ≥80 | Address all current attack within 2 years, stand proofing, other actions. The intent is to "control" the outbreak in that area and stop spread. |
| **Holding Action** | 50-79 | Address the largest proportion of the new infested material, at least close to the rate of expansion. The intent is to reduce beetle populations to levels that can be dealt with annually. |
| **Salvage** | <50 | The priority is to salvage timber previously attacked to minimize value loss. Relevant in areas where suppression or holding actions are no longer appropriate or feasible. |
| **Monitor/Undesignated and Protected Areas** | 0 | No action is required beyond monitoring and recording. This is most appropriate in Parks and Ecological Reserves and in inoperable areas where the outbreak has peaked, salvage is not possible, and there is no chance for any mitigation of further loss. |

Control strategies are 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.

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.

BMU's cannot be considered in isolation as each will have an effect on the adjacent ones. Therefore, the strategy selected for a BMU must be compatible with those declared in adjacent units.

It is important to note that MSMA (monosodium methanearsenate) is no longer an acceptable chemical control method for any strategy and any future considerations for using an active ingredient similar to that of MSMA must conform to the Integrated Pest Management Act and its regulations *(Memorandum, Management of MSMA- treated trees in British Columbia, FLNRO, July 25th, 2007, file 18818-01).* Table 19 outlines the parameters for allowable adjacent control strategies.

**Table 19. Adjacent BMU Control Strategy Evaluation**

| Assigned Strategy/Adjacent Strategies | Suppression / Prevention | Holding Action | Salvage | Monitor, Undesignated, Parks, Protected Areas and Ecological Reserves |
|---|---|---|---|---|
| **Prevention /Suppression** | X | X | | |
| **Holding Action** | X | X | X | |
| **Salvage** | | X | X | X |
| **Monitor, Undesignated, Parks, Protected Areas and Ecological Reserves** | | | X | X |

Specific details related to each BMU and their adjacent control strategies are allocated in the report by BMU found in APPENDIX I.

## 7.11 Invasive Plants

### 7.11.1 Treatment Efforts

Treatment and inventory efforts are driven by land holder and stakeholder management strategies. Current treatment efforts in the Mackenzie TSA are summarized in Tables 20 and 21.

**Table 20. Treatment effort during 2012 in the Mackenzie TSA**

| Species | Mechanical Treatments | Chemical Treatments | Total Treatments | Total Area Treated (ha) |
|---|---|---|---|---|
| Hawkweed species (HIER SPP) | 2 | 0 | 2 | 0.0300 |
| Mullein (VERB THA) | 1 | 0 | 1 | 0.0001 |
| Oxeye daisy (LEUC VUL) | 1 | 0 | 1 | 0.0200 |
| Spotted knapweed (CENT BIE) | 1 | 0 | 10 | 0.0010 |
| **Total** | **5** | **0** | **5** | **0.0526** |

Treatment data extracted from IAPP May 2013

**Table 21. Selected invasive species inventoried in the Mackenzie TSA for FLNRO in 2011 without treatments**

| Species | Number of Sites | Area Inventoried (ha) |
|---|---|---|
| Common tansy (TANA VUL) | 1 | 0.0150 |
| Hawkweed species (HIER SPP) | 2 | 5.5000 |
| Oxeye daisy (LEUC VUL) | 5 | 5.5675 |
| Yellow hawkweed (HIER PRA) | 1 | 1.0000 |
| **Total** | **3** | **12.0825** |

Treatment data extracted from IAPP May 2013

## 8.0 ROBSON VALLEY TSA FORESTHEALTH STRATEGY

This section has been prepared for FLNRO Headwaters District for the Robson Valley Timber Supply Area (RV TSA) in response to the provincial request for submission of a forest health and annual bark beetle strategy encompassing the Timber Supply Area (TSA). A newly released Provincial Forest Health Strategy gives a broad outline of the objectives and goals set by FLNRO. As well a more comprehensive overview is provided in the Provincial Forest Health Program Document. This document follows the goals and objectives of the Provincial Forest Health Strategy. The new Provincial Forest Health Implementation Strategy will form the link between the Forest Health Program and the Robson Valley TSA Forest Health Strategy. Also this document will be consistent where practicable with the Robson Valley Land and Resource Management Plan (LRMP), while incorporating the RV TSA specific tactics and initiatives for a number of identified forest health agents.

- Links to obtain each publication are as follows:
- Provincial Forest Health Program Document: http://www.for.gov.bc.ca/hfp/health/Strategy/FH%20Program.pdf
- Provincial Forest Health Strategy: http://www.for.gov.bc.ca/hfp/health/Strategy/FH%20Strategy.pdf
- Provincial Forest Health Program Document: http://www.for.gov.bc.ca/hfp/health/Strategy/FH%20Program.pdf
- Provincial Forest Health Implementation Strategy: http://www.for.gov.bc.ca/hfp/health/Strategy/FH%20Impl.%20Strategy.pdf

The Robson Valley TSA is located in the interior wet-belt of the province and includes four biogeoclimatic zones. The sub-boreal spruce zone (SBS) is found at low elevations primarily in the Rocky Mountain trench. The interior cedar hemlock (ICH) occurs at lower to mid elevations and is one of the most species diverse zones of any zone in B.C. The Engelmann spruce-subalpine fir (ESSF) is the mid to high elevation forested zone. The alpine tundra (AT) is present at the highest elevations above the ESSF. These ecosystem units reflect distinct differences in terrain, climate, and species diversity. This diversity presents a challenge as it supports a complex mix of forest health agents, hosts, and management circumstances.

The FLNRO recognizes that implementation of the Forest Health Program will address key issues that forest managers are currently facing in British Columbia. The Forest Health Program identifies five specific issues;

1. Tree species at high risk of pest damage.
2. International trade and export controls.
3. Climate change and its need for further forest health monitoring and research.
4. Introduction and spread of a variety of invasive plant species.
5. The current legislative framework enshrines results based forest management and professional reliance. For forest professionals, forest health management applies at each stage of stand development.

The provincial Forest Health Program includes three emphasis areas: legislation and policy support, program delivery, and adaptive management. The various functions are stated in the Forest Health Implementation Strategy along with the function's key objectives, performance measures, provincial priorities, and the roles and responsibilities for branch, regions and districts. Licensees and others are included where relevant.

## 7.11 Robson Valley TSA Priority Ranking of Importance of Forest Health Factors

The ranking of known forest health factors will be based on:

- Collective knowledge of the FLNRO, licensees, regional forest health specialists, and local consultants/contractors;
- Known or suspected impacts to forest resource values;
- Availability of operational detection and treatment methods;
- Costs and benefits of applying detailed detection and treatment activities;
- Overall level of knowledge about the hazard and risk zones;
- Distribution of forest health agents and their current incidence levels;
- Resources required to obtain missing information necessary for management of forest health factors;
- Surveys of the forest health community to identify information needs.

**Table 22. Robson Valley TSA Ranking of Pest Species by Potential Impact on Forest Management Activities.**

| Very High | High | Moderate | Low | Very Low |
|---|---|---|---|---|
| Armillaria root disease | Spruce bark beetle | Douglas-fir beetle | White pine blister rust | Sweet fern blister rust |
| Mountain pine beetle | Comandra blister rust | Western balsam beetle | Black army cutworm - if present | Circinatus root rot |
| | Stalactiform blister rust | Tomentosus root disease | Other conifer foliage diseases | Pine Needle Cast |
| | Western gall rust | Lodgepole pine dwarf mistletoe | | Annosus root disease |
| | Two-year cycle spruce budworm | Western hemlock looper | | Atropellis canker |
| | | Dothistroma needle blight | | Blackstain root disease |
| | | White Pine Weevil (Spruce leader weevil) | | Conifer foliar diseases |
| | | Pine engraver beetle (*Ips pini*) – if present | | Elytroderma needle cast |
| | | Warren's root collar weevil | | Hardwood cankers |
| | | Wood decay fungi | | Hardwood defoliators |
| | | Cattle | | Northern pitch twig moth |

## 7.12 Tactics with Deviations from Currently Available Management Practices

### 7.12.1 Armillaria root disease (*Armillaria ostoyae*)

Armillaria root disease has been identified within the RV TSA. Its infection distribution ranges from scattered individual trees to well defined centers. Currently data is available from both aerial flights and ground assessments, which form the initial hazard and risk rating digital layer and database encompassing the susceptible biogeoclimatic subzones within the TSA.

**Tactics and Current Armillaria Research**

To date within the RV TSA, the recommended method for Armillaria root disease detection is ground surveys at the operational planning stage. Armillaria root disease is delineated based on disease incidence. Area' based Armillaria hazard and risk digital layer maps have been generated for portions of the RV TSA. An Armillaria database has also been developed containing site specific attributes and survey methodology corresponding to the digitized overlay base maps. The digital overlay maps and database is available from Richard Reich Regional Forest Pathologist, Omineca Forest Region at (250)-565-6203 or Richard.Reich@gov.bc.ca. Please refer to the

following document "Armillaria Root Disease Hazard and Risk Digital Layer and Database for the Robson Valley TSA" for a project history and description (APPENDIX VIII).

In 2006 an Armillaria Root Disease Map Verification Project was initiated by Richard Reich in collaboration with Michelle Cleary Regional Forest Pathologist, Southern Interior Forest Region, to determine the reliability of the Armillaria map for the RV TSA. The purpose of this ongoing project is to assess the accuracy of the Armillaria map of the northern portion of the Headwaters District (formerly the Robson Valley District). The map was assembled over a period of several years starting in 1991 using detection methods ranging from specialized low-level aerial sketch mapping using rotary wing aircraft, to detailed ground surveys. Preliminary results show that the current Armillaria map is largely reliable in showing the distribution of Armillaria at a landscape level. See APPENDIX VIII for a complete project description.

Future planned work as per the Armillaria Map Verification Project includes:

- Ground surveying additional stands to improve the reliability of the map in high risk areas.
- Transfer of all verified disease strata into the FLNRO forest inventory in the forest health layer to be used as an on-line planning tool.
- Investigation of local Armillaria population genetics through DNA characterization of disease centers (into unique genets) in order to interpret landscape level infection patterns as they relate to operational surveys.
- Comparing the verification survey results of this study with the free growing results recorded in the RESULTS database.

A Forest Health Stand Establishment Decision Aid (SEDA) for Armillaria root disease was finalized in 2008 for the Southern Interior Forest Region. http://www.forrex.org/jem/ISS48/vol9_no2_art7.pdf.

The SEDA contains information specific to Armillaria root disease management stemming from current Armillaria research in the Southern Interior Region. The SEDA also contains a revised table of susceptibility ratings for host species and a decision key by BEC zone/subzone that aims to differentiate between the distribution of Armillaria root disease inoculum and extent of damage on host species, and then suggests appropriate measures to be taken in order to minimize losses. The SEDA can be used as a tool for decision making in areas where Armillaria root disease management is a priority (personal communication. Michelle Cleary Regional Forest Pathologist, Southern Interior Forest Region).

Ongoing research verifies differences in Armillaria root disease distribution within the high hazard BEC zones/subzones within the RV TSA from that of the ICH zone in the southern portion of the region. This is most evident within the ICH where Armillaria distribution is patch-wise, ranging from scattered individual trees to well defined centres. It deviates from the southern ICH zone where Armillaria is considered to be universally present in all but the driest and wettest site series. For forest managers to make an informed decision in respect to management options and impacts, the decision key within the SEDA should consider the distribution pattern of Armillaria as it occurs in the high hazard BEC zones/subzones within the RV TSA.

Three permanent sample plots (PSP's) were established in the early 1990's to monitor Armillaria root disease rate of spread within the RV TSA. The plots are on a 5 year re-measurement and maintenance schedule. Contact Richard Reich, Regional Forest Pathologist, Northern Interior Forest Region, Prince George, for further information.

It should be noted that within the 2006 rationale for allowable cut determination within the RV TSA it is specifically recommended in the implementation section to undertake projects to help reduce the risk and uncertainty associated with key factors (Forest health factors - Armillaria root diseases) that affect the timber supply in the RV TSA.

### 7.12.2 Tomentosus root disease (*Inonotus tomentosus)*

Tomentosus root disease has been identified within the RV TSA. It can be found in stands containing susceptible species (its preferred host is Spruce) and is most often evidenced by windthrow. Its infection distribution ranges from scattered individual trees to defined centers dependent on the presence of host species.

For Tomentosus root disease a number of high hazards biogeoclimatic subzones were omitted within the Root Disease Management Guidebook.

**Tactics for detection of Tomentosus**

Tomentosus has been found to have inconsistent above ground symptoms. Therefore, root drilling is a recommended tool that can be used to aid in confirming the presence of Tomentosus root disease within high hazard areas with known risk at the operational planning stage. This method has been employed to determine incidence levels of Tomentosus root disease within the RV TSA.

### 7.12.3 Circinatus root disease (*Inonotus circinatus)*

Circinatus root disease, which is closely related to Tomentosus root disease but primarily affects pine, has been confirmed within the RV TSA. To date this root disease has only been detected within the RV TSA at minor incidences. Thus, it has been classified with a very low priority within the TSA.

**Tactics - Circinatus**

Record and evaluate occurrences to determine whether further information is required in regards to stand level impacts.

### 7.12.4 Black stain root disease (*Leptographium wageneri)*

Black stain root disease, which primarily affects Douglas-fir and Pl, has been confirmed within the RV TSA. To date this vascular wilt disease has only been detected within the RV TSA at minor incidences. Thus, it has been classified with a very low priority within the TSA.

**Tactics - Black stain root disease**

Record and evaluate occurrences to determine whether further information is required in regards to stand level impacts. A Forest Health Stand Establishment Decision Aid (SEDA) for black stain root disease was developed for the Southern Interior Forest Region. The SEDA is available at:
http://www.forrex.org/JEM/ISS27/vol6_no1_art6.pdf

### 8.2.5 Hard pine stem rusts - Comandra blister rust (*Cronartium comandrae)*, Stalactiform blister rust (*Cronartium coleosporioides)* and Western gall rust (*Endocronartium harknessii)*

**Tactics and Current Hard Pine Stem Rusts Research:**

Pre-stand tending surveys have been conducted within high hazard stands within the RV TSA. When high incidences are encountered and sanitation spacing is required, consideration is given to increasing the prescribed target stocking.

One of the three PSP's established for Armillaria root disease rate of spread within the Robson Valley also contains data on incidences of hard pine stem rusts. Contact Richard Reich Regional Forest Pathologist, Omineca Region in Prince George for further information.

### 7.12.5 Sweet Fern Blister Rust (*Cronartium comptoniae*)

This stem rust has only been found in a few locations within the RV TSA. It is commonly found near its alternate host, sweet gale. Sweet gale is restricted to wetlands making the overall hazard and risk throughout the RV TSA very low. Thus, it has been classified with a very low priority.

**Tactics - Sweet Fern Blister Rust**
No specific treatment tactics or recommendations are given.

### 7.12.6 White Pine Blister Rust (*Cronartium ribicola*)

**Host species:** Western White Pine (*Pinus monticola)*

The Robson Valley encompasses the northern limit of the range of white pine within British Columbia. White pine makes up a very small component of the merchantable volume within the RV TSA. White pine blister rust has prevented white pine from being considered a preferred species for regeneration within the TSA.

**Tactics - White Pine Blister Rust for Western White Pine:**
White pine can be considered a potential crop tree if bred for blister-rust tolerance and/or branch pruning is used as part of the basic silviculture obligation. 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 http://www.forrex.org/JEM/ISS27/vol6_no1_art6.pdf

**Tactics - White Pine Blister Rust for Whitebark Pine**
FLNRO and Parks Canada is reviewing management objectives for high elevation stands, conducting cone collections for breeding purposes and conducting site preparations.

Whitebark pine only occurs at high-elevation, subalpine locations. Within the Robson Valley it can be expected to occur in the ESSF and AT biogeoclimatic zones. The significance of whitebark pine is foremost ecological and social and not as a merchantable product. The importance of the species is foremost wildlife cover and food, watershed protection, ecological succession, subalpine biodiversity and for its visually aesthetic and recreational considerations (Tomback et al. 2001). The species is threatened by its susceptibility to white pine blister rust. Until recently only marginal attention had been given to the impact of the disease throughout the province. However, a province wide study that included sites within the Robson Valley was conducted over a 3 year period and has raised awareness of the species. The study findings conclude it as being a species in a precarious state (Zeglen 2002).

A published report entitled Whitebark Pine and White Pine Blister Rust in British Columbia, Canada, is available through the Canadian Journal of Forest Research Volume 32 Number 7 - 2002. http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfr&volume=32&calyLang=fra&articleFile=x02-049.pdf

### 7.12.7 Dothistroma Needle Blight(*Dothistroma septospora*)

Confirmation of the presence of Dothistroma needle blight occurred during the 2003 re-assessments of four provenance trial plots located within the RV TSA (personal communication. Alex Woods Regional Forest Pathologist, Northern Interior Forest Region, Smithers).

Dothistroma is not new to this area. The Forest Insect and Disease Surveys (FIDS) reports cite these same areas being impacted more than 20 years ago. Favourable climate conditions in the early spring and summer and a

higher concentration of young susceptible hosts on the landscape may have allowed the disease to spread and intensify in this area (2006 Overview of Forest Health in the Southern Interior Forest Region).

**Tactics and Current Status - Dothistroma Needle Blight**

A low level flight with ground checks was conducted to identify and confirm the presence of Dothistroma within the RV TSA in June 2004. It should be noted that based on the incidence levels found (with the exception of two specific areas identified during the 2004 overview flight) the needle blight has been ranked as moderate for its potential impact on forest management activities within the RV TSA.

An overview flight was also completed within the Headwaters district in 2005 to examine the extent of Dothistroma in stands of lodgepole pine. Following this flight, the SIFR recommended that monitoring the incidence, severity, and forest stand impacts caused by needle diseases, including Dothistroma, will be essential in future years particularly for those areas (like the Robson Valley) that are likely to undergo increases in summer precipitation indirectly associated with global climate change, which may serve to benefit the development of foliar pathogens (2006 Overview of Forest Health in the Southern Interior Forest Region).

Monitoring: A 2007 overview flight was conducted by Michelle Cleary Regional Forest Pathologist, Southern Interior Forest Region and Alex Woods through the Robson Valley TSA, at that time the northern portion of the Headwaters District. Michelle Cleary prepared the following summary: An overview flight was conducted in the northern portion of the Headwaters District to examine the extent of Dothistroma in stands of lodgepole pine. The most severely affected areas were Castle Creek and the Upper Holmes River drainage southeast of McBride. The Holmes River drainage was also the locale for a number of other foliar pathogens on young planted host species including Rhabdocline pseudotsugae and Phaeocryptopus gaeumannii on Douglas-fir and Meria laricis on western larch. In a selected number of stands of lodgepole pine found along the north end of Kinbasket Lake, 70-80% of trees were severely blighted with about 1 year foliage retention.

A report titled “What effects will a changing climate have on lodgepole pine in British Columbia” was published in October 2006, by Alex Woods Regional Forest Pathologist, Northern Interior Forest Region, Smithers and Greg O’Neill Forest Geneticist, BC Forest Service, Vernon. The report findings are partly generated from data collected in the 2003 re-assessment of the four provenance trial plots located within the RV TSA (Goat River, Holmes River, Dave Henry and Valemount). Please contact Alex Woods at Alex.Woods@gov.bc.ca for a copy of this report.

**Recommended Actions - Dothistroma Needle Blight**

If lodgepole pine continues to be a preferred species in Stocking Standards embedded within Forest Stewardship Plans for the Robson Valley, then Dothistroma will remain a medium to high priority forest health factor (personal communication. Michelle Cleary Regional Forest Pathologist, Southern Interior Forest Region and Alex Woods Regional Forest Pathologist, Northern Interior Forest Region, Smithers).

Future monitoring of Dothistroma within susceptible areas as well as locations that may be influenced by climatic changes (increases in summer precipitation) is recommended.

### 7.12.8 Warren’s Root Collar Weevil (*Hylobius warreni)*

Warren's root collar weevil has been detected within the RV TSA where host species are present. Foremost, it has been detected within pine leading stands. To date information on tree mortality and volume loss is inconclusive.

**Tactics - Warren’s Root Collar Weevil**

Mixed species planting will reduce the damage impacts from this insect.

### 7.12.9 Lodgepole Pine Dwarf Mistletoe (*Arceuthobium americanum)*

Lodgepole pine dwarf mistletoe is found within the RV TSA. In the late 1980's and early 1990's buffer zones were established prior to logging in a number of areas where mistletoe was detected.

**Tactics - Lodgepole Pine Dwarf Mistletoe**

Experienced forest health surveyors can use a walkthrough survey or the formal Hawksworth survey to detect and quantify mistletoe. The Dwarf Mistletoe Management Guidebook gives guidance on how to deal with mistletoe infection within both clearcut and partial-cut harvesting systems. It also gives guidance 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.

### 7.12.10 Black Army Cutworm (*Actebia fennica*)

Burnt over areas predispose newly planted areas to black army cutworm. Attack can be severe locally (by plantation). High seedling mortality occurs if conditions are favourable with damage usually lasting one season.

**Tactics - Black Army Cutworm**

The preferred tactic is to determine population development on sites recently burnt, prior to planting. A Forest Health Stand Establishment Decision Aid (SEDA) for Black Army Cutworm was developed for the Southern Interior Forest Region. The SEDA is available at http://www.forrex.org/JEM/ISS27/vol6_no1_art6.pdf

### 7.12.11 Western Balsam Bark Beetle (*Dryocoetes confuses)*

This bark beetle has been confirmed within the RV TSA. District specific information is available from annual aerial overview flights conducted by the southern interior forest region.

**Tactics - Western Balsam Bark Beetle**

Infestations are detected and recorded as part of the aerial overview flight. Harvesting operations are managed to avoid creation of favourable breeding situations through debris management, disposal and salvage logging of beetle infested trees and blowdown, where feasible. Stands scheduled for harvest could use aggregative pheromones to help concentrate the beetle into the stands prior to harvest.

### 7.12.12 Pine Engraver Beetle (*Ips pini)*

Under normal conditions the pine engraver beetle *Ips pini* usually only attacks dead, dying or damaged trees. However, this beetle is known to attack tops and limbs of trees attacked by mountain pine beetle causing population build-up during mountain pine beetle outbreak years. Populations can also build-up in windthrow and slash. In large numbers the pine engraver bark beetle has been known to attack healthy living trees.

**Tactics - Pine Engraver Beetle**

Monitor cut block edges as well as debris piles for population build-up. If signs of population build-up are evident during mountain pine beetle outbreaks, stand management treatments such as spacing in young pine stands, should be delayed until 2 to 3 years after the collapse of the mountain pine beetle outbreak.

### 7.12.13 Two-year cycle Budworm (*Choristoneura biennis)*

A current outbreak is continuing within the RV TSA. High risk and hazard stands are located within the ESSF biogeoclimatic zone (Shand and Alfaro, 2005). The present outbreak was first observed in 1994 (Shepherd *et al*. 1995). Different locations within the RV TSA have varying initial outbreak times, ranging from 1992 to 1998. The current outbreak appears to have major defoliation episodes during even numbered years (Shand and Alfaro, 2005). Defoliation episodes in the Robson Valley have occurred roughly every 30 to 40 years over the past 300 years, with episodes lasting for about 10 years (Zhang and Alfaro, 2002).

**Tactics and Current Two-year cycle Budworm Research**

Six research plots located within the TSA were re-assessed and findings have been summarized in the 2006 Canadian Forest Service (CFS) report "Impacts of the two–year cycle spruce budworm in the Prince George Region". This was one of two studies conducted by the CFS, initiated during the Robson Valley Enhanced Forest Management Pilot Project (EFMPP). The second study is listed below as bullet two. Both studies originated in 2001/02. Updated information was published in both 2005 and 2006. Please Forestry Canada Pacific Forestry Centre in Victoria for the updated reports listed below.

- Impacts of the two–year cycle spruce budworm in the Prince George Region (Shand, and Alfaro - February 2006).
- Impacts of the two-year cycle spruce budworm in the Headwaters District, Southern Interior Forest Region (Shand, and Alfaro - February 2005).

Available EFMPP studies and publications for two-year cycle budworm in addition to the ongoing CFS projects include:

- Seles Landscape Model Sub-project Description of Two-Year Cycle Budworm (TCB) Dynamics and TCB Model Specification for the Robson Valley Landscape Model (RVLM) (Dec 2002). Sutherland, Glenn D., Alfaro, Rene., Shand, Angus., Eng, Marvin., and Fall, Andrew. Canadian Forest Service, Pacific Forestry Centre.
- Tree-Ring Record of the Two-Year Cycle Budworm Outbreaks in the Past 120 Years in the Robson Valley (March 2001) Zhang, Qibin., Alfaro, Rene. I., Shand, Angus., and Taylor, Stuart. - Canadian Forest Service, Pacific Forestry Centre.
- The Two-Year Cycle Spruce Budworm, Choristoneura biennis, in British Coloumbia Report on research in 2001 (2001) Nealis, Vince. Canadian Forest Service, Pacific Forestry Centre.

These projects can be found at the following website:
http://www.for.gov.bc.ca/hcp/enhanced/robson/efmpp/index.htm

### 7.12.14 Western Hemlock Looper (*Lambdina fiscellaria lugubrosa*)

Western hemlock looper has a historical presence within the RV TSA. The population tends to be cyclic and is known to rise to damaging levels in certain years. The most recent epidemic occurred between 1992 and 1994. Damage varied in severity from light defoliation to tree mortality. Damage occurred as patches of partly or completely defoliated forest within high hazard and risk areas.

Small scattered populations occur as per the 2012 Overview of Forest Health in the Southern Interior Region.

**Tactics and Current Western Hemlock Looper Research:**

Salvage harvesting was the approach used to address the objective of removing dead, dying or deteriorating wood before it degraded and was no longer merchantable.

A Western Hemlock Looper study was conducted in three stages as part of the RV EFMPP to determine the impact on resource management caused by the looper. The study entitled "Western Hemlock Looper Forest Disturbance in the ICHwk3 of the Robson Valley" can be accessed at the following website http://www.for.gov.bc.ca/hcp/enhanced/robson/efmpp/index.htm.

### 7.12.15 White Pine Weevil (Spruce Leader Weevil) (*Pissodes strobe*)

The impact of White Pine Weevil within the RV TSA varies by hazard zone. During development of Forest Stewardship Plans and stand tending activities it is recommended for White Pine Weevil (Spruce Leader Weevil) Management Strategies and Tactics for the Robson Valley TSA.

An extensive research project in regards to hazard and risk of White Pine Weevil within the RV TSA was concluded in 2000. (See Final Report for White Pine Weevil *Pissodes strobi* (Peck) Hazard and Risk Project for the Robson Valley District - Pathfinder Forestry Consultants Ltd. T & J Qureshi).

**Tactics - White Pine Weevil (Spruce Leader Weevil)**
See APPENDIX VII for management tactics for White Pine Weevil within the RV TSA.

A Spruce weevil hazard research project was initiated in 2007 by Art Stock, the Regional Entomologist for the Southern Interior Forest Region. Objectives include assessing spruce weevil hazard in B.C and determining possible impacts on timber supply due to spruce weevil and climate change (Stock 2009).

### 7.12.16 Wood Decay Fungi

Wood decay fungi are an important forest health factor within both mature and over-mature stands within the RV TSA.

These decay fungi include: Rusty-red stringy rot *Echinodontium tinctorium*, Brown crumbly rot *Fomitopsis pinicola*, Cedar brown pocket rot *Poria sericeomollis*, Red ring rot *Phellinus pini* and Schweinitz butt rot *Phaeolus schweinitzii*.

**Tactics - Wood Decay Fungi**
No specific tactics are in place at this time to address the impacts of wood decay fungi within the RV TSA. A review of the decay waste and breakage factors for the TSA could have significant implications for timber supply forecasts.

### 7.12.17 Cattle

Within the RV TSA the majority of cattle damage has been noted in young plantations (pre-free growing). This damage includes trampling wounds resulting in various degrees of girdling, scarring, and breakage. This type of damage may cause reduced growth rates, deformities, mortality, and/or predispose young crop trees to pathogens.

**Tactics - Cattle**
Refer to the Range Management Guidebook for implementation of tactics to mitigate damage to trees that are not free growing. Attention should be given to the level of use, timing, and salt placement.

## 7.13 Survey Methodologies

The 2001Generic Forest Health Surveys Guidebook (second edition) contains various higher level plan and stand level survey methodologies as well as hazard and risk rating systems. This guidebook is available at the following website: http://www.for.gov.bc.ca/TASB/LEGSREGS/FPC/FPCGUIDE/health/Httoc.htm.

The Interim Field Guidelines for the Selection of Stands for Spacing (Interior) combined with the Interior Forest Health Decision Key and Matrices is an excellent tool for use when planning silvicultural activities. This guideline can be found at the following website: http://www.for.gov.bc.ca/hfp/publications/00022/fs448b.pdf

Survey methodology for detection and incidence determination of hard pine stem rusts is found in the Prince George Standard Operating Procedure - ground detection and assessment procedures for pine stem rusts, (western gall rust, comandra blister rust and stalactiform blister rust) in the Prince George Region (dated April 2000). Contact Richard Reich, Regional Forest Pathologist, Northern Interior Forest Region, Prince George at Richard.Reich@gov.bc.ca for further information.

## 7.14 Landscape Level Hazard and Risk for Forest Health Agents within the Robson Valley TSA

Table 23 gives the landscape level hazard for forest health agents within the RV TSA by biogeoclimatic zone and subzone.

**Table 23. Landscape Level Hazard for Forest Health Agents by Biogeoclimatic Units within the Robson Valley TSA**

| Damaging agent | BEC zone | BEC subzone | Hazard | Total Area/ha in each Subzone |
|---|---|---|---|---|
| Armillaria root disease | ICH | mm | H* | 96,018 |
| | | wk1 | H* | 81,594 |
| | SBS | dh | H* | 79,859 |
| Tomentosus root rot | ICH | mm | H* | 96,018 |
| | | wk1 | H* | 81,594 |
| | SBS | dh | H* | 79,859 |
| Lodgepole pine dwarf mistletoe | ICH | mm | M | 96,018 |
| | SBS | dh | M | 79,859 |
| Dothistroma Needle Blight | ICH<br>SBS | | M | |
| Comandra blister rust<br>Stalactiform blister rust<br>Western gall rust | ICH<br>SBS | mm<br>dh | H<br>H | 96,018<br>79,859 |
| White pine blister rust | | Through-out host range | H | |
| Mountain pine beetle | | Through-out host range | H | |
| Spruce beetle | | Through-out host range | M | |
| Spruce beetle | | EBBMA SMU | H | 194,380 |
| Douglas-fir beetle | | Through-out host range | M | |
| Douglas-fir beetle | | EBBMA SMU | H | 171,525 |
| Western balsam bark beetle | | Through-out host range | L | |
| Two-year cycle budworm | ESSF | wk, wc, dc, mm | H | |
| Western hemlock looper | | Through-out host range | M | |
| Black stain root disease | ICH | Through-out Fd and Pl host range e | VL | |
| Black army cutworm | ESSF | wc2 | H | |

Note: "H*" denotes root disease is considered a high hazard in this subzone and, as such, requires attention in all plans.
H = High; M = Moderate; L = Low; VL = Very Low
- T.F. Braumandl and M.P. Curran (1992) consider that black stain root disease generally occurs on Douglas-fir throughout the ICH and IDF zones in southeast British Columbia.

**Table 24. Hazard Zones by Aspect and Elevation for White Pine Weevil within the RV TSA**

| Hazard Zones by Aspect and Elevation for White Pine Weevil | | | | | |
|---|---|---|---|---|---|
| **Elevation Bands – m** / **Aspects** | **600-800** | **801-1000** | **1001-1200** | **1201-1400** | **1400+** |
| **South Southwest West** | **H** | **H** | **M** | **L** | **L** |
| **North Northeast East** | **H** | **H** | **L** | **L** | **L** |
| **Northwest** | ***H** | ***H** | **L** | ***L** | ***L** |
| **Southeast** | ***H** | ***H** | ***L** | ***L** | ***L** |
| **Flat** | **H** | **H** | **N/A** | **N/A** | **N/A** |
| **Hazard Ratings** **High = H Moderate = M Low = L** | | | | | |
| **Management Areas** **Apply spruce weevil management strategies within high and moderate hazard zones.** | | | | | |

*As no significant difference in current incidence was found between aspects below 1000-m, findings for these elevation bands have been extrapolated to the Northwest and Southeast aspects. Correspondingly, as current incidence on average did not exceed 9% above 1201-m in any aspect, similar extrapolations were applied. Southeast at 1001-1200-m elevation is also an extrapolation.

## 7.15 Robson Valley TSA Bark Beetle Strategy

The bark beetle strategy for the RV TSA has been developed to assist with the management of current and future bark beetle infestations. The FLNRO will submit this information as part of their obligation to the provincial government for a RV TSA specific forest health strategy. The bark beetle strategy plan outlines management objectives, recent bark beetle activity, susceptible area and management strategies and tactics that may be applied to bark beetles within the RV TSA.

The FLNRO, following the beetle flight, will conduct an annual review of the bark beetle strategy. This review will be conducted in order to include current beetle status and to evaluate the tactics to ensure they are consistent with beetle activity, licensee objectives, provincial and regional forest management objectives, legislative requirements and current bark beetle management practices.

### 7.15.1 Bark Beetle Strategy, Goal and Objectives

The goal of the Robson Valley bark beetle strategy is to provide the framework for bark beetle management within the TSA.

The major objective of the Robson Valley bark beetle strategy is to address active beetle infestations. This objective may be met through the following points:

- Maintaining a scheduled detection program within suppression/prevention Beetle Management Units (BMUs);
- Following annual overview flights review emergency management unit (EMU) designations;
- Maintaining current hazard and risk assessments;
- Implementing appropriate strategies and tactics;
- Maintaining a historical record of beetle infestations within the RV TSA;
- Maintaining open communication with stakeholders, communities and other agencies.

Constraints that may affect strategy achievement include: milling capacity, market forces, adequate government funding, and cutting permit symmetry (depletion of green standing timber inventory requirement). These constraints may need to be addressed in order to effectively manage bark beetle infestations within the RV TSA.

## 7.16 Strategies for Managing Bark Beetles within the RV TSA

Five broad strategies have been identified of which one may be applied to each of the BMUs. Selection of the relevant strategy is based on the extent and distribution of the beetle infestations in the area, the stated integrated resource management objectives and the expected impact of beetle activity in adjacent management areas. As well, strategy selection must consider the available resources with which to successfully deploy the strategy.

**Table 25. Bark Beetle Strategy Definitions**

| Bark Beetle Strategy Definitions | | |
|---|---|---|
| **Strategy** | **Where Strategy is Applicable** | **Strategic Objectives and Performance Measures** |
| **Prevention** | Large areas of un-infested or lightly infested timber with a moderate to high hazard rating. | Reduce the susceptibility/attractiveness of a stand to bark beetles. |
| **Suppression** | Area with low level of infestation or incipient populations where levels are building and where resources are available for aggressive management actions | Maintain area in a relatively un-infested state.<br>Treat > 80% of polygons within 1 year. |
| **Holding Action** | Infestations in areas where resources or access are unavailable now, but are expected in the future. | Maintain an existing outbreak at a relatively static level over the short term.<br>Treat 50-79% of polygons within 1 year. |
| **Salvage** | Areas where management efforts cannot reduce the beetle population, or where harvesting capacity and/or access is unavailable. | Delineate affected areas and salvage log stands to recover losses and rehabilitate. Other management objectives take precedent.<br>Treat <50% of polygons within 1 year. |
| **Monitor** | Inaccessible areas or areas where management activities are restricted or where potential exits but no current or recent attack has been noted. | Satisfy other resource objectives or access concerns, some timber loss accepted. |

The strategy chosen for each BMU will remain in place as long as the objectives are being met. If the state of infestation changes, or if additional resources become available, a more aggressive strategy may be implemented. As infection intensities change from year to year, management strategies for each BMU will be reassessed on an annual basis. See APPENDIX V for maps showing the strategy by BMU.

B.C. Parks Park Management Plans prepared in co-operation with the FLNRO and the Ministry of Environment will govern management practices for the park areas regarding bark beetles.

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.

**Table 26. Bark Beetle Management Tactics as they apply to Specific BMU Strategies**

| Bark Beetle Management Tactics applicable to Specific BMU Strategies | | | | | |
|---|---|---|---|---|---|
| **Activity** | **Prevention** | **Suppression** | **Holding** | **Salvage** | **Monitor** |
| **Aerial Overview Survey** | Yes | Yes | Yes | Yes | Yes |
| **Detailed Aerial Survey** | Yes | Yes | No – detail not required to direct harvest | No – detail not required to direct harvest | No – no action will be taken |
| **Harvesting** | High hazard host removal | Sanitation and high hazard host removal | Sanitation and high hazard host removal | Focus no longer on beetle removal but salvage of merchantable timber | Other resource objectives take precedence over harvest. |
| **Single tree Treatments** | Where conventional harvest not possible and treatment success is expected | Where conventional harvest not possible and treatment success is expected | Very minimal use when combined with harvest in adjacent areas | No – infestations too widespread to expect success. | Other resource objectives take precedence. |
| **Access Development** | Yes, into high hazard stands | Yes, into infested high hazard stands | Yes, into infested high hazard stands | Yes, into infested high hazard stands | Other resource objectives take precedence. |

### 7.16.1 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 include:

***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 BMUs and the direction of small scale salvage and Non-renewable Forest License (NRFL) priorities into suppression/prevention BMUs under the guidance of the FLNRO. Within the RV TSA the majority of BMU classifications are either holding or monitor. Within a number of the holding BMUs, harvesting can be used as a tactic to help reduce existing infestations to a relatively static level.

***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 GPS located and mapped for follow-up treatment.

***Hauling Restrictions and Yard Management (included as guidance/best practices):*** These restrictions are generally not required if trucks do not stop between the logging site and the destination and infested logs are watered, debarked or processed promptly. Due to the level and distribution of the mountain pine beetle within the RV TSA, hauling restrictions may be varied by the FLNRO and individual licensees in order to allow prompt processing of infested timber. The main goal of yard management is the prompt processing/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 the mountain pine beetle and other bark beetles in high value and/or high hazard stands.

***Beetle Proofing:*** Beetle proofing is a thinning from below in previously unmanaged mature lodgepole pine to create a more open and uniformly spaced stand. The objective is to improve vigour of individual trees and to alter stand microclimate by increasing temperature, light intensity, and air movement in the clear bole zone. Research suggests that a combination of these factors decreases both stand and tree susceptibility to attack by mountain pine beetle (Safranyik et al 1974; Bartos and Amman 1989; McGregor et al 1981; Mitchell et al 1983).

Therefore, through stand manipulation, beetle proofing may reduce the attractiveness of a stand to the mountain pine beetle. Suitable stands may be chosen and host removal through all-aged selection or even-aged partial cutting employed.

***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 within the RV TSA. This treatment regime requires a long-term focus and can be considered one of the most effective long-term proactive tactics.*

Relevant tactics and dates for Bark Beetle management, by species, are listed in tables APPENDIX IX. The tactic listing is not intended to be exhaustive. New treatments are constantly being developed and applications refined. The tables also contain the strategy to which the tactic applies and the critical date/s when the tactic should be completed to be most effective.

### 7.16.2 Objectives for the Preparation of a Mountain Pine Beetle Salvage Strategy:

To date the majority of the BMU's within the RV TSA are identified as salvage, and the emphasis for management will have to reflect current conditions.

The overall salvage objectives will be to:

- maximize the economic value obtained from the dead standing timber,
- select salvage BMU's within the TSA and generate/prioritize harvest areas within these BMU's,
- extend the salvage term (i.e. holding the stands with the longest "shelf-life" for salvage at a later date) and
- expedite the restoration of impacted stands to the harvesting land base.

This would entail salvage of affected pine stands consistent with a salvage strategy, the Regional Biodiversity Conservation Strategy (and updates) and provincial guidelines from British Columbia's Mountain Pine Beetle Action Plan 2006-2011. Objectives from these plans are used as guidance to develop the following tactics specific to the RV TSA.

**A - Action Plan Objective:** Encourage long-term economic sustainability for communities affected by the epidemic.
**TSA Tactics:** Prioritize harvest in areas of the shortest "shelf-life" thereby retaining longer lasting stands for future harvest. Shelf-life, (approximated by the relative moisture of each BEC Zone) has been estimated in relative terms of "short" and "long". Use partial cutting systems wherever practicable to reduce the amount of healthy trees harvested during salvage and sanitation operations. Generate a TSA specific map that includes susceptible stands with short shelf-life, where salvage harvesting may help to reduce economic losses, and assist in stand rehabilitation efforts.

**B - Action Plan Objective:** Maintain and protect public health, safety and infrastructure.
**TSA Tactics:** Prioritize management of public areas (especially adjacent recreation sites and trails, roads and wildfire prone areas).

Action Plan Objective: Recover the greatest value from dead timber before it burns or decays, while respecting other forest values.
TSA Tactics: Identify unconstrained areas where there is low "shelf-life" and prioritize salvage of dead stands in those areas based on the provincial guidance, beetle severity, and local priorities.

**C - Action Plan Objective:** Conserve the long-term forest values identified in land use plans.
**TSA Tactics:** Harvest will be consistent with LRMP direction and strategies including biodiversity updates where practicable. Prioritize forest health strategies in accordance with existing and forthcoming direction. Salvage harvest should not occur in constrained areas including permanent OGMAs, Caribou no-harvest areas, riparian reserves and critical fish areas except under exceptional circumstances and after consultation with Ministry of Environment and the Integrated Land Management Bureau.

**D - Action Plan Objective:** In conjunction with the mountain pine beetle salvage strategy, consideration should be given to prevent or reduce damage to forests in areas that are susceptible to spruce and Douglas-fir beetles. If these beetle population levels are found to increase, allow the option to change the strategy to suppression and apply the appropriate tactics promptly.
**TSA Tactics:** Monitor highly susceptible stands not yet experiencing epidemic infestations. If beetle population levels increase, direct forest management activities where they can have the most impact on the spread, within the unconstrained landbase. After beetle flight, conduct detailed aerial surveys to identify spruce and Douglas-fir stands with beetle infestations of three trees or more. Identify "suppression" zones for spruce beetle and Douglas-fir beetle. Plan suppression activities for the following winter with the goal of treating at least 80% of all identified sites in the suppression zones.

**E - Action Plan Objective:** Restore the forest resources in areas affected by the epidemic. **TSA Tactics:** Identify specific stand types where harvesting would be appropriate to expedite stand recovery (especially in mountain pine beetle infested areas). Establish responsibility to address these stands in the short term.

## 7.17 Guidance for the Preparation of a Salvage Strategy within BMU's:

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

**General Strategies:**

- Prioritize salvage in areas where human safety is at risk.
- Salvage harvest the maximum volume from high value stands before they degrade economically.
- Schedule harvesting to maximize the "window" for salvage (i.e. target shortest shelf-life areas first where appropriate).
- Identify high productivity stands where salvage harvesting can be expedited to assist in stand recovery.
- Adhere to LRMP targets and strategies.
- Reserve riparian and other constrained areas where appropriate (for maximum biodiversity/stand structure contribution).

Generate a TSA specific map that prioritizes susceptible stands, where salvage harvesting may help to reduce economic losses, and assist in stand rehabilitation efforts. It is estimated that 5 years is the maximum shelf-life for saw logs, and 15 years may be the maximum shelf-life for other wood products including firewood.

**High Priority for Salvage (unconstrained landbase):**

- Pure pine stands with little or no advanced regeneration (especially high site index) to expedite stand recovery (i.e. ideal candidate areas for stand rehabilitation).
- High beetle infestation levels (>30% affected-all attack types – green, red and grey combined).
- Unconstrained portions of the landbase.
- Areas where shelf-life is considered short (i.e. wetter BEC zones).

**Moderate Priority for Salvage (unconstrained landbase):**

- Areas where shelf-life is considered short.
- >50% Pine by volume.
- >30% beetle attack (red, green and gray combined).
- High/moderate susceptibility.
- Unconstrained portions of the landbase.

**Low Priority for Salvage (unconstrained and constrained areas):**

- Mixed Stands (<50% pine).
- Maximize harvest of infested pine through selective harvesting.
- Prescriptions should target pine removal rather than clearcut, where residual stands can be maintained in a windfirm condition to target the maximum volume of infested pine and to encourage natural regeneration of non-pine (climax) species especially where advanced regeneration exists in the understory. Where more than one beetle species has infested a mixed stand, then the rational should be explicit.
- Old growth management areas OGMA's, mule deer winter range MDWR's, riparian and other constrained areas in accordance with higher level plan guidelines.
- High amount of advanced regeneration.

**Table 27. Priority for Pine Salvage Based on Stand Characteristics and Level of Beetle Kill (modified from McLennan 2003) (Eng 2004)**

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

## 7.18 Management of Mountain Pine Beetle on Private Land:

The Canadian Forest Service - Pacific Forestry Centre in Victoria currently had a previous program to assist private landowners with funding and technical support in order to address MPB on private land. The objectives were to assist private landowners with management plans, harvesting of MPB attacked timber and reforestation.

## 7.19 Invasive Plants

Treatment and inventory efforts are driven by land holder and stakeholder management strategies. Current treatment efforts in the Robson Valley TSA are summarized in Tables 28 & 29.

**Table 28. Treatment effort during 2012 in the Robson Valley TSA**

| Species | Mechanical Treatments | Chemical Treatments | Total Treatments | Total Area Treated (ha) |
|---|---|---|---|---|
| Chicory (CICH INT) | 1 | 0 | 1 | 0.1000 |
| Common tansy (TANA VUL) | 16 | 16 | 32 | 0.1341 |
| Knapweed species (CENT SPP) | 12 | 14 | 26 | 0.4783 |
| Marsh plume thistle/Marsh thistle (CIRS PAL) | 2 | 1 | 3 | 0.215 |
| Spotted knapweed (CENT BIE) | 39 | 180 | 219 | 4.9434 |
| **Total** | **70** | **211** | **281** | **5.8708** |

Treatment data extracted from IAPP May 2013

**Table 29. Selected invasive species inventoried on Robson Valley TSA FLNR jurisdiction in 2012 without treatment**

| Species | Number of Sites | Area Inventoried (ha) |
|---|---|---|
| Hawkweed species (HIER SPP) | 5 | 0.0780 |
| Marsh plume thistle/ Marsh thistle (CRIS PAL) | 8 | 0.1495 |
| Spotted knapweed (CENT BIE) | 2 | 0.0421 |
| **Total** | **15** | **0.2696** |

Inventory data extracted from IAPP May 2013

## 9.0 REFERENCES


B.C. Parks. Mountain pine beetle information. http://www.env.gov.bc.ca/bcparks/

Braumandl, T.F. and M.P. Curran (editors). 1992. A field guide for site identification and interpretation for the Nelson Forest Region. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 20. Part 1. URL: www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh20-2.pdf

Burrows, Jeff. Personal Communication. 2011. Stewardship Officer. BC Ministry of Natural Resource Operations, Prince George Forest District, 2000 South Ospika Blvd. Prince George, BC V2N 4W5.

Cerezke, H.F. 1992. Large aspen tortrix. Nat. Resource. Can., Can. For. Serv., North. For. Cent., Edmonton Alberta. For. Leafl. 21.

Cleary, Michelle (personal communication 2007) Southern Interior Forest Region Regional Forest Pathologist Southern Interior Forest Region 515 Columbia Street, Kamloops, BC V2C 2T7 Phone (250) 828-4583.

Dance, B.W. 1961. Leaf and shoot blight of poplars (section *Tacamahaca*) caused by *Venturia populina* (Vuill.) Fabric. Can. J. Bot. 39:875-890.

Duthie-Holt, M.A. and R. Setter. 1999. Two-Year Cycle Budworm Impact Analysis Final Report for Fort St. James and Mackenzie Forest Districts. Finlay Forest Industries Inc. (Resource Inventory Agreement No. FRBC98-009-057/1) and Canfor Forest Products Ltd. (Forest Services Agreement 97-F26) Internal Document. Pp. 83.

Ebata, T. Personal Communication. 2005. Forest Health Project Specialist. Forest Practices Branch, BC Ministry of Forests, P.O. Box 9513 Stn. Prov. Gov., British Columbia, V8W 9C2.

Fort St. James Bark Beetle Subcommittee. 2000. Fort St. James Forest District Bark Beetle Strategic Plan.

Fort St. James Land Resource Management Plan (LRMP). 2002. http://ilmbwww.gov.bc.ca/lup/lrmp/northern/ftstjames/index.html

Forest Practices Board. 2006. Control of Invasive Plants on Crown Land in British Columbia.

Greenstar Forest Solutions Inc. 2008. Maps and RV TSA Zone and Beetle Management Unit Areas. Valemount, British Columbia.

Hawksworth, F.G. and O.J. Dooling. 1984. Lodgepole pine dwarf mistletoe. USDA Forest Service. Forest Insect and disease Leaflet. http://www.na.fs.fed.us/spfo/pubs/fidls/lodgepole/lodgepole.htm

Hodges, Ken. Personal Communication. 2006. Tenures Forester. BC Ministry of Forest and Range, Prince George Forest District, 2000 South Ospika Blvd. Prince George, BC V2N 4W5.

Hodgkinson, Robert. Personal Communication. 2005. Forest Entomologist. BC Ministry of Forests and Range, Northern Interior Forest Region. 1011-4th Ave. Prince George, BC V2L 3H9.

Hodgkinson, R., K. White, and A. Stock. 2011. British Columbia's Northern Interior Forest Region: Spruce/White Pine Weevil Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 11(3):51–54. http://jem.forrex.org/index.php/jem/article/view/16/47

Invasive Alien Plants Program. Ministry of Forests and Range. http://www.for.gov.bc.ca/hfp/invasive/IAP_01.htm

Invasive Plant Council of British Columbia. Invasive Plant Strategy for British Columbia. http://www.invasiveplantcouncilbc.ca/

Mackenzie Timber Supply Area DFAM Forest Health Committee May 2004. DFAM Forest Health Strategy and Tactical Plan.

McCulloch, L., B. Aukema, K. White, and M. Klingenberg. 2009. British Columbia's northern interior forests: Warren Root Collar Weevil Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 10(2):105–107. *www.forrex.org/publications/jem/ISS51/vol10_no2_art8.pdf*

Ministry of Agriculture and Lands. 2002. A Guide to Weeds in British Columbia. http://www.weedsbc.ca/

Ministry of Environment (MoE), Biodiversity Branch. 2004. Invasive Alien Species Framework for BC: Identifying and Addressing Threats to Biodiversity - A working document to address issues associated with biodiversity in British Columbia.

Ministry of Forests. October 1995. Forest Practices Code of British Columbia Bark Beetle Management Guidebook. British Columbia, Ministry of Forests II. BC Environment III Series.

Ministry of Forests. October 1995. Forest Practices Code of British Columbia Defoliator Management Guidebook. British Columbia, Ministry of Forests II. BC Environment III Series.

Ministry of Forests. July 1995. Forest Practices Code of British Columbia Dwarf Mistletoe Management Guidebook. British Columbia, Ministry of Forests II. BC Environment III Series.

Ministry of Forests. June 1996. Forest Practices Code of British Columbia Pine Stem Rust Management Guidebook. British Columbia, Ministry of Forests II. BC Environment III Series.

Ministry of Forests. July 1995. Forest Practices Code of British Columbia Root Disease Management Guidebook. British Columbia, Ministry of Forests II. BC Environment III Series.

Ministry of Forests. 2000. Strategies and Tactics for Managing the Mountain Pine Beetle (*Dendroctonus ponderosae).* British Columbia, Ministry of Forests, Kamloops Region Forest Health Strategy.

Ministry of Forests. February 2001. Forest Practices Code of British Columbia Generic Forest Health Surveys Guidebook (Second Edition). British Columbia, Ministry of Forests.

Ministry of Forests. 2003. Provincial Forest Health Strategy 2003/04 (Draft). British Columbia, Ministry of Forests, Victoria B.C.

Ministry of Forests. 2003. Provincial Bark Beetle Management Technical Implementation Guidelines. British Columbia, Ministry of Forests, Branch, Victoria.

Ministry of Forests. 2003. Strategic Bark Beetle Management Plan - Robson Valley Timber Supply Area. British Columbia, Ministry of Forests, Kamloops Forest Region.

Ministry of Forests. 2003/04. Kispiox Forest Health Strategy (Draft) for the Kispiox Timber Supply Area. British Columbia, Ministry of Forests, Northern Interior Forest Region.

Ministry of Forests and Range, Northern Interior Forest Region. 2004. Pest Management Plan 402-0644-05/10 - 2005 to 2010 - Invasive Alien Plants, (Weeds) [for] Skeena-Stikine, Kalum, Nadina, Vanderhoof, Fort St. James, Prince George and Mackenzie Forest Districts.

Ministry of Forests. 2004. Summary of Forest Health Conditions in British Columbia. Draft – Kamloops Forest Region. Kamloops, British Columbia.

Ministry of Forests. 2004. Headwaters Forest District. Historical Bark Beetle and Two-Year Cycle Budworm Data. McBride, British Columbia.

Ministry of Forests and Range. 2005. 2005 Overview of Forest Health in the Southern Interior Forest Region. Southern Interior Forest Region Kamloops, British Columbia. Prepared by Lorraine MacLauchlan, Leo Rankin and Kevin Buxton

Ministry of Forests. 2006. Williams Lake Timber Supply Area Forest Health Strategy 2005-2006. British Columbia, Ministry of Forests and Range.

Ministry of Forests. 2006. TSA Forest Health Strategies and Tactical Plans. British Columbia, Ministry of Forests.

Ministry of Forests and Range. 2006. 2006 Overview of Forest Health in the Southern Interior Forest Region. Southern Interior Forest Region Kamloops, British Columbia. Prepared by Lorraine Maclauchlan, Michelle Cleary, Leo Rankin, Art Stock and Kevin Buxton.

Ministry of Forests and Range. January 2007. Memorandum Re: Emergency Bark Beetle Management Area Declaration – Rod DeBoice - Provincial Bark Beetle Coordinator – Victoria, British Columbia
Ministry of Forests. March 2007. Provincial Forest Health Strategy. British Columbia Minister of Forests (Version 9b).

Ministry of Forests and Range. Provincial Forest Health Program, June 2007. British Columbia Ministry of Forests and Range.

Ministry of Forests and Range. 2010. Forest and range health: Invasive plant strategy. http://www.for.gov.bc.ca/hra/Plants/RefGuide.htm. Accessed Mar. 6, 2012.

Ministry of Forests, Lands and Mines, 2010. Summary of Forest Health Conditions in British Columbia. http://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/2010/FH%20Conditions%202010.pdf

Ministry of Forests and Range. Forest Practices Act, Invasive Plants Regulation. http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/invplants/ipr.htm

Mountain Pine Beetle Action Plan 2006-2011- Sustainable Forests, Sustainable Communities – Government of British Columbia.

Nealis, Vince. 2001. The two-year cycle spruce budworm, Choristoneura biennis, in British Coloumbia Report on research in 2001 (2001). Canadian Forest Service, Pacific Forestry Centre, Victoria B.C.

Northwest Invasive Plants Council: Hotline: 1-866-44WEEDS (1-866-449-3337)

NWIPC. 2010. Northwest invasive plant council strategic plant and plant profiles. http://www.nwipc.org/documents/2010nwipcstrategicplan_20100916.pdf Accessed Jan. 13, 2011.

Pathfinder Forestry Consultants Ltd. 2000. Final Report for White Pine Weevil Pissodes strobi (Peck) Hazard and Risk Project for the Robson Valley Forest District. Submitted to Ministry of Forests and Range Headwaters Forest District.

Prince George Land Resource Management Plan (LRMP). 1999. http://ilmbwww.gov.bc.ca/lup/

Prince George Region Standard Operating Procedure (dated April 2000) - Ground detection and assessment procedures for pine stem rusts, (western gall rust, comandra blister rust and stalactiform blister rust) in the Prince George Region.

Prince George TSA Replaceable License Holders and BC Timber Sales, February 3, 2004. Prince George Timber Supply Area Forest Health Care Strategic Plan.

Ramsfield, T.D., S.F. Shamoun, and B.J. van her Kamp. 2002. Fungal Parasites of lodgepole pine dwarf mistletoe in British Columbia. Canadian Forestry Service. Pacific Forestry Centre, Victoria, BC.

Reich, Richard. Personal Communication. 2011. Forest Pathologist. BC Ministry of Natural Resource Operations, Northern Interior Forest Region, 1011-4th Ave. Prince George, BC V2L 3H9.

Reich, Richard - Armillaria Map Verification Project 2006, Northern Interior Forest Region Regional Pathologist 1011 4th Ave Prince George, B.C. V2L 3H9 - Phone 250-565-6203.

Robson Valley Timber Supply Area – Rationale for Allowable Annual Cut (AAC) Determination August 4, 2006 – Jim Snetsinger Chief Forester.

Shand, Angus (personal communication 2005) Landscape Analyst - Canadian Forest Service, Pacific Forestry Centre, 506 West Burnside Road Victoria, B.C.V8Z 1M5 – Phone 250-363-0648.

Shand, A., and Alfaro, R.I.. Feb 2005. Impacts of the two-year cycle spruce budworm in the Headwater District, Southern Interior Forest Region. Canadian Forest Service -Pacific Forestry Centre - Victoria B.C.

Shand, A., and Alfaro, R.I.. March 2005. Impacts of the two-year cycle spruce budworm in the Prince George Region. Canadian Forest Service - Pacific Forestry Centre - Victoria B.C.

Stock, A., M. Duthie-Holt, S. Walsh, J. Turner, and K. Swift. 2005. Southern Interior Forest Region: Forest health Stand Establishment Decision Aids. *BC Journal of Ecosystems and Management* 6(1):55–73.

Sutherland, Glenn D., Alfaro, Rene., Shand, Angus., Eng, Marvin., and Fall, Andrew. Dec 2002. Seles Landscape Model Sub-project Description of Two-Year Cycle Budworm (TCB) Dynamics and TCB Model Specification for the Robson Valley Landscape Model (RVLM). Canadian Forest Service, Pacific Forestry Centre Victoria B.C.

Vanderhoof Land Resource Management Plan (LRMP). 1997 http://ilmbwww.gov.bc.ca/lup/lrmp/northern/vanderhf/index.html

Whitney, R.D. 1977. *Polyporus Tomentosus* root rot of conifers. Can. For. Serv. For. Tech. Rep. No. 18.

Woods, Alex (personal communication 2004/05/06) - Northern Interior Forest Region Regional Pathologist - 3726 Alfred Ave, Bag 5000 Smithers, B.C. V0J 2N0 - Phone 250-847-6300.

Zeglen Stafan. 2002. Whitebark Pine and White Pine Blister Rust in British Columbia, Canada. Canadian Journal of Forest Research, Volume 32 number 7 pages 1265-1274.

Zhang, Qibin., Alfaro, Rene. I., Shand, Angus., and Taylor, Stuart. March 2001. Tree-Ring record of the Two-Year Cycle Budworm Outbreaks in the Past 120 Years in the Robson Valley - Canadian Forest Service - Pacific Forestry Centre - Victoria B.C.

Ziller, W.G. 1974. The tree rusts of western Canada. Can. For. Serv., Publ. No. 1329. Victoria, B.C

**APPENDIX I**
**Beetle Management Unit Designation Strategies**
**in the Prince George, Mackenzie and Robson Valley TSA's**

| Forest District | Landscape Unit | IBM Strategy | IBS Strategy | IBD Strategy |
|---|---|---|---|---|
| DJA | Asitka | Monitor | Monitor | N/A |
| DJA | Beaver/Salmon | Salvage | Suppression | Suppression |
| DJA | Blanchet | PA | PA | PA |
| DJA | Chuchi | Salvage | Suppression | Suppression |
| DJA | Cunningham East | Salvage | Suppression | Suppression |
| DJA | Cunningham North | Salvage | Suppression | Suppression |
| DJA | Cunningham South | Salvage | Suppression | Suppression |
| DJA | Damdochax | PA | PA | PA |
| DJA | Dust Creek | Salvage | Holding Action | N/A |
| DJA | Duti River | Monitor | Monitor | N/A |
| DJA | East Takla Lake | Salvage | Suppression | Suppression |
| DJA | Fall/Silver Middke | Monitor | Holding Action | N/A |
| DJA | Fall/Silver North | Monitor | Holding Action | N/A |
| DJA | Fall/Silver South | Monitor | Holding Action | N/A |
| DJA | Fleming | PA | PA | PA |
| DJA | Frypan | Monitor | Holding Action | N/A |
| DJA | Grostete/Hat | Salvage | Suppression | Suppression |
| DJA | Inzana | Salvage | Suppression | Suppression |
| DJA | Klawli | Salvage | Holding Action | N/A |
| DJA | Kluatantan | Monitor | Monitor | N/A |
| DJA | Lion/Kastberg | Monitor | Holding Action | N/A |
| DJA | Lovell | Monitor | Holding Action | N/A |
| DJA | Middle | Salvage | Suppression | Suppression |
| DJA | Mt. Pope | PA | PA | PA |
| DJA | Mudzenchoot | PA | PA | PA |
| DJA | Nation | PA | PA | PA |
| DJA | North Nation | Salvage | Holding Action | N/A |
| DJA | Omineca | PA | PA | PA |
| DJA | Omineca Headwaters | Monitor | Monitor | N/A |
| DJA | Ominicetla | Monitor | Holding Action | N/A |
| DJA | Pinchi | Salvage | Suppression | Suppression |
| DJA | Skeena | Monitor | Monitor | N/A |
| DJA | Skeena Headwater | Monitor | Monitor | N/A |
| DJA | Skeena/Mosque | Monitor | Monitor | N/A |
| DJA | Slamgeesh | Monitor | Monitor | N/A |
| DJA | Squingula | Monitor | Monitor | N/A |
| DJA | Stuart River | PA | PA | PA |
| DJA | Stuart River | Salvage | Suppression | Suppression |
| DJA | Sustut Lake | Monitor | Monitor | N/A |
| DJA | Sustut/Bear | Monitor | Holding Action | N/A |
| DJA | Tchentlo | Salvage | Suppression | N/A |
| DJA | Tchentlo South | Salvage | Salvage | Suppression |
| DJA | Tezzeron/North S | Salvage | Suppression | Suppression |
| DJA | TFL #42 | Salvage | Salvage | Suppression |
| DJA | Upper Birdflat | Monitor | Monitor | N/A |
| DJA | Upper Driftwood/ | Monitor | Holding Action | N/A |
| DJA | Upper Sustut/Thu | PA | PA | PA |
| DJA | Whitefish | Salvage | Suppression | Suppression |

| Forest District | Landscape Unit | IBM Strategy | IBS Strategy | IBD Strategy |
|---|---|---|---|---|
| DPG | Anzac | N/A | Suppression | N/A |
| DPG | Averil | Salvage | Suppression | Monitor |
| DPG | Bastille | N/A | Suppression | N/A |
| DPG | Bill's | Salvage | Suppression | N/A |
| DPG | Bowron | N/A | Suppression | N/A |
| DPG | Captain | N/A | Suppression | N/A |
| DPG | Carp | Salvage | Suppression | N/A |
| DPG | Crooked | Salvage | Suppression | N/A |
| DPG | Dome | N/A | Suppression | N/A |
| DPG | Dunkley | Salvage | Suppression | N/A |
| DPG | Firth | Salvage | Suppression | N/A |
| DPG | Fontinako | N/A | Suppression | N/A |
| DPG | Framstead | N/A | Suppression | N/A |
| DPG | Fraser | Salvage | Suppression | N/A |
| DPG | Gleason | N/A | Suppression | N/A |
| DPG | Gregg | Salvage | N/A | Monitor |
| DPG | Grizzly | Salvage | Suppression | N/A |
| DPG | Haggen | N/A | Suppression | N/A |
| DPG | Hixon | Salvage | Suppression | N/A |
| DPG | Humbug | N/A | Suppression | N/A |
| DPG | Jarvis | N/A | Suppression | N/A |
| DPG | Kenneth | N/A | Suppression | N/A |
| DPG | Kitchi | N/A | Suppression | N/A |
| DPG | Mcleod | Salvage | Suppression | N/A |
| DPG | Missinka | N/A | Suppression | N/A |
| DPG | Mollie | Salvage | Suppression | N/A |
| DPG | Mud | Salvage | N/A | Monitor |
| DPG | Muskeg | Salvage | Suppression | N/A |
| DPG | Nechako | Salvage | N/A | Suppression |
| DPG | Ovington | N/A | Suppression | N/A |
| DPG | Parsnip | N/A | Suppression | N/A |
| DPG | Prince | Salvage | Suppression | N/A |
| DPG | Punchaw | Salvage | N/A | Monitor |
| DPG | Purden | Salvage | Suppression | N/A |
| DPG | Reynolds | N/A | Suppression | N/A |
| DPG | Seebach | Salvage | Suppression | Monitor |
| DPG | Slender | Salvage | Suppression | N/A |
| DPG | Slim | N/A | Suppression | N/A |
| DPG | Spakwaniko | N/A | Suppression | N/A |
| DPG | Stony | Salvage | Suppression | N/A |
| DPG | Stuart | Salvage | Suppression | Suppression |
| DPG | Table | N/A | Suppression | N/A |
| DPG | Torpy | N/A | Suppression | N/A |
| DPG | Willow | Salvage | Suppression | N/A |
| DPG | Woodall | N/A | Suppression | Monitor |
| | | | | |
| | | | | |
| | | | | |

| Forest District | Landscape Unit | IBM Strategy | IBS Strategy | IBD Strategy |
|---|---|---|---|---|
| DVA | Beaumont Park | Park | Park | Park |
| DVA | Blackwater East | Salvage | Monitor | N/A |
| DVA | Blackwater West | Salvage | Monitor | N/A |
| DVA | Capoose Claims | N/A | N/A | N/A |
| DVA | Chilako - ER #78 | Park | Park | Park |
| DVA | Chilako - ER #79 | Park | Park | Park |
| DVA | Chilako - ER (Mi | Park | Park | Park |
| DVA | Chilako - Finger | Park | Park | Park |
| DVA | Chilako East | Salvage | Monitor | Suppression |
| DVA | Chilako West | Salvage | Monitor | N/A |
| DVA | Cluculz East | Salvage | Monitor | Suppression |
| DVA | Cluculz Ecologic | Park | Park | Park |
| DVA | Cluculz West | Salvage | Monitor | Suppression |
| DVA | Cluculz West | Salvage | Monitor | Suppression |
| DVA | Dry William Lk | Park | Park | Park |
| DVA | Endako | Salvage | Monitor | Suppression |
| DVA | Entiako East | Salvage | Monitor | N/A |
| DVA | Entiako North | Salvage | Monitor | N/A |
| DVA | Entiako Protecte | Park | Park | Park |
| DVA | Entiako West | Salvage | Monitor | N/A |
| DVA | Francois South | Park | Park | Park |
| DVA | Halett North | Salvage | Suppression | N/A |
| DVA | Halett South | Salvage | Suppression | N/A |
| DVA | Jerryboy | Salvage | Monitor | N/A |
| DVA | Kluskoil Provinc | Park | Park | Park |
| DVA | Kluskus | Salvage | Monitor | N/A |
| DVA | Kluskus - Chedak | Salvage | Monitor | N/A |
| DVA | Lake | Lake | Lake | Lake |
| DVA | Lake | Lake | Lake | Lake |
| DVA | Lucas | Salvage | Suppression | N/A |
| DVA | Nechako | Salvage | Monitor | Suppression |
| DVA | Nechako Canyon | Park | Park | Park |
| DVA | Nithi | Salvage | Suppression | Suppression |
| DVA | Stuart | Salvage | Suppression | Suppression |
| DVA | Stuart River | Park | Park | Park |
| DVA | Stuart River | Park | Park | Park |
| DVA | Sutherland North | Salvage | Suppression | N/A |
| DVA | Sutherland River | Park | Park | Park |
| DVA | Sutherland South | Salvage | Suppression | N/A |
| DVA | Tachick North | Salvage | Monitor | N/A |
| DVA | Tachick South | Salvage | Monitor | N/A |
| DVA | Tachick West | Park | Park | Park |
| DVA | Tatelkuz - First | Salvage | Monitor | N/A |
| DVA | Tatelkuz East | Salvage | Monitor | N/A |
| DVA | Tatelkuz Middle | Salvage | Monitor | N/A |
| DVA | Tatelkuz West | Salvage | Monitor | N/A |
| DVA | Wolf Claims | N/A | N/A | N/A |

| Forest District | Landscape Unit | IBM Strategy | IBS Strategy | IBD Strategy |
|---|---|---|---|---|
| DMK | Bluff Creek | Monitor | Monitor | N/A |
| DMK | Frog-Gataga | Monitor | Monitor | N/A |
| DMK | Frog | Monitor | Monitor | N/A |
| DMK | Braid | Monitor | Monitor | N/A |
| DMK | Upper Gataga | Monitor | Monitor | N/A |
| DMK | Kwadacha | Monitor | Monitor | N/A |
| DMK | Fox | Salvage | Monitor | N/A |
| DMK | Obo River | Monitor | Monitor | N/A |
| DMK | Kwadacha Additio | Monitor | Monitor | N/A |
| DMK | Upper Akie River | Monitor | Monitor | N/A |
| DMK | Finlay-Russel | Monitor | Monitor | N/A |
| DMK | Thutade | Monitor | Monitor | N/A |
| DMK | Buffalohead | Salvage | N/A | N/A |
| DMK | Upper Pelly | Monitor | Monitor | N/A |
| DMK | Akie | Salvage | Monitor | N/A |
| DMK | Akie River | Monitor | Monitor | N/A |
| DMK | North Firesteel | Monitor | Monitor | N/A |
| DMK | McCusker | Monitor | Monitor | N/A |
| DMK | Pesika | Salvage | Monitor | N/A |
| DMK | Lower Akie | Salvage | Monitor | N/A |
| DMK | Tatlatui | N/A | N/A | N/A |
| DMK | Upper Ospika | Monitor | Monitor | N/A |
| DMK | South Firesteel | Monitor | Monitor | N/A |
| DMK | Pelly | Salvage | Monitor | N/A |
| DMK | Akie | Salvage | Monitor | N/A |
| DMK | Lower Pesika | Salvage | Monitor | N/A |
| DMK | Ospika Cones | N/A | N/A | N/A |
| DMK | Ed Bird Estella | N/A | N/A | N/A |
| DMK | North Ingenika | Salvage | Monitor | N/A |
| DMK | Ingenika | Salvage | Monitor | N/A |
| DMK | Lower Ospika | Salvage | Monitor | N/A |
| DMK | Swannell | Salvage | Monitor | N/A |
| DMK | Mesilinka | Salvage | Monitor | N/A |
| DMK | Chase | N/A | N/A | N/A |
| DMK | Aiken | N/A | Monitor | N/A |
| DMK | Nabesche | Salvage | Monitor | N/A |
| DMK | Tutizza | N/A | Monitor | N/A |
| DMK | Wicked River | Salvage | Monitor | N/A |
| DMK | Osilinka | Salvage | Suppression | N/A |
| DMK | Blackwater | Salvage | Monitor | N/A |
| DMK | Omineca | N/A | N/A | N/A |
| DMK | Nina Creek | Salvage | Monitor | N/A |
| DMK | Muscovite | N/A | N/A | N/A |
| DMK | Discovery | Salvage | Monitor | N/A |
| DMK | Duckling | Salvage | Monitor | N/A |
| DMK | Jackfish | Salvage | Monitor | N/A |
| DMK | Eklund | Salvage | Suppression | N/A |
| | | | | |

| Forest District | Landscape Unit | IBM Strategy | IBS Strategy | IBD Strategy |
|---|---|---|---|---|
| DMK | Twenty Mile | Salvage | Monitor | N/A |
| DMK | Gillis | Salvage | Monitor | N/A |
| DMK | South Germansen | Salvage | Monitor | N/A |
| DMK | Germansen Mounta | Salvage | Monitor | N/A |
| DMK | Manson River | Salvage | Suppression | N/A |
| DMK | Gaffney | Salvage | Suppression | N/A |
| DMK | Connaghan Creek | Salvage | Monitor | N/A |
| DMK | Heather Dina Lak | N/A | N/A | N/A |
| DMK | Klawli | Salvage | Monitor | N/A |
| DMK | Nation | Salvage | Suppression | N/A |
| DMK | Blackwater | Salvage | Suppression | N/A |
| DMK | Morfee | Salvage | Suppression | N/A |
| DMK | Bijoux Falls | N/A | N/A | N/A |
| DMK | Kennedy | Salvage | Suppression | N/A |
| DMK | Phillip | Salvage | Suppression | N/A |
| DMK | Parsnip | Salvage | Suppression | N/A |
| DMK | Tudyah | Salvage | Suppression | N/A |
| DMK | Philip Lake | Salvage | Monitor | N/A |
| DMK | Tudyah Lake | Salvage | Monitor | N/A |
| DMK | Schooler | Salvage | Monitor | N/A |
| DMK | Selwyn | Salvage | Suppression | N/A |
| DMK | Clearwater | Salvage | Monitor | N/A |
| DMK | Parsnip | Salvage | Suppression | N/A |
| DMK | Misinchinka | Salvage | Suppression | N/A |
| DMK | Pine Pass | N/A | N/A | N/A |
| DMK | Collins - Davis | Salvage | Monitor | N/A |
| DMK | Chunamon | Salvage | Monitor | N/A |

| BEETLE MANAGEMENT UNIT STRATEGIES with SPECIAL MANAGEMENT UNITS (SMU) for IBM for the Robson Valley TSA 20012/13 | | | | | | |
|---|---|---|---|---|---|---|
| | | | Gross BMU | STRATEGY BY BEETLE SPECIES. | | |
| Zone | BMU | SMU | Areas/ha | IBM | IBD | IBS |
| 1 | Northern Trench | | 81,475 | Salvage | Holding | Monitor |
| 1 | McBride/Dunster | | 48,190 | Salvage | Holding | Monitor |
| 1 | Rearguard Falls | | 8,174 | Salvage | Suppression | Monitor |
| 1 | Southern Trench | | 74,154 | Salvage | Suppression | Suppression |
| | TOTALS | | **211,993** | | | |
| 2 | Morkill River | | 130,119 | Monitor | Monitor | Monitor |
| 2 | E. Twin / McKale | | 47,500 | Monitor | Monitor | Monitor |
| 2 | Holmes River | | 69,666 | *Salvage | Monitor | Monitor |
| 2 | Small River | | 63,526 | Salvage | Monitor | Monitor |
| | TOTALS | | **310,726** | | | |
| 3 | Goat / Milk | | 60,863 | Monitor | Monitor | Suppression |
| 3 | Dore River | | 36,155 | Monitor | Monitor | **Suppression |
| 3 | Cariboo River | | 34,344 | Monitor | Monitor | Monitor |
| 3 | Castle Creek | | 50,924 | Salvage | Monitor | **Suppression |
| | TOTALS | | **182,286** | | | |
| 4 | Raush River | | 93,599 | Salvage | Monitor | Monitor |
| 4 | Kiwa Creek | | 52,447 | Salvage | Monitor | Monitor |
| 4 | Camp Creek | | 41,314 | Salvage | Monitor | Monitor |
| | TOTALS | | **187,360** | | | |
| 5 | Dave Henry | | 38,852 | Salvage | Monitor | Monitor |
| 5 | Ptarmigan | | 30,237 | Salvage | Monitor | *Suppression |
| 5 | Hugh Allan | | 56,240 | Salvage | Monitor | Monitor |
| 5 | Foster Arm | | 59,363 | Salvage | Suppression | Suppression |
| 5 | East Kinbasket L. | | 29,834 | Salvage | Suppression | *Suppression |
| 5 | West Kinbasket L. | | 40,822 | Salvage | Monitor | *Suppression |
| | TOTALS | | **255,348** | | | |

* Change in status in 2011 ** Change in status in 2013

**Notes:**

- IBD – The 2012 overview survey did not report any Douglas-fir beetle activity. However, the strategy for Northern Trench and McBride/Dunster remains holding, and the strategy for Rearguard, Southern Trench, Foster Arm, and East Kinbasket L. remains suppression because of the historic on-going presence of the beetle in these areas.
- IBS – The 2012 overview survey reported recent evidence of spruce beetle activity in Dore River and Castle Creek BMUs so the strategy has been upgraded from monitor to suppression.

**APPENDIX II**
**Provincial Ranking of Pest Species by Forest Health Maintenance Category and Important Abiotic Damaging Agents**

**Provincial Ranking of Pest Species by Forest Health Maintenance Category (Tables A-C)**

**A. Protection of Standing Timber Inventory Activities (Pests that have operational treatments available)**

| Very High | High | Medium | Low | Very Low |
|---|---|---|---|---|
| Mountain pine beetle | Western spruce budworm | Eastern spruce budworm | | |
| Spruce beetle | | Western hemlock looper | | |
| Gypsy Moth | | Western balsam bark beetle | | |
| | | Douglas fir beetle | | |
| | | Douglas fir tussock moth | | |

**B. Stand Management Practice Improvement Activities (pests whose impacts are known or expected to be minimized by modifying forest practices)**

| Very High | High | Medium | Low | Very Low |
|---|---|---|---|---|
| Armallaria root disease | Red band needle blight (Dothistroma) | Lodgepole pine dwarf mistletoe | Spruce weevil | Atropellis canker |
| | Comandra blister rust | Pine needle cast (Lophodermella) | Stalactiform blister rust | Blackstain root disease |
| | Laminated root rot | Western hemlock dwarf mistletoe | Blackheaded budworm | All other conifer foliar diseases |
| | White pine blister rust | Western gall rust | | Douglas fir dwarf mistletoe |
| | Tomentosus root rot | | | Hardwood cankers |
| | | | | Wood decay fungi |
| | | | | Warren's collar weevil |
| | | | | Lodgepole pine terminal weevil |
| | | | | All other conifer and hardwood defoliators and bark beetles |

**C. Data management needs for TSR pests whose impact is known or suspected to significantly affect timber supply in either the short or long term( and other stewardship functions**

| Very High | High | Medium | Low | Very Low |
|---|---|---|---|---|
| Mountain pine beetle | Western spruce budworm | Eastern spruce budworm | Blackheaded budworm | All other pests |
| Spruce beetle | Comandra blister rust | Western hemlock looper | Spruce weevil | |
| Armallaria root disease | Laminated root rot | Western balsam bark beetle | Stalactiform blister rust | |
| | White pine blister rust | Red band needle blight (Dothistroma) | | |
| | Tomentosus root rot | Lodgepole pine dwarf mistletoe | | |
| | | Western hemlock dwarf mistletoe | | |
| | | Western gall rust | | |

**D. The most important biotic damaging agents of forests in British Columbia as of June 2007**

| Damaging Agent[1] | Management Priority[2] | Impact to Timber Supply Known?[3] | Potential Impact on Forest values[4] | Management Strategies available[5] | Performance Measurable?[6] | How Measured?[7] |
|---|---|---|---|---|---|---|
| Armallaria root disease | **VH** | **(Yes)** | **High** | **Yes** | **Yes** | G&Y, FG |
| Gypsy Moth | **VH** | **Yes** | **NA** | **Yes** | **Yes** | PM |
| Mountain pine beetle | **VH** | **Yes** | **Severe** | **Yes** | **Yes** | PM |
| Spruce beetle | **VH** | **Yes** | **High** | **Yes** | **Yes** | PM |
| Dothistroma needle blight | **H** | **Yes** | **High** | **Yes** | **Yes** | FG |
| Comandra blister rust | **H** | **Yes** | **Moderate** | **Yes** | **Yes** | G&Y |
| Laminated root rot | **H** | **(Yes)** | **Moderate** | **Yes** | **Yes** | G&Y, FG |
| Tomentosus root rot | **H** | **(Yes)** | **Moderate** | **Yes** | **Yes** | G&Y, FG |
| Western spruce budworm | **H** | **Yes** | **Moderate** | **Yes** | **Yes** | PM |
| White pine blister rust | **H** | **Yes** | **High** | **Yes** | **Yes** | G&Y, FG |
| Douglas-fir beetle | **M** | **Yes** | **Moderate** | **Yes** | **Yes** | PM |
| Douglas-fir tussock moth | **M** | **Yes** | **Moderate** | **Yes** | **Yes** | PM |
| Eastern spruce budworm | **M** | **(Yes)** | **Moderate** | **Yes** | **Yes** | PM |
| Lodgepole pine dwarf mistletoe | **M** | **(Yes)** | **Moderate** | **Yes** | **(Yes)** | G&Y, FG |
| Western hemlock dwarf mistletoe | **M** | **(Yes)** | **Moderate** | **Yes** | **(Yes)** | G&Y, FG |
| Western hemlock looper | **M** | **(Yes)** | **Moderate** | **Limited reactive strategies, no proactive strategies** | **(Yes)** | (PM) |
| Pine needle cast | **M** | **(Yes)** | **Moderate** | **No** | **NA** | NA |
| Western balsam bark beetle | **M** | **(Yes)** | **Moderate** | **No** | **NA** | NA |

***the above table taken from British Columbia Ministry of Forests and Range, Forest Health Program, June 2007.**

[1] An operational detection method is available for each damaging agent.
[2] VH-very high, H-high, M-medium.
[3] Stand and forest level impact data are collected and analyzed. Yes = operational methods are available, although application may be limited by budget or legal obligation. (Yes) = limited information, research in progress to determine.
[4] Relates to the 11 resource values listed in the Forest and Range Practices Act. NA = not applicable.
[5] Refers to both reactive and proactive management strategies, except as shown for Western Hemlock Looper.
[6] Yes = operational methods are available, although application may be limited by budget or legal obligation. (Yes) = limited information, research in progress to determine.

[7] G&Y = growth and yield assessment, FG = free growing survey, PM = performance measure established, (PM) = performance measure under development.

**APPENDIX III**
**2012 Aerial Overview Summary of Forest Pests**

**2012 Aerial Overview Summary for British Columbia by TSA's**

| **Regions** | **Omineca Forest Region** | | | | | |
|---|---|---|---|---|---|---|
| **TSA's** | **Prince George** | | **(TPG)** | | | |
| | Trace | Light | Moderate | Severe | Very Sev | Total |
| Bark Beetles | | | | | | |
| IBM=Mountain Pine Beetle | 169,825 | 53,126 | 78,824 | 20,079 | | 321,854 |
| IBS=Spruce Beetle | 570 | 387 | | 15 | | 972 |
| IBB=Western Balsam Bark Beetle | 63,892 | 9,550 | 360 | 254 | | 74,055 |
| IBD=Douglas-fir Beetle | 350 | 1,692 | 121 | 40 | | 2,203 |
| IBF = Fir engraver Beetle | | | | | | 0 |
| IBP = Twig Beetle | | | | | | 0 |
| IBI=Engraver Beetle (Ips species) | | | | | | 0 |
| IBW=Western Pine Beetle | | | | | | 0 |
| IBL=Lodgepole Pine Beetle | | | | | | 0 |
| IBT=Red Turpentine Beetle | | | | | | 0 |
| I?B=Young pine mortality | | 74 | | 39 | | 113 |
| IWW=Warrens Root Collar Weevil | | | | | | 0 |
| Total All BB= | 234,637 | 64,830 | 79,304 | 20,427 | 0 | 399,198 |
| | | | | | | |
| Defoliators | | | | | | |
| ID=Defoliators | | | | 20 | | 20 |
| IAB=Balsam Woolly Adelgid | | | | | | 0 |
| IAS=Green Spruce Aphid | | | | | | 0 |
| ID2=Bruce spanworm | | | | | | 0 |
| ID6=Aspen Leaf Miner | | 29,424 | 95,210 | 56,037 | | 180,671 |
| IDA=Black Army Cutworm | | | | | | 0 |
| IDB=2-Year Budworm | | 5,396 | | | | 5,396 |
| IDC=Larch casebearer | | | | | | 0 |
| IDE=Spruce Budworm | | | | | | 0 |
| IDF=Forest Tent Caterpillar | | 14,505 | 90,480 | 73,881 | | 178,866 |
| IDH=Western Blackheaded Budworm | | | | | | 0 |
| IDI=Pine needle sheathminer | | | | | | 0 |
| IDK=Northern Tent Caterpillar | | | | | | 0 |
| IDL=Western Hemlock Looper | | | | | | 0 |
| IDN=Birch Leaf Miner | | | | | | 0 |
| IDP=Larch Sawfly | | | | | | 0 |
| IDR=Alder Sawfly | | | | | | 0 |
| IDS=Conifer Sawflies | | | | | | 0 |
| IDT=Douglas-fir Tussock Moth | | | | | | 0 |
| IDU=Satin Moth | | | | | | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| IDW=Western Spruce Budworm | | | | | | 0 |
| IDX=Large Aspen Tortrix | | | | | | 0 |
| IDZ=False Hemlock Looper | | | | | | 0 |
| IEB=Hemlock Sawfly | | | | | | 0 |
| Total Defoliators= | 0 | 49,325 | 185,691 | 129,938 | 0 | 364,954 |
| | | | | | | |
| Other | | | | | | |
| N | | | | | | 0 |
| NAV=Avalanche or snow slide | | | | | | 0 |
| NB=Fire | | | 43 | 4,792 | | 4,835 |
| NBP=Post Fire | | 1,035 | 1,040 | 306 | | 2,380 |
| NCA=Aspen decline | | | | 7 | | 7 |
| NCB=Birch decline | | | | | | 0 |
| NCY=Yellow cedar decline | | | | | | 0 |
| ND=Drought | | | | | | 0 |
| NF=Flooding | | 31 | 14 | 518 | | 563 |
| NGK=Shoot/Bud Frost Kill | | | | | | 0 |
| NH=Hail | | | | | | 0 |
| NK=Fumekill | | | | | | 0 |
| NN=Road Salt | | | | | | 0 |
| NS=Slide | | | | | | 0 |
| NR=Redbelt | | | | | | 0 |
| NW=Windthrow | | | | 1,017 | | 1,017 |
| NY=Snow/Ice | | | | | | 0 |
| Total Abiotics= | 0 | 1,066 | 1,096 | 6,640 | 0 | 8,802 |
| | | | | | | |
| Diseases | | | | | | |
| DF= Unknown Disease | | | | | | 0 |
| DFB=Delphinella needle cast | | | | | | 0 |
| DFC=Large-spored Spruce-labrador Tea Rust | | | | | | 0 |
| DFH=Larch Needle Blight | | | | | | 0 |
| DFL=Lophodermella Needle Cast | | | 837 | | | 837 |
| DFG=Cottonwood Leaf Rust | | | | | | 0 |
| DFM=Larch Needle Cast | | | | | | 0 |
| DFR=Douglas-fir Needle Cast | | | | | | 0 |
| DFS=Dothistroma Needle Blight | | 102 | 432 | 493 | | 1,028 |
| DFZ=Rhizosphaera Needle Cast | | | | | | 0 |
| DL=Unknown Dieback | | | | | | 0 |
| DLV=Venturia Blight | | 1,545 | 4,556 | 17 | | 6,117 |
| DMP=Lodgepole Pine Dwarf Mistletoe | | | | | | 0 |
| DR=Unknown Root Disease | | | | | | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| DRA=Armillaria Root Disease | | | | | | 0 |
| DRB=Blackstain root disease | | | | | | 0 |
| DRL=Laminated Root Disease | | | | | | 0 |
| DSB=White Pine Blister Rust | | | | | | 0 |
| DSC=Comandra Blister Rust | | | | | | 0 |
| PDT=Cedar Leaf Blight | | | | | | 0 |
| Total Diseases= | 0 | 1,647 | 5,825 | 510 | 0 | 7,982 |
| | | | | | | |
| Animals | | | | | | |
| A=Animal | | | | | | 0 |
| AB=Bear | | | | | | 0 |
| AD=Deer | | | | | | 0 |
| AH=Hair | | | | | | 0 |
| AP=Porcupine | | | | | | 0 |
| Total Animals= | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Total Other= | 0 | 2,713 | 6,921 | 7,150 | 0 | 16,784 |
| Total Region = | 234,637 | 116,868 | 271,916 | 157,515 | 0 | 780,936 |

**2012 Aerial Overview Summary for British Columbia by TSA's**

| **Regions** | **Omineca Forest Region** | | | | | |
|---|---|---|---|---|---|---|
| **TSA's** | **Mackenzie** | **(TMK)** | | | | |
| | Trace | Light | Moderate | Severe | Very Sev | Total |
| Bark Beetles | | | | | | |
| IBM=Mountain Pine Beetle | 515,931 | 265,123 | 262,261 | 70,476 | 719 | 1,114,511 |
| IBS=Spruce Beetle | 59 | | | | | 59 |
| IBB=Western Balsam Bark Beetle | 33,479 | 764 | 102 | 58 | | 34,403 |
| IBD=Douglas-fir Beetle | | | | | | 0 |
| IBF = Fir engraver Beetle | | | | | | 0 |
| IBP = Twig Beetle | | | | | | 0 |
| IBI=Engraver Beetle (Ips species) | | | | | | 0 |
| IBW=Western Pine Beetle | | | | | | 0 |
| IBL=Lodgepole Pine Beetle | | | | | | 0 |
| IBT=Red Turpentine Beetle | | | | | | 0 |
| I?B=Young pine mortality | | | | | | 0 |
| IWW=Warrens Root Collar Weevil | | | | | | 0 |
| Total All BB= | 549,469 | 265,887 | 262,364 | 70,534 | 719 | 1,148,973 |
| | | | | | | |
| Defoliators | | | | | | |
| ID=Defoliators | | | | | | 0 |
| IAB=Balsam Woolly Adelgid | | | | | | 0 |
| IAS=Green Spruce Aphid | | | | | | 0 |
| ID2=Bruce spanworm | | | | | | 0 |
| ID6=Aspen Leaf Miner | | 255 | 32,912 | 586 | | 33,753 |
| IDA=Black Army Cutworm | | | | | | 0 |
| IDB=2-Year Budworm | | | | | | 0 |
| IDC=Larch casebearer | | | | | | 0 |
| IDE=Spruce Budworm | | | | | | 0 |
| IDF=Forest Tent Caterpillar | | | 5,399 | | | 5,399 |
| IDH=Western Blackheaded Budworm | | | | | | 0 |
| IDI=Pine needle sheathminer | | | | | | 0 |
| IDK=Northern Tent Caterpillar | | | | | | 0 |
| IDL=Western Hemlock Looper | | | | | | 0 |
| IDN=Birch Leaf Miner | | | | | | 0 |
| IDP=Larch Sawfly | | | | | | 0 |
| IDR=Alder Sawfly | | | | | | 0 |
| IDS=Conifer Sawflies | | | | | | 0 |
| IDT=Douglas-fir Tussock Moth | | | | | | 0 |
| IDU=Satin Moth | | | | | | 0 |
| IDW=Western Spruce Budworm | | | | | | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| IDX=Large Aspen Tortrix | | | | | | 0 |
| IDZ=False Hemlock Looper | | | | | | 0 |
| IEB=Hemlock Sawfly | | | | | | 0 |
| Total Defoliators= | 0 | 255 | 38,312 | 586 | 0 | 39,152 |

| Other | |
|---|---|
| N | 0 |
| NAV=Avalanche or snow slide | 0 |
| NB=Fire | 1,269 |
| NBP=Post Fire | 0 |
| NCA=Aspen decline | 0 |
| NCB=Birch decline | 0 |
| NCY=Yellow cedar decline | 0 |
| ND=Drought | 0 |
| NF=Flooding | 38 |
| NGK=Shoot/Bud Frost Kill | 0 |
| NH=Hail | 0 |
| NK=Fumekill | 0 |
| NN=Road Salt | 0 |
| NS=Slide | 0 |
| NR=Redbelt | 0 |
| NW=Windthrow | 2,558 |
| NY=Snow/Ice | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total Abiotics= | 0 | 0 | 904 | 2,961 | 0 | 3,865 |

| Diseases | |
|---|---|
| DF= Unknown Disease | 0 |
| DFB=Delphinella needle cast | 0 |
| DFC=Large-spored Spruce-labrador Tea Rust | 0 |
| DFH=Larch Needle Blight | 0 |
| DFL=Lophodermella Needle Cast | 0 |
| DFG=Cottonwood Leaf Rust | 0 |
| DFM=Larch Needle Cast | 0 |
| DFR=Douglas-fir Needle Cast | 0 |
| DFS=Dothistroma Needle Blight | 0 |
| DFZ=Rhizosphaera Needle Cast | 0 |
| DL=Unknown Dieback | 0 |
| DLV=Venturia Blight | 248 |
| DMP=Lodgepole Pine Dwarf Mistletoe | 0 |
| DR=Unknown Root Disease | 0 |
| DRA=Armillaria Root Disease | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| DRB=Blackstain root disease | | | | | | 0 |
| DRL=Laminated Root Disease | | | | | | 0 |
| DSB=White Pine Blister Rust | | | | | | 0 |
| DSC=Comandra Blister Rust | | | | | | 0 |
| PDT=Cedar Leaf Blight | | | | | | 0 |
| Total Diseases= | 0 | 248 | 0 | 0 | 0 | 248 |
| | | | | | | |
| Animals | | | | | | |
| A=Animal | | | | | | 0 |
| AB=Bear | | | | | | 0 |
| AD=Deer | | | | | | 0 |
| AH=Hair | | | | | | 0 |
| AP=Porcupine | | | | | | 0 |
| Total Animals= | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Total Other= | 0 | 248 | 904 | 2,961 | 0 | 4,113 |
| Total Region = | 549,469 | 266,390 | 301,579 | 74,081 | 719 | 1,192,239 |

**2012 Aerial Overview Summary for British Columbia by TSA's**

| **Regions** | **Omineca Forest Region** | | | | | |
|---|---|---|---|---|---|---|
| **TSA's** | **Robson Valley** | | **(TRV)** | | | |
| | Trace | Light | Moderate | Severe | Very Sev | Total |
| Bark Beetles | | | | | | |
| IBM=Mountain Pine Beetle | 11,335 | 28,059 | 10,135 | 2,191 | | 51,719 |
| IBS=Spruce Beetle | | 134 | | | | 134 |
| IBB=Western Balsam Bark Beetle | 1,173 | 10,887 | 18 | 11 | | 12,089 |
| IBD=Douglas-fir Beetle | | | | | | 0 |
| IBF = Fir engraver Beetle | | | | | | 0 |
| IBP = Twig Beetle | | | | | | 0 |
| IBI=Engraver Beetle (Ips species) | | | | | | 0 |
| IBW=Western Pine Beetle | | | | | | 0 |
| IBL=Lodgepole Pine Beetle | | | | | | 0 |
| IBT=Red Turpentine Beetle | | | | | | 0 |
| I?B=Young pine mortality | | | | | | 0 |
| IWW=Warrens Root Collar Weevil | | | | | | 0 |
| Total All BB= | 12,508 | 39,080 | 10,153 | 2,202 | 0 | 63,942 |
| | | | | | | |
| Defoliators | | | | | | |
| ID=Defoliators | | | | | | 0 |
| IAB=Balsam Woolly Adelgid | | | | | | 0 |
| IAS=Green Spruce Aphid | | | | | | 0 |
| ID2=Bruce spanworm | | | | | | 0 |
| ID6=Aspen Leaf Miner | | 3,128 | 568 | 45 | | 3,741 |
| IDA=Black Army Cutworm | | | | | | 0 |
| IDB=2-Year Budworm | | 6,929 | | | | 6,929 |
| IDC=Larch casebearer | | | | | | 0 |
| IDE=Spruce Budworm | | | | | | 0 |
| IDF=Forest Tent Caterpillar | | | | | | 0 |
| IDH=Western Blackheaded Budworm | | | | | | 0 |
| IDI=Pine needle sheathminer | | | | | | 0 |
| IDK=Northern Tent Caterpillar | | | | | | 0 |
| IDL=Western Hemlock Looper | | | | | | 0 |
| IDN=Birch Leaf Miner | | | | | | 0 |
| IDP=Larch Sawfly | | | | | | 0 |
| IDR=Alder Sawfly | | | | | | 0 |
| IDS=Conifer Sawflies | | | | | | 0 |
| IDT=Douglas-fir Tussock Moth | | | | | | 0 |
| IDU=Satin Moth | | | | | | 0 |
| IDW=Western Spruce Budworm | | | | | | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| IDX=Large Aspen Tortrix | | | | | | 0 |
| IDZ=False Hemlock Looper | | | | | | 0 |
| IEB=Hemlock Sawfly | | | | | | 0 |
| Total Defoliators= | 0 | 10,056 | 568 | 45 | 0 | 10,670 |

| Other | |
|---|---|
| N | 0 |
| NAV=Avalanche or snow slide | 70 |
| NB=Fire | 4 |
| NBP=Post Fire | 0 |
| NCA=Aspen decline | 0 |
| NCB=Birch decline | 0 |
| NCY=Yellow cedar decline | 0 |
| ND=Drought | 0 |
| NF=Flooding | 0 |
| NGK=Shoot/Bud Frost Kill | 0 |
| NH=Hail | 0 |
| NK=Fumekill | 0 |
| NN=Road Salt | 0 |
| NS=Slide | 0 |
| NR=Redbelt | 0 |
| NW=Windthrow | 0 |
| NY=Snow/Ice | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total Abiotics= | 0 | 0 | 0 | 74 | 0 | 74 |

| Diseases | |
|---|---|
| DF= Unknown Disease | 0 |
| DFB=Delphinella needle cast | 0 |
| DFC=Large-spored Spruce-labrador Tea Rust | 0 |
| DFH=Larch Needle Blight | 0 |
| DFL=Lophodermella Needle Cast | 0 |
| DFG=Cottonwood Leaf Rust | 0 |
| DFM=Larch Needle Cast | 0 |
| DFR=Douglas-fir Needle Cast | 0 |
| DFS=Dothistroma Needle Blight | 0 |
| DFZ=Rhizosphaera Needle Cast | 0 |
| DL=Unknown Dieback | 0 |
| DLV=Venturia Blight | 0 |
| DMP=Lodgepole Pine Dwarf Mistletoe | 0 |
| DR=Unknown Root Disease | 0 |
| DRA=Armillaria Root Disease | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| DRB=Blackstain root disease | | | | | | 0 |
| DRL=Laminated Root Disease | | | | | | 0 |
| DSB=White Pine Blister Rust | | | | | | 0 |
| DSC=Comandra Blister Rust | | | | | | 0 |
| PDT=Cedar Leaf Blight | | | | | | 0 |
| Total Diseases= | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Animals | | | | | | |
| A=Animal | | | | | | 0 |
| AB=Bear | | | | | | 0 |
| AD=Deer | | | | | | 0 |
| AH=Hair | | | | | | 0 |
| AP=Porcupine | | | | | | 0 |
| Total Animals= | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Total Other= | 0 | 0 | 0 | 74 | 0 | 74 |
| Total Region = | 12,508 | 49,136 | 10,721 | 2,322 | 0 | 74,686 |

**APPENDIX IV**
**Bark Beetle Strategies and Tactics**

**Tactics for Mountain Pine Beetle by Strategy with Critical Dates**

| Tactics | Strategy | Critical Dates |
|---|---|---|
| **1. Survey / Assessment** | | |
| • Timing of adult flight | All | June 15 to September 15 |
| • Infestation intensity rating | All | Any time |
| • Hazard rating | All | Any time |
| • Risk rating | All | Any time |
| • Overview and Detailed Aerial Sketch mapping | 2, 3, 4, 5<br>2 | July 15 to September 15<br>August 1 to September 15 |
| • Aerial photography | 2, 3, 4 | April 1 |
| • Ground probe or walkthrough | 2, 3, 4 | Oct - May |
| **2. Harvesting** | | |
| • Sanitation | 1, 2, 3, 4 | Any time outside beetle flight |
| • Salvage | 5 | Any time outside beetle flight |
| • High hazard host removal | 1, 2, 3 | Any time |
| • Harvest priority rating system | 2, 3, 4, 5 | Any time |
| **3. Single Tree Treatments (STT)** | | |
| • Fall and burn | 1, 2, 3, 4 | October 15 to May 1 |
| • Verbenone | 2 | April 1 to May 15 |
| • Debarking | 2, 3 | Prior to flight |
| • Small patch / single tree selection | 2, 3 | Any time |
| **4. Bait Use (with B and C above)** | | |
| • Containment | 2, 3, 4 | May 1 to June 30 |
| • Monitoring | 2, 3, 4 | July 1 to August 15 |
| • Prior and follow-up to STT | 2, 3, 4 | Treatment to June 30 |
| **5. Hauling Restrictions** | 2, 3 | June 15 to September 15, or as per the Regional Guidelines |
| **6. Access Development** | All | Any time |
| **7. Beetle Proofing** | All | Any time |
| **8. Silvicultural Treatments**<br><br>**Long Term** | | |
| • Species manipulation | All | As per harvest |
| • Age class mosaic manipulation | All | As per harvest |

The strategies are as follows:
1. Prevention 2. Suppression 3 & 4. Holding 5. Salvage 6. Monitor 7. Undesignated

**Tactics for Douglas fir Beetle by Strategy with Critical Dates**

| Tactics | Strategy | Critical Dates |
|---|---|---|
| **1. Survey / Assessment** | | |
| • Timing of adult flight | All | April 15 to August 15 |
| • Infestation intensity rating | All | Any time |
| • Hazard rating | All | Any time |
| • Risk rating | All | Any time |
| • Overview and Detailed Aerial Sketch mapping | All | July 25 to September 25 |
| • Aerial photography | 2 | July 25 to September 25 |
| • Ground probe or walkthrough | 2, 3, 4 | September to April 15 |
| **2. Harvesting** | | |
| • Sanitation | 2, 3, 4 | Any time outside beetle flight |
| • Salvage | 5 | Any time outside beetle flight |
| • High hazard host removal | 1, 2, 3 | Any time |
| • Harvest priority rating system | 2, 3, 4, 5 | Any time |
| • Post Harvesting Mop-up | 2, 3, 4, 5 | Prior to next flight |
| **3. Single Tree Treatments (STT)** | | |
| • Fall and burn | 2, 3, 4 | October to March |
| • Trap tree placement | 1, 2, 3, 4 | January to March |
| • Trap tree removal | 1, 2, 3, 4 | September to December |
| • Debarking | 2, 3, 4 | September to October |
| • Small patch / single tree selection | 2, 3 | Any time |
| • Helicopter logging | 2, 3, 4, 5 | Any time |
| **4. Pheromone Bait Use** | | |
| • Containment | 1, 2, 3, 4 | April 15 to August 15 |
| • Control with Funnel Traps | 2, 3 | April 15 to August 15 |
| • Follow-up prior to STT | 1, 2, 3, 4, 5 | Continual |
| **5. Hauling Restrictions** | 2, 3, 4, 5 | April 15 to August 15, or as per the Regional Guidelines |
| **6. Access Development** | All | Any time |
| **7. Beetle Proofing** | All | Any time |
| **8. Silvicultural Treatments – Long Term** | | |
| • Species manipulation | 1 | As per harvest |
| • Age class mosaic manipulation | 1 | As per harvest |

The strategies are as follows:
1. Prevention 2. Suppression 3 & 4. Holding 5. Salvage 6. Monitor 7. Undesignated

Table note: Justification for some of the strategies to be applies:

A. Trap tree placement and removal also apply to the Prevention strategy as the planning and construction of access routes can have trap trees deployed along R/W's where appropriate.

B. Debarking ideally should be done early enough before flight to dry out and/or freeze the exposed adults and/or larvae.

C. Heli-burning (helicopter logging) has been successfully tested in the Peace and could be applied in the Prince George TSA.

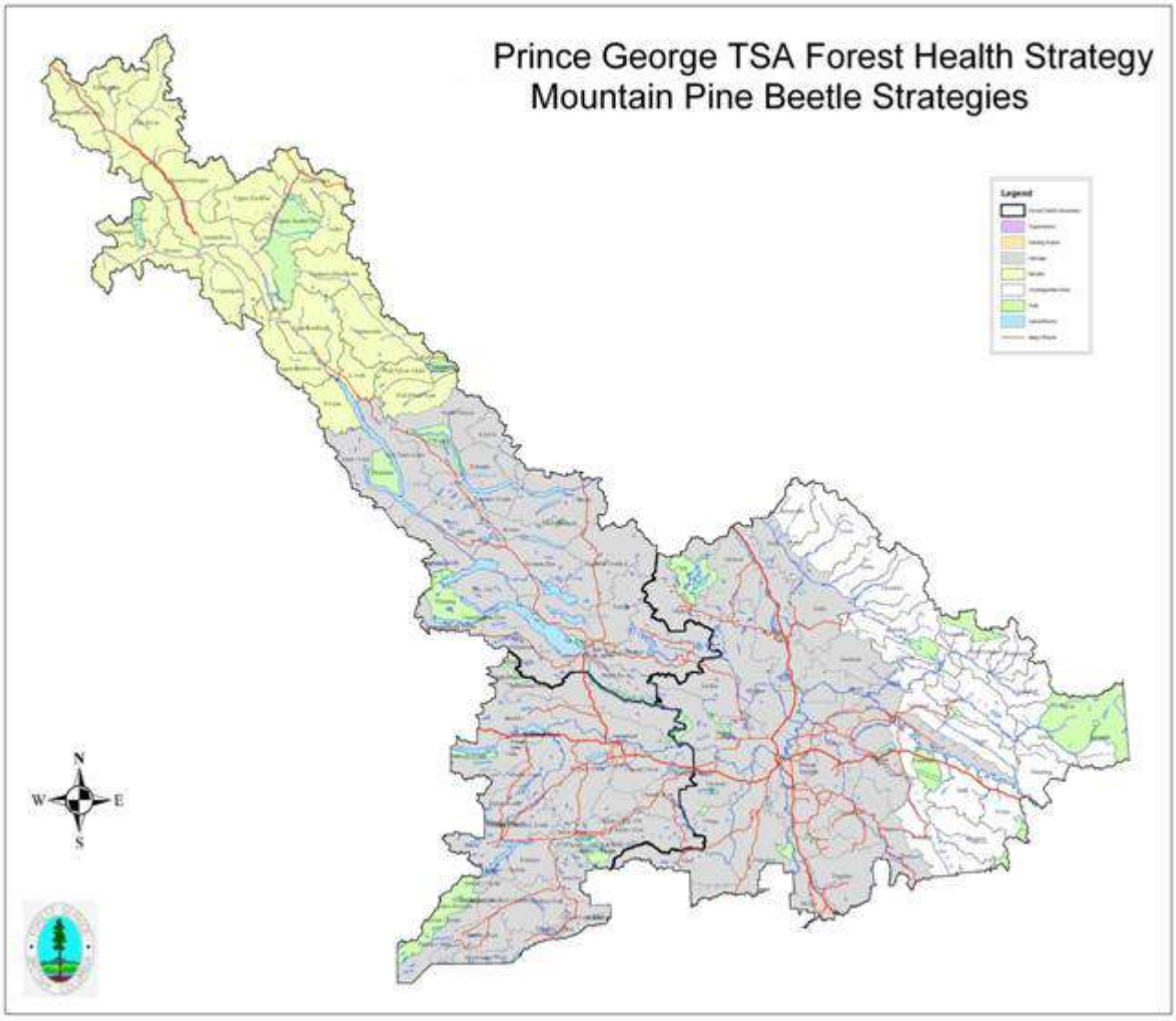
**Tactics for Spruce Beetle by Strategy with Critical Dates**

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

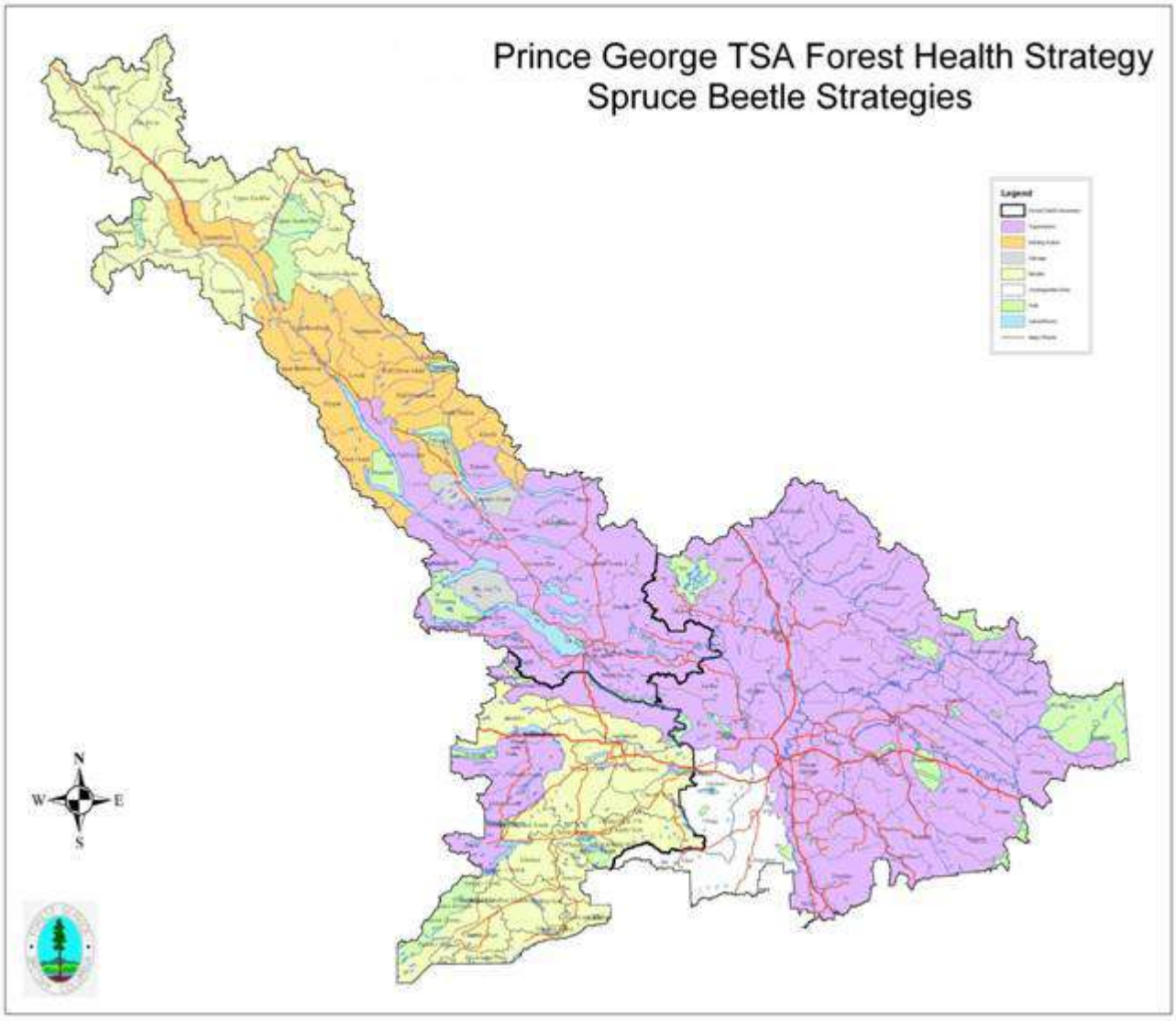
The strategies are as follows:
1. Prevention 2. Suppression 3 & 4. Holding 5. Salvage 6. Monitor 7. Undesignated

**APPENDIX V**
**Prince George, Mackenzie and Robson Valley TSA's BMU Maps**

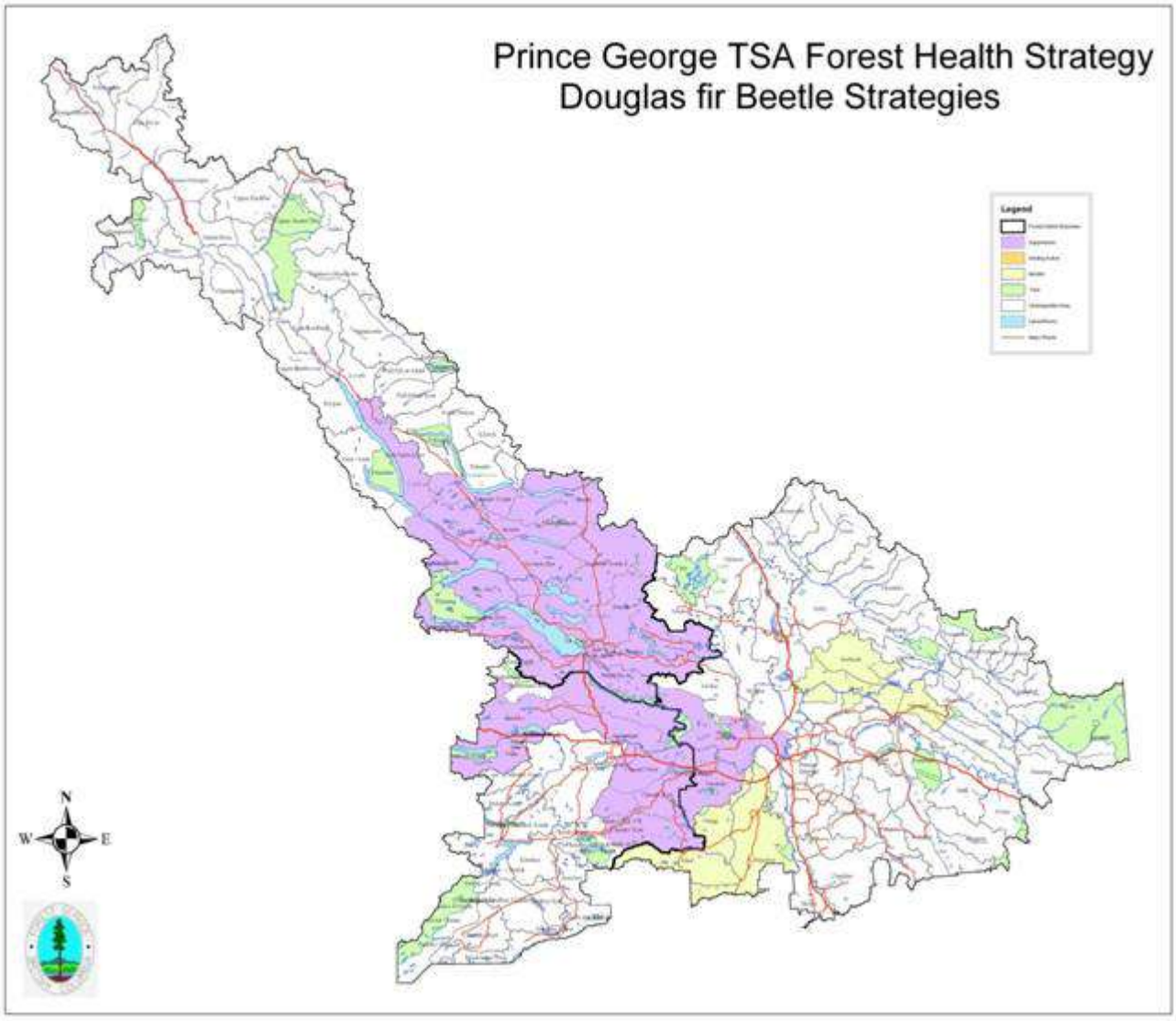
**Mountain Pine Beetle (IBM) Strategies**



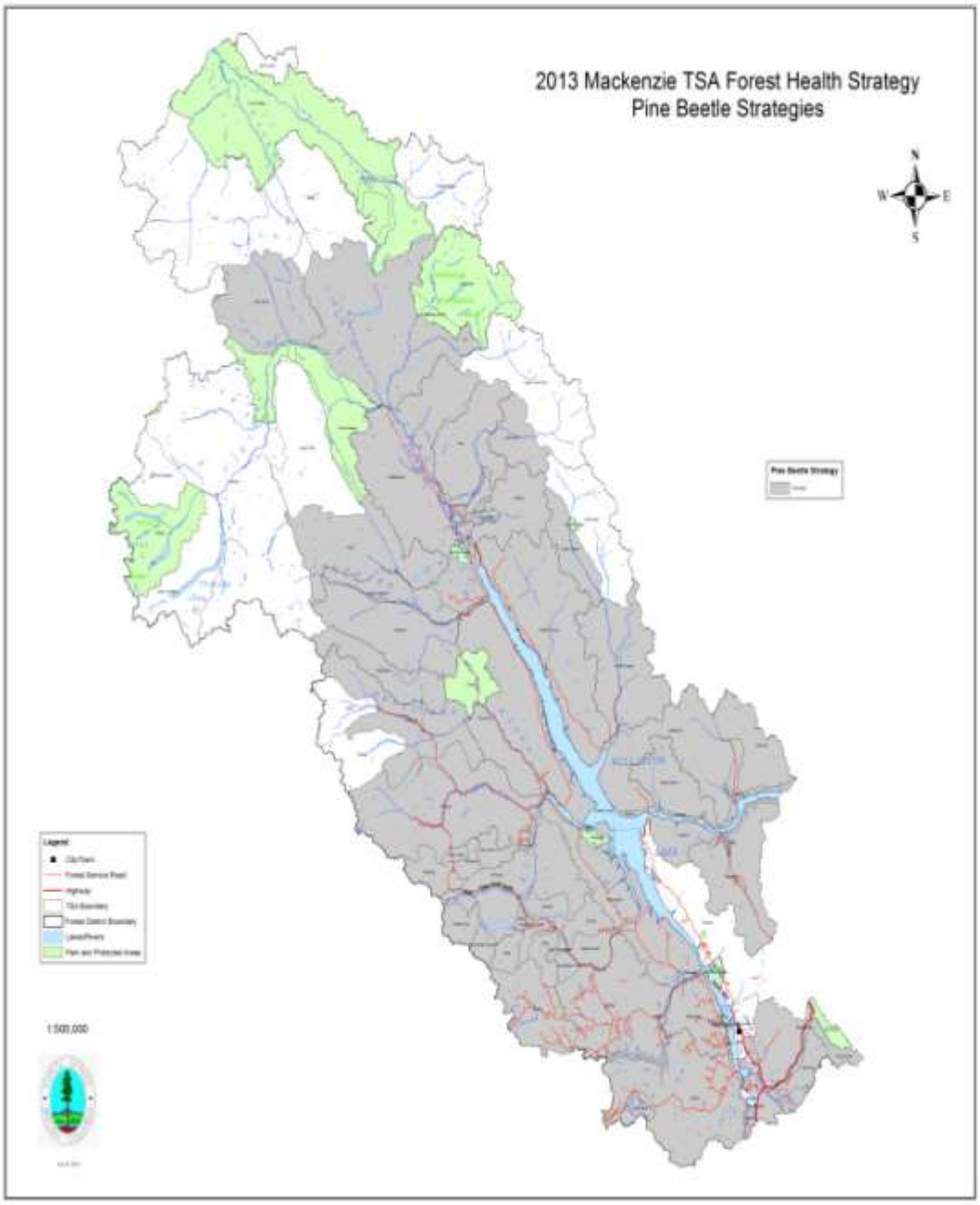
**Spruce Beetle (IBS) Strategies**



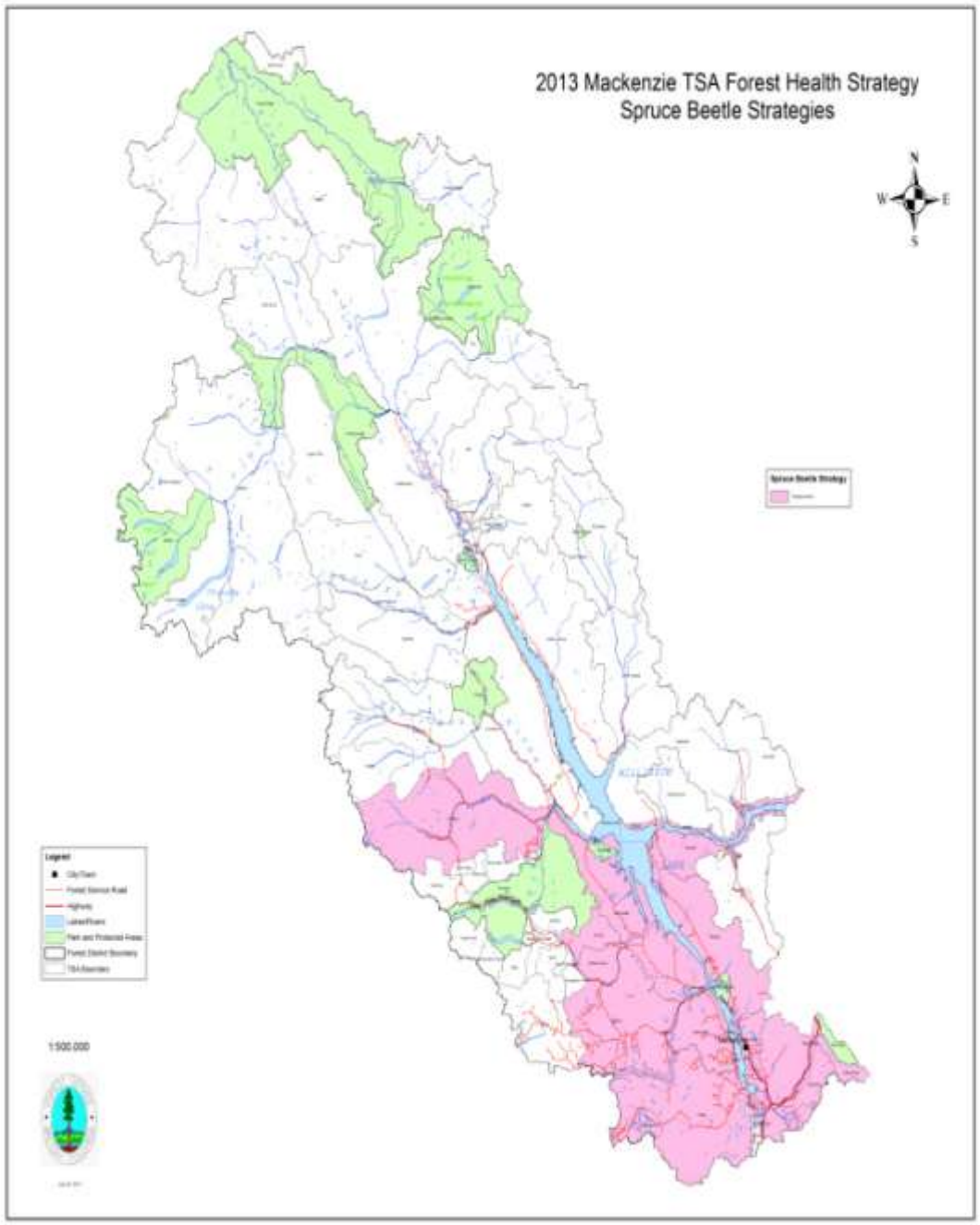
**Douglas-fir Beetle (IBD) Strategies**



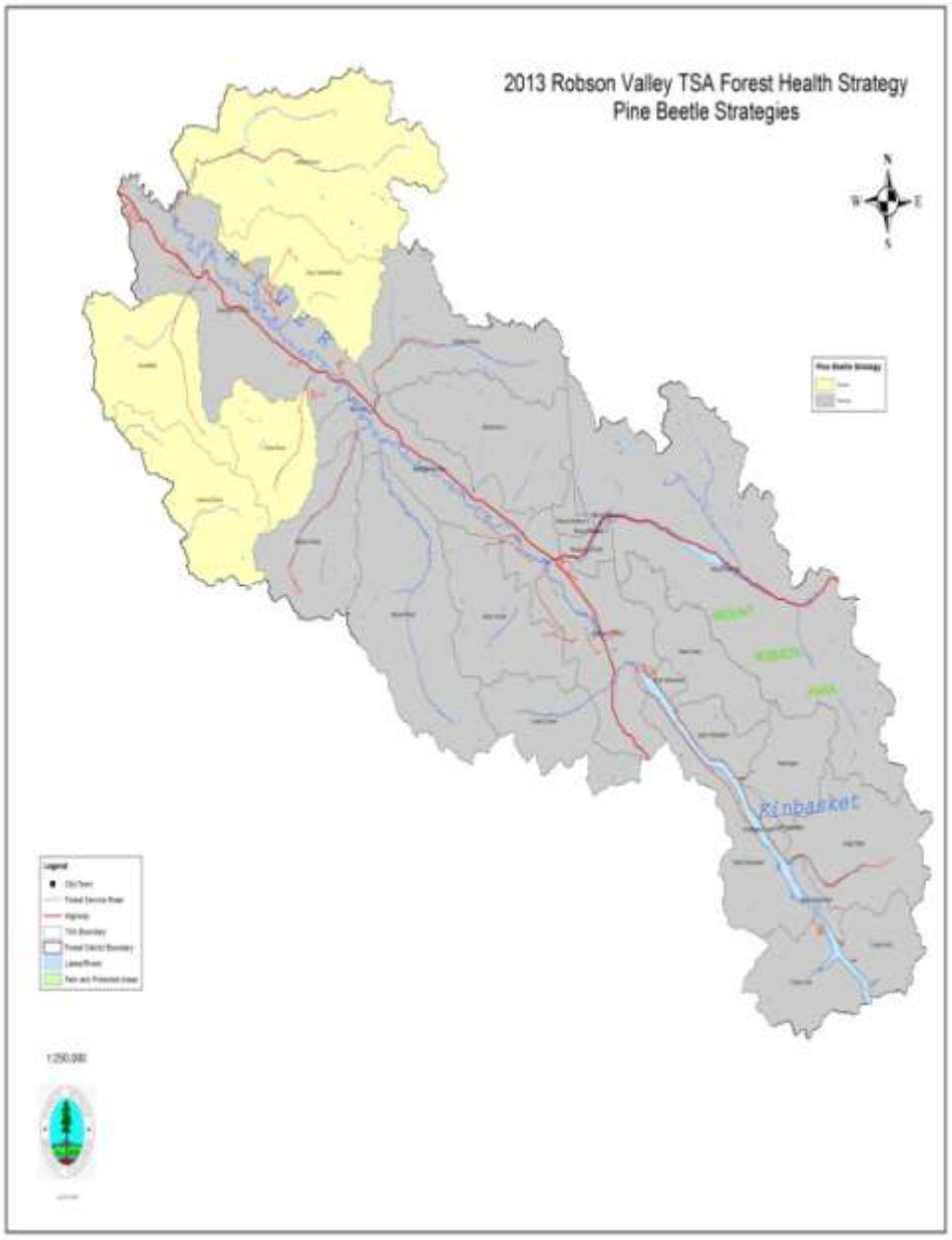
**Mountain Pine Beetle (IBM) Strategies**



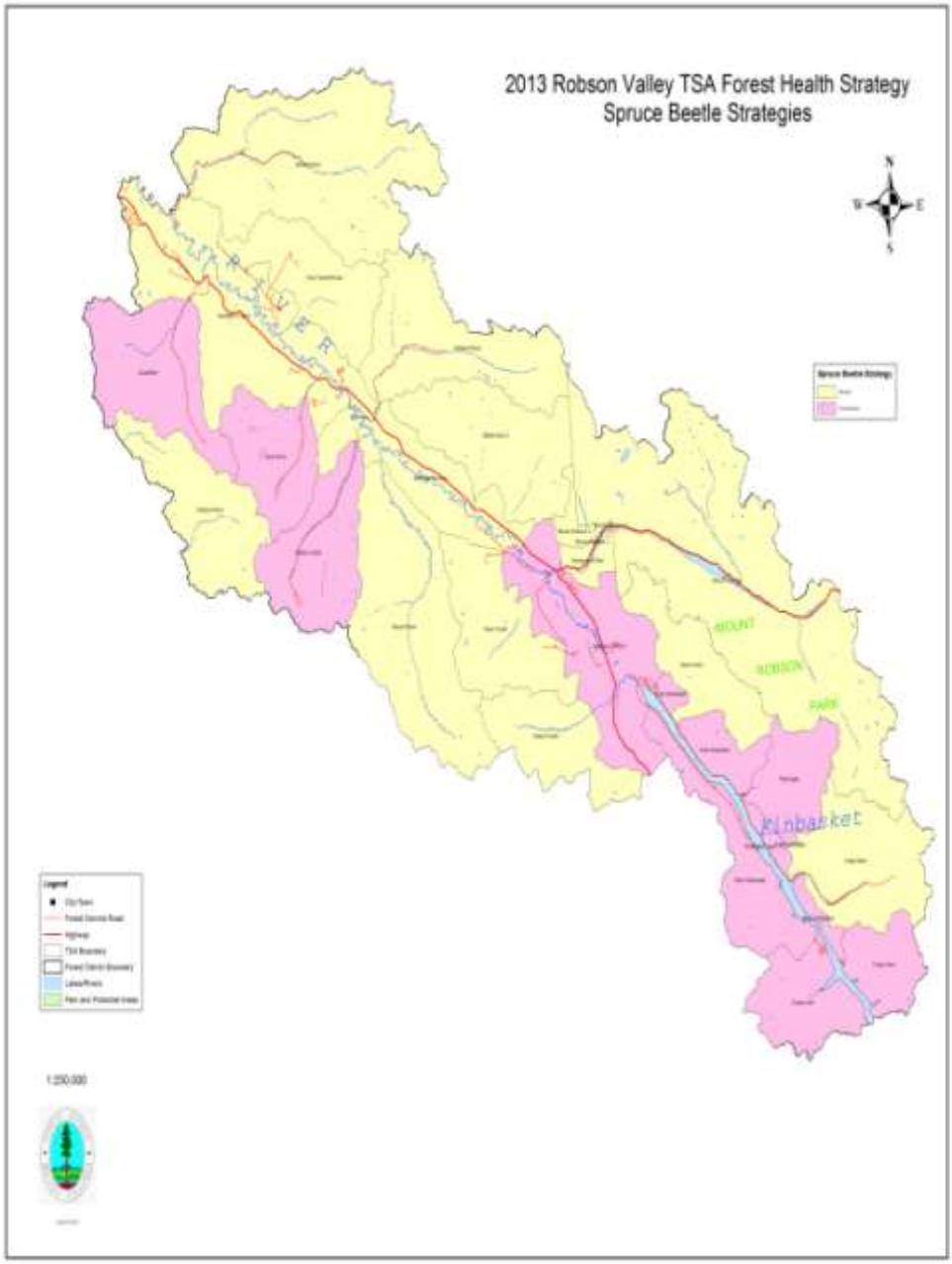
**Spruce Beetle (IBS) Strategies**



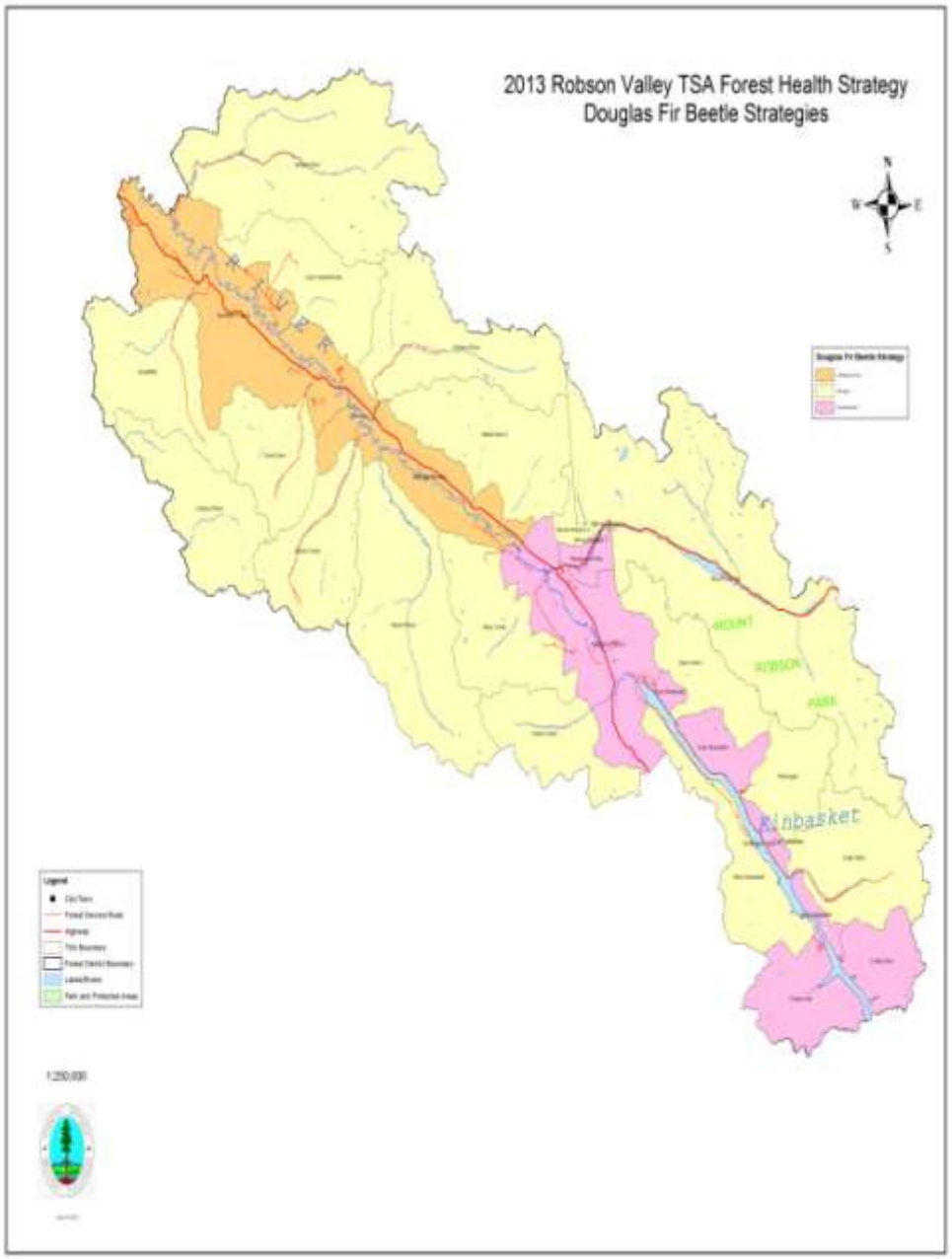
**Mountain Pine Beetle (IBM) Strategies**



**Spruce Beetle (IBS) Strategies**



**Douglas Fir Beetle (IBD) Strategies**



**APPENDIX VI**
**BC Legislation Applicable to Forest Health and FSP Stocking Standards**

**FOREST PLANNING AND PRACTICES REGULATION**

**Schedule 1**

**Factors relating to stocking specifications**

**6** (2) The following factors apply to the development of stocking standards, generally:

(a) the long term forest health risks that are relevant to species selection for the purposes of establishing a free growing stand under section 29 *[free growing stands]* of the Act;
(b) the occurrence and extent of forest health factors.

**Part 2 — Forest Stewardship Plans**

**Stocking standards**

**16** (2) In specifying a stocking standard under this section, a person who prepares a forest stewardship plan may consider the factors set out in section 6 *[factors relating to stocking standards]* of Schedule 1.

**Minister's consideration of stocking standards**

**26** (2) The minister may request information under section 16 (2.1) of the Act in respect of stocking standards if the information is

(a) relevant to the factors in section 6 of Schedule 1 that were addressed, if any,
(b) relevant to any factor that the person addressed that is not a factor listed in section 6 of Schedule 1, and
(c) either available to the person or in the control or possession of the person.

(4) The minister must approve the stocking standards referred to in section 16 (4) if the minister is satisfied that the standards will result in the area being stocked with ecologically suitable species that address immediate and long-term forest health issues on the area…

**FOREST AND RANGE PRACTICES ACT**

**Part 3 — Forest Practices**

**Control of insects, diseases, animals or abiotic factors**

**26** (2) If the minister determines that on a forested area on Crown land that is subject to

(a) a forest stewardship plan…

there are insects, diseases, animals or abiotic factors that are causing damage to the forest, the minister, by written notice given to the holder of the plan, may require the holder to submit, for that forested area, a proposal that conforms to subsection (3) to control or dispose of the insects, diseases, animals or abiotic factors.

(3) …a holder required under subsection (2), to submit a proposal must

(b) in the proposal, specify reasonable measures to be carried out for that forested area by the owner or holder, as the case may be, to control or dispose of the insects, diseases, animals or abiotic factors…

(9) If a proposal approved, or an order made, by the minister under this section requires the holder of an agreement under the *Forest Act* to carry out a measure other than timber harvesting, then to the extent provided in the regulations, the expenses of the measure are to be paid by the government.

**APPENDIX VII**

**White Pine Weevil (Spruce Leader Weevil) Management Strategies and Tactics for the Robson Valley TSA.**

Management Strategies and Tactics for White Pine Weevil (Spruce Leader Weevil) within the Robson Valley TSA

**Definitions for Hazard, Hazard Zone, Risk and Susceptibility**

**Hazard**: Hazard is based on stand characteristics and climate. Hazard is dependent on stand and site factors that are conducive to successful spruce leader weevil buildup. In general the higher the hazard the more damage will occur during an infestation.

**Hazard Zone**: Three hazard zones have been defined for the Robson Valley TSA.

- **High**: where on average current attack rates are likely to exceed 20% - **< 1000-m all aspects**.
- **Moderate**: where on average current attack rates will fall between 10 to 19% **- 1001-1200-m S, SW, W aspects**.
- **Low**: where on average current attack rates are unlikely to exceed 9% - **> 1000-m all aspects except S, SW, W**.

**Risk**: Risk is dependent on the presence or absence of weevil within a stand. A stand is considered to have risk if the weevil is present based on collected data. Risk ratings are included in a spreadsheet for all stands rated to date (both ground and aerial surveys) in the Robson Valley TSA.

**Stand Susceptibility**: This term replaces risk in its conventional meaning. It defines the proximity to risk. Spruce grown on sites where weevil has been noted within 3-km are considered as being susceptible.

Selection of management strategies for spruce leader weevil

**Instructions for using key:**

1. Determine the hazard zone the area falls within by determining the elevation.
2. Determine whether spruce leader weevil is present within 3-km of the plantation or proposed plantation.
3. Determine the age of established plantations within 3-km, if applicable.

**KEY:**

1. What hazard zone does the area fall within?
- < 1000-m all aspects - **HIGH** - Go to 2
- 1001-1200-m S, SW, W - **MODERATE** - Go to 2
- > 1000-m all aspects except S, SW, W - **LOW** - Go to 10

**RISK/SUSCEPTIBITLITY - for new and/or existing plantations**

2. Is there a known spruce weevil population in established plantations within 3-km of the proposed management area?
   Yes - Go to 8
   No - Go to 3

3. Are there any spruce plantations within 3-km greater than 5 years of age?
   Yes - Go to 7
   No - Go to 4

4. Are there any spruce plantations within 3-km less than 5 years of age?
   Yes - Go to 8
   No - Go to 5

5. Is there an endemic/resident spruce weevil population within 3-km? Areas to consider include roadsides with natural regeneration and areas with advanced regeneration.

Yes - Go to 9
No - Go to 6

**Management Areas - Five delineated Management Areas**

6. **Management Areas** - with no susceptible stands, mixed species mature canopy in the surrounding area, undeveloped areas, and no known infestation within 3-km.

**Strategies - Go to C**

7. **Management Areas** - with stands that are greater than 5 years of age which render them susceptible to weevil attack, with no known infestation within 3-km.

**Strategies**
**Proposed plantations - Go to B**

**Existing plantations - Go to E**

8. **Management Areas** - with consecutively planted spruce stands and/or, known spruce weevil infestations present within 3-km or, susceptible stand/s within 3-km too young to assess.

Strategies:

**Proposed plantations - Go to A**

**Existing plantations** - Go to E

9. **Management Areas** - generally susceptible due to hazard with evidence of an endemic/resident population within 3-km.

**Management Strategies and Tactics for White Pine Weevil (Spruce Leader Weevil) within the Robson Valley TSA continued:**

**Strategies - Go to A**

10. **Management Areas** - > 1000-m all aspects except S, SW, W

**Strategies -** Go to D

**Strategies:**
**Recommendations and tactics:**
There are five strategies.

Strategies - For proposed plantations within management areas 6 to 10
- For existing plantations within management areas 7 and 8

**A. Prevention - Protection of new plantations**
*Following stand establishment > 5 years of age refer to strategy E - Silvicultural

Control
**Within moderate and high hazard - high susceptibility areas**

**Increase planting density** - from 1600st/ha to 2200st/ha (temperature & humidity - impacting on larval development and increased exposure to mortality) (see references).

Use resistant stock of diverse genotypes - **(experimental to date, apply on a trial basis)**

**Reduce spruce component** - Uniformly mixing a non-susceptible host in with spruce such that the later comprises plus or minus **25%** of the stand. (25% is a suggested baseline).

Encourage deciduous component for shading **- may include planting or retaining existing deciduous. Should be retained in lines in an east to west direction where possible (experimental to date). (Overstorey shading can decrease over-wintering success of adult weevils and reduce leader length and thickness).**

**Establishment Brushing** - eliminate vegetation that will not contribute to side shading. Brush species that only form low-lying canopies like Alder and Willow should be retained in lines in an east to west direction where possible (experimental to date). Brushing could also be conducted only within a specified radius around each crop tree.

**Avoidance**

- **Fertilization - to avoid increases in leader length and thickness**

**B. Prevention - Protection of new plantations**
*Following stand establishment > 5 years of age refer to strategy E - Silvicultural Control

**Within moderate and high hazard - low susceptibility areas**

Use stock with low resistance

Management Strategies and Tactics for White Pine Weevil (Spruce Leader Weevil) within the Robson Valley TSA continued:

**Species mixture** - Uniformly mixing a non-susceptible host in with spruce such that the later comprises greater than **25%** of the stand. (25% is a suggested baseline).

**Brushing for establishment** - as required

Continued monitoring **- for initial attack and/or increase in current incidence**

Avoidance

- **Fertilization - to avoid increases in leader length and thickness**

**C. Monitor** - Monitor plantations - assessment of presence/absence within 5 to 20 year old stands for isolated plantations, and more often if consecutively planted within 3-km of one another.

**D.**

E. **No action required - >** 1000-m all aspects except S, SW, W - above this elevation no action is required for spruce weevil management as it is unlikely to exceed 9% current incidence within the plantation's life.

F. **Silvicultural Control** - Protection of established plantations > 5 years of age
**Within moderate and high hazard - low and high susceptibility areas**

**Add non-host mixture** - as a fill-planting option. Include within:

- High Hazard - High Susceptibility areas
- Moderate Hazard - High Susceptibility areas

Interplant spruce weevil resistant stock - **(experimental to date, apply on a trial basis). Include within:**

- High Hazard - High Susceptibility areas

**Encourage deciduous component for shading** - may include planting or retaining existing deciduous. Should be retained in lines in an east to west direction where possible (experimental to date). (Overstorey shading can decrease over-wintering success of adult weevils and reduce leader length and thickness). Include within:

- High Hazard - High Susceptibility areas
- Moderate Hazard - High Susceptibility areas

**Brushing, manipulate existing shading** - eliminate vegetation that will not contribute to side shading. Brush species that only form low-lying canopies like Alder and Willow should be retained in lines an east to west direction where possible (experimental to date). Brushing could also be conducted only within a specified radius around each crop tree.
Include within:

- High Hazard - High Susceptibility areas
- Moderate Hazard - High Susceptibility areas

**Spacing, pre-commercial thinning** - after attack rates decline.

**Pruning to increase value** - only after crown closure. Include within:

- High Hazard - High Susceptibility areas

**Species conversion/rehabilitation** - refer to Management of terminal weevils in British Columbia FPC Guidebook - note this treatment can apply to any stand or strata. Include within:

- High Hazard - High Susceptibility areas

**APPENDIX VIII**

**Armillaria Root Disease Hazard and Risk Digital Layer and Database for the Robson Valley TSA and Armillaria Map Verification Project, by Richard Reich Forest Pathologist, FLNRO-Northern Interior Forest Region**

**Armillaria Root Disease Hazard and Risk Digital Layer and Database for the Robson Valley TSA**

**Project History:**

The project was initiated in 1991 by Richard Reich - Forest Pathologist, FLNRO-Northern Interior Forest Region. The objective was to detect, identify and assess incidence of Armillaria root disease Armillaria ostoyae at the stand level and for the entire landscape comprising the Robson Valley TSA. Ground surveys were initiated in young stands with confirmed root disease incidence starting in 1991. Aerial flights were conducted the following season to evaluate the potential of collecting overview occurrence and distribution information over a much broader and often inaccessible landscape. A selected number of aerial overview sites were then ground checked to confirm the aerial stratification of the root disease and determine incidence levels. This overview information was then digitized onto an Armillaria GIS layer to show the incidence and spatial distribution of disease within assessed areas.

A second phase of mapping areas of known risk was applied to the base maps using data generated from field assessments conducted pre-logging for both local licensee's and BCTS.

In time an Armillaria root disease database was developed containing specific attributes such as the type of survey method used, date surveyed and stand incidence and was spatially linked to the digital layer. The intent of the database is to enable the user to better understand the system inputs in order to have a greater understanding of how the maps can be used. For instance:
Aerial overview data has a lower overall reliability than low intensity ground surveys, which have a lower reliability than high intensity ground surveys regarding tree level incidence of disease. However, the stratification of aerial surveys may provide a better overview of the spatial distribution of disease centers, which low intensity ground surveys cannot provide.

Project objectives:
The objectives and uses for the digital layer and database are to:

- provide a tool for evaluating landscape level hazard and risk for Armillaria root disease to be used in forest stewardship plans as well as other higher-level plans where they exist.
- serve as a planning tool during the operational planning stage for licensee's operating within high hazard and risk biogeoclimatic subzones within the RV TSA.
- provide the basis for determining the impact during timber supply review
- provide supporting documentation for to the Robson Valley Forest Health Strategy.

**Applications and Limitations:**

Detection activities have been conducted within portions of the 22 mapsheets listed below:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 83E 021 | 83E 012 | 83E 011 | 83E 004 | 83E 003 | 83E 002 | 83D 094 | 83D 093 |
| 83D 085 | 83D 084 | 83D 083 | 83D 075 | 83D 074 | 83D 066 | 83D 065 | 83D 057 |
| 83D 028 | 83D 056 | 83D 047 | 83D 038 | 83D 037 | 83D 036 | | |

I
ndividually digitized base maps encompassing areas with hazard and known risk for Armillaria root disease within the Robson Valley TSA have also been generated as pdf. files.

Identified for each mapsheet is the hazard rating for biogeoclimatic subzones that have known root disease occurrence or a high probability of root disease occurrence and which require evaluation as part of the operational site planning process. Also identified are the known Armillaria affected areas using color theming to denote the incidence level. The incidence levels are as follows: healthy (green) = (0%

observed incidence), minimal (yellow) = (< 2% observed incidence), alternate (orange) = (2 to 8% observed incidence), and intensive (red) = (> 8% observed incidence).

**Root Disease Assessment Procedure:**

Reviewing the Armillaria layer (base map overlays) and database in the office provides a reasonable level of guidance as to what may be expected on a specific site, but does not replace a stand level assessment.

In order to develop a site prescription that adequately addresses root disease, two levels of hazard and risk assessments are required. (**1**) A landscape level hazard and risk assessment – review overlay maps to determine whether the site is located within a susceptible biogeoclimatic subzone, and (**2**) a stand level risk assessment consisting of a walkthrough survey for the purpose of detecting, identifying and delineating affected areas by incidence level and finally mapping.

The root disease hazard and risk assessment considers two key factors:

1. the hazard inherent in the ecosystem at the biogeoclimatic subzone level and the susceptibility of the indicated forest cover;
2. the risk *value* (or probability of root disease presence and its expected impact) within a polygon or block.

The Root Disease Management Guidebook provides relevant information regarding management of Armillaria root disease within susceptible biogeoclimatic subzones as well as other root diseases found throughout B.C.

**Limitations of the Armillaria digital layer and database:**

Although a number of Armillaria root disease centers have been mapped with GPS, not all have been identified this way. New disease centers will be evident in areas previously rated as healthy since symptom expression is often delayed on certain sites and under certain forest cover types.

The age of the survey may be relatively old. Assessment dates can be found in the database. This is important as some surveys have been conducted more than 10 years ago.

This document was written by Pathfinder Forestry Consultants Ltd. in consultation with Richard Reich - Regional Forest Pathologist - Northern Interior Forest Region.

**Armillaria Map Verification Project,**
by Richard Reich

Landscape level detection and mapping of Armillaria root disease is one of the most challenging Forest Health activities. The end product reaps large dividends due to vastly enhanced silviculture and timber supply planning. The reason for the challenge is that the fungus occupies a largely belowground niche of classical “icebergian” proportions. Stand level symptoms of Armillaria root disease are evident above ground by a ring-like spatial pattern of dead and dying trees that spreads out from the center, with the interior area converting to less susceptible, typically deciduous species. Over long periods of time these disease centers become so large and fragmented that their boundaries become indistinguishable from a collection of unique, but smaller infection centers. How could this seemingly esoteric issue possibly be an operational problem? Correctly interpreting disease biology and stratifying for Armillaria root disease can greatly assist silviculture and timber supply planning by not overestimating diseased area.

The purpose of this project is to assess the accuracy of the Armillaria map of the northern portion of the Headwaters District (former Robson Valley District). The map was assembled over a period of several years starting in 1991 using detection methods ranging from specialized low-level aerial sketch mapping using rotary wing aircraft, to detailed ground surveys. The detailed aerial sketch mapping was conducted extensively across the district and worked well for mapping above ground symptoms of Armillaria root disease centers in older plantations and unmanaged stands, especially for moderately to highly susceptible species. The detailed ground surveys provided reliable spatial and incidence data, but are expensive and were therefore conducted on a limited number of openings.

In 2006 a verification project was initiated in collaboration with Michelle Cleary of the SIFR to determine the reliability of the Armillaria map by surveying a number of representative young stands. This project also addresses the question of how well can Armillaria be operationally detected in relation to plantation age and species composition. The stands were selected to provide generally uniform coverage of the spatial distribution across the district, and to represent the full range of species composition found in young stands. Approximately 28 stands were surveyed in the fall of 2006. The survey recorded: species composition, an estimate of the tree based incidence of Armillaria, and the GPS location of each transect segment on a 50 meter interval. Observations were also made on the general detectability of Armillaria symptoms by tree species.

Preliminary results show that the current Armillaria map is largely reliable in showing the distribution of Armillaria at a landscape level. However, there is lots of room for improvement based on the following observations:

- On several openings, which were rated as “uninfected”, Armillaria was located during the ground survey. The reason for this may be because the initial aerial assessment was done at too young of an age (prior to observable symptoms). On other sites it may be that the species composition was not conducive for aerial detection.
- On other openings the level of incidence was much higher than originally observed. This appeared to be related to conducting detection surveys at too young of an age.
- Conversely, there were also examples of entire plantations rated as “infected” at a low level, which contain only a few discrete centers, which could easily be mapped, but had not been delineated.
- Finally, there were numerous openings where the “uninfected” rating was maintained. The reliability of stands rated as “uninfected” is particularly important for silviculture and timber supply.

At the landscape level, the spatial pattern of disease centers are not uniform. This indicates that various environmental and ecological factors may play a role in the distribution of the root disease. Investigation of the role of these factors will be facilitated by the ongoing verification of the reliability of the Armillaria map.

Future planned work includes:

- Ground surveying additional stands to improve the reliability of the map in high risk areas
- transfer of all verified disease stratum into the FLNRO forest inventory in the forest health layer to be used as an on-line planning tool
- Investigation of local Armillaria population genetics through DNA characterization of disease centers (into unique genets) in order to interpret landscape level infection patterns as they relate to operational surveys
- Comparing the verification survey results of this study with the free growing results recorded in the RESULTS database.

**APPENDIX IX**
**Bark Beetle Control Strategies**

**Suppression/Prevention Strategy (S/SP)**

This is the most aggressive strategy. It is selected when the infestation status is such that aggressive direct control actions are expected to keep an area at a low level of infestation. Areas 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 Action (H)**

With vigorous directed harvesting and limited single tree treatments it is biologically feasible to at least hold infestations static. 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 (SL)**

Applied to areas where management efforts would be ineffective in 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 case is to salvage affected stands and minimize value loss. This strategy may also apply to areas containing small volumes of pine, or areas where pine is marginally economic – that is, where control is not worth the effort that would be expended and the objective is to salvage whatever values are there.

**Monitor (M)**

This strategy is applied to areas where management efforts would be ineffective in substantially reducing the beetle population and subsequent levels of damage, or where there is no short-term (less than 5 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.

**Undesignated (U)**

These units have not been assigned a strategy because no forest health factors have been identified for treatment.

**Park, Protected Areas, and Ecological Reserves (PA/ER)**

There is a requirement to have a description for the Protected Area polygons on FLNR 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 considers a different set of values. Planning for beetle management in protected area will occur through co-operation between Ministry of Environment (MoE) and FLNR.

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*.

**APPENDIX X**

**Land base Bark Beetle Funding Requests for the Omineca Region for 2013-2014**

| | Detailed Air | Ground Surveys | Fall & Burn & Other | Pheromones | Totals |
|---|---|---|---|---|---|

| District | Beetle | Ha | $ | Ha | $ | | Baits | $ | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| **Prince George*** | SB | 15, 120 | $12,000 | | | | | | **$12,000** |
| | | | | | | | | | |
| **Vanderhoof** | DFB | 3,000 | $5,000 | 90 | $18,600 | 40 F & B for $10,000 plus 500 MCH for $1200 | 30 | $200 | **$35,000** |
| | | | | | | | | | |
| **Ft. St. James** | DFB | 19,500 | $16,500 | | | | | | **$16,500** |
| | | | | | | | | | |
| Totals = | | 37,620 | $33,500 | 90 | $18, 600 | $11, 200 | 30 | $200 | **$63, 500** |

*Includes Robson Valley TSA

**APPENDIX XI**
**Listing of Provincial Priority Forest Health Agents and Forest Health Agents with an Integrated Forest Health Management Regime**

**The most Important Biotic Damaging Agents of Forests in British Columbia as of January 2003 Listed by Priority.**

| Damaging agent | Origin | Primary host(s) | Geographic extent of problem | Typical occurrence cycle | Most typical type of damage[i] | Possible impact on forest values | Control strategies available? | Priority[ii] |
|---|---|---|---|---|---|---|---|---|
| Armillaria root disease | Native | B, Cw, Hw, S, Fd, P | Ecozone | Persistent | 2, 3, 4 | High | Yes | |
| Mountain pine beetle | Native | Pl, Pw, Py | Throughout host range | Persistent to widespread outbreak | 4 | Severe | Yes | **VH** |
| Spruce beetle | Native | Se, Ss, Sw | Throughout host range | Persistent to local outbreak | 4 | High | Yes | **VH** |
| Comandra blister rust | Native | Pl, Py | Throughout host range | Persistent to local outbreak | 1, 3 | Moderate | Yes | **H** |
| Tomentosus root rot | Native | Pl, S | Ecozone | Persistent | 2, 4 | Moderate | Yes | **H** |
| Western spruce budworm | Native | B, Fd, S, Lw | TSA-level | Persistent to local outbreak | 2, 4 | Moderate | Yes | **H** |
| White pine blister rust | Introduced | Pw, Pa | Throughout host range | Persistent | 1, 3 | High | Yes | **H** |
| Douglas-fir beetle | Native | Fd | Throughout host range | Persistent to local outbreak | 4 | Moderate | Yes | **M** |
| Eastern spruce budworm | Native | Se, Sw | TSA-level | Persistent to local outbreak | 2, 4 | Moderate | Yes | **M** |
| Lodgepole pine dwarf mistletoe | Native | Pl | Ecozone | Persistent | 1, 2 | Moderate | Yes | **M** |
| Pine Needle Cast | Native | Pl, Py | Ecozone | Persistent to local outbreak | 2, 3 | Moderate | No | **M** |
| Western balsam bark beetle | Native | Bl | Throughout host range | Persistent | 4 | Moderate | No | **M** |
| Western hemlock looper | Native | Hw | TSA-level | Persistent to local outbreak | 2, 4 | Moderate | Yes | **M** |
| Dothistroma needle blight | Native | Pl | Ecozone | Persistent to local outbreak | 2, 4 | High | Yes | **M** |

| Damaging agent | Origin | Primary host(s) | Geographic extent of problem | Typical occurrence cycle | Most typical type of damage[i] | Possible impact on forest values | Control strategies available? | Priority[ii] |
|---|---|---|---|---|---|---|---|---|
| Spruce weevil | Native | S | Ecozone | Persistent | 1 | Moderate | No | **L** |
| Stalactiform blister rust | Native | Pl | Throughout host range | Persistent | 1, 3 | Low | Yes | **L** |
| Western blackheaded budworm | Native | B, Fd, H, S | TSA-level | Persistent to local outbreak | 2, 3, 4 | Moderate | No | **L** |
| Annosus root disease | Native | Ba, Cw, Hw, Fd, Ss | Ecozone | Persistent | 2, 3, 4 | Low | Yes | **VL** |
| Atropellis canker | Native | Pl | Ecozone | Persistent | 1, 4 | Low | No | **VL** |
| Blackstain root disease | Native | Fd, Pl | Ecozone | Persistent | 2, 3, 4 | Low | No | **VL** |
| Conifer foliar diseases | Native | Various | Ecozone | Local outbreak | 2, 3, 4 | Moderate | No | **VL** |
| Douglas-fir dwarf mistletoe | Native | Fd | Local | Persistent | 1, 2 | Moderate | Yes | **VL** |
| Elytroderma needle cast | Native | Pl, Py | Ecozone | Persistent | 2 | Low | No | **VL** |
| Hardwood cankers | Native | A, Dr, Ep, M | Throughout host range | Persistent | 1, 4 | Moderate | No | **VL** |
| Hardwood defoliators | Native | Various | Ecozone | Local outbreak | 2, 3, 4 | Moderate | No | **VL** |
| Lodgepole pine terminal weevil | Native | Pl | Ecozone | Persistent | 1 | Low | No | **VL** |
| Warren's root collar weevil | Native | Pl | Ecozone | Persistent | 3 | Low | No | **VL** |
| Western gall rust | Native | Pl | Throughout host range | Persistent | 1 | Low | No | **VL** |
| Western larch dwarf mistletoe | Native | Lw | Local | Persistent | 1, 2 | Moderate | Yes | **VL** |
| Wood decay fungi | Native | All | Widespread | Persistent | 1, 2, 4 | Moderate | Yes | |

[i] **Type of damage**: 1 = quality loss (pest causes stem deformities and indirect mortality); 2 = growth reduction (pest impedes host vigour and may cause mortality prior to rotation); 3 = young tree mortality (mainly prior to maturity); 4 = mature tree mortality (pest attacks trees of sufficient size and accelerates senescence).

[ii] **Estimated impact**: low = occasional tree mortality and negligible visual impact; moderate = noticeable tree mortality and occasional visual impact; high = readily apparent tree mortality and visual impact; severe = abundant tree mortality and inescapable visual impact.

[iii] **Provincial Priority** - VH= Very High, H= High, M= Medium; L= Low; VL= Very Low

**Matrix Showing General Status of Provincial Integrated Forest Health Management for Very High to Moderate Priority Biotic Forest Health Damaging Agents**

| Damaging agent | Priority | Operational detection method available? | Impact known? | Potential impact on forest values | Reactive Management strategies available? | Proactive Management strategies available? | Performance measurable? | Measured how? |
|---|---|---|---|---|---|---|---|---|
| Armillaria root disease | VH | Yes | (Yes) | High | Yes | Yes | Yes | G&Y, FG |
| Mountain pine beetle | VH | Yes | Yes | Severe | Yes | Yes | Yes | PM |
| Spruce beetle | VH | Yes | Yes | High | Yes | Yes | Yes | PM |
| Comandra blister rust | H | Yes | Yes | Moderate | Yes | Yes | Yes | G&Y |
| Laminated root rot | H | Yes | (Yes) | Moderate | Yes | Yes | Yes | G&Y, FG |
| Tomentosus root rot | H | Yes | (Yes) | Moderate | Yes | Yes | Yes | G&Y, FG |
| Western spruce budworm | H | Yes | Yes | Moderate | Yes | Yes | Yes | PM |
| White pine blister rust | H | Yes | Yes | High | Yes | Yes | Yes | G&Y, FG |
| Douglas-fir beetle | M | Yes | Yes | Moderate | Yes | Yes | Yes | PM |
| Douglas-fir tussock moth | M | Yes | Yes | Moderate | Yes | Yes | Yes | PM |
| Eastern spruce budworm | M | Yes | (Yes) | Moderate | Yes | Yes | Yes | PM |
| Lodgepole pine dwarf mistletoe | M | Yes | (Yes) | Moderate | Yes | Yes | (Yes) | G&Y, FG |
| Pine Needle Cast | M | Yes | (Yes) | Moderate | No | No | N/A | |
| Western balsam bark beetle | M | Yes | (Yes) | Moderate | No | No | N/A | |
| Western hemlock looper | M | Yes | (Yes) | Moderate | (Yes) | No | (Yes) | (PM) |
| Dothistroma needle blight | M | Yes | Yes | High | Yes | Yes | Yes | FG |

Yes = operational methods available though application may be limited by budget or lack of obligation
(Yes) = limited information, work in progress
No = no operational method available or insufficient information
N/A = not applicable
Operational Detection Method? = method described in guidebook or regional procedures
Impact known? = stand and forest level impact data collected and analysed
Control strategies available? - are operational methods necessary, described and supported with efficacy data?
Performance Measurable? = are there indicators of a management action's success. (Yes) = theoretically possible but not operational
PM=performance measure established; G&Y = potentially measurable if PSPs established at time of treatment; FG=free-growing targets achieved
(PM)=under development