Headwaters Forest District Forest Health Strategy for the Robson Valley Timber Supply Area

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1.0 Introduction

This document has been prepared for the Ministry of Forests and Range (MoFR) Headwaters Forest 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 MoFR. 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 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 RV 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 MoFR 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 result' 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.

2.0 Forest Health Implementation Strategy Directives

The MoFR has identified a number of functions to meet the goals of the Forest Health Program. The following table (1) 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.

Table 1- 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		

2.1 Legislation and Policy Support

Function 1: Develop provincial, regional and TSA strategies.

Overview: *Describes the Ministry of Forest and Range'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 MoFR 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.
- Promote workshops, training and other sessions to improve skill set for staff, licensees and others, and make training opportunities available.
- Embed training requirements into Employee Performance and Development Planning (EPDPs) and professional learning plans.

2.2 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: Forest Investment Account (FIA) eligibility criteria.
- Provide feedback to regions regarding SOPs 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: *The Ministry of Forests and Range 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 MoFR 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: *The Ministry of Forests and Range 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 MoFR.

2.3 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 receive 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.

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.

3.0 RV TSA Priority Ranking of Importance of Forest Health Factors

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

- Collective knowledge of the MoFR, 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 2 - Robson Valley TSA Ranking of Pest Species by Potential Impact on Forest Management Activities.

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

4.0 Tactics with Deviations from Currently Available Management Practices

4.01 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. See table 3 for biogeoclimatic subzones with high hazard ratings within the RV TSA. 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, Northern Interior 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 II).

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 Forest District (formerly the Robson Valley Forest 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 II 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 MoFR 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.

As table 6 (page 27) indicates, further information on detection and operational methods regarding Armillaria root disease is available and is employed within the RV TSA.

4.02 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 hazard biogeoclimatic subzones were omitted within the Root Disease Management Guidebook. For the updated subzones refer to table 3 (page 23).

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.

As table 6 (page 27) indicates, information on detection and operational methods regarding Tomentosus root disease is available and is employed within the RV TSA. For further information regarding Tomentosus management strategies contact regional forest health specialists.

4.03 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.

4.04 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

4.05 Hard pine stem rusts - Comandra blister rust *Cronartium comandrae*, Stalactiform blister rust *Cronartium coleosporioides* and western gall rust *Endocronartium harknessii*:

High incidences of pine stem rusts can be present in the high hazard and risk biogeoclimatic subzones (see table 3 page 23) within the RV TSA. It is acknowledged that there is a potential high impact during stand management treatments.

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.

As table 6 (page 27) indicates, further information on detection and operational methods regarding hard pine stem rusts is available and is employed within the RV TSA. Further information regarding survey methodology for detection and incidence determination of hard pine stem rusts can be found in section 4.22.

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, Northern Interior Forest Region, Prince George for further information.

4.06 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.

4.07 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

White Pine Blister Rust - *Cronartium ribicola* cont:
Host Species: Whitebark Pine *Pinus albicaulis*

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).

Tactics - White Pine Blister Rust for Whitebark Pine:

The Ministry of Forest and Range and Parks Canada is reviewing management objectives for high elevation stands, conducting cone collections for breeding purposes and conducting site preparations.

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

4.08 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 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.

4.09 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.

4.10 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.

4.11 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

4.12 Western Balsam Bark Beetle - *Dryocoetes confusus*:

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 (see table 17, page 47).

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.

4.13 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.

4.14 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 (Shepard *et al*.). 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 contact Angus Shand at the Canadian Forestry Service - Pacific Forestry Centre in Victoria at ashand@pfc.cfs.nrcan.gc.ca or call (250) 363-0648 for the updated reports listed below.

- Impacts of the two–year cycle spruce budworm in the Prince George Region (Shand, Angus., and Alfaro, Rene. I. - February 2006).

- Impacts of the two-year cycle spruce budworm in the Headwaters District, Southern Interior Forest Region (Shand, Angus., and Alfaro, Rene. I. - 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

As table 6 (page 27) indicates, further information on detection and operational methods regarding two-year cycle budworm is available.

4.15 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 2008 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.

As table 6 (page 27) indicates, further information on detection and operational methods regarding Western Hemlock Looper is available.

4.16 White Pine Weevil (Spruce Leader Weevil) - *Pissodes strobi*:

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 to consult table 4 (page 24) and appendix I for hazard zones by aspect and elevation for White Pine Weevil within the RV 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 Forest District - Pathfinder Forestry Consultants Ltd. T & J Qureshi).

Tactics - White Pine Weevil (Spruce Leader Weevil):

See appendix I 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. Preliminary findings should be available in March 2008. Contact Art Stock, Regional Forest Entomologist, Southern Interior Forest Region Art.Stock@gov.bc.ca.

4.17 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.

4.18 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.

4.19 Survey Methodologies:

The 2001Generic Forest Health Surveys Guidebook (second addition) 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.

All Ministry of Forests and Range guidebooks can be found at the following website: http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/guidetoc.htm

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

The following table gives the landscape level hazard for forest health agents within the RV TSA by biogeoclimatic zone and subzone.

Table 3 – Landscape Level Hazard for Forest Health Agents by Biogeoclimatic Unit/s 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 SBS		M	
Comandra blister rust Stalactiform blister rust Western gall rust	ICH SBS	mm dh	H H	96,018 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	

"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

[e] 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.

Further information in regards to hazard and risk classes for individual forest health agents can be found in the Forest Practices Code Guidebooks for British Columbia.

Table 4 - 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.

6.0 Listing of Provincial Priority Forest Health Agents (Table 5) and Forest Health Agents with an Integrated Forest Health Management Regime (Table 6).

Table 5. 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[ii]	Control strategies available?	Priority[iii]
Armillaria root disease	Native	B, Cw, Hw, S, Fd, P	Ecozone	Persistent	2, 3, 4	High	Yes	**VH**
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**
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**

Damaging agent	Origin	Primary host(s)	Geographic extent of problem	Typical occurrence cycle	Most typical type of damage[i]	Possible impact on forest values[ii]	Control strategies available?	Priority[iii]
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	**VL**

[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

Table 6 – 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

7.0 Major Damaging Agents Impacts Documented in Timber Supply Review 3

Timber Supply Review (TSR 3) information regarding current impacts due to unsalvaged losses from major forest health agents within RV TSA.

The RV TSA currently has a third timber supply review (TSR 3) that was initiated in 2003. The analysis report was released in November 2005 followed by the chief forester's rationale released August 4, 2006. The following excerpts demonstrate methods, analysis and rationales used within the TSR 3 to address major forest health agents for the RV TSA.

Impacts due to unsalvaged losses within the TSR represent the timber volume that cannot be harvested due to insect and disease epidemics, extreme fire and blowdown events. The TSR 3 addresses the reduction of the forecasted timber volume due to un-salvaged losses for a number of forest health agents specific to the RV TSA (see table 7).

Table 7 - List of Selected Damaging Agents and their Ranking Specifically Addressed within the TSR 3.

Damaging Agent	Possible Impact on Forest Values [1]	RV TSA Ranking	Impact Reduction TSR 3
Armillaria root disease	High	Very high	Yes
Mountain pine beetle	Severe	Very high	Yes
Spruce bark beetle	High	High	Yes
Douglas Fir beetle	Moderate	Moderate	Yes
Western Balsam beetle	Moderate	Low	Yes
Western hemlock looper	Moderate	Moderate	Yes
White Pine Weevil (Spruce leader weevil)	Moderate	Moderate	Yes

[1]Provincial Forest Health Strategy

In the 2005 timber supply analysis, the standard MoFR growth and yield model Table Interpolation Program for Stand Yields, TIPSY (version 3.0h), was used to estimate the timber volumes for regenerated, managed stands. All TIPSY projections are initially based on ideal conditions however, two operational adjustment factors (OAF's) were applied to yields generated using TIPSY, to account for losses of timber volume resulting from a number of operational conditions. OAF 1 is designed to account for factors such as small stand openings that affect the yield curve across all ages. And, OAF 2 accounts for factors such as pests, disease, decay, waste and breakage, whose impacts tend to increase over time.

The following excerpts pertain to reduction rational included in the TSR 3 for selected damaging agents:

In the RV TSA timber supply analysis, the standard provincial reductions of 15 percent for OAF 1 and 5 percent for OAF 2 were applied to most areas, with refinements for analysis units likely to be impacted by the spruce leader weevil or Armillaria. For areas subject to the weevil, OAF 1 was increased to 25 percent, and for areas subject to Armillaria, OAF 2 was increased by 10 percent for moderate incidence, and by 20 percent for areas subject to severe incidence.

Armillaria root disease

The MoFR provided Armillaria root disease risk maps for the years between 1991 and 2002. The maps were compiled into one inventory indicating the risk level. The inventory covered the entire RV TSA identifying severe and moderate risk areas as well as those areas without Armillaria present. The moderate incidence rating (2 to 8%) relates to scattered incidence and the severe incidence rating (> 8%) relates to concentrated incidence of large patches.

Spruce-leader weevil

Spruce-leader weevil damage to spruce-leading stands in the ICH and SBS zones were estimated to account for up to a 200 m^3/ha loss in volume over the rotation of a spruce stand. In TSR 2, the MoFR used TIPSY SWAT (TIPSY with spruce weevil and brush impacts) to determine the losses caused by both brush and the spruce-leader weevil. They derived an OAF 1 of 10% in addition to the standard adjustment of 15%; therefore, all spruce leading regenerated stands will receive an OAF 1 of 25%. It was agreed upon by the DFAM Group that these OAF's still reflect current growth reductions.

Bark Beetles

In the RV TSA, the Mountain Pine Beetle is now epidemic in the lodgepole pine stands which make up 18 percent of the THLB. Because the beetle population in the TSA is too large to suppress, the management strategy is to attempt to hold it at current levels using partial - and clear-cutting and small scale salvage. For unsalvaged losses due to the bark beetles, each licensee provided an estimate of the average unsalvaged losses (i.e. volume loss after taking into account salvage volumes) for their operating areas over the last three years. Mountain pine beetle is the most significant insect disturbance agent in the Robson Valley, and the DFAM Group has expressed concern over its future impact on the timber supply. In TSR 2, a 5-year average (1992-1997) was used in predicting the unsalvaged losses caused by bark beetles. For TSR 3, the weighted average between TSR 2 and the licensee's estimate (3 years of data) will be used for the unsalvaged losses from beetle damage.

Table 8 - Unsalvaged Volume Losses (m3/year) from Bark Beetle Damage in the Robson Valley TSA

Disturbance Factor	TSR 2 (1992-1997)1	Licensee's data (2000-2003)	TSR 3 (average between the 8 years of data)
Mountain Pine Beetle	3,642	12,750	7,058
Spruce Beetle	6,485	1,475	4,606
Douglas Fir Beetle	1,849	1,525	1,727
Balsam Bark Beetle	536	5,925	2,557
Subtotal	12,512	21,675	15,948

1Numbers have been revised to account for the unsalvaged volume loss in McBride Community Forest area that was included in TSR 2. The community forest accounts for 8.3% of the AAC in the second determination (50,000/602,377 m3/yr) and therefore, the unsalvage losses reported above are the original TSR2 estimates reduced by 8.3%.

In the 'Base Case' analysis, the MPB attack was simulated by incorporating an annual unsalvaged loss of 7,058 cubic metres to the harvest forecast. (This was included in, not additional to, the 15,948-cubic-metres annual loss attributed to all beetles in Unsalvaged losses, above.)

Two other scenarios were also modeled:
• A 'Best Case' scenario, in which all pine-leading stands over 60 years of age are successfully

salvaged in the next 20 years, such that no unsalvaged losses result from MPB beetle damage and all affected stands are converted to managed stands; and
• A 'Worst Case' scenario, in which all pine-leading stands over 60 years of age are immediately lost to the MPB infestation with no salvaged volume.

Western Hemlock Looper

Except for unsalvaged losses associated with bark beetles, no new studies have been undertaken since TSR 2. The Forest Insect and Disease Survey (FIDS Reports) were used for the western hemlock looper losses with the results averaged over 10 years (1987-1997). The DFAM Group noted that since the last TSR, western hemlock looper has decreased but the mountain pine beetle infestation has increased.

Table 9 - Total Unsalvaged Volume Losses – due to Western Hemlock Looper

Disturbance Factor	TSR 2 Net Volume Loss (m3/year)	TSR 3 Net Volume Loss (m3/year)1
Western Hemlock Looper	6,588	6,041

Implementation section – 2006 TSR Rationale

In the period following this decision and leading to the subsequent determination, I encourage MoFR staff and licensees to undertake the tasks and studies noted below, which are also described in appropriate sections of this rationale document. I recognize that the ability of staff and licensees to undertake these projects is dependent on available resources including funding. These projects are, however, important to help reduce the risk and uncertainty associated with key factors that affect the timber supply in the Robson Valley TSA.

Unsalvaged losses: To maintain a current perspective on forest health in relation to these losses, I have noted in 'Implementation' a recommendation that MoFR staff work with licensees to obtain updated information on unsalvaged losses for use in the next analysis and AAC determination.

Mountain pine beetle epidemic: For the purposes of this determination, I am satisfied that the level of accounting in the base case projection for losses to MPB damage provides an adequate representation of the timber supply implications of current management of the MPB. However, I remain mindful that continuing the present management of the MPB is very important to the continuing health of the forests in the TSA, and to the integrity of the projected timber supply particularly in the mid term. I therefore encourage the continuing direction of appropriate harvest volumes under the new AAC toward the management of stands infested by the MPB. Jim Snetsinger Chief Forester (as per the chief forester's rationale released August 4, 2006).

Specific RV TSA strategies and tactics pertaining to identified forest health agents are outlined in section 4.0 within this document. "Tactics with Deviations from Currently Available Management Practices".

Robson Valley TSA Bark Beetle Strategy

8.0 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 MoFR 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 MoFR, 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.

9.0 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.

10.0 Emergency Bark Beetle Management Area Designation

An Emergency Bark Beetle Management Area (EBBMA) is a separate designation process from the existing Bark Beetle Management Unit objectives (BMU) (see section 11). The objective of the EBBMA's is for the government to aggressively address B.C.'s bark beetle epidemic in expanded outbreak areas. Separate EBBMA's / EMU's designation maps have been created for Mountain Pine (IBM), Spruce (IBS) and Douglas fir (IBD) bark beetles. The Headwaters Forest District is included under these EBBMA's (see appendix III, Re-designation of Emergency Management Units, with Strategic Planning Maps, February 4, 2009). http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/. Figures 1 to 3 outline the beetle management

units (BMU) and special management units (SMU) where applicable, and include both the current BMU and EBBMA designations with strategies for the RV TSA.

Under the EBBMA, the provincial bark beetle coordinator annually monitors ongoing beetle conditions and has the ability to designate emergency management units (EMU).

The provinces' beetle infested areas have been divided into three broad "provincial bark beetle management zones" and are based on several parameters including level of attack, distribution of attack, susceptible stands remaining, age of outbreak, etc. relating to the likelihood of successful management. The three zones are:

A. Aggressive Management – beetle populations are managed down to endemic levels;
B. Containment/(Sanitation) – populations are held static;
C. Salvage/Limited Activity – minimal active management of beetle populations; and
D. Undesignated – either no host in area or low host and/or operational constraints.

As of February 18th 2005 the provincial bark beetle coordinator may designate EMUs within the EBBMA as aggressive or sanitation but for the purposes of the updated maps included in appendix III, containment will replace sanitation. Areas designated as salvage are not considered as part of the EBBMA.

Designated EMU's are the means for the MoFR to meet its stewardship mandate to aggressively deal with the beetle epidemic, and also contribute to the provincial Mountain Pine Beetle Action Plan objective of limiting further damage to B.C.'s forests and environment.

Within each broad zone are many different Beetle Management Units (BMUs) that each have been assigned one of five specific strategies (see section 12 table 11).

11.0 Beetle Management Unit Boundary Delineation

Beetle Management Unit (BMU) boundaries were established as the basis for developing management strategies and the tactical plan to address bark beetles. Each BMU identifies an area where specific beetle management strategies can be applied and tactics implemented. The BMUs selected for the RV TSA coincide with established boundaries of existing planning cells or groups of planning cells (see figures 1, 2 & 3 pages 34, 35, 36).

Current BMU's and three Special Management Units (SMU) for IBM for 2009/2010 have been identified with strategies applied (table 10 page 33). The three SMU's within the RV TSA have been identified in order to apply an aggressive strategy within a portion of a BMU.

It is important not to consider any one BMU in isolation, as each one may have an effect on the beetle situation in adjacent BMUs. Therefore, the strategy selected for a BMU must be compatible with those of adjacent units and with the overall integrated resource use plans for the area.

An overview of the RV TSA Beetle Management Units and Special Management Units with current strategies is given in table 10 below.

Table 10 - Assigned Beetle Management Unit (BMU) Strategies and Special Management Units (SMU) for IBM for the Robson Valley TSA 2009/10.

BEETLE MANAGEMENT UNIT STRATEGIES with SPECIAL MANAGEMENT UNITS (SMU) for IBM for the Robson Valley TSA 2009/10						
			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		Renshaw–Upper Morkill (IBM)	(41,359)	Suppression		
2	E. Twin / McKale		47,500	Monitor	Monitor	Monitor
2	Holmes River		69,666	Holding	Monitor	Monitor
2		Upper Holmes River (IBM)	(26,062)	Suppression		
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	Monitor
3	Cariboo River		34,344	Monitor	Monitor	Monitor
3	Castle Creek		50,924	Salvage	Monitor	Monitor
	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	Monitor
5	Hugh Allan		56,240	Salvage	Monitor	Monitor
5		Upper Hugh Allan (IBM)	(27,616)	Suppression		
5	Foster Arm		59,363	Salvage	Suppression	Suppression
5	East Kinbasket L.		29,834	Salvage	Suppression	Monitor
5	West Kinbasket L.		40,822	Salvage	Monitor	Monitor
	TOTALS		**255,348**			

Areas within brackets represent the areas of each SMU.

12.0 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 11 - 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. 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. 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. 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.

B.C. Parks Park Management Plans prepared in co-operation with the MoFR and the Ministry of Environment will govern management practices for the park areas regarding bark beetles. Currently, on ground project administration (probing and fell and burn treatments) are being conducted through Valemount Forest Products with funding from the Forest Investment Account (FIA).

The Mount Robson Provincial Park Forest Health Strategy (July 2005) is available on the website of the Ministry of Environment at http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/mtrobson/mtrobson.html.

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 12 - 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.

Additional tactics for bark beetle management are included in this section and in tables 13, 14, and 15 (pages 41-43).

12.1 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:

12.2 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.

12.3 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.

12.4 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 MoFR. 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.

12.5 Single Tree Treatment:

This includes fall and burn or fall and peel for IBM, IBD and IBS. It may also include MSMA (monosodium methane arsenate) use for IBM, when and where, to be determined by the MoFR and individual licensees. Since 2005 MSMA's registration has expired and is no longer used in British Columbia. Please go to http://www.for.gov.bc.ca/hfp/health/MSMA.htm for further information.

12.6 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.

12.7 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 MoFR 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.

12.8 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.

12.9 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.

12.10 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 13, 14, and 15. 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.

Table 13 - Tactics for **Mountain Pine Beetle** by Strategy with Critical Dates

Tactics	**Strategy #**[1]	**Critical Dates**
1. Detection/Prediction		
· Timing of adult flight		June 15-September 15
· Infestation intensity rating	All	Any time
· Hazard rating	All	Any time
· Risk rating	All	Any time
· Overview/Detailed Aerial Sketch Mapping	1, 2, 3	July 15-September 15
· Aerial photography	1	August 1-September 15
· Ground probe or walkthrough	1, 2	post-flight to pre-flight
2. Harvesting		
· Sanitation	1, 2	Any time
· Salvage	3	Any time
· High hazard host removal	1, 2	Any time
· Harvest priority rating system	1, 2, 3	Any time
3. Single Tree Treatments (STT)		
· Fall and burn	1, 2	October 15-May 1
· Debarking	1, 2	Up to flight time
· Small patch/single tree selection	1, 2	Any time
4. Bait Use (with 2 and 3 above)		
· Containment	1, 2	May 1-July 15
· Monitoring	1, 2	July 1-August 15
· Prior and follow-up to STT	1, 2	Treatment-July 15
5. Hauling Restrictions	1, 2	June 15-September 15 or as per the Regional Guidelines
6. Access Development	All	Any time
7. Beetle Proofing	All	Any time
8. Reduction of Stand Susceptibility/Prevention		
Long Term		
· Species manipulation	All	As per harvest
· Age class mosaic manipulation	All	As per harvest

[1]**The strategies are as follows:**
1. Suppression **2. Holding** **3. Salvage** **4. Monitor**
5. Prevention

Table 14 - Tactics for **Douglas-Fir Beetle** by Strategy with Critical Dates

Tactics	Strategy #[1]	Critical Dates
1. Detection/Prediction		
· Timing of adult flight		April15-August 15
· Infestation intensity rating	All	Any time
· Hazard and Risk rating	All	Any time
· Overview/Detailed Aerial Sketch Mapping	All	July 25th-September 25th
· Aerial photography	1	July 25th-September 25th
· Ground probe or walkthrough	1, 2, 3	September-June 15th
2. Harvesting		
· Sanitation	1, 2	Any time
· Salvage	3	Any time
· High hazard host removal	1, 2	Any time
· Harvest priority rating system	1, 2, 3	Any time
· Post Harvesting Mop-up	1, 2, 3	Prior to next flight
3. Single Tree Treatments (STT)		
· Fall & Burn	1, 2	October-March
· Trap tree placement	1, 2	January-March
· Trap tree removal	1, 2	September-December
· Debarking	1, 2	September-October
· Small patch/single tree selection	1, 2	Any time
· Helicopter logging	1, 2, 3	Any time
4. Pheromone Bait Use (with 2 & 3 above)		
· Containment	1, 2	April 15th – August 15th
· Funnel Trap Monitoring	1, 2	April 15th – August 15th
· Prior and follow-up STT	1, 2, 3	Continual
5. Hauling Restrictions	1, 2, 3	April 15th August 15th or as per the Regional Guidelines
6. Access Development	All	Any time
7. Beetle Proofing	All	Any time
8. <u>Reduction of Stand Susceptibility/Prevention</u>		
<u>Long Term</u>		
· Species manipulation	1	As per harvest
· Age class mosaic manipulation	1	As per harvest

[1]**The strategies are as follows:**

1. Suppression **2. Holding** **3. Salvage** **4. Monitor**

5. Prevention

Table Note: Justification for some of the strategies to be applied:

A. Ground Probes apply to # 3 strategy (salvage) "as harvesting capacity becomes available timber can be salvaged." Walkthroughs can be done in conjunction with layout in order to determine and prioritize what is to be salvaged.

B. Trap tree placement and removal also apply to the Suppression/Prevention strategy as the planning and construction routes of access can and should use trap trees along R/W where applicable.

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

Table 15. Tactics for **Spruce Beetle** by Strategy with Critical Dates

Tactics	Strategy	Critical Dates
1. Detection/Prediction		
· Timing of adult flight		May 1-August 1
· Infestation intensity rating	All	Any time
· Hazard rating	All	Any time
· Risk rating	All	Any time
· Overview / Detailed Aerial Sketch Mapping (18-24 month delay for faders)	1, 2	July 15-Oct 15
· Aerial photography	1	August 1-Oct 15
· Ground probe or walkthrough	1, 2	July 15-May 1
2. Harvesting		
· Sanitation	1, 2	Any time
· Salvage	3	Any time
· High hazard host removal	1, 2	Any time
· Harvest priority rating system	1, 2, 3	Any time
3. Single Tree Treatments (STT)		
· Fall and burn	1, 2	October 15-May 1
· Conventional Trap Trees-Fall	1, 2	March 1-April 1
· Conventional Trap Trees-Remove	1, 2	July 15-April 30
· Debarking	1, 2	Up to flight time
· Small patch/single tree selection	1, 2	Any time
· Helicopter logging	1, 2	Any time
4. Bait Use (with 2 and 3 above)		
· Containment	1, 2	May 1- early July
· Monitoring	1, 2	May 1 – July 15
· Prior and follow-up to STT	1, 2	July 15
5. Hauling Restrictions	1, 2	May 1 – August 1or as per the Regional Guidelines
6. Access Development	All	Any time
7. Beetle Proofing	All	Any time
8. Reduction of Stand Susceptibility/Prevention		
· Species manipulation	1, 2	As per harvest
· Age class mosaic manipulation	1, 2	As per harvest

[1]**The strategies are as follows:**
1. Suppression **2. Holding** **3. Salvage** **4. Monitor**
5. Prevention

13.0 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.

1. **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.

2. **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).

3. **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.

4. **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.

5. **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.

6. **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.

13.1 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 16 - 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

14.0 Management of Mountain Pine Beetle on Private Land:

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

The current program is for both research and private lands. Please refer to the following website for further information: **http://mpb.cfs.nrcan.gc.ca/control/private_e.html**.

15.0 Current and Historical Information in Regards to Bark Beetles and other Forest Health Agents within the RV TSA and Aerial Overview Summary for the Headwaters Forest District (the RV TSA comprises approximately half the area of the Headwaters forest district)

For past and current information in regards to winter mortality estimates and green to red expansion rations etc. for mountain pine beetle in the RV TSA please contact the Forest Health & Tenures Technician Headwaters Forest District, McBride Field Office.

Headwaters Forest District is part of an annual provincial aerial overview flight program that surveys a number of forest health factors. Table 17, summarizes forest health factors mapped for the entire Headwaters Forest District for the years 2007/2008. For an overview of findings from 2004 to 2006 see appendix IV.

Table 17 - Headwaters Forest District Annual Aerial Overview Surveys Summary (2007/08)

Annual Aerial Overview Surveys Summary												
	2007/ha						2008/ha					
Year Assessed/ Affected Area	Trace	Light	Mod	Severe	Very Severe	Totals	Trace	Light	Mod	Severe	Very Severe	Totals
Mountain Pine Beetle	99,128.4	59,893.9	55,004.0	16,416.4	2,826.2	233,269.0	73,172.3	48,795.5	31,132.3	8,010.3	3,378.8	164,489.2
Douglas-fir Beetle	202.8	2.5	0.0	1.8	0.0	207.1	67.6	47.8	51.4	4.3	0.0	171.1
Spruce Beetle	320.1	160.5	75.8	2.2	0.0	558.6	104.2	423.0	1103.1	1.0	0.0	1631.3
Western Balsam Bark Beetle	73,382.9	16,506.4	265.8	86.9	0.0	90,242.0	22,785.8	1,241.1	0.0	0.0	0.0	24,027.2
Two-Year Cycle Budworm	-	3,093.6	-	-	-	3,093.6	-	50,715.6	304.0	18.6	0.0	51,038.2
Western Spruce Bud worm	-	622.7	-	-	-	622.7	-	2.291.1	-	-	-	2.291.1
Western Hemlock Looper	-	-	-	-	-	-	-	469.1	-	-	-	469.1
Forest Tent Caterpillar	-	-	-	-	-	-	-	217.9	700.7	-	-	918.6
Pine Needle Cast	-	-	-	-	-	-	-	-	-	-	-	-
Flooding	-	-	-	-	-	-	-	-	3.6	-	-	-
Drought Mortality	-	-	-	-	-	-	-	-	-	-	-	-
Wildfire	-	-	-	1,560.5	11.5	1,572.0	-	-		70.5	35.4	105.9

Ministry of Forests and Range Aerial Overview Survey.
Bark Beetle Severity Classes - Trace represents < 1% - **Light** 1 to 10% - **Moderate** 11 – 30%, **Severe** 31 to 50% and **Very Severe** > 50% current mortality.
Defoliation Severity Classes – **Light** – some branch tip and upper crown defoliation, barely visible from the air – **Moderate** – thin foliage, top third of many trees severely defoliated, some completely stripped –
Severe – bare branch tips and completely defoliated tops, most trees sustaining >50% total defoliation.

Table 18. Headwaters Forest District Annual Aerial Overview Surveys Summary (2007/08) pertaining only to Mountain Pine Beetle in young pine stands.

Annual Aerial Overview Surveys Summary												
	2007/ha						2008/ha					
Year Assessed/ Affected Area	Trace	Light	Mod	Severe	Very Severe	Totals	Trace	Light	Mod	Severe	Very Severe	Totals
PL - Young only	33.0	844.7	559.8	199.3	437.0	2,073.8	432.9	2,003.8	2,230.9	984.9	368.0	6020.4

Historical overview data collected between 1998 and 2006 is found in appendix IV.

16.0 Budget and Tactical Plan for 2009-2010

The Robson Valley TSA SMUs for 2009/10 are presented in table 19, followed by the 2009/2010 fiscal year budget (table 20 page 49).

Table 19. Robson Valley TSA Special Management Units SMUs for 2009/10.

ROBSON VALLEY TSA SPECIAL BARK BEETLE MANAGEMENT UNITS (SMU) Robson Valley TSA 2009/10					
Zone	Sub-Units-SMU	THLB AREA/ha	STRATEGY BY BEETLE SPECIES		
			IBM		
2	Renshaw-Upper Morkill	41,359	Aggressive		
2	Upper Holmes River	26,060	Aggressive		
5	Upper Hugh Allan	27,610	Aggressive		

The tactics described in section 12 of this report may be applied within bark beetle BMUs within the RV TSA.

Table 20 - Robson Valley TSA 2009/10 Fiscal Year Budget.

Bark Beetle and Forest Health Funding Proposal

IBS - Spruce Beetle

									Single Tree Treatment							
					Detailed Aerial Survey		Ground Survey/Probe – Heli Access		Fall & Burn		Other			Baiting		
Region	District	Industry delivery? (Y/N)	District Ranking	BMU Name	Ha	$	ha	$	trees	$	trees	$	Description	#	$	Total BMU $
RSI	DHW	N	1	Goat/Milk	60,863	9,738.08										
				South Trench	74,154	11,864.64										
				Foster Arm	59,363	9,498.08										
Totals					**194,380**	**31,100.80**	**200**	**20,000.00**								**51,100.80**

51,100.80

IBD - Douglas-fir Beetle

									Single Tree Treatment							
					Detailed Aerial Survey		Ground Survey/Probe – Truck Access		Fall & Burn		Other			Baiting		
Region	District	Industry delivery? (Y/N)	District Ranking	BMU Name	ha	$	ha	$	trees	$	trees	$	Description	#	$	Total BMU $
RSI	DHW	N	1	Rearguard	8,174	1,307.84										
				South Trench	74,154	11,864.64										
				East Kinbasket	29,834	4,773.44										
				Foster Arm	59,363	9,498.08										
Totals					**171,525**	**27,444.00**	**400**	**20,000.00**								**47,444.00**

47,444.00

Other FH Project Work

									Single Tree Treatment							
					Detailed Aerial Survey		Ground Survey/Probe		Fall & Burn		Other			Baiting		
Region	District	Industry delivery? (Y/N)	District Ranking	All BMUs:	ha	$	ha	$	trees	$	trees	$	Description	#	$	Total BMU $
RSI	DHW	N	1	FH Strategy (1) NRL Prep-work.		4,500										**4,500.00**

4,500.00

District Ranking = The BMU's priority as assigned by the district (1 to n) with n = total number of suppression BMUs

Costs for detailed aerial surveying include: aircraft hire, contractor fees, administration costs, equipment and supplies

Costs for ground survey and fall and burn include all aircraft hire including for contract monitoring, contractor fees, equipment and supplies
Costs for baiting include both bait purchase and placement

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Appendix I: 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

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

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. **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.

E. **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

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

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 II: 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, MoFR-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, MoFR-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 can not 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 in table 1.
Table 1:

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		

Individually 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 Forest District (former Robson Valley Forest 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 MOFR 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 III: Emergency Bark Beetle Management Area Declaration, Re-designation and Expanded Units, with Strategic Planning Maps

Appendix IV: Historical Overview (1998 to 2006) of Bark Beetle Activity within the Robson Valley TSA

Historical Overview (1998 to 2004) of Bark Beetle Activity within the Robson Valley TSA.
* Totals reflect the level of funding by year (source-MoFR-data)

Mountain Pine Beetle				**Spruce Beetle**			
Year	**# ha**	**# Trees**	**# Sites**	**Year**	**# ha**	**# Trees**	**# Sites**
1998	312	1,965	288	1998	2,550	9,847	86
1999	673	3,498	517	1999	3,350	14,200	95
2000	1,012	33,808	1,017	2000	11,285	35,251	108
2001	2,015	82,463	2,860	2001	247	6,700	78
2002	1,765	19,074	2,101	2002	114	635	28
2003	3,466	114,126	4,401	2003			
2004	23,678.9[1]			2004	559.4		
Total	**32,921.9**	**254,934**	**11,184**	**Total**	**18,105.4**	**66,633**	**395**
Douglas -Fir Beetle				**Total IBM, IBD & IBS**			
1998	67	1,050	113	1998	**2,929**	**12,862**	**487**
1999	34	284	87	1999	**4,057**	**17,982**	**699**
2000	46	436	90	2000	**12,343**	**69,495**	**1,215**
2001	299	3,159	380	2001	**2,561**	**92,322**	**3,318**
2002	82	765	57	2002	**1,961**	**20,474**	**2,186**
2003				2003 (IBM only)	**3,466**	**114,126**	**4,401**
2004				2004 (IBM & IBS only)	23,678.9		**559.4**
Total	**528**	**5,694**	**727**				

[1]Prior to 2004 the Ministry of Forests and Range used four categories to describe beetle attack across the province; spot, light, moderate, and severe. In 2004 a new category was added called "trace", where beetle trees are not in definite spots, but are located evenly throughout stands at a low level. The new category was added to reflect changing dynamics of beetle population growth and dispersion. This new category was used in order to acknowledge that the mountain pine beetle is now apparent in a great many pine stands at a dispersed low level. The category "trace" gives a good picture of the significant expansion of the beetle population but also the opportunity to manage the beetles. The trace category comprises 8863 ha out of 23,678 ha within the RV TSA. During the 2004 beetle flight 34 spot infestations were also mapped.

Historical Overview Headwaters Forest District Annual Aerial Overview Surveys Summary (2004/05/06)

Annual Aerial Overview Surveys Summary																		
Year Assessed/ Affected Area	**2004/ha**						**2005/ha**						**2006/ha**					
	Trace	Light	Mod	Severe	Very Severe	Totals	Trace	Light	Mod	Severe	Very Severe	Totals	Trace	Light	Mod	Severe	Very Severe	Totals
Mountain Pine Beetle	10,275.6	17,214.6	2,580.3	349.5	508.6	30,928.6	42,948.8	39,199.2	14,437.0	2,122.4	343.0	99,050.4	67,986.7	51,553.2	31,349.6	5,994.2	764.1	157,647.8
Douglas-fir Beetle	63.9	159.3	20.5	0	9.0	252.7	211.8	0	0	0	0	211.8	0	7.3	11.1	0	0	18.4
Spruce Beetle	1.2	400.9	270.0	477.1	1,863.0	3,012.2	5,212.2	2,390.6	1,637.1	717.2	33.3	9,990.4	1,245.1	0	56.6	0	0	1,301.7
Western Balsam Bark Beetle	60,766.9	29,120.7	6,760.5	75.7	0	96,723.8	80,770.1	14,655.4	726.3	0	20.2	96,172.0	34,725.3	15,676.4	186.0	0	0	50,587.7
Two-Year Cycle Budworm	418.8	27,257.7	1,789.6	0	0	29,466.1	-	-	-	-	-	-	N/A	9,480.7	998.3	0	0	10,479.0
Western Hemlock Looper	0	0	22.8	0	0	22.8	0	2,251.1	39.5	0	0	2,290.6	N/A	661.1	22.0	0	0	683.1
Pine Needle Cast	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	4.4	0	0	4.4
Flooding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	5.1	0	5.1
Drought Mortality	0	151.2	0	0	0	151.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wildfire	0	0	0	0	14,802.2	14,802.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	307.9	0	307.9

Ministry of Forests and Range Aerial Overview Survey.

Bark Beetle Severity Classes - Trace represents < 1% **- Light** 1 to 10% **- Moderate** 11 – 30%, **Severe** 31 to 50% and **Very Severe** > 50% current mortality.

Defoliation Severity Classes – **Light** – some branch tip and upper crown defoliation, barely visible from the air – **Moderate** – thin foliage, top third of many trees severely defoliated, some completely stripped –

Severe – bare branch tips and completely defoliated tops, most trees sustaining >50% total defoliation.