Columbia Forest District

2010/2011

Forest Health Strategy

for the

Golden
Timber Supply Area

prepared by:

John Cruickshank, RPF
Stewardship Forester
Columbia Forest District

Kurt Huettmeyer, RPF
Acting District Manager
Columbia Forest District

Date: June 25, 2010

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1.0 INTRODUCTION

The goal of the Forest Health Strategy[1] is to serve as a resource for directing forest health management and for communicating hazards or other relevant information on forest health agents in the Columbia Forest District (DCO) Golden TSA. It provides the tools necessary to improve sustainability and resiliency of forested ecosystems by identifying strategies and tactics to minimize losses from damaging insects, diseases and abiotic disturbances. It will further serve to guide supporting documentation for Forest Stewardship Plans, operational plans, and forest health investments by licensees, BC Timber Sales and the Columbia Forest District through FFT and FIA funded activities.

The responsibility for the development of District Forest Health Strategy was transferred from the Defined Forest Area Management group to the Ministry of Forests and Range (MOFR). This document fulfils the MOFR requirement to prepare a Forest Health Strategy for the Golden TSA.

The *Provincial Forest Health Implementation Strategy* (March 2007) provides guidance for implementing a forest health program. The implementation strategy bridges higher level provincial forest health strategies and the Provincial Forest Health Program with the regional strategies for TSAs. This document provides a template for the content of the Columbia Forest – Golden TSA Forest Health Strategy and describes the roles and responsibilities of the MOFR and licensees.

The mandate of the Ministry of Forests and Range regarding forest health is described in Section 4 of the Ministry of Forest Act:

- **Encourage maximum productivity of the forest and range resources;**

- **Manage, protect and conserve the forest and range resources of the government, having regard to the immediate and long term economic and social benefits they may confer on British Columbia**

This Forest Health Strategy follows the guiding principles that forests should be managed on an ecological basis. This principle is of great importance in the Columbia Forest District as the area contains a diversity of biogeoclimatic zones, with exceptional species diversity as a result. The dominant zones include the Interior Cedar Hemlock (ICH) and the Englemann Spruce Subalpine Fir (ESSF). In the Columbia Forest District, managing forest on an ecological basis requires the inherent species diversity of those forests to be maintained. The timber supply impacts of most forest health concerns in the Columbia can be greatly reduced, if not eliminated, by maintaining tree species diversity in managing stands.

[1]The Columbia Forest District Forest Health Strategy incorporates the approach used by Northwood Timberlands Ltd in the Kalum Forest Health Strategy

This Forest Health Strategy is structured as follows:

1. Describe the objectives of the *Forest Health Strategy* and specific actions necessary to meet the objectives
2. Identify the known forest health factors in the Golden TSA and ranks their relative importance.
3. Describe links to specific strategies and tactics that apply to those factors, and identify and justify any deviations from currently available best management practices.
4. Identify the Beetle Management Unit (BMU) strategies for the mature forest component for IBM, IBD and IBS.
5. Provide the most up-to-date value for non-recoverable losses for Timber Supply Reviews.

Implementing a forest health strategy can augment and stabilize the timber supply of a management unit by increasing the success of regeneration practices, increasing the productivity of immature stands, and decreasing losses of mature timber. These benefits imply a reduced risk to silviculture investment and a more stable planning environment, both of which are important to the MOFR and the timber industry. In addition, ecologically appropriate forest health practices will reduce the risk of wildfire associated with widespread timber mortality, improve public safety in multiple use areas, and lower the risk to non-timber resource values. Establishment of a proactive framework emphasizing the early detection of forest health problems and the prompt implementation of scientifically sound solutions will allow licensees and the MOFR to take full advantage of potential benefits. It will so this by ensuring that expenditures of resources are necessary, efficacious, and cost effective.

This strategy provides a framework to co-ordinate and guide forest health activities within the Columbia Forest District. The current focus of forest health activities is divided between control of pests and abiotic factors (e.g. windthrow), and accounts for only a portion of potential activities.

A comprehensive Forest Health Strategy should incorporate the principles of "Integrated Forest Health Management: (IFHM) to effectively manage the interactions between forest practices and forest health agents impacting on resource objectives, and apply ecologically sound techniques for the protection and enhancement of resource values".

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

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

2.0 TSA DESCRIPTION

The Golden Timber Supply Area (TSA) lies in the East Kootenay area in the southeastern part of the province. The TSA covers 902,000 hectares; it is bounded by the Selkirk and the Purcell Mountains to the west and the Rocky Mountains to the east. It straddles the Rocky Mountain Trench and the Columbia River Valley, which runs through the town of Golden and northward to the Big Bend area near the Mica Dam. The TSA is bordered by five national parks; Kootenay, Yoho, Banff, Jasper and Glacier, as well as Hamber and Cummins Lake Provincial Parks. The Trans-Canada highway passes through the south-central part of the area providing relatively easy access to an area of outstanding mountain scenery. The following 28 Beetle Management Units are included in the Golden TSA. All BMUs follow landscape unit boundaries. This strategy excludes National Parks.

Table 1 BMUs covered by the forest health strategy

BMU#	BMU Name	BMU#	BMU Name
G01	Upper Wood	G16	Blackwater Ridge
G02	Molson/Dainard	G17	Hope/Goodfellow
G03	Lower Wood	G18	Valenciennes
G04	Tsar	G19	Bluewater/Waitabit
G06	Kinbasket	G20	Moberly
G07	Sullivan	G21	Blaeberry
G08	Foster/Garrett	G22	Quartz
G09	Chatter/Prattle	G23	West Bench
G10	Bush River	G24	Canyon
G11	Goosegrass	G25	Mount Seven
G12	Windy/Austerity	G26	Kicking Horse/Beaverfoot
G13	Bachelor	G27	Ice/Moose
G14	Ventego	G28	Kootenay
G15	Esplanade	G29	Swan

Most of the Golden TSA lies in the interior wet belt of the province. The major biogeoclimatic zones include the Interior Cedar Hemlock, Engelmann Spruce-Subalpine Fir, Montaine Spruce, Interior Douglas-fir and Alpine Tundra zones. The dominant tree species is Spruce, occupying 35% of the Timber Harvesting Land Base (THLB); Douglas-fir and Lodgepole pine comprise 40%, cedar and hemlock 17%, and Balsam and deciduous others 17%. About 30% of the stands are over 140 years old and approximately 47% of the stands in the THLB are at or above their minimum harvestable age. Stands between 60 and 100 years occupy a significant portion and will reach minimum harvest age within the next 20 years. Reaching this threshold makes them more susceptible to attack from insects such as bark beetle.

The Golden TSA is characterized by steep mountainous terrain in the north, with gentler and wider valleys in the south. The mountainous environment creates varied climates and growing conditions, resulting in diverse forests. In the more predominant, wetter parts of the TSA, valley bottoms are covered with cedar and hemlock, and stands of

spruce and subalpine fir occupy the higher elevations slopes. The southern portion of the TSA experiences a significantly drier climate and the drier valley bottoms are occupied by Douglas-fir forests, while lodgepole pine is often found at higher elevations.

Throughout the timber supply area, mountain peaks are covered by vast expanses of alpine tundra, rock and ice. Because of the rugged landscape and generally cold, wet climate, only a small portion of the timber supply area is productive forest land. The current area estimated to be economically and environmentally suitable for harvesting – the 'timber harvesting land base' – covers 141,530 hectares. A significant portion of the THLB is unavailable for timber harvesting due to its inoperability, environmentally sensitive areas, unstable soils, steep slopes sites with low timber productivity and problem forest types. Other resource constraints on the land base include but not limited to Ungulate Winter Range, Caribou Habitat, Old Growth Management Areas and Connectivity Corridors.

Bark beetles are posing a significant threat to the management objectives of many of these resources. The Mountain pine beetle (IBM), Douglas-fir beetle and Spruce beetle are classed as priority forest health agents. The susceptible host area for IBM is 163,022 hectares primarily in the southern portion of the TSA. The susceptible host area for IBD is 171,110 hectares again primarily in the southern portion of the TSA. The susceptible host area for IBS is 336,883 hectares covering all of the TSA.

Catastrophic infestations result in millions of dollars of reduced revenue due to timber losses, degraded lumber values, and reduced stumpage values, degradation of non-timber resources, increases in unsalvaged losses and disruptions in forest planning and long – term impacts on resource sustainability. Large scale tree mortality within the Golden TSA could also have negative impacts on recreation, fire hazard, visual quality objectives, fish and wildlife resources, water management and other resource values.

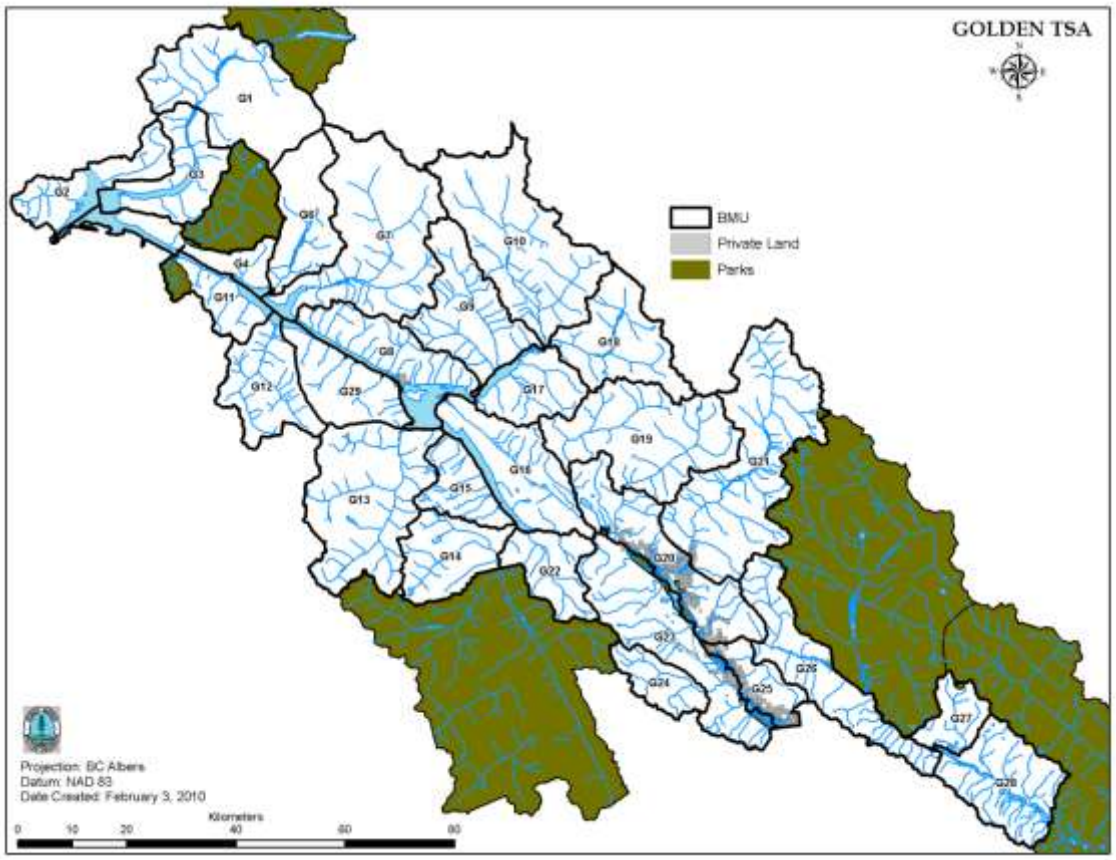

Figure 1 Map of Golden TSA, identifying BMUs, national and provincial parks and private land.

3.0 OBJECTIVE OF THE *COLUMBIA FOREST DISTRICT FOREST HEALTH STRATEGY – GOLDEN TSA* AND ACTIONS REQUIRED AT THE DISTRICT LEVEL

The overall objective for forest health management of all forest health factors is to minimize losses and the hazard and risk from forest health factors.

Objective 1: Maintain a detection program for damaging agents over the landbase.

Columbia Forest District Actions

a) Apply the results of the annual provincial overview survey to prioritize the location and need for detailed aerial and ground surveys within the District. As required, quantify the incidence and intensity of damaging agents to the standard in the appropriate guidebooks.
    - The most damaging forest health agents in the Golden TSA are Mountain pine beetle, Western balsam bark beetle and the Birch leaf miner.
    - Mountain pine beetle infestations are identified on the provincial overview surveys covering vast areas south of the Bush River. As one moves northward the incidence of pine reduces and the infestation levels are smaller. Harvesting and single tree treatments have held the spread of IBM infestations in check over the last five years.
    - Western balsam bark beetle and the Birch leaf miner are identified through the provincial overview survey. The Western Balsam Bark beetle causes significant mortality to subalpine fir leading stands. Given that most of the sites infested are inaccessible and small, the attack dynamics of this insect do not lend themselves to direct control action, therefore no direct strategies have been developed to deal with this forest health factor at this time. As birch is not considered commercially viable species, there have also been no direct strategies developed to deal with this forest health factor.
b) Maintain a record of all survey information for the landbase.
c) Standardize data collection among MOFR and licensees when and where required to facilitate strategic objectives.
d) Improve and refine detection methods in consultation with Regional Forest Health specialists.
e) Ensure forest workers, consultants and industry staff, are competent at identifying specific forest health agents. Training, both formal and informal may be obtained from Regional Forest Health specialists.

Objective 2: Assess current and future stand and landscape level hazard and risk from detected damaging agents, including the impact of forest management practices on resource values.

Columbia Forest District Actions

a) Use the best current information to determine hazard and risk and probable impacts of all detected and potential forest health agents on the landbase.

b) Update existing hazard and risk rating systems as new information becomes available.
c) Develop, support and implement modelling of pest dynamics and impact assessments for Timber Supply Reviews.
d) Evaluate and prescribe approaches to deal with introductions of non-native, potentially harmful organisms.

Objective 3: Identify significant pest risks to resource values and identify appropriate management strategies and tactics, while considering constraints and limitations imposed by other resource management imperatives.

Columbia Forest District Actions

a) Consider all scientifically sound, forest health management strategies and tactics. New strategies and tactics are always being developed but they **must** be reviewed by regional forest health specialists, for scientific validity before being adopted as operational practice.
b) Identify knowledge gaps that limit the ranking and assignment of priorities and hinder identifying appropriate management strategies and tactics. Notify forest managers, licensees and contractors of emerging forest health issues as they are identified.

Objective 4: Implement mitigating strategies and tactics based on scientifically sound forest health management practices.

Columbia Forest District Actions

a) Assign mitigating strategies where deemed appropriate (include prevention, suppression, exclusion, and eradication through direct or indirect control tactics). Forest tenure holders to incorporate the district strategies into operational plans and actively co-operate to work towards meeting the forest health goals and objectives. Wherever economically feasible, direct harvesting efforts to meet those strategic forest health objectives.
b) Quantify the outcome of selected strategies and tactics, including doing nothing (e.g., change in quantified yields or diminished future management options).
    - Columbia Forest District staff has initiated Stand Development Monitoring (SDM) plots in declared free growing blocks within the Golden TSA in 2009 to assess the health and vigor of our plantations after free growing declarations have been approved. Sixteen (16) polygons have been assessed to date.
c) Accelerate implementation of mitigating strategies and tactics to deal with unforeseen outbreaks of damaging agents in a timely manner.

Objective 5: Evaluate results of forest health management practices over the short and long-term and modify practices accordingly.

Columbia Forest District Actions

a) Inspect field practices to ensure forest management objectives are met.
b) Target applied research activities to support scientifically based standards of forest practice on Crown lands.

c) Bring issues of particular concern, where more research could be directed, to the attention of Regional forest health specialists.
d) Apply the results of inspections and monitoring to the development and refinement of future actions. Consider providing a tabular report summarizing the status of the actions indentified in the Forest Health Strategy.
For example:

ACTION	STATUS

4.0 RANKING OF IMPORTANCE OF FOREST HEALTH FACTORS

The priority forest health agents have been ranked following the Provincial Forest Health Strategy (**Table 2**).
Rankings were based on the following factors:

- The collective knowledge of the Regional and District forest health specialists, forest managers, licensees and contractors
- Known or suspected impacts to forest resource values, based on the knowledge of local forest professional and regional forest health specialists
- 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 pest and current incidence levels
- Resources required to obtain missing information necessary for management of the pests

The rankings are somewhat subjective, so an additional approach is to consider what the impact of the forest health factor would be equivalent to in terms of area. This approach provides a useful perspective to the rankings and generally applies as follows:

- Very High: a forest health factor that could result in damage equivalent to the loss of >400 ha per year
- High: loss of 200 – 400 ha per year
- Moderate: loss of 100 – 200 ha per year
- Low: loss of 50 – 100 ha per year
- Very Low: very little or no known damage (<50 ha per year)

Note: abiotic injuries (i.e. windthrow, flooding) are not ranked, as the severity can change with each event. Also note that not all forest health factors are ranked, only the more significant pests within the Golden TSA.

Table 2 Ranking of forest health agents by potential impact on forest management activities in the Golden TSA.

Very High	High	Moderate	Low
Defoliators			
Birch leaf miner		Western hemlock looper	Black army cutworm Forest tent caterpillar
Diseases			
		Armillaria root disease Hard pine rusts	White pine blister rust
Insects			
Mountain pine beetle Western balsam bark beetle		Spruce weevil	Northern pitch twig moth Douglas-fir beetle Spruce beetle
Mammals			
		Voles Bear	Moose Deer
Abiotic Factors			
	Fire		Windthrow

Table 3 records the amount (hectares) of the forest health agents found from the provincial aerial overview survey for 2009 and gives the incidence of each forest health agent for the four years prior.
Figure 2 shows the spatial significance of each forest health agent found in the 2009 provincial aerial overview survey.

Table 3 Primary forest health agents recorded during the aerial overview survey 2005-2009 (excluding incidence in National Parks) on the crown forested land base.

Forest Health Agents	**Common Name**	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Golden TSA							
IBM	Mountain pine beetle	35,570	11,781	6,409	12,056	4,359	**70,175**
DF	Foliage Diseases					71	**71**
DFH	Larch needle cast					270	**270**
IBD	Douglas-fir beetle	4	0	0	158	14	**176**
IBS	Spruce beetle	154	161	28	0	0	**343**
IBB	Western balsam bark beetle	6,364	1,650	3,496	2,327	2,052	**15,889**
IBF	Fir engraver beetle	23	0	0	0	0	**23**
ID	Defoliators	0	4	0	0	0	**4**
IDA	Black army cutworm	0	453	0	0	0	**453**
IDH	Western blackheaded budworm	82	950	66	0	0	**1,098**
ID6	Birch leaf miner	0	874	0	0	935	**1,809**
NB	Fire	2,516	805	457	0	317	**4,095**
NF	Flooding	0	8	4	0	7	**19**
NS	Slide	35	0	0	49	3	**87**
NW	Windthrow	13	2	62	0	13	**90**
	Totals	**44,761**	**16,688**	**10,522**	**14,590**	**8,041**	

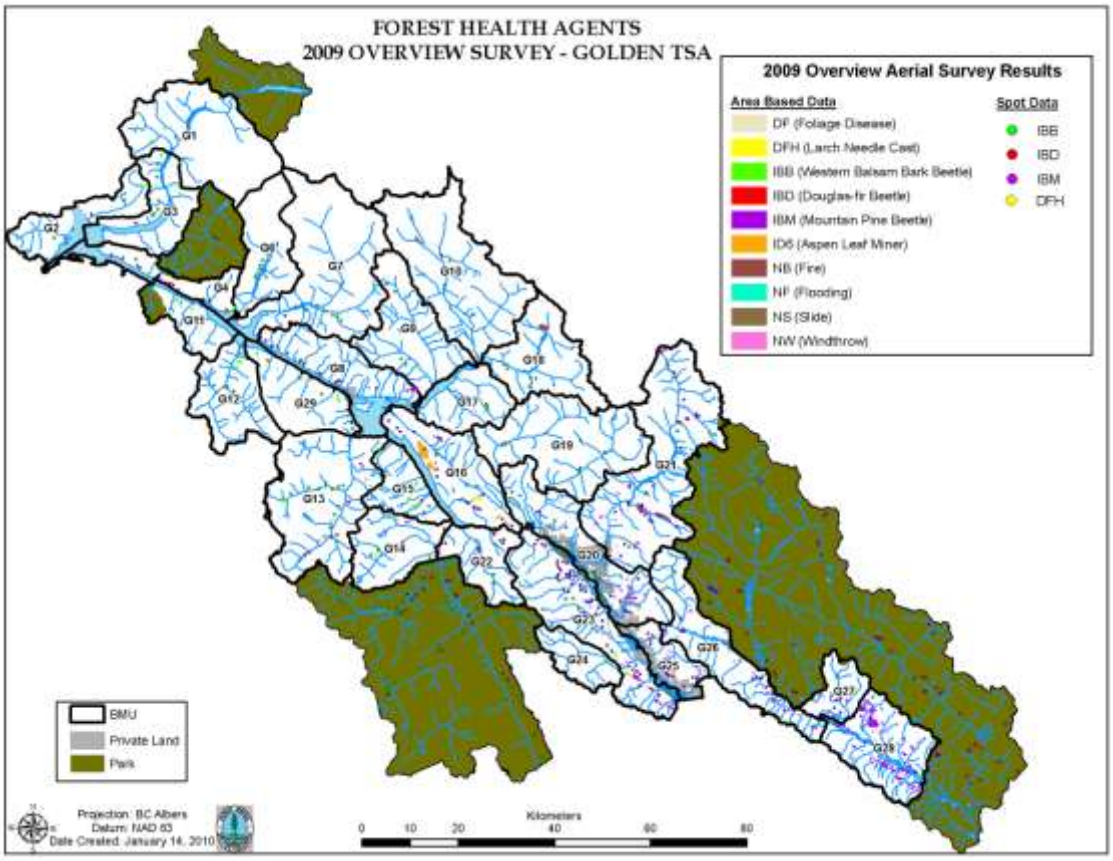

Figure 2 2009 Provincial Aerial Overview Survey results by forest health agent for the Golden TSA

5.0 STRATEGIES AND TACTICS

This section summarises the strategies and tactics to be used for the forest health factors identified in the Forest Health Strategy, and is organized as follows:

Current Status: Provides a one-word description of the current state of the Forest Health Factor (FHF) in the Columbia Forest District.

- Endemic: The FHF is at its natural (generally low) level of influence on forest health.
- Building: The influence on forest health by the FHF is increasing,
- Outbreak: The FHF has grown in influence and is (or is at significant risk of) causing a high level of damage.
- Declining: The FHF was at a high level and is now diminishing in importance.

Management Strategy: Provides a two word description of the strategy.

- Do nothing: No strategy as the FHF is of minimal concern.
- Passive Monitoring: The FHF does not necessitate or lend itself to direct monitoring, so use overview flights, anecdotal information gathered in silviculture surveys, etc. Passive monitoring generally is not focused on a specific FHF.
- Active Monitoring: Specifically monitor the FHF.
- Indirect Action: Actions that treat the results of the FHF (e.g. salvage of trees killed by a FHF)
- Direct Action: Treatments that focus on the FHF itself (e.g. stump removal to eliminate a root disease)

Tactics: Describes the planned tactic in just a few words.

TSR Implication: Application to short term, mid-term or long term timber forecasting.

A discussion of the Forest Health Factor then provides more information.

5.1 DEFOLIATORS

Western hemlock looper *(Lambdina fiscellaria lugubrosa)*

Current Status: Building
Management Strategy: Active Monitoring
Tactics: Overview flights, 3 Tree beatings, Funnel traps
TSR Implication: Short term timber supply

The last outbreak of Western hemlock looper occurred in 2002-2003, defoliating approximately 16,000 hectares of forest land north of Revelstoke and the northern portion of the Golden TSA north of Mica at Kinbasket Lake. The preferred host of the looper is western hemlock followed by sub-alpine fir, western red cedar and white spruce and found primarily in mature and overmature hemlock and hemlock-cedar stands. Looper outbreaks run on a 10 year cycle, the 2009 overview survey and yearly ground sampling by our regional entomologist are showing that the looper defoliation is starting to build. The next full outbreak is anticipated to occur between 2012 and 2014.

Birch leaf miner *(Fenusa pusilla)*

Current Status: Building
Management Strategy: Do Nothing
Tactics: N/A
TSR Implication: N/A

Birch leaf miner has been noted in many areas within the Golden TSA. It has been identified on the annual aerial overview survey sporadically over the TSA the last 5 years. Currently this foliar disease is not being managed though the presence of foliar diseases and climate change could impose constraints on future management.

Black army cutworm *(Actebia fennica)*

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Silviculture surveys
TSR Implication: Long term timber supply

The Black army cutworm hazard is highest when a site is burnt in the spring and no herbaceous food source is available. Most mortality occurs among those seedlings that are more than 60% defoliated. Hosts are Spruce, lodgepole pine, western larch, Douglas-fir and trembling aspen with Douglas-fir and Spruce being highly susceptible and lodgepole pine being relatively resistant to damage. The number of blocks broadcast burnt in recent years has been relatively low in the Golden TSA.
For blocks burned in the spring (May-June) of the previous year, one should try to delay planting until most cutworms have pupated. This allows seedlings 1 year to establish before being subjected to attack; sites also gain an additional summer to "green-up" and provide cutworms with alternative food sources. If cutworm damage is expected when seedlings are planted, the simplest and fastest approach is to plant on moist sites as early as possible in the spring; on sites where significant moisture stress is expected, or delay planting for 1 year.

Forest tent caterpillar *(Malacosoma disstria)*

Current Status: Endemic
Management Strategy: Do nothing
Tactics: N/A
TSR Implication: N/A

The Forest tent caterpillar has been noted in many areas within the Golden TSA. Primarily trembling aspen is attacked though black cottonwood and paper birch have also been attacked in the TSA. This is a defoliator that attacks deciduous species; our management strategy is to nothing.

5.2 DISEASES

Armillaria root disease *(Armillaria ostoyae)*

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Overview flights, Silviculture surveys
TSR Implication: Long term timber supply

Armillaria root disease (DRA) is known to occur in a high proportion of the stands in the ICH. The root disease causes considerable losses in immature stands by killing natural and planted coniferous trees. Tree mortality usually begins about 5-7 years after stand establishment, peaks around age 12, and then declines, although mortality can continue throughout a rotation. On the roots of older trees, repeated non-lethal infections will result in growth loss. The disease also increased the susceptibility of trees to attack by other pathogens and insects. DRA poses a long-term threat to forest productivity and sustainable forest management because current silviculture practices increase the amount and potential of Armillaria inoculums and put regenerated or residual trees at risk of becoming infected. This threat can be moderated by planting trees that are more resistant to Armillaria or modifying silviculture practices to minimize exposure of trees to Armillaria inoculums in managed, second-growth stands.

Host Susceptibility Table (from *British Columbia's Southern Interior Forests*: Armillaria Root Disease Stand Establishment Decision Aid (2008))

Species	IDF	MS	ICH	ESSF
Fd	H	H	H	-
Bl	-	H	H	H
Bg	H	-	H	-
Hw	-	-	H	H
S	M-H	M-H	M-H	M-H
Py	M	-	M	-
Pw	-	-	M	-
Pl	M	M	L	M
Lw	L	L	L	-
Cw	L	-	L	L
Ep	L	L	L	-
At	L	L	L	L
Ac	L	L	L	L

White pine blister rust *(Cronartium ribicola)*

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Overview flights, Silviculture surveys, planting of resistant stock
TSR Implication: Long term timber supply

The primary hosts of White pine blister rust are western white, limber and whitebark pine. Alternate hosts include most species of *Ribes* (currants and gooseberries). Trees of all ages can be infected but mortality occurs most rapidly on juvenile trees. This non-native fungus is an obligate parasite and only occurs on 5-needle pines. It has essentially removed western white pine from use in reforestation and threatens to eliminate whitebark pine from high elevation sites. If reforesting a site with white pine, resistant planting stock should only be considered.

Hard pine rusts

Cronartium comandrae (Commandra blister rust), ***Cronartium coleosporioides*** (Stalactiform blister rust), ***Endocronartium harknessii*** (Western gall rust)

Current Status: Endemic
Management Strategy: Do Nothing
Tactics: N/A
TSR Implication: Mid to Long term timber supply

Hard pine rusts are a minor concern in the pine plantations south of the Bush Arm.

5.3 INSECTS

Mountain pine beetle *(Dendroctonus ponderosae)*

Current Status: Epidemic
Management Strategy: Active Monitoring
Tactics: Overview flights, Detailed aerial flights, ground probe surveys, fall & burn treatments, active harvesting
TSR Implication: Short term timber supply

Mountain pine beetle (IBM) has been ranked as the number one priority; it is considered to be the most destructive pest in the Golden TSA. Epidemic population levels are present throughout the southern portions of the TSA, aggressive action is being undertaken in efforts to control and minimize damage to susceptible pine forests. Harvesting has targeted the Kootenay, Ice/Moose, Kickinghorse, Blaeberry, Moberly and West Bench BMUs in recent years though dependent on market conditions. Presently ground probe surveys and fall and burn treatments have targeted the West Bench, Blaeberry and Morberly BMUs, primarily the northern BMUs in the TSA. The Blackwater BMU is being monitored for IBM activity due to the large amount of maturing pine in the Sue Fire. Green to red ratios from the fall of 2009 show the Blaeberry/Moberly BMUs with values averaging 1.9 (increasing) and the West Bench BMU with values averaging 1.1 (static). Continuation of ground probes and fall and burn treatments in the future will be dependent on receiving funding for detailed aerial surveys. Presently budgets are being squeezed and areas for treatment are being determined by priority on the provincial level.

Western balsam bark beetle *(Dryocoetes confuses)*

Current Status: Building
Management Strategy: Active Monitoring
Tactics: Overview flights
TSR Implication: Short term timber supply

Populations of western balsam bark beetle have occurred throughout the range of sub-alpine fir within the Golden TSA. Given that most of the sites infested are inaccessible and small, the attack dynamics of this insect do not lend themselves to direct control action, therefore no direct strategies have been developed to deal with this forest health factor at this time.

Douglas-fir beetle *(Dendroctonus pseudotsugae)*

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Overview flights
TSR Implication: Short term timber supply

Large outbreaks of Douglas-fir beetle have not been recorded in the Golden TSA likely due to the widespread occurrence of mixed species stands. Over the last four years, the provincial aerial overview survey has identified a low incidence of Douglas-fir beetle throughout the TSA.

Spruce beetle *(Dendroctonus rufipennis)*

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Overview flights
TSR Implication: Short term timber supply

Spruce beetle outbreaks have occurred sporadically in the past though nothing has been noted in recent years in the Golden TSA.

Spruce weevil *(Pissodes strobe)*

Current Status: Endemic
Management Strategy: Indirect Action
Tactics: Stocking Standards
TSR Implication: Short term timber supply

Spruce weevil is an insect that will repeatedly attack and will the leader of spruce trees, causing poor form and reduced growth. Spruce weevil is currently a medium to low priority issue overall, but in plantations that contain a large proportion of spruce seedlings; it is a medium to high priority. The best method of dealing with this insect is to ensure that there is a good species mix on the site.

5.4 MAMMALS

Voles

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Silviculture surveys
TSR Implication: Long term timber supply

Voles are a reoccurring issue in the Golden TSA. Some areas are experiencing extensive damage such as the Glenogle, Beaverfoot, and Blaeberry areas annually whereas other areas appear to be on a four year cycle. Vole research treatments have included various types of repellants, guards and feeding station establishment consisting of a sunflower mix in areas where annual populations reside eg. Glenogle and Redburn Valley.
Other things to consider when harvesting in known vole areas are:

- using alternative silvicultural systems – green-tree retention (Douglas-fir, spruce) wherever possible, avoid contiguous clearcut units,
- enhance habitat for predators and predation – increase the number of debris piles will increase small carnivores, increase the amount of snags and shrub trees will increase birds of prey,
- avoid the use of seeding of pasture grasses – use alternative shrub species (alder, willow) for erosion control,
- tree species selection/planting regime – plant spruce, subalpine fir, or larch where possible – all are relatively unpalatable to voles compared with lodgepole pine and Douglas-fir, plant more trees per ha to accommodate expected damage, use larger stock where possible, nursery seedlings with reduced fertilization regime and tree guards,
- and provide a diversionary food source.

Bear

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Silviculture surveys
TSR Implication: Long term timber supply

Bear damage is not easily identified by the overview survey as only red attack trees are identified; ground checks are required to positively identify the cause of death. Bear damage has been identified at the free growing survey stage and in a number of blocks where Stand Development Monitoring (SDM) plots have been established in the Golden TSA. Trees that are pole sized are usually attacked though occasionally saplings are damaged. Damage is caused by bears feeding at the base of trees, removing the bark and feeding on the sap in the early spring shortly after and bears have come out of hibernation. Rapidly growing, vigorous trees in moderately to lightly stocked stands are preferred. Stands that have been juvenile spaced appear to have a greater incidence of bear damage than stands that have not been spaced. Bear damage has been identified in stands in the area of the Sue Fire and southward to the Golden/Invermere TSA boundary.

Deer, Moose

Current Status: Endemic
Management Strategy: Passive Monitoring
Tactics: Silviculture surveys
TSR Implication: Long term timber supply

Deer and moose populations and the potential damage their feeding can cause, are cyclical: natural predation will generally control the population before human strategies can be enacted. In the future, as moose populations increase, and second growth forests become harvestable, moose browse on plantations may become an issue. Currently these pests are of low concern.

5.5 ABIOTIC FOREST HEALTH FACTORS

Windthrow

Current Status: Endemic
Management Strategy: Passive Monitoring; Indirect Action
Tactics: Overview flights; Block design; Salvage
TSR Implication: Short to Mid-term timber supply

Overall, damage as a result of wind can cause significant forest loss in the Golden TSA. The geography of the area consists of many narrow valleys that drain cold air from higher elevations and flow into the Columbia River drainage: this concentrates air flows and creates turbulence pockets both of which can result in increased wind speeds. Strategies for managing windthrow risk include considering dominant wind patterns when establishing the boundaries for harvest areas, and, in rare cases where there are high values at risk and forested areas that are not overly decadent, feathering the edges of harvest blocks by selectively removing trees and retaining the more wind-firm stems. Since management strategies cannot account for unpredictable storm winds, aerial overview survey data will identify new patches of windthrow and can be evaluated for salvage potential. Whenever reasonable, windthrown timber is salvaged within a short time from discovery so that bark beetle infestation levels are minimized.

Fire

Current Status: Endemic
Management Strategy: Indirect Action; Direct Action when it occurs
Tactics: Fire Prevention Plans; Firefighting
TSR Implication: Short, Mid and Long term

In recent history, fire has not been a major concern in the Columbia Forest District. Nonetheless fire has the greatest potential to damage the most forest area in the shortest time. Due to this fact, internal fire response plans are prepared by all forest licencees and the Ministry of Forests and Range. These documents address details of fire prevention and fire management.

6.0 ROLES AND RESPONSIBILITIES

The Ministry of Forests and Range has the responsibility for managing the forest health program in the province. Licensees, BCTS, and government agency reviewers collaboratively undertake implementation of this strategy.

1. Meetings are held on an as-needed basis to discuss the implementation and effectiveness of this strategy. Meetings are to be co-ordinated through the Columbia Forest District Steering Committee.
2. MoFR completes aerial overview surveys in the late summer and provides the resulting information to the licensees. The 2009 results are located on the regional and provincial websites. www.for.gov.bc.ca/rsi/ForestHealth/Aerial_Surveys.htm
3. Detailed aerial surveys and ground probe surveys are the responsibility of MoFR and licensees as decided through the collaborative effort and as per available funding. Detailed aerial survey results are posted on the DCO Forest Health FTP site when completed. http://www.for.gov.bc.ca/ftp/DCO/external/!publish/
4. Single tree removal/disposal, trap tee placement/removal and larger scale treatments are the responsibility of MoFR and licensees as decided through the collaborative effort.
5. The MoFR will pursue additional funding opportunities to undertake trap-tree programs, ground surveys, and small-site treatments in areas designated as "suppression" for Douglas-fir beetle and Spruce beetle.
6. Specific roles for monitoring, reporting and consolidation of information are determined via the meetings mentioned above.
7. Assessment of hazard and risk information is carried out by the MoFR and provided to licensees and other agencies as requested. http://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Bark%20Beetle%20Susceptibility%20Ratings/

Table 4 Roles and responsibilities for the implementation of the Golden TSA Forest Health Strategy in mature timber types.

Action	Completion Date	Responsibility		
		Region	District	Licensee
Preparation of TSA Strategy Document	February/ March		X	
Aerial Overview Survey (all forest health agents)	August	X		
Detailed Aerial Survey (forest agents in suppression units)	September		X	X
Ground Surveys/Probes (forest agents in suppression units)	December		X	X
Single Tree Treatment/ Bait and Trap Tree (Bark beetles)	January to March		X	X
Monitoring, Reporting and Consolidation of Information (all forest health agents)	Ongoing	X	X	X
One on One Communication (with licensees, forest managers, consultants, specialists)	Ongoing		X	X
Aerial Spray Program (defoliators)	May-June	X		
Hazard and Risk rating (IBD, IBS and IBD)	Maps available on FTP site	X		
Overwintering Mortality Surveys (IBM)	February and March	X		
Updates and Revisions to the TSA Forest Health Strategy document	January and February of following year		X	
Sign-off by District Manager of Updated Forest Health Strategy	March 31st		X	

7.0 BMU STRATEGY FOR IBD, IBS AND IBM

Table 5 BMU Strategy by beetle: IBM, IBS, IBD for 20010/2011 for the Golden TSA

BMU	BMU Name	Bark Beetle		
		IBM	IBS	IBD
G01	Upper Wood	Monitor	Monitor	monitor
G02	Molson/Dainard	Monitor	Monitor	Monitor
G03	Lower Wood	Monitor	Monitor	Monitor
G04	Tsar	Monitor	Monitor	Monitor
G06	Kinbasket	Monitor	Monitor	Monitor
G07	Sullivan	Monitor	Monitor	Monitor
G08	Foster/Garrett	Monitor	Monitor	Monitor
G09	Chatter/Prattle	Monitor	Monitor	Monitor
G10	Bush River	Monitor	Monitor	Monitor
G11	Goosegrass	Monitor	Monitor	Monitor
G12	Windy/Austerity	Monitor	Monitor	Monitor
G13	Bachelor	Monitor	Monitor	Monitor
G14	Ventego	Monitor	Monitor	Monitor
G15	Esplanade	Monitor	Monitor	Monitor
G16	Blackwater Ridge	Suppression	Monitor	Monitor
G17	Hope/Goodfellow	Monitor	Monitor	Monitor
G18	Valenciennes	Monitor	Monitor	Monitor
G19	Bluewater/Waitabit	Monitor	Monitor	Monitor
G20	Moberly	Suppression	Monitor	Monitor
G21	Blaeberry	Suppression	Monitor	Monitor
G22	Quartz	Monitor	Monitor	Monitor
G23	West Bench	Suppression	Monitor	Monitor
G24	Canyon	Monitor	Monitor	Monitor
G25	Mount Seven	Suppression	Monitor	Monitor
G26	Kickinghorse/Beaverfoot	Suppression	Monitor	Monitor
G27	Ice/Moose	Holding	Monitor	Monitor
G28	Kootenay	Holding	Monitor	Monitor
G29	Swan	Monitor	Monitor	Monitor

8.0 NON-RECOVERABLE LOSSES

Non-recoverable losses (NRLs), or unsalvaged losses, are the amount of volume lost annually to damaging agents that is not harvested. This represents losses above and beyond those already accounted for in existing growth and yield models, often as a result of unpredictable events. These losses can be both incremental losses (e.g. defoliation, defect) and mortality. NRLs are generally subtracted from yield projections.

The majority of NRLs are generally the result of abiotic factors like wind and fire. Catastrophic or sustained events (e.g. prolonged defoliation) or those which are not well-

suited to either OAF (e.g. drought, windthrow) may also qualify. The most recent NRL estimates for the Golden TSA are provided in **Table 6**.

Table 6 Summary of non-recoverable (unsalvaged) losses by damaging agent and percent of AAC affected as accounted for in TSR4.

TSA (effective date)	Fire m^3	Wind m^3	Pests m^3	Total m^3	Current AAC m^3	% of AAC
Golden TSA TSR4 (2009)	5,702	525	1,400	7,627	485,000	1.6

9.0 CONCLUSION

This Forest Health Strategy provides strategic direction for the licensees and the Ministry of Forests and Range in the Columbia Forest District – Golden TSA. Specific practices conducted by each licensee should fall within the strategic direction provided within this document.

Periodic review of the Forest Health Strategy will allow adaptive management principles to be used. The plan is to reviews on an annual basis will ensure forest managers regularly turn their minds to other potential sources of damage or risk to the forest.

With the effects of climate change and the unforeseen impacts that this will have on forest health, it will be important to recognize changing environmental conditions and predict the effect that this will have on the management of forest ecosystems. Forest managers will need to assess the suitability of other non-native species as well as how current species will respond to changing climatic conditions.

Forest managers will need to evaluate stocking standards that will develop genetically diverse forests of mixed species that will be healthier and less susceptible to the infection and spread of forest health factors.

The active co-operation of licensees and the MOFR in working together to promote and manage healthy forests through diversity, early detection of forest health issues, and direct action as required, will ensure a sound and sustainable industry

APPENDIX 1: SOURCES OF INFORMATION

A Field Guide to Forest Damage in British Columbia (2001). Henigman, J., Ebata, T., Allen, E., Holt, J., and Pollard, A., Joint Publication Number 17. BC Ministry of Forests and Canadian Forest Service.

A Susceptibility and Risk Rating System for the Douglas-fir Beetle in British Columbia (2000). Safranyik, L. and Shore, T., Version 9. For. Can., Pac. For. Cen., 3 p. http://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Bark%20Beetle%20Susceptibility%20Ratings/2006/Douglas-fir%20beetle/

A Susceptibility and risk rating systems for the mountain pine beetle in lodgepole pine stands (2005). Safranyik, L. and Shore, T., For. Can., Pac. For. Cen., Inf. Rep. BC-X-336. 12 p. http://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Bark%20Beetle%20Susceptibility%20Ratings/2006/mountain%20pine%20beetle/

A Susceptibility and Risk Rating System for Spruce Beetle Dendroctonus rufipennis. Safranyik (1999), L. and Shore, T., Version 5. Canadian Forest Service. Pacific Forestry Centre. Victoria, BC. http://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Bark%20Beetle%20Susceptibility%20Ratings/2006/spruce%20beetle/

Arrow TSA Forest Health Strategy 2008/2009, Ministry of Forests and Range.

British Columbia's southern interior forests: *Armillaria Root Disease Stand Establishment Decision Aid* (2008). Cleary, M., van der Kamp, B., Morrison, D., Extension Note, *BC Journal of Ecosystems and Management* 9(2):60-65.

Common Tree Diseases of British Columbia (Web version). Canadian Forest Service – Pacific Forestry Centre website http://www.pfc.cfs.nrcan.gc.ca/diseases/CTD/index_e.html

Extension Note,
Forest and Range Practices Act, Guidebooks: Ministry of Forests and Range, website: http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm

- Bark Beetle Management Guidebook(1995)
- Defoliator Management Guidebook (1995)
- Generic Forest Surveys Guidebook (2001)
- Pine Stem Rust Management Guidebook (1996)
- Root Disease Management Guidebook (1995)
- Tree Wound and Decay Guidebook (1997)

Forest Health Aerial Overview Survey website. Forest Practices Branch, Ministry of Forests and Range; website: http://www.for.gov.bc.ca/hfp/health/overview/overview.htm

Golden Timber Supply Area – TSR3 Analysis Report (2009), Ministry of Forests and Range, Victoria, BC.

Golden Timber Supply Area – TSR3 AAC Rationale (2009), Ministry of Forests and Range Victoria, BC.

Kamloops TSA Forest Health Strategy March 2007, Ministry of Forests and Range.

Merritt TSA Forest Health Strategy 2007/2008, Ministry of Forests and Range.

100 Mile House Forest Health Strategy 2007/2008, Ministry of Forests and Range.

Okanagan Shuswap Forest District Forest Health Strategy 2007, Ministry of Forests and Range.

Spruce Leader Weevil Hazard Rating for British Columbia (2008), Campbell, K., Hawkins, C., Ministry of Forests and Range, Nelson, BC.

TSA Forest Health Strategy Template.
http://www.for.gov.bc.ca/hfp/health/fhdata/template.htm

Personal Communication:

Arnett, T., Louisianna-Pacific Ltd., Golden, BC.

Doebert, D., Downie Street Sawmills Ltd., Revelstoke, BC.

Gribbon, P., BC Timber Sales, Ministry of Forests and Range, Revelstoke, BC.

King, S., Louisianna-Pacific Ltd., Golden, BC.

MacLauchlan, L., Regional Entomologist, SIFR, Ministry of Forests and Range, Kamloops, BC.

McCleary, M., Regional Pathologist, SIFR, Ministry of Forests and Range, Kamloops, BC.

Mohr, R., BC Timber Sales, Ministry of Forests and Range, Revelstoke, BC.

Stock, A., Regional Entomologist, SIFR, Ministry of Forests and Range, Nelson, BC.

APPENDIX 2: BARK BEETLE OBJECTIVE, STRATEGY AND TACTICS

Background

Due to the diversity of forest types, all major tree-killing bark beetle species pose a threat to the forests of the Golden TSA. The main threat comes from Mountain pine beetle and then to a lesser degree Spruce beetle, Douglas-fir beetle and Western Balsam Bark beetle.

Priority and strategy assignment occurs on two levels: broad provincial zonations and landscape level beetle management units (BMUs). Information that is used to determine the status of forest health agents is provided by the MOFR via the annual aerial overview survey and by reports from licensees, regional, district and branch forest health specialists and district staff.

Management Objectives for IBS, IBD and IBM

The following are the management objectives to be implemented for the three main bark beetles in the Golden TSA: Spruce beetle and Douglas-fir beetle and Mountain pine beetle.

- Identify and prioritize bark beetle infestations the TSA;
- Identify the risk posed by bark beetles using susceptibility mapping;
- Reduce the spread of bark beetles;
- Salvage beetle killed areas where economically feasible
- Manage the age class structure of susceptible timber types by focusing on mature/over mature forest types;

Bark Beetle Management Zones

The Province is broken down into broad management zones within a defined Emergency Bark Beetle Management Area (EBBMA). Provincial bark beetle management zones allow rational allocation of resources to support aggressive actions in areas where management will have the greatest impact. The Province's beetle infested areas are divided into three broad "provincial bark beetle management zones" based on several parameters (i.e. level of attack, distribution of attack, susceptible stands remaining, age of outbreak, etc) that relate to the likelihood of successful management. The three management zones are:

- Aggressive Management - beetle populations are managed down to endemic levels;
- Containment – populations are held static; and
- Salvage/Limited Activity – minimal active management of beetle populations.

The tactics are:

- Aggressive and Containment Emergency Management unit: all forest health treatments including harvesting may be used to control the infestation.
- Sanitation Emergency Management unit: harvesting is the primary forest health treatment used against the infestation.

Emergency Bark Beetle Management Areas (EBBMA)
The Provincial Bark Beetle Coordinator updated the provincial zonations for Mountain pine beetle, Douglas-fir beetle and Spruce beetle in January of 2010. The designation followed examination of the 2009 provincial aerial overview data as well as consideration of management objectives.

Strategies

Within each broad bark beetle management zone are individual Beetle Management Units (BMUs). BMUs are planning and reporting units for operational beetle management. These BMUs usually coincide with landscape unit boundaries. This strategy includes twenty-eight (28) BMUs in the Golden TSA. For each bark beetle, the BMUs have been assigned one of four specific strategies. These strategies are:

1. **Suppression** – (includes Prevention), this is the most aggressive strategy. It is selected when the infestation status is such that aggressive direct control actions are expected to keep an area at a low level of infestation. Areas are lightly infested, and resources for direct control or harvesting and milling capacities equal or exceed the amount of infestation. The intent of the strategy is to reduce or keep the outbreak to a size and distribution that can be managed within "normal resource capability".

2. **Holding Action** – The intent of this strategy is to maintain an existing outbreak at a static level. It is a delaying strategy until adequate resources are available, or access is created that allow for a more aggressive approach, or to reduce overall loss while waiting for a killing climatic event. This is appropriate in areas with chronic beetle infestations that are too large to deal with using single tree treatments or where access is poorly developed for directed harvesting.

3. **Salvage** – Applied to areas where management efforts would be ineffective in substantially reducing the beetle populations and subsequent levels of damage. Such areas have extensive outbreaks covering a large proportion of susceptible stands. The objective in this case is to salvage affected stands and minimize value loss.

4. **Monitor** – This strategy is applied to areas where management efforts would be ineffective in substantially reducing the beetle population and subsequent levels of damage, or where there is no short term (less than 5 years) possibility of salvaging dead timber. This may be due to management constraints such as wilderness area, Park or ecological reserve, or because access cannot be put in place before substantial merchantable degradation of the dead material occurs.

Strategies are selected biannually based on the level of outbreak in an area, stand susceptibility rating, accessibility, beetle pressure from surrounding areas and the estimated effectiveness of management actions in achieving the strategy objective and

performance measure. Potential constraints to meeting objectives are considered when assigning strategies within the TSA. Examples of constraints are: conflicting resource values, operability, economic feasibility and harvest and treatment capacity. The implementation of a particular strategy in a BMU represents a commitment on the part of forest licensees and forest districts to work towards a measurable goal or performance measure prior to the next beetle flight.

Table 7 Provincial control strategies and associated objectives for beetle population removal.

Strategy	**% of current infestation to treat**	**Comments**
Suppression/ Prevention	>80%	Address all current attack within two years. The intent is to "control" the outbreak in the area and stop the spread.
Holding	50-79%	Address the largest population of the new infested material, at least close to the rate of expansion. The intent is to maintain beetle populations at a level that can be dealt with annually without a huge expansion.
Salvage	<50%	The priority is to salvage timber previously attacked to minimize value loss. Relevant in areas where suppression or holding actions are no longer appropriate or feasible.
Monitor	0	No action is required beyond monitoring and recording. This is most appropriate in Parks and Ecological Reserves and in inoperable areas where the outbreak has peaked, salvage is not possible, and there is no chance for any mitigation of further loss.

Tactics

A variety of treatment options are presently available. Most are used in combinations or in phases lasting up to several years. Wherever possible the utilization of tree fibre in conjunction with beetle population reduction is the preferred treatment. The following list identifies the common tactics used in the Golden TSA. *The Bark Beetle Management Guidebook* contains a more comprehensive list of possible tactics and treatments. Tactics must be appropriate for the strategy used to manage the area and must be consistent with other resource management objective (e.g. community watersheds or protected areas).

- **Detection:** Infestation presence and intensity may be assessed by aerial overview flights, detailed aerial surveys and by ground detection (walkthrough recces and detailed probes).
- **Prediction/Monitoring:** Hazard (susceptibility) and risk rating, overwintering mortality studies and green to red ratio calculations may be used to predict the size and potential location of future populations. Baited Lindgren funnel traps may be used as a flight monitoring tool for mountain pine beetle.

- **Harvesting:** Harvesting may be divided into 3 categories: sanitation, salvage, and high hazard host removal. This includes small patch and single tree selection in suppression BMUs and the direction of small scale salvage and SNRFL priorities into suppression BMUs.
- **Single Tree Treatment:** This tactic includes small patch and single tree selection, fall and burn, debarking and helicopter logging. MSMA is no longer to be used as a bark beetle management tool by the Ministry of Forests and Range.
- **Baiting and trap trees:** Aggregation semiochemicals (MCH) or the intentional creation of patches of preferred host may be used to contain and concentrate beetle population in an area where harvesting or other treatments are planned and access is available.
- **Hauling restrictions and log yard management:** 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. Restriction may be implemented during beetle flights if points of destinations are located within infested, high hazard drainages. Due to the level and distribution of the mountain pine beetle, hauling restrictions are not in place in this TSA. The goal of logyard management is prompt manufacturing of delivered logs during the beetle flight.
- **Access Planning/Development:** Access planning/development is important for short and long term management of the mountain pine beetle i.e. road building into high value and/or high hazard stands.
- **Beetle Proofing:** Through stand manipulation, this tactic may reduce the attractiveness of a stand to the mountain pine beetle. Suitable stands must be chosen and host removal uses all-age or even-age partial cutting. Verbenone is a major ingredient of the anti-aggregation pheromone of the mountain pine beetle. Although not practical for large-scale applications, verbenone may be used as part of an integrated pest management program in specific situations such as on private property or high value recreation sites where attacks by the beetle are likely.
- **Silviculture treatments:** Silviculture treatments such as species and age class manipulation on a landscape level with the reduction of large, continuous areas of mature and over-mature forest types (that have been the result of activities such as fire suppression), in order to reduce the level of future damage to the forest. Requires a long-term focus and is arguably the most effective long-term proactive prevention tactic.

Timely use of appropriate tactics, considering the biology of the pests and planning process, is critical to successfully achieving management goals.

Management tactics used within the TSA are appropriate for the strategy identified for a particular BMU (**Table 8**).

Table 8 Bark Beetle Management Tactics as they apply 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 – infestation too widespread to expect success	Other resource objectives take precedence
Access Development	Yes, into high hazard stands	Yes, into high hazard stands	Yes, into high hazard stands	Yes, into high hazard stands	Other resource objectives take precedence

APPENDIX 3: SUSCEPTIBLE FOREST TYPES

An important part of designating strategies is to determine how much of the forest is at risk from a particular beetle. The area of susceptible forest was determined for the Golden TSA for Mountain pine beetle, Douglas-fir beetle and Spruce beetle (Table 9). The range of the susceptible forest types are shown for Mountain Pine beetle, Douglas-fir beetle and Spruce beetle in **Figures 3 to 5**.

The most current susceptibility data available is based on the updated Shore and Safranyik model (Safranyik et al 1992, 2000, 2005) was provided by the MoFR – Southern Interior Region (spatial data – January 2007). This system considers age, susceptible pine basal area, stand density and location. The model represents overall stand susceptibility, but does not necessarily represent individual tree susceptibility. Observations have shown that often the most susceptible trees where infestations tend to start are located in lower elevation stands.

It is important to note that with Mountain pine beetle, Spruce beetle and Douglas-fir beetle, stress factors such as fire, drought, root disease and windthrow play a pivotal role in infestation development, so susceptibility ratings can only be viewed as a rough estimate.

Table 9 Susceptibility ratings for Mountain pine beetle, Spruce beetle and Douglas-fir beetle in the Golden TSA by hectares and percent on crown forest land base.

Beetle	Susceptibility	Hectares	Percent
Mountain pine beetle	Nil (0)	729,855	81.7
	VL (0-5)	114,434	12.8
	Low (5-20)	30,459	3.4
	LM (20-40)	12,778	1.5
	Moderate (40-60)	4,033	0.5
	High (60-80)	1,111	0.1
	VH (80-100)	207	0
Total susceptible Pl	(>0)	**163,022**	**18.3**
Total moderate to high susceptible Pl		**5,351**	**0.6**
Spruce beetle	Nil (0)	555,994	62.3
	VL (0-5)	69,486	7.8
	Low (5-20)	159,254	17.8
	LM (20-40)	89,350	10.0
	Moderate (40-60)	15,644	1.8
	High (60-80)	2,645	0.3
	VH (80-100)	504	0
Total susceptible Sx	(>0)	**336,883**	**37.7**
Total moderate to high susceptible Sx		**18,793**	**2.1**
Douglas-fir beetle	Nil (0)	721,767	80.8
	VL (0-5)	71,139	8.0
	Low (5-20)	61,731	6.9
	LM (20-40)	28,558	3.2
	Moderate (40-60)	8,642	1.0
	High (60-80)	897	0.1
	VH (80-100)	142	0
Total susceptible Fd	(>0)	**171,110**	**19.2**
Total moderate to high susceptible Fd		**9,681**	**1.1**

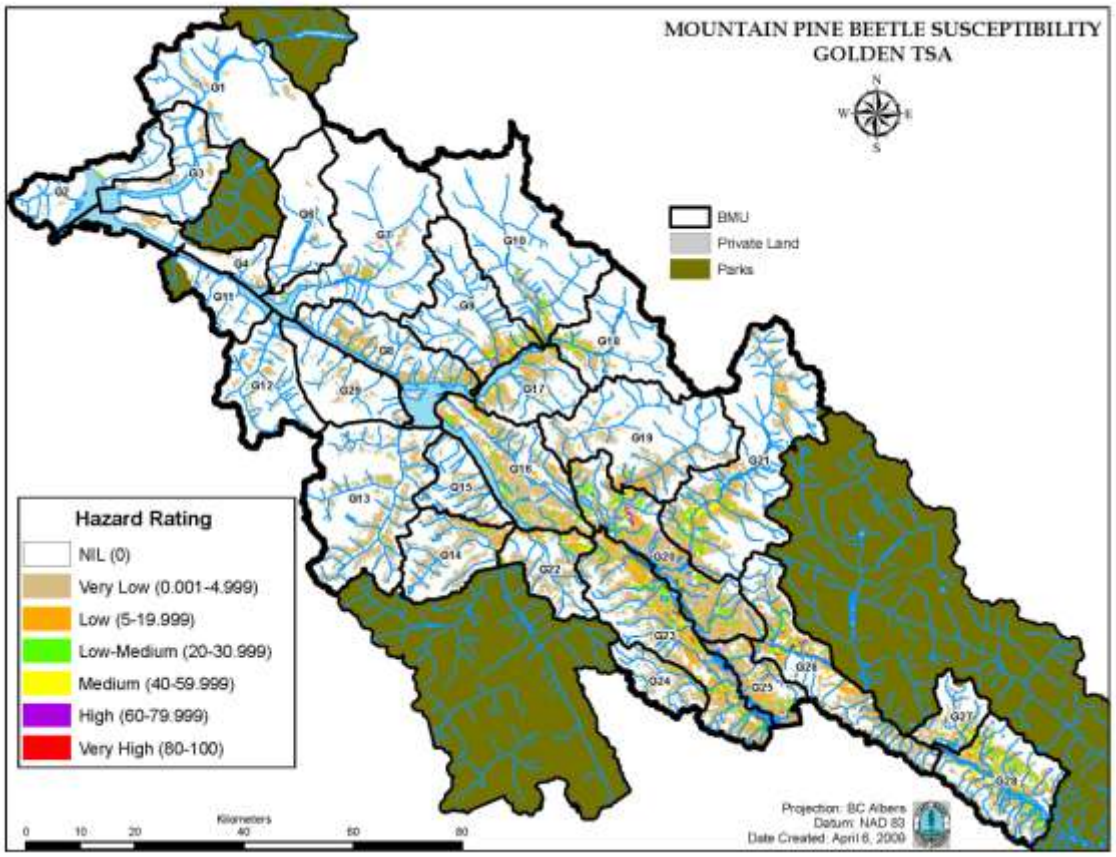

Figure 3 Pine stand susceptibility in the Golden TSA

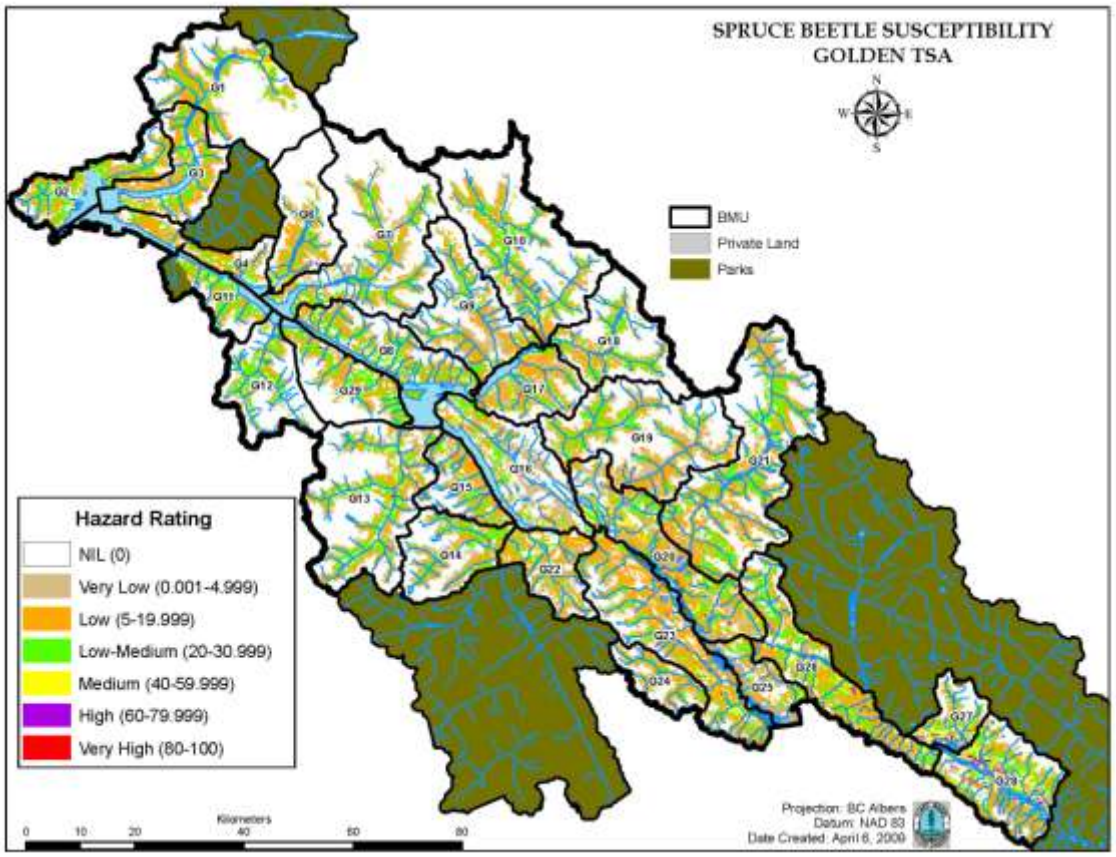

Figure 4 Spruce stand susceptibility in the Golden TSA

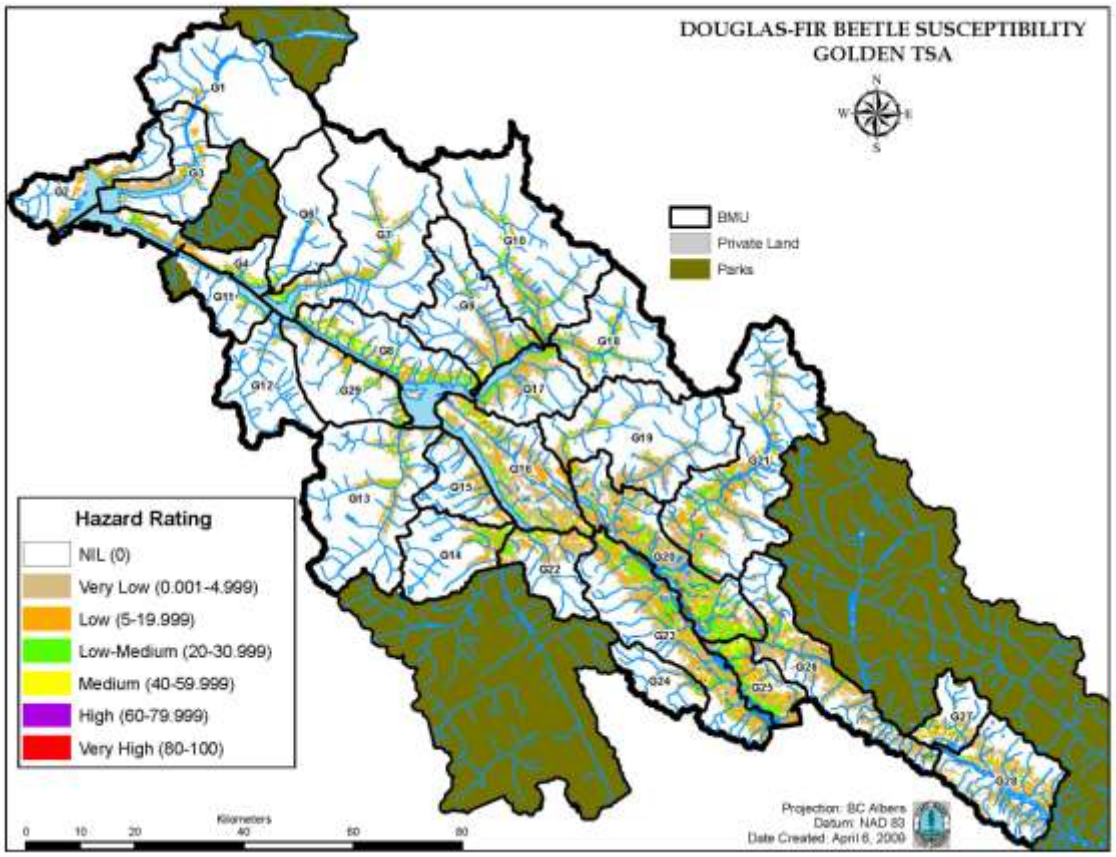

Figure 5 Douglas-fir stand susceptibility in the Golden TSA

Table 10 Summary of 2009 Overview survey of hectares of attack and hectares of susceptible host (2006) on the crown forest land base.

BMU	BMU Name	Hectares of attack			Hectares of susceptible host		
		IBM	IBS	IBD	IBM	IBS	IBD
G01	Upper Wood	0	0	0	991	10,798	317
G02	Molson/ Dainard	0	0	0	285	8,421	2,232
G03	Lower Wood	0	0	0	989	10,583	3,135
G04	Tsar	0	0	0	1,428	5,845	3,604
G06	Kinbasket	0	0	0	370	5,707	750
G07	Sullivan	0	0	0	2,010	14,363	4,950
G08	Foster/ Garrett	138	0	0	6,002	11,582	6,970
G09	Chatter/ Prattle	53	0	0	4,810	12,418	6,715
G10	Bush River	0	0	0	2,465	15,007	5,207
G11	Goosegrass	0	0	0	244	4,525	540
G12	Windy/ Austerity	0	0	0	1,125	5,926	327
G13	Bachelor	158	0	0	7,028	17,177	3,914
G14	Ventego	42	0	0	5,752	10,180	2,980
G15	Esplanade	49	0	0	2,633	9,322	2,988
G16	Blackwater Ridge	42	0	14	15,763	12,992	16,219
G17	Hope/ Goodfellow	31	0	0	4,602	10,028	5,552
G18	Valenciennes	0	0	0	2,635	8,083	3,746
G19	Bluewater/ Waitabit	18	0	0	7,108	18,565	6,194
G20	Moberly	315	0	0	20,642	21,612	21,110
G21	Blaeberry	330	0	0	14,369	28,636	14,710
G22	Quartz	18	0	0	6,112	10,732	5,729
G23	West Bench	457	0	0	19,610	21,427	17,580
G24	Canyon	0	0	0	2,706	5,090	1,042
G25	Mount Seven	132	0	0	4,938	4,291	7,782
G26	Kickinghorse/ Beaverfoot	346	0	0	11,993	21,566	13,107
G27	Ice/ Moose	217	0	0	2,776	5,030	2,321
G28	Kootenay	2,013	0	0	12,533	17,708	8,577
G29	Swan	0	0	0	1,104	9,268	2,812
Total		**4,359**	**0**	**14**	**163,022**	**336,883**	**171,110**