MINISTRY OF
FORESTS AND RANGE

INVERMERE TSA
FOREST HEALTH STRATEGY 2009

DISTRICT MANAGER APPROVAL
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DATE

TABLE OF CONTENTS

List of Figures and Tables

1.0 INTRODUCTION

The Invermere TSA Forest Health Strategy goal and objectives are in accordance with the Ministry of Forests and Range *Draft Provincial Forest Health Strategy* to**:**

Protect forest resources from damaging agents that threaten the resources' immediate and long-term value by maintaining a high standard of forest health practice across the land base.

OBJECTIVES

1. Maintain a detection program for damaging agents over the land base.
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.
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.
4. Implement mitigating strategies and tactics according to scientifically sound, forest health management practices.
5. Evaluate results of forest health management practices over the short and long-term and modify practices accordingly.

The Forest Health Strategy gives strategic direction for operational plans and serves to prioritise forest health investments in the TSA. The components of the plan that will aid in achieving the goals and objectives are as follows:

<u>Identification and ranking of priority forest health factors in the TSA:</u>
Identifying forest health factors in the TSA, and describing their current status; and
ranking each forest health factor as to their impact on forest management;

<u>Management strategies for managed stands and defoliators:</u>
Specifying management objectives for priority forest health factors, and
assigning specific strategies, tactics and proposed activities for addressing priority forest health factors.

<u>Bark Beetle Management:</u>
Identifying bark beetle management units for mountain pine beetle, and Douglas-fir bark beetle, and their assigned strategies;
Detailing a tactical plan for carrying out detection and treatment activities and,
outlining a mountain pine beetle monitoring plan that identifies factors that collectively contribute to reviewing the need for requesting an uplift in AAC.

2.0 GENERAL DESCRIPTION OF INVERMERE TSA

The Invermere Timber Supply Area (TSA) is within the boundaries of the Rocky Mountain Forest District and is administered by the district office in Cranbrook. It is situated in the southeastern portion of British Columbia, within the Kamloops Forest Region and covers approximately 1,150,000 hectares. This TSA is bounded by the Skookumchuck Valley to the south, the Golden TSA and Tree Farm License 14 to the north, the Purcell Mountains to the west, and the B.C.-Alberta border to the east. Approximately 553,473 hectares of the TSA are considered productive forest in terms of timber growth. The remaining 596,525 hectares are not considered productive forest, or are not managed by the Ministry of Forests. Of the productive land base, about 223,873 hectares are available for harvesting, which represents 20% of the total TSA. About 41% of the timber harvesting land base (THLB) are dominated by lodgepole pine, while the remaining area is covered by 29% Douglas-fir, 13% spruce, 7% larch, 4% balsam, and 1.3% yellow pine, and <1% cedar. Of the aforementioned stands, 39% are older than minimum harvest age, 26% of which are dominated by lodgepole pine.

The Invermere TSA contains six biogeoclimatic zones, an indication of the climatic and biological diversity in the area:

- The Ponderosa Pine Zone occurs at low elevations (700 to 900 metres) in very dry valleys of the Rocky Mountain Trench

- Interior Douglas-Fir Zone also occurs in the Rocky Mountain Trench, at elevations of 800 to 1200 metres, generally between the Ponderosa Pine and Montane Spruce Zones

- The Montane Spruce Zone is found at mid-elevations of 1200 to 1600 metres, often between the Interior Douglas-fir and Englemann Spruce Zones.

- The Interior Cedar-Hemlock Zone occurs at low to mid elevations (700 to 1500 metres) in the wetter portions of the Purcell and Rocky Mountains.

- Engelmann Spruce-Subalpine Fir Zone is the uppermost-forested zone, lying below the Alpine Tundra Zone from 1600 to 2000 metres.

- Alpine Tundra Zone lies above the Engelmann Spruce-Subalpine Fir Zone, and is by definition treeless although stunted or krummholz trees are common at the lower elevations of this zone. Overall, rock, ice, and grassy meadows dominate this zone.

3.0 CURRENT FOREST HEALTH CONDITIONS

Aerial overview surveys conducted by the MOFR between 1999 and 2008 detected bark beetles, defoliators, needle casts, abiotic damage and impacts from feeding by mammals. The most significant impact over the last five years has been from mountain pine beetle (Table 1). Other agents that have affected over 100 hectares in the last five years include Douglas-fir beetle,

western balsam bark beetle, pine needle cast, larch needle cast and western false hemlock looper. Agents affecting less than 100 hectares in the last five years include impacts from geomorphic slides, western pine beetle, red turpentine beetle, white pine blister rust, and conifer sawflies. The following Map 1 provides spatial aerial overview survey results of forest health factor incidence for the Invermere Timber Supply Area. Often, other key forest health factors, such as Armillaria root disease, dwarf mistletoe and wildfire, have a significant impact on forest management but are not always detectable from the air, are ongoing, or have not occurred at time of aerial overview flight. Forest Health Factor activity tracking results are summarized in Table I and include estimated volume losses not recovered through harvesting activities (largely due to economics or other resource value constraints). This information is input into Timber Supply Reviews to aid in analysis and determination of Annual Allowable Cut.

Map 1

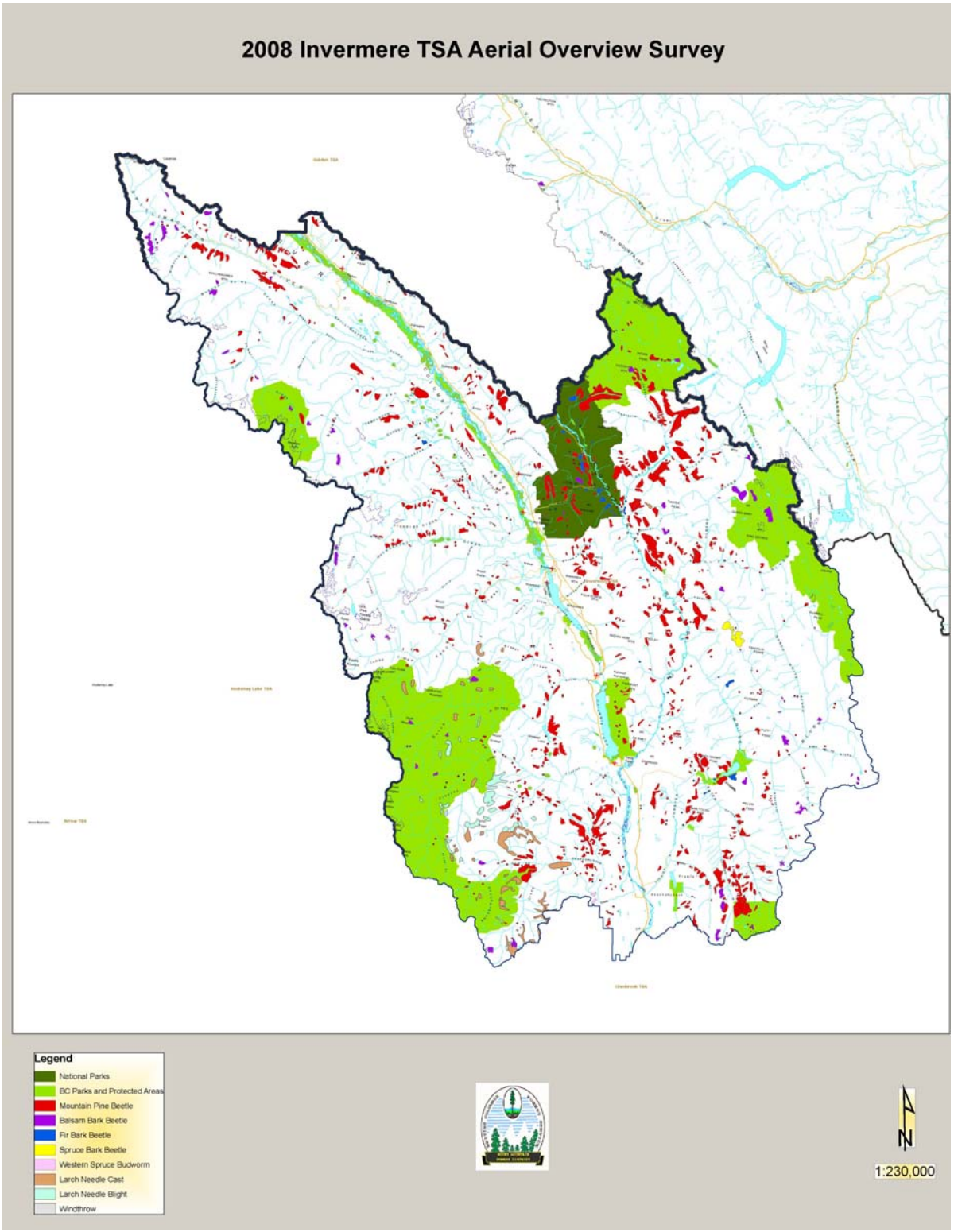

2008 Invermere TSA Aerial Overview Survey
Legend
National Parks
BC Parks and Protected Areas
Mountain Pine Beetle
Balsam Bark Beetle
Fir Bark Beetle
Spruce Bark Beetle
Western Spruce Budworm
Larch Needle Cast
Larch Needle Blight
Windthrow
N
1:230,000

TABLE 1 - 1999-2008 INVERMERE TSA AERIAL OVERVIEW SURVEY RESULTS

Type of impact: 1=quality, 2=growth reduction, 3=young tree mortality, 4=mature tree mortality

Forest Health Factor	Hectares Affected 2008	Cumulative Hectares Affected '99-08	Type of Impact	% of THLB stands led by host species	Non-Recoverable Loss Estimates 2008 m^3
Mountain Pine Beetle	34,930	119,948	4	41	34,660
Western Balsam Bark Beetle,	4,131	24,645	4	4	29,574
Douglas-Fir Beetle	1,260	11,665	4	29	5,600
Spruce Bark Beetle	766	3,195	4	13	0
Two-Year Budworm			3,4	13	
Western false hemlock looper	0	2,500	2,3	29	0
Serpentine Leaf Miner	0	326	2,3	<1	0
Catastrophic Blowdown/Snowpress	8	90,008	3,4	100	1,440
Non Catastrophic Blowdown/Snowpress (right of way & cutblock edge)	40	40,000	3,4	100	4,000
Wildfires	87	65,087	1,3,4	100	6,264
Larch Needle Cast/Blight	9,045	14,546	2,3	7	N/A
Pine Needle Cast	0	5,094	2,3	41	N/A

4.0 RANKING OF FOREST HEALTH FACTORS

The following table's lists forest health factors ranked according to their potential impact on forest management in the Invermere TSA. Those factors ranked as Very High or High are considered as priorities to address. The ranking were derived using data from MOFR aerial overview surveys (1999-2008), local knowledge and guidance from the Draft Provincial Forest Health Strategy which ranks forest health factors as to their importance in three forest health maintenance categories:

- Protection of current inventory (bark beetle and defoliator management pests with operational treatments available);
- Improving stand management practices activities (pests whose impacts are known or suspected to be minimised by modifying forest practices);
- Data management analysis to support the activities above, and other stewardship functions (pests whose impact is known or suspected to significantly alter timber supply in either the short or long-term).

Rational is provided where the TSA ranking is different from the Provincial ranking.

TABLE 2 – POTENTIAL IMPACT RANKING OF FOREST HEALTH FACTORS ON FOREST MANAGEMENT PROTECTION ACTIVITES ACTIVITIES IN THE INVERMERE TSA

PEST	RANKING	RATIONALE (if TSA ranking differs from Provincial ranking)
Mountain pine beetle	Very High	
Douglas–fir beetle	Very High	If suitable conditions occur, potential for significant future impact in TSA could occur given 29% of the THLB is fir leading. Provincially ranked Medium.
Spruce beetle	Medium	Very little activity over the last 20 years due to better access & harvest practices. Provincially ranked Very High.
Gypsy moth	Medium	No occurrences in TSA to date. Monitoring program in place. Provincially ranked Very High
Western balsam bark beetle	Very Low	

Table 3 – POTENTIAL IMPACT RANKING OF FOREST HEALTH FACTORS ON STAND MANAGEMENT PRACTICE IMPROVEMENT ACTIVITIES

PEST	RANKING	RATIONALE (if TSA ranking differs from Provincial ranking)
Armillaria root disease	Very High	
Commandra blister rust	High	
Western gall rust	High	Widespread and in some cases severe incidence of DSG is occurring in the TSA between 1000-1500 metres in elevation. Concerns for achieving free growing are beginning to arise in some locales.
Northern pitch twig moth Sequoia pitch moth	Medium	Widespread and in some cases severe infestations of ISP and ISQ are occurring in young pine stands in the TSA. Concerns for achieving free growing are beginning to arise in some locales. Provincially ranked Very Low.
Lodgepole pine dwarf mistletoe Pine Needle Cast	Medium	
Tomentosus root rot	Low	Not of major concern in the TSA with light incidence in ICH, and rarely noted in ESSF. Provincially ranked as High.
Larch dwarf mistletoe Spruce Weevil Stalaciform Blister Rust Balckheaded Budworm	Low	
Spruce weevil	Low	
Stalitiform blister rust	Low	
Blackheaded budworm	Low	
Laminated root rot	Very Low	Minor incidence in TSA to date.
Red band needle blight	Very Low	Minor incidence in TSA to date.
Atropellis canker Blackstain root disease All other conifer foliar diseases Hardwood cankers Wood decay fungi All other conifer & hardwood defoliators and bark beetles Warren's root collar weevil Lodgepole pine terminal weevil	Very Low	
White pine blister rust	Very Low	< 0.5 % of THLB composed of whitebark and western white pine. Provincially ranked as High.

TABLE 4 - POTENTIAL IMPACT RANKING OF FOREST HEALTH FACTORS ON DATA MANAGEMENT NEEDS FOR TSR

PEST	RANKING	RATIONALE (if TSA ranking differs from Provincial ranking)
Mountain pine beetle Armillaria root disease	Very High	
Douglas-fir beetle	High	29% of THLB is fir leading. If suitable conditions occur, potential for outbreak given access and constraint issues
Lodgepole pine dwarf mistletoe	High	The TSA contains lodgepole pine stands, with significant incidence in the ESSFdk, ICHdw, ICHmk1, IDFm2 and the MSdk. Lodgepole pine is the leading species in 41% o THLB stands. Provincially ranked as Medium.
Commandra blister rust	High	
Western gall rust	High	Widespread and in some cases severe incidence of DSG is occurring in the TSA between 1000-1500 metres in elevation. Concerns for achieving free growing are beginning to arise in some locales. Provincially ranked as meduim.
Spruce beetle	Medium	Very little activity over the last 20 years due to better access & harvest practices. Provincially ranked Very High.
Western balsam bark beetle	Medium	
Northern pitch twig moth sequoia pitch moth	Medium	Widespread and in some cases severe infestations of ISP and ISQ are occurring in young pine stands in the TSA. Concerns for achieving free growing are beginning to arise in some locales. Provincially ranked Very Low.
Tomentosus root rot	Medium	Not of major concern in the TSA with light incidence in ICH, and rarely noted in ESSF. Provincially ranked as High.
Abiotic disturbances	Medium	Wind and wildfire events are common in the TSA, and can often elevate activity of other forest health factors.
Larch dwarf mistletoe	Low	Limited incidence , but multi-layered pine larch stands may be a concern. Not ranked Provincially.
False hemlock looper	Low	Historically, periodic localised outbreaks occur every 10 to 15 years.. Not ranked Provincially.
Two-year cycle budworm	Low	Periodic localised outbreaks occur. 19% of THLB dominated by spruce and balsam.
Spruce weevil	Low	

5.0 MANAGEMENT STRATEGIES FOR MANAGED STANDS AND DEFOLIATORS

Specific management strategies are provided for forest health factors ranked *very high* or *high* as to their potential to impact forest management activities and values. Forest health factors with a ranking of *medium, low* or *very low* will be monitored using the Provincial aerial overview surveys, silviculture surveys and pest incidence surveys where possible. If these factors threaten a specific value they should be managed accordingly. Responsible parties will be primarily the MOFR, unless the forest health issue affects preparation of site plans, free growing obligations, or licensees address the issue voluntarily or undertake activities eligible for FIA funding. Management strategies for priority forest health factors should incorporate the following principles of Integrated Forest Health Management:

- Know the land base and resource management objectives
- Manage from an ecological perspective
- Don't make the situation worse
- Practice adaptive management

There is a Provincial need to compile, centralise and extend forest health data and research. Currently much of the knowledge about the location and results of the operational trials and permanent sample plots resides with a few people in the Ministry and with licensees. As experts move, the knowledge often moves with them. Operational trials should be documented and added to a central, publicly accessible database. Results should be extended to licensees via peer reviewed, accessible reports and presentations.

5.1 *Armillaria ostoyae (DRA)*

Armillaria root rot is the most common disease in the Invermere TSA, particularly in the ICH and IDF, and is scattered in pockets in other biogeoclimatic zones. Most tree species and age classes are susceptible. Armillaria is an important driver of structural diversity in interior forests - e.g., 62% of 111 active nests of primary cavity nesters were associated with Armillaria centres in studied ICHdw stands in the Nelson Forest Region (Steeger and Machmer 1995). Armillaria is challenging to manage because it can be difficult to identify in the field. Also, spread is exacerbated by partial cutting and thinning (Morrison et al. 2001), and given extensive calcareous and fine textured soils in the TSA, traditional management such as stumping and push-over harvesting may not be possible due to unacceptable levels of associated soil disturbance (Kishchuk et al. 1999, Curran et al. 2000).

5.11 *DRA Management Objectives:*

Avoid exacerbating spread in managed stands.

Quantify impact of DRA on long-term timber supply.

5.12 *DRA Management Strategies:*

Detect and manage according to the Armillaria Root Disease Guidelines for the Nelson Forest Region (Norris et al. 1998).

Support permanent plot establishment and measurements:
Re-measurement of the Fort Steele Operational Trial in the adjacent Cranbrook TSA should occur to quantify long term impacts of DRA on volume. This would assist in improving estimates used in timber supply reviews.

Consider stumping and/or stand density control options:
In fire maintained ecosystems it is suggested that as a result of fire exclusion these stands are overstocked relative to historic conditions (Morrsion et al.). Decreasing stand density with selective cutting, and reducing inoculum with stumping could decrease DRA impact and spread by reducing root to root contact.

Any research plans should dovetail with the Provincial Armillaria Research Strategy (Wienscyzk et al. 2003).

5.2 *Lodgepole Pine Dwarf Mistletoe (DMP):*

Research has indicated that growth of severely infected lodgepole pine can be reduced up to 32% (Unger 1992). Dwarf mistletoe brooms can increase fire hazard as they contribute to ladder fuel load and are highly flammable (Kipfumueller and Baker 1998). Brooms and fruiting bodies also provide important habitat and food sources (Watson 2001).

5.21 *DMP Management Objectives*:

Avoid exacerbating spread in managed stands.

Quantify impact of growth reduction on long-term timber supply.

5.22 *DMP Management Strategies*:

Detect and manage according to the Dwarf Mistletoe Guidebook (1995)

Support operational trial re-measurements:
In 1997 six permanent sample plots were established on a 1984 DML operational trial in the St. Mary drainage in the adjacent Cranbrook TSA. Re-measurement occurred in 2001. These plots need to be maintained for statistical analysis and long-term measurements. Preliminary evidence suggests that to reduce the impact of DML on regeneration, retention and understory in partial harvests, the following should be implemented (D.G. Murphy & Associates and D. Smith Consultants 2001):
Removing infected overstory trees with or without juvenile spacing, and
Juvenile spacing without removing the infested overstory can increase infection levels, unless spacing specifically targets infected understory.

Support permanent plot establishment:
TSR3 in the Invermere TSA does not incorporate any specific impacts due to DMP. Permanent sample plots to quantify long-term impacts on volume, particularly in infested stands that have been selectively harvested could improve estimates in future timber supply reviews.

5.3 Western Gall Rust (DSG) and Commandra Blister Rust (DSC)

In the Invermere TSA stands of lodgepole pine less than 15 years of age are likely to contain

high incidence of DSG (Swift et al. 2003), and/or DSC. Incidence of DSG and DSC occur sporadically throughout the TSA, and may be a major concern in regard to wood quality issues, growth reduction and in some cases mortality rates.

5.31 DSG and DSC Management Objectives:
Reduce spread and/or impact in managed stands.

Quantify impact on long-term timber supply.

***5.32 DSG and DSC Management Strategies*:**
Detect and manage according to the Pine Stem Rust Management Guidebook (1996) and the Establishment to Free Growing Guidebook for the Nelson Forest Region.

Promote mixed species regeneration where possible (Swift et al. 2003)

Test provenances, where allowed under seed transfer guidelines (Wu et al. 1998, White et al. 2000).

Establish and/or support operational trails to test the effect of stand density on DSG incidence and severity.

Pursue means to quantify DSG and DSC incidence within the THLB, and refine hazard and risk rating to promote best management practices.

5.4 *Northern Pitch Twig Moth (ISP) and Sequoia Pitch Moth (ISQ)*

In the past several years, incidence levels of pitch moth have reached up to 70% of trees in young lodgepole pine stands in the TSA (Hodge 2002). Similar incidence levels have been observed in a number of locations in the adjacent Cranbrook TSA. In other areas of the Province some lodgepole pine stands regenerating after mountain pine beetle outbreaks are being severely impacted by ISP (Phero Tech Inc. 2000). Plantations tend to be more heavily attacked than dense, naturally regenerating stands (Henigman 2001). ISP preferentially attacks pine between 0.3 and 3.0 metres in height, although trees up to 10 metres may be attacked (Duncan 1996).

Seven permanent sample plots to measure long-term impacts of ISP in the TSA were established in 1999. The plots were re-measured in 2001, and incidence of ISP ranged from 300 to 6000 stems/hectare and averaged 1 to 4 nodules attacked per stem.

Moderate incidence of ISQ has been reported in lodgepole pine stands in the TSA . Pine stands taller than 2 metres are susceptible, particularly those that are open-growing or suffering from recent wounding (Henigman 2001). Occasionally, repeated attacks can girdle and kill small diameter trees, or predispose them to breakage.

***5.41 Pitch Moth Management Objectives*:**
Prevent outbreaks of pitch moths.

Quantify impact on volume and wood quality on long-term timber supply.

5.42 Pitch Moth Management Strategies:

Detect and manage according to the Establishment to Free Growing Guidebook for the Nelson Forest Region.

Hodge (2002) recommends free growing standards use up to 70% girdling as acceptable on poor sites, and 80% girdling elsewhere.

Reduce risk of ISP and/or ISQ damage by planting mixed species where possible.

As ISP attack appears to decrease with age (Hodge 2002, Ives and Rentz 1993 from Hodge 2002) spacing should be delayed until trees reach at least 15 years of age in stands with high levels of Petrova.

Avoid pruning or spacing in stands with ISQ incidence, as attack will likely increase on wounded trees.

Support re-measurement and maintenance of the Invermere TSA permanent sample plots.

Consider restricting cattle grazing in stands with high levels of ISP or ISQ to limit stem breakage from animal rubbing (Hodge 2002).

Pursue means to quantify pitch moth incidence within the THLB, and provide information towards determining susceptibility and risk information to promote best management practices.

5.5 *Black Army Cutworm (IDA) and Rhizina Root Rot (DRR)*

There is a long history of large wildfires in the TSA, and the likelihood of future large fires is high. Black army cutworm has most commonly consumed white spruce and lodgepole pine in the ESSF and ICH zones. Rhizina infection tends to occur one or two years post-burn, particularly after those of moderate intensity in the ICH. Mortality of seedlings can reach up to 60% (Henigman et al. 2001).

5.51 IDA and DRR Management Objectives:

Monitor wildfire/burn areas for population/incidence levels to aid in making management decisions for reforestation requirements.

5.52 IDA and DRR Management Strategies:

Establish a monitoring program:
In areas recently burned by fire, pheromone trapping for Black Army cutworm moths from July through to September can indicate the risk of high populations of larvae occurring the following spring (Maher 1990).

The size of the population, it's stage and the availability of alternate vegetation for the larvae could influence which of the following management options is chosen and are listed in decreasing order of preference:(Maher 1990):
1. Postpone planting until pupation has occurred to avoid larval feeding period.

2. Proceed with planting, conduct a survival survey the following year and re-plant spots of mortality.
3. Delay planting for one year.
4. Apply insecticide.
5 Avoid planting in dry sites when population levels are high as post-defoliation drought can significantly increase seedling mortality from black army cutworm attack (Maher 1990). Relay the importance of proper planting techniques and micro site selection to planting crews.

In high-risk DDR areas, consider delaying planting for two or more years after a burn http://www.pfc.forestry.ca/diseases/CTD/Group/Root/root8_e.html).

5.6 *Activities to Manage Priority Forest Health Factors*

1. Maintain a detection program for damaging agents across the land base.
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.
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.
4. Implement mitigating strategies and tactics according to scientifically sound forest management practices.
5. Evaluate results of forest health management practices over the short and long-term and modify practices accordingly.

To assign rank to meeting TSA objectives, strategies were prioritise in order of most to least important (1 to 8 respectively) by reviewing and ranking activities. The results are presented in the following Table 5. Commitment to most of the activities will be subject to availability of funds. Estimated costs are provided for those activities that could be undertaken by the District, or voluntarily by licensees.

TABLE 5- ACTION PLAN TO MEET TSA LEVEL OBJECTIVES
Priority 1-8 = Highest to lowest priority

PRIORITY	PROPONENT	$ EST.	ACTION
1	MOFR Aerial Overview and Detailed Surveys	$10,000	Conduct detailed aerial and ground surveys, to maintain a detection program for damaging agents across the land base. 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. 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. Implement mitigating strategies and tactics according to scientifically sound forest management practices. Evaluate results of forest health management practices over the land base.
2	MOFR - TSA FH Strategy Licensee - Site Plans	$5,000	Follow Armillaria Root Disease Guidelines for the Nelson Forest Region Follow Dwarf Mistletoe Guidelines. Follow Pine Stem Rust Management Guidebook and Establishment to Free Growing Guidebook for the Nelson Forest Region
3	MOFR Region District and Licensees		Establish and monitor PSPs for DMP. Support re-measure/ stand density reduction trial in fire maintained ecosystem (Fort Steele operational trial). Support re-measure of St. Mary operational trial. Support model development. Establish operational trials for effects of stand density.. Coordination and extension of forest health research - archive and extend results from FH research. Maintain database of plots and operational trial locations.
4	MOFR District Licensees	$15,000	Monitor other forest health factors via: Pest Incidence Surveys (1,000 ha annually). Silviculture surveys and Monitoring traps
5	MOFR Region		Support Regional re-measurement and establishment of further DRA trials
6	MOFR Aerial Overview and Detailed Surveys Licensees		Consistent aerial delineation and archiving of burns and windthrow events via special flights, as required.
7	MOFR Region		Re-measurement of PSPs in Invermere TSA for pitch moth to quantify long-term impact on timber volume and wood quality (2006).
8	MOFR District	$7,500	Continue to survey incidence of pitch moth in TSA (400 ha est. annually.). Develop SOP from Hodge (2002) work, modify free growing standards.

6.0 BARK BEETLE MANAGMENT

Within the Invermere TSA the mountain pine beetle (IBM), Douglas-fir beetle (IBD), and spruce beetle (IBS) are disturbance agents of pines, Douglas-fir, and spruce, respectively. While hosts differ between IBM, IBD, and IBS there are several similarities in biology and impacts. All three of these bark beetles are considered primary tree-killers, which are capable of attacking healthy trees when populations are high. These bark beetles pose a major threat to land management objectives as large-scale mortality could have a negative impact on timber and non-timber resources. Effective management techniques are required to mitigate and prevent losses. Priority ranking systems, such as susceptibility and risk analysis are key decision making tools. These systems aid in assessing potential impacts of insect outbreaks and the development of management plans.

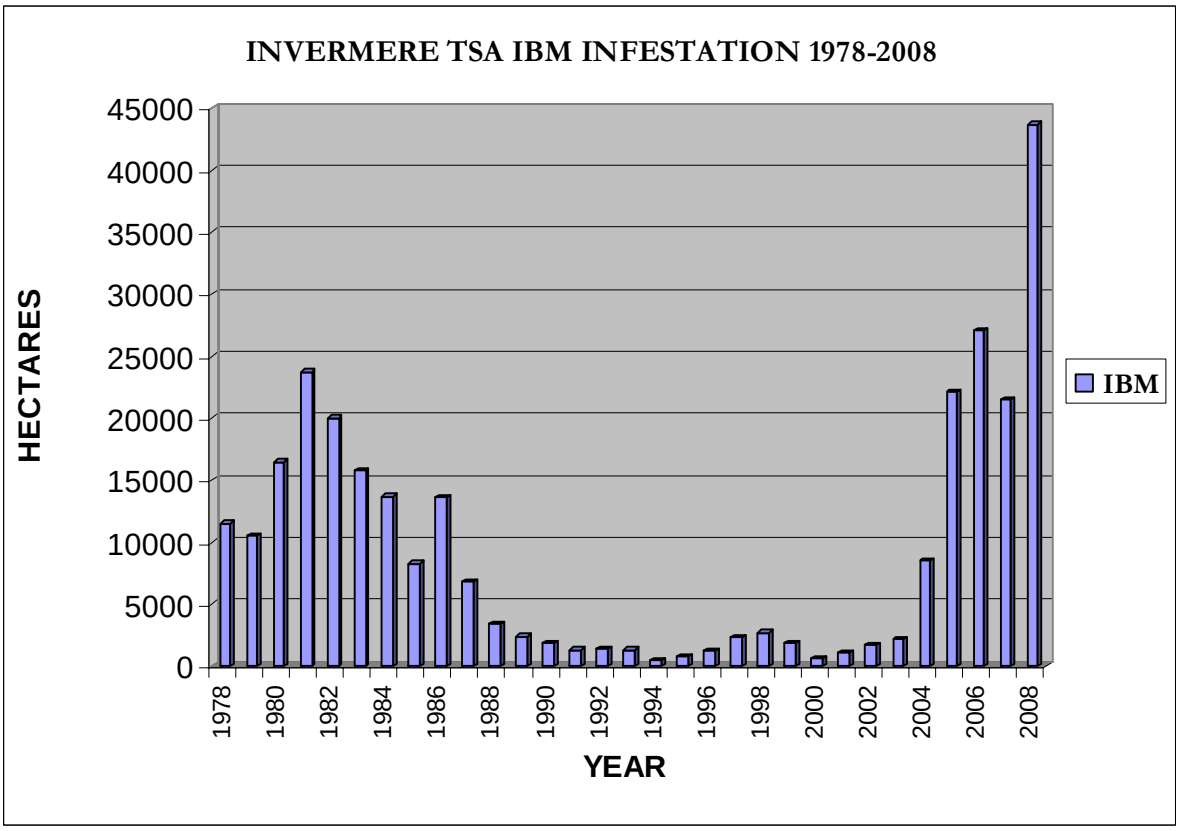
Specific management strategies are provided for mountain pine and Douglas-fir beetle as they are currently ranked *very high* or *high* as to their potential to impact forest management activities and values. Spruce bark beetle currently has a ranking of *medium,* and will be monitored using the Provincial aerial overview surveys, silviculture surveys and pest incidence surveys where possible.

6.1 *Mountain Pine Beetle (IBM)*

Mountain pine beetle has historically influenced the landscape in the TSA, with the peak of the last outbreak in 1981 recorded at 24,000 hectares. Currently 30,000 hectares of the TSA area is rated as moderate to high hazard to IBM attack (Spatial Mapping Ltd, 2002).

Aerial overview flight results for the TSA in 2008 indicate that hectares have been attacked, a 20% decrease over 2007. Temperature fluctuations and volatile winds during the summer resulted in a less concentrated flight period, thus current attack tends to be dispersed in scattered single tree or small pockets versus large contiguous patches. The Cross and Mitchell River drainages have been influenced by a large outbreak in Kootenay National Park, and as result contain the most active, large concentrations of current attack in the TSA . The following graph depicts the number of hectares attacked by IBM as detected by MOFR aerial overview surveys between 1999 and 2008.

FIGURE 1. 1999-2008 INVERMERE TSA AERIAL OVERVIEW RESULTS OF IBM ATTACK

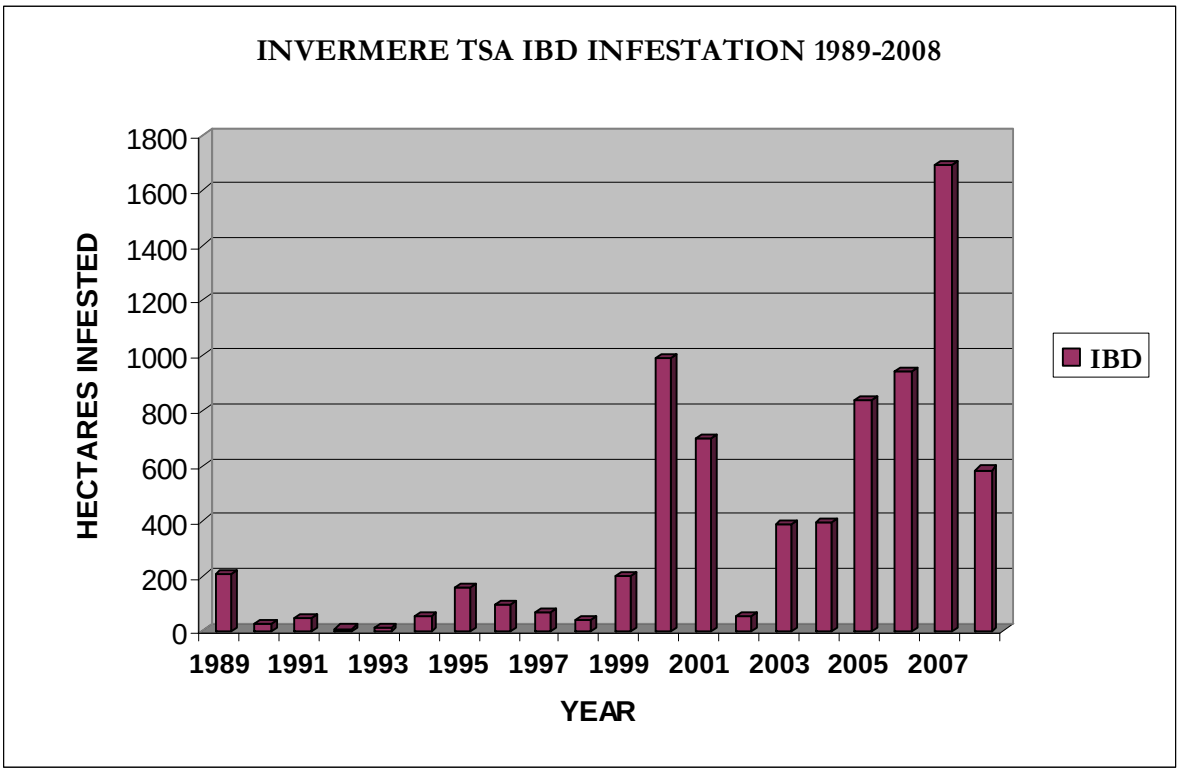


6.2 *Douglas-fir Beetle (IBD)*

Douglas-fir beetle has historically influenced the landscape of the Invermere TSA, although to a lesser degree than mountain pine beetle. The TSA contains 66,382 hectares rated moderate to high hazard to IBD attack (Spatial Mapping Ltd. 2002).

Aerial overview flight results for the TSA in 2008 indicate that IBD populations increased to hectares, a 45% increase over 2007 levels. Most of the current infestation is associated with scattered root rot or isolated windthrow or snow damage events. The following graph depicts the number of hectares attacked by IBD as detected by MOFR aerial overview surveys between 1999 and 2007.

FIGURE 2. 1999-2008 INVERMERE TSA AERIAL OVERVIEW RESULTS OF IBD ATTACK



6.3 *Bark Beetle Management Objectives:*

Monitor population build-up and spread through annual survey program.

Reduce beetle populations to manageable levels, with the intent of minimising future losses and reducing rate of spread of infestations.

Reduce susceptibility of high hazard stands by harvesting or other modification, creating a forest mosaic of diverse species and age classes that are at lower risk to damaging agents.

Quantify impact on volume and wood quality on long-term timber supply.

6.4 *Bark Beetle Management Strategies:*

There are 34 landscape units in the Invermere TSA. Each individual landscape unit is considered a Beetle Management Unit (BMU) for planning and reporting purposes. An annual review of each BMU occurs to assign appropriate management strategies and treatment tactics

in accordance with the approach and guidance provided by the *Provincial Bark Beetle Strategy* and *Provincial Bark Beetle Management Technical Guidelines*. There are four possible management strategies for a BMU as follows:

1. Suppression - address all current attack within two years (80% + target of brood kill per year). The intent is to drive bark beetle populations down and stop the spread.
2. Holding - maintain beetle populations at a level that can be dealt with under current AAC by addressing 50-80% of current attack (at least close to rate of expansion)
3. Salvage - relevant in areas where suppression or holding actions are no longer feasible. The priority is to salvage previously attacked timber to minimise value loss.
4. Monitor - No action required beyond monitoring and recording.

The Invermere TSA has been designated as an Emergency Bark Beetle Management Area as a result of a mountain pine beetle outbreak. Thus, BMUs are also designated into provincial zones (aggressive and containment) that aid in high-level resource allocation.

Table 6 lists BMU names, assigned management strategies and Provincial Zones for the entire TSA, including Provincial Parks and Protected Areas.

TABLE 6 - INVERMERE TSA 2009 BARK BEETLE MANAGEMENT STRATEGIES

BMU #	BMU Name	IBM Strategy	EMU Zone	IBD Strategy	EMU Zone	Provincial Park
I01	Findlay	**Holding**	Containment	**Holding**	Containment	Purcell Wilderness
I02	Buhl-Bradford	**Holding**	Containment	**Holding**	Containment	Purcell Wilderness
I03	Skookumchuck-Torrent	**Holding**	Containment	**Suppression**	Aggressive	
I04	Premier-Diorite	**Holding**	Containment	**Holding**	Containment	Premier Lake
I05	Lussier-Coyote	**Holding**	Contai0nment	**Holding**	Containment	Whiteswan Top of the World
I06	Blackfoot-Thunder	**Suppression**	Aggressive	**Holding**	Containment	
I07	East-Middle White	**Suppression**	Aggressive	**Holding**	Containment	Height of the Rockies
I08	North White	**Suppression**	Aggressive	**Suppression**	Aggressive	Height of the Rockies
I09	Grave	**Suppression**	Aggressive	**Suppression**	Aggressive	Whiteswan
I10	Nine Mile-Moscow	**Holding**	Containment	**Suppression**	Aggressive	Whiteswan
I11	Kootenay	**Holding**	Containment	**Suppression**	Aggressive	
I12	Doctor-Fir	**Holding**	Containment	**Suppression**	Aggressive	Thunderhill
I13	East Columbia	**Holding**	Containment	**Holding**	Containment	Columbia Lake Canal Flats
I14	Brewer-Dutch	**Holding**	Containment	**Holding**	Containment	Purcell Wilderness
I15	Toby	**Holding**	Containment	**Holding**	Containment	Purcell Wilderness
I16	Jumbo	**Holding**	Containment	**Holding**	Aggressive	
I17	Goldie	**Holding**	Containment	**Suppression**	Aggressive	
I18	Invermere	**Holding**	Containment	**Suppression**	Aggressive	James Chabot
I19	Fenwick	**Holding**	Containment	**Suppression**	Aggressive	
I20	Palliser	**Holding***	Containment	**Suppression**	Aggressive	Height of the Rockies
I21	Cochran	**Holding**	Containment	**Suppression**	Aggressive	
I22	Albert	**Holding**	Containment	**Suppression**	Aggressive	Height of the Rockies
I23	Cross	**Holding***	Containment	**Suppression**	Aggressive	Assiniboine
I24	Pedley	**Holding**	Containment	**Suppression**	Aggressive	
I25	Shuswap-Windermere	**Holding**	Containment	**Holding**	Containment	
I26	Horsethief	**Holding**	Containment	**Suppression**	Aggressive	
I27	Forster	**Holding**	Containment	**Suppression**	Aggressive	
I28	Frances	**Holding**	Containment	**Holding**	Containment	
I29	Steamboat-Cartwright	**Holding**	Containment	**Suppression**	Aggressive	
I30	Kindersley/Macaulay	**Holding**	Containment	**Suppression**	Aggressive	
I31	Bugaboo	**Holding**	Containment	**Holding**	Containment	Bugaboo Alpine
I32	Dunbar-Templeton	**Holding**	Containment	**Suppression**	Aggressive	
I33	Luxor	**Holding**	Containment	**Holding**	Containment	
I36	McMurdo-Fraling	**Holding**	Containment	**Suppression**	Aggressive	

* Special designation as part of the Alberta/BC Inter-agency plan to mitigate IBM spread into Alberta

6.5 Tactical Plan

The Tactical Plan prioritizes Suppression BMUs for IBM and estimates a budget for implementation of a single tree treatment program for 2009/10.

6.51 Prioritization

In order to assign resource allocation and treatments, Suppression BMUs have been biologically ranked in general order of importance according to the process outlined in the *Provincial Bark Beetle Management Technical Guidelines*. The ranking process is based on the relative severity of the outbreak (e.g. number of currently attacked trees and infested spots), and the amount of susceptible area remaining. Each of these attributes is rated high or low relative to the median value for the attribute. BMUs containing community watersheds will be elevated to a high priority regardless of their biological ranking as a means of preventing long-term consequences of bark beetle impact in these sensitive areas. Tables 7 (IBM) and 8 (IBD) list the outcome of this process for the TSA.

TABLE 7 – INVERMERE TSA 2009 BIOLOGICAL RANKING OF IBM SUPPRESSION BMUS

BMU #	BMU NAME	Biological Ranking	Ha M-H Hazard	# Current Attack	# Infested Sites	G:R	Resource Value Comments
I06	Blackfoot-Thunder	4	2,676	488	56	1.2	Grizzly habitat, biodiversity, recreation
I07	East-Middle White	4	6,001	58	15	1.2	Grizzly, Rocky Mtn. goat and sheep habitat, ungulate migration and connectivity corridor, recreation
I08	North White	4	2,670	108	16	1.1	Fisheries, grizzly habitat, ungulate migration corridors, recreation
I09	Grave	4	5,420	286	38	1.1	Recreation, grizzly and Rocky Mtn. goat habitat
I23	Cross	4	5,162	5,000	228	4.1:1	Fisheries, grizzly habitat, ungulate migration corridors, recreation
I20	Palliser	6	4,720	1,500	108	2.0	Fisheries, ungulate and grizzly habitat and recreation
I22	Albert	6	925	468	63	2.0	Grizzly habitat, biodiversity, recreation

TABLE 8 – INVERMERE TSA 2009 BIOLOGICAL RANKING OF IBD SUPPRESSION BMUS

BMU #	BMU NAME	Biological Ranking	Ha M-H Hazard	# Current Attack	# Infested Sites	G:R	Resource Value Comments
I09	Grave	3	4,321	426	8	1	Recreation, grizzly and Rocky Mtn. goat habitat
I12	Doctor-Fir	3	4,326	0	0	0	Grizzly habitat, wildlife, range, and recreation.
I10	Nine Mile/Moscow	4	8654	0	0	0	Recreation, grizzly and Rocky Mtn. goat habitat
I11	Kootenay	4	4600	0	0	0	Fisheries, grizzly and Rocky Mtn Bighorn sheep habitat, ungulate winter range and migration corridors, and recreation.
I18	Invermere	4	8123	0	0	0	Recreation and ungulate winter range
I29	Steamboat-Cartwright	4	12,235	1	6	0.8	Recreation ungulate winter range, and grizzly habitat
I30	Kindersley	4	8029	0	0	0	Domestic watersheds, grizzly habitat, ungulate travel corridors and recreation
I17	Goldie	6	1587	0	0	0	Community watershed and recreation, District considers this a Priority 1 since it is a community watershed
I23	Cross	7	1,426	15	3	0.8	Grizzly habitat, ungulate migratory and connectivity corridors, biodiversity, recreation
I32	Dunbar-Templeton	7	4,177	6	35	0.8	Domestic watersheds, grizzly habitat, ungulate travel corridors and recreation
I24	Pedley	8	3,097	40	5	1	Fisheries, grizzly and Rocky Mtn Bighorn sheep habitat, ungulate winter range and migration corridors, and recreation.
I19	Fenwick	8	2449	0	0	0	Fisheries, grizzly habitat , ungulate winter range and migration corridors, and recreation.

TABLE 8 – INVERMERE TSA 2009 BIOLOGICAL RANKING OF IBD SUPPRESSION BMUS (cont.)

BMU #	BMU NAME	Biological Ranking	Ha M-H Hazard	# Current Attack	# Infested Sites	G:R	Resource Value Comments
I08	North White	8	924	0	0	0	Recreation, grizzly and Rocky Mtn. goat habitat
I20	Palliser	8	1773	0	0	0	Fisheries, grizzly habitat , ungulate winter range and migration corridors,
I21	Cochran	8	3458	1	50	1	Fisheries, grizzly habitat , ungulate winter range and migration corridors
I22	Albert	8	1676	0	0	0	Fisheries, grizzly habitat , ungulate winter range and migration corridors
I27	Forster	8	907	12	2	0.8	Community watershed and recreation, District considers this a Priority 1 since it is a community watershed.

6.52 Proposed Activities for Single Tree Treatment:

All single tree treatments under the tactical plan are to be carried out in IBM Suppression BMUs only. Standards for these activities must follow the guidelines established for the Rocky Mountain Forest District and the Bark Beetle Management Guidebook (1995). Activities will be undertaken in a collaborative management effort between licensees, stakeholders, Ministry of Forests and Range, Ministry of Environment, private land holders and other concerned government agencies. Other management efforts that will form an integral part of an effective beetle management program will include timely harvest removal via single load or pockets of current attack, as well as larger block removal of infested or high risk stands.

Proposed single tree treatment activities in the Invermere TSA for 2009/10 include:

1. Detailed aerial surveys of all red attack identified in the MOFR Aerial Overview Surveys, including inoperable stands.
2. Ground surveys of detailed survey sites, and moderate to high susceptible stands in areas where risk of spread is identified as high.
3. Mountain Pine Beetle fall and burn (or peel), focusing efforts in remote and/or inoperable areas along the BC/Alberta corridor.
4. Douglas-fir Beetle trap trees and/or lethal funnel traps.
5. Pheromone Baiting for anti-aggregation in high value stands, or for mop-up following single tree disposal.
6. Use of funnel traps for monitoring populations and planning locations of mortality surveys.
7. Tracking treatment activities and annual update of the TSA Forest Health Strategy.

6.53 Proposed Suppression Budget:

Funding for bark beetle management is only available for suppression activities, and may be allocated to the district from two different sources: a "spread control" funding initiative from the federal government (for use in forest district's that have a shared border with the Province of Alberta) and Ministry voted funds. Federal funding will be jointly managed at the district level and by Tembec Industries Inc. (the lead licensee) through recipient agreements with PicewaterhouseCoopers (a company that supplies the Province with audit and assurance services). Provincial funds will be managed at the district level by the Forest Health Specialist.

Budget requests are detailed in the following Tables 9 and 10 and identify BMU treatment priority, estimated treatment activity units and estimated funding levels. The estimates provided are based on historic survey and treatment data, and local knowledge. These tables will be utilised as a "best estimate" and revision will occur periodically during the course of program delivery if/when funding allocations are assigned, when updated survey data becomes available, and as ongoing assessments of management strategy targets are jointly conducted by the lead Licensee and Forest Health Specialist.

TABLE 9 - INVERMERE TSA 2009/10 SUPPRESSION BMU IBM SPREAD CONTROL PLAN

BMU NAME	AGENCY	PRIORITY	AIR SURV $	AIR SURV HOURS	SURVEY $	SURVEY HA	F&B $	F&B TREES	TOTAL $
Blackfoot-Thunder	Tembec	2	6000	4	39000	600	117000	650	$162,000.00
East-Middle White	Tembec	2	6000	4	39000	600	117000	650	$162,000.00
	MOFR	2	4500	3	26000	400	90000	500	$120,500.00
North White	Tembec	2	4500	3	39000	600	117000	650	$160,500.00
Grave	Tembec	2	4500	3	32500	500	108000	600	$145,000.00
4 BMU's			**$25,500**	**17**	**$175,500**	**2700**	**$549,000**	**3050**	**$750,000.00**

TABLE 10 - INVERMERE TSA 2009/10 SUPPRESSION PLAN FOR IBD

BMU NAME	AGENCY	PRIORITY	AIR SURV $	AIR SURV HOURS	SURVEY $	SURVEY HA	TREAT $	TREAT UNITS	TOTAL BMU $
Invermere	MOFR	1	0	0	1125	25	0		$ 1,125.00
Grave	MOFR	1	0		450	10	2250	10	$ 2,700.00
Nine Mile-Moscow	MOFR	1	1500	1	1125	25	0	0	$ 2,625.00
Kootenay	MOFR	1	1500	1	1125	25	2250	10	$ 4,875.00
Doctor-Fir	MOFR	1	1500	1	1125	25	0	0	$ 2,625.00
Goldie	MOFR	1	1500	1	450	10	2250	10	$ 4,200.00
Kindersley	MOFR	1	0	0	1125	25	0	0	$ 1,125.00
Forster	MOFR	1	0	0	1125	25	2250	10	$ 3,375.00
North White	MOFR	2	1500	1	0	0	0		$ 1,500.00
Cochran	MOFR	2	0		450	10	0	0	$ 450.00
Albert	MOFR	2	0		450	10	0		$ 450.00
Cross	MOFR	2	0		450	10	2250	10	$ 2,700.00
Fenwick	MOFR	2		1	1125	25	2250	10	$ 3,375.00
Steamboat-Cartwright	MOFR	2	1500	1	1125	25	2250	10	$ 4,875.00
Dunbar-Templeton	MOFR	2	0	0	1125	25	2250	10	$ 3,375.00
Kindersley/Macaulay	MOFR	2	0	0	1125	25	2250	10	$ 3,375.00
Cochran	MOFR	2	0		1125	25	2250	10	$ 3,375.00
Pedley	MOFR	2	0	0	450	10	2250	10	$ 2,700.00
18 BMUs			$ 9,000	7	$ 15,075	335	$ 24,750	110	**$ 48,825.00**

6.6 Performance Measures for Beetle Management

Beetle management in the TSA will be assessed annually using the following three performance measures required by the Ministry of Forests and Range:

1. Survey and Detection
   Area (ha) and % of susceptible forest land base that has been surveyed and where existing infested areas have been identified, evaluated, and assigned a management strategy.
2. Treatment
   Percent of currently infested trees (can also use volume/ ha. or number of sites to track), but must be reported in tree units removed/treated annually, prior to the beetle flight period (does NOT include areas baited where no other action was carried out). Aerial overview survey data provided by MOFR will be overlaid onto detailed aerial survey data collected by the lead, and other licensees. Overlapping infestations recorded in both surveys will be used as the maximum number of infestations to be treated by the next beetle flight. Lead licensees will be required to track which of the "target" infestations have been treated. The percentage of target infestations treated will be reported by July 1st annually.
3. Plan Achievement
   Percent of each strategy that has been achieved.

6.7 *Bark Beetle Monitoring Plan for IBM*

At the current harvest level the term to address the mature Pl component of the timber profile

on the Timber Harvesting Land Base is 36 years. In order to assess harvest capacity in managing recent exponential increase in mountain pine beetle populations, the TSA Forest Health sub-committee has identified the following four "trigger" factors that must be collectively examined bi-annually (pre and post-flight) to determine if an AAC uplift request is warranted.

Factor 1 - Landscape level outbreak
Experiencing increasing current to red attack ratios, less spot and more patch infestations building, continued exponential population expansion predicted from mortality survey results, and decreasing chance of reducing/maintaining populations despite aggressive management activities.

Factor 2 - Unattainable BMU Treatment Targets:
If treatment targets are not being achieved, requiring management shifts from suppression into containment BMUs, and non-recoverable losses are increasing beyond 6% of AAC (DM direction – which equates to at or above, 35,000m^3/yr for Invermere TSA).

Factor 3 - Unacceptable proportion of AAC containing affected volume not being addressed before next beetle flight:
Pre-flight (June): Carry-over of Priority 1 & 2 volume exceeds 25% of AAC:
Post-flight (September): 75 to 125% of AAC contains infested volume

Factor 4 – Determining proportion of Priority 1 & 2 volume that is unconstrained

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