

**2013/2014
Lillooet TSA Forest Health Strategy**



Cascades District

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Forest Health Strategy

Introduction

Forest health factors such as insects and diseases are natural components of our forested ecosystems. When present below certain thresholds, native forest health factors are integral to healthy ecosystems, contributing to the food chain and biodiversity. What is considered an acceptable level for a certain forest health factor depends in part on the management goals and objectives for the area. At unacceptable levels (such as the present Mountain Pine Beetle outbreak in many parts of British Columbia) damage by pests can lead to economic instability, unsalvaged losses, degraded lumber values, reduced stumpage values, disruption of long-term forest management planning, and negative impacts on recreation and aesthetic values, range, fish and wildlife resources, and watershed management.

Responsible stewardship directed at protecting forests in British Columbia (BC) from unacceptable damage is guided in principle by the BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) *Provincial Forest Health Strategy* (2008/09 – 2010/11). The provincial government's three key strategic forest health objectives are to:

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

All parties involved in forest management within the Lillooet TSA, including the Ministry of Forests, Lands and Natural Resource Operations, forest licensees, woodlots, contractors and members of the general public have, and will continue to demonstrate their commitment to that vision. This document endeavours to present that commitment to managing damaging forest health agents.

In response to the Mountain Pine Beetle epidemic in the BC interior, in April 2005 the BC government released the Mountain Pine Beetle Action Plan for 2005 – 2010 (updated Plan for 2006-2011 released September 2006) in effort to mitigate the impacts of the beetle on the forest values, communities and the economy in the short term, and to implement measures to ensure their sustainability in the long term. The five year plan presents seven (7) broad objectives which outline a government-wide effort of cooperation between multiple ministries, the forest industry and other impacted stakeholders, including

- Recovering the maximum value from the infested, dying and beetle-killed timber before it decays or is destroyed by wildfire,
- Prevent or minimize the damage to susceptible forest that is not yet significantly infested,
- Reforest areas of beetle-infested and killed timber that have been salvage/sanitation harvested, and
- Conserve the longer-term forest values identified in higher-level land use plans.

The following 2013/14 Forest Health Strategy is an update of the 2012/13 strategy document, and is specific to the Lillooet TSA. Specifically for the Mountain Pine Beetle, the strategy will also be guided by the key objectives within the provincial 2006 – 2011 Mountain Pine Beetle Action Plan.

Objectives

The primary objective of the Lillooet TSA Forest Health Strategy is to identify the priority forest health factors and their associated risks to resource values. For priority forest health factors, appropriate ecologically and scientifically sound management strategies and tactics will be identified. Implementation and monitoring of these strategies and tactics will be discussed in context of constraints and limitations. Important forest health knowledge gaps will also be identified.

Forest Health Responsibilities

As of April 1, 2005 the responsibility for managing the forest health program in the province returned to the BC Ministry of Forests, Lands and Natural Resource Operations. The individual forest licensees within the Lillooet TSA are still obligated to record and evaluate the occurrence of detected forest health factors for stewardship, development and operational plans, as well as conduct ground surveys and timber reconnaissance in efforts to develop salvage/sanitation harvest plans and treatments.

Table 1a and 1b describe the basic functions required by the Government of BC and the forest licensees within the Lillooet TSA as of April 1, 2005.

Table 1a. Forest health obligations for the Lillooet TSA: BC Government

District Responsibilities	Region / Branch Responsibilities
<ul style="list-style-type: none">• Prepare an annual Forest Health Strategy consistent with the provincial Forest Health Strategy• Strategic planning for uplift volume.• TSA Forest Health committee meetings.• Conduct detailed aerial and ground surveys for the TSA, within the existing identified Suppression Beetle Management Units (BMU) of the Lillooet TSA• Within the Suppression BMU's of the TSA, conduct bark beetle detection and deliver measures for single tree treatment of Bark Beetles.• Provide maps showing the results of detailed aerial surveys. The district forest health program will be the 'keeper of the data' for aerial overview (supplied by Region) and detailed overview and ground survey information.• Produce an annual report describing bark beetle performance measures for the single tree treatment operations.	<ul style="list-style-type: none">• Define performance measures for specific strategies and tactics• Conduct annual aerial overview survey on all provincial forests• Provide the annual province-wide forest health overview• Conduct aerial treatment of defoliator epidemics.• Monitor and evaluate activities.• Mortality estimates of Bark Beetles

Table 1b. General forest health roles and responsibilities in the Lillooet TSA.

Activity	Government	Forest Licensees
Conduct annual aerial overview forest health survey on all provincial forests and report on results	X	
Conduct detailed aerial surveys of suppression beetle management units	X	
Conduct ground surveys as required to quantify incidence and intensity of damaging agents.	X	X
Maintain a record of collected survey information	X	
Conduct bark beetle treatments when required by the Forest Health Strategy	X	X*
Provide annual reporting of bark beetle activities to the Province	X	
Conduct treatment of defoliator outbreaks when appropriate	X	
Monitor and treat, if necessary, introductions of non-native potentially harmful organisms	X	
Identify knowledge gaps	X	
Utilize the best current information to detect and manage forest health factors	X	X
Monitor and evaluate forest health activities to attain adaptive management	X	

* Includes pheromone baiting, trap tree felling, and salvage/sanitation harvesting.

Where management activities are recommended in this strategy, procedures would follow the standards set by the Ministry of Forests, Lands and Natural Resource Operations, and/or those detailed in the *Forest Practices Code* guidebooks, if appropriate. Reforestation with species that are suitable for each biogeoclimatic zone is addressed by following the stocking standards in the appropriate licensee Forest Stewardship Plan. To the best of present knowledge, these guidelines take into consideration potential forest health hazards in species selection. If management strategies and tactics may be improved by investigating identified knowledge gaps, the Ministry of Forests, Lands and Natural Resource Operations will consider addressing these issues if government funding is available.

Although the Lillooet Land and Resource Management Plan (LRMP) is still in draft form, the “spirit” of this higher level plan is adopted as guidance for this Forest Health Strategy.

TSA Description

The Lillooet TSA encompasses a total of 1,125,025 hectares, of which 505,933 hectares (45%) is productive forest land and 259,572 hectares (23%) is within the operable land base available for timber harvest. Of the land base, various designations apply and forest health management objectives, responsibilities and potential control activities differ depending on the land designation (Table 2).

Mountainous terrain predominates across the landscape of the Lillooet TSA. This geography results in great variation of climate and vegetation complexes. The western portion experiences predominately wet coastal conditions, while the eastern portion has dry interior conditions.

Table 2. Lillooet TSA Landbase Profile

Landbase Designation	Area (ha)	% of Total Area
Lillooet TSA Total	1,125,025	
Parks and Protected Areas	121,824	10.8%
Proposed South Chilcotin Park	56,977	5.0%
Proposed South Chilcotin Mining/Tourism Area	14,297	1.3%
Private Land	47,157	4.2%
First Nations Reserves	20,354	1.8%
Woodlots	8,788	0.8%

The landscape across BC is classified according to biogeoclimatic zones using vegetation, soils and climate. Dominant climatic climax vegetation is utilized to name each zone. These zones are used frequently in forestry management to help determine hazard ratings for forest health factors. Due to the landscape diversity in the Lillooet TSA, eight of the total sixteen zones found in BC are represented (Table 3a, Figure 1a).

Table 3a. Biogeoclimatic zones in the Lillooet TSA.

Biogeoclimatic zones	Area (ha)	% of Total Area
Engelmann Spruce Subalpine Fir (ESSF)	513,811	45.8%
Interior Douglas-fir (IDF)	288,495	25.7%
Montane Spruce (MS)	147,734	13.2%
Interior Mountain-heather Alpine (IMA)	111,242	9.9%
Ponderosa Pine (PP)	38,294	3.4%
Bunchgrass (BG)	15,283	1.4%
Boreal Altai Fescue Alpine (BAFA)	4,944	0.4%
Coastal Western Hemlock (CWH)	2,210	0.2%

Five natural disturbance types (NDTs) are recognized as occurring in BC, which characterize areas with different natural disturbance regimes. Stand-initiating disturbances (e.g. wildfires and insect outbreaks) are those processes that largely terminate the existing forest stand and initiate secondary succession in order to produce a new stand. Disturbances such as the understorey ground fires that occur in the IDF and PP ecosystems characteristic of the NDT4 are vital to keeping the successional processes stable in these zones. The frequent ground fires also prevent large, dense thickets of immature Douglas-fir from forming in the understory which encourages the build-up of Western spruce budworm populations.

Table 3b. Natural Disturbance Type (NDT) zones in the Lillooet TSA.

NDT zone	Disturbance Interval	Area (ha)	% of Total Area
NDT1	Rare, 250-350yrs	3	<0.1
NDT2	Infrequent, 200yrs	134,654	12.0
NDT3	Frequent, 100yrs	419,920	37.5
NDT4	Frequent, 4-50yrs	173,228	15.5
NDT5	Rare, Alpine	382,134	34.1

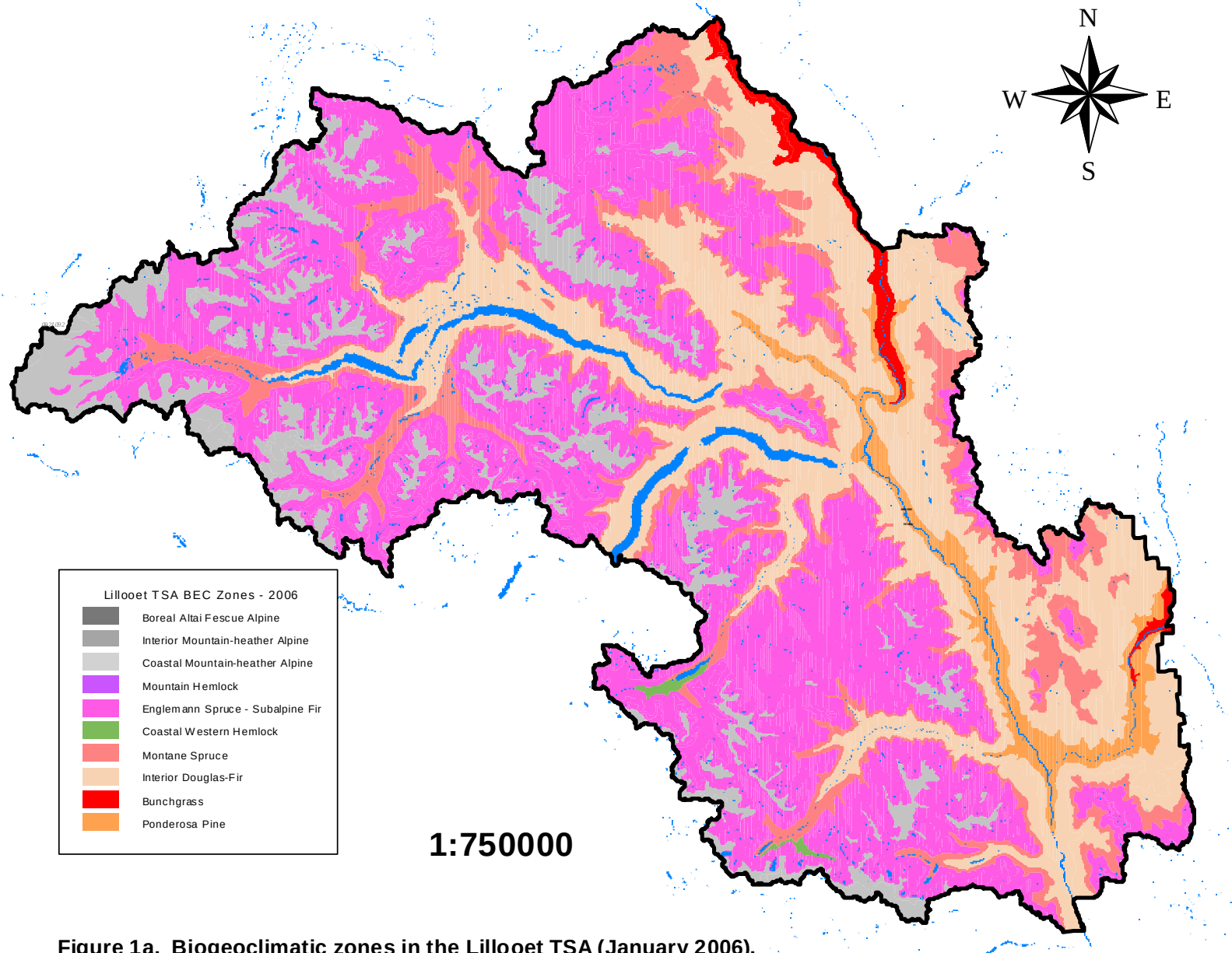


Figure 1a. Biogeoclimatic zones in the Lillooet TSA (January 2006).

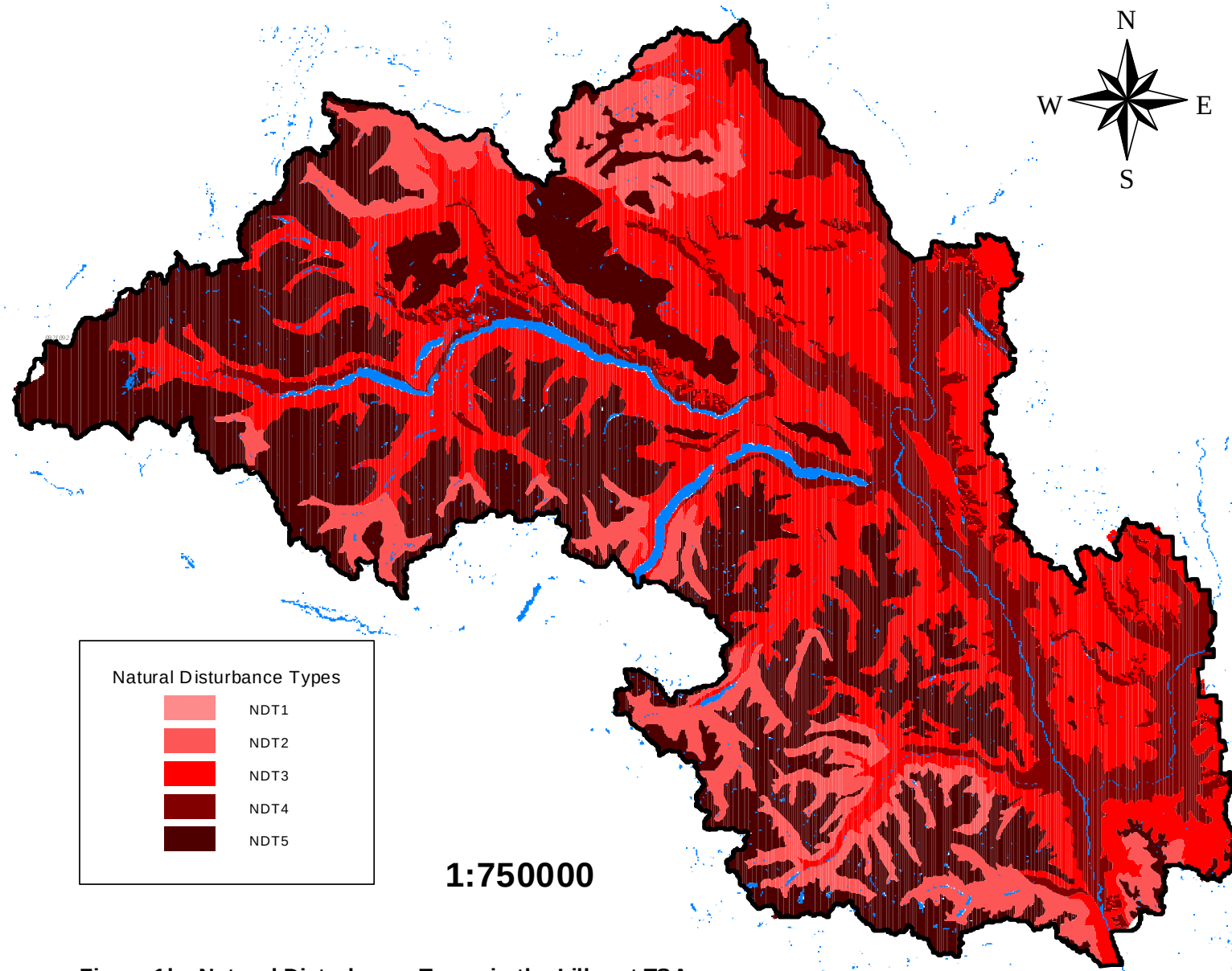


Figure 1b. Natural Disturbance Types in the Lillooet TSA.

As shown in Table 3b and Figure 1b, the mountainous terrain of the TSA results in a tremendous variation in ecosystem types and natural disturbance regimes within a given area. For example, the area immediately surrounding Lytton is hot, dry PP and IDF of the NDT4 and at risk of frequent wildfires, where less than 5 km away in a straight line distance up Lytton Creek you move through NDT3, NDT2 zones and into the NDT5. A significant portion of the Lillooet TSA (46.1%) contains sub-alpine and alpine ecosystems of the NDT2 and NDT5 subject to infrequent-to-rare stand-initiating disturbances. In the Lillooet TSA, the large insect outbreaks such as Mountain pine and Douglas-fir beetle are found in the NDT3 and NDT3/NDT4 transition zone, which contain BEC ecosystems with forest types of greater susceptibility. Spruce and western balsam bark beetle outbreaks are found in ecosystems of the NDT2 and NDT3 typical of the higher elevation spruce and subalpine fir ecosystems.

Constraints and Challenges

Forestry is a key economic activity in the Lillooet TSA. Approximately 45% of the plan area is forested, but only 23% of the total area is within the timber harvesting land base (THLB) due to the rugged terrain and a diverse range of environmental and social values. Some of the constraints and challenges to forest health management include:

- Curtailment of harvesting due to current global market conditions and lumber export tariffs. The operability of the THLB is very sensitive to market conditions.
- The high production costs in the TSA, combined with lengthy haul distances to suitable processing facilities for pulp and sawlog-grade timber associated with Mountain Pine Beetle salvage, challenges the economic viability of such operations.
- Removal or deferral of portions of the harvestable landbase for reasons such as parks, proposed parks, protected areas, approved study areas, riparian reserves and old growth management areas (OGMA).
- Rough, mountainous terrain with steep and unstable slopes means high road costs both in construction and maintenance due to avalanche and landslide potential, and leaves many areas without road access.
- Managing for many significant wildlife species, including bighorn sheep, moose, mountain goats, mule deer, grizzly bears, and spotted owls.
- Many conflicting land use pressures. This is evident in the development of the Lillooet Land and Resource Management Plan (LRMP), which was initiated in 1995 and is still in draft form.

Together, these issues result in harvesting costs that are among the highest in the interior of the province and cause difficulties in reacting quickly to forest health problems. It is the greatest challenge to bark beetle management in the Lillooet TSA. Stumpage rates that are considered reasonable in other areas of the province are too high for many forest harvesting operations in the Lillooet TSA to be economically viable. “Coastal logging in the interior” is a common reference associated with forest management activities. The fact that it is often more cost-effective for forest companies to purchase log inventory on the open market and have it delivered to the local processing facilities rather than harvesting timber within the TSA underlines this challenge. Addressing this challenge is complex and beyond the scope of this forest health strategy as it applies to all forest management activities in the TSA and not solely bark beetle management. It is recommended in this strategy document that the MFLNRO, First Nations, local communities and forest licensees in the TSA continue to work together to find an innovative solution that will allow access to and the harvesting of timber (specifically beetle-infested) that at present cannot be harvested. In the interim, the MFLNRO and forest licensees will continue to work together to facilitate and promote bark beetle management activities.

Forest Health Agents of Concern

Stands damaged by forest health agents are recorded annually by two levels of aerial survey by the BC Ministry of Forests and Range. This information is recorded as spots or polygons of affected trees, with associated severities and hectares involved. The more general aerial overview survey is conducted over the entire Lillooet TSA, and it is the quantitative data gathered from the aerial overview that is quoted in the Forest Health strategy to allow consistent comparison with other TSA's. Only forest health factors that are readily distinguishable from the air are recordable with the overview survey. The general forest health agents (excluding bark beetles) identified during the 2012 overview survey are shown in Figure 2a (primary agents only) and Figure 2b (all agents). All forest health agents identified each year since 2001 are listed in Table 6. Identified bark beetle infestations are presented in the Bark Beetle Strategy in Figure 7. The detailed aerial GPS forest health survey is more operational in nature, and tends to drive the on-the-ground beetle management activities within the *suppression* beetle management units where ground surveys and single-tree treatments may be implemented.

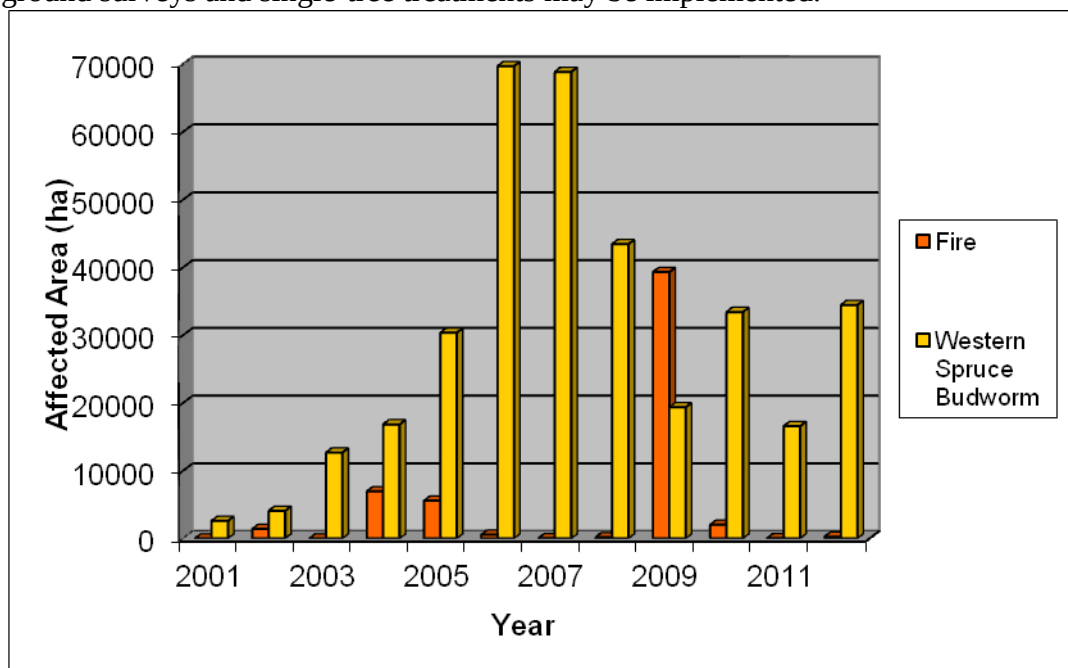


Figure 2a. Primary forest health agents (excluding beetles) in the Lillooet TSA 2001 – 2012.

Utilizing various sources such as the *Provincial Forest Health Strategy (PFHS)* other literature, forest health specialists and forest practitioners in the Lillooet TSA, a listing of priority forest health agents has been developed and ranked based on a combination of the *PFHS* guidelines, local stand susceptibility conditions, local knowledge and incidence and impact (Tables 4 and 5). The pests are grouped into two categories:

- Whether operational treatments such as biological control of defoliators or pile and burn of beetle-infested trees are presently available (Table 4).
- Where the modification of forest practices such as species selection, stand or landscape level species mix, thinning, landscape level age management and pruning are felt to reduce impacts (Table 5).

Each forest health factor named is followed by an abbreviation for the general geographic area in the TSA which correspond to beetle management unit (BMU) boundaries (Figure 7 and described further in the bark beetle strategy section). These units are: Fraser-East (FE), Fraser-West (FW), Fraser-Cascade (FC), Relay (RE), Yalakom (YA), and Big Bar (BB). These define specific areas in the TSA where each pest is important.

Table 4. Ranking of forest health factors that have operational treatments available.

Very High	High	Medium	Low
Mountain pine beetle (RE, YA, FE, FW, BB)	Western spruce budworm (FE, RE, YA, BB)	Mountain pine beetle (FC)	Douglas-fir tussock moth (FW, FC)
Spruce beetle (FW, FC, RE, YA)	Douglas-fir beetle (RE, YA, BB, FE, FW, FC)	Spruce beetle (FE)	
Gypsy moth (all)		Western spruce budworm (FW, FC)	
		Western balsam bark beetle (all)	
		Douglas-fir tussock moth (RE, YA, FE, BB)	

Table 5. Ranking of forest health factors whose impacts are known or suspected to be minimized by modifying forest practices.

High	Medium	Low	Very Low
Armillaria root disease (all)	Laminated root rot (FW, RE, YA, BB, FC)	White pine blister rust (FW, FE, YA)	Warren's collar weevil (RE, YA, FC, FW)
Laminated root rot (FE)	White pine blister rust (FC)	Tomentosus root rot (all)	Lodgepole pine terminal weevil (all)
Lodgepole pine dwarf mistletoe (FE)	Comandra blister rust (all)	Stalactiform blister rust (all)	Misc. defoliators and foliage diseases (all)
Deer browse (FE)	Western gall rust (all)	Spruce weevil (RE, FC)	
Drought (YA, BB, FE, FW)	Lodgepole pine dwarf mistletoe (FW, YA, BB, FC)	Atropellis canker (all)	
Western spruce budworm (FW, FC)	Pine needle cast (YA, BB, FE)	Pine needle cast (FW, FC)	
	Elytroderma (YA, BB, FE, FW)	Cattle damage (YA, BB)	
	Cattle damage (FE)	Deer browse (FC)	
	Deer browse (RE, YA, BB, FW)	Bear damage (RE, YA, FC, FE)	
	Rock pika browse (FC)	Squirrel feeding (FE, FW, FC)	
	Squirrel feeding (YA, BB)	Bark beetles (all)	
	Balsam woolly adelgid (FC)		
	Drought (FC)		

Stand Establishment Decision Aids

Stand Establishment Decision Aids (SEDAs) exist for forest health factors that affect this TSA. These SEDAs are available for download at <http://www.forrex.org/tools/sedas/>. The FH SEDAs that reference ecosystems from this TSA (and therefore may be of interest) are:

1. Southern Interior Forest Region Forest Health SEDAs (Blackstain Root Disease, Comandra Blister Rust, Western Gall Rust, Western Spruce Budworm, and White Pine Blister Rust)
2. Spruce Weevil coastal forests
3. White Pine Blister Rust
4. Armillaria Root disease
5. Laminated Root Rot coastal forests
6. Hemlock Dwarf Mistletoe coastal forests
7. Cariboo Forest Region SEDAs (Comandra & Stalactiform Stem Rusts, Pine Dwarf Mistletoe, Lodgepole Pine Terminal Weevil, Pine Needlecast, Western Gall Rust, Laminated Root Rot, Spruce Terminal Weevil, and Warrens Root Collar Weevil).

Several of these SEDAs are from the Coast and Cariboo in name, but due to the transitional ecosystems in our TSA, some of them apply. It is recommended that you monitor the Forrex webpage as new SEDAs are published from time to time and may be applicable to this TSA.

Where a SEDA identifies that there is a high hazard from a specified forest health factor in a given ecosystem, and the ranking of that forest health factor is high or very high, it may be appropriate to follow the management recommendations given in the SEDA. For your convenience and to help inform delegated decision makers (when reviewing proposed FSP stocking standards) those high hazard, high rank intersections are presented below.

- Western spruce budworm is noted as high hazard in the Southern Interior Region Forest Health SEDA. When operating in the IDF xh2, dk1, dk3 the following regeneration and establishment considerations are suggested: promote species mixtures and consider converting stands to non-host species (ie lodgepole pine, ponderosa pine and western redcedar). Further harvest and plantation maintenance considerations are made in the SEDA.
- Armillaria root disease is noted as high hazard, in the Armillaria Root Disease SEDA, when operating in any of our ecosystems except the PP. If Armillaria is detected within a block strong consideration should be given to the recommendations contained within the SEDA.
- Lodgepole pine dwarf mistletoe is noted as high hazard in the Cariboo Forest Region Part 1 Forest Health SEDA. When operating in the IDF dk1, dk3, xw, and ESSF dc2, consideration should be given to the recommendations contained within the SEDA, including removal of residual lodgepole pine over 50cm tall.

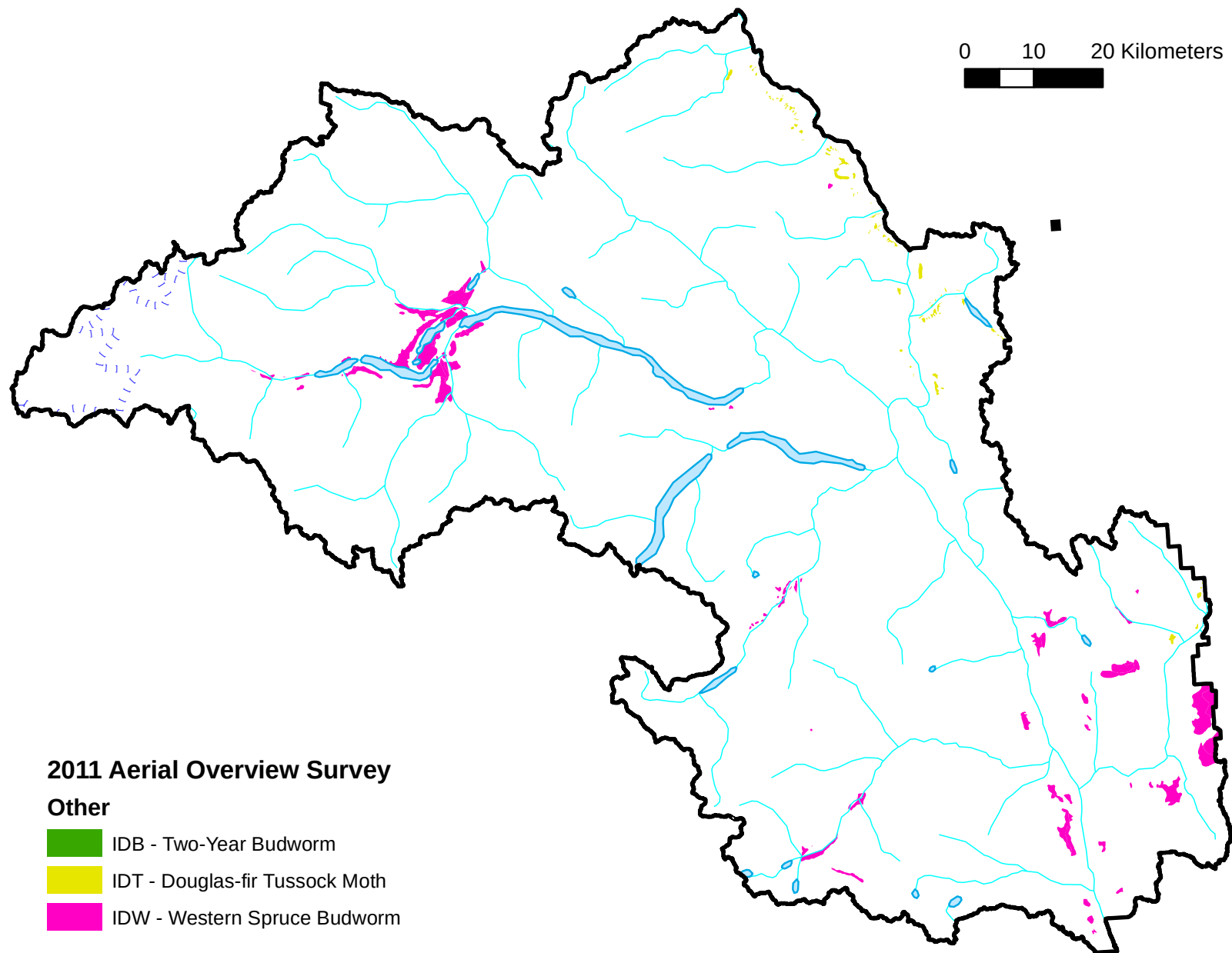


Figure 2b. 2012 Aerial Overview Survey of the Lillooet TSA: forest health factors excluding bark beetles.

Defoliators

Western spruce budworm (*Choristoneura occidentalis*) is the primary defoliator of concern for interior Douglas-fir in the Lillooet TSA. Outbreaks of this budworm cause significant damage through larval feeding on the foliage, resulting in reduced seed production due to damaged cones, growth loss, topkill, formation of stem deformities and even mortality, particularly in the understory. The IDF biogeoclimatic zone, which covers almost a quarter of the TSA (Figure 1), is a high hazard zone for western spruce budworm in Douglas-fir stands. Western spruce budworm defoliation has increased from 2011 to 2012. There are currently 34,443 hectares of defoliation. Of the total affected area, the severity class distribution is weighted to moderate defoliation.

The **Douglas-fir tussock moth** (*Orgyia pseudotsugata*) is a destructive defoliator of Douglas-fir of all ages. Since the larvae consume both old and new foliage, one year's defoliation can result in top kill and mortality. Outbreaks tend to be cyclical, and of short duration. If mature trees survive the defoliation, the resulting stress can put them at high risk of attack by the Douglas-fir beetle. The potential exists for a Douglas-fir tussock moth outbreak within the Lillooet TSA, particularly in the IDFxh2 and IDFxh3 subzones, which cover 109,500 ha in the Lillooet TSA. As part of the provincial defoliator strategy, the Ministry of Forests and Range monitors adult moth populations annually with the use of pheromone traps placed at permanent monitoring sites. In 2012 the area of tussock moth defoliation has collapsed to 38 hectares. The severity ratings are weighted to light defoliation.

The **gypsy moth** (*Lymantria dispar*) is a serious defoliator that causes reduced growth and mortality on a wide range of deciduous trees and shrubs, as well as some coniferous trees. It is an insect that has been periodically intercepted in BC since 1978 but aggressive monitoring and eradication programs have thus far prevented its establishment. As part of the provincial defoliator strategy, pheromone traps are placed in permanent monitoring locations to detect and treat incursions of gypsy moth in BC. Since Gypsy moth pupae may be transported on recreational vehicles, there exists great potential for its introduction into the Lillooet TSA through the Duffey Lake and Gun Lake corridors due to a high level of recreational use in these areas.

Miscellaneous defoliators such as birch leafminer and satin moth have been recorded in the past in small amounts during the overview surveys (Table 6). Deciduous trees can sustain severe defoliation without mortality, infested hectares have been low, and deciduous trees are not presently important crop trees in the Lillooet TSA. These defoliators will continue to be monitored through the overview surveys.

Climatic Injuries

In the past, **drought** has significantly impacted seedling establishment. All species have been affected, and significant mortality has occurred in first year plantations. Replanting has been necessary in some areas. Trees on dry slopes and in transitional zones from dry to wet ecosystems have particularly been impacted. In 2004, 509 ha of drought-affected plantations were observed in the West Pavilion, from McKay Creek north to Watson Bar Creek, but no significant areas have been recorded since.

Over the years there has been significant **wildfire** activity in the Lillooet TSA, particularly in 2009. In 2012 there was a 247 ha fire on Highway 99 north of Lillooet in the Pavilion lake area. Areas of damaged timber associated with wildfires, specifically Douglas-fir and spruce, will be monitored for infestation by bark beetles through aerial survey, ground reconnaissance and pheromone monitoring traps (if warranted), with subsequent treatment of beetle-infested trees through targeted trap tree and salvage/sanitation harvesting programs, where operationally feasible.

Table 6. Primary forest health agents recorded during aerial overview surveys 2003 – 2012 for the Lillooet TSA, excluding major bark beetles.

Year	Forest Health Agents	Light Disturbance (ha)	Moderate Disturbance (ha)	Severe Disturbance (ha)	Total Hectares
2003	Western spruce budworm	11,934	732		12,666
2004	Western spruce budworm	10,681	6,015	134	16,830
	Drought	509			509
	Fire			6,950	6,950
2005	Western spruce budworm	26,311	4,040		30,351
	Fire			5,560	5,560
2006	Western spruce budworm	43,713	25,511	470	69,695
	Fire			539	539
2007	Western spruce budworm	47,232	21,616	7	68,855
	Fire	8	2		28
2008	Western spruce budworm	42,341	1,089		43,430
	Fire	182			182
2009	Western spruce budworm	18,920	436		19,356
	Fire			39,311	39,311
	Douglas Fir Tussock Moth		31	206	237
2010	Western spruce budworm	28,087	5,328		33,415
	Fire	13		2000	2013
	Douglas Fir Tussock Moth	33	324	767	1,124
2011	Western spruce budworm	8,242	8,142	196	16,579
	Fire	25	24		49
	Douglas Fir Tussock Moth	277	569	181	1,027
2012	Western spruce budworm	15,608	18,371	462	34,443
	Fire			247	247
	Douglas Fir Tussock Moth	27	11		38

Animal Damage

Various animals cause damage to certain tree species in the Lillooet TSA on a localized or cyclical basis. Therefore, the importance of each animal varies by place and time. The **rock pika** is an example of intensive, but very localized damage that occurs near rocky outcroppings north of Downton Lake in the Fraser-Cascade BMU. The pikas live in the rocks, and feed on nearby seedlings of all species, which can be a real problem for regeneration of harvested areas. Significant mortality can occur; replanting and the use of browse protectors is sometimes required in this geographic area.

Deer browse can also be a regeneration problem, particularly in the Fraser East BMU. Douglas-fir are a particular favourite for browse in the Lillooet TSA, and browse protectors are sometimes required. There does not seem to be a particular pattern as to where damage occurs and is in fact more of a “hit and miss” situation.

Damage by **squirrel** feeding is cyclical and sporadic, with population fluctuations tending to coincide with cone crops. Trees 20 – 60 years of age tend to sustain the greatest injury, and feeding on rusts and mistletoe infections is common in lodgepole pine stands. Squirrel damage has been the most prevalent in the Relay and Yalakom BMUs.

Cattle damage due to trampling and rubbing is common in heavy grazing areas, particularly in the Fraser-East BMU. **Bear** damage through feeding and territory marking on bark has been observed on mature lodgepole pine trees in the Relay and Yalakom BMUs, and to a lesser extent in the Fraser-Cascade BMU. **Porcupine** damage due to feeding on lodgepole pine trees has been observed in the Big Bar and Fraser-East BMUs.

Animal damage is a licensee problem that must be addressed only when damage is sufficient that it interferes with the obligation to produce free-growing stands. The potential for this problem must be considered in relevant operational plans.

Sucking Insects

Balsam woolly adelgid (*Adelges piceae*) is an introduced organism to British Columbia that can cause serious damage to its host species, true fir. Depending on the intensity of attack and susceptibility of the host, damage can include top-kill, growth reduction, wood quality reduction and mortality. The first infestations of balsam woolly adelgid were found on the slopes above Vancouver and on southern Vancouver Island. A quarantine zone, which was established for the Lower Mainland, Vancouver Island and Gulf Islands, helped to slow the spread of balsam woolly adelgid, but has not prevented its movement. This forest health agent has significant damage potential to susceptible stands at the back end of the Nicoamen and Hurley River drainages bordering the Fraser and Soo TSAs respectively.

Balsam woolly adelgid monitoring

In efforts to monitor for Balsam woolly adelgid introduction and movement within the Lillooet TSA (same objective as Gypsy Moth monitoring), resuming annual sampling through branch clipping of susceptible sub-alpine fir in 22 established locations in the Nicoamen and Hurley River drainages by the MFLNRO – Cascades District is recommended. Reports from the Coastal Forest Region entomologist indicate that the adelgid is within the district boundaries in each of these locations.

Root Diseases

Armillaria root disease (*Armillaria ostoyae*) occurs throughout the Lillooet TSA, with the highest hazard biogeoclimatic zones being the IDF and MS, which cover more than a third of the TSA. A variety of living conifers of all ages are its principal hosts, though many living deciduous tree species and shrubs are also attacked. A comprehensive list of host susceptibility is included in the *FPC of BC Root Disease Management Guidebook*. Douglas-fir is the species of greatest concern in the Lillooet TSA. Armillaria root disease can cause growth loss and minor butt rot in diseased trees, however mortality and reforestation issues are the greatest cause of loss. **Laminated root rot** (*Phellinus weirii*) is also a forest health factor of concern primarily for Douglas-fir in the IDF biogeoclimatic zone in the Lillooet TSA. Infections can result in extensive butt rot and mortality can occur at all ages.

Tenure obligations in regards to root disease include an assessment of root disease incidence that may be required by the District Manager to ensure potential impacts are accommodated for in relevant operational plans. Results of these assessments and surveys are used to determine management options based on recommended practices in the *FPC Root Disease Management Guidebook*.

Pine Diseases

Lodgepole pine has a preponderance of diseases that influence growth, tree form and cause mortality. The disease of primary concern in the Lillooet TSA is **lodgepole pine dwarf mistletoe** (*Arceuthobium americanum*). The IDF and MS biogeoclimatic zones, which cover a third of the TSA, are high hazard areas for lodgepole pine dwarf mistletoe (DMP), though this disease is present throughout the range of lodgepole pine. Incidence and intensity of DMP has increased with fire exclusion practices. Heavily infected trees suffer reduced height and diameter growth, structural weakness leading to breakage, and occasional mortality. This disease can have significant impact in regenerating stands. **White pine blister rust** (*Cronartium ribicola*) on white pine and **western gall rust** (*Endocronartium harknessii*), **stalactiform blister rust** (*Cronartium coleosporioides*), and **comandra blister rust** (*Cronartium comandrae*) on lodgepole and ponderosa pine infect the host species throughout its range. Although these rusts can be found on trees of all ages, young trees are the most susceptible to serious damage including reduced tree growth, defects and mortality. White pine blister rust is the most serious, but white pine comprises a very low component of stands in the Lillooet TSA. Regenerating stands in the Lillooet TSA are affected by rusts, but usually at relatively low levels. White pine blister rust resistant stock is now available for operational use within BC. This stock should be considered when developing artificial regeneration prescriptions.

Atropellis canker (*Atropellis piniphila*) is a stem disease that infects lodgepole pine and occasionally ponderosa pine. The resulting cankers lower wood quality and can induce stem breakage. This disease does not usually become apparent in a stand until after freegrowing has been achieved.

Two **pine needle casts** are of concern in the Lillooet TSA, Elytroderma needle disease (*Elytroderma deformans*) and pine needle cast (*Lophodermella concolor*). Elytroderma needle disease is most common on ponderosa pine, and pine needle cast on lodgepole pine. Infection can cause severe defoliation, resulting in growth reductions and occasionally mortality. Small areas of pine needle cast defoliation were noted during the 2001 overview survey. Since then, moist summer conditions favorable for infections have not recurred.

Forest Health Strategy and Adaptive Management

Adaptive management as defined by the MFLNRO is a formal process for continually improving management by learning from the outcomes of operational plans. The ability to improve forest management outcomes through the implementation of alternative policies or practices resulting from the adaptive management process is a tremendous asset.

Important steps in the process include:

- acknowledging uncertainty about what policy or practice is “best” for the particular management issue,
- thoughtfully selecting the policies or practices to be applied,
- carefully implementing the plan of action,
- monitoring key response indicators,
- analyzing the outcome in light of the original objectives, and
- incorporating the results into future decisions.

This same process can be applied to the Forest Health Strategy, where the policies and practices implemented under the plan to meet the guiding strategic goals and objectives are closely monitored over time through key indicators (e.g. green:red ratio within managed areas), with the results of such actions evaluated against the stated objectives as a measure of success. Recommendations are then made to modify the existing forest health management goal and/or objective, policy and/or practice to be considered for incorporation in the Forest Health Strategy in efforts to meet or exceed current performance levels (i.e. continual improvement). In order for the adaptive management process to succeed, there must be active support by all parties involved in forest health the Lillooet TSA.

Bark Beetle Strategy and Tactical Plan

Bark Beetle Strategy Background

At a provincial level, broad mountain pine beetle management zones have been enacted. This allows for judicial allocation of limited resources to areas where aggressive management will most likely have the greatest impact and includes provisions for streamlining extraction of infested trees in a timely manner. These zones (Units) are defined within the overall management area known as the Emergency Bark Beetle Management Area (EBBMA). Designations have not changed over the last few years and the 2010 EBBMA designations will remain in effect. As of 2010 all of the Lillooet TSA is within an EBBMA *Salvage* unit for mountain pine beetle, except for the Shulaps, South Chilcotin and Stein beetle management units. Within salvage EBBMA units, consideration is given to larger timber salvage operations rather than direct control treatments such as fall-and-burn and small-scale sanitation harvesting.

The MFLNRO Cascades District continues to be the lead agency responsible for managing bark beetles in the Lillooet TSA. This includes reviewing and delineating beetle management units (BMUs), developing strategies and a tactical plan for each BMU, conducting detailed aerial surveys, conducting applicable ground surveys, applying treatments where needed, auditing activities, tracking actions taken and reporting on the program annually. All activities will be done in a cooperative approach with forest licensees who will be responsible for conducting bark beetle reconnaissance surveys within their operating area and developing bark beetle salvage/sanitation harvesting targets which would include the implementation of trap tree and pheromone baiting programs where necessary.

The Lillooet TSA strategy is guided by the *Provincial Bark Beetle Management Technical Implementation Guidelines*. The four possible strategies are Suppression, Holding action, Salvage and Monitor. These strategies will be selected on an annual basis for each bark beetle of concern for each BMU based on a combination of stand susceptibility, levels of attack (including spot to polygon ratio, total hectares, attack intensity, current to previous year attack ratios and adjacent population pressures), and consideration of whether the strategy objectives can realistically be achieved.

Susceptible Forest Types

An important part of designating strategies is to determine how much of the forest is at risk from a particular beetle. Area of susceptible forest types was determined for the Lillooet TSA for the mountain pine beetle, Douglas-fir beetle and spruce beetle (Table 7). The range of the susceptible forest types are shown for mountain pine beetle, Douglas-fir beetle and spruce beetle in Figures 3, 4, and 5, respectively.

The most current susceptibility data available 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 Douglas-fir/lodgepole pine stands. As this system produces a continuum of numbers from 0 – 100, the following categories were used:

0: none, 1-5: very low, 6-30: low, 31-60: moderate, 61-80: high 81+: very high

Table 7. Susceptibility ratings for mountain pine beetle, spruce beetle, and Douglas-fir beetle in the Lillooet TSA

Beetle	Susceptibility	Hectares	Percent of TSA
Mountain pine beetle	none	705,196	62.7%
	very low	178,039	15.8%
	low	131,807	11.7%
	mod	58,617	5.2%
	high	45,924	4.1%
	very high	5,441	0.5%
Total moderate to high susceptible PI		109,982	9.8%
Douglas-fir beetle	none	814,117	72.4%
	very low	52,587	4.7%
	low	197,744	17.6%
	mod	39,355	3.5%
	high	21,222	1.9%
	very high	0	0.0%
Total moderate to high susceptible Fd		60,577	5.4%
Spruce beetle	none	923,365	82.1%

	very low	20,052	1.8%
	low	132,872	11.8%
	mod	45,882	4.1%
	high	2,561	0.2%
	very high	293	0.0%
Total moderate to high susceptible Sx		48,736	4.3%

It is very important to note that with spruce beetle and particularly 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.

Larger versions of the following susceptibility mapping are available at the Cascades District Forest Health FTP site located at:
<http://www.for.gov.bc.ca/ftp/DCS/external/!publish/Forest%20Health/>

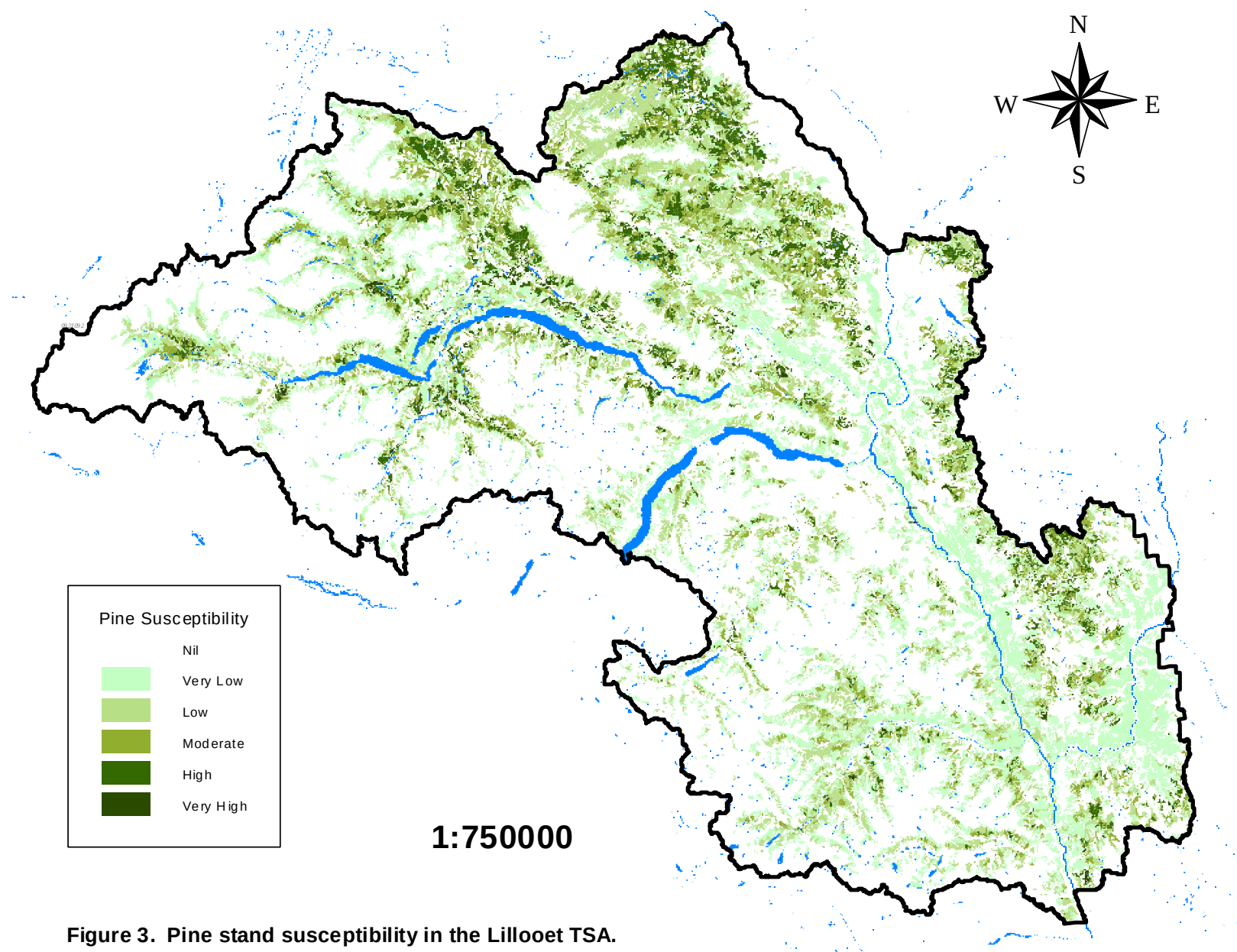


Figure 3. Pine stand susceptibility in the Lillooet TSA.

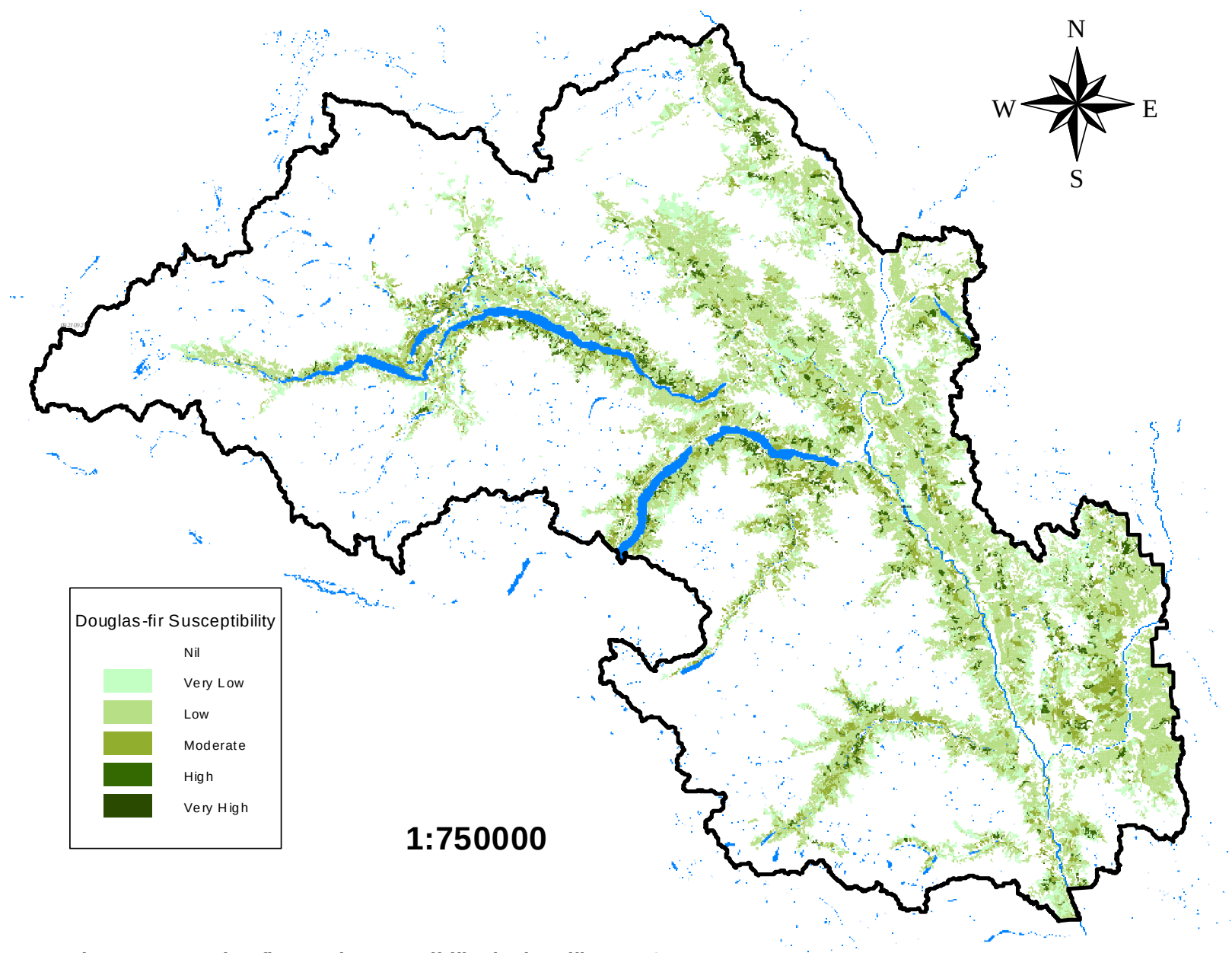


Figure 4. Douglas-fir stand susceptibility in the Lillooet TSA.

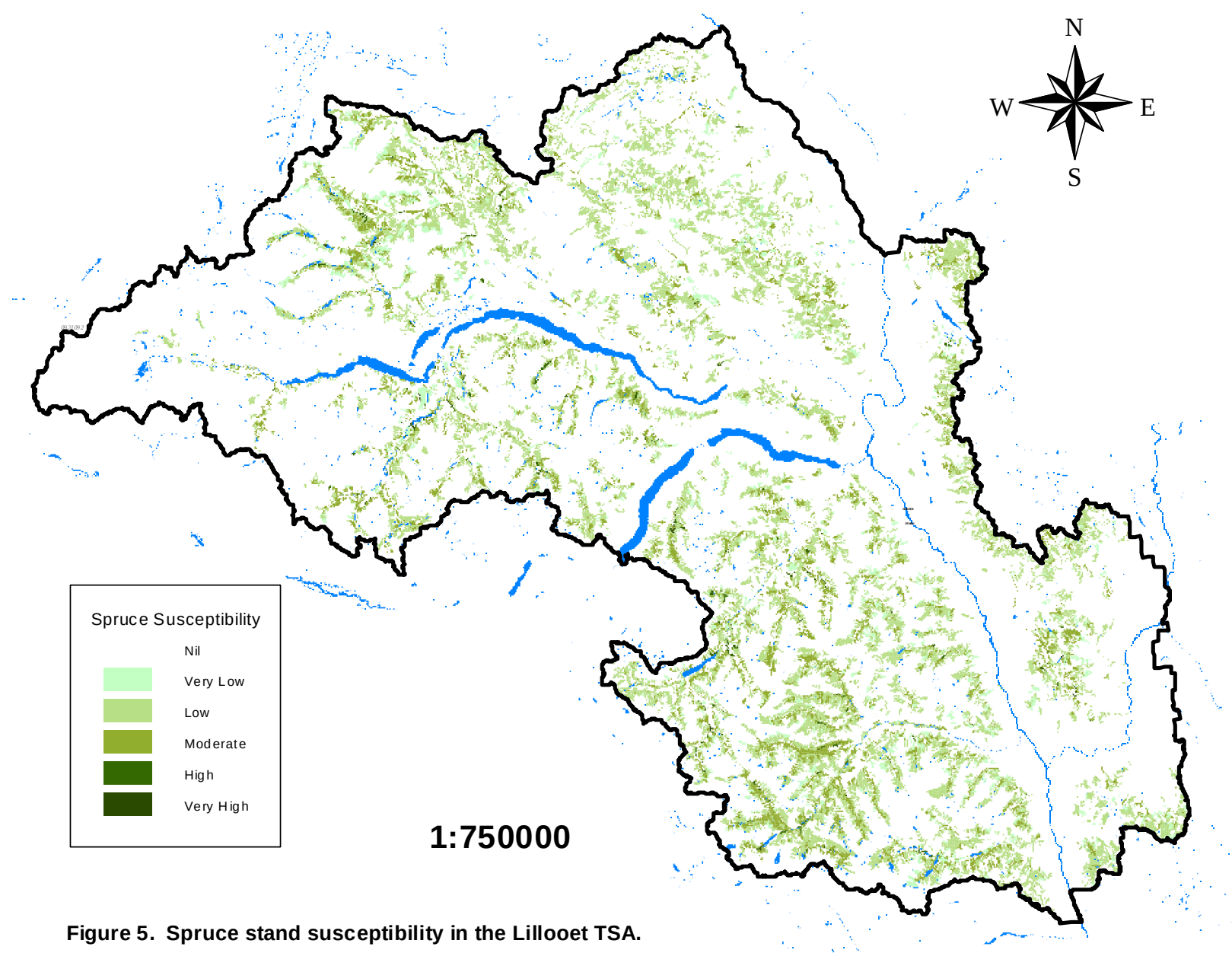


Figure 5. Spruce stand susceptibility in the Lillooet TSA.

Bark Beetles in the Lillooet TSA

The data quoted in this strategy stems from the Provincial aerial overview fixed wing survey. Although this data is not as accurate as the detailed aerial GPS survey data that drives the suppression activities, it has several advantages. The survey is cost efficient, covers all forested areas within the TSA (not just suppression BMUs), flags areas of interest that require detailed flights, includes all forest health factors visible from the air, and employs consistent methodology throughout the province year after year. As shown in Figures 6 and 7 and Table 8, four primary bark beetles have been recorded as active in the Lillooet TSA. In 2012, infested hectares of the balsam bark beetle remained constant at 1,601 hectares, while the spruce beetle increased to 660 hectares. Douglas fir beetle dropped to 366 hectares. The mountain pine beetle once again significantly decreased in infested area to 4,858 hectares.

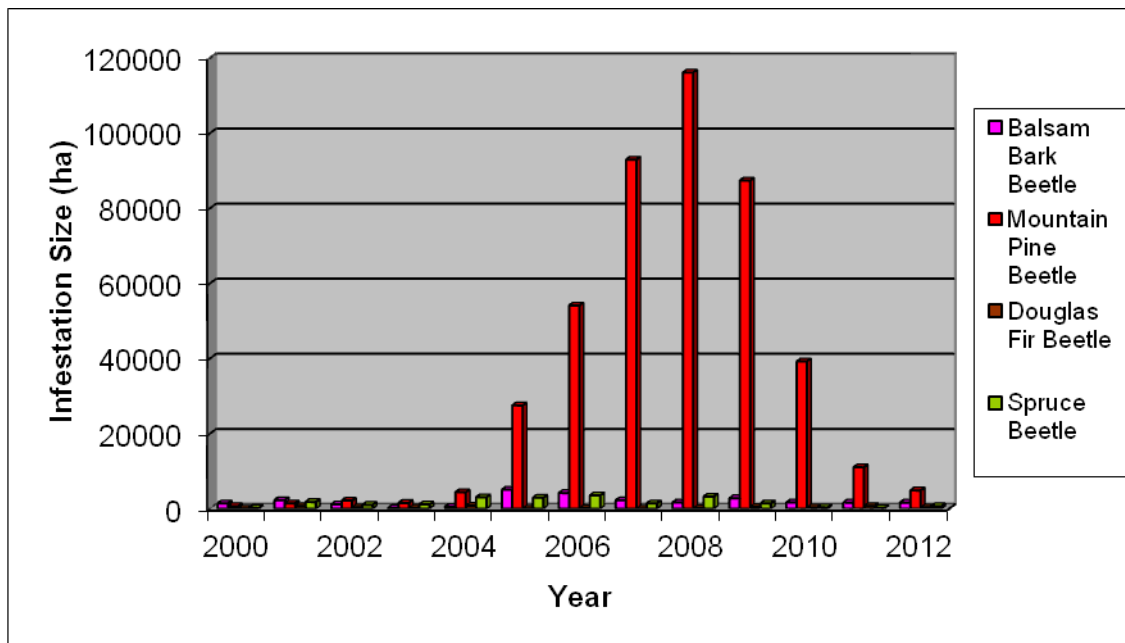


Figure 6. Primary bark beetle infestation levels in the Lillooet TSA 2000 – 2012.

Mountain Pine Beetle

The mountain pine beetle (*Dendroctonus ponderosae*) is the most destructive pest of mature pine in British Columbia, and continues to be the largest threat to BC forests in terms of timber loss, environmental concerns and negative economic impacts. The most extensive mountain pine beetle (IBM) epidemic in recorded history is presently underway in British Columbia.

The Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak (BCMPB, V8) suggests that peak infestation of green attack trees was in 2007. This correlates with overview data suggesting the Lillooet TSA peaked in hectares of red trees in 2008. The model suggests a cumulative pine killed percentage of 44% in 2021 for the Lillooet TSA.

Douglas-fir Beetle

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is an important pest of mature Douglas-fir in BC. At low population levels, the beetle infests scattered, stressed trees and windthrow. However, Douglas-fir beetle (IBD) populations can quickly build under favourable conditions, at which time significant numbers of healthy trees can be killed. Drought, fire, root disease or significant windthrow/breakage from ice and snow are often the precipitators of outbreaks.

Normally the annual beetle dispersal flight begins in late April or early May, but historical pheromone monitoring trap catches have shown that there are areas within the Lillooet TSA where the beetle flight has began much earlier, such as in the first week of April. This flight behaviour has been observed in the IDFxh2 and xh3 biogeoclimatic zones along the Thompson River around Lytton, and north as far as Lillooet along the Fraser River, during years of mild winter followed by a warm-to-hot spring. It is for this reason that trap tree programs targeted at beetle infestations in these locations *must* be implemented (trap trees felled) prior to the end of March.

Table 8. Total area of infestation for the primary bark beetles recorded during aerial overview surveys in 2003 – 2012 for the Lillooet TSA.

Beetle Species	Total Area of Infestation (ha) by Year									
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Douglas-fir beetle	242	789	53	111	33	127	459	330	681	366
Spruce beetle	1,113	3,034	2,940	3,525	1,396	3,185	1,401	338	104	660
Balsam Bark beetle	225	532	5,077	4,174	2,228	1,646	2,798	1,623	1,612	1,601
Mountain Pine beetle	1,525	4,357	27,485	54,103	92,931	116,161	87,369	39,200	11,013	4,858

Spruce Beetle

The spruce beetle (*Dendroctonus rufipennis*) is the most destructive agent of mature spruce in BC. At low population levels, the spruce beetle prefers to infest weakened trees and downed host material. If a significant amount of a preferred food source such as windfall or breakage from ice or snow is available, populations can build to the point of outbreak, where beetles then move into healthy trees.

Typically, the spruce beetle has a 2-year life cycle. Spruce beetle attack is often very difficult to observe due to the nature of how the foliage of attacked and killed spruce trees fade. The unreliable fading of foliage combined with the bi-annual adult beetle dispersal flight presents a challenge when attempting to map the true extent of spruce beetle infestations from the air. Ground truthing of representative spruce beetle infestations identified from the detailed aerial survey is imperative to determine whether the mapping is accurate, and allows confirmation whether the beetle populations are in year 1 or 2 of the life cycle. This ensures the most accurate information is available for beetle management planning and considering a BMU strategy assignment for spruce beetle.

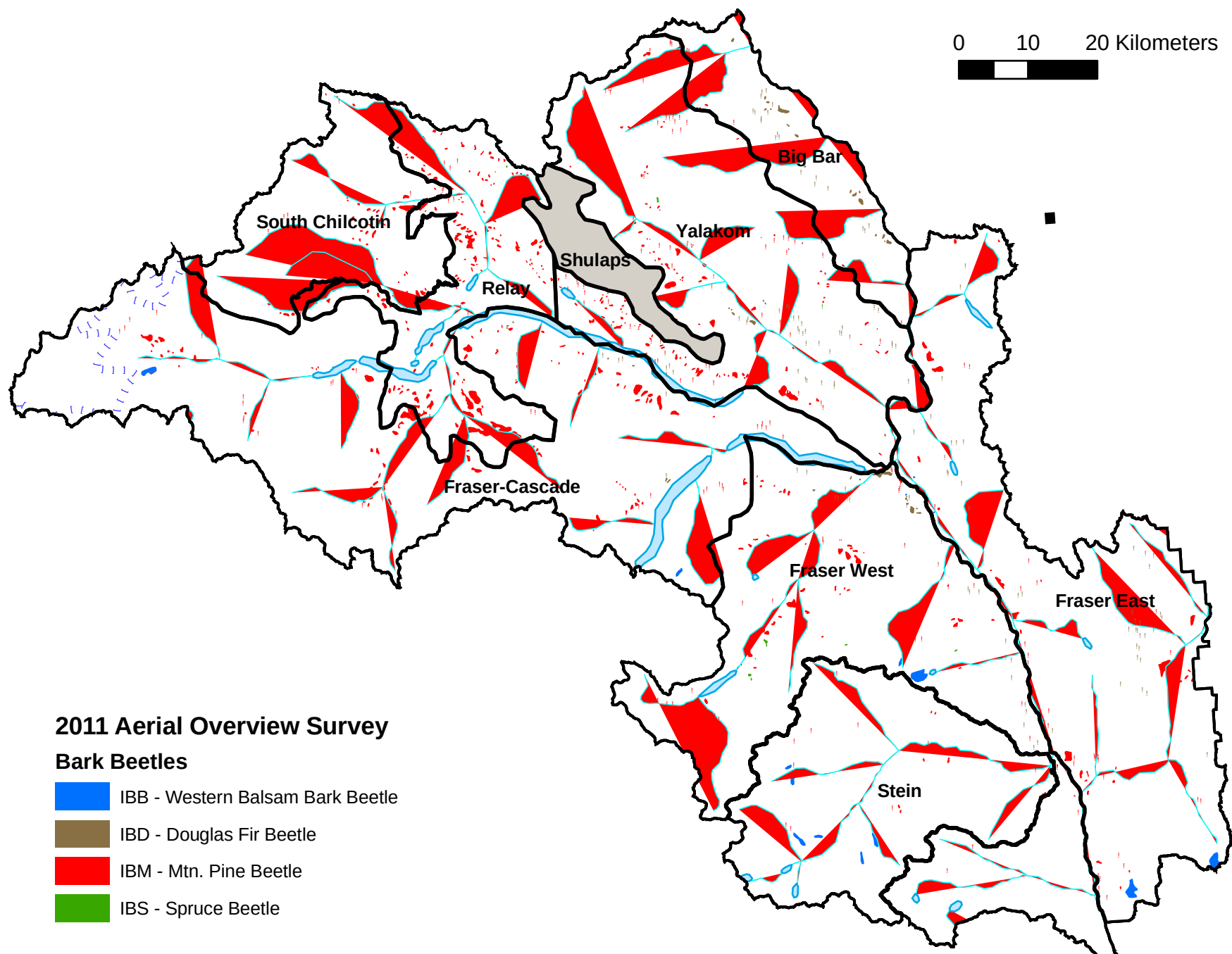


Figure 7. Lillooet TSA Beetle Management Units (BMUs) and 2012 Overview Survey of the Lillooet TSA: bark beetles

Western Balsam Bark Beetle

Western balsam bark beetle (*Dryocoetes confusus*) is the most significant damaging agent of its primary host, mature sub-alpine fir, in BC. This bark beetle and an associated pathogenic fungus can be responsible for significant tree mortality in high elevation ecosystems. More commonly however, less than 5% of a stand is killed in one year.

Currently this beetle species is not targeted for beetle management activities as much of the infestations are found in the high elevation ESSF, outside of the timber harvesting land base (inaccessible for salvage/sanitation harvesting). Western balsam bark beetle infestations and resulting impacts will continue to be monitored through aerial surveying and re-evaluated for management potential where possible.

Beetle Management Units and Strategy Designations

A Beetle Management Unit (BMU) is a delineated area of the landscape for the purposes of planning, implementing and reporting on bark beetle management activities. A BMU is assigned and designated for an area based upon parameters including susceptible forest types, topographic features, bark beetle activity (incidence and risk) and management opportunities, challenges and constraints such as parks and protected areas.

There are a total of nine (9) BMUs designated within the Lillooet TSA with varying strategies (Figure 7, Table 9).

Table 9. BMU areas and strategy designations in the Lillooet TSA as of April 1, 2013.

BMU	IBM Strategy	IBD Strategy	IBS Strategy	Hectares
Fraser – East (FE)	Salvage	Suppression	Monitor	184,302
Fraser – West (FW)	Salvage	Suppression	Salvage	192,483
Fraser – Cascade (FC)	Salvage	Suppression	Salvage	259,207
Relay (RE)	Salvage	Suppression	Suppression	77,125
Yalakom (YA)	Salvage	Suppression	Suppression	161,468
Big Bar (BB)	Salvage	Holding	Suppression	50,162
Shulaps (SH)	Monitor	Monitor	Monitor	20,579
South Chilcotins (SC)	Monitor	Monitor	Monitor	71,274
Stein (ST)	Monitor	Monitor	Monitor	108,424

Upon review, the strategies for all BMUs remain unchanged from that in 2012. The Fraser West BMU will be maintained at Suppression for IBD. Detailed surveys will not be completed in this BMU, the intent is to keep all harvesting and tenure options open to licencees for one more year. All BMUs that have pine and are under the MFLNRO's jurisdiction are designated as salvage. The Shulaps, Stein and South Chilcotins BMU strategies for all three beetle species remains *monitor*.

Following is a more detailed description of each BMU within the Lillooet TSA, including the current bark beetle infestation status recorded from the 2005 - 2011 overview surveys, and the forest types susceptible to bark beetle attack (Tables 10-21). **The tables have not been filled out for 2012 to facilitate an expedited update of this strategy.**

Fraser-East BMU

The Fraser-East BMU is situated on the east side of the Fraser River south of Lillooet to the TSA boundary (Figure 7), and includes the key drainages of North Lalluwissin, Murray, and Twaal Creeks, and Nicoamen River. The IDF and PP zones are in this BMU (Figure 1a) and it has many types susceptible to Mountain pine and Douglas-fir beetle.

Table 10. Summary of bark beetle dynamics in the Fraser-East BMU in 2005 - 2011.

		# Spots	#Spot Trees	Spot Area (ha)	# Polys	Poly Area (ha)	Spot to Poly	Total Area (ha)
Mountain pine beetle	2005	52	590	13	407	12,155	0.13	12,168
	2006	72	815	19	377	22,286	0.19	22,305
	2007	16	170	1.6	815	23,217	0.01	23,219
	2008	12	215	3.75	585	39,133	0.02	39,137
	2009	5	55	1.25	4,374	31,678	0.01	31,679
	2010	44	495	11.25	1,791	11,074	0.02	11,085
	2011	8	255	8.75	242	1,173	0.03	1,182
Douglas-fir beetle	2005	16	135	4			-	4
	2006							
	2007	1	5	0.1	1	5	1.00	5
	2008	7	50	1.75				1.75
	2009	18	190	4.5	31	51	0.58	55
	2010	40	340	10.25	39	157	1.02	167
	2011	20	315	10				10
Spruce beetle	2005							
	2006				2	237		237
	2007				1	16.2		16.2
	2008				1	179		179
	2009				32	121		121
	2010				19	64		64
	2011				3	12		12

Table 11. Stand susceptibility ratings for bark beetles in Fraser-East BMU

Beetle	Susceptibility	Hectares	% of BMU	Beetle	Susceptibility	Hectares	% of BMU
Mountain pine beetle	none	93,972	51	Douglas- fir beetle	none	82,293	44.7
	very low	49,979	27.1		very low	14,402	7.8
	low	20,833	11.3		low	71,198	38.6
	mod	10,320	5.6		mod	10,802	5.9
	high	8,421	4.6		high	5,607	3
	very high	776	0.4		very high	0	0
	Total mod - high	19,518	10.6		Total mod - high	16,409	8.9
Spruce beetle	none	158,401	85.9				
	very low	2,593	1.4				
	low	18,215	9.9				
	mod	4,957	2.7				
	high	136	0.1				
	very high	33	0				
	Total mod - high	5,126	2.8				

Fraser-West BMU

The Fraser-West BMU is situated on the west side of the Fraser River south and west of Lillooet to the TSA boundary (Figure 7). It includes Kwoiek, Intl pam, and Siwhe Creeks, as well as Cayoosh Creek, Duffey Lake and south of Seton Lake. A large part of the BMU is high elevation, with MS, ESSF, and AT biogeoclimatic zones. The IDF is in the valley bottoms of major drainages (Figure 1a). There is also a small area of CWH zone in the upper Cayoosh valley bottom. The broad spectrum of BEC zones represented in this BMU results in a significant amount of types susceptible to all beetle species.

Table 12. Summary of bark beetle dynamics in the Fraser-West BMU in 2005 - 2011.

		# Spots	#Spot Trees	Spot Area (ha)	# Polys	Poly Area (ha)	Spot to Poly	Total Area (ha)
Mountain pine beetle	2005	52	430	13	96	1,865	0.54	1,878
	2006	44	475	11	154	3,651	0.29	3,662
	2007	35	440	3.5	308	6,062	0.07	6,065
	2008	26	355	7	496	8,888	0.05	8,895
	2009	21	205	5.25	1,740	8,483	0.01	8,488
	2010	57	568	15	1,056	4,522	0.05	4,537
	2011	35	240	7.5	255	910	0.14	917
Douglas-fir beetle	2005	7	45	2	1	7	7.00	9
	2006	4	25	1				1
	2007				1	3	0.00	3
	2008	22	255	5.75	1	5.3	22	11
	2009	4	40	1	2	3.8	2.00	5
	2010	36	275	9	7	52	5.1	61
	2011	40	220	6	66	231	0.61	237
Spruce beetle	2005	1	10	0.25	4	138	0.25	138
	2006				27	510		510
	2007				22	668	0.00	668
	2008	2	20	.5	73	867	0.03	867
	2009				87	425		425
	2010	2	20	0.5	79	159	0.03	159
	2011				33	69		69

Table 13. Stand susceptibility ratings for bark beetles in Fraser-West BMU

Beetle	Susceptibility	Hectares	% of BMU	Beetle	Susceptibility	Hectares	% of BMU
Mountain pine beetle	none	147,679	76.7	Douglas-fir beetle	none	146,085	75.9
	very low	23,710	12.3		very low	7,097	3.7
	low	15,447	8.0		low	27,269	14.2
	mod	4,343	2.3		mod	8,126	4.2
	high	1,195	0.6		high	3,906	2.0
	very high	109	0.1		very high	0	0.0
	Total mod - high	5,647	2.9		Total mod - high	12,032	6.3
Spruce beetle	none	146,789	76.3				
	very low	4,421	2.3				
	low	29,112	15.1				
	mod	11,435	5.9				
	high	726	0.4				
	very high	50	0.0				
	Total mod - high	12,211	6.3				

Fraser-Cascade BMU

The Fraser-Cascade BMU is west of Lillooet to the TSA boundary encompassing the watersheds within the Bendor mountain range (excluding the lower Cadwallader Creek and Hurley River), Downton, Carpenter and Anderson Lakes, and the upper Bridge River to the Bridge Glacier (Figure 7). Much of this BMU is of higher elevation with AT, ESSF and MS ecosystems (Figure 1a) with a significant amount of susceptible spruce. A narrow band of IDF is along the south of Carpenter Lake and north of Anderson Lake.

Table 14. Summary of bark beetle dynamics in the Fraser-Cascade BMU in 2005 -2011.

		# Spots	#Spot Trees	Spot Area (ha)	# Polys	Poly Area (ha)	Spot to Poly	Total Area (ha)
Mountain pine beetle	2005	14	90	4	59	1,128	0.24	1,132
	2006	15	150	3.75	50	1,238	0.3	1,242
	2007	67	670	6.7	168	3,474	0.19	3,481
	2008	53	420	13.75	285	4,972	0.19	4,985
	2009	55	434	13.75	1,034	4,142	0.05	4,156
	2010	71	735	18.75	593	2,736	0.12	2,754
	2011	29	301	8.25	560	2,374	0.05	2,832
Douglas-fir beetle	2005	4	20	1	1	18	4.00	19
	2006	1	10	0.25			-	0.25
	2007	1	15	0.1				0.1
	2008	30	205	7.5				7.5
	2009	15	109	3.75	6	9	2.5	13
	2010	31	305	8				8
	2011	23	55	1.25	35	53	0.66	54
Spruce beetle	2005	1	30	0.5	76	2,516	0.01	2,517
	2006				38	2,626	-	2,626
	2007	2	10	0.2	17	500	0.12	500
	2008				58	1,795		1,795
	2009				113	312		312
	2010	3	40	0.75	68	100	0.04	100
	2011							0

Table 15. Stand susceptibility ratings bark beetles in Fraser-Cascade BMU

Beetle	Susceptibility	Hectares	% of BMU	Beetle	Susceptibility	Hectares	% of BMU
Mountain pine beetle	none	207,295	80.0	Douglas- fir beetle	none	221,102	85.3
	very low	25,664	9.9		very low	6,700	2.6
	low	17,116	6.6		low	21,963	8.5
	mod	5,566	2.1		mod	6,263	2.4
	high	2,550	1.0		high	3,178	1.2
	very high	1,016	0.4		very high	0	0.0
	Total mod - high	9,132	3.5		Total mod - high	9,441	3.6
Spruce beetle	none	233,925	90.2				
	very low	1,829	0.7				
	low	15,713	6.1				
	mod	7,179	2.8				
	high	561	0.2				
	very high	88	0.0				
	Total mod - high	7,828	3.0				

Relay BMU

The Relay BMU is situated northwest of Lillooet near Goldbridge (Figure 7), and includes the lower Cadwallader and Hurley River, Mud, Noaxe, Tyaughton, lower Relay and Gun Creek drainages. All biogeoclimatic zones found in the Lillooet TSA with the exception of the CWH are represented in this BMU (Figure 1a). A large proportion of the unit contains lodgepole pine and Douglas-fir susceptible forest types.

Table 16. Summary of bark beetle dynamics in the Relay BMU in 2005 - 2011.

		# Spots	#Spot Trees	Spot Area (ha)	# Polys	Poly Area (ha)	Spot to Poly	Total Area (ha)
Mountain pine beetle	2005	17	130	4.25	15	119	1.13	123
	2006	16	191	4.25	47	1,387	0.34	1,391
	2007	40	590	4.0	329	12,433	0.05	12,437
	2008	15	140	4	429	13,835	0.03	13,839
	2009	14	155	3.5	2,067	8,252	0.01	8,255
	2010	3	30	0.75	1,433	5,908	0.01	5,908
	2011	33	140	3.25	1,101	3,572	0.03	3,575
Douglas-fir beetle	2005							
	2006							
	2007							
	2008	1	5	0.25				0.25
	2009							
	2010							
	2011							
Spruce beetle	2005				1	31		31
	2006				1	30		30
	2007				5	69		69
	2008				5	63		63
	2009				22	67		67
	2010				3	2		2
	2011				2	6		6

Table 17. Stand susceptibility ratings for bark beetles in Relay BMU

Beetle	Susceptibility	Hectares	% of BMU	Beetle	Susceptibility	Hectares	% of BMU
Mountain pine beetle	none	33,527	43.5	Douglas- fir beetle	none	57,444	74.5
	very low	12,552	16.3		very low	5,177	6.7
	low	11,466	14.9		low	9,251	12.0
	mod	9,087	11.8		mod	4,027	5.2
	high	8,506	11.0		high	1,226	1.6
	very high	1,987	2.6		very high	0	0.0
	Total mod - high	19,580	25.4		Total mod - high	5,253	6.8
Spruce beetle	none	59,639	77.3				
	very low	1,885	2.4				
	low	11,863	15.4				
	mod	3,368	4.4				
	high	370	0.5				
	very high	54	0.1				
	Total mod - high	3,791	4.9				

Yalakom BMU

The Yalakom BMU is situated northwest of Lillooet (Figure 7), and encompasses the entire Yalakom River drainage, as well as the lower Bridge River including Ama, Moon and Camoo Creeks. A large proportion of the unit contains lodgepole pine and Douglas-fir susceptible forest types.

Table 18. Summary of bark beetle dynamics in the Yalakom BMU in 2005 - 2011.

		# Spots	#Spot Trees	Spot Area (ha)	# Polys	Poly Area (ha)	Spot to Poly	Total Area (ha)
Mountain pine beetle	2005	120	1,115	30	124	2,283	0.97	2,313
	2006	54	530	14	220	8,631	0.24	8,645
	2007	16	225	1.6	555	27,515	0.01	27,517
	2008	8	120	2.25	742	35,128	0.01	35,130
	2009	10	105	2.5	3,483	21,941	0.01	21,943
	2010	24	305	6.5	1,066	7,748	0.02	7,754
	2011	9	677	19	456	1,687	0.02	1,706
Douglas-fir beetle	2005	10	80	2.5	1	3	10.00	5.5
	2006							
	2007	2	15	0.2				0.2
	2008	5	55	1.25	2	19	2.5	20
	2009	5	55	1.25	7	49	0.71	50
	2010	16	180	4	21	52	0.76	56
	2011	21	281	9.5	19	75	1.11	85
Spruce beetle	2005				8	191	-	191
	2006				16	111	-	111
	2007				3	63		63
	2008				24	207		207
	2009				76	428		428
	2010				3	13		13
	2011	1	15	0.25	5	18	0.2	18

Table 19. Stand susceptibility ratings for bark beetles in Yalakom BMU

Beetle	Susceptibility	Hectares	% of BMU	Beetle	Susceptibility	Hectares	% of BMU
Mountain pine beetle	none	62,145	38.5	Douglas- fir beetle	none	102,244	63.3
	very low	25,988	16.1		very low	10,149	6.3
	low	40,081	24.8		low	40,148	24.9
	mod	17,354	10.7		mod	5,023	3.1
	high	14,859	9.2		high	3,904	2.4
	very high	1,042	0.6		very high	0	0.0
	Total mod - high	33,254	20.6		Total mod - high	8,927	5.5
Spruce beetle	none	127,965	79.3				
	very low	2,804	1.7				
	low	26,289	16.3				
	mod	4,361	2.7				
	high	50	0.0				
	very high	0	0.0				
	Total mod - high	4,411	2.7				

Big Bar BMU

The Big Bar BMU is situated directly north of Lillooet extending to the TSA boundary (Figure 7), and encompasses the entire area known as the West Pavilion. This BMU falls almost entirely within the hot and dry zones of the IDF, with MS at the higher elevations and PP along the Fraser River (Figure 1a). A significant proportion of the unit contains lodgepole pine and Douglas-fir susceptible forest types, but very little susceptible spruce.

Table 20. Summary of bark beetle dynamics in the Big Bar BMU in 2005 - 2011.

		# Spots	#Spot Trees	Spot Area (ha)	# Polys	Poly Area (ha)	Spot to Poly	Total Area (ha)
Mountain pine beetle	2005	26	350	6.5	158	9,634	0.16	9,641
	2006	1	20	0.25	90	15,267	0.01	15,267
	2007	4	70	0.4	164	12,657		12,657
	2008				104	10,875		10,875
	2009	1	10	0.25	295	1,925	0.01	1,925
	2010	1	15	0.25	177	888	0.01	888
	2011	2	55	2	15	32	0.13	34
Douglas-fir beetle	2005	2	20	0.5	1	24.5	2.00	25
	2006				2	110	-	110
	2007	12	195	1.2	7	26	1.71	27
	2008	15	295	5.25	9	443.5	1.67	449
	2009	22	260	5.5	109	330	0.20	335
	2010	33	415	8.75	24	94	1.38	102
	2011	127	215	5	76	323	1.67	328

Table 21. Stand susceptibility ratings for bark beetles in Big Bar BMU

Beetle	Susceptibility	Hectares	Percent of BMU
Mountain pine beetle	none	28,223	56.3
	very low	4,869	9.7
	low	5,483	10.9
	mod	3,901	7.8
	high	7,512	15.0
	very high	174	0.3
	Total mod to high	11,587	23.1
Douglas-fir beetle	none	29,614	59.0
	very low	3,476	6.9
	low	14,379	28.7
	mod	676	1.3
	high	2,018	4.0
	very high	0	0.0
	Total mod to high	2,693	5.4
Spruce beetle	none	47,260	94.2
	very low	407	0.8
	low	2,000	4.0
	mod	484	1.0
	high	11	0.0
	very high	0	0.0
	Total mod to high	496	1.0

Shulaps BMU

The Shulaps BMU is situated in the north-central portion of the Lillooet TSA, bisects the Relay-Yalakom BMU, and includes the lakes and headwaters of streams draining the alpine of the Camelsfoot Range (Figure 7). There is very little forested area within this BMU; only 86 of 20,579 hectares of this BMU falls within the timber harvesting land base. Very little forest pest activity was identified in this unit (~ 13 hectares of Mountain pine beetle) and no bark beetle management activities are proposed other than continued monitoring through aerial surveys.

South Chilcotins and Stein BMUs

The South Chilcotins BMU is situated in the northwest corner of the Lillooet TSA (Figure 7), and includes the upper Relay, Tyaughton, Gun, Leckie and Slim Creeks, and Spruce Lake. The BMU boundary encompasses the entire South Chilcotins Park, which includes the 14,700 hectares of Mining/Tourism Special Management Zones (from the LRMP).

The Stein BMU is situated near the southern boundary of the Lillooet TSA (Figure 7) on the west side of the Fraser River, covering the entire Stein River watershed. The BMU boundary encompasses the entire 108,424 hectares of the Stein Wilderness Park.

As both the South Chilcotins and Stein BMUs are protected areas under the management of BC Parks, no bark beetle management activities are proposed other than continued monitoring through aerial surveys. Information gathered through the aerial surveys is available to BC Parks for incorporation into their Park Forest Health Plans.

Bark Beetle Management and Reporting Activities

A variety of management activities will be considered and implemented to work towards meeting the management targets and expected performance measures in suppression BMUs. Communications and synchronization with forest licensees and other stakeholders representing forested lands in the Lillooet TSA such as parks is integral to the success of the bark beetle management activities.

Detection

The detailed aerial surveys for bark beetle attack and windthrow will be conducted to Ministry of Forests, Lands and Natural Resource Operations standards for *Detailed GPS Mapping Procedures*. The aerial survey is expected to begin the first week of August (weather and wildfires permitting), and complete within 3 weeks. Draft 1:30,000 colour-theme mapsheet plots would then be available for the priority beetle management areas by mid-September to allow ground surveys and forest licensee timber recce and development activities to commence immediately to expedite winter salvage/sanitation harvest operations. Final mapsheet plots and shapefiles will be available by early October to commence detailed management planning and prioritizing of identified beetle infestations for ground surveys and treatments. Information obtained from the detailed surveys will be provided to forest licensees, woodlots, small scale salvage loggers, and other interested stakeholders.

Single-tree Treatments

Single tree disposal by fall and burn will be conducted according to the Cascades District schedules. Single tree disposal will be utilized to destroy small numbers of beetle-infested trees that cannot be addressed by harvesting, such as in riparian management

areas, environmentally sensitive areas, wildlife tree patches, and other no-harvest zones. Fall-and-burn programs will be targeted to support forest licensee beetle management efforts in suppression BMUs.

Salvage/Sanitation Harvesting and Harvesting Priorities

Harvesting currently-attacked trees before beetle flight is the most effective form of beetle management and will be utilized whenever possible.

Harvesting activities by stakeholders other than the major forest licensees (such as Salvage Non-renewable Forest Licences and Small Scale Salvage) will be directed, wherever possible, into priority areas that will assist with TSA beetle management efforts in suppression BMUs.

The following harvesting priorities in order of importance will be followed where practical to maximize the beetle management effort (eliminate as many adult beetles and brood as possible) and minimize un-salvaged losses over the long term:

1. Stands that are heavily-infested with bark beetles (high numbers of beetle-infested trees in patches/polygons) and having existing or high potential for spread and damage (outbreak).
2. Stands that are infested with bark beetles in a scattered spot (“salt-and-pepper”) pattern and having existing or high potential for spread and damage (building).
3. Timber that has blown down, been damaged or killed by fire, forest pests, or other similar factors before the wood significantly deteriorates (salvage).
4. Stands at moderate-high susceptibility of being damaged by forest pests (stand susceptibility reduction).
5. Oldest, declining timber (stands that have reached culmination age) on most productive timber sites, exclusive of OGMA’s or other stands identified as important for wildlife habitat.
6. Other timber.

It is expected that forest licensee bark beetle management planning, detection and timber development activities will commence immediately for priority 1 (and possibly 2) areas, upon receiving aerial survey information. The emphasis will be to expedite the priority 1 and 2 areas of proposed salvage/sanitation permits to allow harvesting of those blocks prior to the next beetle flight (less than 1 year detection-to-harvest timeline).

Hauling Restrictions

To minimize the spread of beetles through log transportation, hauling and milling restrictions will be adhered to as per the Cascades District standard operating procedures.

Yard Management and Harvesting Practices

Activities to monitor beetles and reduce spread possibilities may include pheromone traps, watering of decks, and prompt manufacturing of logs delivered during beetle flight.

Clean harvesting practices are promoted, including the burning of slash piles prior to beetle flight.

Reporting Activities

The MFLNRO will report on accomplishments, expenses, issues, recommendations and performance measures in the update of the Forest Health strategy.

Bark Beetle Management and the Timber Harvesting Land Base (THLB)

The extremely mountainous terrain that covers a large portion of the Lillooet TSA presents a challenge to bark beetle management. Surveys and treatments outside of the THLB in inoperable areas tend to be very expensive, with little return on investment. Resources are limited, and need to be applied judiciously. The potential treatment prescribed for these areas is fall and burn, but safety of the crewpersons is a critical issue in conducting this treatment on steep unstable slopes. Figure 8, and Tables 22 and 23 summarize the amount of bark beetle attack (hectares) in the THLB, in each of the key BMUs.

Table 22. Beetle Management Units and the THLB.

BMU	THLB ha (% of BMU)
Fraser-East	69,276 (37.6)
Fraser-West	33,301 (17.3)
Fraser-Cascade	36,324 (14.0)
Relay	38,192 (49.5)
Yalakom	59,952 (37.1)
Big Bar	22,527 (44.9)
Total:	259,572 ha

Table 23. Summary of bark beetle attack (hectares) in 2008 - 2012 in the THLB by BMU.

Infested Area within the THLB (ha), by BMU															
Year	Mountain Pine beetle					Douglas-fir beetle					Spruce beetle				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Fraser-East	18,739	12,830	3,774	141	20		9	91		24	157	81	15	5	84
Fraser-West	2,769	4,083	1,174	346	286		4	20	53	7	569	381	31	14	
Fraser-Cascade	1,714	2,043	1,206	1,174	857		3		40		665	200	62		8
Relay	6,050	2,036	4,021	2,128	739						50	36		3	
Yalakom	16,434	11,825	2,541	686	373		13	28	45	36	158	255		7	81
Big Bar	6,631	959	501	16	10	109	69	9	205	66					
TSA Totals:	52,337	33,776	13,217	4,491	2,283	109	98	148	343	134	1,599	953	108	29	173

Bark Beetle Non-Recoverable Losses and Lillooet Timber Supply Reviews

When determining the allowable annual cut for the Lillooet TSA, the chief forester must take into consideration the "abnormal infestations in and devastations of, and major salvage programs planned for, timber in the area" (Sec.8(8)(e) of the *Forest Act*). Standing timber volume that is destroyed by natural causes (such as bark beetles) and is not salvaged is referred to as a non-recoverable loss (NRL). An NRL estimate calculated for a timber supply review is presented as the average annual unsalvaged loss of timber volume projected throughout the planning period, occurring within the timber harvesting

land base. The TSR analysis considers this value as how much timber volume was projected to be there, but will in fact *not* be there when that point in time is reached.

In the last few years salvage harvesting has dropped to almost non-existent levels (see table 25 in this report). The 2012 unsalvaged loss estimates for the Lillooet TSA do not include Mountain Pine Beetle (IBM). This insect is killing stands on a landscape level and assigning an annual loss estimate is beyond the scope of this TSA Forest Health Strategy. Losses due to IBM should be calculated in a TSR process in the future. Salvage for fibre uses of pine may occur for many years into the future after death due to IBM. Information regarding actual fibre uses of pine in the TSA should be included at that time.

The most recent projections by the Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak (BCMPB.v9) suggest that by the year 2022 the beetle will have killed 32% of the pine volume.

Table 24. Annual unsalvaged loss estimates (cubic metres) by factor in the Lillooet TSA for 2012.

Bark Beetle Species			Fire	Windthrow	Misc.	TSA Total
IBM	IBD	IBS				
Not Calculated	2,700	8,000	5,000	5,000	1,000	16,700

In efforts to address the magnitude of pine volume killed, the MoFLNRO continues TSA-wide aerial surveys to identify beetle infestations. This information is then provided to forest licensees, woodlots and small scale salvage loggers for harvesting consideration. In addition, the MoFLNRO places a priority on working with First Nations, local communities and forest licensees in the TSA to find solutions to the key constraints and challenges outlined on page 8 of this document that will allow access to and the harvesting of timber (specifically beetle-infested) that at present cannot be harvested.

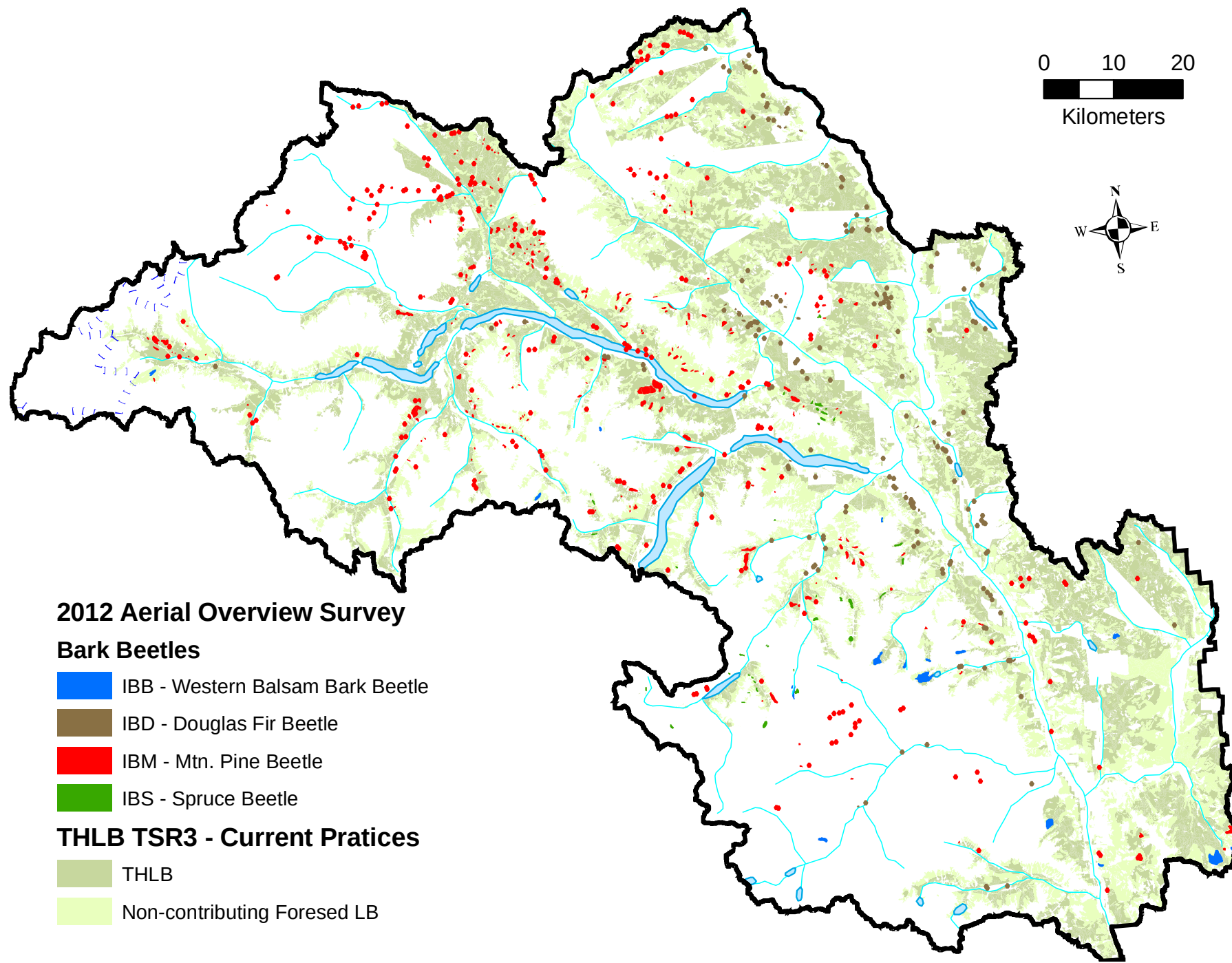


Figure 8. Timber Harvesting Land Base (THLB) and 2012 bark beetle infestations in the Lillooet TSA.

Bark Beetle Management Targets

The current approach to bark beetle management in the Lillooet TSA will be to target management activities at sites where the infestations are accessible and can be harvested in consideration of the constraints and challenges outlined on page 7 of this document. A cooperative and aggressive beetle management approach must be adopted and implemented by the MoFR, forest licensees, woodlots, and all other parties involved in beetle management activities in the TSA to maintain Douglas-fir and Spruce beetle populations at low levels. The Mountain Pine beetle outbreak within the TSA has not been economical to harvest for sawlogs at this time and it appears that the beetle will run its course before pine is economical to harvest for sawlogs again.

The forest licensee beetle management efforts (2012 accomplishments and 2013 proposed targets) are outlined in Table 25 and 26. Note that these targets are only estimates, and actual harvesting of the proposed blocks are dependent upon final approval and are subject to change due to the issues identified in the “Constraints and Challenges” section of this document.

Table 25. Summary of forest licensee beetle harvest accomplishments in 2012/13 in the Lillooet TSA.

BMU	FHF	Location/Drainage	Licensee ^a	Area (ha)	Proposed Volume (m ³)	Harvested Volume (m ³)
No harvest for forest health reasons.					0	0

Table 26. Summary of forest licensee beetle harvest targets in 2013/14 in the Lillooet TSA.

BMU	FHF	Location/Drainage	Licensee ^a	Area (ha)	Volume (m ³)
Fraser-East	IBM	Twaal/Blue Earth	INT	10	3,000
	IBM	E. Murray/Twaal Creeks	INT	10	3,000
Fraser-West	IBM	Murray	BCTS	35	10,000
	IBM,IBS	Duffy	BCTS	52	23,300
	IBS	Upper Cayoosh	INT	70	30,000
Relay	Fire	Tyaughton	SSS	100	30,000
Big Bar	IBM	Upper McKay (re-sell)	BCTS	227	75,700
				500+	175,000

^a – Forest Licensees as follows:

MoFR	Ministry of Forests and Range	BCTS	BC Timber Sales Program
ASP	Aspen Planers Ltd.	INT	Interwest Timber
MCF	Marble Canyon Forestry	SSS	Small Scale Salvage Program

Tactical Plan for Forest Health/Bark Beetle Activity in the Lillooet TSA for 2013/14

This portion of the Forest Health plan summarizes the total bark beetle management efforts proposed for 2013/14 in six of the BMUs in the Lillooet TSA (Tables 27). The forest licensee management targets are commitments by individual licensees to ground survey and salvage/sanitation harvest, if warranted. The proposed MoFR suppression activity targets are in consideration of those of forest licensees, and are based upon a combination of historical data, infestation data, and population dynamics.

The unit costs were based on:

- Detailed aerial surveys: \$0.19/ha
This cost is based on the Lillooet TSA average and includes the three aerial GPS mapping components: the helicopter and pilot, the on-board GPS mapping technician, and producing maps from the data.
- Ground surveys: \$60.00/ha
This cost was based on the all-found cost in the Lillooet TSA of a ground survey crew comprised of one senior and one junior technologist, including vehicle and field equipment.
- Fall & Burn treatments: \$65/tree (pine), \$110.00/tree (Douglas-fir, spruce)
This cost is based on the Lillooet TSA average for fall-and-burn of lodgepole pine, Douglas-fir and spruce and includes the all-found cost for a crew of one Worksafe BC-certified faller and 1-2 spotter/crewpersons.

Ministry of Forests and Range Forest Health/Beetle Management Activities and Proposed Budget

Table 27: Summary of MoFR forest health/bark beetle management activities and costs recommended for 2013/14.^a

BMU Name	Bark Beetle Species	Strategy	Surveys				Treatments		Total BMU Cost (\$)
			Detailed Air ^b		Ground ^c		Fall & Burn ^d		
			ha	\$	ha	\$	trees	\$	
<hr/>									
No funds are requested this year.									
		Total							
		Total							
Grand Total									\$

^a - Based upon historical data, infestation data, and population dynamics for the Lillooet TSA.

^b - \$0.19/ha all-found cost includes helicopter/pilot, FH technician, and GPS-mapping technician and digital file production.

^c - \$60/ha all-found cost for a survey crew of 2 persons.

^d - \$65/pine tree & \$110/Douglas fir or spruce tree all-found cost for a fall-and-burn crew of 1 certified faller and 1-2 spotter/crewpersons.

^e - Cost is for ground surveying of selected spot beetle infestations throughout the BMU to monitor population trends and determine G:R ratios.

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