Columbia Forest District

2010/2011

Forest Health Strategy

for the

Revelstoke
Timber Supply Area

prepared by:

John Cruickshank, RPF
Stewardship Forester
Columbia Forest District

Kurt Huettmeyer, RPF
Acting District Manager
Columbia Forest District

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Table of Contents

1.0 INTRODUCTION

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

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

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

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

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

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

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

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

The Columbia Forest District – Revelstoke TSA Forest Health Strategy is structured as follows:

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

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

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

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

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

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

2.0 TSA DESCRIPTION

The Revelstoke timber supply area is situated in the eastern portion of the Southern Interior Forest Region and is administered by the Ministry of Forests and Range, Columbia Forest District office, located in Revelstoke. The Revelstoke TSA is lies within the traditional lands of Okanagan and Shuswap Nations though there are no First Nation reserve communities within the TSA.

The TSA covers 549,420 hectares of rugged and mountainous terrain. Approximately 222,822 hectares or 41 percent of the total TSA area is considered forest land managed by the BCFS. The area defined as the timber harvesting land base, 52,358 hectares, represents about 23 percent of the productive forest land base following area exclusions for factors such as poor operability, environmental sensitivity and unmerchantable forest types.

The forests of the Revelstoke TSA provide a variety of habitat for wildlife, including large animals such as black bear, grizzly bear, moose, elk, mule deer, mountain goat, and mountain caribou. The TSA provides important habitat for the Revelstoke/Shuswap caribou herd.

Recreational values and uses of forests in the Revelstoke TSA are high due to proximity of national and provincial parks, exceptional natural scenery, and the presence of highway and rail transportation. Consequently, tourism is becoming an increasingly important economic sector in the area's economy.

Bark beetle pests are posing a threat to management objectives for many of these resources. Western Hemlock looper is considered the highest priority forest health agent, with Douglas-fir beetle and Spruce bark beetle to a lesser extent in the TSA. Catastrophic infestations result in millions of dollars in reduced revenue due to timber losses, degraded lumber values, reduced stumpage values, degradation of non-timber resources, increases in unsalvaged losses, and disruptions in forest planning and long-term impacts on resource sustainability. Large scale tree mortality within the Revelstoke TSA could also have negative impacts on recreation, fire hazard, visual objectives, fish and wildlife resources, water management and other resource values.

Beetle Management Units (BMUs) follow the same boundary lines as Landscape Units. The following Beetle Management Units (BMUs) contain TFL area and are not covered by this strategy with the exception of R01 and R02 which contain isolated parcels of TSA lands (timber licences that have reverted back to the crown).

TFL BMU #	TFL BMU Name
R01	Pingston
R02	Cranberry
R04	Mulvehill
R05	French
R12	Downie
R17	Mica
R19	Goldstream

The following 13 BMUs are included in the Revelstoke TSA Forest Health Strategy.

BMU#	BMU Name	BMU#	BMU Name
R01	Pingston (TSA portion only)	R11	Big Eddy
R02	Cranberry (TSA portion only)	R14	Liberty
R03	Akolkolex	R15	Horne
R06	Redrock	R16	Soards
R07	Jordan	R18	Bigmouth
R08	Frisby Ridge	R20	Illecillewaet
R10	Laforme		

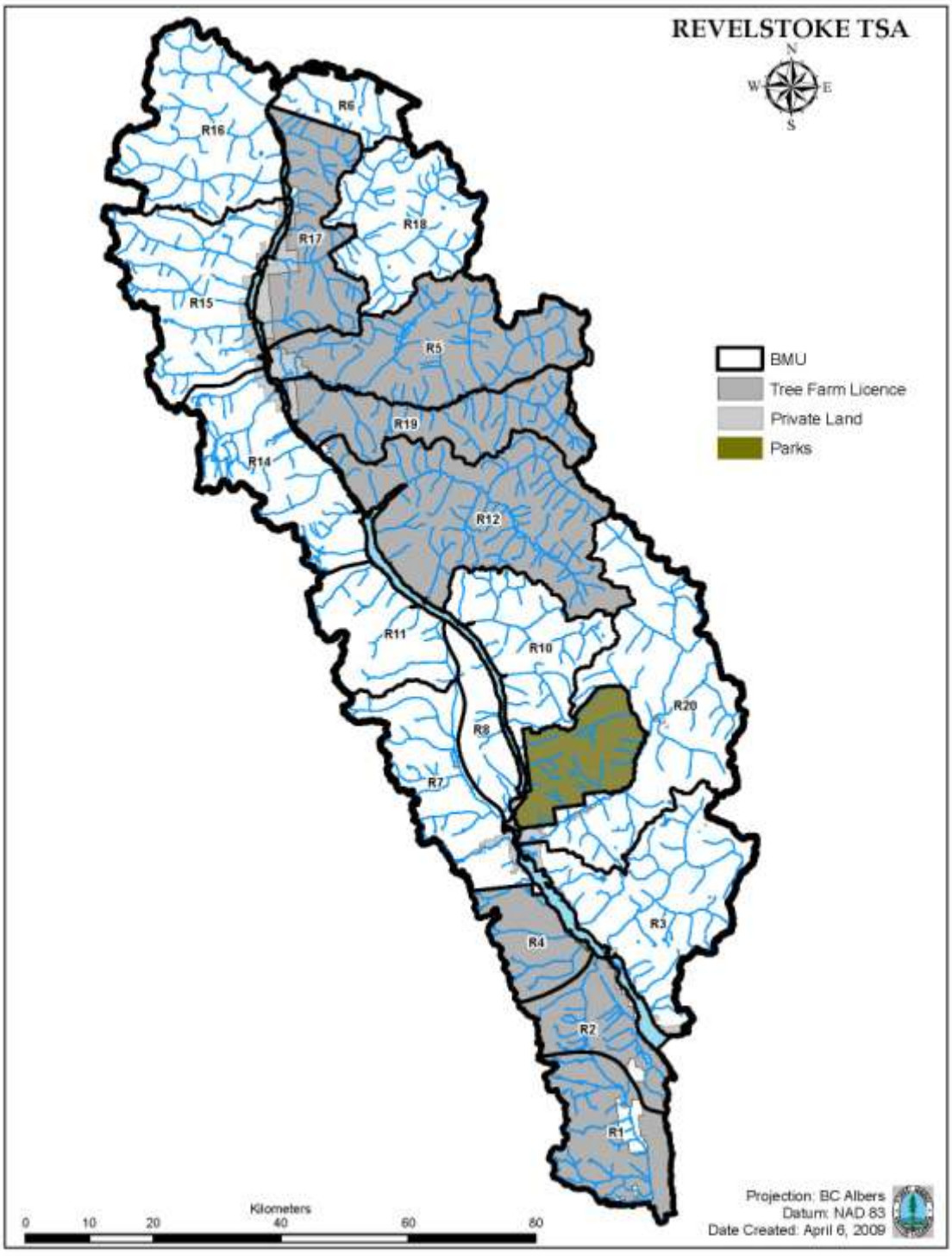

Figure 1 Map of Revelstoke TSA, identifying Revelstoke National Park, private land and TFL area not included in this forest health strategy.

3.0 OBJECTIVES OF THE *COLUMBIA FOREST DIDTRICT FOREST HEALTH STRATEGY – REVELSTOKE TSA* AND ACTIONS REQUIRED AT THE DISTRICT LEVEL

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

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

Columbia Forest District Actions

a) Apply the results of the annual provincial overview survey to prioritize the location and need for detailed aerial and ground surveys within the District. As required, quantify the incidence and intensity of damaging agents to the standard in the appropriate guidebooks.
    - The two most damaging forest health agents currently in the Revelstoke TSA are Western balsam bark beetle and the Birch leaf miner.
    - Western balsam bark beetle and the Birch leaf miner are identified through the provincial overview survey as covering fairly large areas of the Revelstoke TSA. The Western balsam bark beetle causes significant mortality to subalpine fir leading stands. Given that most of the sites infested are inaccessible and small, the attack dynamics of this insect do not lend themselves to direct control action, therefore no direct strategies have been developed to deal with this forest health factor at this time. The Birch leaf miner attacks both aspen and birch. Both species are not considered commercially viable species and there have also been no direct strategies developed to deal with this forest health factor.
b) Maintain a record of all survey information for the landbase.
c) Standardize data collection among MOFR and licensees when and where required to facilitate strategic objectives.
d) Improve and refine detection methods in consultation with Regional Forest Health specialists.
e) Ensure forest workers, consultants and industry staff, are competent at identifying specific forest health agents. Training, both formal and informal may be obtained from Regional Forest Health specialists.

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

Columbia Forest District Actions

a) Use the best current information to determine hazard and risk and probable impacts of all detected and potential forest health agents on the landbase.
b) Update existing hazard and risk rating systems as new information becomes available.
c) Develop, support and implement modelling of pest dynamics and impact assessments for Timber Supply Reviews.

d) Evaluate and prescribe approaches to deal with introductions of non-native, potentially harmful organisms.

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

Columbia Forest District Actions

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

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

Columbia Forest District Actions

a) Assign mitigating strategies where deemed appropriate (include prevention, suppression, exclusion, and eradication through direct or indirect control tactics). Forest tenure holders to incorporate the district strategies into operational plans and actively co-operate to work towards meeting the forest health goals and objectives. Wherever economically feasible, direct harvesting efforts to meet those strategic forest health objectives.
b) Quantify the outcome of selected strategies and tactics, including doing nothing (e.g., change in quantified yields or diminished future management options).
    - Columbia Forest District staff will be initiating Stand Development Monitoring (SDM) plots in declared free growing blocks within the Revelstoke TSA in 2010 to assess the health and vigor of our plantations after free growing declarations have been approved.
c) Accelerate implementation of mitigating strategies and tactics to deal with unforeseen outbreaks of damaging agents in a timely manner.

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

Columbia Forest District Actions

a) Inspect field practices to ensure forest management objectives are met.
b) Target applied research activities to support scientifically based standards of forest practice on Crown lands.
c) Bring issues of particular concern, where more research could be directed, to the attention of Regional forest health specialists.
d) Apply the results of inspections and monitoring to the development and refinement of future actions. Consider providing a tabular report summarizing the status of the actions indentified in the Forest Health Strategy.

For example:

ACTION	STATUS

4.0 RANKING OF IMPORTANCE OF FOREST HEALTH FACTORS

The priority forest health agents have been ranked following the Provincial Forest Health Strategy (Table 1).
Rankings were based on the following factors:

- The collective knowledge of the Regional and District forest health specialists, forest managers, licensees and contractors
- Known or suspected impacts to forest resource values, based on the knowledge of local forest professional and regional forest health specialists
- Availability of operational detection and treatment methods
- Costs and benefits of applying detailed detection and treatment activities
- Overall level of knowledge about the hazard and risk zones
- Distribution of pest and current incidence levels
- Resources required to obtain missing information necessary for management of the pests

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

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

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

Table 1 Ranking of forest health agents by potential impact on forest management activities in the Revelstoke TSA

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

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

Table 2 Primary forest health agents recorded during the aerial overview survey 2005-2009 (excluding incidence in National Parks) on crown forested lands.

Forest Health Agents	Common Name	2005	2006	2007	2008	2009	Total
DFH	Larch needle cast					13	**13**
IBM	Mountain pine beetle	294	397	673	883	111	**2,358**
IBD	Douglas-fir beetle	290	62	0	364	40	**756**
IBS	Spruce beetle	14	94	0	0	0	**108**
IBB	Western Balsam bark beetle	3,651	1,388	3,516	261	1,844	**10,660**
IBF	Fir engraver beetle	0	99	0	240	0	**339**
ID	Defoliators					15	**15**
IDA	Black army cutworm	0	0	49	0	0	**49**
IDF	Forest tent caterpillar					59	**59**
IDL	Western Hemlock looper	3,408	1,359	4,166	0	235	**9,168**
IDU	Satin moth	13	48	0	0	0	**61**
ID6	Birch leaf miner	0	0	4,107	0	2,580	**6,687**
NB	Fire	340	1,429	1,336	0	767	**3,872**
ND	Drought					93	**93**
NS	Slide	0	65	0	9	31	**105**
NW	Windthrow		83	23	0	0	**106**
	Total	**8,014**	**5,024**	**13,870**	**1,757**	**5,788**	

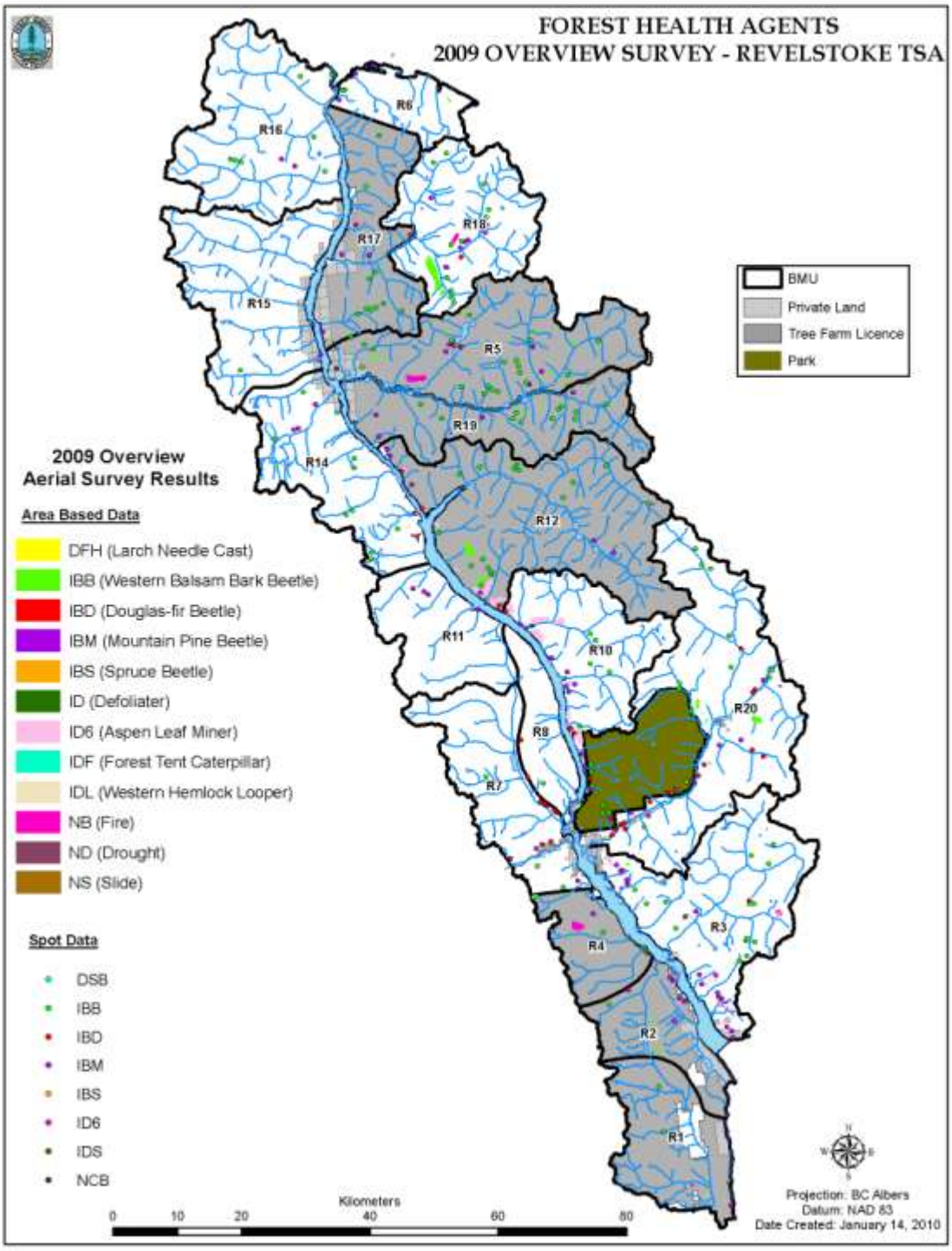

Figure 2 2009 Provincial Aerial Overview Survey results by forest health agent

5.0 STRATEGIES AND TACTICS

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

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

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

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

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

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

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

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

5.1 DEFOLIATORS

Western hemlock looper *(Lambdina fiscellaria lugubrosa)*

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

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

Birch leaf miner *(Fenusa pusilla)*

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

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

Black army cutworm *(Actebia fennica)*

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

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

Forest tent caterpillar *(Malacosoma disstria)*

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

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

5.2 DISEASES

Armillaria root disease *(Armillaria ostoyae)*

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

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

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

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

Tomentosus root disease *(Inonotus tomentosus)*

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

Tomentosus root disease often causes small gaps in stand canopies that can coalesce into larger opening, within which lay randomly-oriented, downed trees with decayed roots. Symptoms include chlorotic thinning foliage, reduced shoot growth, and distress cones. Juvenile trees die quickly; older trees suffer extensive butt rot leading to increased susceptibility to windthrow and insect attack. Tomentosus spreads primarily through root contact and can survive in infected large stumps for decades.

White pine blister rust *(Cronartium ribicola)*

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

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

Hard pine rusts

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

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

Hard pine rusts are a very minor concern as pine is not usually planted in harvested blocks in the Revelstoke TSA.

5.3 INSECTS

Western balsam bark beetle *(Dryocoetes confuses)*

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

Populations of Western balsam bark beetle have occurred throughout the range of Sub-alpine fir within the Revelstoke TSA. The 2009 aerial overview survey noted low levels of attack primarily spots and trace amounts from Shelter Bay north to Mica primarily on

the east side of Arrow Lake and Lake Revelstoke. Given that most of the sites infested are inaccessible and very small and the attack dynamics of this insect do not lend themselves to direct action, no direct strategies will be developed to deal with this forest health factor at this time.

Douglas-fir beetle *(Dendroctonus pseudotsugae)*

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

Large outbreaks of Douglas-fir beetle have not been recorded in the Revelstoke TSA likely due to the widespread occurrence of mixed species stands. Over the last four years, the provincial aerial overview survey has identified a low incidence of Douglas-fir beetle throughout the TSA. Spot infestations have been identified surrounding Revelstoke and on the west side of Lake Revelstoke north to Mica.

Spruce beetle *(Dendroctonus rufipennis)*

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

Spruce beetle outbreaks have occurred in the past in the Pingston/Cranberry creek area on TFL 23 and in the Crawford creek area. More recently the provincial aerial overview survey has not identified any infestations of spruce bark beetle in the Revelstoke TSA. When identified, the outbreaks will be dealt with on a site-specific basis.

Spruce weevil *(Pissodes strobe)*

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

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

Mountain pine beetle *(Dendroctonus ponderosae)*

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

Mountain pine beetle has been noted on white pine as spot infestations on the aerial overview surveys over the last number of years. Due to the minor lodgepole pine component, the majority of the Revelstoke TSA is considered low hazard to mountain pine beetle, with most of the hazard found in the southern part of the TSA.

5.4 MAMMALS

Deer, Moose

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

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

5.5 ABIOTIC FOREST HEALTH FACTORS

Windthrow

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

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

Fire

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

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

6.0 ROLES AND RESPONSIBILITIES

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

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

Table 3 Roles and responsibilities for the implementation of the Revelstoke TSA Forest Health Strategy in mature timber types.

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

7.0 BMU STRATEGY FOR IBD, IBS AND IBM

Table 4 BMU Strategy by beetle: IBD, IBS, IBM for 2010/2011 for the mature forest

BMU	BMU Name	Beetle		
		IBD	IBS	IBM
R01	Pingston	Monitor	Monitor	Monitor
R02	Cranberry	Monitor	Monitor	Monitor
R03	Akolkolex	Suppression	Monitor	Monitor
R07	Jordan	Suppression	Monitor	Monitor
R08	Frisby Ridge	Suppression	Monitor	Monitor
R10	LaForme	Monitor	Monitor	Monitor
R11	Big Eddy	Monitor	Monitor	Monitor
R14	Liberty	Monitor	Monitor	Monitor
R15	Horne	Monitor	Monitor	Monitor
R16	Soards	Monitor	Monitor	Monitor
R20	Illecillewaet	Suppression	Monitor	Monitor

8.0 NON-RECOVERABLE LOSSES

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

The majority of NRLs are generally the result of abiotic factors like wind and fire. Catastrophic or sustained events (e.g. prolonged defoliation) or those which are not well-suited to either OAF (e.g. drought, windthrow) may also qualify. The most recent NRL estimates for the Revelstoke TSA are provided in **Table 5**.

Table 5 Summary of non-recoverable (unsalvaged) losses by damaging agent and percent of AAC affected as accounted for in TSR3.

TSA (effective date)	Fire m^3/yr	Wind m^3/yr	Avalanche m^3/yr	Pests m^3/yr	Total m^3/yr	Current AAC m^3/yr	% of AAC
Revelstoke TSA TSR4 (2009) (in progress)	10,759	230	70	660	11,719	230,000	5.09

9.0 CONCLUSION

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

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

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

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

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

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APPENDIX 2: BARK BEETLE OBJECTIVE, STRATEGY AND TACTICS

Background

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

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

Management Objectives for IBS and IBD

The following are the management objectives to be implemented for the two main bark beetles in the Revelstoke TSA: Spruce beetle and Douglas-fir beetle.

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

Bark Beetle Management Zones

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

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

The tactics are:

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

Emergency Bark Beetle Management Areas (EBBMA)
The Provincial Bark Beetle Coordinator updated the provincial zonations for Mountain pine beetle, Douglas-fir beetle and Spruce beetle in January of 2009. The designation followed examination of the 2008 aerial overview data as well as consideration of management objectives.

Strategies

Within each broad bark beetle management zone are individual Beetle Management Units (BMUs). BMUs are planning and reporting units for operational beetle management. These BMUs usually coincide with landscape unit boundaries. This strategy includes thirteen (13) BMUs in the Revelstoke TSA. For each bark beetle, the BMUs have been assigned one of four specific strategies. These strategies are:

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

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

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

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

Strategies are selected biannually based on the level of outbreak in an area, stand susceptibility rating, accessibility, beetle pressure from surrounding areas and the estimated effectiveness of management actions in achieving the strategy objective and performance measure. Potential constraints to meeting objectives are considered when

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

Table 6 Provincial control strategies and associated objectives for beetle population removal.

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

Tactics

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

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

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

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

Table 7 Bark Beetle Management Tactics as they apply to specific BMU strategies.

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

APPENDIX 3: SUSCEPTIBLE FOREST TYPES

An important part of designating strategies is to determine how much of the forest is at risk from a particular beetle. The area of susceptible forest was determined for the Revelstoke TSA for Mountain pine beetle, Douglas-fir beetle and Spruce beetle (Table 8). 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.

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

Table 8 Susceptibility ratings for Mountain pine beetle, Spruce beetle and Douglas-fir beetle by hectares on crown forest land base within the Revelstoke TSA.

Beetle	Susceptibility	Hectares	Percent
Mountain pine beetle	Nil (0)	470,120	96.2
	VL (0-5)	7,836	1.6
	Low (5-20)	8,494	1.7
	LM (20-40)	1,995	0.4
	Moderate (40-60)	308	0.1
	High (60-80)	35	0
	VH (80-100)	5	0
Total susceptible Pl	(>0)	**18,673**	**3.8**
Total moderate to high susceptible Pl		**348**	**0.07**
Spruce beetle	Nil (0)	357,049	75.9
	VL (0-5)	13,839	2.9
	Low (5-20)	48,092	10.2
	LM (20-40)	40,148	8.5
	Moderate (40-60)	9,690	2.1
	High (60-80)	1,782	0.4
	VH (80-100)	21	0
Total susceptible Sx	(>0)	**113,572**	**24.1**
Total moderate to high susceptible Sx		**11,493**	**2.4**
Douglas-fir beetle	Nil (0)	448,447	91.7
	VL (0-5)	17,283	3.5
	Low (5-20)	18,961	3.9
	LM (20-40)	3,592	0.7
	Moderate (40-60)	498	0.1
	High (60-80)	12	0
	VH (80-100)	0	0
Total susceptible Fd	(>0)	**40,346**	**8.3**
Total moderate to high susceptible Fd		**510**	**0.1**

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

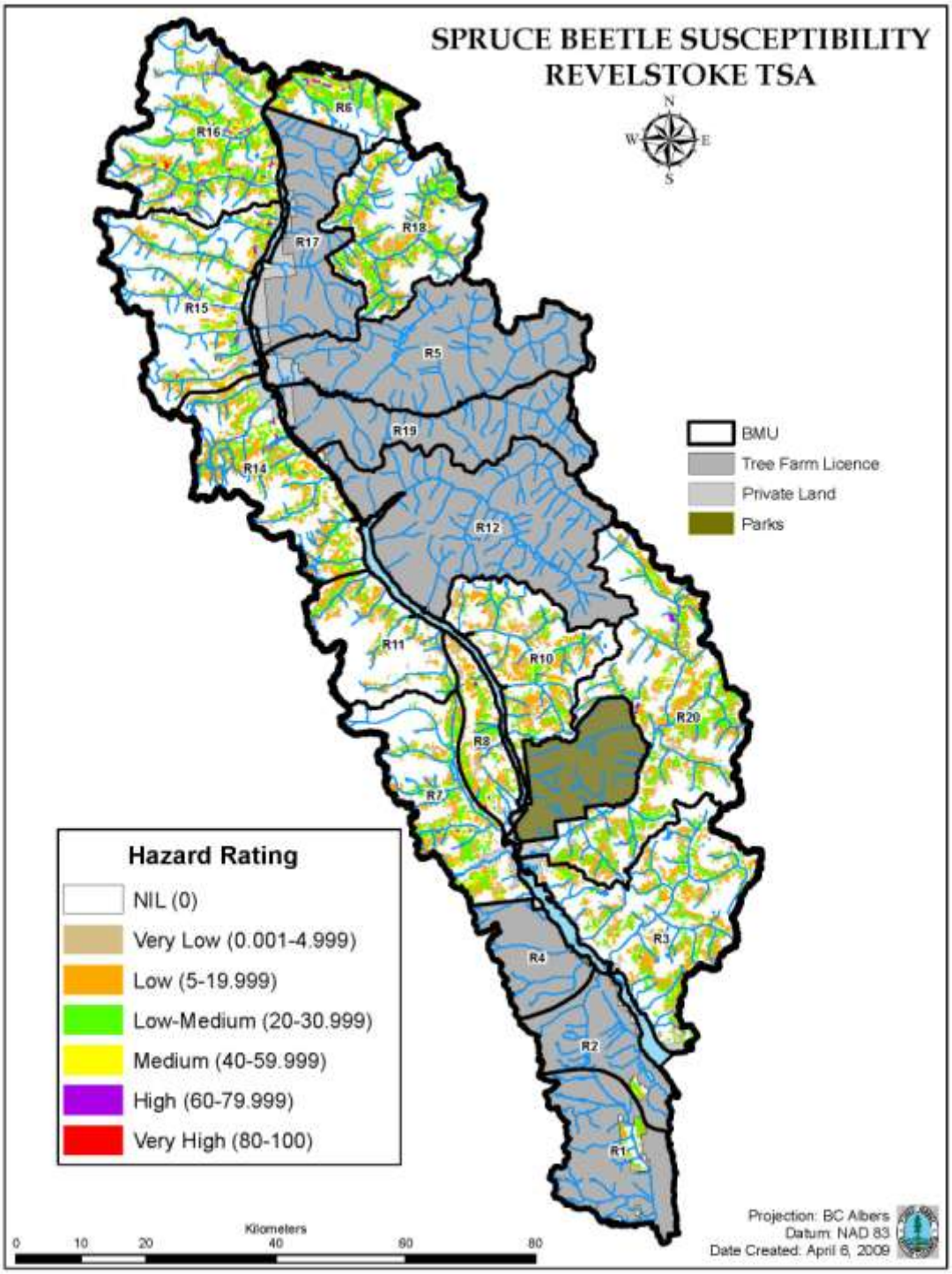

Figure 3 Spruce stand susceptibility in the Revelstoke TSA

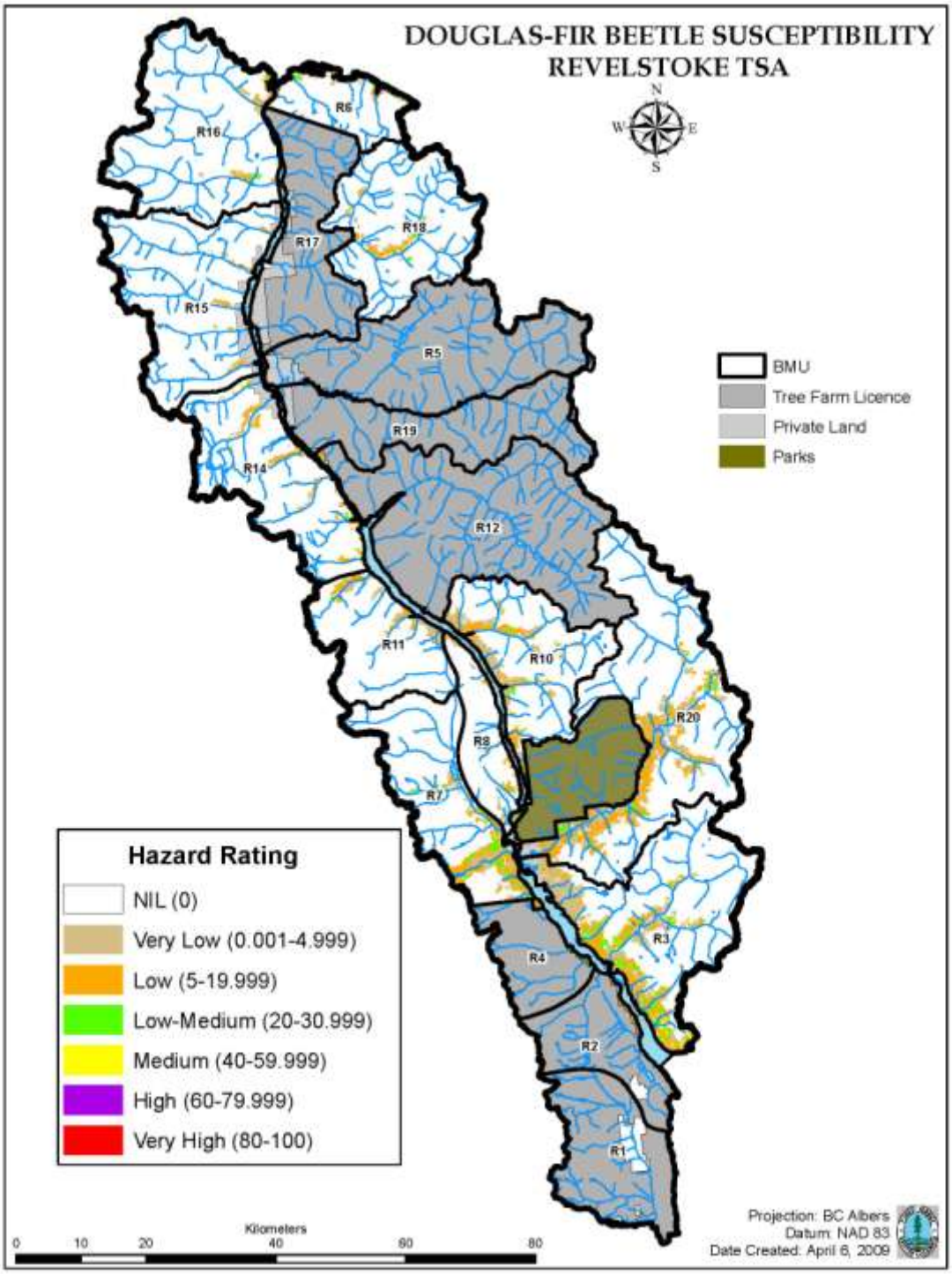

Figure 4 Douglas-fir stand susceptibility in the Revelstoke TSA

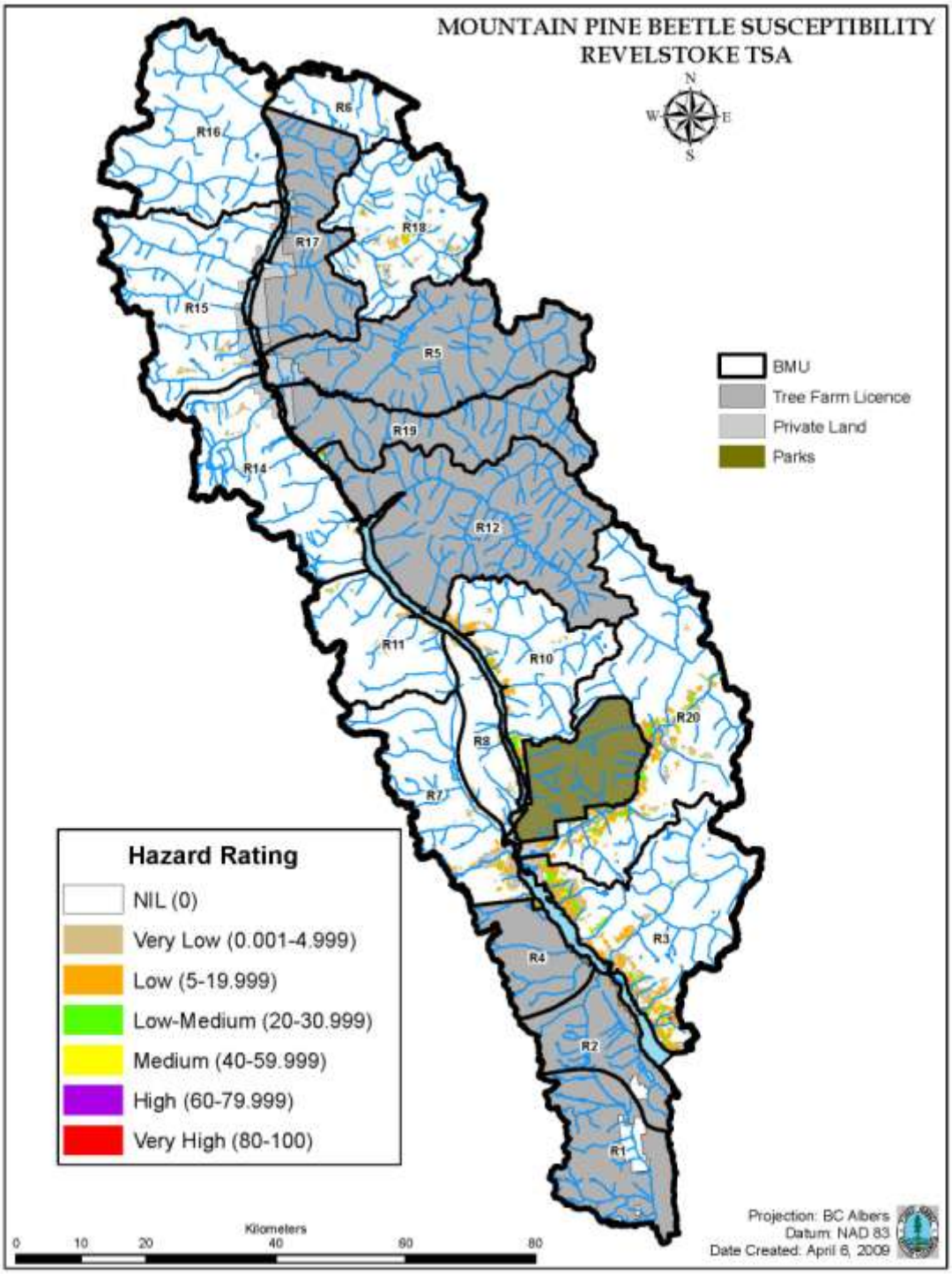

Figure 5 Pine stand susceptibility in the Revelstoke TSA

Table 9 Summary of 2009 Overview survey of hectares of attack and hectares of susceptible host (2006) on the crown forest land base in the Revelstoke TSA.

BMU	BMU Name	Hectares of attack			Hectares of susceptible host (where hazard is > 0)		
		IBM	IBS	IBD	IBM	IBS	IBD
R01	Pingston	0	0	0	0	1,177	8
R02	Cranberry	0	0	5	236	465	341
R03	Akolkolex	81	0	4	6,471	13,820	12,396
R06	Redrock	0	0	0	180	6,985	756
R07	Jordan	0	0	6	1,373	10,596	4,905
R08	Frisby Ridge	0	0	0	637	6,388	1,150
R10	LaForme	0	0	0	2,108	11,577	5,108
R11	Big Eddy	0	0	0	546	5,395	1,697
R14	Liberty	0	0	25	431	13,827	1,749
R15	Horne	0	0	0	454	9,490	645
R16	Soards	0	0	0	91	17,623	865
R20	Illecillewaet	18	0	0	5,055	21,340	10,067
	Total	**99**	**0**	**40**	**14,582**	**118,683**	**38,687**