2011 Overview of Forest Health for Southern British Columbia

Summary of Aerial Overview Surveys for Southern B.C.

2011

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Introduction

This report summarizes the results of the 2011 Aerial Overview Surveys for the southern interior of British Columbia. These surveys are performed annually by the B.C. Forest Service, Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) and document forest damage due to bark beetles, defoliators, and any other visible forest health factors, such as foliar diseases and abiotic damage. Surveys were carried out using the standardized Provincial Aerial Overview Survey protocols (http://www.for.gov.bc.ca/hfp/health/overview/methods.htm). Table 1 describes severity ratings used in the surveys.

The 2011 surveys were completed between July 11 and August 20, 2011. A total of 281.5 hours of fixed-wing aircraft flying in 57 separate flights were required to complete the surveys, which covered the entire landbase of the Cariboo, Thompson Okanagan, and Kootenay Boundary Natural Resource Regions. Flying conditions were generally good, although some delays were experienced due to cloudy, wet weather. Unseasonably cool weather during the spring and early summer slowed the development of some damage signatures. As a result, detection of mountain pine beetle attack was more difficult and possibly underrepresented in some areas.

Conifer defoliating insects were the most commonly mapped damage, totaling 630,000 hectares. Bark beetles affected 176,500 hectares, and were the most prevalent tree mortality factor and cause of volume loss. Other major damage types were insect defoliators of deciduous trees (nearly 96,000 hectares) and needle diseases (over 33,000 hectares). An assortment of other disturbances, such as root diseases, animal damage, declines, and abiotic agents such as wildfire, caused damage on another 4,360 hectares (Table 2).

In 2011, realignment of the Natural Resource Regions resulted in some organizational changes to some Districts. The southern portion of the Headwaters District which is within the Kamloops Timber Supply Area, was re-aligned with the former Kamloops District and renamed the Thompson Rivers District, within the Thompson Okanagan Natural Resources Region. The northern portion of the Headwaters District is now part of the Omineca Region. Similarly, the Arrow Boundary, Columbia, and Kootenay Lake Districts were functionally realigned into a single Natural Resources District, the Selkirk District. For the purposes of this report, the results of the aerial overview surveys will be reported out using the original pre-2011 District organizational units to facilitate easier comparison to previous years (Headwaters District results will represent the southern portion of the District only). No changes were made to the District boundaries in the Cariboo Natural Resources Region.

Table 1. Severity ratings used in the aerial overview surveys. Two types of severity ratings are used. Bark beetles and other direct mortality-causing agents are rated based on the percentage of recently killed trees in the stand. Defoliators (both insect and disease) are rated based on the severity of foliage loss.

Disturbance Type	Severity Class	Description
Tree Mortality (including bark beetles, abiotic and animal damage, and declines)	Trace	< 1% of trees in the polygon recently killed
	Light	1-10% of trees in the polygon recently killed
	Moderate	11-29% of trees in the polygon recently killed
	Severe	30-49% of trees in the polygon recently killed
	Very Severe	50% + of trees in the polygon recently killed
Defoliation (including defoliating insect and foliar disease damage)	Light	some branch tip and upper crown defoliation, barely visible from the air
	Moderate	thin foliage, top third of many trees severely defoliated, some completely stripped
	Severe	bare branch tips and completely defoliated tops, most trees sustaining >50% total defoliation

Table 2. Area summaries for forest health factors mapped during the 2011 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (hectares)					
	Trace	Light	Moderate	Severe	Very Severe	Total
Mountain Pine Beetle						
Okanagan Shuswap	15,222.7	22,774.8	5,659.3	843.4	240.2	44,740.4
Cascades	20,103.3	18,652.4	2,999.5	245.7	76.5	42,077.5
Rocky Mountain	10,434.9	10,400.2	6,608.9	1,286.2	0.0	28,730.3
Arrow Boundary	5,187.3	7,488.9	1,879.8	30.7	3.7	14,590.4
Kootenay Lake	2,098.1	4,013.5	2,457.2	383.1	0.0	8,952.0
Chilcotin	2,388.4	6,122.0	46.2	0.0	2.2	8,558.8
Columbia	1,917.9	2,997.9	1,780.9	449.1	0.0	7,145.7
Central Cariboo	2,487.4	1,340.5	42.7	0.0	0.0	3,870.7
Quesnel	485.6	583.2	0.0	0.0	0.0	1,068.8
Headwaters	571.3	284.2	12.1	5.3	0.0	872.9
100 Mile House	187.1	39.7	78.9	0.0	0.0	305.7
Kamloops	86.3	8.2	4.4	0.0	0.0	98.8
Total	**61,170.2**	**74,705.5**	**21,570.0**	**3,243.5**	**322.6**	**161,011.9**
Douglas-fir Beetle						
Chilcotin	588.9	1,191.6	39.3	0.0	0.0	1,819.8
Rocky Mountain	10.8	169.9	479.5	54.5	0.0	714.6
Cascades	50.4	445.4	125.8	32.2	4.2	657.9
Kamloops	0.0	226.1	297.2	19.5	13.9	556.7
Kootenay Lake	13.4	332.2	15.7	0.0	0.0	361.3
Columbia	79.7	211.9	6.2	0.0	0.0	297.8
Okanagan Shuswap	0.0	87.7	159.2	37.6	3.6	288.1
Central Cariboo	144.7	98.5	39.8	0.0	0.0	283.0
Quesnel	0.0	195.6	71.5	0.0	0.0	267.0
100 Mile House	35.4	143.6	5.0	0.0	0.0	184.1
Arrow Boundary	0.0	33.1	38.8	0.0	0.0	72.0
Headwaters	0.0	6.8	9.3	0.0	0.0	16.2
Total	**923.3**	**3,142.5**	**1,287.1**	**143.8**	**21.7**	**5,518.5**
Spruce Beetle						
Central Cariboo	1,868.5	2,649.5	344.5	0.0	0.0	4,862.6
Kamloops	0.0	552.6	1,044.2	607.1	87.8	2,291.7
100 Mile House	409.6	1,027.5	268.9	0.0	0.0	1,705.9
Rocky Mountain	0.0	120.7	309.8	47.4	0.0	477.9
Cascades	0.0	35.2	363.6	41.4	26.7	466.9
Quesnel	43.5	134.4	0.0	0.0	0.0	177.9
Headwaters	0.0	0.0	25.6	0.0	0.0	25.6
Okanagan Shuswap	0.0	7.3	10.6	0.0	0.0	17.9
Chilcotin	0.0	0.0	3.5	0.0	0.0	3.5
Total	**2,321.6**	**4,527.3**	**2,370.5**	**695.9**	**114.5**	**10,029.8**
Western Balsam Bark Beetle						
Okanagan Shuswap	52,916.6	120.4	0.0	0.0	0.0	53,037.0
Headwaters	38,663.9	1,247.8	0.0	0.0	0.0	39,911.8
Central Cariboo	15,746.0	5,785.8	335.6	0.0	0.0	21,867.4
Kamloops	12,811.0	476.6	9.7	0.0	0.0	13,297.3
Quesnel	12,456.1	166.6	0.0	0.0	0.0	12,622.7
100 Mile House	3,624.9	1,018.4	634.7	0.0	0.0	5,278.0
Chilcotin	4,052.2	970.5	6.5	0.0	0.0	5,029.2
Cascades	4,408.6	61.9	9.2	0.0	0.0	4,479.7
Arrow Boundary	1,628.3	21.7	0.0	0.0	0.0	1,649.9
Rocky Mountain	1,451.6	143.4	27.1	0.0	0.0	1,622.1
Columbia	887.9	98.4	20.8	0.0	0.0	1,007.1
Kootenay Lake	584.5	375.8	0.0	0.0	0.0	960.3
Total	**149,231.6**	**10,487.4**	**1,043.6**	**0.0**	**0.0**	**160,762.5**

Table 2 continued. Area summaries for forest health factors mapped during the 2011 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (ha)			
	Light	Moderate	Severe	Total
Western Spruce Budworm				
Central Cariboo	267,388.3	36,529.1	1,797.5	305,714.9
100 Mile House	61,309.8	955.2	0.0	62,265.1
Cascades	34,044.7	18,177.9	196.0	52,418.7
Arrow Boundary	21,332.7	17,318.6	1,452.9	40,104.3
Okanagan Shuswap	39,869.5	36,398.1	1,033.0	77,300.6
Chilcotin	29,238.6	3,558.6	1,206.7	34,003.9
Quesnel	16,922.2	953.5	0.0	17,875.7
Kamloops	12,136.8	4,970.4	0.0	17,107.2
Rocky Mountain	3,538.7	3,241.3	387.3	7,167.2
Columbia	51.6	180.6	45.0	277.2
Headwaters	80.1	0.0	0.0	80.1
Total	**485,913.0**	**122,283.4**	**6,118.5**	**614,314.8**
Douglas-fir Tussock Moth				
Kamloops	1,369.6	2,660.6	1,400.7	5,430.9
Okanagan Shuswap	518.4	371.2	660.2	1,549.8
Cascades	277.4	568.8	180.9	1,027.2
100 Mile House	60.0	0.0	299.4	359.3
Total	**2,225.4**	**3,600.7**	**2,541.2**	**8,367.3**
Western Hemlock Looper				
Central Cariboo	5,144.5	629.8	0.0	5,774.4
Headwaters	585.7	16.7	0.0	602.4
Columbia	492.4	104.3	0.0	596.7
Okanagan Shuswap	77.3	0.0	0.0	77.3
Total	**6,300.0**	**750.9**	**0.0**	**7,050.8**
Aspen Serpentine Leaf Miner				
Headwaters	23,670.3	5,866.2	0.0	29,536.5
Central Cariboo	0.0	0.0	3,942.4	3,942.4
Kamloops	2,548.5	1,077.4	0.0	3,625.9
Quesnel	2,077.9	1,236.2	1.8	3,315.8
Chilcotin	2,952.1	150.1	0.0	3,102.2
Columbia	1,730.4	231.4	0.0	1,961.8
Okanagan Shuswap	1,248.3	454.8	0.0	1,703.1
100 Mile House	42.3	127.2	817.7	987.1
Kootenay Lake	454.9	187.0	0.0	642.0
Rocky Mountain	11.8	314.7	66.7	393.3
Arrow Boundary	46.9	296.6	0.0	343.5
Total	**34,783.3**	**9,941.6**	**4,828.7**	**49,553.6**
Forest Tent Caterpillar				
Quesnel	22,279.8	7,694.2	10,124.7	40,098.7
Okanagan Shuswap	742.7	683.4	0.0	1,426.1
Headwaters	36.5	769.4	0.0	805.9
Kamloops	357.6	71.3	0.0	428.9
Chilcotin	0.0	5.4	23.0	28.4
Total	**23,416.6**	**9,223.7**	**10,147.8**	**42,788.0**
Birch Leaf Miner				
Arrow Boundary	438.1	538.2	0.0	976.3
Kamloops	790.1	94.7	0.0	884.8
Kootenay Lake	495.9	81.1	0.0	577.0
Okanagan Shuswap	159.3	54.4	0.0	213.8
Columbia	130.0	0.0	0.0	130.0
Rocky Mountain	65.3	8.5	13.6	87.5
Headwaters	45.4	0.0	0.0	45.4
Total	**2,124.1**	**776.9**	**13.6**	**2,914.7**

Table 2 continued. Area summaries for forest health factors mapped during the 2011 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (ha)			
	Light	Moderate	Severe	Total
Larch Needle Blight				
Arrow Boundary	13,775.8	4,525.4	1,315.1	19,616.4
Rocky Mountain	6,019.0	2,607.0	2,045.4	10,671.4
Kootenay Lake	1,528.3	644.6	245.7	2,418.5
Okanagan Shuswap	224.2	10.6	0.0	234.8
Columbia	7.5	0.0	0.0	7.5
Total	**21,554.8**	**7,787.6**	**3,606.2**	**32,948.6**
Dothistroma Needle Blight				
Okanagan Shuswap	94.2	79.1	0.0	173.3
Headwaters	33.6	38.2	0.0	71.8
Total	**127.8**	**117.3**	**0.0**	**245.1**
Pine Needle Sheath Miner (*Zellaria*)				
Okanagan Shuswap	157.8	82.2	0.0	240.0
Kamloops	7.7	21.2	0.0	28.9
Total	**165.5**	**103.4**	**0.0**	**268.9**
Larch Casebearer				
Okanagan Shuswap	21.7	56.5	0.0	78.2
Total	**21.7**	**56.5**	**0.0**	**78.2**
Satin Moth				
Arrow Boundary	569.4	0.0	0.0	569.4
Cascades	23.9	11.0	0.0	34.9
Total	**593.3**	**11.0**	**0.0**	**604.3**
Aspen Decline				
Cascades	8.0	262.4	0.0	270.4
100 Mile House	7.6	0.0	36.8	44.4
Okanagan Shuswap	0.0	0.0	34.3	34.3
Kamloops	0.0	24.9	0.0	24.9
Total	**15.6**	**287.3**	**71.1**	**374.0**
Wildfire				
Central Cariboo	0.0	0.0	298.5	298.5
100 Mile House	0.0	0.0	274.0	274.0
Cascades	0.0	0.0	135.6	135.6
Okanagan Shuswap	0.0	0.0	53.8	53.8
Kamloops	0.0	0.0	43.6	43.6
Columbia	0.0	0.0	29.5	29.5
Headwaters	0.0	0.0	23.9	23.9
Rocky Mountain	0.0	0.0	21.0	21.0
Quesnel	0.0	0.0	20.3	20.3
Arrow Boundary	0.0	0.0	17.7	17.7
Kootenay Lake	0.0	0.0	12.6	12.6
Chilcotin	0.0	0.0	3.4	3.4
Total	**0.0**	**0.0**	**933.8**	**933.8**

Figure 1. Mountain pine beetle infestations and Natural Resource District locations in the Southern Interior in 2011.

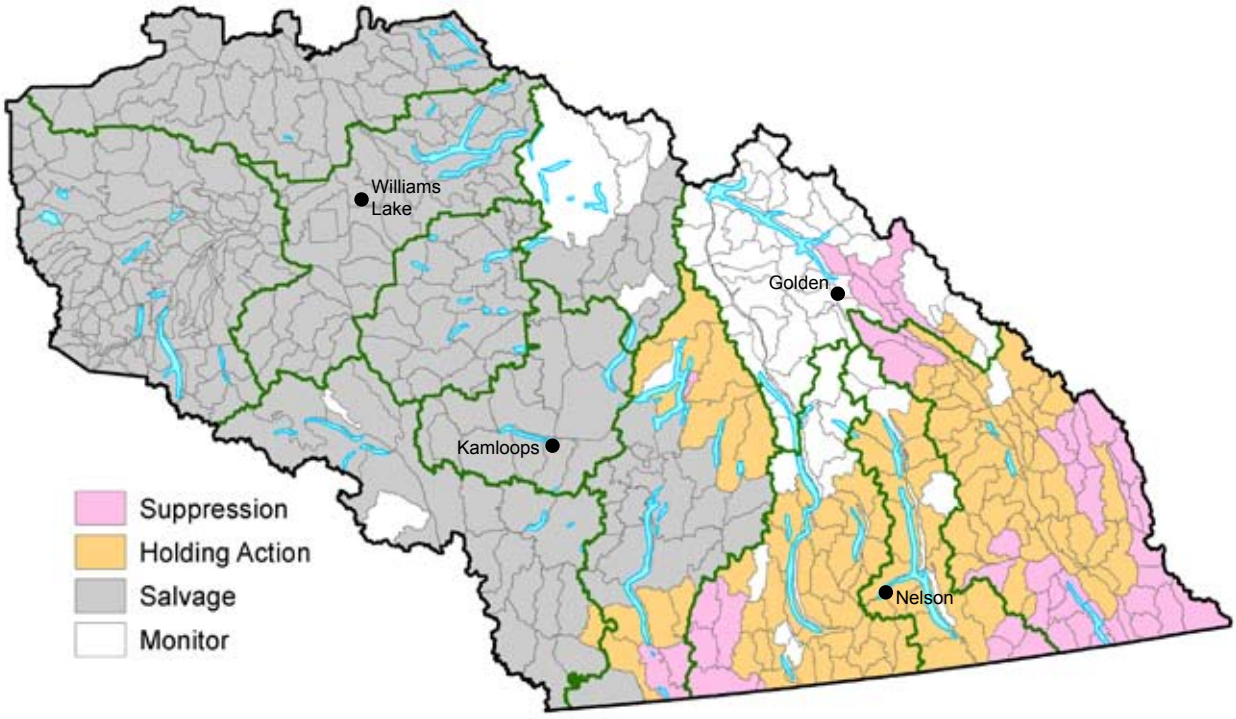

Figure 2. Beetle Management Unit (BMU) boundaries, and associated mountain pine beetle strategies, as of February 2012.

Regional Overview

Mountain Pine Beetle, *Dendroctonus ponderosae*

Mountain pine beetle attack continued to subside, from a peak of 5,380,000 hectares in 2007, to just 161,000 hectares in 2011 (Figure 3, Figure 4, Table 3). Area affected was down in all Districts, with the biggest declines being in the Chilcotin, 100 Mile House, Kamloops, and Headwaters Districts. Although much of the decline has been due to depletion of susceptible host, unseasonably cool weather during the summer, causing late emergence and beetle flight, has also been a factor. Despite the general downward trend, populations are still widespread across much of the southern and eastern portions of the province (Figure 1) and significant green pine inventories remain. Potential for future population expansion still exists in these areas.

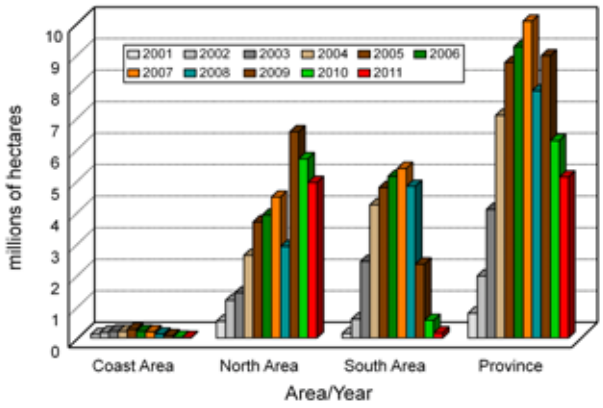

Figure 3. Area affected by mountain pine beetle from 2000 - 2011 in British Columbia, by area.

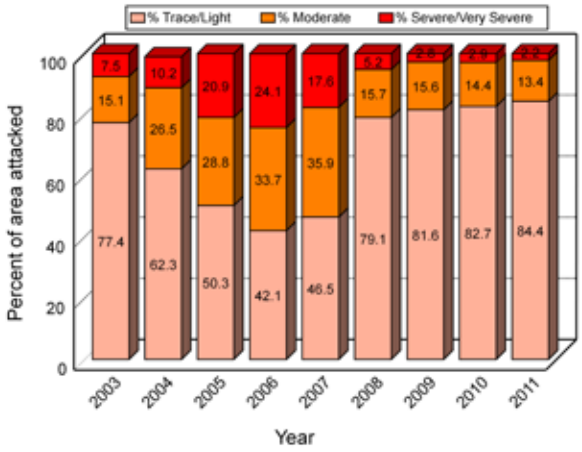

Figure 4. Proportion of mountain pine beetle infested area by infestation severity level, from 2003 - 2011, in the Southern Interior.

Table 3. Area infested, number of polygons, average polygon size, and number of trees killed in spot infestations, for mountain pine beetle in the Southern Interior, 2001-2011.

Year	Area Infested (ha)	Number of Polygons	Average Polygon Size (ha)	Number of Spot Infestations	Number of Trees Killed in Spot Infestations
2001	141,176	4,760	29.7	3,672	37,074
2002	612,054	7,349	83.3	6,308	56,054
2003	2,525,722	13,133	192.4	5,270	42,372
2004	4,220,499	41,057	101.9	4,932	63,410
2005	4,853,830	49,381	95.6	3,839	35,033
2006	5,125,879	59,971	85.5	5,672	71,803
2007	5,379,219	59,373	90.6	5,429	71,409
2008	4,812,045	52,402	67.0	3,181	39,569
2009	2,342,129	23,493	99.7	5,745	73,994
2010	558,118	15,127	36.9	6,573	89,747
2011	161,012	5,999	26.8	4,526	56,835

Bark beetle attack in young lodgepole pine has declined, and was mapped on just 1,850 hectares, most of which was light or trace (under 10% red attack). Most of this activity was in the Okanagan Shuswap and Central Cariboo Districts.

Ponderosa pine mortality continued, caused by a combination of mountain pine beetle, western pine beetle and/or *Ips* (engraver beetles) attack in some geographic locations. Most ponderosa pine mortality was in the Cascades District (3,720 ha) and Okanagan Shuswap District (3,556 ha). Scattered mortality was observed in the 100 Mile House, Kamloops, Arrow Boundary, Kootenay Lake, and Rocky Mountain Districts. Whitebark pine mortality has declined, although scattered attack is still occurring in the Bendor and Lillooet Ranges of the Cascades District, and the Purcell Range of the Rocky Mountain District. Many whitebark pine stands have suffered high levels of cumulative mortality over the past several years.

Mountain pine beetle red attack was detected in fifty-three separate Provincial Parks, and three National Parks, although the area mapped has declined to just 11,350 hectares (Table 4). The most affected parks were Yoho (4,843 ha), Ts'yl-os (1,395 ha), (1,335 ha), Purcell (1,335 ha), and Gladstone (1,130 ha). B.C. Parks has continued to focus on removal of danger trees and mitigation of fire hazard.

Table 4. Area (hectares) of mountain pine beetle in Provincial Parks and National Parks in the Southern Interior in 2011.

	Provincial Parks		National Parks	
District	**# with MPB**	**Area affected (ha)**	**# with MPB**	**Affected Area (ha)**
Okanagan Shuswap	20	2,382	0	0
Arrow Boundary	5	2,169	0	0
Rocky Mountain	7	2,029	1	259
Kootenay Lake	7	1,554	0	0
Chilcotin	4	1,428	0	0
Cascades	10	1,323	0	0
100 Mile House	2	231	0	0
Central Cariboo	2	229	0	0
Columbia	0	0	3	5,003
Kamloops	0	0	0	0
Headwaters	0	0	0	0
Quesnel	0	0	0	0
Total	**53****	**11,346**	**3****	**5,262**

*Provincial Parks - includes Provincial Parks, Protected Areas, Ecological Reserves, and Recreation Areas.
**Several parks cross over District boundaries, hence these totals are lower than would be indicated by the data in this table.

Tunkwa Provincial Park, July 2011.

Beetle Management Unit (BMU) strategies are re-assessed annually for the three major bark beetle species, after the completion of the aerial overview surveys, and any detailed surveys and/or ground surveys. Strategies for mountain pine beetle remained unchanged in most areas (see Figure 2 and Table 6) due to static or declining populations. Nearly 60% of the land base of the Southern Interior continues to be in Salvage for mountain pine beetle. Suppression activities are confined to 8% of the land base, in the south and southeast of the Rocky Mountain District, the southwest of the Columbia District, and the southern Okanagan and Boundary areas. Two BMU's were upgraded from Holding Action to Suppression in Rocky Mountain District, and in the Okanagan Shuswap, one BMU was downgraded from Suppression to Holding Action, and another from Holding Action to Salvage.

Table 5. Number of spot and polygon infestations of mountain pine beetle in the Southern Interior in 2011.

	Number of infestations	
District	Spots	Polygons
Rocky Mountain	1,385	1,514
Okanagan Shuswap	847	1,471
Arrow Boundary	758	502
Cascades	601	1,340
Chilcotin	371	317
Kootenay Lake	343	449
Columbia	115	205
Central Cariboo	33	127
Headwaters (Kamloops TSA)	31	42
Kamloops	24	7
Quesnel	13	11
100 Mile House	5	14
Total	4,526	5,999

Left: Mountain pine beetle salvage harvesting near Dardanelles Lake, Kamloops District - Cascades District boundary

Right - area designated as suppression strategy for mountain pine beetle near Baldy Mountain, Arrow Boundary District.

Table 6. Beetle management unit mountain pine beetle strategy designations in the Southern Interior Forest Region as of February 2012, by number of units, and area (hectares).

District	Suppression	Holding Action	Salvage	Monitor	Total
Quesnel	0	0	71 (2,077,316)	0	71 (2,077,316)
Central Cariboo	0	0	51 (2,063,411)	0	51 (2,063,411)
100 Mile House	0	0	43 (1,235,998)	0	43 (1,235,998)
Chilcotin	0	0	69 (2,870,249)	0	69 (2,870,249)
Kamloops	0	0	14 (1,315,254)	0	14 (1,315,254)
Cascades	0	1 (40,607)	17 (2,015,284)	3 (200,281)	21 (2,256,171)
Okanagan Shuswap	6 (325,107)	9 (758,443)	19 (1,329,689)	1 (45,929)	35 (2,449,168)
Headwaters	0	1 (72,266)	34 (1,801,170)	9 (1,040,938)	44 (2,914,375)
Columbia	6 (233,189)	2 (44,249)	0	50 (1,866,870)	58 (2,144,309)
Arrow Boundary	5 (279,923)	35 (1,297,539)	0	10 (419,063)	50 (1,996,524)
Kootenay Lake	3 (102,915)	17 (884,511)	0	7 (253,430)	27 (1,240,857)
Rocky Mountain	30 (1,113,161)	46 (1,621,913)	0	1 (41,458)	77 (2,800,531)
Total	**49 (2,125,679)**	**111 (4,739,983)**	**318 (14,630,532)**	**81 (3,867,969)**	**560 (25,364,163)**

Douglas-fir Beetle, *Dendroctonus pseudotsugae*

Overall area affected by Douglas-fir beetle continued to decline, from 10,160 hectares in 2010 to 5,520 hectares in 2011. However, populations remain very active and widespread, with many small, scattered spot infestations mapped in the Central Cariboo, Kamloops, Okanagan Shuswap, 100 Mile House, and Cascades Districts (Table 7). Of particular concern, is the increasing number of spot infestations in the Central Cariboo District, in and around Williams Lake, Chimney Creek, Knife Creek, and Beaver Creek. Due to the cool spring, tree fade was late across much of the Cariboo, and some attack may have been missed.

Table 7. Number of spot infestations of Douglas-fir beetle in the Southern Interior in 2011.

District	# spot infestations	# trees
Central Cariboo	586	2,364
Kamloops	377	2,906
Okanagan Shuswap	247	2,055
100 Mile House	213	786
Chilcotin	213	1,097
Cascades	171	1,461
Rocky Mountain	106	1,587
Quesnel	85	447
Headwaters (Kamloops TSA)	47	345
Kootenay Lake	43	534
Arrow Boundary	30	385
Columbia	14	268
Total	2,132	14,235

Spruce beetle attack near Sun Peaks Resort, Kamloops District.

Spruce Beetle, *Dendroctonus rufipennis*

Spruce beetle was mapped on 10,030 hectares, down from nearly 30,000 hectares in 2010. This was mainly due to a significant decline in the ongoing outbreak in the Central Cariboo and 100 Mile House Districts, which had accounted for 85% of all attack in 2010. Populations also appear to be declining in the north-eastern parts of the Cascades District, and stable in the Kamloops and Rocky Mountain Districts. Populations remain low in most other areas.

Western Balsam Bark Beetle, *Dryocoetes confusus*

Western balsam bark beetle continues to be active in most high elevation areas where subalpine fir is the dominant species. Mortality was mapped on 160,760 hectares, which is a slight decrease from 2010 levels of 183,167 hectares. The Okanagan Shuswap District and Headwaters District continued to account for nearly 60% of all infested area.

Western balsam bark beetle, Scotch Creek area, Okanagan Shuswap District.

Western Spruce Budworm, *Choristoneura occidentalis*

The total area defoliated by the western spruce budworm in the South Area (Thompson Okanagan, Cariboo and Kootenay Boundary Regions) increased by 25% to 614,315 hectares in 2011. Of most significance was the expansion of the area classified as moderate or severe defoliation, which increased 2.5 fold to 128,400 hectares. The most notable expansions were observed in the Central Cariboo, Chilcotin, 100 Mile House, Okanagan Shuswap and Arrow Boundary Districts. Defoliation was also detected in the southern Trench area of the Rocky Mountain District for the first time, although the area affected was very limited. Defoliation levels in the Thompson Rivers District declined sharply, in part due to a large control program in the Sabiston-Deadman Creek area where over 17,600 hectares were sprayed. Defoliation levels also declined in parts of the Cascades District where very protracted cool spring weather resulted in high levels of dispersing 2nd instar larvae mortality. Budworm populations remained healthy in stands west of Nicola Lake and in the southern portion of the Merritt TSA. Approximately 16,488 hectares of defoliation were mapped near Gold Bridge in the Lillooet TSA.

Egg mass sampling was carried out in the fall at 680 sites in the Thompson Okanagan, Cariboo and Kootenay Boundary Regions combined plus 26 sites in the Coast Region (a total of 706 sites). The relative abundance of egg masses predicts budworm populations the following year. 2011 sampling results indicate that the budworm outbreak will continue to be widespread throughout the three Regions in 2012, with the highest populations located in the Chimney Lake, Dog Creek, Alkali Creek, Canoe Creek, Merritt, Blue Grouse Mountain, South Okanagan, and Rock Creek areas.

50,763 hectares of high-priority stands were treated with Foray 48B (*B.t.k.*) between June 21 and July 5 in the Thompson Okanagan and Cariboo Regions. A full report on the 2011 spray program can be found in the Special Projects section at the end of this document.

Western spruce budworm defoliation, Mount Kobau, Okanagan Shuswap District.

Western Hemlock Looper, *Lambdina fiscellaria lugubrosa*

Defoliation caused by the western hemlock looper and associated defoliating insects increased to 7,050 hectares in 2011 from 3,035 hectares in 2010, although 90% was classified as light. Most of the new defoliation was in the Quesnel Lake area. Scattered, small pockets of defoliation were also mapped in the North Thompson River, Lake Revelstoke, and Upper Shuswap River areas. A full report on population monitoring activities and results can be found in the Special Projects section of this document.

Douglas-fir Tussock Moth, *Orgyia pseudotsugata*

The Douglas-fir tussock moth outbreak is now in its decline phase, yet populations remained high in several areas. Defoliation was mapped on 8,367 hectares with over 30% of the defoliation rated as severe and 43% as moderate. The more active populations and most severe defoliation were located in the Veasy Lake, Cache Creek, Battle Creek, Sabiston Creek, and Carrs Landing areas, with more scattered pockets of defoliation mapped in the Eneas Creek, Penticton, Spences Bridge, Pavilion, West Fraser Road, and Big Bar areas. The infestations around Big Bar expanded north as far as China Gulch. This represents the most northerly record of tussock moth defoliation in B.C. and the first visible defoliation in the 100 Mile House District. Rotary-wing detailed aerial surveys were conducted to map tree mortality in areas where the outbreak has collapsed. Nearly 8,800 hectares of Douglas-fir forest has sustained some level of mortality, with about half of the area sustaining 50% or more mortality. The most impacted stands are in Barnhartvale, Monte Creek, Campbell Creek, Heffley Creek, Cherry Creek, Six Mile, and Savona. A final assessment of tree mortality will be done over the next 1-2 years as localized populations of tussock moth collapse.

Foray 48B (*B.t.k.*) was applied aerially to 7,280 hectares of high priority stands near Battle Creek, Cache Creek, Veasy Lake, Pavilion Lake, and Peachland Creek between June 21 -24, in an attempt to reduce larval populations and limit tree mortality. Over the past four years, the B.C. Forest Service's spray programs have significantly reduced the extent and severity of damage by treating nearly 22,000 hectares with nuclear polyhedrosis virus or *B.t.k.* A more detailed account of population monitoring and the 2011 spray operations can be found in the Special Projects section at the end of this document.

Severe Douglas-fir tussock moth defoliation near Deadman River, Kamloops District.

Two-Year Cycle Budworm, *Choristoneura biennis*

2011 was an "off" year in the life cycle of this defoliator, when larvae are small and little feeding occurs, and as such no defoliation was visible. An operational spray trial using *B.t.k.* on the two year cycle budworm is planned for 2012. A site near Mount Tom in the Quesnel District was delineated for the trial after ground checks confirmed moderate to high levels of budworm in this area and significant defoliation is predicted for 2012. The plan is to treat peak 4th instar larvae with 2.4 litres *B.t.k.* per hectare. Close monitoring of larval development will be done in the early summer to determine the optimal timing of the treatment as well as pre- and post-spray larval sampling to determine efficacy of the treatment.

Aspen Serpentine Leaf Miner, *Phyllocnistis populiella*

Aspen serpentine leaf miner continues to be widespread, with defoliation mapped on 49,554 hectares. Aspen, especially in the Cariboo, is widely distributed but often occurs in spatially patchy distributions of mixed species stands and small non-treed openings. Because of this, adequately capturing the extent and severity of serpentine leaf miner damage is difficult. The actual incidence is much greater than indicated by the aerial survey results, as it is generally only mapped when damage is pronounced and readily visible from the air. Notations are often made on survey maps to indicate a general "background" level of infestation. The majority of the mapped areas were in the Headwaters District, with scattered areas noted across the Cariboo, Okanagan, and Kootenays.

Aspen serpentine leaf miner damage in scattered aspen in Wells Gray Park. Inset shows closeup of leaf damage.

Forest Tent Caterpillar, *Malacosoma disstria*

Forest tent caterpillar defoliation increased slightly to 42,790 hectares, from 37,840 hectares in 2010. Over 90% of the affected area was in the Quesnel District, where an extensive outbreak has been ongoing for several years. Nearly 19,000 hectares suffered moderate to severe defoliation in 2011, and in some of these areas, branch and top dieback, as well as some tree mortality, is being seen. Smaller outbreaks were recorded in the Okanagan Shuswap, Kamloops, and Headwaters Districts.

Larch Needle Blight, *Hypodermella laricis*

Larch needle blight infections increased substantially, likely as a result of the cool, wet weather during the spring and early summer. A total of 32,950 hectares of damage was mapped, most of which was in the Arrow Boundary, Rocky Mountain, and Kootenay Lake Districts.

Larch needle blight infection.

Birch Leaf Miner, *Fenusa pusilla*

Birch leaf miner damage levels decreased to 2,915 hectares, from 8,420 hectares in 2010. Affected stands were scattered through the south Kootenays, central Okanagan, and Kamloops areas.

Gypsy Moth, *Lymantria dispar*

The MFLNRO, in co-operation with the Canadian Food Inspection Agency and the Canadian Forestry Service, monitors for occurrence of European gypsy moth at many sites throughout the southern interior, such as woodland recreation sites and other small venues. One European gypsy moth was confirmed from a pheromone trap site at Kokanee Creek Park in 2009. A subsequent delimit trapping grid (16 traps in a square mile) at that site in 2010 did not catch any moths, however two moths were caught outside the grid in two nearby traps. Delimiting grids were installed at each of these two sites in 2011 but no moths were caught. A single moth was caught in a regular monitoring trap near the Revelstoke Mountain Resort. A delimiting grid may be deployed in this area in 2012.

Pine Needle Sheath Miner, *Zellaria haimbachi*

Several small, isolated pockets of pine needle sheath miner damage were detected in lodgepole pine plantations in the Okanagan Shuswap, Kamloops, and Quesnel Districts. Defoliation levels ranged from light to moderate. This is the first detection of *Zellaria* in several years.

Larch Casebearer, *Coleophora laricella*

Larch casebearer defoliation was detected in the Okanagan for the first time in many years. A total of 78 hectares suffered light to moderate defoliated in the King Edward Main area, southeast of Vernon. The small area of larch casebearer that was detected in the Elk River in 2010 did not reappear in 2011.

Satin Moth, *Leucoma salicis*

570 hectares of trembling aspen were lightly defoliated by satin moth near New Denver. Another three small areas totalling 35 hectares were defoliated in the Cascades District.

Dothistroma Needle Blight, *Dothistroma septosporum*

Dothistroma needle blight was visible at damaging levels on several scattered lodgepole pine plantations in the Headwaters and Okanagan Shuswap Districts. The affected stands were in the interior cedar-hemlock ecosystem, commonly in cold air drainage areas along valley bottoms. This pathogen has been causing serious damage to pine plantations in the northwest interior of B.C., and has become more prevalent in the South over the past few years. Research suggests the increasing incidence may be linked to an increase in the frequency of summer precipitation.

Dothistroma needle blight on lodgepole pine near Raft Peak. Note typical "bottom up" damage pattern.

Aspen Decline

Symptoms of decline (dead tops and branch tips and tree mortality) were observed in several scattered trembling aspen stands in the Cascades, Kamloops, Okanagan Shuswap, and 100 Mile House Districts. Most of the stands showing the symptoms were in dry areas, often surrounded by grassland. A total of 374 hectares were mapped. One single causal agent has not been identified, but repeated drought conditions over several years may be a contributor in addition to a variety of insects and diseases.

Stand of trembling aspen exhibiting symptoms of decline near Douglas Lake, Cascades District.

Windthrow

Windthrow damage was mapped on 500 hectares, mostly in small, scattered pockets in the Rocky Mountain, Columbia, and 100 Mile House Districts. Over half of the affected stands were spruce leading, which may contribute to locally increased spruce beetle populations.

Wildfire

Wildfire activity was very low in 2011, with less than 1,000 hectares burned in southern B.C. This is attributed to a cool and wet spring and summer.

Other

Several other forest health agents were observed during the aerial overview surveys. These included 545 hectares of redbelt in the west Cariboo, 378 hectares of bear damage in plantations, 440 hectares of slide and avalanche damage, 197 hectares of flooding damage, 8 hectares of lodgepole pine mortality caused by engraver beetles (*Ips*), and 9 hectares of damage caused by road salt near 108 Mile House. 830 hectares of western red cedar stands in the Headwaters District exhibited slightly yellowed foliage without any other symptoms; no causal agent was determined due to difficult ground access.

Kootenay Boundary Region Summary

The Kootenay-Boundary portion of the 2011 aerial overview survey was conducted between July 23rd and August 20th. Total flying time was 102 hours, conducted over 18 flight days. Surveys covered the entire 6.2 million hectare land base, including National Parks, within the Arrow Boundary, Columbia, Kootenay Lake, and Rocky Mountain Forest Districts. The surveyors were Neil Emery and Adam O'Grady of Nazca Consulting Ltd. and utilized a Cessna 337 Skymaster, operated by Babin Air.

Arrow Boundary District

Mountain Pine Beetle

Area affected by mountain pine beetle declined by just over 20%, to 14,590 hectares. This is the third consecutive year that infested area has dropped, from a high of over 88,000 hectares in 2008. The number of spot infestations also declined, to only 758 (1,290 in 2010). Ground surveys conducted post-beetle flight indicated declining populations, with many of the smaller infestation sites showing less than one new mass attacked tree. Despite this general downward trend, beetle activity is still widespread across nearly all areas of the District, especially in the upper Kettle River, Rendell Creek, Christina Lake, Rossland, Inonoaklin Creek, and Lost Creek areas, and potential for population increases exist depending upon weather conditions in 2012. Attack of other pine species was rare, with only a few spots of ponderosa pine mortality observed. No young pine plantations are yet under attack.

Late fading mountain pine beetle attack in the Kettle River valley, Arrow Boundary District.

Douglas-fir Beetle

Douglas-fir beetle activity remains relatively low, with just 72 hectares of light and moderate attack, and an additional 30 spot infestations. Infestations in the Trout Lake and Ingram Creek Road areas declined, and other infestations are small and scattered.

Western Balsam Bark Beetle

Western balsam bark beetle damage continued to decline, from 2,680 hectares in 2010, to 1,650 hectares in 2011. Most of the attack was in the Valhalla Range and in and around TFL 3. Nearly all of the attack was classified as trace.

Shepherd, R.F., T.G. Gray, R.J. Chorney and G.E. Daterman. 1985. Pest management of Douglas-fir tussock moth, Orgyia pseudotsugata (Lepidoptera: Lymantriidae): Monitoring endemic populations with pheromone traps to detect incipient outbreaks. Canadian Entomologist 117:839–848.

Western Spruce Budworm

Western spruce budworm defoliation was mapped for the first time since 1991. 40,100 hectares were affected, nearly half of which was classified as moderate or severe. Defoliation was extensive on stands extending from the District Boundary, west to Grand Forks, and north to Westbridge and Henderson Creek. Defoliation was also mapped west of Beaverdell. Populations are expected to remain high in 2012, with nearly 50% of the 117 sites sampled for egg masses in the fall predicting moderate or severe defoliation. Aerial spraying with *B.t.k.* is being planned for 2012 for high priority stands.

Western spruce budworm defoliation near Ingram Creek, Arrow Boundary District.

Douglas-fir Tussock Moth

Rising populations were detected near Rock Creek in 2008 and 2009. An aerial spray program using nuclear polyhedrosis virus (NPV) was completed in 2010, and only a few trees were defoliated that year.

At the nine permanent sample sites in the District, total moth catch over all sites (six traps per site) declined from 38 in 2009 to 15 in 2010, but increased to 654 in 2011. The highest average moth catches per site were at Kettle Provincial Park, Johnstone Creek, and Midway, at 57.5, 23.3, and 18.0 moths per trap, respectively. However, no site had consecutive years of average trap catches exceeding 20-25 moths which is used as the threshold to indicate building populations that may cause visible defoliation (Shepherd et al. 1985). In general average moth catches per site remained low overall and defoliation is not anticipated in 2012. Only two larvae were found in the three-tree beating larval surveys at the nine sites, and no defoliation attributed directly to Douglas-fir tussock moth was mapped during the aerial surveys. Trap catches at six additional sites deployed by members of the woodlot association caught 252 moths, but no larval beatings were done. Egg mass surveys will be conducted in the spring of 2012 in the Rock Creek, Midway, and Bridesville areas to determine if there is potential for a building tussock moth population.

Douglas-fir tussock moth egg mass.

Aspen Serpentine Leaf Miner


Serpentine leaf miner.

Aspen serpentine leaf miner defoliation declined, from 3,010 hectares in 2010, to just 344 hectares in 2011. The little activity that was visible was scattered across the northern half of the District.

Birch Leaf Miner

After increasing in 2010, birch leaf miner populations appear to have declined, with defoliation down from 2,750 hectares to 976 hectares. Most of the activity was in the Big Sheep Creek, Inonoaklin Creek, and Hoder Creek areas.

Satin Moth

Satin moth lightly defoliated 570 hectares of aspen in Seaton Creek, just east of New Denver. No permanent damage is expected.

Larch Needle Blight

Area affected by larch needle blight increased nearly ten-fold, to 19,615 hectares. Nearly 30% of the area was classified as moderate or severe, where growth loss impacts may occur. Damage was scattered throughout the southern two-thirds of the District, mainly in mid-aged plantations. The most extensive areas mapped were in the Trapping Creek area.

Other

Other damage recorded by the aerial surveys included 16 hectares of bear damage, 18 hectares of wildfire, nine hectares of windthrow, four hectares of flooding, and 34 hectares of slide damage.

A few other noteworthy pests were observed during ground surveys. Scattered single tree mortality of mature Douglas-fir was once again evident along Highway 3 between Eholt and Grand Forks. The symptoms were not typical of Douglas-fir beetle and are more likely attributable to drought and/or secondary insects. Douglas-fir exhibited thinning crowns accompanied by stem mortality along hillsides south of Trout Lake. No ground assessment was done in this area however the likely agents are a combination of *Armillaria* root disease and Douglas-fir beetle. Moderate to severe birch leaf miner defoliation was observed along the Salmo-Creston Highway. Foliar diseases (leaf rusts and ink spots) on aspen and cottonwood were prevalent throught the monitoring area, especially along the Greenwood/Midway corridor. Venturia twig blight and serpentine leaf miner were noted on aspen near Eholt.


Douglas-fir exhibiting thinning crowns near Trout Lake, Arrow Boundary District.

Columbia District

Mountain Pine Beetle

Mountain pine beetle activity has continued to decline in the District, from 12,600 hectares in 2010 to 7,145 hectares in 2011. An additional 1,340 trees were killed in 115 spot infestations. Only 1,420 hectares of the red attack were on the Provincial land base, with the bulk being in one of the National Parks (5,725 hectares). Most of the attack outside of the National Parks was in the Blaeberry River and Golden areas. Attack in whitebark pine has also declined, with only 58 hectares of trace and light mortality mapped.

Western Balsam Bark Beetle

Infestations in Kootenay and Yoho National Parks declined, resulting in a drop in infested area from 2,160 hectares in 2010, to just over 1,000 hectares in 2011. Beetle populations are relatively low in most areas, and subablpine fir mortality is mostly in small scattered patches.

Douglas-fir Beetle

Area affected by Douglas-fir beetle declined by 45%, to 298 hectares. Attack severity tended to be low, and infestations were limited to smaller patches or spots of 5-50 trees. Most of the activity was in the Beaverfoot River area of Yoho National Park

Western Hemlock Looper

Several small pockets of light and moderate defoliation were detected along the edges of Lake Revelstoke, north of Downie Creek, as well as along the eastern slope of Frisby Ridge and near Cranberry Creek. Affected area was 597 hectares, up from 358 hectares in 2010.

Trap catches at 11 permanent sampling sites (six traps per site) doubled from an average of 347 to 725 moths per trap. The largest increases in average trap catches were at the sites north of Downie Creek, with a range of 689 to 1,533 moths per trap, up from a range of 303 to 468 in 2010.

Three-tree beatings were also conducted to assess late stage larval populations at these sites as well as two additional sites east of Rogers Pass. All of the 13 locations were positive for western hemlock looper larvae. The highest levels were at Pitt Creek and Beaver River, with 105 and 107 larvae, respectively. The majority of sites sampled north and east of Revelstoke saw an increased number of larvae per site, from an average of 3.7 in 2010, to 39.5 in 2011. Larval trends are similar to those experienced one to two years before the last outbreak which commenced in 2002. The Ministry expects to treat approximately 1,500 hectares of high value crown forest with *Btk*.

Trace western hemlock looper defoliation near Revelstoke, Columbia District.

Western Spruce Budworm

A few small patches of western spruce budworm defoliation were mapped just east of Eagle Pass, along the Highway 1 corridor. Budworm populations high enough to cause visible defoliation are rare in this area, having been recorded only twice, in 1976 and 1990.

Aspen Serpentine Leaf Miner

After increasing for two years, damage levels fell in 2011, to 1,960 hectares. Affected stands were recorded in the Kinbasket Lake, Blaeberry River, Illecillewaet River, and Lake Revelstoke areas. Most of the areas showing defoliation in 2010, showed little sign of it in 2011.

Gypsy Moth

A single European gypsy moth was caught in a pheromone trap near Revelstoke Mountain Resort. A delimiting grid of 16 traps per square mile may be deployed at this location in 2012.

Western spruce budworm east of Three Valley Gap, Columbia District.

Other

Other forest health factors mapped during the surveys were 130 hectares of birch leaf miner, 12 hectares of bear damage in plantations, 8 hectares of larch needle blight, 85 hectares of windthrow, 77 hectares of new slide damage, 30 hectares of wildfire, and nine hectares of flooding mortality. Serpentine leaf miner and/or foliar diseases were commonly visible during ground surveys on both trembling aspen and cottonwood throughout the District.

Rocky Mountain District

Mountain Pine Beetle

Both area affected and intensity of red attack declined between 2010 and 2011. Red attack area fell by nearly 50%, from 51,400 hectares to 28,730 hectares, while the the proportion of attack classed as moderate or severe fell from 48% to 27%. Most infestations remain small, with an average polygon size of just 19 hectares. The number of additional small spot infestations also fell by 50% from 2,366 to 1,385. Decreased levels of attack were seen throughout the Elk, Cross, and Lussier River valleys, and in Kootenay National Park. Red attack is still quite widespread in many areas east of the Trench, and in the Bull River area. Populations appear to be trending downwards significantly, with fall 2011 green:red attack ratios in suppression areas averaging 0.2:1. Two more Beetle Management Units (Hell-Meachen and Kimberly Watershed) have been upgraded from holding action to suppression status. It is expected that red attack levels will continue to decline in 2012.

Attack in whitebark pine was relatively low, with 595 hectares of mostly trace and light attack mapped. Only a few ponderosa pine were killed, near Elko.

Douglas-Fir Beetle

Total area affected by Douglas-fr beetle declined, from 1,270 hectares in 2010, to 715 hectares in 2011, mostly due to reduced red attack in Kootenay National Park. Attack continued to decline in the Kishinena Creek area, although infestations have been observed nearby, just over the U.S. border. A drop in attack near Grasmere may be due to masking by locally heavy western spruce budworm defoliation. A significant number of new spot infestations were recorded in the Cranbrook, Sparwood, and Lussier River areas.

Spruce Beetle

Spruce beetle continued to be active in the Fenwick Creek area, with 478 hectares of new damage noted. Stands in this drainage now contain a high proportion of grey stems. Attack has expanded over the past two years into the neighbouring North White River, which has large areas of high hazard spruce stands.

Spruce beetle attack in the North White River, Rocky Mountain District.

Western Balsam Bark Beetle

Area affected by western balsam bark beetle declined from 4,035 hectares in 2010, to 1,622 hectares in 2011. The majority of the attack was in small, scattered pockets, scattered throughout the District.

Western Spruce Budworm

Western spruce budworm defoliation was mapped on 7,170 hectares in the Flathead River, Wigwam River, and Grasmere areas. Defoliation was first visible in the Flathead valley in 2010, but positive identification of defoliator species (western spruce budworm or two-year cycle budworm) was not possible at the time ground checks were made. In 2011, several field checks and larval collections confirmed the species as western spruce budworm. General larval sampling results (three-tree beatings) at the 13 permanent sample sites in the District indicate a general increase in western spruce budworm populations throughout the Rocky Montain Trench. The proportion of sites positive for budworm increased from 15% in 2010, to 69% in 2011, with the highest counts at the Grasmere and Elko sites. Eggmass sampling at 38 sites in the Flathead valley and east of Grasmere indicates continued light to moderate defoliation in 2012.

Western spruce budworm in the Flathead Valley, Rocky Mountain District.

Larch Needle Blight

Larch needle blight damage has increased, from 1,820 hectares in 2010, to 10,600 hectares in 2011. The most widespread damage was in the Flathead River area, with affected stands scattered throughout the Wigwam River, Bull River, White River, St. Mary River, Moyie, Gold Creek, and Bugaboo areas. A wide range of age classes at low to mid elevations were affected. In general, defoliation noted in 2011 was not as severe as that observed from 2006 to 2008, and no tree mortality was noted.

Other

Other damage agents recorded during the aerial surveys included 393 hectares of aspen serpentine leaf miner, 88 hectares of birch leaf miner, 304 hectares of bear damage, 145 hectares of windthrow, 71 hectares of slide and avalanche damage, 29 hectares of flooding, and 20 hectares of widlfire.

During the routine defoliator three-tree beating sampling, several additional types of damage were noted: thinning crowns of Douglas-fir were seen throughout much of the Rocky Mountain Trench, indicative of a combination of abiotic events, overstocking due to fire exclusion, and/or chronic root disease; a bud fungus, possibly *Dichorera gemmicola*, killing Douglas-fir buds at Swansea trailhead and Horsethief Forest Service Road; top dieback of birch near Parsons and Brisco; and suspected herbicide damage on young Douglas-fir at Matthews Creek.

Enlarged avalanche path, Rocky Mountain District.

Kootenay Lake District

Mountain Pine Beetle

Although mountain pine beetle remained active in nearly all areas of the District, total affected area declined by 60%, from 22,000 hectares in 2010 to 8,950 hectares in 2011. This is the lowest area in eight years. Some of the most significant declines in red attack were seen in the West Arm Park, Riondel, Crawford Bay, and Sanca Creek areas. Beetle populations in the southeast corner of the District, around Hawkins Creek, Kid Creek, and Yahk, remained low, which is of particular note given the abundance of healthy, standing green pine in this area.

Whitebark pine mortality also decreased, to 118 hectares, and only a few scattered ponderosa pine were killed, near Balfour and Creston.

Douglas-Fir Beetle

Douglas-fir beetle activity has increased slightly, from 310 hectares in 2010, to 361 hectares in 2011. The number of small spot infestations remained nearly unchanged, at 43. Areas of highest incidence were in the Davis Creek, Meadow Creek, Poplar Creek, Tenderfoot Creek, Mobbs Creek, and Duncan Lake areas. A few scatterd attacks were also seen in the Ainsworth and North Shore areas.

Western Balsam Bark Beetle

Western balsam bark beetle attack was quite scattered, which is typical for this District. The most concentrated areas of tree mortality were near West Arm Park, La France Creek, and Skelly Creek. A total of 960 hectares of trace and light attack was mapped.

Aspen Serpentine Leaf Miner

642 hectares of trembling aspen were defoliated in the Lardeau River and Trout Lake area. Ground checks confirmed the damage agent was aspen serpentine leaf miner; no tree mortality was seen.

Birch Leaf Miner

Birch leaf miner defoliation was mapped on 577 hectares, down from 1,800 hectares in 2010. Most of the affected stands were in the Lardeau River and Duncan River valleys.

Larch Needle Blight

Larch needle blight damage was recorded on 2,420 hectares. This is a significant increase from 2010 levels of 340 hectares, although it is still a much lower area than seen during the peak years of 2006-2008. Affected stands were scattered across the southern half of the District. No tree mortality was noted.

Larch needle blight near Yahk, Kootenay Lake District.

Gypsy Moth

After a single European gypsy moth was caught in a pheromone trap at Kokanee Creek Park in 2009, delimiting grids of 16 traps per square mile were deployed. Two more moths were caught in 2010, but after further delimiting grids were deployed in 2011, no more moths have been trapped.

Other

Other forest health agents mapped during the aerial surveys were 90 hectares of slide and avalanche damage, 62 hectares of windthrow, 23 hectares of flooding, and 13 hectares of wildfire.

Thompson Okanagan Region Summary

The Thompson Okanagan portion of the aerial overview surveys was conducted between July 22nd and August 3rd, 2011, and required 53.9 hours of flight time over 11 days. Surveys covered the Kamloops, Lillooet, Merritt, and Okanagan TSA's. Weather conditions for the surveys were generally good, although cloudy weather caused a few delays. Due to the low level of wildfire activity, smoke did not interfere with the surveys. All surveys were conducted by Kevin Buxton (Ministry of Forests, Lands, and Natural Resource Operations) and Janice Hodge (JCH Forest Pest Management), and utilized a Cessna 206 aircraft, operated by Westair Aviation out of Kamloops.

Kamloops District

Mountain Pine Beetle

Mountain pine beetle activity is now at insignificant levels. Only 100 hectares of new red attack were mapped, most of which was in upper Maiden Creek. A few scattered spot infestations were also recorded, both in lodgepole pine, and ponderosa pine. This insect is expected to remain at low levels for the foreseeable future.

Extensive stands of grey lodgepole pine killed by mountain pine beetle near Willowgrouse Lake, north of Kamloops.

Spruce Beetle

The area infested by spruce beetle remained nearly unchanged in 2011, at 2,292 hectares. However, the intensity of attack has increased - the proportion of affected area classified as moderate or greater has increased from 40% to 76%. Infestations have moved into new stands in the upper Mow Creek - Criss Creek area after depleting most of the suitable host near Porcupine Ridge. Infestations around Sun Peaks and Cahilty Creek continue to infest new stands, although in many cases smaller, less suitable trees are being attacked as larger trees have already been killed over the previous several years.

Western Balsam Bark Beetle

Western balsam bark beetle attack remained common in several areas, especially the Dunn Peak, Barriere River, Chu Chua Creek, Louis Creek, and Wentworth Creek areas. A total of 13,300 hectares were mapped, most of which was classified as trace.

Douglas-fir Beetle

Due to the District's aggressive trap tree program and a concerted effort on the part of salvage harvest clients to harvest as many accessible red and green attack centers as possible, Douglas-fir beetle activity has been successfully maintained at manageable levels. Across the District as a whole, attack levels remained nearly unchanged from 2010 levels, at 557 hectares. However, the total number of infestations remains high, with over 430 separate polygons and spot infestations mapped. Red attack was widespread across most of the District, with local increases in the Black Pines, Louis Creek, and Agate Bay Road areas.

A small project designed to protect the Douglas-fir overstory of a special interest area near Georges Creek was successfully implemented over two years (2010-2011). In 2010 conventional trap trees and funnel traps were utilized around the perimeter of the site. The trap trees and overflow attack trees were removed in the fall. In year two (2011) MCH repellent was deployed in a 20 metre grid thoughout the forest, and 8 sets of funnels traps (three funnel traps per set) were deployed around the perimeter of the site and in adjacent cut blocks. Follow-up monitoring shows very good results with no evidence of beetle attack in the stand.

Douglas-fir bark beetles cover the bottom of a hard hat – example of trapping in a special interest area near Georges Creek, Kamloops District.

Western Spruce Budworm

Western spruce budworm damage declined dramatically, partly due to a cold spring and poor tree - larval development synchrony, which resulted in high larval mortality. Visibly defoliated area fell from 116,255 hectares in 2010, to just 17,110 hectares in 2011. Populations did remain high in several areas, however, including the Tranquille River, Watching Creek, Lac du Bois, Inks Lake, Paul Lake, Deadman River, and Jamieson Creek areas. An aerial *B.t.k* spray program area helped to limit defoliation to low levels in the Sabiston Creek area, where budworm populations were forecast to be high.

Egg mass sampling conducted in the fall of 2011 indicate that populations will increase again in several areas, including Inks Lake, Cherry Creek, Tranquille River, Watching Creek, and Monte Creek. Populations should remain low in the Scottie Creek and Deadman River areas.

B.t.k. spray operations in the Kamloops District.

Douglas-fir Tussock Moth

Area defoliated by Douglas-fir tussock moth declined significantly, from just over 14,000 hectares in 2010, to 5,430 hectares in 2011. This was due to a combination of aggressive spray programs over the past several years, and the natural decline seen at the end of the outbreak cycle. Damage was still extensive in the Hat Creek, Cache Creek, and Battle Creek areas, with somewhat lower level, scattered defoliation in the Deadman River, Sabiston Creek, and Venables Valley area. In addition to the current defoliation, tree mortality was mapped in areas where the outbreak has ended, and to date 7,740 hectares of Douglas-fir has sustained some level of tree mortality. This figure is expected to rise over the next 1-2 years as the rest of the area reaches the end of the outbreak cycle. These heavily impacted stands were seen throughout the Pritchard, Barnharvale, Campbell Creek, Heffley Creek, Cherry Creek, Savona, Barnes Creek, Deadman River areas.

Douglas-fir killed by Douglas-fir tussock moth, near Campbell Creek Road, Kamloops District.

An aerial spray program conducted on June 23-24, treated 5,770 hectares in 11 separate blocks with *B.t.k.* (Foray 48B) in the Deadman River, Back Valley, Cache Creek, and Veasy Lake areas. Results were positive, with good population reduction and foliage protection in larger blocks and in areas with comparatively low levels of previous defoliation. Some smaller spray blocks and stands with higher levels of previous defoliation suffered tree mortality despite treatment. Only 5% of the treated areas showed current defoliation visible from the air, and another 10% of treated areas suffered tree mortality.

Egg mass ground surveys were conducted in the fall. Some light defoliation may be seen in 2012 in the Hat Creek and cache Creek areas, with a few small pockets of moderate to severe defoliation near Veasy Lake and the upper Deadman River. However, evidence of nuclear polyhedrosis virus (NPV) was found in most areas sampled, and tussock moth populations may decline naturally in the spring.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner damage was mapped on 3,225 hectares in the Lemieux Creek, Taweel Lake, Eakin Creek, and Darlington Creek areas. Most of the defoliation was classified as light or moderate becasue of the scattered nature of aspen in these stands, despite the often heavy defoliation of individual trees.

Birch Leaf Miner

Birch leaf miner lightly defoliated 885 hectares of paper birch, scattered through the Louis Creek, Fadear Creek, and Gorman Lake areas.

Pine Needle Sheath Miner

Pine needle sheath miner defoliated three separate lodgepole pine plantations near O'Connor Lake and Jamieson Creek. Minimal tree mortality has resulted so far, however repeated defoliation can lead to significant growth losses. This is the first occurrence of this insect at damaging levels in many years. Moderate levels of parasitism were noticed in the O'Connor Lake plantations when the area was ground checked.

Pine needle sheath miner, Zellaria haimbachi.
Top left: defoliated lodgepole pine stands near O'Connor Lake, Kamloops District.
Top right: feeding damage on new growth.
Bottom left: adult moth resting on foliage.

Other

Other damaging agents mapped during the aerial surveys were 430 hectares of forest tent caterpillar near Harper Creek, Adams Lake, and Louis Creek, 25 hectares of aspen decline near Maiden Creek and Droppingwater Creek, two hectares of bear damage near Adams Lake, 16 hectares of *Armillaria* root disease east of Pinantan Lake, and 44 hectares of wildfire. Discoloured western red cedars were observed on 78 hectares in the Harper Creek area; no ground checks were performed but the foliage discolouration was most likely a response to climate conditions. A forester working for the Adams Lake Indian Band observed an unidentified sawfly (*Neodiprion* spp.) defoliating a nine year old lodgepole pine plantation near Aylmer Lake. Infestations of this type tend to last one-two years without causing tree mortality.

Headwaters District

Mountain Pine Beetle

Mountain pine beetle populations have continued to decline, to just 873 hectares. The only significant areas of attack in mature lodgepole pine were in the upper North Thompson River, and in the upper Adams River valley near Mica Lake. Several lodgepole pine plantations in the Allan Creek and upper North Thompson River areas (56 hectares) showed light attack. Western white pine was attacked in the upper Cayenne Creek and Adams River areas, although mortality was only at trace levels.

Mountain pine beetle attack in a young lodgepole pine stand near Allan Creek, Headwaters District.

Western Balsam Bark Beetle

Area affected by western balsam bark beetle was mapped on 39,912 hectares in 2011, a total that has remained nearly unchanged for the past several years. Attack was scattered across most high elevation areas of the District, especially the Raft River, Battle Mountain, and T.F.L. 18 areas.

Douglas-fir Beetle

Douglas-fir beetle continued to be active around Vavenby and Mount MacLennan, while attack rates declined in the Mahood Lake and Adams Lake areas. Most of the tree mortality was in small spot infestations (47 separate spots), rather than in larger polygons (only 16 hectares in two polygons).

Western Hemlock Looper

Small areas of defoliation were recorded near Hobson Lake, Azure Lake, Albreda river, Canvas Creek, Manteau Creek, Serpentine Creek, and North Blue River. At the six permanent sampling sites in the District, adult moth catches were up slightly (see the Special Projects section). The highest trap catches were at Murtle Lake Road and Mud Lake. Three-tree beating larval collection increased slightly at three sites. The trapping system is not yet fully calibrated so it is not yet clear whether 2012 will mark the start of another outbreak cycle, yet all indications are that in specific geographic areas 2012 could be the first year of significant defoliation. Egg sampling is currently being carried out at all six trapping locations, the results of which will give population and defoliation estimates for 2012 and allow for strategic placement of spray blocks.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner populations remained high, with defoliation being mapped on 29,540 hectares. This insect is present at low levels in most aspen stands in the District; however only heavier or more widespread defoliation that is typically mapped. Defoliation was most common in the Wells Gray Park, Raft River, Mad River, Avola and Adams River areas.

Forest Tent Caterpillar

A forest tent caterpillar infestation caused moderate defoliation of 805 hectares of mixed birch and aspen at Cayenne Creek. Little permanent damage is expected, however populations have been increasing in nearby areas over the past two years and more defoliation may occur in 2012.

Two-Year Cycle Budworm

2011 was an "off" year in the feeding cycle of this insect, and no defoliation was recorded.

Dothistroma Needle Blight

Dothistroma needle blight infection was visible on 72 hectares in the District. Four plantations were affected near TumTum Lake, two along the Raft-Moilliet Forest Service Road, and one along the Vavenby-Adams Forest Service Road (Road 2).

Other

Other forest health factors in the District included 80 hectares of western spruce budworm south of Clearwater Lake, 26 hectares of spruce beetle north of Azure Lake, 45 hectares of birch leaf miner near the Clearwater River, and minor areas of *Armillaria* root disease, bear feeding damage, wildfire, windthrow. Discoloured western red cedars were observed on 751 hectares near Graffunder Lake, Mad River, Raft River, Mann Creek, and Adams River; no ground checks were performed but the foliage discolouration was most likely a response to climate conditions.

Dothistroma needle blight damage in a lodgepole pine plantation near TumTum Lake, Headwaters District.

Cascades District

Mountain Pine Beetle

Red attack continued to decline sharply throughout the Cascades District due to a combination of aggressive harvesting, host depletion and a natural collapse of local populations. Area affected was down by 70% from 2010 levels to 42,078 hectares. This represents a 90% decline from the levels seen during 2007-2009, when the area affected peaked at over 370,000 hectares. Attack in lodgepole pine is rare in the northern half of the Merritt TSA and was only mapped in a few scattered pockets in the southern half of the Lillooet TSA. Attack is still fairly widespread across much of the northern and western Lillooet TSA but has become more scattered as it continues to be pushed into small and less suitable host material. Likewise, in most areas south of the Similkameen River and west and south of Princeton, attack is still common, but increasingly scattered. The most active areas of new red attack were in the vicinity of Siwash Creek, Red Creek, McNulty Creek and Coquihalla Lakes where attack continues into the Coast Region. Attack in young stands was limited to 141 hectares in the Spius Creek and Hurley River areas.

Attack in ponderosa pine has also declined, from over 19,000 hectares in 2010, to 3,700 hectares in 2011. Whitebark pine is still being killed, but levels are low, with just 232 hectares recorded.

Mixed-age lodgepole pine stand south of Merritt. Note that older and larger trees have been killed by mountain pine beetle, while most smaller trees remain unattacked.

Douglas-fir Beetle

Douglas-fir beetle remained widespread in historical locations in the Lillooet TSA with most new attack located in the Yalakom, Seton Lake, Duffy Creek, Lillooet, Fountain Valley, Fraser River and Murray Creek areas. Populations remain low in most of the Merritt TSA, although some increases were seen near Skuhun Creek and Eastgate. Affected area was up, from 368 hectares, to 658 hectares, and the number of additional spot infestations remained high, at 171.

Spruce Beetle

Total area affected was 467 hectares. Attack levels have continued to decline in the Lillooet TSA, with only a few small areas detected near Duffy Lake, Siwhe Creek, Cinquefoil Creek, and Yalakom River. Scattered pockets of attack continued to be mapped in the Placer Creek, Pasayten River, and Young Creek, although it is mostly confined to higher elevation drainages. A few additional small areas of green attack were located during ground surveys in the Copper Creek area, but these were not visible from the air.

Western Balsam Bark Beetle

Incidence of western balsam bark beetle remained unchanged, at 4,480 hectares. Nearly all attack was classified as trace. Most of the affected stands were in the Prospect Creek, Spius Creek, Maka Creek, Steffens Creek, Stein River areas.

Western Spruce Budworm

Western spruce budworm populations declined across most of the east and central portions of the Merritt TSA, resulting in a 64% drop in defoliated area, to 52,420 hectares. The extent of the outbreak declined, but the population density increased in several areas affected, resulting in the area classified as moderate or severe defoliation increasing from 16,440 hectares (11% of the total) to 18,375 hectares (35% of the total). The most heavily defoliated areas were in the Gun Lake, Nsatiscou Lake, Spius Creek, Swakum Mountain, Clapperton Creek, Jesse Creek, and Skoonka Creek areas. Aggressive spray programs have treated 28,790 hectares of high priority stands with *B.t.k.* (Foray 48B) over the past two years; results have been very positive, with very little defoliation occurring in stands sprayed in either 2011, or 2010.

Egg mass surveys conducted in the fall of 2011 were focused on areas showing current damage, and other high priority stands. Heavy defoliation is expected in 2012, from Nicola Lake, through Merritt, to Spences Bridge, and in the Guichon Creek and Kingsvale areas. Moderate defoliation can be expected in the Princeton and Gun Lake areas. Approximately 13,000 hectares of high priority, heavily impacted stands are being considered for spraying in 2012.

Douglas-fir Tussock Moth

Total defoliated area remained nearly unchanged, at 1,027 hectares. Populations declined along the Fraser River near Leon Creek and Watson Bar Creek, and along Pavilion Lake. New defoliation was seen north of Spences Bridge, and near Pavilion townsite, Sallus Creek, and along the Fraser River between Fountain Valley and McKay Creek. Most new defoliation occurred in stands which were adjacent to areas of historic defoliation, but not previously affected during this outbreak. Approximately 650 hectares near Marble Canyon, Pavilion Lake, and Pavilion townsite were treated with *B.t.k.* in June. A localized area near Sky Blue Resort suffered additional tree mortality, where the *B.t.k.* alone was not sufficient to reduce larval populations to below damaging thresholds (see Special Projects section).

Results of the fall 2011 egg mass surveys predict little to no defoliation in 2012. Evidence of nuclear polyhedrosis virus was also found in several locations which should further reduce tussock moth populations.

Douglas-fir tussock moth defoliation near Watson Bar Creek, Cascades District.

Aspen Decline

Symptoms of aspen decline were observed on 270 hectares in several locations around Midday Creek, Nicola Lake, Swakum Mountain, Glimpse Lake, and Douglas Lake. Most affected stands suffered branch and top dieback, and moderate levels of tree mortality.

Other

Other forest health agents detected during the aerial surveys were 35 hectares of satin moth near Maka Creek, 136 hectares of wildfire, 22 hectares of slide and avalanche damage, and four hectares of windthrow.

Mountain Pine Beetle

Scattered mountain pine beetle attack near Bruer Creek, Okanagan Shuswap District.

Total red attack area continued to decline, to 44,740 hectares. This is down from 82,590 hectares in 2010 and 135,913 hectares in 2009. Attack intensity was low in most stands, with only 15% of affected area classified as moderate or greater. A combination of salvage harvesting, host depletion in portions of the District north and west of Vernon, and poorly synchronized beetle flights caused by cool summer weather has led to this general decline. Despite this, infestations are still widespread in the Trout Creek, Eneas Lakes, Aberdeen Plateau, Mission Creek, west Kettle River, and Hydraulic Lake areas. Several lodgepole pine plantations near Jackpine Flats, Sandberg Creek, and the Aberdeen Plateau suffered additional beetle attack, although levels tended to be light. The number of small scattered polygons and spot infestations continued to increase in the south-east corner of the District, around Naramata, Penticton Creek, and TFL 59. Mountain pine beetle populations could rebound quickly if more favourable weather conditions occur over the next few summers.

Mountain pine beetle continued to attack ponderosa pine, along the west side of the main Okanagan valley, and in the Glenmore, Kelowna, Vernon, and Deep Creek areas. Area affected was less than 1,100 hectares, with another 235 spot infestations.

Douglas-fir Beetle

Although area affected in larger polygons fell from 531 hectares in 2010, to 288 hectares in 2011, attack was still common, with nearly 300 separate infestations mapped. Several new infestations were mapped near Cherryville, and active infestations continued to be seen throughout the Shuswap, Chase Creek, Westwold, Falkland, Mabel Lake, and Ashnola River areas. Four days of detailed aerial surveys for Douglas-fir beetle were conducted by the District in late July followed by strategic ground assessments. Numerous additional epicenters were detected in the Falkland/Adelphi Creek areas.

Western Balsam Bark Beetle

Overall area affected fell slightly, to 53,040 hectares. There were some declines seen in the Park Mountain and Pearson Creek areas, but attack remains widespread in the Pukeashun Mountain, Grizzly Lake, Hunters Range, Harris Creek, Spa Hills, Whiteman Creek, and Winnifred Creek areas.

Spruce Beetle

Spruce beetle populations remained low, with only 18 hectares of new attack recorded in 2011, in the Ashnola River area.

Western Spruce Budworm

Populations expanded and intensified throughout the south Okanagan, as the total defoliated area increased from 40,900 hectares in 2010, to 77,300 hectares in 2011. The area classified as moderate or severe defoliation increased from 1,800 hectares (4% of total area) to 37,430 hectares (48% of total area). Bud flush and and insect development was more sychronized in 2011, resulting in distinctive upper crown defoliation, therefore making aerial detection more reliable. The most severe defoliation occurred around Blue Grouse Mountain, Shingle Creek, Marron Valley, Orofino Mountain, Mount Kobau, Inkaneep Creek, and Naramata. Scatttered defoliation was also recorded around Westwold, Falkland, Chase Creek, Coldstream, and Armstrong, but damage was light. Widely scattered pockets of defoliation were seen throughout the Sugar Lake, Mabel Lake, and Three Valley Gap areas, many of which were in stands having no previous record of defoliation. Douglas-fir stands in this area are typically isolated, and restricted to drier hillsides and ridges. Egg mass sampling carried out in the fall of 2011 at 113 sites indicated that defoliation intensity will continue to be high in 2012, with 65% of sites predicting moderate to severe defoliation (see Special Projects section).

Aerial application of *B.t.k.* on 5,130 hectares successfully reduced larval populations and limited defoliation near Fish Lake Road, Agur Lake, and Peachland Creek. Egg mass sampling results indicate very low budworm populations in these areas in 2012. Spray operations will be expanded in 2012, with up to 30,000 hectares of high priority stands scheduled for treatment.

Severe defoliation of Douglas-fir by western spruce budworm in the south Okanagan Valley.

Light western spruce budworm defoliation on a dry hillside on the west side of Sugar Lake. This stand has no previous record of budworm defoliation.

Douglas-fir Tussock Moth

Area affected increased slightly, to 1,550 hectares. New infestations were recorded near Carrs Landing and Blue Mountain. Defoliation was widespread, but caused minimal damage (no tree mortality) to stands impacted. Despite initially high populations near Peachland Creek, defoliation was limited due to aerial application of *B.t.k.* on 565 hectares. Results of ground sampling carried out in the fall indicate that no defoliation will occur in these sprayed areas in 2012. Approximately 430 hectares of tree mortality has resulted from this outbreak cycle that has now collapsed in the south Okanagan, Similkameen, and Ashnola areas.

Western Hemlock Looper

A few small patches of light defoliation occurred near Cherry Ridge, Vigue Creek and Greenbush Lake, totalling 77 hectares. Three tree beatings at the ten permanent sampling sites were all positive for larvae, with high numbers at the Greenbush Lake and Three Valley Gap sites. Adult moth catches at the sites were highest at the Greenbush Lake, Kingfisher Creek, Noisy Creek and Shuswap River Ecological Reserve sites. Increased defoliation may occur in 2012 in these areas.

Pine Needle Sheath Miner

Defoliation of lodgepole pine plantations caused by pine needle sheath miner (*Zellaria haimbachi*) was mapped on 240 hectares, in the Gleneden Fire, Charcoal Creek, Haddo Road, and Belgo Creek areas. Damage was light to moderate and no tree mortality is expected as populations usually collapse within one to two years due to high levels of parasitism.

Aspen Serpentine Leaf Miner

Incidence of aspen serpentine leaf miner decreased from 4,380 hectares in 2010, to 1,700 hectares in 2011. Defoliation was limited to the Reinecker Creek, Equesis Creek and Reinecker Creek areas.

Larch Casebearer

Larch casebearer defoliation was detected in the Okanagan for the first time in many years. 78 hectares suffered light to moderate defoliated around the 3-4 kilometer mark on the King Edward Main, southeast of Coldstream.

Larch casebearer damage, King Edward Main area.

Forest Tent Caterpillar

The forest tent caterpillar outbreak in the Ross Creek area declined in overall area affected, to 1,425 hectares. Top and branch dieback of affected trees (aspen, cottonwood, and birch) is becoming visible from the air. Small patches of new defoliation were recorded nearby, above Scotch Creek and along Five Mile Creek.

Forest tent caterpillar defoliation in an aspen - cottonwood - birch stand near Ross Creek. Some top and branch dieback is noticeable.

Dothistroma Needle Blight

Dothistroma needle blight infection of lodgepole pine plantations was visible on 173 hectares. Affected stands were in the Monashee Creek, upper Cherry Creek, Tsuius Creek, Cavanaugh Creek and Kidney Lake areas.

Other

Other forest health agents mapped during the aerial surveys were 235 hectares of larch needle blight, 214 hectares of birch leaf miner, 76 hectares of *Armillaria* root disease, 35 hectares of bear damage, 34 hectares of aspen decline, 54 hectares of wildfire, and 18 hectares of flooding damage.

An assessment of dead and dying trees near Sugar Lake identified *Armillaria* root disease and Douglas-fir beetle. District staff conducted Stand Development Monitoring surveys on five plantations in 2011.

Cariboo Region Summary

The Cariboo portion of the aerial overview surveys was conducted between July 11th and August 8th, and required 28 flights and 125.8 hours of flight time. Conditions for the surveys were generally good with few delays. Two contract crews surveyed the area encompassed by the Quesnel, Central Cariboo, 100 Mile House and Chilcotin Forest Districts. The surveys also covered the Robson Valley TSA and small portions of the North Island - Central Coast, Kalum, Sunshine Coast, Prince George, and Vanderhoof Forest Districts. One crew comprised of Don Wright and Darryl Wright surveyed the east half of the Region. A second crew comprised of Joe Cortese and Bob Erickson surveyed the west half of the Region. Aircraft were chartered from White Saddle Air Services, Lawrence Aviation, Cariboo Air, Daviation, and Lakes District Air Service, and utilized Cessna 180, 185, and 206 aircraft, both on and off floats.

Quesnel District

Mountain Pine Beetle

New red attack was limited to 1,070 hectares of trace and light attack in the upper Baezaeko River area. Beetle populations have completely collapsed in all other areas of the District.

Spruce Beetle

Spruce beetle activity remained low. 178 hectares of light and trace mortality was recorded near Nyland Lake, Bowron Lakes, and Deserters Creek.

Douglas-fir Beetle

Douglas-fir beetle populations continued to decline. 267 hectares of new attack, and an additional 85 spot infestations, were mapped in the Nazko River and Victoria Creek-Swift River areas, and along the Fraser River north of the Cottonwood-Fraser confluence. Ground surveys revealed several pockets of very severe attack along the Fraser River.

Western Balsam Bark Beetle

Almost all balsam bark beetle activity continued to be east of the Quesnel River. Most of the 12,620 hectares of attack were within TFL 52, and in Bowron Lakes Park.

Subalpine fir stand attacked by western balsam bark beetle.

Western Spruce Budworm

Area defoliated by western spruce budworm increased by over 75%, to 17,785 hectares. Defoliation extended along both sides of the Fraser River, from the southern District boundary, as far north as Moffatt Lake Road. Treatment of 6,200 hectares of Douglas-fir stands with *B.t.k.* in June reduced damage intensity on both sides of the Fraser River, and as a result less than 1,000 hectares of forest was moderately or severely defoliated. Budworm populations now appear to be decreasing, with only one of eleven sampling sites predicting heavy defoliation in 2012.

Forest Tent Caterpillar

Defoliation by forest tent caterpillar in the Quesnel area increased from 34,860 hectares in 2010, to 40,100 hectares in 2011. Nearly half of this area suffered moderate or severe defoliation. Ground checks indicated that forest tent caterpillar populations were beginning to decline, and aspen serpentine leaf miner was becoming more active. Venturia twig blight was also noted in approximately 5% of the affected area. This combination of heavy forest tent caterpillar damage over several years, and additional damage from the leafminer and Venturia, may be leading to aspen decline symptoms such as dead tops and branches. Damage was especially severe in stands east of Quesnel.

Aspen Serpentine Leaf Miner

In addition to the increasing levels of aspen serpentine leaf miner seen during ground checks of forest tent caterpillar infestations near Quesnel, an additional 3,316 hectares of defoliation visible from the air was mapped around Bowron Lake.

Pine Needle Sheath Miner

A pine needle sheath miner infestation was observed in a lodgepole pine plantation along Garnet Road, southwest of Quesnel. Defoliation was moderate and covered 112 hectares.

Other

Other forest health agents recorded during the aerial surveys were 35 hectares of flooding, 27 hectares of windthrow, and 20 hectares of widlfire.

Central Cariboo District

Mountain Pine Beetle

The only mountain pine beetle activity in the District was at high elevations in the southwest corner of the District. Scattered, light mortality was mapped on 3,315 hectares in the upper Churn Creek, Lone Valley Creek, and Dash Creek. Some widely scattered small pockets of attack were also mapped in Big Creek Park. Low severity attack in young lodgepole pine was mapped on 512 hectares around Koster Creek, Dog Creek and Gaspard Creek.

Western Balsam Bark Beetle

Western balsam bark beetle activity expanded in the Mackay River and Seller Creek areas, and as a result total area affected increased slightly to 12,623 hectares. Nearly all of the attack was classified as trace.

Spruce Beetle

Spruce beetle activity declined significantly, from 16,520 hectares in 2010, to 4,860 hectares in 2011. Most of the remaining attack was in the Mackay River, Niagara Creek, upper Horsefly River, and Warttig Lake areas.

Douglas-fir Beetle

Attack declined in several of the larger patches near Dog Creek and Gaspard Creek, leading to a decrease in overall area affected, from 670 hectares in 2010, to 285 hectares in 2011. However, many new attack centers were mapped across the central regions of the District, especially around Skelton and Buxton Creeks, which led to an increase in the number of spot infestations of over 70%, to 586. Walk-through assessments of the large 2010 fires in the District indicate that the extent and severity of Douglas-fir beetle attack is high with populations likely to expand significantly in 2012. These areas were not detected in the overview or detailed flights because all the attack is still in fire killed/ stressed trees.

Western Spruce Budworm

After declining in 2010, defoliated area increased by over two-fold, to 305,715 hectares. Expansions were seen in the Riske Creek, Meldrum Creek, Chilcotin River, Gaspard Creek, Churn Creek, Dog Creek and Alkali Creek areas. Just over 38,000 hectares around Williams Lake, Soda Creek, Blue Lake, McLeese Lake and the west side of Chimney Lake were moderately or severely defoliated. 13,880 hectares were treated with *B.t.k.* in June, which reduced damage levels near Soap Lake, Till Lake, Bald Mountain, Farwell Canyon, Word Creek, and the east side of Chimney Lake. Populations are expected to remain high in 2012, especially around Alkali Lake, Chimney Lake, Riske Creek, Farwell Creek, Gaspard Creek, Sting Lake and Brigham Lake.

Douglas-fir stand heavily defoliated by western spruce budworm near McCleese Lake, Central Cariboo District.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner continued to be active across much of the District. However, due to generally low damage levels, only 3,940 hectares of defoliation were mapped during the aerial surveys, mostly near Tisdall Lake, Black Creek Ranch, McCauley Lake, and Big Lake.

Trembling aspen showing thin foliage after several years of serpentine leaf miner defoliation. Big Lake, Central Cariboo District.

Western Hemlock Looper

Defoliation due to western hemlock looper was observed on 5,775 in the East Arm Quesnel Lake area. Damage occurred in several locations along the south edge and east end of the lake. Egg sampling was carried out in the fall at 45 sites, 20 of which were positive for eggs. Moderate to severe defoliation is expected at Tasse Lake, Hen Ingram Lake, Kill Dog Creek, and Bouldery Creek in 2012. Up to 10,000 hectares may be treated with *B.t.k.* in 2012.

Other

Other forest health factors mapped during the aerial surveys were 460 hectares of redbelt near Lone Cabin Creek and Koster Creek, 300 hectares of wildfire, 31 hectares of windthrow and 1.5 hectares of flooding damage.

Chilcotin District

Mountain Pine Beetle

The total area of new red attack dropped by 90% for the second consecutive year, to 4,300 hectares. This is down from 103,870 hectares in 2010 and the peak of almost 1 million hectares in 2009. Infestations have almost completely collapsed, with the exception of a few higher elevation areas areas around the south end of Taseko Lake, Gunn Valley, the southeast end of Chilko Lake and Ottarasko Creek. Infestations in other areas have been reduced mainly to spot infestations (371 were recorded; Table 4). Beetle populations have declined due to high overwinter mortality and fewer beetles immigrating from adjacent outbreak areas, rather than a lack of susceptible host material.

Western Balsam Bark Beetle

Western balsam bark beetle populations are confined to the southern high elevation portions of the District. 5,030 hectares of trace attack were mapped in the Taseko Lake, Chilco Lake, Homathko River, and Klinaklini River areas.

Douglas-fir Beetle

Douglas-fir beetle populations remained low, with 1,820 hectares affected in patches and 213 spot infestations. Attack was recorded throughout the Chilcotin River, lower Chilanko River, Tatlayoko Lake, and lower Chilko Lake areas. The Alexis Creek area saw a significant increase in the number of small spot infestations. Walk-through assessments of the large 2009 and 2010 fires in the District indicate that there were some extremely concentrated pockets of attack associated with the fires and their extended perimeters. Populations are likely to expand significantly in 2012. These areas were not detected in the overview or detailed flights because all the attack is still in fire killed/stressed trees.

Western Spruce Budworm

Western spruce budworm populations increased and expanded in 2010 resulting in an increase in area defoliated in 2011. Affected area was up to 34,000 hectares, with 4,765 hectares moderately or severely defoliated. Most of the increases were in the Alexis Creek, Bull Canyon, Young Road, Lees Corner, Haines Creek and Zenzaco Creek areas.

Extensive stands of lodgepole pine killed by mountain pine beetle in the Chilcotin District.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner defoliation reached visible levels on 3,100 hectares. Affected stands were scattered in the Klinaklini River, Mosley Creek, Tatlayoko Lake, and Anahim Lake areas. Stands in many other areas continue to be affected but at levels too low to be visible from the air.

Other

Several other forest health factors of minor consequence were mapped during the aerial surveys. These included 28 hectares of forest tent caterpillar east of Anahim Lake, 85 hectares of redbelt damage in the Klinaklini River area, 90 hectares of widely scattered avalanche damage, 77 hectares of flooding mortality, 56 hectares of landslide damage and very small areas of spruce beetle and engraver (*Ips*) beetle. 18 hectares of windthrow were mapped along the northern edge of the 2010 Chilko Lake fire in what appeared to be fire damaged lodgepole pine.

Windthrow on the northern edge of the 2010 Chilko Lake fire.

100 Mile House Forest District

Mountain Pine Beetle

Mountain pine beetle was mapped on just 306 hectares in 2011. Of this, only 172 hectares were in mature lodgepole pine, nearly all of which was in a few scattered, trace and light pockets near the south end of the Marble Range. Forty-two hectares were in lodgepole pine plantations near Pigeon Creek and Meadow Lake, and 91 hectares were in ponderosa pine in Edge Hills Park.

Douglas-fir Beetle

Douglas-fir beetle activity continued to drop in the Big Bar, Canoe Creek, and China Gulch areas, where only a few occasional spot infestations were mapped. Beetle is still active around Lac La Hache, Canim Lake, and Loon Lake although most of the attack remained in smaller scattered spots. Only 184 hectares of patch infestations were mapped, with another 213 spot infestations.

Spruce Beetle

After a large increase in spruce beetle activity in 2010, both the area affected and infestation severity have declined. New attack fell from 9,990 hectares to 1,700 hectares, while the proportion of area classified as moderate or severe fell from 60% to 16%. All of the infestations were in the northeast portion of the District, near Boss Creek, Hendrix Mountain and Deception Creek.

Western Balsam Bark Beetle

Western balsam bark beetle was mapped on 5,280 hectares in the Hendrix Lake, Deception Creek, Spanish Creek, and Windy Mountain areas. Attack intensity has been comparatively high in this District with over 30% of all infestations being classified as light or moderate.

Western Spruce Budworm

Budworm populations expanded around Dog Creek and Canoe Creek, resulting in an increase in area affected of 60% to 62,265 hectares. Although damage levels remained low in most affected stands in 2011, populations are expected to increase significantly around Dog Creek and Canoe Creek in 2012, and moderate to severe defoliation may occur. Population levels should remain lower around Loon Lake, 100 Mile House and Lac La Hache.

Grey lodgepole pine stands south of Elbow Lake, near the 100 Mile House District - Kamloops District boundary.

Douglas-fir Tussock Moth

After two years of high populations across the Fraser River in the Lillooet TSA, several small pockets of defoliation were mapped in the 100 Mile House District, in the China Gulch and Big Bar areas. The infestations near China Gulch are the furthest north record of Douglas-fir tussock moth outbreak, although moths have been previously trapped in the area. A total of 360 hectares were defoliated, in ten patches.

Pheromone traps were deployed in 6-trap clusters at 30 sites. The average adult moth catch per trap remained low, at 1.6. A few sites such as the Alkali Lake site that had an average 18 moths per trap, recorded slightly higher catches recorded slightly higher catches, but none that indicated outbreak populations.

Other

Other forest health factors mapped during the aerial surveys were 990 hectares of aspen serpentine leaf miner defoliation around Bridge Lake and Deka Lake, 52 hectares of *Armillaria* root disease, 44 hectares of aspen decline around Lac La Hache, 275 hectares of wildfire (mostly in one fire near China Gulch), 118 hectares of windthrow near Mt. Timothy, and 9 hectares of road salt damage at 108 Mile Ranch.

Forest Health - Special Projects

2011 Western Spruce Budworm Program Summary Report

Background

The 2011 western spruce budworm spray program saw a total of 50,763 hectares of infested Douglas-fir forest treated with Foray 48B (*Bacillus thuringiensis* var. *kurstaki*, P.C.P. No. 24977, or *B.t.k.*) in the South Area (Thompson Okanagan and Cariboo Regions). A 661 hectare area was re-sprayed in the Sabiston-Red Lake area (Block K1, Table 1) bringing the total area sprayed for budworm to 51,424 hectares (123,418 litres *B.t.k.*). Foray 48B was applied at 2.4 litres per hectare.

Western Aerial Applications Ltd. conducted the aerial application for the Thompson Okanagan Region using two 315B Lama helicopters and two Hiller UH12ET helicopters. A total of seventy-five 1,000 litre bulk containers of *B.t.k.* were delivered to 15 staging sites to service the 16 spray blocks in the Okanagan Shuswap, Thompson Rivers and Cascades Forest Districts. Region and District staff as well as local contractors assisted in the delivery of the program, from spray planning and population assessments to daily weather monitoring. The Thompson Okanagan program treated 29,875 hectares (Fig. 1) in total using 73,285 litres of *B.t.k.* Spraying was conducted from June 21st to July 5th, taking a total of 6 days to complete (Table 1). Budworm development was very slow in 2011 due to cool wet weather throughout May and June. Even after treatment the cool weather persisted at many sites, affecting the amount of larval feeding on treated trees. Despite the cool weather, good results were achieved on blocks treated.

The aerial spray contractor for the Cariboo Region program was Conair, using two AT-802F Air Tractors. The project was a joint effort between Region and District staff and the Provincial Air Tanker Centre, Conair Aviation, Highland Helicopters and several forest health consultants. The *B.t.k.* was delivered to the Cariboo in tanker trucks where it was transferred to 2,500 US gallon storage tanks located at the Williams Lake airport. The airport was used as the 2011 staging area for all the Cariboo spray blocks. The Cariboo program treated 20,888 hectares in total using 50,131 litres of *B.t.k.* The program took 5 days to complete, spanning from June 26th to July 4th, 2011. Start-up and completion of both programs was delayed due to cool, wet weather in early June that delayed insect development. All treatments targeted 4th instar budworm larvae.

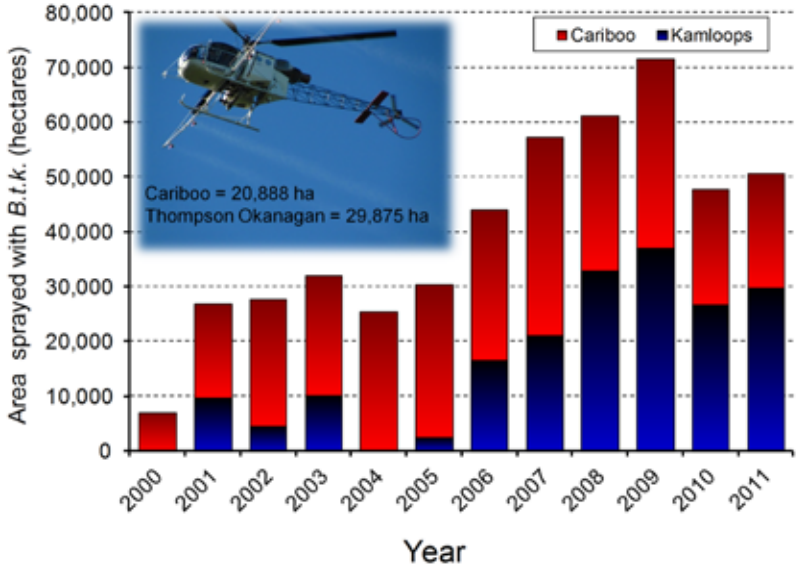

Figure 1. Area sprayed with *B.t.k.* for western spruce budworm from 2000 to 2011 in the Cariboo and Thompson Okanagan Regions.

Table 1. List of western spruce budworm spray blocks treated with Foray 48B in 2011, showing hectares treated, litres of *B.t.k.* applied and date sprayed. All treatments were at 2.4 litres per hectare.

Block #	Location	Area sprayed (ha)	Litres Foray 48B (*B.t.k.*)	Date(s) Sprayed
Thompson Okanagan Region				
Okanagan Shuswap District				
K11	Agur Lake	2,392	5,741	June 22
K12	Fish Lake Road	1,380	3,312	June 21-22
K13	Peachland - Spring Lake	1,131	2,714	June 21
K14	Peachland - McCall Lake	223	535	June 21
	sub-total	5,126	12,303	
Thompson Rivers (Kamloops) District				
K1	Sabiston-Red Lake	11,787	28,289	June 24-25
	(661 ha re-sprayed on K1)	661	1,586	June 25
K1a	Sabiston-Criss Creek West	1,107	2,657	June 25
K2	Sabiston-Red Lake East	2,078	4,987	June 25
K3	Deadman - McLeod Rd	2,682	6,437	June 24
	sub-total	17,654	43,956	
Cascades District				
M4	Spahomin Creek	2,518	6,043	July 5
M3	Spahomin Creek	1,350	3,240	July 5
M7a	S. Princeton - Deep Gulch	7761,862	June 29	
M7b	Friday-Saturday Creek	346830	June 29	
M8	Sunday Summit	8752,100	June 29	
M8a	Sunday Summit West	96230	June 29	
M9	Placer-Belgie Creek	8472,033	June 29	
M10	Crowley Creek	287688	June 29	
	sub-total	7,095	17,027	
Thompson Okanagan Region total		**29,875**	**73,285**	
Cariboo Region				
1	Marguerite	5,393	12,943	June 26-27; July 4
2	Tingley Creek	1,900	4,560	June 26
3	Soap Lake	568	1,363	June 27
4	Till Lake	2,680	6,432	June 26-27
5	Chimney Lake North	3,896	9,350	June 27
6	Bald Mountain	1,396	3,350	June 29
7	Farwell	3,328	7,987	June 29; July 4
8	Word Creek	1,727	4,145	June 28
Cariboo Region Total		**20,888**	**50,131**	
South Area Total		**50,763**	**121,830**	**June 21-July 5**

Efficacy Assessment of the 2011 western spruce budworm spray program

A select number of sites within and adjacent to treatment areas were assessed for budworm population before and after treatment. This larval sampling procedure was conducted by selecting 10-15 trees per site and at each sampling date (one day pre-spray and at 5-7 day intervals post-spray), two 45 cm branch tips per tree were clipped and the number of budworm larvae on each branch counted. Current year defoliation and total tree defoliation was recorded at each assessment date. A total of 42 control trees and 85 treated trees (Table 2) over 10 sites were sampled pre- and post-spray. The percent mortality of budworm larvae was calculated as below:

$$\% \text{ Mortality} = \frac{(\text{pre-spray density of live insects}) - (\text{post-spray density of live insects})}{(\text{pre-spray density of live insects})} \times 100$$

To determine the larval mortality attributed to *B.t.k* treatment, Abbott's corrected mortality was calculated using the formula below:

$$\text{Abbott's corrected \% mortality} = \frac{(\text{treated \% mortality}) - (\text{check \% mortality})}{100 - (\text{check \% mortality})} \times 100$$

Table 2. Number of trees sampled for western spruce budworm populations in control and treatment areas showing date of pre-spray sampling (conducted the day prior to treatment areas being sprayed).

	Number of Trees		Pre-spray
Geographic area	**Control**	**Treatment**	**Sampling Date**
Princeton blocks	15	15	28-Jun
Sabiston-McLeod Rd. blocks	12	40	24-Jun-25
Peachland blocks	15	30	20-Jun
Total trees	**42**	**85**	

Budworm populations were comparable among sites selected for sampling, with larval density ranging from 124 to 301 larvae per m^2 foliage in spray blocks and 247 to 295 larvae/m^2 foliage in control areas, at the pre-spray assessment (Table 3). At the first post-spray assessment (Table 3) the average number of budworm larvae per m^2 foliage was significantly lower in sprayed blocks compared to unsprayed blocks with an average of 72 larvae/m^2 compared to 224 larvae/m^2, respectively. This population reduction represented an average of 65.3% mortality in spray blocks and 17.3% mortality in control blocks (Table 4). At the second post-spray assessment average larval morality across spray blocks was 83.1%, ranging from a high of 94.8% mortality in the Sabiston Creek #2 block to 63.1% in the Princeton block (Table 4). Fewer control sites were sampled than spray sites.. The Sabiston and Princeton budworm populations decreased significantly in the control blocks, so Abbott's corrected mortality did not reflect the overall population reduction achieved by *B.t.k.* treatment. The first post-spray calculation of percent larval mortality and Abbott's corrected mortality better described the overall results of treatment. Larval numbers decreased rapidly in treatment areas compared to control areas thereby protecting trees from further defoliation. The average Fettes defoliation estimate for sprayed blocks in Princeton was 1.4 (<20% defoliation) compared to a Fettes estimate of 4.1 (>60% defoliation) in the corresponding control block (Fig. 2). Larvae were predominantly late 3rd to early 4th instar at the time of treatment (Fig. 3). From initial treatment to the first post-spray assessment (about 5-7 days after treatment), very little growth was observed in larvae primarily due to the cool weather conditions . By the 2nd post-spray assessment, spanning from July 4th in the Okanagan to July 28th in the Princeton area, larval development had progressed and ranged from late 4th instar to 6th instar.

Table 3. Average density of western spruce budworm larvae (larvae/m^2 foliage), in control areas and spray blocks (*B.t.k.*), at each of the sampling times (Pre=pre-spray; 1=1st post-spray; 2=2nd post-spray).

	Average no. larvae/m^2 foliage (by block)					
Block	Pre-*Btk*	*Btk*-1	*Btk*-2	Pre-Control	Control-1	Control-2
Peachland-3 km	210.2	87.3	42.4	247.1	239.5	103.5
Peachland-5 km	234.7	142.4	12.5	247.1	239.5	103.5
Peachland - Law Street	301.9	98.9	72.8	247.1	239.5	103.5
Sabiston-McLeod	129.7	42.6	10.3	295.3	217.4	60.3
Sabiston Creek #2	124.1	17.7	6.4	295.3	217.4	60.3
Sabiston Creek #3	228.4	73.4	42.3	295.3	217.4	60.3
Princeton	147.9	42.3	54.5	294.5	197.5	35.1
Average (all blocks)	196.7	72.1	34.5	274.5	224.0	75.2

Table 4. Percent mortality of western spruce budworm larvae in control and treatment blocks (*B.t.k.*) and Abbott's corrected percent mortality, at two post-spray sampling times. Averages were also calculated excluding the Princeton blocks which did not show significant mortality due to treatment in the corrected mortality calculation.

	% mortality				**Abbott's corrected % mortality**	
Block	***Btk*-1**	***Btk*-2**	**Control-1**	**Control-2**	**Post-1**	**Post-2**
Peachland-3km	58.5	79.8	3.1	58.1	57.2	51.9
Peachland-5 km	39.4	94.7	3.1	58.1	37.4	87.3
Peachland - Law St	67.2	75.9	3.1	58.1	66.2	42.4
Sabiston-McLeod	67.1	92.0	26.4	79.6	55.4	61.0
Sabiston Cr #2	85.7	94.8	26.4	79.6	80.6	74.6
Sabiston Cr #3	67.9	81.5	26.4	79.6	56.3	9.2
Princeton	71.4	63.1	32.9	88.1	57.3	-
Average (all blocks):	65.3	83.1	17.3	71.6	58.6	16.8
Ave. excluding Princeton	**64.3**	**86.5**	**14.7**	**68.9**	**58.9**	**54.4**

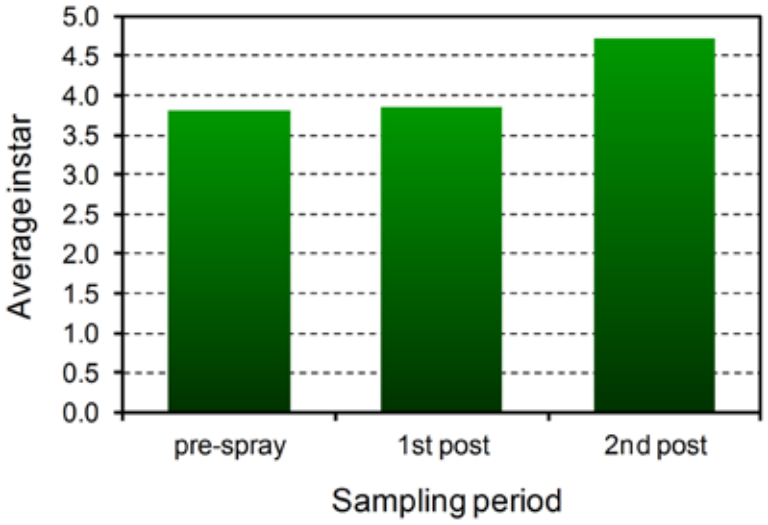

Figure 3. Larval instar at time of sampling, averaging all sites (average instar + SD).

Small third instar western spruce budworm larva.

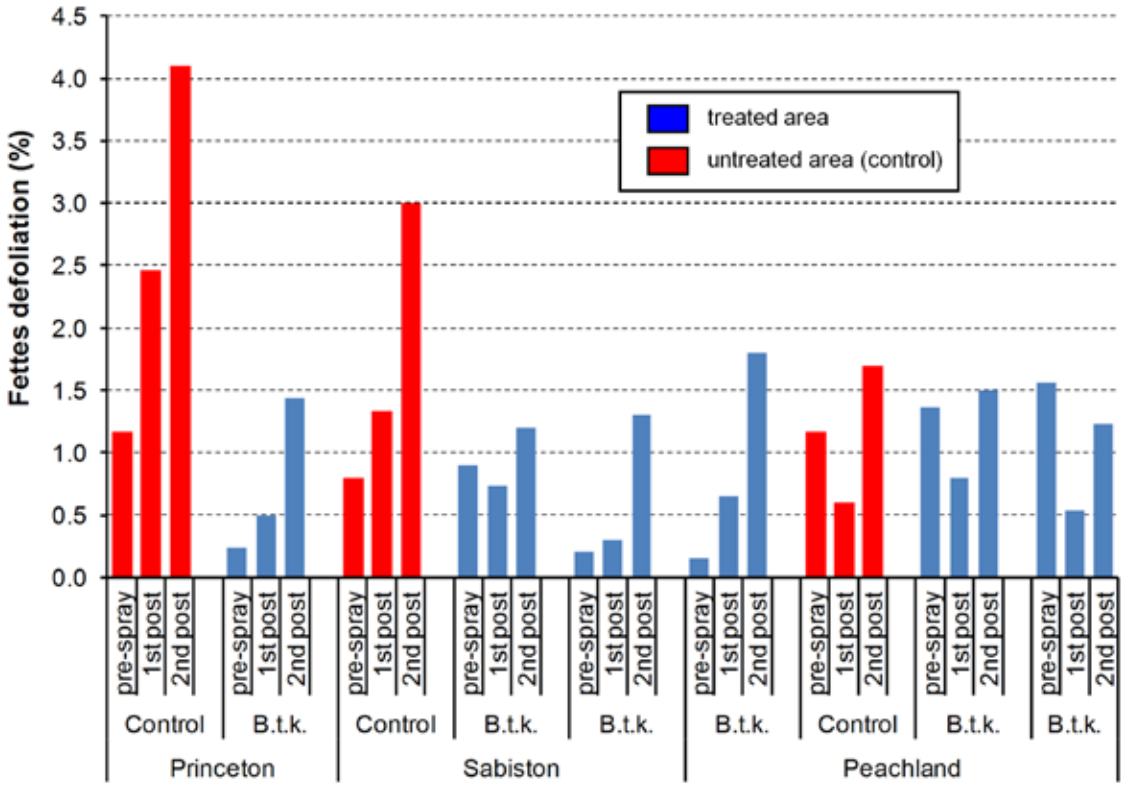

Figure 2. Fettes defoliation estimate (current year defoliation) at the pre-spray and two post-spray sampling times in 3 control and 6 treated sites. Fettes defoliation scale (%): 0=0; 1=1-20; 2=21-40; 3=41-60; 4=61-80; 5=81-99; 6=100; and 7=100% defoliation plus bud destruction).

Western spruce budworm treatment plans for 2012

Using the results of the 2011 aerial overview survey mapping of budworm defoliation and stand hazard rating as a guide, egg mass sampling was conducted in a total of 706 sites in the fall of 2011 (Table 5). By Region a total of 288, 237, 155 and 26 sites were assessed in the Thompson Okanagan, Cariboo, Kootenay Boundary and Coast Regions, respectively. All sites in the Chilliwack District predicted nil or light defoliation, so no spray program is planned for 2012 in this District, and population monitoring will continue in 2012.

Nearly 43% of sites in the Kootenay Boundary Region (compared to 9% of all sites assessed in 2011) predict moderate to severe defoliation in 2012. It is anticipated that up to10,000 hectares will require *B.t.k.* treatment next year. Over 22,000 hectares of moderate and severe defoliation were mapped, representing nearly 47% of total defoliation mapped in the Region.

The budworm also continued to build significantly throughout the South Okanagan, with approximately 145,955 hectares of defoliation mapped in the Okanagan Shuswap District. Of this, 41% (59,696 hectares) were classed as moderate to severe. Egg mass sampling revealed 72 sites in the Okanagan Shuswap District (62% of sites assessed in this district) predicting moderate to severe defoliation in 2012. Approximately 62% of sites in the Cascades District and 33% of sites in the Thompson Rivers District resulted in egg mass counts predicting moderate to severe defoliation in 2012, representing 62 sites and 24 sites in each district respectively (Table 5). A spray program of approximately 40,000 hectares is planned for this Region in 2012.

In the Cariboo Region, 90 egg mass sampling sites (38% of sites assessed in this Region) resulted in moderate to severe defoliation predictions for 2012. Most of the high budworm populations were in the Central Cariboo and 100 Mile House Districts (Table 5). Approximately 98% of the total 378,231 hectares of defoliation mapped in 2011 occurred in these two districts. The Cariboo has over 40,000 hectares planned for *B.t.k.* treatment in 2012.

The combination of natural and applied controls effectively decreased budworm populations in 2011, however, infestations in untreated areas continued to increase and spread. The area of mapped defoliation in 2011 increased to over 616, 689 hectares from 499,104 hectares in 2010.

Up to 90,000 hectares of Interior Douglas-fir forests are scheduled for treatment with Foray 48B® (*Bacillus thuringiensis* var. *kurstaki*, *B.t.k.*; PCP #24977) under the "2008-2013 Southern Interior Pest Management Plan" in 2012. Treatments will be targeted at high priority stands within the Thompson Okanagan, Cariboo and Kootenay Boundary Regions as noted above.

Table 5. Results of fall 2011 western spruce budworm egg mass sampling in B.C. Results are summarized by District indicating the number of sites predicting either nil (no defoliation predicted in 2012), light, moderate or severe defoliation in 2012.

	# of sites in each defoliation category				Total number	Average # egg
District	**Nil**	**Light**	**Moderate**	**Severe**	**of sites**	**masses/10m² foliage***
Chilliwack	3	23	0	0	26	11.6
Cascades	0	38	42	20	100	91.4
Okanagan Shuswap	6	38	55	17	116	82.1
Kamloops	11	37	19	5	72	47.3
Central Cariboo	0	52	42	13	107	81.9
100 Mile House	23	42	23	6	94	51.0
Chilcotin	8	12	4	1	25	27.6
Quesnel	4	6	1	0	11	14.2
Arrow Boundary	16	45	49	7	117	54.6
Rocky Mountain	1	27	10	0	38	37.2
Total	**72**	**320**	**245**	**69**	**706**	**48.7**
percent of sites	10	45	35	10		

*Nil = no egg masses found
Light = 1-50 egg masses/10 m² foliage
Moderate = 51-150 egg masses/10m² foliage
Severe = >150 egg masses/10m² foliage

Western spruce budworm eggmass sampling training session, Rock Creek, 2011.

Background

In 2007, patches of defoliation due to the Douglas-fir tussock moth (DFTM) were detected in the Thompson Rivers District. In the fall, a significant increase in egg masses at numerous sampling sites led to the first aerial pesticide treatment in the summer of 2008. 2011 marked the 5th year in the outbreak cycle of DFTM. The 2011 control program targeted areas with the highest egg mass densities located in surveys conducted during the fall of 2010. The program covered 20 blocks located in the Okanagan Shuswap, Thompson Rivers and Cascades Forest Districts for a total of 7,281 hectares treated (Fig. 1; Table 1). In the Cascades District, the spray program was covered under a separate Pesticide Use Permit, PUP #402-0659-11/11, because most of the blocks were on private forested land or within a Provincial Park. All blocks on Crown forested land were treated with Foray 48B (*B.t.k.*) applied once at 4 litres per hectare. The private land and Provincial Park at Pavilion Lake were treated twice at 4 litres per hectare. No nuclear polyhedrosis (NPV) virus was used in 2011 due to lack of supply. Larval hatch was greatly delayed this year due to cool, wet weather throughout the spring and early summer period. The Peachland blocks were treated on June 21, 2011, followed by the Cascades and Thompson Rivers blocks. Larvae had all hatched and dispersed from egg masses at the time of treatment and ranged from 2nd to 3rd instar, however, due to continuing cool weather after treatment, particularly in the Pavilion area, larvae were not actively feeding. Western Aerial Applications Ltd. conducted the aerial application using a 315B Lama helicopter and Hiller UH12ET helicopter from five staging sites.

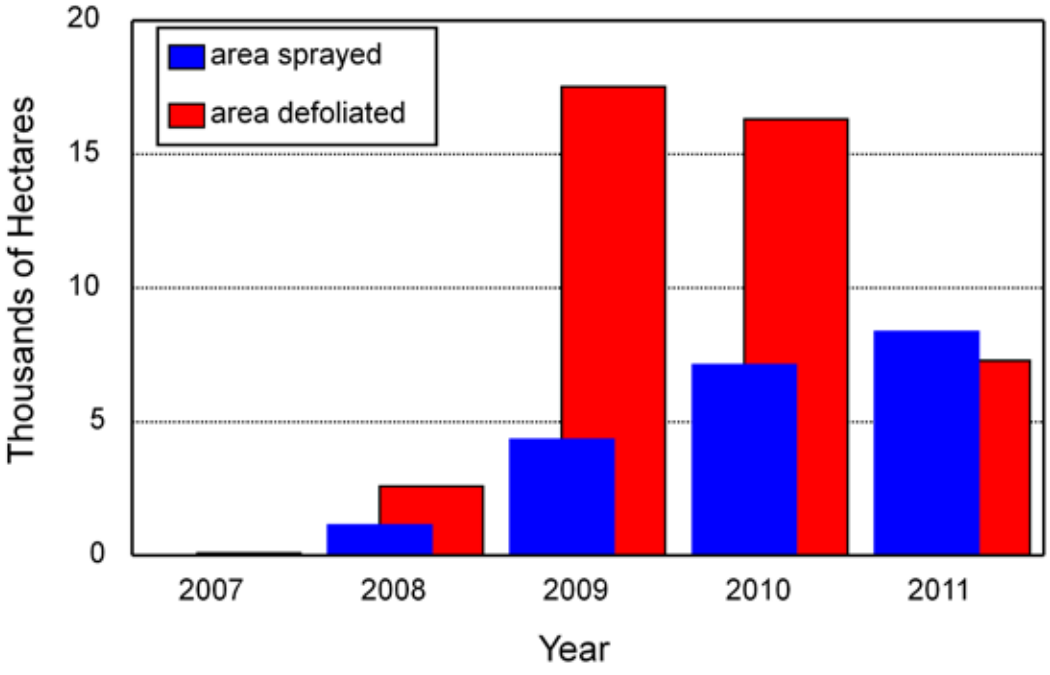

Figure 1. Total annual defoliation by Douglas-fir tussock moth compared to total area sprayed for the current outbreak period (2007-2011).

Table 1. List of Douglas-fir tussock moth spray blocks treated with Foray 48B in 2011, showing hectares treated, litres of *B.t.k.* applied and date sprayed. Blocks followed by an asterisk (*) were treated under PUP #402-0659-11/11, while all other blocks were treated under the Southern Interior Region Pest Management Plan.

Block #	Location	Area sprayed (ha)	Litres Foray 48B (*B.t.k.*)	Date(s) Sprayed
Okanagan Shuswap District				
14	Peachland - Law Street	191	764	June 21
K12 NW	Peachland - Fish Lake	130	520	June 21
15	Peachland - Spring Lake	160	640	June 21
15a	Peachland - Princeton Ave.	10	41	June 21
16	Peachland - Eneas Creek	204	814	June 21
District total		695	2,779	
Cascades District				
10*	Pavilion Lake & Smith Rd	405	2,700	June 23
11*	North Pavilion Lake	125	500	June 23
12*	Diamond "S" Ranch	27	108	June 23
13*	Pavilion IR	87	693	June 23
District total		644	4,001	
Thompson Rivers (Kamloops) District				
1	Veasy Lake	2,044	8,178	June 23
2	Veasy Lake -S-side of Hwy 99	38	152	June 23
3	McLean Creek - NW of Cache Creek	134	536	June 23
4	Hat Creek - West of Veasy	268	1,071	June 23
8	McLean Creek - NW of Cache Creek	115	462	June 24
7	McLean Creek - NW of Cache Creek	121	485	June 24
6	Cache Creek Airport	112	446	June 24
5	North Cache Creek	392	1,568	June 24
9a	Battle Creek	104	418	June 24
9b	Battle Creek	256	1,024	June 24
9	Battle Creek	2,358	9,432	June 24
District total		5,943	23,772	
Total area treated		**7,281**	**30,551**	**June 21 - 24**

Efficacy assessment of Douglas-fir tussock moth control program

Pre- and post spray larval sampling was conducted in select treated and untreated sites to evaluate treatment efficacy, determine best timing of the spray application and monitor tussock moth density and presence of virus. It was difficult to locate comparable control sites because most high tussock moth population sites were targeted for treatment. However, three control sites were selected, one each near the Peachland, Pavilion and Veasy Lake treatment blocks. Four sites within the treatment blocks were also sampled (Tables 2, 3). All treatment and control blocks were sampled one day prior to spray application (pre-spray sample). The standard protocol of snipping two 45 cm branch tips from mid-crown of approximately 15 trees per site was used. All larvae were counted and assessed for virus infection. At pre-spray sampling, larval density varied from 55 larvae per m^2 foliage (Peachland control; Table 2) to over 623 larvae per m^2 foliage (Sky Blue campground on Pavilion Lake; Table 2). At the first post-spray assessment undertaken 10-14 days after the spray, larval numbers had decreased noticeably in all but the Sky Blue site and on the private land adjacent to this sampling site. Average larval density at Sky Blue was 525.6 + 245.0 larvae per m^2 foliage (Table 2) indicating minimal larval mortality due to treatment (Table 3). The percent larval mortality in the other treatment areas was good, ranging from 56% to 100% at the 1st post-spray assessment (Table 3). Abbott's corrected mortality was 70.8% on the Veasy block and 96.6% on the other Pavilion blocks (Table 3). Despite the two applications of *B.t.k.* at 4 litres/ha on the private land adjacent to Pavilion Lake and the Sky Blue campground, negligible control was achieved and significant defoliation occurred at Sky Blue. The private land owners subsequently hired a private company to spray their properties. A number of factors could have influenced this lack of control such as: extremely high larval numbers; minimal foliage on trees for feeding larvae to consume *B.t.k.*; and cool weather following the spray so minimal feeding occurred. As well, there were many houses and other structures on the properties leading to an unsynchronized hatch (e.g. under shaded eaves of some buildings) so it is possible that some larvae had not dispersed at the time of the spray. There was very little evidence of virus at any of the sampling locations except in the Peachland control.

Table 2. Average number of Douglas-fir tussock moth larvae (± standard deviation) in treated (*B.t.k.*) and control blocks at the pre-spray and post-spray sampling times.

	Ave # larvae/m^2 (*B.t.k.*)			Ave # larvae/m^2 (control)		
Block	Pre	1st post	2nd post	Pre	1st post	2nd post
Veasy	374.9 ± 107.2	163.9 ± 99.6	61.7 ± 41.0	238.0 ± 152.8	206.5 ± 66.1	134.0 ± 112.9
Peachland	125.3 ± 67.5	0.0	NA	55.7 ± 55.1	45.5 ± 10.8	NA
Sky Blue	623.3 ± 328.6	525.6 ± 245.0	NA	238.0 ± 152.8	206.5 v 66.1	134.0 ± 112.9
Pavilion	264.7 ± 147.9	65.8 ± 52.5	5.0 ± 12.0	238.0 ± 152.8	206.5 ± 66.1	134.0 ± 112.9

Table 3. The percent mortality of DFTM larvae in treated (*B.t.k.*) and control blocks at two post-spray sampling times.

	Percent mortality				Abbott's corrected mortality (%)	
Block	*B.t.k.*-1	*B.t.k.*-2	Control-1	Control-2	Abbott's-1	Abbott's-2
Veasy	56.3	83.5	13.2	43.7	49.6	70.8
Peachland	100.0	NA	18.3	NA	100.0	NA
Sky Blue	15.7	NA	13.2	NA	2.8	NA
Pavilion	75.1	98.1	13.2	43.7	71.4	96.6

Detailed aerial mapping was conducted in July and August to delineate total area of mortality caused by tussock moth during this outbreak. The entire 2008-11 outbreak area in the Thompson Okanagan Region was assessed. Approximately 8,813 hectares of Douglas-fir mortality were mapped (Fig. 2) with the highest levels of mortality occurring in the Thompson Rivers District (Fig. 3). Much of the mortality was due to defoliation in 2009 and 2010, particularly in the Cultus Lake-Savona, Barnhartvale, Monte Creek, Heffley Creek and Six Mile areas. Additional mortality may occur where the tussock moth is still active and in areas defoliated in 2011 such as Cache Creek, Pavilion and Spences Bridge. Small patches of mortality are already evident in the Pavilion-Marble Canyon area because of extremely severe larval densities in 2010 and 2011. This population represents an expansion of the known historic range of tussock moth and appears to be expanding northwards (Fig.4). The Marble Canyon drainage is very narrow with steep, dry rocky cliffs on either side of the lake. With tussock moth range being very limited by elevation, it is moving along the valley north and west.

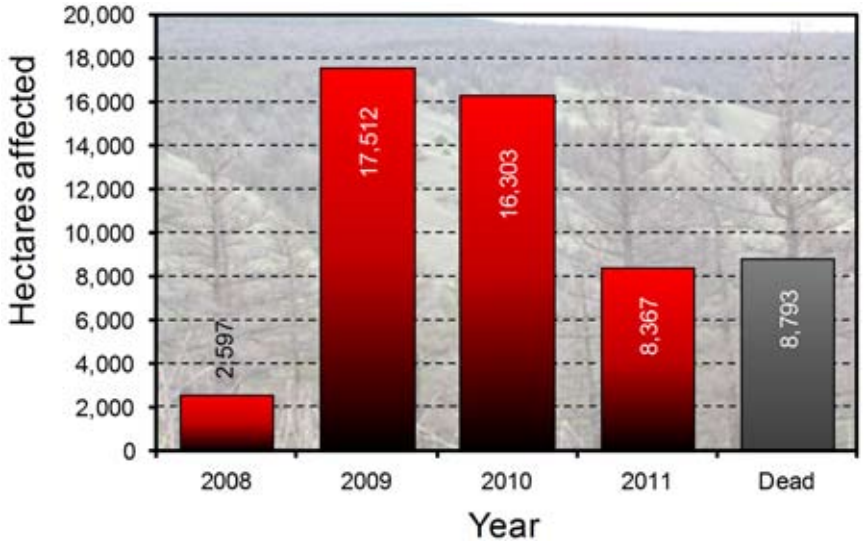

Figure 2. Area of annual defoliation (red bars) caused by the Douglas-fir tussock moth from 2008-2011 in the southern interior of B.C. Detailed mapping in 2011 delineated 8,793 hectares of dead Douglas-fir (grey bar) as a result of the four year tussock moth outbreak.

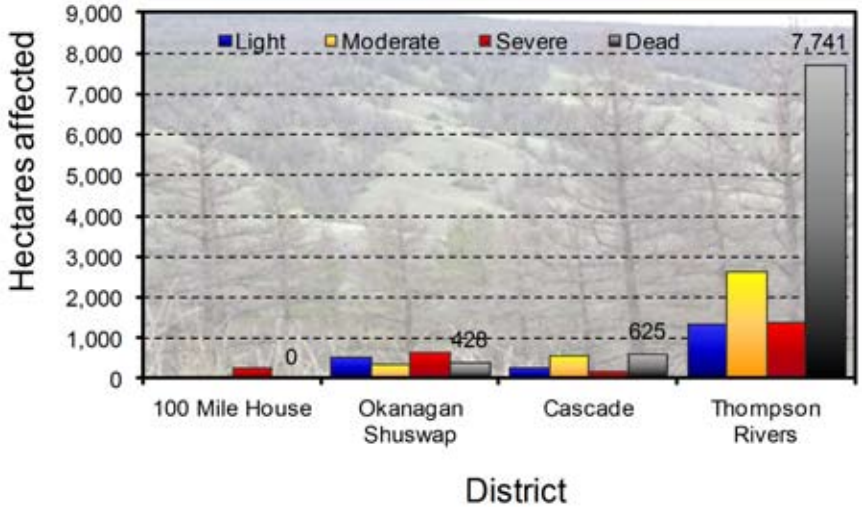

Figure 3. Area of light, moderate and severe 2011 defoliation and cumulative mortality (2008-2011) caused by the Douglas-fir tussock moth in the Southern Interior. The hectares of mortality caused by tussock moth are shown for each District above grey bar.

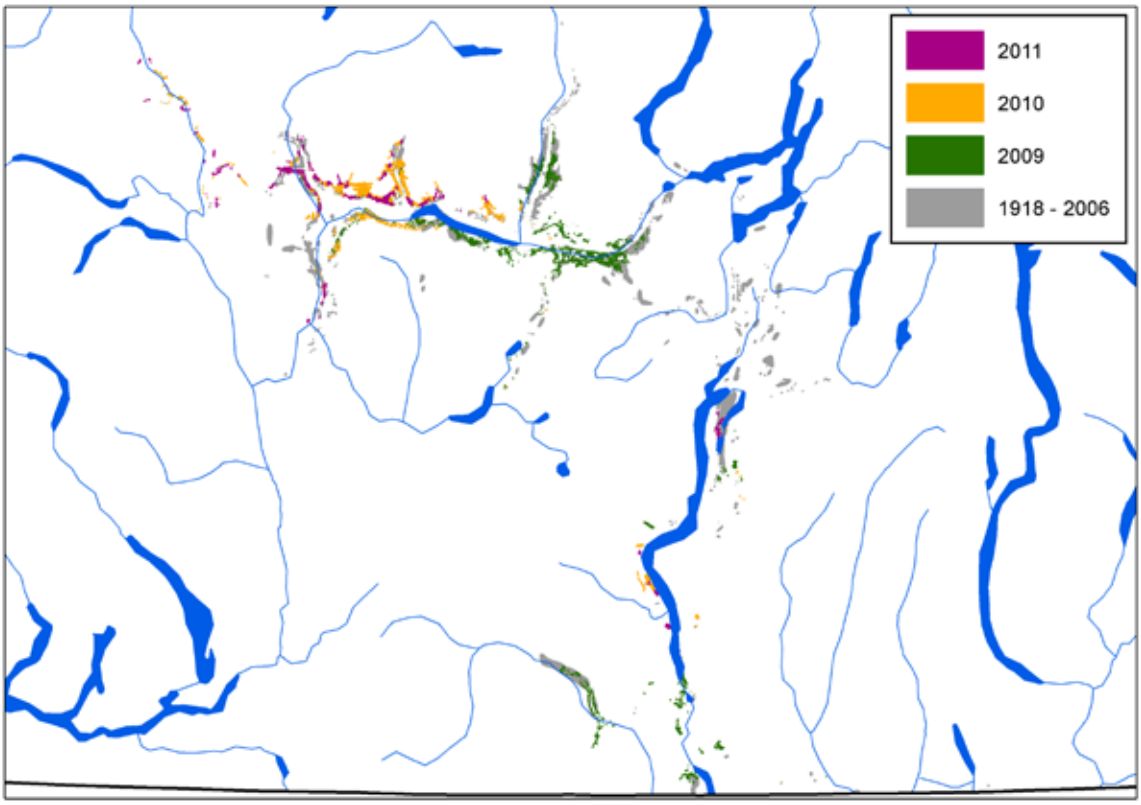

Figure 4. Area defoliated by the Douglas-fir tussock moth in the southern interior 2009-2011 and area of historic defoliation (grey).

The current outbreak cycle is the most extensive and damaging outbreak recorded in B.C., particularly in the Thompson Rivers District (Figs. 2-4), which has many scattered areas of defoliation throughout the dry Interior Douglas-fir (IDF) forests. 2009 was the first significant year of the outbreak, with moderately sized patches of defoliation (average size ranging from 13.9 hectares to 20.3 hectares; Fig. 5) occurring primarily in the Thompson Rivers District and into the adjacent Okanagan Shuswap District. Average patch size did not vary greatly between Districts in 2009, although there were far fewer patches in the Okanagan Shuswap and Cascades Districts (Fig. 5). Since then, there have been interesting fluctuations in the outbreak, with almost all known historic areas of tussock moth having population build-ups and visible defoliation. As expected, the tussock moth population increased exponentially in 2010. Although fewer patches of defoliation were mapped, patch size and severity of defoliation, increased significantly, particularly in the Thompson Rivers District (Fig. 5).

The total defoliation mapped in 2011 decreased overall through a combination of targeted control treatments and the natural population collapse caused mainly by NPV. Defoliation mapped in 2011 showed a higher number, but generally smaller polygons than in 2010, which was more reflective of the 2009 outbreak pattern (Fig. 5). In 2011, 273 hectares of severe tussock moth defoliation (Fig. 3, 4) were mapped in the 100 Mile House District, along the west side of the Fraser River and North Bonaparte River. Much of this defoliation was a continuation of the outbreak in the Cascades District that was largely in the Lillooet TSA along Pavilion and Crown Lakes, and north along the west side of the Fraser River to French Bar Creek. Some of these populations represent a range expansion for the tussock moth. Other active populations were primarily in the south Okanagan from West Kelowna through the Summerland-Penticton areas. These populations displayed a very eruptive signature and there was little to no evidence of egg masses at survey sites this fall.

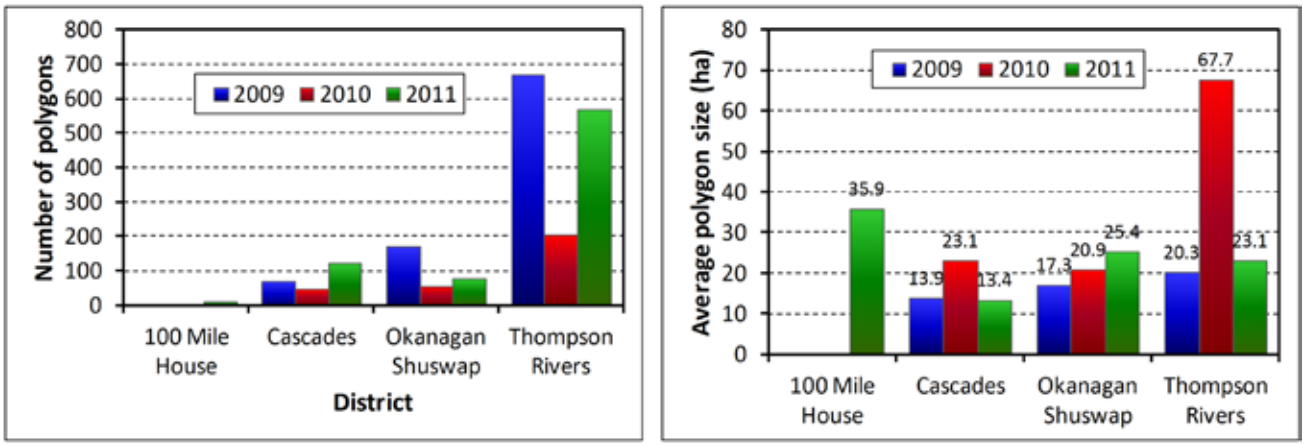

Figure 5. Graph on the left shows the number of discrete polygons (patches) of defoliation caused by the Douglas-fir tussock moth from 2009 through 2011, by District. Graph on the right shows the average polygon size (ha) in each district for 2009-2011.

2012 population predictions for Douglas-fir tussock moth

The Douglas-fir tussock moth has a fully integrated management strategy which includes monitoring, predictive population sampling, biological control and assessment. Predictive sampling is conducted by quantifying egg masses on trees over numerous geographic areas. A total of 19 sites in the Thompson Rivers, Cascades and Okanagan Shuswap Districts were ground surveyed in September and October 2011 for tussock moth egg masses. Surveyors assessed 508 plots within the 19 sites (Table 4; Fig. 6). Fourteen sites surveyed (210 plots) had viable egg masses that are predicted to have some level of defoliation in 2012 (Fig. 6) and 16 sites (67 plots) had egg masses that were small or possibly infected with NPV.

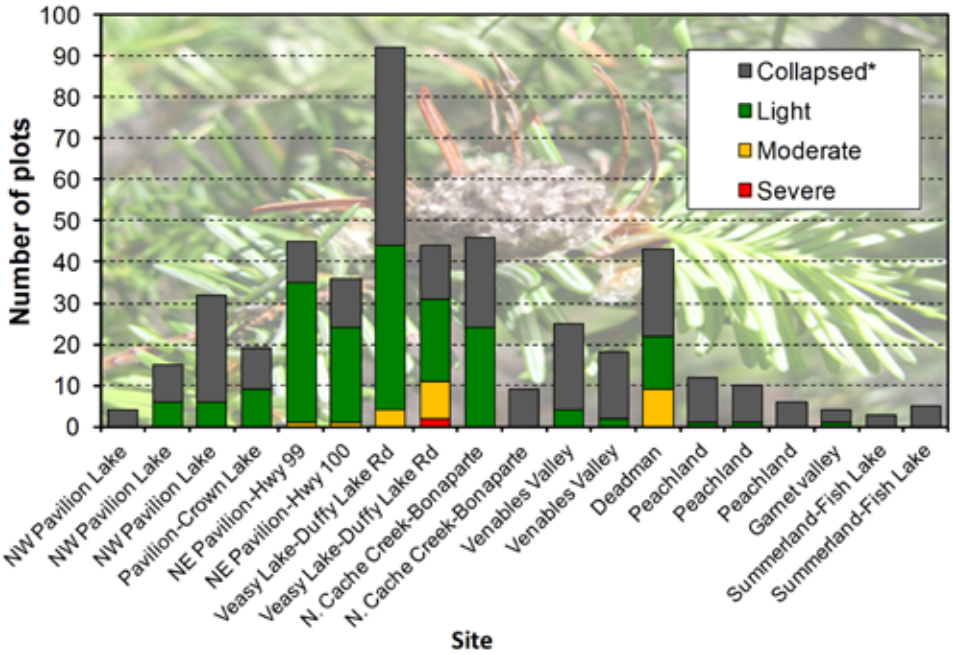

Figure 6. Defoliation and population predictions for 2012 (collapsed; light; moderate; or severe) based upon density of viable Douglas-fir tussock moth egg masses observed. A total of 508 plots distributed among 19 sites were surveyed. *Collapsed = no egg masses found or those observed were few in number, very small and possibly infected with NPV.

Table 4. The number of plots and percent of 508 plots surveyed having no viable Douglas-fir tussock moth egg masses or with densities indicating very light to light defoliation, moderate defoliation or severe defoliation in 2012.

2012 Defoliation Prediction	Number of plots	Percent of plots
No viable egg masses*	258	51%
Very Light/Light	184	36%
Moderate	24	5%
Severe	2	0.4%

* includes plots where egg masses were thought to be infected with NPV

A collection of three-tree beating sites and six-trap clusters (21 historic plus 22 new for a total of 43 sites) give annual estimates of current abundance of Douglas-fir tussock moth and other insect defoliators as well as defoliation predictions for the following year, respectively. Twenty-one sites have been monitored for several years, while twenty-two sites were added in 2010 for better coverage of areas susceptible to the tussock moth. Some of the new 6-trap cluster sites are located where "singlet" traps used to be deployed. Trapping and 3-tree beating sites are located in areas with a history of Douglas-fir tussock moth defoliation. Three-tree beatings were conducted in 30 of these sites in late June - early July. Traps were deployed at the same time at all 43 sites and were collected in late September. The geographic outbreak areas were updated in 2011 to better reflect current and historic outbreak dynamics (Fig. 7). This exercise is part of a project to refine susceptibility maps for tussock moth in B.C.

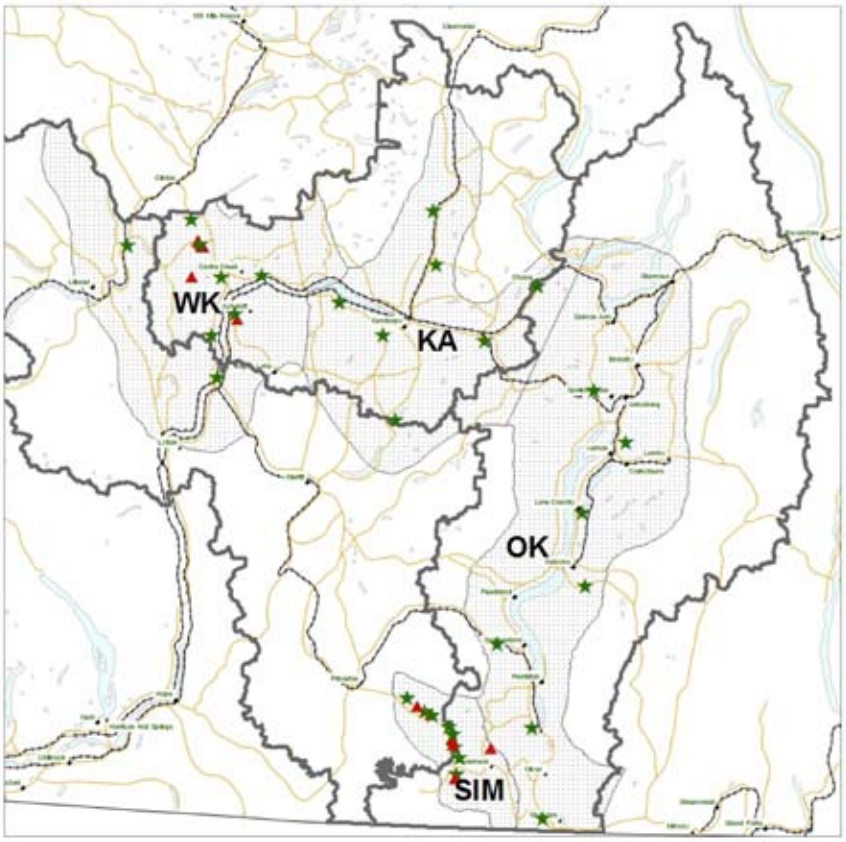

Figure 7. Location of Douglas-fir tussock moth monitoring sites (▲=three-tree beatings and 6-trap clusters; * =6-trap cluster only) and revised geographic outbreak areas (WK=West Kamloops, KA=Kamloops, OK=Okanagan, SIM=Similkameen).

Douglas-fir tussock moth larvae (through 3-tree beatings) were found at 57% of the sites, down from 66% in 2010. The highest levels were in the West Kamloops outbreak area near Veasy Lake, Campbell Hill, Pavilion and Spences Bridge where 577, 358, 132, and 107 larvae were found, respectively. Both Veasy Lake and Pavilion were sprayed in 2011. However, due in part to the very high insect populations at these sites and the use of *B.t.k* rather than virus, remnant populations were still viable. Populations in the North Thompson, Okanagan, and Similkameen were very low, which reflected the absence of any noticeable defoliation. Three-tree beatings give an indication of the abundance and diversity of defoliating insects over time but are not used a predictive tool. They are useful in supporting other monitoring and population assessment methods.

Overall, 74% of permanent trapping sites had increased trap catches in 2011 compared to 2010. The West Kamloops outbreak area had 14 sites with higher than average catch and one site only had lower moth numbers than in 2010 (Table 6). Average trap catch (of moths) was highest at sites in the West Kamloops outbreak area, with the highest catches at the Pavilion, Veasy Lake and Spences Bridge sites (Table 5). During the outbreak and toward the collapse, trap catch numbers can be extremely variable and do not accurately predict population trends. Average trap catch per site averaged among all sites within an outbreak region was compared to actual yearly defoliation (Fig. 8). The general decline in DFTM populations throughout the outbreak area was then more clearly seen. Sites in the Kamloops and West Kamloops outbreak areas overall best predicted the population increases that resulted in visible defoliation. In general, there were two years prior to visible defoliation with high average trap catches (>20 moths/trap). Trap results in the Okanagan fluctuated greatly in years leading up to the defoliation in 2009 and there was no warning in the Similkameen. Given that the Similkameen is one of the outbreak areas that tends to have very short, but severe, outbreaks, an early warning system is imperative if control efforts are to be implemented. Twelve additional 6-trap cluster sites have been added to this outbreak region to increase the reliability of the early-warning system. In summary, the ground surveys (Fig. 6) indicate very low populations in most geographic areas with moderate trap catch results. The area of active infestation will continue to decline in 2012 marking the end of this outbreak cycle.

Table 6. Number of DFTM 6-trap clusters sites that showed increasing or decreasing average moth catches from 2010 to 2011 in four southern interior outbreak regions.

Outbreak	**Number of 6-trap sites**	
Region	**Increasing**	**Decreasing**
Okanagan	3	4
Kamloops	6	1
Similkameen	9	5
West Kamloops	14	1
Total	32	11
% of total sites	**74%**	**26%**

References:
Fettes, J.H. 1950. Investigation of sampling techniques for population studies of the spruce budworm on balsam fir in Ontario. Forest Insect Laboratory, Sault Ste. Marie, Ontario Annual Technical Report.

Table 5. Average number of Douglas-fir tussock moths caught per 6-trap cluster site in 4 outbreak regions (Kamloops, Okanagan, Similkameen, West Kamloops), and the Boundary (near Rock Creek and Midway) and Clinton-Big Bar areas.

Site	Location	Average Catches Per Trap							2012 Predicted Defoliation
		2005	2006	2007	2008	2009	2010	2011	
Kamloops									
1	McLure	0	9.8	33.3	65.7	4.5	25.6	40.5	light
2	Heffley Creek	38	14.8	34.2	89.8	15.8	2	3.3	nil
3	Inks Lake	0.3	10.2	5.6	58.8	26.6	1	6.2	nil
4	Six Mile	33.6	52.5	73.5	73.3	51	48.8	19.2	light
9	Stump Lake	3.8	2.8	8.7	61.8	15.6	22.7	79.8	light
10	Monte Creek	40.2	18.3	80.5	75.2	9.2	21.7	54.5	light
11	Chase	9.3	0	0	25.3	7.8	0	1.8	nil
	Average of sites	**17.9**	**15.5**	**33.7**	**64.3**	**18.6**	**17.4**	**29.3**	
Okanagan									
12	Yankee Flats	2	0	0	38.5	2.2	3	32.0	light
13	Vernon	79.8	12.2	1.3	24.8	24.3	22	35.2	light
14	Winfield/Wood Lake	11	0.3	1	38.8	50.8	34	14.7	nil
15	Kelowna/June Springs	-	-	-	-	-	46.8	0.7	nil
16	Summerland	4.5	1	0.3	43.5	13.2	0	8.5	nil
17	Kaleden	18.6	11.6	29	55.4	27.7	2.9	3.7	nil
18	Blue Lake	39.8	8.3	1.3	63.2	5.2	0	0.5	nil
	Average of sites	**26.0**	**5.6**	**5.5**	**44.0**	**20.6**	**15.5**	**13.6**	
Similkameen									
19	Stemwinder Park	29.5	1.5	17.8	40.2	30.7	0	0	nil
20	Ashnola River	14.3	0	12.3	43.3	20.5	0	0.8	nil
32	Olalla	-	-	-	-	-	5.7	3.7	nil
33	Red Bridge Rec Site	-	-	-	-	-	0.3	0.3	nil
34	Ashnola Road	-	-	-	-	-	0	0.3	nil
36	Hwy 3 Lawrence Rch	-	-	-	-	-	0	0.8	nil
37	Hwy 3 Willow Hts	-	-	-	-	-	0	0.3	nil
38	Hwy 3 Bradshaw Crk	-	-	-	-	-	0	3.2	nil
39	Hwy 3 Winters Crk	-	-	-	-	-	0	1.2	nil
40	Hwy 3 Nickelplate Rd	-	-	-	-	-	0	6.2	nil
41	Stemwinder FSR	-	-	-	-	-	0	3.0	nil
42	Old Hedley Rd	-	-	-	-	-	0	0.4	nil
43	Pickard Crk Rec Site	-	-	-	-	-	0.3	2.5	nil
44	5.7 km Old Hedley Rd	-	-	-	-	-	5.7	0.7	nil
	Average of sites	**21.9**	**0.8**	**15.1**	**41.8**	**25.6**	**0.9**	**1.7**	
West Kamloops									
5	Battle Creek	1.2	14	34.8	64.5	12.3	46.5	2.5	nil
6	Barnes Lake	1.5	34.5	21.3	58	0.5	24.3	37.5	nil-light
7	Carquille/Veasy Lake	0	13.8	22.5	59	13	38.2	54.5	light
8	Pavilion	0	1.5	15.7	40	15.7	7.8	82.5	nil-light
21	Spences Bridge	0	1.5	10.2	5.7	29.5	59.3	68.5	light
22	Veasy Lake	-	-	-	-	-	27.8	68.0	light
23	Veasy Lake	-	-	-	-	-	5.6	43.3	light
24	Veasy Lake	-	-	-	-	-	6.8	76.3	light
25	Hwy 99	-	-	-	-	-	11.0	23.0	nil-light
26	Venables Valley	-	-	-	-	-	24.3	39.7	light
27	Maiden Creek	-	-	-	-	-	3.5	8.0	nil
28	Hwy 99	-	-	-	-	-	3.0	9.3	nil
29	Cornwall 79	-	-	-	-	-	28.8	49.5	nil-light
30	Cornwall 80	-	-	-	-	-	2.0	6.0	nil
31	Barnes Lake	-	-	-	-	-	7.7	9.8	nil
	Average of sites	**0.5**	**13.1**	**20.9**	**45.4**	**14.2**	**19.8**	**38.6**	
Boundary (Avg of 9 sites)		-	-	-	-	4.0	2.0	73.0	nil-light
Cariboo (Avg of 58 sites)		-	-	-	2.3	4.0	1.7	1.6	nil

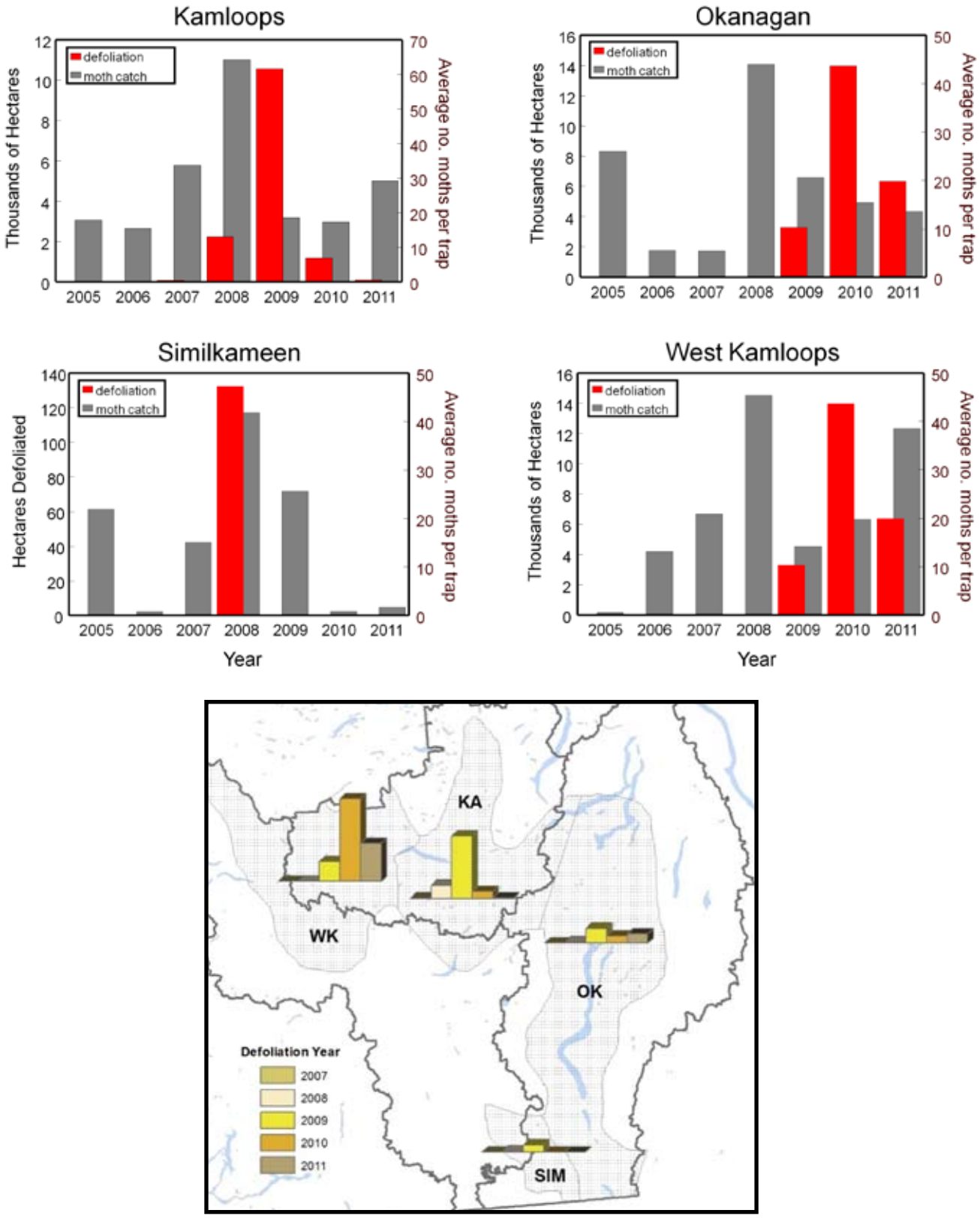

Figure 8. Upper: Four graphs comparing the area defoliated (hectares) by tussock moth (2005-2011) and the average number of moths caught per trap (average of sites within each outbreak region), by outbreak region for 2005-2011. Lower: Map showing boundaries of the 4 outbreak regions (WK=West Kamloops; KA= Kamloops; OK=Okanagan; SIM=Similkameen) in the Thompson Okanagan Region with inset graphs showing hectares of defoliation between 2007 and 2011.

Western Hemlock Looper in the Thompson Okanagan, Cariboo and Kootenay Boundary Regions

Western hemlock looper annual population trends are monitored by pheromone trapping of male moths and by doing three-tree beating larval sampling at permanent sample sites located in susceptible stands. Forty one permanent sites have been established and are situated throughout the Thompson Okanagan and Kootenay Boundary Regions. Six pheromone traps are deployed at 27 of these sites (Table 1), while three-tree beatings occur at these and an additional 14 sites (Kootenay Boundary Region). The six trap clusters were set up and the three-tree beatings were conducted in mid-July this year (Table 1; Fig. 1). All primary and secondary insect defoliators were identified and recorded from the three-tree beatings. All traps were collected and moths counted in early October.

Table 1. Average number of male western hemlock looper moths per trap at each 6-trap cluster site in the Thompson Okanagan and Kootenay Boundary Regions from 2006-2011.

		Average Catches Per Trap					
Site	**Location**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Thompson Okanagan Region							
1	Serpentine Creek	2.2	14	232	898	325	412
2	Thunder River	3	44	864	730	575	645
3	Mud Lake	4	14	310	1070	574	761
4	Murtle Lake	12	21	576	1219	968	1,376
5	Finn Creek	4	6	781	450	312	613
7	Scotch Creek	3	6	107	621	610	582
8	Yard Creek	12	4	66	805	417	508
9	Crazy Creek	1	7	154	logged	438	256
10	Perry River North	6	18	206	714	510	323
11	Three Valley Gap	5	9	169	85	849	319
12	Perry River South	4	9	83	623	801	314
13	Kingfisher Creek	3	5	227	535	316	1,608
14	Noisy Creek	1	10	606	698	525	1,091
15	Shuswap River	2	3	72	341	416	842
16	Greenbush Lake	2	logged	29	450	533	2,682
17	Adams / Tum Tum	3	13	512	613	534	264
Kootenay Boundary Region							
72	Sutherland Falls	1	1	29	30	221	328
87	Tangier FSR	2	1	22	75	384	284
83	Martha Creek	2	1	8	6	259	228
78	Goldstream River	4	3	4	81	303	689
85	Downie Creek	1	1	30	60	372	1,135
76	Bigmouth Creek	13	1	9	30	318	769
73	Carnes Creek	2	1	16	31	313	373
84	Begbie Creek	3	1	25	55	551	635
75	Pitt Creek Rec Site	3	2	16	130	431	1,274
66	Kinbasket Lake	17	8	89	237	468	1,533
74	Jumping Creek	1	1	27	30	196	bear

Thirty-eight new trapping sites were established in the Cariboo in 2011 (Table 2). One trap was set at each site in 5 general geographic locations. Prior to 2011, only three-tree beatings were done. All traps were collected and moths counted in late September/early October.

Trap catches increased significantly in the Mabel/Sugar Lake area with the highest catch occurring at Greenbush Lake, with an average of 2,682 moths per trap (Table 1). Catches at trapping sites between Perry River and Three Valley Gap decreased significantly. Large increases in trap catch were noted at five sites north of Downie Creek (Goldstream, Bigmouth Creek, Pitt Creek Rec Site, Kinbasket Lake, and Downie Creek), whereas south of Downie Creek, catches remained somewhat static (Martha and Carnes Creek) (Table 1).

Table 2. Number of male western hemlock looper moths caught per trap at 38 sites in the Cariboo Region in 2011, showing average moth catch per trapping location.

Site #	Location	Number of moths per trap 2011	Average moth catch catch by area
1	6100 Rd - Archie Creek to Wartig Lake	30	**149.9**
2	6100 Rd - Archie Creek to Wartig Lake	118	
3	6100 Rd - Archie Creek to Wartig Lake	260	
4	6100 Rd - Archie Creek to Wartig Lake	0	
5	6100 Rd - Archie Creek to Wartig Lake	22	
6	6100 Rd - Archie Creek to Wartig Lake	206	
7	6100 Rd - Archie Creek to Wartig Lake	301	
8	6100 Rd - Archie Creek to Wartig Lake	233	
9	6100 Rd - Archie Creek to Wartig Lake	220	
10	6100 Rd - Archie Creek to Wartig Lake	250	
11	6100 Rd - Archie Creek to Wartig Lake	78	
12	6100 Rd - Archie Creek to Wartig Lake	270	
13	6100 Rd - Archie Creek to Wartig Lake	35	
14	6100 Rd - Archie Creek to Wartig Lake	65	
15	6100 Rd - Archie Creek to Wartig Lake	161	
16	Crooked Lake to Canim Lake	61	**49.7**
17	Crooked Lake to Canim Lake	46	
18	Crooked Lake to Canim Lake	71	
19	Crooked Lake to Canim Lake	98	
20	Crooked Lake to Canim Lake	30	
21	Crooked Lake to Canim Lake	12	
22	Crooked Lake to Canim Lake	30	
23	6000 Road, 20km	47	**278.8**
24	6000 Road, 15km	173	
25	6000 Road, 09 km	74	
26	6000 Road, 06 km	1053	
27	6000 Road, Canim Place	47	
28	Abbott Creek (traps damaged)	29	**185.0**
29	Abbott Creek	118	
30	Abbott Creek	255	
31	Abbott Creek	365	
32	Spanish Lake Road	164	
33	Spanish Lake 0.5 Rec Site Road	23	
34	Cariboo Bridge	217	**98.6**
35	5.5km past Cariboo Bridge	81	
36	12.5km past Cariboo Bridge	67	
37	17.5km past Cariboo Bridge	58	
38	27.5km past Cariboo Bridge	70	

Western hemlock looper larvae were found at all three-tree beating sites sampled in the Thompson Okanagan Region in 2011, with the average number of larvae doubling since 2010 to 28 larvae per site (Fig. 1). Sawflies (*Neodiprion* sp.) were the most common and abundant defoliators, also recorded at 100% of the sites sampled.

Hemlock looper larval counts doubled at the Serpentine and Finn Creek sites (Fig. 1) and the number of moths caught in the pheromone traps remained relatively high with an average of 412 and 613 moths per trap, respectively (Table 1). Thunder River and Murtle Lake larval counts decreased, yet their average moth catches were higher than the Serpentine and Finn Creek sites, with an average of 645 and 1,376 moths per trap respectively (Table 1).

Other sites worthy of mention are Greenbush Lake, 3 Valley Gap and Perry River South which had significantly higher larval counts than in 2010 (Fig. 1). Elsewhere, larval populations remained static or increased slightly. In the southern portion of the Thompson Okanagan Region the highest trap catches were the Kingfisher Creek, Noisy Creek, Shuswap River and Greenbush Lake sites. Murtle Lake had very high moth catch in the traps but fairly low larval numbers in the beatings (Table 1; Fig. 1).

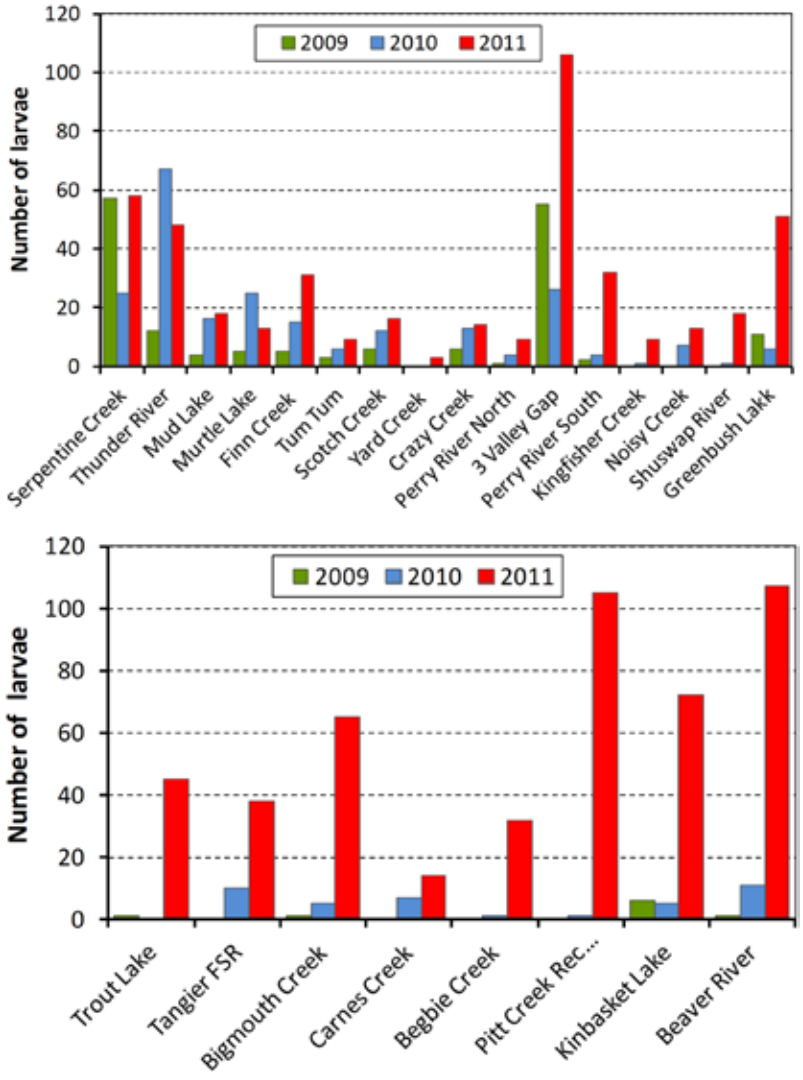

Figure 1. Upper graph: average number of western hemlock looper larvae collected in the 16 three-tree beatings permanent sample sites in the Thompson Okanagan Region (2009-2011). Lower graph: average number of western hemlock looper larvae collected in 8 of 25 sites sampled in the Kootenay Boundary Region (2009-2011).

Figure 2 illustrates western hemlock looper population trends through annual average moth catches, at trapping sites in the Thompson Okanagan Region. The average number of male western hemlock looper moths caught per 6-trap cluster site has now surpassed the average seen in 2003 which was the collapse year in the last outbreak cycle. All population monitoring seems to indicate that 2012 will be the first year of significant defoliation in many sites throughout the southern interior.

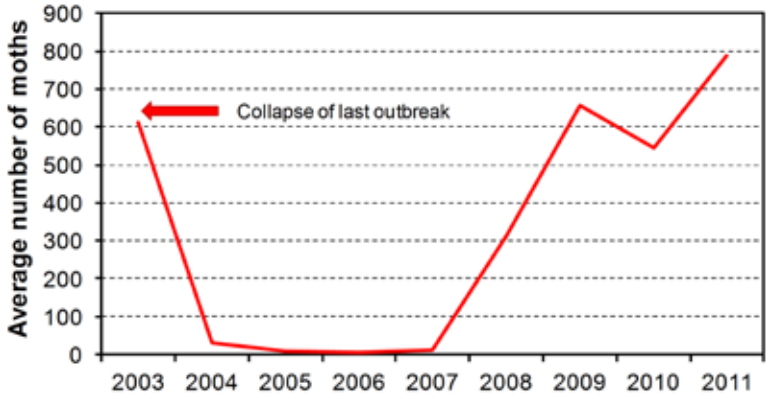

Figure 2. Average number of male western hemlock looper moths caught per 6-trap cluster site averaged over 16 trapping sites in the Thompson Okanagan Region (2003-2011) showing the point of collapse of the 2001-2003 outbreak.

In addition to the 11 sites mentioned above (Table 1) which had both traps and three-tree beatings, fourteen other sites also had 3-tree beatings in the Kootenay Boundary Region. Western hemlock looper larvae were recorded at 84% of the beating sites, up from 68% in 2010, with larval counts averaging 21.9 larvae per site. Pitt Creek and Beaver River had very high larval presence in the beatings, 105 and 107 larvae respectively, and the Pitt Creek trapping site had the second highest average trap catch of all sites in the Kootenay Boundary Region (Table 1; Fig. 1). The majority of sites sampled north and east of Revelstoke increased from an average of 3.7 larvae per site in 2010 to 39.5 in 2011, while those south of Revelstoke and through the Kaslo-Trout Lake corridor increased from an average of 1.1 larvae per site in 2010 to 5.6 in 2011 (Figs. 1, 3). Larval trends are similar to those experienced 1 to 2 years before the last outbreak that started in 2002 (Figure 3). The abundance and diversity of defoliator insect species identified in the three-tree beatings, increased to 24, more than double the 2010 records.

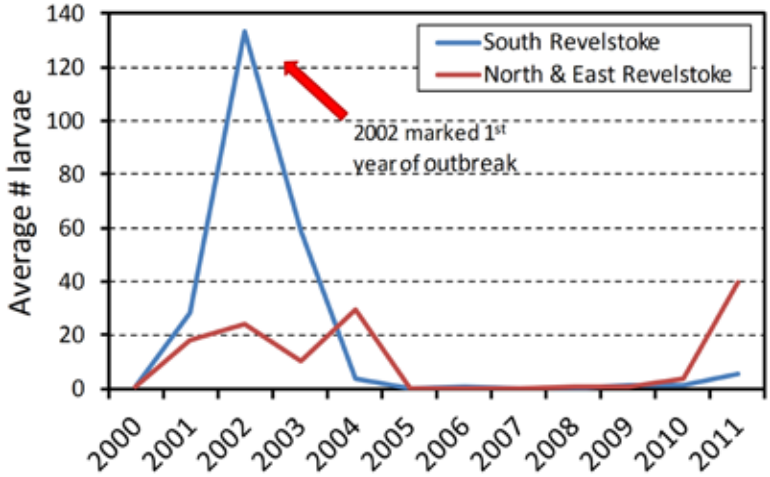

Figure 3. Average number of western hemlock looper larvae collected in 3-tree beatings in the Kootenay Boundary Region. Trapping sites are averaged by two larger geographic areas: South Revelstoke; and, North and East Revelstoke (2000-2011). Arrow indicates peak of last outbreak cycle (2002).

Historically the Cariboo Region has only conducted 3-tree beatings to monitor western hemlock looper and associated insect defoliators. In 2011, five geographic areas that historically have western hemlock looper outbreak were selected and 38 single trap sites were established (Table 2). As expected, the single trap catches varied considerably, ranging from 12 to 1,053 moths per trap. Averageing trap catches by geographic location gives a better indication of the population trend (Table 2) with traps in the Canim Lake area of the 100 Mile House TSA averaging 279 moths per trap. The other two areas with high average trap catches were in the Williams Lake TSA at the east tip of Horsefly Lake (average=150 moths/trap; Table 2) and near Spanish Lake (185 moths/trap; Table 2).

With the possibility of 2012 being the first year of outbreak level defoliation, egg sampling was conducted at select sites through the southern interior to anticipate population build-ups and plan for targeted control programs. Western hemlock looper moths lay eggs in the lichen growing on mature hemlock. Lichen samples must be collected to assess the number and condition of eggs (healthy, parasitized). Egg sampling is done in the fall to predict levels of defoliation the following summer. Lichen is collected from the bole and lower crown branches of mature hemlock until approximately 100 grams of lichen per site is collected (usually about 5-10 trees). The lichen is then: air dried; weighed; rinsed in 100°C water; and then sieved through 3 stacked strainers of different mesh size. All dislodged eggs are then counted and categorized by colour (healthy, parasitized, infertile, old) (Table 3). Based on the number of eggs per 100 g of lichen, we can then predict the level of defoliation at each site (Table 3).

Table 3. Western hemlock looper egg condition and the number of healthy eggs per 100 grams lichen for each defoliation category.

Egg Condition	Colour of eggs	# healthy eggs per 100 g dry weight lichen	Predicted 2012 defoliation
Healthy	Bronze	0-4	nil
Parasitized	Black	5-26	light
Infertile	Yellow	27-59	moderate
Old	Opaque	60+	severe

Trap catch data and known areas of historic defoliation were the primary data used to identify the areas for egg sampling. A total of 45 egg collection sites were sampled in the Cariboo. Six of the sites sampled had egg densities that indicated moderate-severe defoliation in 2012 (Table 4), most of these located in the general area of Quesnel and Horsefly Lakes in the Williams Lake TSA (near Tasse Lake). In the Thompson Okanagan Region, 11 geographic areas were identified for egg sampling with 31-43 sites being sampled. In the Kootenay Boundary Region, 13 geographic areas were identified for egg sampling with 25-46 sites being sampled. Lichen/egg processing is still in progress for these two regions. Pending results from the egg sampling, 5,000 to 7,500 hectares in each of the three Regions are planned for treatment (*B.t.k.* application).

Table 4. Results of lichen collection and egg extraction in the Cariboo Region to predicted defoliation levels for 2012.

Predicted 2012 defoliation	# of sites	Avg. # eggs per 100 g lichen
None	25	3.3
Light-Moderate	14	26.2
Moderate	3	39.2
Severe	3	99.6
Total	45	14.9

Defoliator Treatment Plans For 2012

Approximately 90,000 hectares of Interior Douglas-fir forests are scheduled for treatment with Foray 48B® (*Bacillus thuringiensis var. kurstaki, B.t.k.*; PCP #24977) for western spruce budworm under the "2008-2013 Southern Interior Pest Management Plan" in 2012 (Table 1). Treatments will be targeted at high priority stands within the Thompson Okanagan, Cariboo and Kootenay Boundary Regions.

Douglas-fir tussock moth should collapse during the 2012 feeding cycle; however there are still areas of concern near Veasy Lake and Deadman River. As such, 5,000-6,000 hectares have been delineated for treatment with *B.t.k*. in 2012. Egg masses will be collected and reared in the spring to determine viability.

All three Regions are anticipating a significant increase in western hemlock looper populations in 2012. Therefore, to reduce defoliation and prevent tree mortality, the Cariboo and Kootenay Boundary Regions are each planning to treat 7,500 hectares, while the Thompson Okanagan plans to treat 5,000 hectares (Table 1). Foray 48B® will be used at 4.0 litres per hectare. One application will be applied when larvae are approximately 3rd instar.

Table 1. Estimation of hectares to be treated with *B.t.k.* by Region for western spruce budworm, western hemlock looper, Douglas-fir tussock moth and 2-year cycle budworm in 2012.

Region / Defoliator / Application rate	Estimated Area (hectares)
Cariboo budworm (@ 2.4 L/ha)	40,000
Thompson Okanagan budworm (@ 2.4 L/ha)	40,000
Kootenay Boundary budworm (@ 2.4 L/ha)	10,000
Cariboo looper (@ 4.0 L/ha)	7,500
Thompson Okanagan looper (@ 4.0 L/ha)	5,000
Kootenay Boundary looper (@ 4.0 L/ha)	7,500
Thompson Okanagan tussock moth (@ 4.0 L/ha)	5,000
Quesnel 2- year cycle budworm (@ 2.4 L/ha)	1,500
Total Estimated Area	**116,500**

Boom truck delivering 1,000 litre mini-bulks of Foray 48B to western spruce budworm spray block loading site.

Mountain Pine Beetle, *Dendroctonus ponderosae*, Impact to Young Pine on TFL 35

Background

The mountain pine beetle, *Dendroctonus ponderosae* Hopkins, is the most destructive insect of mature pines in western North America. The preferred hosts of the mountain pine beetle (MPB) are large diameter, mature lodgepole pine (or other native pines). Beetle populations are prone to periodic landscape-level outbreaks. Mature stands may be heavily depleted in a few years over large, extensive areas. The current outbreak in British Columbia peaked in 2006 at over 10 million hectares of affected forest (mapped in the 2007 aerial overview surveys; BCMFR 2008). During such large, aggressive outbreaks, younger stands are also at risk (Safranyik and Wilson 2006; Maclauchlan and Brooks 2008).

There are approximately 15 million hectares of mature lodgepole pine forest in British Columbia, plus two million hectares of young lodgepole pine (plantations and natural regeneration from fire and other disturbances) between 20-55 years of age. These stands are integral to future harvests, habitat and forest structure. Many young stands were, and continue to be, impacted by the MPB and associated bark beetles, although at a much lower intensity and frequency than observed at the peak of the outbreak in mature timber. Historically, young or small diameter lodgepole pine become a "sink" or last resort for MPB during the declining phase of an outbreak. A beetle "sink" describes trees or stands that are not normally highly susceptible to MPB due to age, size, or location, and relatively few MPB brood develop successfully within attacked trees under these conditions. The current outbreak has produced exponentially greater MPB populations over the landscape, and consequently the phenomenon of young stands at risk resulted in markedly higher levels of young stand mortality prior to the collapse of the outbreak.

Normally, lodgepole pine less than 40 years old are not considered at risk to MPB because of age, diameter and other attributes (Shore and Safranyik 1992). However as documented above, many young stands in these putatively low susceptible age- and size-classes are currently being killed by MPB.

A project was initiated in 2005 to quantify mortality due to mountain pine beetle in young lodgepole pine stands, where both aerial and ground surveys were conducted throughout affected areas. 7,497 polygons were aerially surveyed, between 2005-2008 and 2011, representing over 266,460 hectares (Table 1) (Maclauchlan 2006; Maclauchlan and Brooks 2008). Since the initiation of this project, over 830 young pine stands have been aerially surveyed during two or more years, providing an indication of change in extent and severity of attack over time.

Table 1. This table lists the total number of polygons aerial surveyed by year, the area of these polygons (hectares), and the average red attack (%) and total attack (%) (red attack plus grey attack).

Survey Year	Number of polygons surveyed[1]	Area surveyed (ha)	Average red attack (%)	Average total attack (%)[2]
2005	1,096	42,576	7.6	9.3
2006	2,475	87,687	12.4	14.8
2007	2,065	72,927	21.8	27.7
2008	1,778	60,692	6.7	27.2
2011	83	2,578	1.9	25.9
Total	**7,497**	**266,460**		

1 polygon area (ha) for TFL 35 was not available so the 2011 data only shows the sum of ha on Crown land that were surveyed
2 in 2011 only a small area in the Kamloops District was surveyed

In ground surveys, the incidence of MPB attack was highest in the SBPS biogeoclimatic zone, with the mild, moist ICH, warmer and dry IDF and moist cool SBS zones having similar levels of attack (approximately 10%) and the cooler ESSF zone the lowest incidence of attack overall (Maclauchlan and Brooks 2008). Slight variation was seen in the aerial data, which had a larger sample size than the ground survey data, with the incidence of MPB attack highest in the SBPS and IDF, followed by the cooler MS and SBS (Fig. 1). Overall, the ICH and ESSF suffered far less impact. The aerial surveys give a higher confidence level in the overall trend of MPB attack in B.C. and reflect the known mature stand susceptibility of this insect.

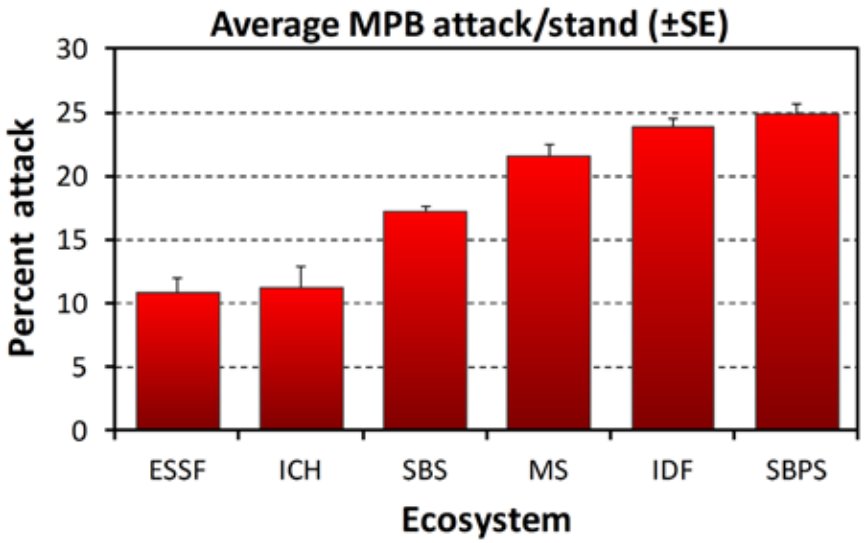

Figure 1. Mountain pine beetle attack (sum of red plus grey attack) in stands aerially surveyed 2005-2008, showing average percent trees affected by ecosystem (average attack ± standard error). Ecosystems where less than 10 stands were sampled are not shown. ESSF: Engelmann spruce-subalpine fir; ICH: Interior cedar-hemlock; IDF: Interior Douglas-fir; MS: Montane spruce; SBPS: Sub-boreal pine-spruce; SBS: Sub-boreal spruce.

Since 2008, there has been very little detailed aerial assessment of young pine mortality. However, numerous requests inquiring about the status of young pine have been made. Therefore, in response to a particular request in 2011, a survey was conducted to estimate young pine mortality in and around TFL 35, northwest of Kamloops near Jamieson Creek. Polygon-specific aerial surveys enable a large subset of candidate stands to be assessed each year and compared over time and is relatively quick and simple to do. The survey involves a visual estimate of percent red attack and percent grey attack in each stand; plus other parameters not discussed in this report (Maclauchlan 2006). Total attack is then obtained by adding these two values for each polygon. A photograph is taken of each polygon. An area containing six mapsheets (including a corner of Map 092P029) was assessed as per the 2008 methodology on July 11, 2011.

Potential polygons for survey were highlighted on a map based on age (20-55 years) and percent pine component (>80% Pl; or, 50-80% Pl). The area surveyed represents about 13% of available candidate polygons.

Results

A total of 76 polygons were surveyed in 2011 covering 4, 257 hectares (Table 2) and the average total attack observed in these polygons was 26.1% (ranging from 0-77%). Table 3 and Figure 2 illustrate the MPB attack trend over time. Average mortality on a mapsheet ranged from almost 5% to over 40% mortality. Polygons were randomly chosen each year, which could account for the average total attack levels decreasing in some mapsheets over time. As well, grey attack is much more difficult to observe from the air than is red attack (Fig. 2).

Table 2. Mapsheets surveyed in 2011 for mountain pine beetle attack in young pine, showing the area of leading pine polygons, age 20-55 years by mapsheet in TFL or non-TFL land, the number of polygons surveyed in 2011, the proportion of polygons surveyed, and the average attack (%) by mapsheet.

	Area of young pine (ha) 20-55 years		# polygons	Proportion surveyed in 2011		Avg. %
Mapsheet #	**TFL 35**	**Crown**	**surveyed**	**TFL 35**	**Crown**	**attack**
092I098	130.3	570.2	18	30.0%	35.0%	28.7
092I099	525.6		17	28.3%		33.5
092P008	65.4	365.4	8		18.0%	4.8
092P009	678.7		4	5.4%		10.8
092P018	30.2	489.4	15	50.0%	37.0%	13.1
092P019	729.2	192	19	23.9%	20.0%	38.8
092P029	5.5	474.8	1		1.0%	43
Total	**2,165.0**	**2,091.8**	**76**			**26.1**

Table 3. Percent mortality, averaged by number of polygons surveyed in 2007, 2008 and 2011, in the non-TFL portions of six mapsheets. Average percent mortality for polygons surveyed on TFL 35 in 2011 is also shown.

	Average percent mortality			
	Crown (non-TFL)			TFL
	2007	**2008**	**2011**	**TFL-2011**
092I088	55.8	33.4		
092I097		7.5		
092I098	40.7	28.7	22.3	41.3
092I099				33.5
092P008	2	5.2	6	
092P009				10.8
092P018	17.7	8.7	15.7	5.8
092P019	20	26	29.3	40.3
092P029	54.4	37.9	43	
Average	**37.8**	**23.7**	**18.8**	**32.5**

Figure 2. Photographs of three polygons in 2007, 2008 and 2011. From the top: 092I098 polygon 476 and 477; and, 092P018 polygon 566.

Attack since 2008 has declined dramatically in the Kamloops District (Table 4). In order to compare TFL 35 and adjacent forest to the rest of the province, Table 4 shows the average total attack (%) in each year surveyed from 2005-2008. Some of the highest levels of mortality were observed in the Kamloops (39.9%), 100 Mile House (DMH) and other Districts in central B.C. (Table 4).

Table 4. Summary of mountain pine beetle attack in young pine (age 20-55 years) surveyed between 2005-2011. The table lists by District and year surveyed, the total percent attack (red attack + grey attack) observed and the overall average attack in each District.

	Attack observed by year (%)					Average
District	**2005**	**2006**	**2007**	**2008**	**2011**	**Average % attack**
Central Cariboo	16.2	11.9	28.7	28.3		19.4
Chilcotin	17.1	10.3	18			14.7
Cascades			19.4	10.4		14.9
Headwaters			7.5	41.9		16.5
Fort St. James			9.7			9.7
Kamloops			46	37.1	25.9	39.9
100 Mile House	3.6	11.4	42.3	37.8		25.3
Nadina	6.2	8.6	14.2	8.9	0	7.58
Okangan Shuswap			14.3	14.6		14.5
Prince George	13.6	16.6		40.5		20.2
Quesnel	13.8	19.9	39.2	29.2		25
Vanderhoof	6.2	17.3	0	0	0	4.7

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Other pests observed in young pine stands. Left photo: Atropellis canker. Right photo: porcupine feeding.

Western Balsam Bark Beetle (*Dryocoetes confusus*) Long-Term Monitoring

Ten long-term monitoring plots were established between 1998 and 2003 to follow the dynamics of western balsam bark beetle (*Dryocoetes confusus*) in subalpine fir ecosystems in the southern interior of B.C. Each plot is one hectare and all trees over 15 cm DBH are permanently tagged. The plots have been assessed several times since initial establishment and are now on a 5-year re-measurement cycle. The last assessment was in 2008-2009 except for one plot (Scotch Creek), which was not reassessed until 2011 due to access problems. The plot locations were chosen to reflect a range of sub-alpine fir habitats in which *D. confusus* is active.

In the eight years between the two assessments at the Scotch Creek plot, the percent of live trees in the plot declined by over 12%, from 46.7% live in 2004 to 34.5% live in 2011. Most of the mortality was in the sub-alpine fir component and attributed to *D. confusus*, although in 2011 there was very little current attack in the plot. Figure 1 illustrates the dramatic decline of live sub-alpine fir in the Scotch Creek plot from 2004-2011 and the increase of trees killed by *D. confusus* and those trees now on the ground (blowdown) (Figs. 1, 2). The number of trees killed by other causes (e.g. girdling, pathogens) remained stable over this time period. Of particular interest was the presence of a weevil, *Pissodes striatulus*, which was attacking and killing sub-alpine fir. *P. striatulus* was found in four trees in the Scotch Creek plot during the 2011 assessment (all current attack with brood and/or adult weevils present – see photograph below). This weevil is acting like a primary bark beetle by attacking and killing trees. In the most recent assessment of the 10 permanent sample plot conducted in 2008, 2009 and 2011, eight of the ten plots had evidence of *P. striatulus* attack. Attack ranged from no attack up to 31 trees attacked (2.3%) in the Buck Mountain Plot which is comparable to attack levels seen by *D. confusus*. There is very little known about this insect in terms of biology or host selection.

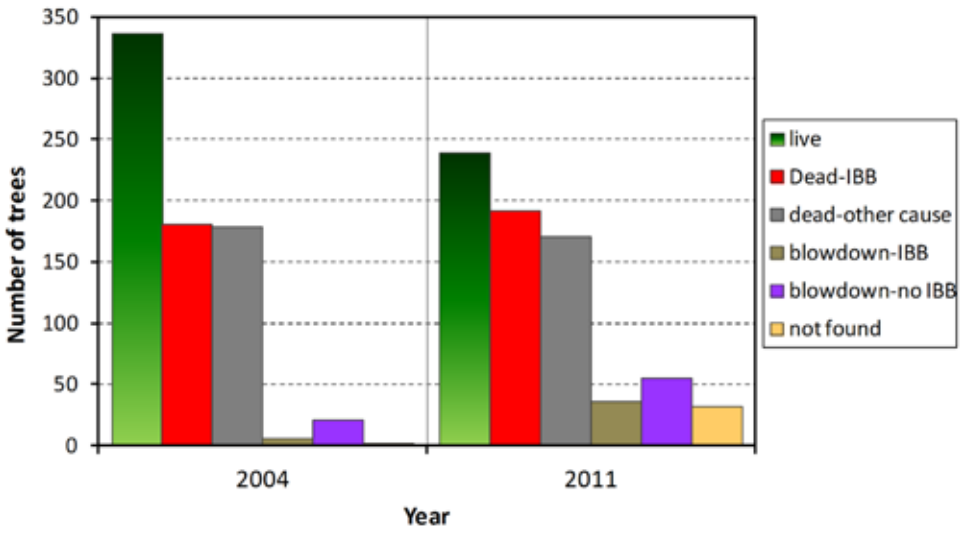

Figure 1. Data from the Scotch Creek one hectare plot comparing the number of live trees (all species), number of trees dead from *D. confusus* (IBB) attack, dead from other causes, two categories of blowdown (those with evidence of IBB attack and those with none) and trees not found in the 2011 assessment.

Spruce composed about 7.5% of the species in the stand. Spruce mortality and blowdown was also a factor in the stand dynamics (Fig. 2) but not to the level as seen in the sub-alpine fir component. As with most tree-killing bark beetle species, *D. confusus* first attacks the largest trees in a stand and subsequently moves into the smaller diameter stems. In the 2004 assessment, trees killed by *D. confusus* had an average diameter of 29.4 cm compared to the live sub-alpine fir that had an average diameter of 27.0 cm (Table 1). Trees killed by other factors were on average smaller than those killed by *D. confusus* and smaller than the remaining live trees (Table 1). In 2011 the same trend was observed but the average diameter of trees killed by *D. confusus* was slightly less (28.1 cm) (Table 1) due to the fact that most of the largest trees were already dead or down. The average diameter of *D. confusus*-attacked trees was still greater than live trees in 2011 (Table 1). Spruce were the largest trees in this stand averaging 37.0 cm in 2011.

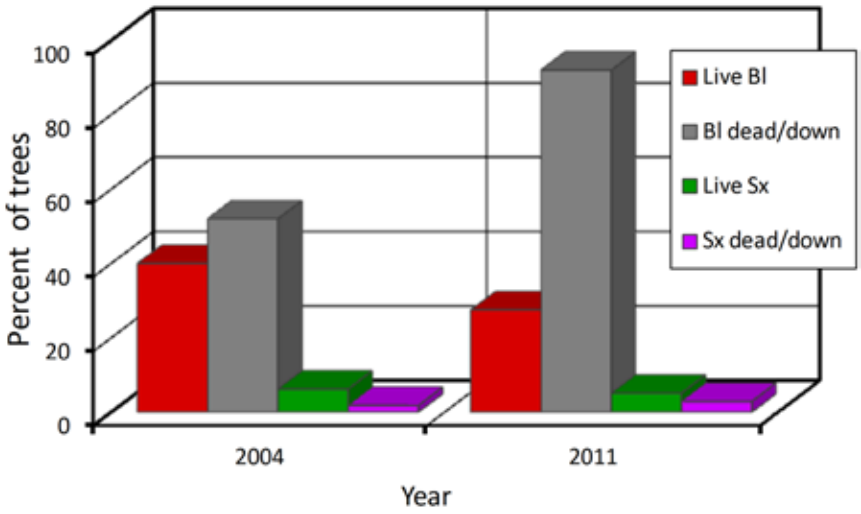

Figure 2. Comparison of live and dead (standing and down combined) sub-alpine fir (Bl) and spruce (Sx) in the Scotch Creek plot in the 2004 and 2011 assessments.

Table 1. Comparison of 2004 and 2011 diameter at breast height (DBH) from live sub-alpine fir and spruce, and dead sub-alpine fir in the Scotch Creek plot.

Tree Category	Average DBH (cm, ±SD)	
	2004	2011
Live Bl	26.3 ± 9.2	27.8 ± 10.2
Live Sx	34.2 ± 12.6	37.0 ± 13.2
Dead Bl - IBB	29.4 ± 7.9	28.1 ± 8.6
Dead - other causes	23.4 ± 8.3	25.1 ± 9.4

Patterns of mortality varied from plot to plot with some sustaining ongoing attack by *D. confusus* (Fig. 3 – Buck Mtn.) while others had very little attack (Fig. 3 – Spius Creek-2). Age, moisture regime and other pathogens all play a role in the susceptibility of trees and stands to the bark beetle. However, it is clear that *D. confusus* is causing significant decline in subalpine fir dominated ecosystems. A full report on this study will be available later in 2012.

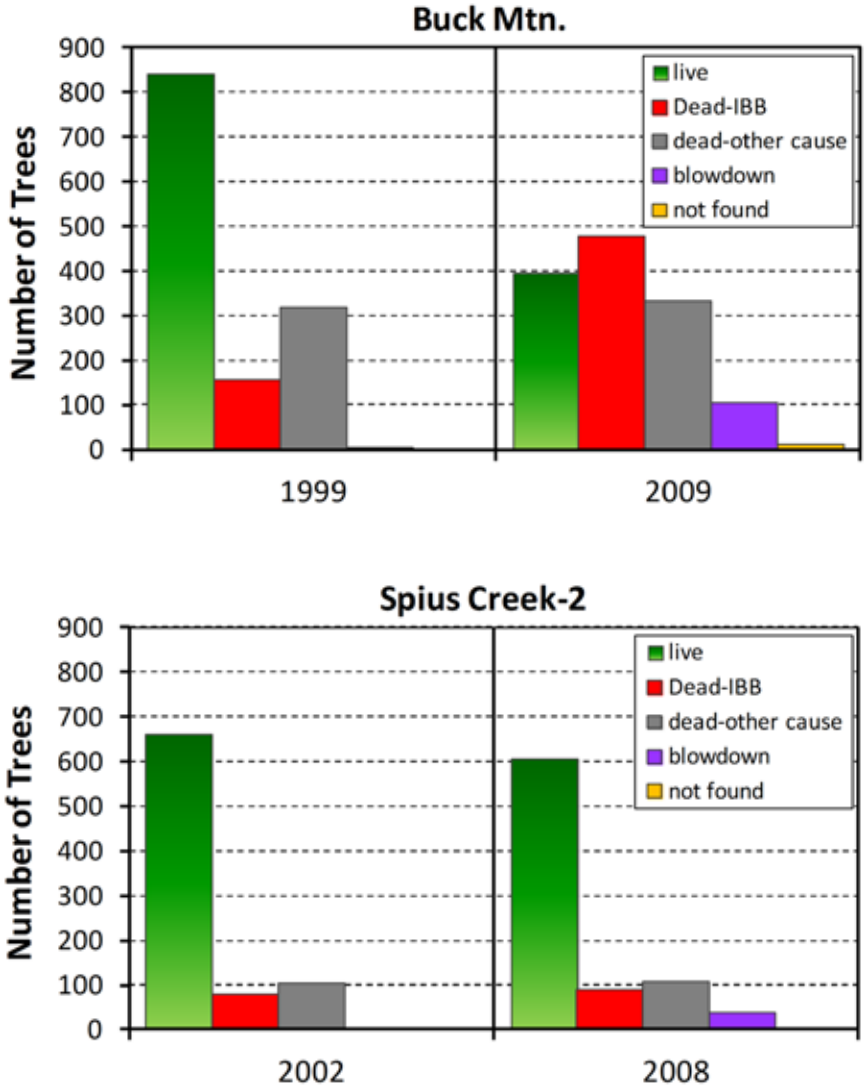

Figure 3. Comparison of the first assessment year and most recent assessment year in two, one-hectare plots showing the change in number of live trees (all species), dead due to IBB (*D. confusus*), dead from other causes, blowdown (with and without evidence of prior IBB attack) and trees not found in 2011 assessment.

Upper Left: Frass and sawdust on bole of sub-alpine fir under attack by Dryocoetes confusus.

Upper Right: Under bark, Dryocoetes confusus *adults.*

Lower Left: Gallery, adult and chip cocoon of Pissodes striatulus *in sub-alpine fir (photograph by Barbara Zimonick).*

Lower Right: View of Scotch Creek plot from access road showing dead and dying sub-alpine fir.

Blister Rust Screening for Whitebark Pine Launched

Michael Murray, Forest Pathologist, Nelson

Over the past year Kootenay/Boundary Region formally initiated efforts to develop disease resistance within whitebark pine (*Pinus albicaulis*). Whitebark pine grow in subalpine ecosystems and are valuable to wildlife for canopy and providing large seeds in a harsh timberline environment. Whitebark pine regulates snowmelt and protects soils on steep mountain slopes. The introduced white pine blister rust disease has reduced whitebark pine over the past century and recently mountain pine beetle has further impacted this fragile ecosystem. Dead and dying trees now dominate many settings.

A small proportion of whitebark pine in B.C. is likely to promote defensive mechanisms that ensure the tree's survival. Successful identification of these rare trees relies on careful selection from naturally occurring populations. By identifying candidates in the field, we can test their resistance through established rust screening procedures similar to the successful white pine screening program.

In 2011, forty trees were selected in B.C. to undergo rust screening. Candidate trees were selected based on their vigour and lack of disease signs. Stands were chosen based on accessibility and disease incidence. Locations having high disease incidence serve as better sample sites because a greater proportion of non-resistant trees are already dead and therefore the remaining trees are more likely to be resistant.

Protective cages were installed over the cones in early summer to shield seeds from wildlife until they were ripe and ready for collection (Figs. 1 and 2). Cages were placed on cones by climbing or using a tree-tong fabricated for this purpose. We returned in September and October to retrieve about 360 cages with approximately 900 cones. Seeds were extracted and sent to two facilities:

1. The Kalamalka Research Centre (MFLNRO), near Vernon, received seeds from all 40 trees and they will propagate seedlings in 2012 and rear them for at least two years before an inoculation process using the blister rust fungus (*Cronartium ribicola*).

2. The Dorena Genetic Resources Center, U.S. Forest Service, in Oregon will rear and inoculate a subset of seedlings.

After inoculations, seedlings are observed for several years for signs of blister rust. Results between the Centers will be compared. Concurrent field trials using a subset of outplanted seedlings are also anticipated to provide additional comparison.

In addition to the Kalamalka and Dorena Centres, valuable partners in this project include the Whitebark Pine Ecosystem Foundation, The Nature Conservancy of Canada, Panorama Ski Area, and the Columbia Basin Trust and its grantees (Keefer and Associates, White Bark Consulting).

Figure 1. Squirrel (top right) and chipmunk (top left) harvest uncaged cones from a whitebark pine near Moyie, B.C.

Figure 2. Caging whitebark pine cones for blister rust screening.

Root Disease Control Trial 1991- 2011: Some Preliminary Findings

Root rot, in particular *Armillaria ostoyae*, causes significant mortality of plantation trees, affecting most biogeoclimatic zones throughout southern B.C. Removal of stumps from the ground has been considered an effective treatment for reducing disease spread associated with planted trees. However, evaluation of the long-term effectiveness of post-harvest stump treatments is lacking. The Knappen Creek Root Disease Trial, near Grand Forks, is one of the earliest established *Armillaria* trials in B.C. After harvesting in 1989, the 30-hectare study site was divided into five treatment subunits: 1) stump removal & root raking; 2) stump removal only; 3) planting one meter away from stumps/major roots, and; 4) planting (no other treatments). An additional fifth unit is provided by a patch of unharvested forest. These distinct treatments provide an excellent opportunity to compare the effects of stumping on *Armillaria* root disease as expressed in the regenerating cohort of trees which were planted in 1991 (mostly lodgepole pine, Douglas-fir, and western larch).

During the autumn of 2011, all 20 original plots were re-located and about 3,000 permanently tagged trees were re-assessed for growth and forest health. A previous survey was conducted in 1997.

Armillaria mushrooms.

Preliminary findings indicate a noticeable difference in incidence of *Armillaria* between the treatments. In the stump removal treatment, 6.7% of trees had signs of *Armillaria*, whereas 17.0% of trees in the stump & root retention area had the disease (Table 1). The percent of dead trees within each treatment reflected similar occurrences with 7.6% and 16.8%, respectively. We examined all dead trees for signs of *Armillaria* and found signs of mycelial fans on 62.5% of these trees. The actual incidence was likely higher, but mycelial fan imprints disappear with natural degradation of woody tissue over time. An unexpected finding relates to the two stump removal treatments, where results indicate more root disease associated with stumping followed by root raking. This is counter to the expectation of lower disease incidence wherever more inoculum sources (roots and stumps) are removed. This may be a reflection of higher incidence of root rot in the vicinity of the root-raked plots found during trial establishment. Differences in tree growth (height and diameter) as a reflection of treatment is not as evident – with a slightly better overall growth where stumps were removed.

Further analyses are being conducted to compare responses between different tree species. Comparisons between 1997 and 2011 are also being performed.

Table 1. Measured observations within each root disease treatment block.

Treatment (location in harvest unit)	Live and Dead Trees with Armillaria (%)	Average Growth (height / dbh)	Dead Trees (%)
Stumps removed (NE)	6.7	9.7 m / 9.1 cm	7.6
Stumps removed + roots raked (SE)	9.7	9.2 m / 9.4 cm	9.6
Stumps retained + seedlings planted 1.5m from all stumps and large roots (SW)	12.2	8.0 m / 7.8 cm	12.7
Stump & roots retained (NW)	17.0	9.3 m / 9.0 cm	16.8

Birch Decline Investigation Continues

Paper Birch (*Betula papyrifera*) offers a variety of attributes in B.C. including syrup, veneer, beverage flavour, medicinal tonic, and teeth cleaner. The decline of paper birch has been widespread throughout the south of the province. Characterized by crown die-back, most mature birch appear susceptible. The spatial distribution patterns and actual causation remain poorly understood. Beginning in 2009, 25 birch sampling sites were inventoried in the Kootenay Boundary Region. A total of 247 trees were increment cored. Additionally, several dozen trees had cross-sections collected. These samples provide the material to identify possible perturbations in growth, tree stress, and better understand predisposing factors and possible links between climate and tree stress are being examined.

In October, a separate sampling was conducted to target fungal pathogens. Birch trees were selected from seven locations (between Slocan Lake and Salmo). Paul Andersen (Wildfire Management Branch, Kootenay Lake Fire Zone) felled 26 trees for analysis. Once felled we cut-off upper stem segments where the dieback was occurring. The logs were then delivered to the UBC Forest Pathology Lab, supervised by Dr. Richard Hamelin. The lab is currently culturing fungi from the logs in order to identify possible pathogens. This process will reliably reveal the various fungal species present. Additionally, samples of *Armillaria* mycelial fans are also being identified to species using DNA at the Pathology Lab.

Dead and dying paper birch near Yahk.

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This report is available in PDF format at http://www.for.gov.bc.ca/rsi/ForestHealth/Overview.htm