Summary of Aerial Overview Surveys in the Southern Interior Forest Region

2009

This summary was prepared by:

Lorraine Maclauchlan

Kevin Buxton

Art Stock

Leo Rankin

Michelle Cleary

Michael Murray

2009 Overview of Forest Health in the Southern Interior Forest Region

Introduction

The 2009 Aerial Overview Surveys for the Southern Interior Region were completed between July 9th and August 19th. A total of 207.6 hours of fixed-wing flying over 55 crew-days were required to complete the surveys. Portions of the Lillooet TSA were surveyed by Coast Forest Region crews, who committed an additional five hours over three days.

Surveys were carried out using the standardized Provincial Aerial Overview Survey protocols (http://www.for.gov.bc.ca/hfp/health/overview/methods.htm), and documented mortality and/or damage resulting from bark beetles, defoliators, and any other visible forest health factors, such as foliar diseases and abiotic damage. Table 1 describes severity ratings used in the surveys.

Weather conditions and visibility were problematic this year, especially in the Cariboo and Thompson - Okanagan. Wildfire activity was extreme and often resulted in restricted visibility and in several instances grounded survey crews for several days at a time.

The most damaging pest in the Southern Interior Region continued to be mountain pine beetle (2,342,088 hectares); other pests causing large scale damage were western spruce budworm (759,591 hectares), western balsam bark beetle (234,515 hectares), Douglas-fir beetle (96,772 hectares), spruce beetle (25,502 hectares), Douglas-fir tussock moth (17,512 hectares), and aspen serpentine leaf miner (51,762 hectares).

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.

Bark Beetles		**Defoliators**	
Mortality severity class	Current mortality	Defoliation severity class	Defoliation Symptoms
Trace*	< 1%	Light	some branch tip and upper crown defoliation, barely visible from the air
Light	1-10%		
Moderate	11-29%	Moderate	thin foliage, top third of many trees severely defoliated, some completely stripped
Severe	30-49%	Severe	bare branch tips and completely defoliated tops, most trees sustaining >50% total defoliation
Very Severe*	50% +		

* Trace and Very Severe categories used for bark beetles and other mortality agents only.

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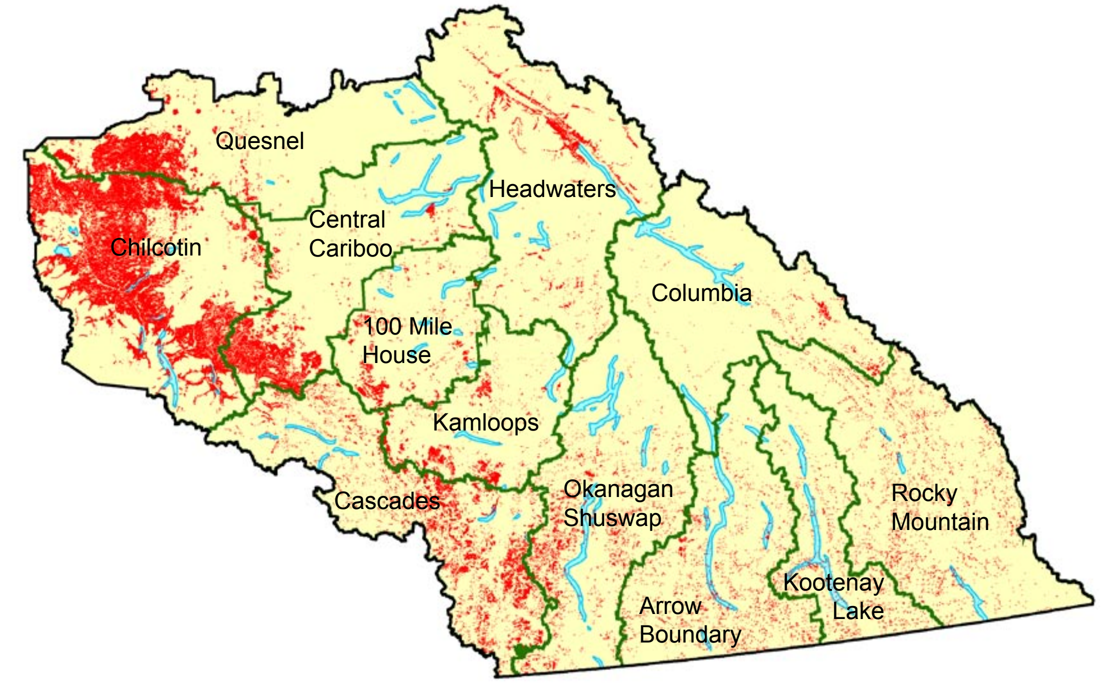


Figure 1. Mountain pine beetle infestations and Forest District locations in the Southern Interior Forest Region in 2009.

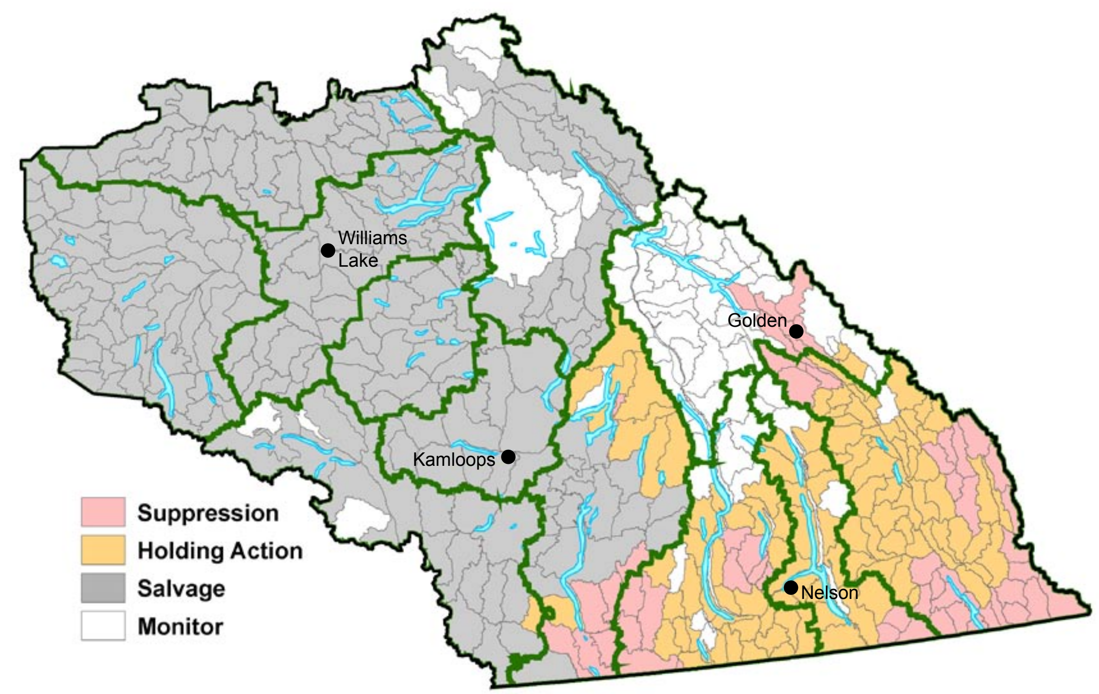


Figure 2. Beetle Management Unit (BMU) boundaries, and associated mountain pine beetle strategies, as of February 2010.

Ministry of Forests, 441 Columbia Street, Kamloops, B.C. V2C 2T3 Telephone: (250) 828-4179

Table 2. Area summaries for forest health factors mapped during the 2009 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (ha)					
	Trace	Light	Moderate	Severe	Very Severe	Total
Mountain Pine Beetle						
Chilcotin	518,880.5	415,381.8	56,708.2	1,184.9	0.0	992,155.4
Cascades	37,708.1	138,192.4	111,873.5	27,884.9	5,027.3	320,686.3
Quesnel	89,886.9	112,876.9	48,239.7	589.0	0.0	251,592.5
Central Cariboo	104,553.7	65,641.5	49,078.9	4,814.6	946.9	225,035.6
Okanagan Shuswap	23,276.2	74,804.7	34,114.0	3,524.3	193.6	135,912.8
Headwaters	68,651.3	27,098.7	14,194.2	2,375.5	106.0	112,425.8
Kamloops	46,619.9	35,931.4	6,599.0	1,094.4	0.0	90,244.7
100 Mile House	61,917.3	9,043.2	4,981.4	905.4	0.0	76,847.4
Rocky Mountain	6,349.4	22,080.8	16,676.3	5,798.2	194.3	51,099.1
Arrow Boundary	10,581.9	20,428.7	10,858.0	854.1	0.0	42,722.7
Kootenay Lake	4,036.6	9,104.2	7,474.5	3,526.8	615.5	24,757.7
Columbia	2,616.3	5,294.0	5,804.0	2,377.5	2,556.9	18,648.7
Total	**975,078.0**	**935,878.4**	**366,601.9**	**54,929.7**	**9,640.5**	**2,342,128.6**
Douglas-fir Beetle						
Central Cariboo	38,295.9	10,360.4	2,049.9	376.5	0.0	51,082.7
100 Mile House	16,037.6	5,617.2	823.2	122.1	0.0	22,600.0
Chilcotin	3,236.8	12,272.0	634.8	0.0	0.0	16,143.6
Quesnel	494.5	2,018.5	519.1	64.3	0.0	3,096.4
Kamloops	0.3	817.2	605.1	118.8	13.3	1,554.6
Cascades	0.0	352.8	120.4	31.9	0.0	505.1
Rocky Mountain	94.8	258.3	80.1	0.0	0.0	433.3
Okanagan Shuswap	0.0	226.8	132.9	35.3	1.6	396.7
Arrow Boundary	80.5	213.5	67.9	0.0	0.0	361.9
Headwaters	163.8	152.8	25.8	0.0	0.0	342.4
Columbia	14.1	93.2	51.6	0.0	0.0	159.0
Kootenay Lake	62.6	37.0	5.9	0.0	0.0	105.6
Total	**58,480.4**	**32,419.8**	**5,116.8**	**748.9**	**14.8**	**96,780.8**
Spruce Beetle						
Central Cariboo	3,471.7	3,223.8	2,016.0	796.4	62.2	9,570.2
Okanagan Shuswap	119.6	1,008.6	3,020.6	1,090.8	0.0	5,239.5
Kamloops	22.2	693.1	2,331.0	2.0	0.0	3,048.3
100 Mile House	455.2	869.6	672.9	986.2	0.0	2,983.9
Cascades	0.0	317.6	2,372.5	270.8	0.0	2,960.9
Headwaters	213.3	327.6	831.2	69.0	0.0	1,441.0
Rocky Mountain	0.0	70.0	53.0	13.0	0.0	136.0
Quesnel	70.8	22.2	0.0	0.0	0.0	93.0
Chilcotin	0.0	29.0	0.0	0.0	0.0	29.0
Total	**4,352.9**	**6,561.4**	**11,297.2**	**3,228.1**	**62.2**	**25,501.9**
Western Balsam Bark Beetle						
Okanagan Shuswap	67,837.4	3,561.5	63.1	0.0	0.0	71,462.0
Headwaters	54,706.8	5,211.1	80.4	0.0	0.0	59,998.3
Chilcotin	7,614.8	14,674.0	49.0	0.0	0.0	22,337.8
Kamloops	13,324.2	4,161.2	4.9	0.0	0.0	17,490.4
Quesnel	15,406.3	726.0	0.0	0.0	0.0	16,132.2
Central Cariboo	12,179.8	663.8	0.0	0.0	0.0	12,843.6
Cascades	6,643.4	1,486.7	225.0	16.2	0.0	8,371.4
Arrow Boundary	5,798.2	1,382.9	193.2	0.0	0.0	7,374.4
Columbia	6,135.2	634.6	27.8	0.0	0.0	6,797.6
100 Mile House	5,373.3	49.1	0.0	0.0	0.0	5,422.4
Rocky Mountain	3,866.9	793.4	36.5	0.0	0.0	4,696.7
Kootenay Lake	1,162.3	113.9	82.8	0.0	0.0	1,359.1
Total	**200,277.4**	**33,458.3**	**762.7**	**16.2**	**0.0**	**234,514.6**

Table 2 continued. Area summaries for forest health factors mapped during the 2009 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (ha)					
	Trace*	Light	Moderate	Severe	Very Severe*	Total
Western Spruce Budworm						
Central Cariboo		218,579.1	28,812.1	2,646.3		250,037.4
Cascades		96,878.1	56,893.5	978.9		154,750.6
Okanagan Shuswap		101,521.5	19,536.3	325.6		121,383.4
100 Mile House		93,343.2	6,547.7	0.0		99,890.9
Kamloops		61,902.6	7,712.7	476.1		70,091.4
Chilcotin		38,693.0	20,027.4	2,029.8		60,750.2
Quesnel		2,557.8	0.0	0.0		2,557.8
Headwaters		93.1	0.0	0.0		93.1
Kootenay Lake		0.0	36.1	0.0		36.1
Total		**613,568.4**	**139,565.8**	**6,456.7**		**759,590.9**
Douglas-fir Tussock Moth						
Kamloops		2,368.4	4,931.7	6,245.8		13,546.0
Okanagan Shuswap		1,056.4	1,151.5	781.9		2,989.8
Cascades		414.1	250.1	312.1		976.2
Total		**3,838.9**	**6,333.3**	**7,339.8**		**17,512.0**
Aspen Serpentine Leaf Miner						
Headwaters		15,808.2	4,131.4	147.2		20,086.7
Quesnel		0.0	8,201.3	1,548.3		9,749.6
Okanagan Shuswap		3,461.4	1,459.6	0.0		4,921.0
Columbia		382.4	3,133.9	0.0		3,516.3
Chilcotin		1,807.2	1,674.5	0.0		3,481.7
Central Cariboo		0.0	413.3	2,899.8		3,313.1
Kamloops		2,618.4	274.2	0.0		2,892.7
Arrow Boundary		433.1	990.3	14.7		1,438.1
100 Mile House		157.9	0.0	990.0		1,148.0
Kootenay Lake		705.7	362.6	0.0		1,068.3
Cascades		0.0	146.2	0.0		146.2
Total		**25,374.4**	**20,787.4**	**5,600.0**		**51,761.8**
Two-Year Cycle Budworm						
Headwaters		2,160.8	0.0	0.0		2,160.8
Kamloops		1,246.7	411.9	0.0		1,658.6
Okanagan Shuswap		283.3	0.0	0.0		283.3
Central Cariboo		0.0	271.8	0.0		271.8
Quesnel		112.0	0.0	0.0		112.0
100 Mile House		18.9	0.0	0.0		18.9
Total		**3,821.7**	**683.7**	**0.0**		**4,505.5**
Forest Tent Caterpillar						
Quesnel		19,642.4	4,257.2	4,420.9		28,320.5
Arrow Boundary		36.5	179.7	0.0		216.3
Columbia		59.3	17.0	0.0		76.3
Kootenay Lake		20.6	7.9	0.0		28.5
Total		**19,758.8**	**4,461.8**	**4,420.9**		**28,641.6**
Western Hemlock Looper						
Okanagan Shuswap		303.7	337.9	0.0		641.6
Columbia		250.3	0.0	0.0		250.3
Total		**554.0**	**337.9**	**0.0**		**891.9**
Larch Needle Blight						
Rocky Mountain		483.6	378.4	0.0		862.0
Arrow Boundary		329.0	83.6	0.0		412.6
Columbia		173.0	110.1	0.0		283.2
Okanagan Shuswap		123.3	125.2	16.8		265.3
Kootenay Lake		17.3	0.0	0.0		17.3
Total		**1,126.2**	**697.4**	**16.8**		**1,840.4**

* Trace and Very Severe categories are not used for these non-direct mortality agents.

Regional Overview

Mountain Pine Beetle, *Dendroctonus ponderosae*

Mountain pine beetle continued to decline in 2009. Total red attack area mapped was slightly less than half of the area mapped in 2008, at 2.34 million hectares (Table 3). Declines were seen at all severity levels, most notably in the severe and very severe categories (Fig. 4); while overall affected area dropped in every District. The proportion of total attack classified as severe/very severe fell from 5.2% to 2.8%, while the proportion of moderate severity remained fairly static (Fig. 4). In the Cariboo, Kamloops, and southern Headwaters, the declines were due to depletion of available mature lodgepole pine. In the Kootenays, the Okanagan, and much of the Cascades, the declines were due to a combination of several factors, depending on specific location - host depletion, poor beetle reproductive success in 2007 and 2008, targeted control efforts (e.g., Kootenay Lake District), and high overwinter mortality in 2007-2008. Low r-values and high overwinter mortality rates were again seen over the winter of 2008-2009 (see the Special Projects section of this report). In the south and southeast of the Region, significant potential for population expansion exists due to a large inventory of live lodgepole pine. Some locations experienced increased red attack area in 2009 (southern portions of Cascades and Okanagan Shuswap Districts). An increase in the number of spot infestations (1 - 50 trees) was especially evident in the Kootenays, where over 80% of the Region's 5,745 spot infestations were mapped. The summer of 2009 was very favourable for the beetle due to a very synchronized emergence and dispersal, with high levels of green attack observed in many locations. It is expected that increased levels of red attack will be seen in 2010 in many areas in the south and southeast of the Region.

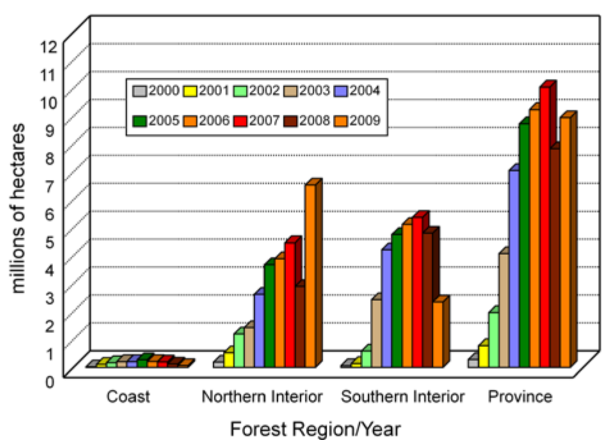


Figure 3. Area affected by mountain pine beetle from 2000 - 2009 in British Columbia, by Forest Region.

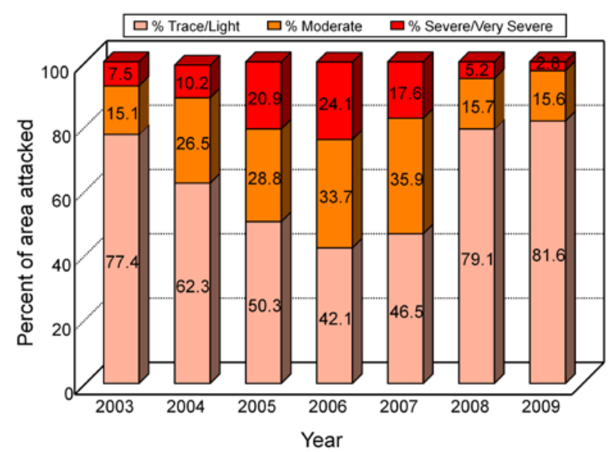


Figure 4. Proportion of mountain pine beetle infested area by infestation severity level, from 2003 - 2009, in the Southern Interior Forest Region.

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 Forest Region, 2001-2009.

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

Extensive grey attacked lodgepole pine on the border of Kamloops and 100 Mile House Districts, looking north from Elbow Lake towards Bonaparte Lake.

Mountain pine beetle attack in young pine stands(20-50 years of age) was still evident in many areas; however overall area was down from 280,000 hectares in 2008, to 52,180 hectares in 2009. Red attack in understory layers was mapped on an additional 6,175 hectares in the Cariboo. The majority of this new mortality was classified as trace or light and occurred in stands which had sustained high levels of mortality in previous years. Over 65% of the moderate and severe red attack in young pine stands was in the Kamloops and Okanagan Shuswap Districts. Significant area of unattacked 20-50 year old pine is still at risk in the south and southeast of the Region. The degree to which these stands are at risk of further attack by mountain pine beetle depends on several factors: adjacent beetle pressure from mature stands; level of adjacent risk reduction (harvest); stage of the outbreak; climate; and other factors.

A heavily impacted young stand near Mayson Lake, Kamloops Forest District. Inset is an aerial view of this stand in 2007.

Each fall, after the completion of the aerial overview surveys, Beetle Management Unit (BMU) strategies are re-assessed for all bark beetles, including mountain pine beetle. In the Okanagan Shuswap District, five BMU's (462,851 hectares) were downgraded from Holding Action to Salvage. In the Arrow Boundary District, two BMU's (54,946 hectares) were downgraded from Suppression to Holding Action, while four other BMU's (174,541 hectares) were upgraded from Salvage to Holding Action. In the Columbia District, two BMU's (44,294 hectares) were downgraded from Suppression to Holding Action, and one BMU (23,815 hectares) was downgraded from Suppression to Monitor. In the Rocky Mountain District, four BMU's (121,751 hectares) were upgraded from Holding Action to Suppression. In the Cascades District, one BMU (40,607 hectares) was upgraded from Salvage to Holding Action. In the Headwaters District, one BMU (77,267 hectares) was downgraded from Holding Action to Salvage, and the four Special Management Units were discarded, which downgraded another 134,652 hectares from Supression to Salvage. Overall, the land base designated as Salvage totals 14.64 million hectares, or 57% of the Region. Figure 2 and Table 4 show the area of each District which falls under the different mountain pine beetle strategies.

Table 4. Beetle management unit mountain pine beetle strategy designations in the Southern Interior Forest Region as of February 2010, 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	7 (372,490)	9 (788,899)	18 (1,251,850)	1 (45,929)	35 (2,449,168)
Headwaters	4 (134,652)	1 (72,266)	33 (1,739,199)	10 (1,102,909)	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)	30 (1,122,997)	5 (174,541)	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	28 (1,062,081)	48 (1,696,993)	0	1 (41,458)	77 (2,800,531)
Total	**49 (2,118,663)**	**112 (4,752,798)**	**317 (14,640,827)**	**82 (3,929,940)**	**560 (25,364,163)**

Area of red attack within provincial parks has declined, from 358,000 hectares in 2008, to 199,730 hectares in 2009. The number of affected parks has declined to 94 and the number of parks sustaining more than 1,000 hectares of red attack has fallen to 21. Over one quarter of all red attack in provincial parks was within Itcha Ilgachuz Park, which has been the most heavily impacted provincial park for several years. Other provincial parks sustaining at least 5,000 hectares of attack were Big Creek, Ts'yl-Os, Homathko River - Tatlayoko, Marble Range, Tweedsmuir, Spruce Lake, and Cathedral. Infestation levels in the four National Parks declined to 17,768 hectares, most of which was in Yoho and Kootenay National Parks (Table 5).

B.C. Parks continues their targeted efforts to minimize the impacts caused by mountain pine beetle in select parks. Many of the projects now underway by Parks are directed at reducing the fire hazard and minimizing hazard to Park users. Activities include fall and burn programs, falling and bucking of danger trees for campground firewood, and verbenone treatments in and around campgrounds and day-use areas. Aggressive removal of green attack ponderosa pine continues in Monck Park near Merritt. About 350 trees were removed by the Merritt Fire Zone crew in the winter of 2009-2010. Similar green attack removal was conducted in Skihist Park by the Lilloet Fire Zone crew (about 550 green attack removed). verbenone was applied in the spring to both parks with moderate success.

Table 5. Area (hectares) of mountain pine beetle in Provincial Parks in the Southern Interior Region in 2009. Numbers in brackets refer to additional areas within National Parks*.

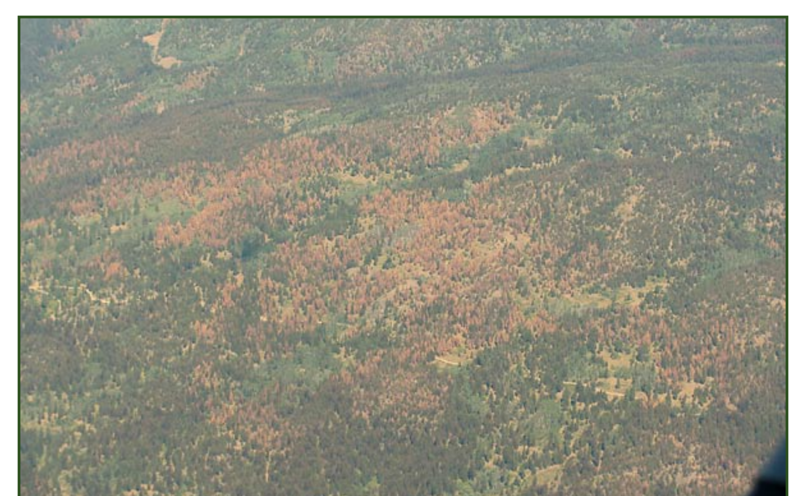
Forest District	Total Number of Parks	Number of Parks with MPB	Area of MPB in Parks (ha)	Total Park Area (ha)
Chilcotin	13	7	84,308	390,766
Central Cariboo	11	4	36,448	195,766
Quesnel	18	5	16,170	202,497
Okanagan Shuswap	110	24	13,455	186,990
Cascades	35	13	11,958	200,814
100 Mile House	29	7	10,351	48,342
Arrow Boundary	33	5	8,760	169,813
Headwaters	40	8	8,351	848,744
Kamloops	49	15	4,092	66,498
Kootenay Lake	23	7	3,642	215,975
Rocky Mountain	35	7 (1)	2,127 (3,744)	272,461 (41,517)
Columbia	21	1 (4)	68 (14,025)	50,929 (387,783)
Total	**305****	**94 (4)***	**199,730 (17, 769)**	**2,849,595 (429,300)**

*National Parks - Yoho, Kootenay, Glacier, and Mount Revelstoke.
**Several parks cross over District boundaries, hence these totals are lower than would be indicated by the data in this table.

While ponderosa pine continues to be killed by mountain pine beetle, western pine beetle and *Ips* (engraver beetles) across much of its range, the overall affected area has declined from a high of 120,000 hectares in 2008, to 89,625 hectares. Over 77% of the total area of mortality was in the Cascades District. Large areas of attack were also mapped in the Okanagan Shuswap and Kamloops Districts, although the affected area has declined sharply in Kamloops, as most stands have now sustained very high levels of cumulative mortality. Attack has been observed in all of the Districts in the Kootenays as well, although most areas of mortality are still in small scattered pockets.

Whitebark pine was killed on 18,165 hectares, which is a slight increase from the 2008 levels of 17,283 hectares. Extensive trace levels of attack were mapped in the Cariboo Mountains west of McBride, and scattered mortality was mapped in the coastal transition areas of the Lillooet TSA and throughout the Selkirk and Purcell Mountains of the Kootenays. High levels of cumulative mortality were observed in many whitebark pine stands in the Kootenays, and attack levels appear to be declining.

Western white pine was attacked at trace levels on 820 hectares in the Adams Lake area. In other areas, only minor, scattered mortality was seen.



Ponderosa pine killed by mountain pine beetle, Cascades Forest District.

Douglas-fir Beetle, *Dendroctonus pseudotsugae*

Douglas-fir beetle infestations were mapped on 96,781 hectares, which is nearly unchanged from 2008 levels. An additional 19,250 trees were killed in 2,417 spot infestations (Table 6). The most widespread attack continues to be in the Central Cariboo, 100 Mile House, and Chilcotin Districts, where extensive areas of light and trace mortality were mapped. Red attack area declined throughout most of the Kootenays, with many infestations mapped as small spot size infestations this year rather than polygons.

Table 6. Number of spot infestations of Douglas-fir beetle in the Southern Interior Forest Region in 2009.

District	# spot infestations	# trees
Central Caribo	655	3,613
Kamloops	366	3,358
100 Mile House	337	1,842
Chilcotin	258	2,485
Quesnel	165	1,083
Okanagan Shuswap	158	1,635
Rocky Mountain	124	1,105
Arrow Boundary	101	1,964
Cascades	93	939
Columbia	71	437
Headwaters	66	595
Kootenay Lake	23	193
Total	2,417	19,250

Spruce Beetle, *Dendroctonus rufipennis*

Spruce beetle infestations increased by 25%, to 25,502 hectares. Infestation severity increased in general with 58% of all area mapped classified as moderate or greater, compared to 33% in 2008. Most of the affected area was in the Central Cariboo, Okanagan Shuswap, Kamloops, Cascades, and Headwaters Districts. Very little attack was mapped in the Kootenays, and area in the Quesnel District was down to less than 100 hectares.

Western Balsam Bark Beetle, *Dryocoetes confusus*

Mortality was mapped on 234,515 hectares, an increase of 27% from 2008 totals. While decreased area was mapped in most of the Central Cariboo and 100 Mile House Districts, and throughout most of the Kootenays, a significant increase was seen across the southern portion of the Headwaters District, and the northern portion of the Kamloops District. Infestations also expanded slightly in the Okanagan Shuswap District. In several areas, decreased rates of mountain pine beetle mortality in mixed lodgepole pine – subalpine fir stands enabled surveyors to detect more balsam bark beetle activity than in 2008.

Western Spruce Budworm, *Choristoneura occidentalis*

Western spruce budworm populations remain widespread in the Region, and overall defoliated area remained unchanged, at nearly 760,000 hectares. Local increases and declines were observed in many areas - defoliation fell by 43% and 44% in the 100 Mile House and Kamloops Districts, respectively, and increased by 63%, 48%, 21%, and 18% in the Okanagan Shuswap, Chilcotin, Cascades, and Central Cariboo Districts, respectively. The proportion of defoliated area classified as moderate or severe increased to over 19%, at 146,000 hectares. Seasonal weather patterns led to more synchronized larval and foliage development in many areas than in 2008, and as a result, damage levels were increased. The highest levels of damage were near Alexis Creek, Williams Lake, Meldrum Creek, Soda Creek, Clinton, Otter Creek, Allison Creek, and Princeton.

Predictive egg mass sampling was carried out in the fall at 720 sites in the Region. Nearly 90% of all sites were positive for egg masses, with 18% of sites predicting moderate or severe defoliation for 2010. Widespread defoliation is expected, with the highest populations being in the Alexis Creek, Soda Creek, Merritt, Monte Lake, Kelowna, Peachland, and Trout Creek areas.

Just over 71,500 hectares of high priority stands were treated with Foray 48B (active ingredient *B.t.k.*) in June. A comprehensive report on the 2009 spray program can be found in the Special Projects section of this report.

Western Hemlock Looper, *Lambdina fiscellaria lugubrosa*

Defoliation was detected in the Perry River, Sugar Lake, and Lake Revelstoke areas, covering 892 hectares. Pheromone trap catches have been increasing in the Headwaters and Okanagan Shuswap Districts, and to a lesser extent in the Columbia District, for three years (Table 7). In addition to the moth trapping, three-tree beatings are conducted at these sites to monitor larval abundance. The beatings detected an increased number of western hemlock looper larvae at most of the sites in the North Thompson; fifty-seven larvae were collected at the Serpentine Creek site. These results indicate that population levels are nearing outbreak levels in several areas, and increased levels of defoliation will likely be seen in 2010, especially in the North Thompson.

Table 7. Average number of western hemlock looper moths caught per trap at 6-trap cluster sites from 2003 - 2009 in the Southern Interior Forest Region.

			Average Trap Catches						
Site	**District**	**Location**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1	Headwaters	Serpentine Creek	77	3.5	11.7	2.2	14	232.3	897.7
2	Headwaters	Thunder River	69	10.8	8.8	3	44	864	729.5
3	Headwaters	Mud Lake	71	13.2	7	4	14.2	310.3	1,070.4
4	Headwaters	Murtle Lake Road	150	8.5	11.3	12	21.2	575.7	1,218.5
5	Headwaters	Finn Creek	29	1.7	7	3.8	6.2	781	449.7
	District Average		**79**	**7.5**	**9.2**	**5**	**19.9**	**552.7**	**873.1**
7	Okanagan	Scotch Creek	567	4.5	0.8	2.8	6.2	106.8	621.0
8	Okanagan	Yard Creek	780	0.2	0.7	11.7	3.5	66.3	804.5
9	Okanagan	Crazy Creek	1,110	4.2	4.5	0.5	6.7	153.7	logged
10	Okanagan	Perry River North	1,471	75	8.2	6	18	206.2	713.7
11	Okanagan	Three Valley Gap	238	25.5	21.3	4.5	9.2	169.2	85.3
12	Okanagan	Perry River South	958	30	6	3.7	9.2	82.5	623.3
13	Okanagan	Kingfisher Creek	203	8.7	24.8	3.3	5.3	227	535.2
14	Okanagan	Noisy Creek	145	4.8	24.8	1.1	10.2	605.8	697.7
15	Okanagan	Shuswap River E.R.	457	107.3	3	1.7	2.8	72.3	340.8
16	Okanagan	Greenbush Lake	2,860	192.3	0.3	1.8	logged	29.3	450.3
17	Okanagan	Adams River	no traps	1.3	9.7	3.2	13.2	512.2	612.7
	District Average		**806**	**38.4**	**8.1**	**3.7**	**8.4**	**202.9**	**548.5**
66	Columbia	Sutherland Falls	n/a	2.5	2.5	1	1.2	28.8	17.4
72	Columbia	Trout Lake	n/a	7	6.2	2	1.2	22.2	17.9
73	Columbia	Martha Creek	n/a	16.6	7.7	2.2	0.8	8	23.4
74	Columbia	Goldstream River	n/a	2.2	5.3	3.8	2.8	4	15.1
75	Columbia	Downie Creek	n/a	no traps	1.3	1.3	1	29.5	18.8
76	Columbia	Bigmouth Creek	n/a	2.3	8.5	13.4	0.7	9.3	18.2
78	Columbia	Carnes Creek	n/a	1.2	4.3	1.5	1.2	16.2	17.3
83	Columbia	Begbie Creek	n/a	9.2	12.7	2.5	1.2	24.5	25.8
84	Columbia	Pitt Creek Rec Site	n/a	1.8	1	2.6	1.8	15.7	21.6
85	Columbia	Redrock	n/a	1.8	22.7	17.3	7.5	89.2	47.9
87	Columbia	Jumping Creek	n/a	3.3	9.4	0.5	1	27.3	69.4
	District Average		**n/a**	**4.8**	**7.4**	**4.1**	**1.9**	**25**	**26.6**

Douglas-fir Tussock Moth, *Orgyia pseudotsugata*

Total defoliated area increased by over five-fold, to 17,512 hectares. Nearly 80% of all affected areas were moderately to severely defoliated. Many locations have now sustained high levels of tree mortality. Population levels have peaked and are now declining in most areas around Kamloops and in the Similkameen, but new outbreaks were detected in the Watson Bar Creek, Savona, Walhachin, Ashcroft, Cache Creek, Deadman River, McLure, Dairy Creek, Ellison Lake, Trepanier Creek, Ashnola River, Oliver, Okanagan Falls, and Inkaneep Creek areas. Defoliation was recorded outside of the historic range in several locations, including Trepanier Creek, Ashnola River, and near Watson Bar Creek. Defoliation was noted in the Boundary area, on single trees and small groups of trees near Rock Creek, Midway, and along Highway 3.

4,341 hectares were treated with Nuclear Polyhedrosis Virus (NPV) in June, which, along with the 970 hectares treated in 2008, helped to reduce larval populations around Kamloops, Barnhartvale, Pritchard, McLure, Vinsulla, Stump Lake, and Stemwinder Provincial Park. In areas treated with NPV, tussock moth populations have declined to endemic levels and no further treatments will be required during this outbreak cycle. Treatment with NPV interrupts the outbreak cycle, causing a premature collapse of the tussock moth in areas treated. This intervention with NPV will also reduce the total area defoliated and impact severity of this outbreak cycle. Trap catches at the 21 permanent 6-trap monitoring sites declined at most locations, except at the Wood Lake and Spences Bridge sites (Table 8). In most areas, trap catches at supplemental single trap sites declined, although catches remained high at a few individual sites, and increased in the Lillooet TSA (Table 9). Additional six-trap clusters set up at 30 sites in the 100 Mile House District and at nine sites in the Arrow Boundary District generally caught low numbers of moths, averaging 3.8 moths and 4.5 moths per trap, respectively; however, catches increased at several sites, which indicates a building population. For a more detailed account of the 2009 Douglas-fir tussock moth spray program results and predictions for 2010, see the Special Projects section at the end of this report.

Table 8. Average number of male Douglas-fir tussock moths caught per trap at 6-trap cluster sites from 2003 - 2009 in the Southern Interior Forest Region (Okanagan Shuswap, Cascades, and Kamloops Forest Districts).

		Average Trap Catches per trap						
Site	**Location**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
1	McLure	6.3	3.3	0	9.8	33.3	65.7	4.5
2	Heffley Creek	76.3	5.5	38	14.8	34.2	89.8	15.8
3	Inks Lake	30	1.5	0.3	10.2	5.6	58.8	26.6
4	Six Mile	67	9.7	33.6	52.5	73.5	73.3	51.0
5	Battle Creek	67.7	5.6	1.2	14	34.8	64.5	12.3
6	Barnes Lake	52.2	6.7	1.5	34.5	21.3	58	0.5
7	Carquille/Veasey Lk.	83	2.7	0	13.8	22.5	59	13.0
8	Pavilion	9.7	0.3	0	1.5	15.7	40	15.7
9	Stump Lake	3.2	1.2	3.8	2.8	8.7	61.8	15.8
10	Robbin's Range	10.7	13.8	40.2	18.3	80.5	75.2	9.2
11	Chase	36.3	11.2	9.3	0	0	25.3	7.8
12	Yankee Flats	1	0.3	2	0	0	38.5	2.2
13	Vernon	24.8	22.7	79.8	12.2	1.3	24.8	24.3
14	Winfield/Wood Lake	1.4	6.7	11	0.3	1	38.8	50.8
15	Kelowna	burned	burned	burned	burned	burned	burned	
16	Summerland	0	0	4.5	1	0.3	43.5	13.2
17	Kaleden	0.3	0.3	18.6	11.6	29	55.4	27.7
18	Blue Lake	9.2	8.4	39.8	8.3	1.3	63.2	5.2
19	Stemwinder Park	1.2	1	29.5	1.5	17.8	40.2	30.7
20	Ashnola River	0.5	0	14.3	0	12.3	43.3	20.5
21	Spences Bridge	21.3	1.5	0	1.5	10.2	5.7	29.5
	Regional Average	**25.1**	**5.1**	**16.4**	**10.4**	**20.2**	**51.2**	**18.8**

Table 9. Average number of Douglas-fir tussock moths caught per trap by District (single trap per site), from 1994 - 2009.

	Forest District					
	Kamloops	**Okanagan Shuswap**			**Cascades**	
Year		**Salmon Arm**	**Vernon**	**Penticton**	**Merritt**	**Lillooet**
	(±30 traps[1])	(9 traps)	(±46 traps)	(27-30 traps)	(±30 traps)	(15 traps)
1994	19.5	NT[2]	NT	NT	0.1	8.0
1995	10.4	NT	0.9	3.6	2.6	NT
1996	1.9	NT	1.5	4.4	1.9	1.2
1997	17.0	0.0	2.5	9.3	17.0	1.6
1998	25.8	0.0	10.6	24.4	25.8	4.9
1999	4.8	0.0	6.8	27.0	19.7	2.5
2000	3.6	2.9	5.9	19.3	17.0	2.0
2001	3.1	0.1	1.9	4.9	4.8	1.0
2002	15.2	2.0	5.6	6.6	13.8	2.4
2003	25.8	11.9	11.9	5.0	5.9	5.4
2004	18.7	6.0	9.8	4.9	4.2	2.0
2005	1.7	0	1.5	0.2	1.4	0
2006	3.7	0	1.6	0.3	2.1	0.4
2007	1.2	N/T	N/T	1.3	2.0	2.3
2008	10.9	2.3	7.9	7.7	8.9	8.6
2009	1.3	0	1.5	6.1	3.3	9.3

[1]: in 2004, Kamloops changed from 100 sites to 30 sites.
[2]: NT= no traps placed

Douglas-fir trees completely defoliated by Douglas-fir tussock moth, near Kamloops. Inset photo shows high numbers of mature larvae feeding on a ponderosa pine located adjacent to the trees in the larger photo.

Two-Year Cycle Budworm, *Choristoneura biennis*

2009 was an "off" year in the feeding cycle of this insect, meaning most larvae are in their first year of development and feed relatively lightly. 4,500 hectares of defoliation were recorded in scattered locations.

Aspen Serpentine Leaf Miner, *Phyllocnistis populiella*

Aspen serpentine leaf miner defoliation continued to be very widespread, especially throughout most of the Cariboo. Affected area totaled 51,762 hectares. Generally, defoliation is only mapped when it becomes more pronounced, and the actual incidence of this insect at lower levels is much greater than indicated by the overview survey results.

Larch Needle Blight, *Hypodermella laricis*

Larch needle blight has continued to decline in extent, and was mapped on only 1,840 hectares. Damage was limited to smaller, scattered areas in the Kootenay and Boundary areas. Little permanent damage has been noted on stands sustaining defoliation over the last several years.

Forest Tent Caterpillar, *Malacosoma disstria*

An outbreak of forest tent caterpillar east of Quesnel expanded significantly, defoliating 28,642 hectares of aspen and cottonwood. Little permanent damage is expected, although 8,700 hectares were moderately to severely defoliated. An additional 320 hectares of defoliation were recorded in scattered pockets in the Kootenays.

Forest tent caterpillar.

Gypsy Moth, *Lymantria dispar*

The BC Ministry of Forests deploys pheromone-baited Delta traps to monitor gypsy moth at 100 sites across south-east BC (Figure 5), in co-operation with the Canadian Food Inspection Agency and the Canadian Forestry Service. Egg masses and occasionally larvae are unintentionally brought to B.C. on vehicles, trains and materials from affected areas in eastern North America. The Ministry concentrates its efforts in high use recreation sites, forested areas around major population centers, near more remote communities with transient populations and other high risk areas such as nurseries and some Provincial Parks.

Over the past decades single moths have been found at Rossland, Syringa Provincial Park, and Grand Forks City Park, but subsequent trapping indicated that populations did not survive. One moth was caught at Kokanee Creek Provincial Park in 2009. Co-operating agencies will establish an intensive delimitation grid of traps in 2010 to assess whether any eggs successfully overwintered in the area.

Windthrow

Approximately fifty small, scattered windthrow events totaling 697 hectares were detected in the Swift and Quesnel River areas, most of which were in spruce stands. Scattered windthrow is chronic in the eastern wetbelt areas of the Quesnel and Central Cariboo Districts, and has led to local build-ups of spruce beetle populations. Outside of this area, windthrow was not a significant concern, totaling just 228 hectares.

Slides/Avalanche Tracks

Slide damage was noted on 420 hectares, most of which was in the Kootenays, with the highest concentration occurring in the Arrow-Boundary Forest District. Most incidents in the Kootenays were due to the widening of existing avalanche tracks. Unstable snow pack during the 2008/2009 winter is the likely cause of this damage. Most of the avalanche activity occurred in higher elevations, and impacted spruce-balsam forests. Some subsequent spruce bark beetle populations may develop in downed trees.

Wildfire

2009 was the most active fire season since 2003, and nearly 200,000 hectares of forest were damaged. A series of 11 large fires in the Lillooet, Fraser Canyon, and Chilcotin areas accounted for nearly 65% of all burned areas. The Kootenays were much less affected, with only one large fire (2,000 hectares) near Galena Bay. Heavy smoke resulted in many delays, flight re-routing and cancellations, and reduced visibility for all survey crews.

Other

Other forest health factors observed during the aerial overview surveys included 734 hectares of birch leaf miner, 1,608 hectares of satin moth in the Shuswap Lake area, 19 hectares of pine needle cast, 245 hectares of birch decline, and 679 hectares of red belt damage. Heavy hail damaged young lodgepole pine on 970 hectares in the Blackwater river area, and other abiotic factors, including drought, flooding, and snow press caused damage to another 3,100 hectares of forests.

Heavy smoke from the Stein Valley fire south of Lillooet. This is an example of conditions which are not suitable for aerial survey work.

Nelson Area Summary

The Nelson portion of the 2009 aerial overview survey was conducted between July 16 and August 19, and required 106.3 hours of flight time over 20 days. The surveys covered the Arrow Boundary, Columbia, Kootenay Lake, and Rocky Mountain Forest Districts as well as all national parks. Although visibility was generally good, weather and smoke conditions were variable during the survey. Several large fires in the Okanagan, and several large storm systems, made scheduling the surveys a challenge, and a few drainages in the east Kooteanays were re-flown under more favourable weather conditions. Surveys were conducted by Dave Robertson of Purcell Resources Inc., and Neil Emery of Nazca Consulting.

Arrow Boundary Forest District

Mountain Pine Beetle

Mountain pine beetle infestations covered 42,723 hectares in the Arrow-Boundary Forest District in 2009, a decline of 52% from 2008. This shows a continually declining trend since 2006 in the moderate and severe classes. In particular, declining populations were noted along the western slope of Slocan Lake, where numerous grey attack trees were observed with very little new red attack. Significant populations of IBM were noted in the Renata Creek, Big Sheep Creek, and Granby River drainages. While the total area attacked declined, the number of small spot infestations increased by 80%, to 1,650 (20,215 trees). 249 hectares of young lodgepole pine stands suffered light to moderate attack in the Fostall Creek and Trapping Creek areas. Ground surveys in the Kettle River area found green:red ratios in mature pine ranging from 1.2:1, to 2.7:1, which indicates a moderately expanding population.

Whitebark pine mortality was mapped on 414 hectares and scattered groups of ponderosa pine were killed around Castelgar, Slocan, and the Boundary area.

Douglas-fir Beetle

The Douglas-fir beetle attack in the Arrow-Boundary Forest District declined from 1,452 hectares in 2008 to 362 hectares in 2009. Another 1,965 trees were killed in 82 spot infestations. Although a general population decline was noted, an increase in Douglas-fir beetle activity was identified north-west of Midway, consisting of several small spot infestations, primarily on south-facing ridges.

Western Balsam Bark Beetle

Mortality caused by the western balsam bark beetle in the Arrow-Boundary Forest District totaled 7,637 hectares in 2009. This is a decline of 30% from 10,539 hectares in 2008. Although an increase in area of moderate severity damage was noted, trace severity class declined by 53 % and light severity class by 32 %. No severe or very severe polygons were noted in 2009.

Douglas-fir Tussock Moth

Additional defoliation occurred near Rock Creek where a small patch of Douglas-fir was severely defoliated in 2008. In 2009, increased occurrences of single tree defoliation were noted in Rock Creek, Cascades, and at spots along Highway 3. During ground surveys, two larger patches were found west of Rock Creek and east of Midway. No defoliation was extensive enough to be visible during the overview survey flights.

Three tree beating and 6-trap cluster pheromone trapping sites were re-established at nine locations in the District in 2009. These sites were formerly maintained by the Forest Insect and Disease Survey unit of the Canadian Forest Service and now augment our annual monitoring program for defoliators. No Douglas-fir tussock moth larvae were collected in the 2009 beatings, and trap catches were low, averaging less than one moth per trap. The highest trap catch was near Kettle Provincial Park, which averaged 4.5 moths per trap.

Historically, defoliation from Douglas-fir tussock moth in south-eastern British Columbia has been limited to the Arrow-Boundary District, recorded from Bridesville as far east as Montrose.

Aspen Serpentine Leaf Miner

Damage caused by aspen serpentine leaf miner was mapped on 1,438 hectares in 2009, up from 23 hectares in 2008. The highest concentration of defoliation was in the Trail, Rossland, and Castlegar areas.

Forest Tent Caterpillar

Forest tent caterpillar was active along the Columbia River south of Castlegar to the U.S. border, and west of Salmo. It was particularly severe around Trail, where there was 100% defoliation in birch, aspen and cottonwood. A total of 216 hectares of defoliation were mapped.

Birch Leaf Miner

Birch leaf miner was noted on 187 hectares, mainly in the Trail area. Moderate to severe defoliation was noted west of Creston along Summit River to the Kootenay Pass summit.

Larch Needle Blight

413 hectares of larch needle blight were mapped in 2009, down from to 482 hectares in 2008. Infestations generally consisted of isolated infestations in mature larch stands. However, several young stands were noted with needle blight/cast near Whatshan Lake.

Birch Decline

Birch decline symptoms were recorded on 200 hectares, near Whatshan Lake, Slocan Valley, and Lower Arrow Lake.

Slide/Avalanche Damage

The 2009 overview survey identified approximately 258 hectares of new avalanche tracks, or widening of existing avalanche tracks in the Arrow-Boundary Forest District. The high level of avalanche activity was likely due to an extremely unstable snow pack over the winter of 2008/2009. The majority of the tree species affected by these avalanches were mainly sub-alpine fir and spruce. Several new avalanche paths were noted in the following areas: Valhalla Park, Kuskanax Creek, and Hamlin Creek.

Twig Beetles

The survey identified 12 hectares of light severity attack by a bark/twig beetle species in a young lodgepole pine stand located south west of Grassy Mountain in the Arrow Forest District. Species identification is pending.

Twig beetle attack on young lodgepole pine in the Arrow-Boundary Forest District.

Other

Other forest health factors observed in the overview survey were 4 hectares of pine needle cast west of Salmo, 25 hectares of windthrow, and 3,842 hectares of wildfire.

Columbia Forest District

Mountain Pine Beetle

Mountain pine beetle was mapped on 18,649 hectares in the Columbia Forest District, a decline of 54% from 41,084 hectares in 2008. Areas with substantial grey attack and fewer red trees included the Beaverfoot and lower portion of the Kicking Horse River drainages. An increase in mountain pine beetle activity was noted in the eastern section of Yoho National Park where several severe and very severe polygons were mapped. Substantial levels of green attack have been found in the Blaeberry River area, adjacent to the park. In most areas, attack centres were smaller and more broken up - the total number of polygons increased by 206, to 475, while the average size of each polygon declined by almost three-quarters, to just 39.3 hectares. At the same time, the number of spot infestations of less than 50 trees has increased by over 2.5-fold, from 127, to 321.

Trace to moderate levels of whitebark pine mortality occurred on 226 hectares, in scattered high elevation locations.

Western Balsam Bark Beetle

There were 6,798 hectares of subalpine fir infested with western balsam bark beetles in the Columbia Forest District, which is a slight increase from 2008 survey results (5,083 hectares). The majority of the area observed in 2009 flight consisted of trace or light damage polygons and was scattered throughout the District.

Douglas-fir Beetle

Area affected by Douglas-fir beetle was down to 159 hectares, from 1,895 hectares in 2008. Smaller infestations of Douglas-fir beetle predominated in 2009. The number of spot infestations rose from just 8 in 2008, to 71 in 2009. Most of the activity was near Revelstoke, Hamber Park, and Glacier National Park.

Spruce Beetle

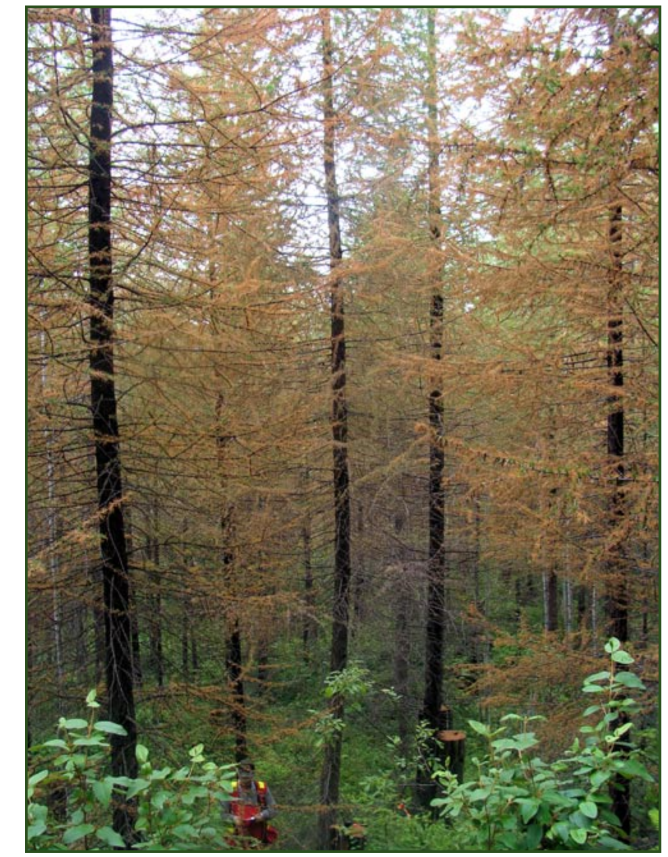
No spruce beetle was visible during the overview surveys.

Western Hemlock Looper

Fifteen separate pockets of light defoliation totaling 250 hectares were mapped along the west side of Lake Revelstoke, between Fissure Creek and Scrip Creek. Trap catches at 11 permanent trapping locations tripled, to 69.5 male moths per trap. Traps in the most northerly portion of the monitoring area had the highest counts, with the highest being at the Red Rock/Kinbasket Lake site, at 237.2 moths per trap. Three tree beatings at these and 14 additional sites yielded only 24 larvae. Trace levels of defoliation were visible from the ground at the Pitt Creek, Beaver River, and Goldstream River sites, however the causal agent was likely hemlock sawfly. It is expected that western hemlock looper populations will continue to increase and more widespread defoliation may occur in 2010.

Other

Other forest health factors mapped were 3,516 hectares of aspen serpentine leaf miner, 76.3 hectares of forest tent caterpillar, 283 hectares of larch needle blight, 40 hectares of birch decline, 1,147 hectares of wildfire, 93 hectares of trace level drought mortality, 14 hectares of flooding damage, 13 hectares of windthrow, and 34 hectares of avalanche damage. In addition, an unidentified insect defoliator damaged 15.3 hectares near Pingston Creek, and an unidentified foliar disease damaged 71 hectares of Douglas-fir in the upper Blaeberry River valley.



Larch needle blight in the Columbia District.

Bear damage is common in many young lodgepole pine plantations in the Columbia District.

Rocky Mountain Forest District

Mountain Pine Beetle

Red attack area declined by 45%, to 51,099 hectares with infestation intensity also decreasing within several areas of the District. Compared to 2008, the area classified as very severe and severe declined by 97% and 60%, respectively. Some of this apparent decline may be due to more accurate mapping, as the number of small spot infestations almost tripled, from 679 (9,615 trees) to 1,935 (27,465 trees). Areas where a significant decline was noted included the Wildhorse Creek, Sparwood Ridge, and Twelve Mile Creek drainages. As well, there are significant areas of lodgepole pine with relatively lowmountain pine beetle populations, e.g. in the Skookumchuk Creek drainage. Ground surveys have found green:red ratios ranging from a low of 0.5:1, to a high of 4.2:1, which indicates variable, and occasionally high, population expansion rates.

Whitebark pine mortality fell from 5,030 hectares, to just 774 hectares, while there was a significant increase in attacked ponderosa pine in the Rocky Mountain Trench.

Douglas-Fir Beetle

Douglas-fir beetle was mapped on 433 hectares in the Rocky Mountain Forest District in 2009. This consisted mostly of spot and light intensity polygons, with a lesser component of trace and moderate polygons. Most of the activity was in the lower trench around Lake Koocanusa, Kootenay National Park, and the upper Elk River.

Douglas-fir beetle infestation south of Grave Lake, Rocky Mountain Forest District.

Western Balsam Bark Beetle

Mortality levels have continued to fall, from over 13,000 hectares in 2007, to 4,697 hectares in 2009. This consisted of primarily trace severity damage with scattered spot infestations.

Spruce Beetle

Spruce bark beetle infestations totaled 136 hectares, down from 791 hectares in 2008. All of these visible infested stands were in the Fenwick Creek area.

Larch Needle Blight

Larch needle blight/cast occurred on 862 hectares, down from 9,860 hectares in 2008 . The upper areas of Findley, Doctor, and Skookumchuck Creek drainages showed significant damage in the 2008 overview survey, however the 2009 survey indicated little to no mortality, and minor current defoliation.

Red Belt

477 hectares of red belt damage were mapped in the 2009 aerial overview survey. The most extensive damage was noted in Vowell Creek, located northwest of Invermere. Stands with red belt are more prone to insect attack or disease.

Red belt in Vowell Creek, north-west of Invermere, Rocky Mountain Forest District.

Other

Other forest health agents recorded were 33 hectares of lodgepole pine attacked by *Ips* (pine engraver beetle) in the Spillmacheen River valley, 15 hectares of light pine needle cast in Vowell Creek, and 6 hectares of an unidentified stem dieback. Abiotc factors caused low levels of damage - wildfire burned 350 hectares, and windthrow, flooding, and slides/avalanches damaged another 105 hectares.

Kootenay Lake Forest District

Mountain Pine Beetle

Although the most damaging forest health agent in 2009 for the Kootenay Lake Forest District continued to be mountain pine beetle, red attack area declined significantly, from 55,139 hectares in 2008, to 24,758 hectares in 2009. Infestation intensity also decreased, as the proportion of infested area classified as severe and very severe declined from 31 %, to 16.7 %. The number of spot infestations almost doubled, from 455 to 843. Attack in young pine was noted on only 14 hectares. Despite this general decline in infestations, extensive damage by the mountain pine beetle was still noted in West Arm Park, Goat River, Sanca Creek, Coffee Creek, and Keen Creek drainages. Suppression areas in the south-eastern section of the Kootenay Lake Forest District, e.g. near Hawkins Creek, have considerable areas of lodgepole pine that continue to remain relatively free of mountain pine beetle.

Ponderosa pine continued to be killed in scattered spots in the Nelson area, and small pockets of whitebark pine mortality were recorded in several high elevation locations.

Lodgepole pine forests in Hawkins Creek showing very low incidence of mountain pine beetle activity, Kootenay Lake Forest District.

Western Balsam Bark Beetle

Mortality levels have continued to drop in the District, from 2,553 hectares in 2008, to 1,359 hectares in 2009. Typical infestations consisted of scattered red attack trees in older age class stands, at trace or light damage levels.

Douglas-Fir Beetle

Douglas-fir beetle populations are low to declining in the District, and attack was mapped on 106 hectares. Most of the mortality was at trace or light levels. The number of spot infestations declined from 31 to 23. Most of the infestations were in the Lardeau River, Duncan Lake, and Fry Creek areas.

Aspen Serpentine Leaf Miner

Defoliation by aspen leaf miner was mapped on 1,068 hectares in the District. No defoliation was observed in the 2008 overview surveys. Aspen forests along the Lardeau River were among the most damaged.

Western Spruce Budworm

Western spruce budworm moderately defoliated 36 hectares of grand fir east of Cottonwood Lake (just south of Nelson). This stand was lightly defoliated in 2008 as well, however at that time no positive identification could be made and the causal agent remained unknown at the time.

Western spruce budworm on Grand fir south of Nelson.

Gypsy Moth

One moth was caught at the Kokanee Creek Provincial Park monitoring site in 2009. In 2010, co-operating agencies will establish an intensive delimiting grid of traps in the area in to assess whether any eggs were laid and successfully overwintered.

Larch Needle Blight

Only 17 hectares of larch needle blight were mapped in the District, representing a significant decline compared to 2008 (1,944 hectares). Although several large areas with severe defoliation were mapped in 2008, observations in the 2009 flight did not detect any mortality. Most of these same areas did not show any evidence of defoliation in 2009.

Other

Other forest health agents detected during the surveys included 29 hectares of forest tent caterpillar, 5 hectares of birch decline and 202 hectares of red belt damage. Other abiotic factors including wildfire, windthrow, and slides/avalanche damage were minor, totaling 255 hectares.

Kamloops Area Summary

The Kamloops portion of the aerial overview surveys were conducted between July 23 and August 19, 2009, and required 55.2 hours of flight time over 13 days. Portions of the Lillooet TSA (Duffy Lake, upper Stein River, upper Bridge River) were surveyed by the Coast Forest Region survey crew, as heavy smoke near Kamloops and the Fraser Canyon prevented the Kamloops survey crew from accessing the area. These areas were completed on August 21, September 2, and September 22 (approximately 5 hours of flight time). Weather conditions for the surveys were good, however, smoke conditions were often challenging and resulted in many delays and flight cancellations. All surveys were conducted by Kevin Buxton (Ministry of Forests and Range) and Janice Hodge (JCH Forest Pest Management), and utilized a Cessna 206 operated by Westair Aviation.

Kamloops Forest District

Mountain Pine Beetle

Mountain pine beetle populations have continued to drop throughout all areas of the District, following the depletion of most of the available mature host material over the 2005 - 2009 period. Red attack area fell by over 60%, to 90,245 hectares. Severity levels have continued to fall, with over 90% of all attacked area classified as trace or light in 2009. Mountain pine beetle is still quite active around Forge Mountain, Glossy Mountain, Hat Creek, Maiden Creek, Lac Le Jeune, and the Bonaparte Plateau, but most of these areas now have a very high component of grey pine and red attack levels are low. There are very few significant areas of attack anywhere in the northern or eastern portions of the District.

Attack in young lodgepole pine stands is still widespread but declining. Affected area dropped from over 18,000 hectares in 2008, to 8,427 hectares in 2009.

Attack levels in ponderosa pine are also declining, with 34,168 hectares mapped in 2008, to 7,228 hectares of mostly trace and light attack in 2009. Most large, mature ponderosa pine stands in the District have been severely depleted by mountain pine beetle and western pine beetle and much of the ongoing mortality is in smaller, younger trees.

An extensive area of dead lodgepole pine, looking northwest from Willowgrouse Lake, Kamloops Forest District.

Spruce Beetle

Spruce beetle populations appear to be increasing, and attack was recorded on 3,048 hectares, which is an increase of nearly three-fold from 2008 levels. Most of the affected stands were in and around Porcupine Meadows Provincial Park and Cahilty Creek, with a smaller infestation in the upper Hat Creek area. All of these locations have had mortality ongoing for several years. Aggressive salvage harvesting continues in the Cahilty Creek area.

Western Balsam Bark Beetle

Affected area continued to increase, from 9,742 hectares in 2008, to 17,490 hectares in 2009. Increased levels of attack were recorded in and around the Barriere River, Harp Mountain, Chu Chua Creek, Louis Creek, and Wentworth Creek. In several of these locations, high levels of mountain pine beetle attack in mixed pine - subalpine fir stands had previously been masking much of the balsam bark beetle.

Douglas-fir Beetle

Douglas-fir beetle populations have increased for the third year in a row. Overall infested area nearly doubled, to 1,554 hectares and the number of small spot infestations increased by 65%, to 366 (3,358 trees). Significant new infestations were recorded in the Durand Creek, Dairy Lake, Hat Creek, Scottie Creek, Scuitto Lake, O'Connor Lake, Jamieson Creek, Heffley Creek, Louis Creek, Barriere River, Johnson Lake, and Highway 24 areas. An aggressive trap tree and harvesting program by the Small Scale Salvage program is ongoing throughout the District

Douglas-fir beetle infestation near Scuitto Lake, Kamloops Forest District.

Small scale salvage program Douglas-fir beetle trap tree site, Kamloops Forest District.

Western Spruce Budworm

Western spruce budworm populations declined in many areas, and overall area affected decreased by 45%, to 70,090 hectares. Aggressive spray programs were conducted in 2007, 2008, and 2009, using aerially applied *B.t.k.* to target the highest priority stands. Approximately 75,000 hectares have been treated over the three years. The spray programs were successful - almost none of the spray blocks treated in 2008 were defoliated in 2009, and most of the spray blocks treated this year, had reduced damage as compared to 2008. Only 1% of the treated area required spraying for more than one year. Defoliation intensity increased to moderate or severe levels on over 7,500 hectares of untreated forests in the Maiden Creek, Cache Creek, Scuitto Lake, and Chase areas; this is the result of both locally increased budworm populations, and synchronous insect and tree development in the spring.

Egg mass sampling conducted in the fall of 2009 indicate that budworm populations will be widespread (102 of 115 sites were positive for egg masses), but low in most areas surveyed.

Douglas-fir Tussock Moth

The Douglas-fir tussock moth outbreak expanded by over 5-fold, to 13,546 hectares. Defoliation was extensive and severe throughout the Barnhartvale, Monte Creek, Pritchard, Campbell Creek, Juniper, Heffley Creek, Vinsulla, Jamieson Creek, Dairy Creek, Kamloops, Cherry Creek, Savona, Walhachin, Ashcroft, Battle Creek, and Deadman River areas. An aerial spray program conducted in June treated 4,327 hectares with nuclear polyhedrosis virus (NPV). Due to the slow-acting nature of the virus, most of the treated areas suffered some damage, but these locations should not require further treatment. Areas treated in 2008 had very low larval populations and showed little to no new defoliation. Ground surveys were conducted during the fall of 2009 to pinpoint areas where populations will be high in 2010; these areas include Venables Valley, Barnes Creek, Pennie Lake, Battle Creek, Deadman River, Stinking Lake, and Indian Gardens Creek. High priority areas will be considered for NPV or *B.t.k.* treatments in 2010.

Other

Other forest health agents observed were 2,893 hectares of aspen serpentine leaf miner, 1,660 hectares of two-year cycle budworm, 48 hectares of birch leaf miner, 114 hectares of satin moth, and 3,937 hectares of wildfire.

Douglas-fir tussock moth defoliation in the Jamieson Creek - Black Pines area north of Kamloops.

Cascades Forest District

Mountain Pine Beetle

Affected area dropped by 13%, to 320,686 hectares. However, attack intensity increased, with area classified as moderate, severe, and very severe up from 36% to 45% of the total affected area. Attack remains widespread across the District, although levels of attack are declining where available host material has been largely depleted - the Yalakom River, Big Bar, French Bar, and the northern areas of the Merritt TSA. The number of small spot infestations remained nearly unchanged, at 251. Green:red attack ratios in the Lillooet TSA indicate a slight population decline for 2009, with a range of 0.8:1 to 1.1:1.

Attack in ponderosa pine and whitebark pine remains at high levels. Just over 69,000 hectares of ponderosa pine were attacked across the District, with the most widespread mortality being in the Spences Bridge, Nicola River, Spius Creek, Coldwater River, and Aspen Grove areas. Nearly 60% of this was classified as moderate or higher attack. In the Merritt areas, pine engraver beetles (*Ips*) and western pine beetles are building in ponderosa pine, and are responsible for a portion of the tree mortality. Western pine beetle had a large flight in early June and again in August. Mountain pine beetle started its large flight in the first week of July and ending in mid-August. Due to the various attack times of western pine beetle, mountain pine beetle, and *Ips* the ponderosa pine, have had 2 - 3 waves of fade from May through to October. The late fade noticed in October 2009 was in part caused by Ips attack in branches. Many of these Ips-attacked trees had little or no evidence of bole attack be either western pine beetle or mountain pine beetle.

11,400 hectares of whitebark pine were attacked by mountain pine beetle, mainly in the Kwoiek Creek, Stein River, Texas Creek, Hurley River, and Bridge River areas.

Attack levels in young lodgepole pine stands have declined in conjunction with reduced beetle pressure over the previous two flight periods. 985 hectares of young stands were affected in 2009, down by nearly 50% from 2008 levels of 1,838 hectares.

Red attacked ponderosa pine, grey and red attacked lodgepole pine, and western spruce budworm are all visible in this photograph, taken near Brookmere on July 27, four days before the start of the Brookmere Fire.

Spruce Beetle

While area affected by spruce beetle fell slightly to 2,961 hectares, the proportion of attacked area classified as moderate or severe increased significantly (to nearly 90%). Infestations have continued to expand in the south, around Smith Creek and Crater Mountain. An estimated 1.4 - 2.2 million cubic metres of spruce have been killed each year in this area. Licensees have been conducting aggressive salvage harvesting and will harvest approximately 425,000 cubic metres of infested timber this winter, and up to 900,000 cubic metres in 2010. Attack continues to be scattered across the Lillooet TSA, although populations have declined in many areas due to depletion of suitable host material.

Western Balsam Bark Beetle

Area affected by western balsam bark beetle has remained nearly unchanged, at 8,371 hectares. Mortality levels fell in the Merritt TSA, while increased mortality was seen in the Lillooet TSA. 97% of the affected area was classified as trace or light.

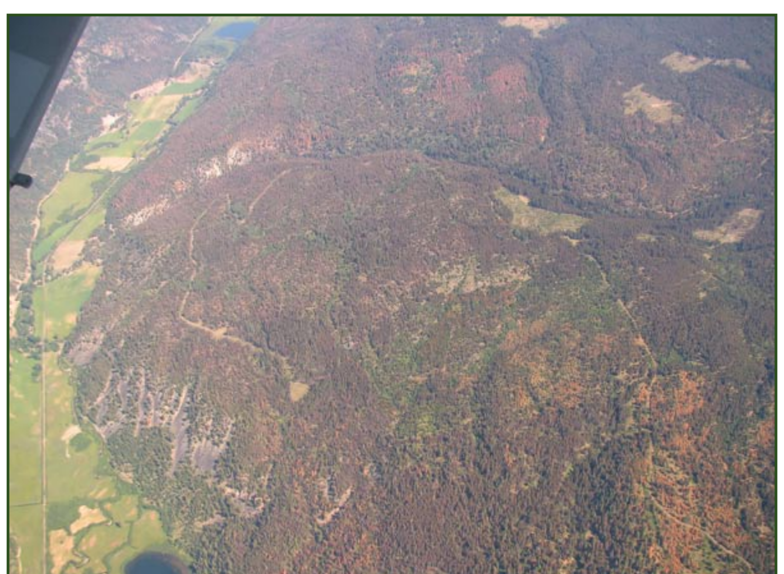
Douglas-fir Beetle

Douglas-fir beetle remained active, with the most significant infestations being in the Big Bar, Yalakom River, Carpenter Lake, Pavilion, and Spences Bridge areas. Just over 500 hectares of light to moderate attack and an additional 93 small spot infestations were mapped.

Western Spruce Budworm

Area visibly defoliated increased by 21%, to 154,750 hectares. Larval development was well synchronized with bud development across much of the Merritt TSA, leading to elevated levels of damage. The area classified as moderate and severe multiplied by over 30-fold, to nearly 58,000 hectares. Most of the heavy defoliation was in the Otter Creek, Allison Creek, Tulameen, Coalmont, Princeton, and Similkameen River areas. Understory damage in these, and other chronically defoliated stands, has been significant and there is a need for aggressive treatment in 2010, as none was undertaken in 2009. Damage levels across much of the Lillooet TSA have fallen, with the exception of the Gun Lake area.

Egg mass survey efforts in the fall of 2009 were concentrated in the Merritt TSA. Eighty five percent of sample sites were positive for egg masses, which indicates that budworm populations will remain widespread in 2010.



Moderate and severe defoliation caused by western spruce budworm feeding near Otter Creek. The bright orange trees are ponderosa pine that have been killed by mountain pine beetle.

Douglas-fir Tussock Moth

Douglas-fir tussock moth defoliated 976 hectares of low elevation Douglas-fir, with most of the damage restricted to the Hedley, Stemwinder, Chuchuwayha Indian Reserve 2, and Ashnola Indian Reserve 10 areas. Most defoliation occurred on private land. Defoliation was recorded for the first year in scattered patches north of Nicola Lake, at the north end of the Fountain Valley, and along the west side of the Fraser River near Watson Bar Creek and Leon Creek. Stemwinder Provincial Park and several neighbouring private land parcels, covering 15 hectares, were treated with aerially applied NPV on May 27. The spray was very successful and no 2009 defoliation occurred. A small number of ground surveys were conducted in September and October 2009; results show that populations have declined in the Similkameen, and light defoliation may occur in 2010 near Twaal Creek. Surveys were not conducted in the Fountain, Lillooet, or Watson Bar areas due to funding limitations, but tussock moth populations and defoliation are expected to increase in these areas in 2010.

Wildfire

2009 was a very severe wildfire year, and 78,012 hectares were burned. Most fire activity was in the Lillooet TSA, which saw several large fires near Tyaughton Lake, the Yalakom River, Seton Portage, Lillooet, Intlpam Creek, and the Stein River. The only large fire in the Merritt TSA was the 3,025 hectares Brookmere fire. Only 3,710 hectares of red attacked lodgepole pine were burned. Most of the fires were in dry, low elevation forests and the potential exists for the buildup of bark beetles and secondary insects, such as Douglas-fir beetle, western pine beetle, and red turpentine beetle.

Wildfire damage near Seton Portage, Cascades Forest District.

Other

Other forest health agents included 146 hectares of aspen serpentine leaf miner near Maka Creek, 15 hectares of windthrow, and 7 hectares of flood damage. Many stands around Lillooet and the Bridge River are beginning to exhibit symptoms of drought damage, which will be recorded by the 2010 aerial surveys.

Okanagan Shuswap Forest District

Mountain Pine Beetle

Heather Rice, Okanagan Shuswap District Forest Health Technician, with a green-attacked lodgepole pine.

Red attack levels have dropped across much of the northern and central portions of the District, due to a combination of host depletion and salvage harvesting. As a result the overall area affected fell by 20%, to 135,913 hectares. The number of spot infestations remained relatively high, at 475. Red attack expanded and/or became more severe in other areas, namely near Peachland Creek, Trout Creek, and Apex Mountain. Other areas with increased activity were Postill Lake, Highway 33, Penticton, and TFL #15, where increased numbers of spot infestations and smaller, scattered polygons were recorded. A warmer, dryer summer resulted in an earlier and more synchronous beetle flight, with expansion rates of up to 6:1 in some areas. Overall, expansion rates averaged 2:1.

3,050 hectares of young pine plantations were attacked, although red attack rates were generally low. Attack in these young stands has declined in the north and the Shuswap, and has spread south into the Shorts Creek, Bear Creek, and Belgo Creek areas.

Ponderosa pine was killed on 10,775 hectares. The level of attack increased around Falkland, Kelowna, Bear Creek, and throughout the Summerland, Penticton, and Okanagan Falls areas. Mountain pine beetle has been the primary mortality agent, with varying levels of western pine beetle. Mortality levels have dropped in most of the north Okanagan due to decreased beetle pressure.

No whitebark pine mortality was evident in the Snowy Protected Area, presumably because most mature trees have been killed off in previous years.

Douglas-fir Beetle

Overall affected arearemained static from 2008 to 2009, with only a slight increase from 356 hectares to 397 hectares. The number of small spot infestations increased from 125 to 158. Most of the infestations in the Shuswap declined, while many new infestations were recorded near Sucker Lake, Falkland, Cherryville, Penticton, the Ashnola River, and the West Kettle River. District staff have observed limited levels of green attack in most areas.

Western Balsam Bark Beetle

Western balsam bark beetle mortality increased by 21%, to 71,462 hectares, nearly 95% of which was classified as trace. The bulk of the affected area continued to be in the Greystokes, Mission Creek, Upper Kettle River, Winnifred Creek, Shuswap Highlands, and Hunters Range areas. Extensive mountain pine beetle red attack has continued to mask balsam bark beetle across much of the western half of the District.

Spruce Beetle

Spruce beetle activity was up, with the majority of the 5,420 hectares mapped being concentrated in and near Snowy Protected Area and Cathedral Park. New mortality was seen in the Flat Top Mountain - Placer Mountain area, which is likely related to the neighbouring 2006 wildfire. Populations are expanding to the north, with new mortality being observed around Crater Mountain, Apex Mountain, and Nickel Plate Lake. Smaller infestations were also recorded at Fly Hills and Winnifred Creek. District staff and licensees have reported significant new green attack in the Apex and Nickel Plate Lake area; licensees are working with First Nations to help address this issue through harvesting opportunities.

Spruce beetle near Crater Mountain, Okanagan Shuswap District.

Western Spruce Budworm

Western spruce budworm populations have continued to expand in the District, for the fourth year in a row. Defoliation was recorded on 121,383 hectares, which is an increase of 63% from 2008 totals. The area of moderate and severe defoliation increased from 2.5 % of the total area (1,864 hectares) in 2008, to 16.3 % of the total area (19,826 hectares) in 2009. Most of the expansions were around Chase, Vernon, Kalamalka Lake, Kelowna, Penticton, and the Similkameen River. The most intense defoliation was around Trout Creek, Predator Ridge, Marron Valley, and the Similkameen River.

Egg mass sampling conducted in the fall of 2009 indicates that populations and defoliation intensity will continue to increase in 2010. Nearly 94% of the 281 sampling sites were positive for egg masses, and one third predicted moderate or severe defoliation levels. The highest egg mass counts were near Monte Lake, Falkland, Equesis Creek, Wood Lake, Mission Creek, Peachland Creek, Shingle Creek, and Marron Valley.

Western spruce budworm defoliation, visible on the far hillside, with Douglas-fir tussock moth defoliation in the foreground. Photograph taken near Trepanier Creek, Okanagan Shuswap District.

Douglas-fir Tussock Moth

As anticipated, Douglas-fir tussock moth populations expanded, and total defoliated area increased by over 13 - fold to 2,990 hectares. Over 65% of the defoliation was classified as either moderate or severe, where significant top-kill and tree mortality can be expected to occur. Most of the defoliation was around the Ashnola River, Richter Pass, Kaleden, Park Rill Creek, Fairview Road, McCuddy Creek, Trepanier, McKinley, and Ellison Lake. Fall 2009 ground surveys were conducted at approximately 1,400 sites indicate moderate to severe defoliation in 2010 near Monte Lake, Ellison Lake, lower Postill Lake Road, McKinley, Glenrosa Road, and Trepanier Creek. Control with *B.t.k.* and NPV is beingplanned for 2010 in select areas. Treatment options are limited on much of the affected area due to land status issues. Manyareas in the south of the District were not positive for egg masses and it appears that most of these populations have declined to post-outbreak levels due to NPV epizootics.

Western Hemlock Looper

Light to moderate defoliation was mapped on 642 hectares, in the Ireland Creek, Outlet Creek, Perry River, and Anstey River areas. Average trap catches increased to an average of 549 moths per trap. Three tree beatings collected very few larvae - the only positive collections in the District were at 3 Valley Gap, near one of the defoliated areas. This indicates that populations are increasing, but still below outbreak level in most areas, therefore widespread defoliation is not expected in 2010.

Aspen Serpentine Leaf Miner

Leaf miner defoliated 4,920 hectares of trembling aspen in the northeast wetbelt areas of the District. Defoliation was moderate on 1,460 hectares, but the trees should be able to recover and no permanent damage is expected.

Two-Year Cycle Spruce Budworm

Two-year cycle spruce budworm lightly defoliated 283 hectares of spruce-subalpine fir near Powers Creek. This damage may have been caused by western spruce budworm spreading into high elevations, as it is active at lower elevations nearby.

Satin Moth

Satin moth defoliated 1,495 hectares of trembling aspen in the Ross Creek area, north of Anglemont.

Wildfire

Wildfires damaged over 14,000 hectares of forest in 2009. Two large wildfires, near Terrace Mountain and Notch Hill, covered 85% of the total burned area. There is concern that the fires could lead to increased activity of spruce and/or Douglas-fir beetles in the coming years, especially around the Terrace Mountain fire.

Other

Other forest health agents included 499 hectares of light birch leaf miner around Sugar Lake, 265 hectares of larch needle blight near Penticton Creek and on TFL #15, 41 hectares of slide damage, and 12 hectares of windthrow. There is also continuing evidence of both birch and cedar decline in many areas, although symptoms are generally not visible from the air. Drought damage symptoms have begun to manifest during the fall and will likely be visible during the 2010 aerial surveys.

Headwaters Forest District

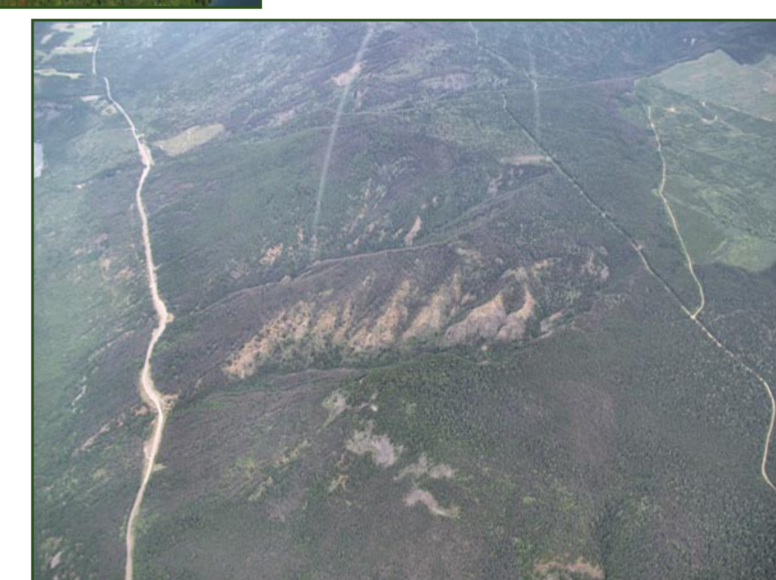
Mountain Pine Beetle

Infested area dropped by one-third for the second year in a row, from 164,464 hectares, to 112,426 hectares. Mountain pine beetle populations have continued to decline in the southern portions of the District, mainly due to a lack of live lodgepole pine. Red attack is still widespread, but scattered into smaller pockets, and totalling only 20,000 hectares in the entire land base south of Albreda. In the Robson Valley, populations are still high, and red attack was mapped on over 92,000 hectares. Infestations increased in area and severity around Valemount, where there is still an abundance of large, healthy, mature pine.

Attack in young pine stands was limited to 2,266 hectares, around TFL #18, Blue River, and Holmes River. Most of the red attack in these young stands was at trace or light levels.

Whitebark pine continued to be attacked in the Cariboo Mountains, although most of the 11,400 hectares affected experienced only trace mortality levels. Western white pine was killed on 827 hectares in the upper Adams River and Raft River areas, but again, most of this damage was at trace levels.

Mountain pine beetle red attack around the Valemount Airport, August 2009, Headwaters Forest District.



Grey attack lodgepole pine killed by mountain pine beetle in the First Canyon area of Wells Gray Park, Headwaters Forest District.

Western Balsam Bark Beetle

Attack levels have increased throughout the District, and trace to light mortality was mapped on 60,000 hectares. Most of the activity occurred around the Raft River, Mad River, TFL #18, Adams River, Dore River, and West Twin Creek.

Spruce Beetle

Spruce beetle infestations were visible on 1,441 hectares in the District, down slightly from 2008 levels of 1,630 hectares. The largest infestation was in the Dawson Creek area, where mortality covered just over 850 hectares. Smaller infestations were scattered near Hobson Lake, Clearwater Lake, and Serpentine Creek.

Douglas-fir Beetle

An increase in Douglas-fir beetle activity was seen in the Vavenby, Mount MacLennan, and Mahood Lake areas. In total, 342 hectares of trace and light mortality were mapped and the number of small spot infestations increased by nearly four-fold, from 17 to 66. The District Small Scale Salvage program completed and sold several trap tree decks on Mount MacLennan and District staff completed a trapping program in the area in an attempt to decrease beetle pressure in the area.

Douglas-fir beetle funnel trap site on MacLennan Mountain, Headwaters Forest District.

Western Spruce Budworm

Populations remained low in the District, with the only two small areas of defoliation (93 hectares) at Adams Lake.

Two-Year Cycle Budworm

2009 was an “off” year in the life cycle of this insect, and defoliation was limited to 2,160 hectares of light defoliation near Hobson Lake, Crescent Spur, and the Raush River.

Western Hemlock Looper

No defoliation was visible during the aerial surveys, however, both trap catches and three-tree beating collections were up significantly. The average number of moths per trap increased to 873 across all five monitoring sites, with the highest catches at the Serpentine Creek, Mud Lake, and Murtle Lake Road sites. Three tree beatings were positive for larvae at all sites, with the highest counts at the Serpentine Creek and Thunder River sites. Population levels have increased sharply over the last two years, and defoliation is likely to occur between Blue River and Albreda in 2010.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner populations continued to be high enough to produce visible defoliation in and around Wells Gray Park, Raft River, Mad River, and Adams River. Most of the 20,090 hectares of mapped were only lightly defoliated, and no long-term damage is expected. Populations are generally present at low levels in most

birch stands in the District.

Wildfire

Three fires, near Momich Lake, Gannett Creek, and the upper North Thompson River, were responsible for most of the burned area of 5,890 hectares.

Other

Other forest health agents observed during the surveys were 252 hectares of unknown alder defoliation near Kinbasket Lake, 1,622 hectares of drought damage to cedar in the Robson Valley, 57 hectares of windthrow, and 11 hectares of flooding damage.

Cariboo Area Summary

The Cariboo portion of the aerial overview surveys began on July 27 and finished August 15. Two contract crews surveyed the area encompassed by the Quesnel, Central Cariboo, 100 Mile House and Chilcotin Forest Districts as well as the Robson Valley TSA portion of the Headwaters Forest District. A total of 119 hours of aircraft time over 24 crew-days were expended to map this area, which included small portions of the Mid-Coast, Prince George, and Vanderhoof Forest Districts. Surveys were conducted by contract personnel (Joe Cortese, Don Wright, Mikko Sipponen, and Bob Erickson) and utilized Cessna 180, 185, and 206 aircraft.

Quesnel Forest District

Mountain Pine Beetle

Red attack area continued to decline rapidly, from the peak of 1.3 million hectares in 2004, and 712,727 hectares in 2008, to 251,593 hectares in 2009. Severity levels have remained low in most areas, as the mature component of most pine stands has been severely depleted. Nearly all red attack occurred in the western portion of the District, around the Baezaeko River and Coglistiko River. In most of this area, the sub-dominant pine component is being attacked, in some cases by a mix of mountain pine beetle and *Ips* engraver beetles. The overstory component in these stands was killed by mountain pine beetle several years ago. There was very little new red attack in the area between Nazko and the Fraser River, and virtually none detected east of the Fraser River.

Attack in younger aged pine stands has also declined sharply, from over 45,000 hectares in 2008, to 5,518 hectares in 2009. Most of the affected young stands were between Nazko and the Fraser River, and nearly all of the mortality was trace or light.

Spruce Beetle

The spruce beetle infestation near the Swift River appears to have subsided. A few small areas of active beetle were seen in the eastern portions of the District, totaling 93 hectares of trace and light mortality. Although beetles have been building up in scattered windthrow, in most areas populations do not appear to have risen high enough to attack much standing timber.

Douglas-fir Beetle

Affected area has continued to decline, from 4,435 hectares in 2008, to 3,096 hectares in 2009. Douglas-fir beetle populations have declined along the Fraser River, and along the Blackwater River downstream of Pantage Creek. The number of small spot infestations is also down, from 221 (2,485 trees) to 165 (1,085 trees). District staff have observed that green attack levels appear to have declined, and West Fraser Mills has been conducting an aggressive trap tree program. Scattered Douglas-fir blowdown in late August and November may lead to some local increases in beetle populations in 2010.

Western Balsam Bark Beetle

Western balsam bark beetle populations are still relatively low, but increasing. The area mapped increased by nearly 3-fold, to 16,132 hectares. Nearly all of the attack was at trace level, at high elevations in the eastern areas of the District.

Western Spruce Budworm

Western spruce budworm has remained confined to a small area along the Fraser River near Marguerite. Affected area was down, totaling just 2,558 hectares of light defoliation.

Forest Tent Caterpillar

Forest tent caterpillar damage expanded to 28,320 hectares in the Cottonwood River, Frye Creek, and Kersley Creek areas. About one-third of the defoliated area was classified as moderate or severe, but little permanent damage is expected.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner was visible on 9,750 hectares in the Maud Lake and Swift River areas. This insect has been present at low levels in virtually all trembling aspen stands in the District over the last several years, but only areas with higher population levels have damage that is visible from the air.

Hail Damage

An unusual damage signature was noted on 970 hectares of young lodgepole pine plantations in the Blackwater River area. The area was ground checked by Leo Rankin (Forest Entomologist, Williams Lake) and Don Wright (aerial surveyor) and the causal agent was determined to be hail. Damage tended to be confined to one side of the trees and consisted of damaged and missing needles and damaged bark.

Hail damage on a young lodgepole pine.

Windthrow

Scattered pockets of windthrow were mapped east of the Fraser River, in spruce and Douglas-fir stands. Additional scattered Douglas-fir blowdown occurred in the fall and was noted by District staff. Area affected totaled 552 hectares and may contribute to the localized buildup of Douglas-fir beetle and spruce beetle populations.

Other

Other forest health agents observed were 112 hectares of two-year cycle budworm defoliation near Nazko, 22 hectares of an unidentified defoliator on alder, and 23,482 hectares of wildfire.

Central Cariboo Forest District

Mountain Pine Beetle

Red attack levels have continued to decline, from 602,000 hectares in 2008, to 225,036 hectares in 2009, with over 75% of all red attack classified as trace or light. Most of the mature pine stands in the District have been severely depleted, and outside of the mid to high elevations around Big Creek and Churn Creek, only scattered red attack was seen. Attack levels in young pine stands have also dropped sharply, from over 113,000 hectares in 2008, to 14,730 hectares in 2009, 95% of which was at trace levels. A portion of the mortality being seen in these younger stands is due to *Ips* and other secondary beetles.

Douglas-fir Beetle

Douglas-fir beetle has remained widespread in the District, with red attack being mapped on 51,083 hectares. In most areas, the attack pattern is very scattered, and 75% of all area was classified as trace. The most widespread attack was in the Williams Lake, Chimney Creek, Soda Creek, Farwell Creek, Riske Creek, Churn Creek, Empire Valley, and Dog Creek areas. Large numbers of spot infestations (a total of 655) and smaller polygons were mapped throughout the range of Douglas-fir in the District, especially in the Beaver Creek, Big Lake, Horsefly, Knife Creek, Chimney Lake, Alkali Creek, and Meldrum Creek areas. Snow breakage that occurred over the 2008-2009 winter may have contributed to beetle population increases in the south of the District.

Spruce Beetle

Spruce beetle attack was scattered around the Niagra Creek, Quesnel Lake, Horsefly River, McKusky Creek, Tisdall Lake, and Bootjack Mountain areas. A total of 9,520 hectares of mortality was recorded, 30% of which was classified as moderate, severe, or very severe.

Western Balsam Bark Beetle

Western balsam bark beetle populations have continued to decline, as the total attacked area dropped from 20,976 hectares in 2008, to 12,843 hectares in 2009. Most of the affected area was around the North Arm of Quesnel Lake.

Western Spruce Budworm

Western spruce budworm populations continue to be at damaging levels across much of the District, and defoliation was mapped on 250,037 hectares. Just over 31,000 hectares were classified as moderate or severe. The highest levels of damage were along the Fraser River between Macalister and Springhouse, near Williams Lake, and along the Chilcotin River. 15,764 hectares of high priority stands were treated with aerially applied *B.t.k* in June, near McCleese Lake, Pine Valley, Williams Lake, Chimney Creek, Riske Creek, Joe's Lake, and Sting Lake. Defoliation is expected to be widespread again in 2010, with the highest levels near Meldrum Creek, Soda Creek, McLeese Lake, Pine Valley, and Alkali Creek.

Other

Other forest health agents were 3,313 of aspen serpentine leaf miner defoliation around Likely and Quesnel Lake, 272 hectares of two-year cycle budworm near the Little River, 3,665 hectares of wildfire, and 145 hectares of windthrow.

Spruce beetle near Big Slide Mountain, Central Cariboo District.

Chilcotin Forest District

Mountain Pine Beetle

Scattered light mountain pine beetle near the north end of the Nuit Range, Chilcotin Forest District.

Red attack levels have continued to decline. There are now large areas through the central portions of the District that have no red attack, and over half of all the new red attack mapped was only at the trace level. The proportion of the area classified as moderate or severe fell from 10% to less than 6%, and total affected area dropped by 35%, to 992,155 hectares. Despite these general declines, there remain extensive areas of scattered, light attack across the southern, higher elevation portions of the District, where there is abundant healthy lodgepole pine. In these higher elevation areas, overwinter mortality levels tend to be high, and this may have a limiting effect on beetle success and spread.

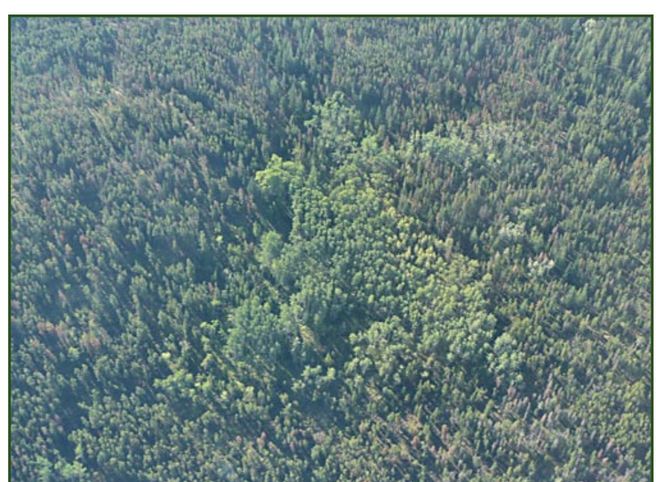
Western Balsam Bark Beetle

Western balsam bark beetle is confined to the Coast and Chilcotin Mountains. Trace and light attack was mapped on 22,338 hectares, which is a slight increase from 2008 levels of 19,685 hectares.

Douglas-fir Beetle

Douglas-fir beetle continues to be very active along the Chilcotin, Chilko, and Taseko Rivers. Overall area affected has increased slightly, to 16,143 trees, while the number of smaller spot infestations has dropped slightly to 258. Some trap tree and MCH work is being done in some of the more active areas. The mule deer winter range status of many infested stands restricts control options. High beetle populations have been exacerbated by chronic western spruce budworm defoliation, and there are concerns about possible population increases in and around the 66,000 hectare Lava Canyon fire.

Western Spruce Budworm



This photo of light defoliation by aspen serpentine leaf miner shows the difficulty of mapping this agent in an overview survey.

As predicted by 2008 egg mass sampling, western spruce budworm damage increased in both area, and intensity. Defoliated area increased by nearly 50%, to 60,750 hectares, and the area of moderate and severe defoliation increased by over 3.5-fold, to 22,000 hectares, or 36% of the total area. The most intense defoliation was in the Hanceville, Lees Corner, and Alexis Creek areas. 13,878 hectares of high-priority Douglas-fir stands were treated with aerially applied *B.t.k.* in June; egg mass sampling conducted in the fall is predicting that population levels and resulting damage levels should be lower in 2010.

Wildfire

Three large wildfires, the 66,720 hectare Lava Canyon Fire, the 1,500 hectare Corkscrew Basin fire, and the 4,285 hectare Chilko Lake Fire, were responsible for over 90% of the 78,012 hectares burned in 2009. The Lava Canyon and Corkscrew Basin fires both burned in areas with high components of grey attacked lodgepole pine.

Other

Other forest health agents mapped were 3,480 hectares of light to moderate aspen serpentine leaf miner damage, 29 hectares of spruce beetle, and 7 hectares of flooding damage.

100 Mile House Forest District

Mountain Pine Beetle

Following the near-depletion of mature lodgepole pine in the District, mountain pine beetle populations have plunged. Red attack levels have dropped from 742,000 hectares in 2008, to 76,847 hectares in 2009. Of this, just under 60,000 hectares were in mature lodgepole pine, with the other 17,570 hectares being in either young lodgepole pine stands (15,256 hectares), or ponderosa pine (2,315 hectares). At the same time, the area of moderate and severe attack has declined to under 6,000 hectares, from a high of 438,340 hectares two years ago. The only areas still showing relatively active beetle populations and high levels of red attack were around Clinton Creek, Pavilion Mountain, the Marble range, and Big Bar Lake. Scattered areas of trace and light red attack were mapped around Scottie Creek, Bonaparte Lake, Eagan Lake, and Dog Creek.

Douglas-fir Beetle

Douglas-fir beetle west of Lac La Hache, 100 Mile House District.

Red attack levels increased from 13,160 hectares in 2008, to 22,600 hectares in 2009, most of which was classified as trace. Most of the increased area was around Big Bar Mountain. The number of spot infestations has remained high, at 337. Fir beetle activity was widespread around Canoe Creek, Jesmond, Big Bar Mountain, Loon Lake, Bonaparte River, Bowers Lake, Canim Lake, Timothy Lake, Ruth Lake, and Lac La Hache. Limited detailed mapping and poor markets for Douglas-fir logs has restricted treatment and control options; a few small scale salvage operators have been harvesting trap trees for the peeler market, and some other trap tree sites were burned. Recent surveys by District staff indicate that beetle populations may have decreased over the summer in some locations, which should lead to some localized decreases in red attack in 2010.

Spruce Beetle

Most spruce beetle activity was confined to the Deception Creek - Hendrix Creek area. Affected area increased from 2,000 hectares in 2008, to 2,984 hectares in 2009, and the proportion of attack classified as moderate or greater increased to 55%. Sporadic, scattered windthrow has been occurring in this area for a few years and this may have led to beetle population increases.

Western Balsam Bark Beetle

Affected area was down for the third year in a row, to 5,422 hectares. Most of the activity was in the Windy Mountain, Deception Creek, and Mount Timothy areas.

Western Spruce Budworm

Following an aggressive *B.t.k.* spray program in 2008, western spruce budworm damage decreased, especially around Jesmond, China Gulch, 100 Mile House, Gustafson Lake, Green Lake, Chasm, and the Bonaparte River. Affected area dropped by over 40%, to 99,891 hectares. Most of the defoliation was light, with 6,550 hectares of moderate defoliation around Clinton and Loon Creek. Another 7,215 hectares of high-priority stands were treated with *B.t.k.* in June 2009, which helped to reduce damage near Helena Lake, Canoe Creek, and China Gulch. Egg mass surveys conducted in the fall of 2009 indicate that populations will remain widespread in 2010, with moderate defoliation around Clinton, Loon Creek, Jesmond, 108 Mile House, and Beaverdam Lake.

Douglas-fir Tussock Moth

Pheromone traps were deployed in 6-trap clusters, at 30 sites in the District. The average catch increased slightly from 2008, from 2.5 to 3.9 moths per trap. This indicates that populations are still low and no defoliation should occur in 2010. Several sites caught relatively high numbers of Rusty Tussock Moth, a closely related species that has not historically produced significant defoliation.

Wildfire

Most of the 23,825 hectares damaged by wildfires were due to the 21,000 hectare Kelly Lake fire. Although Douglas-fir beetle populations have not been particularly active directly around the fire perimeter area over the past few years, there is concern that the large number of fire-damaged Douglas-fir could lead to an increase in beetle populations in areas adjacent to and within the fire boundary.

Other

Other forest health factors observed during the aerial surveys were 1,150 hectares of aspen serpentine leaf miner, 19 hectares of two-year cycle budworm defoliation, 22 hectares of windthrow, and 917 hectares of ice and snow damage.

Snow press in 100 Mile House District.

Black staining caused by Atropellis canker on an immature lodgepole pine near Horse Lake, 100 Mile House District.

Forest Health Projects

Summary Of 2008-2009 Bark Beetle Overwintering Mortality Estimates

Overwintering mortality sampling is conducted annually to provide an estimate of beetle population trends, and brood success and survival. A standard methodology for sample collection and evaluation is used, as referenced in the 2004 version of this report (available in .pdf format from http://www.for.gov.bc.ca/rsi/ForestHealth/overview_reports/Overview_2004.html). In 2008 and 2009, an updated, standardized methodology was by using a 4-inch (10 cm) hole saw and a gas-powered drill.

Two numbers are generated for each sample, the r-value and the % brood mortality. The r-value is a measure of the ratio of successful beetle progeny to initial attack rates, and is a good indicator of population trends. For mountain pine beetle, any r-value greater that 4.0 indicates a generally increasing population, and for Douglas-fir beetle, any value above 1.3 indicates an increasing population. The % mortality is a direct measure of the brood mortality up until the time of sampling, which is usually conducted in March, after most winter mortality has occurred.

Mountain Pine Beetle

Mountain pine beetle brood mortality must reach annual levels of 97% in order for the population to decline significantly. Winter mortality usually accounts for the majority of annual brood mortality. Winter mortality rates below 70% have little effect on population growth rates. During March - April of 2009, sampling for mountain pine beetle was conducted in all Districts (with the exception of Quesnel District), at a total of 174 sites. Of these, 22 sites were in young lodgepole pine stands (20-40 years of age) (Table 1).

Mountain pine beetle overwintering mortality was higher over the 2008-2009 winter than it has been since the beginning of the outbreak. Brood mortality in mature pine ranged from 79.5% to 99.0%, averaging 92.2%. The highest mortality was in the Cascades, Central Cariboo, Chilcotin, and Okanagan Shuswap Districts, and in the Clearwater area of the Headwaters District. The only areas with mortality rates of less than 90% were the Arrow Boundary and Kootenay Lake Districts, and the Robson Valley. Brood mortality in young lodgepole pine was at or near 100% at most sites, averaging 98.7%. R-values were well below 4.0 in all areas, indicating declining populations, except for the Robson Valley, which had an r-value of 4.2, which indicates a slightly expanding population.

In the Cariboo, all Districts indicate a collapse of the MPB infestation. Quesnel Forest District was not sampled due to the difficulty in finding current MPB attack. The mature stands have been decimated and host material for mountain pine beetle is almost non-existent.

As in 2007, the summer of 2008 had cooler, wetter weather than average during the beetle flight period, which in many areas, resulted in a prolonged beetle flight, higher than normal adult mortality, and underdeveloped brood. These factors, along with a cold and prolonged 2008-2009 winter, would have contributed to these high overwinter mortality rates.

Table 1. Percent mortality of mountain pine beetle progeny during the winter of 2008-2009, with associated r-values.

District or TSA	Number of Sites	Number of Samples	Average % Mortality	Average R-Value
Arrow Boundary	15	134	88.8	2.81
Cascades (Lillooet TSA) - mature pine	12	119	99.0	0.46
Cascades (Lillooet TSA) - young pine	5	49	96.0	1.71
Cascades (Merritt TSA) - mature pine	10	98	97.2	0.62
Cascades (Merritt TSA) - young pine	7	68	99.2	0.77
Columbia	14	135	92.8	1.40
Headwaters (Clearwater)	9	79	95.2	1.19
Headwaters (Robson Valley)	20	200	79.5	4.20
Kamloops - young pine	5	50	99.9	0.03
Kootenay Lake	9	89	89.3	1.78
Okanagan Shuswap	15	134	94.4	1.38
Rocky Mountain	30	276	91.1	1.93
100 Mile House - mature pine	8	80	91.4	0.96
100 Mile House - young pine	5	50	99.5	0.02
Central Cariboo	5	50	94.5	0.60
Chilcotin	5	50	93.4	0.81
Totals/Averages - mature pine	152	1,444	92.2	1.51
Totals/Averages - young pine	22	217	98.7	0.63
Totals/Averages	**174**	**1,661**	**93.8**	**1.3**

Douglas-fir Beetle

Overwinter mortality sampling for Douglas-fir beetle was carried out in the Central Cariboo, Chilcotin, Quesnel, and 100 Mile House Districts.

Winter mortality (93.2%) and r-values (0.7) for Douglas-fir beetle point to a declining population in Quesnel Forest District. In 100 Mile House District, the r-value of 1.0 suggests a static to slightly decreasing population. Central Cariboo and Chilcotin had winter mortality of 66.4% and 67.5% respectively, which signify healthy beetle populations. The r-values for these two Districts were 3.8 and 3.4 respectively, again pointing towards increasing infestation levels (Table 2). However finding current attack in Central Cariboo was a difficult task suggesting that the overall population was dropping and that only when hot spot infestation centers were located, was the infestation indicating a viable population. Therefore in general, the trend in Quesnel, Central Cariboo, and 100 Mile House indicates a population collapse. The Chilcotin is still projected as continuing to have a vigorous increasing population.

Table 2. Percent mortality of Douglas-fir beetle progeny during the winter of 2008-2009, with associated r-values.

District or TSA	Number of Sites	Number of Samples	Average % mortality	Average R-Value
Central Cariboo	5	50	66.4	3.8
Chilcotin	7	70	67.5	3.4
100 Mile House	5	50	93.2	1.0
Quesnel	5	50	93.2	0.7
Totals/Averages	22	220	80.1	2.2

Summary of the Southern Interior Region 2009 Western Spruce Budworm Program

The western spruce budworm, *Choristoneura occidentalis*, continued to cause widespread defoliation across the Southern Interior Region in 2009 (Fig. 1). Although some areas saw decreases in area affected, defoliation and budworm populations remained high in the Kamloops and Okanagan areas. Predictive egg mass sampling was conducted throughout the region in the fall of 2008 with 270 sites sampled in the Kamloops area and 69 sites in the Okanagan. Approximately 27% of the sites visited in Kamloops predicted moderate or higher defoliation in 2009. The area of 2007 and 2008 mapped defoliation, the predicted defoliation levels for 2009, stand condition, and management goals were then used as key components for planning the spray program for 2009.

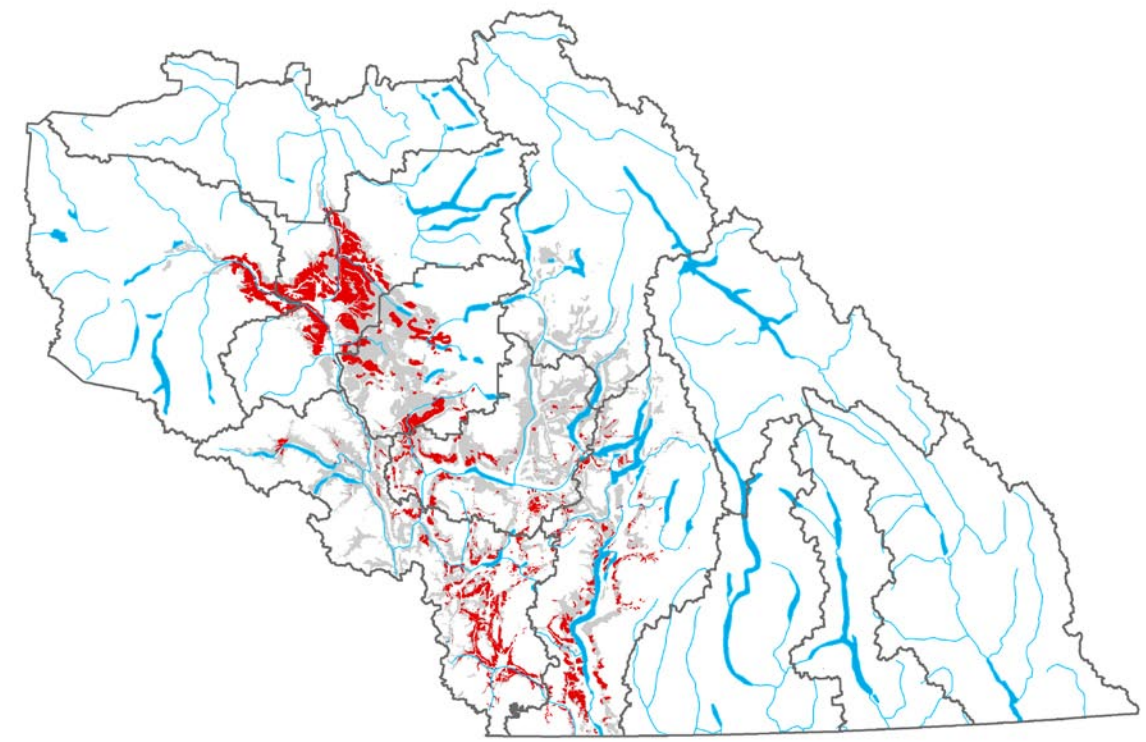


Figure 1. Area of 2009 western spruce budworm defoliation (766,225 ha) in the Southern Interior Region. Grey areas are historical defoliation from 1909 - 2008.

The B.C. ministry of Forests and Range (MFR) has an integrated management strategy for western spruce budworm which includes treatment with biological insecticides in areas where severe damage and tree mortality is predicted if budworm populations are not reduced. The product currently used is Foray 48B, active ingredient *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*). Foray 48B is now OMRI Listed (Organic Materials Review Institute). OMRI listed products may be used on operations that are certified organic under the USDA National Organic Program.

A number of criteria and public and private land issues are considered when determining sites for treatment. Probability and severity of damage, stand structure and density, species and age composition, short- and mid-term management goals, past forestry activities and operational opportunity or constraints, are all considerations for treatment.

Over the past two decades the MFR has treated between 400 ha to 73,000 hectares annually (Fig. 2). The impact of budworm on Douglas-fir, and other species, varies among ecosystems and among sites based on site, stand structure, climate and insect population density and dynamics. The western spruce budworm feeds primarily on buds and new growth; thus it typically takes a number of consecutive years of defoliation to kill or severely impact larger, older trees. In very severe outbreaks, larvae may "back-feed" on older foliage and cause more severe damage in one growing season. Impacts from budworm defoliation range from incremental growth loss (height and diameter) and top-kill to tree mortality. Smaller, often younger, understory and subdominant trees in a stand are the most greatly impacted due to larvae "raining" from the overstory component onto the understory trees and causing a disproportionately higher number of insects feeding on them.

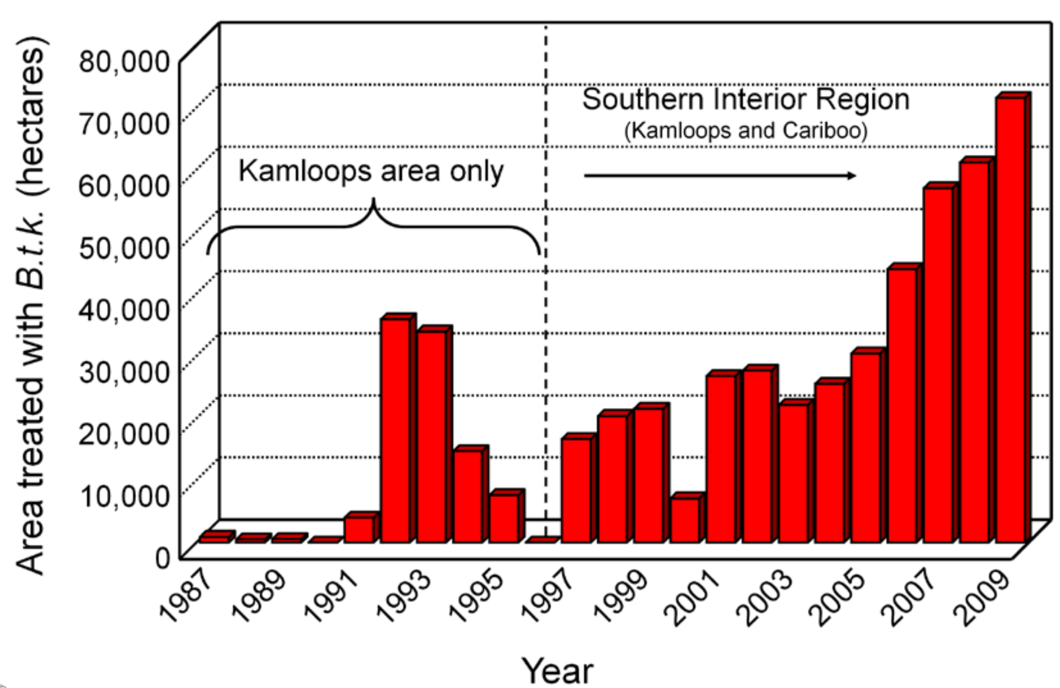


Figure 2. Area treated with *B.t.k* to reduce impact from western spruce budworm in the Kamloops and Cariboo portions of the Southern Interior Region (1987-2009).

2009 Treatment

Approximately 73,000 hectares throughout the Southern Interior Region (Table 1) were identified as high priority for treatment in 2009 with Foray 48B® (*B.t.k.*) based on the criteria outlined above. The program was divided equally between the Cariboo and Kamloops areas, with some young Douglas-fir stands treated in the Chilliwack Forest District in the Coast Forest Region (Table 1). In addition to forestry concerns on Crown land, numerous private landowners and woodlots contacted the Forest Service about the budworm outbreak. Many formal and informal public meetings and information sessions were held to formulate an action plan, which would address both the budworm and Douglas-fir tussock moth (see Douglas-fir tussock moth section) outbreaks. The areas treated in 2009 for budworm are shown in Table 1 and Figures 3a and 3b.

The Ministry of Environment was notified of the MFR's "Intent to Treat" under the "Southern Interior Forest Region Pest Management Plan for Forest Health", Pesticide Use Number 738-009-2008/2013. A Spruce Budworm Consultation letter was sent out to all First Nations that might be affected by the 2009 spray program and meetings were held with interested Bands.

A total of 177,651 litres of Foray 48B (*B.t.k.*) was received from Valent Bioscience at a cost of $7.72 per litre (total cost $1,364,000). The *B.t.k.* was delivered in tanker trucks (±16,700 litres/tanker), mini-bulks (1,000 litres/bulk) and drums (200 litres/drum). Application rate for western spruce budworm is 2.4 litres per hectare at 80 micron mean droplet diameter. Advertisements were placed in local newspapers advising of the spray program and pesticide use signs were posted on all blocks prior to treatment.

The Cariboo spray operations were staged from the Williams Lake airport (5 days) and the 108 Mile House Airport (4 days). Ministry of Forests Protection acted as the aerial spray contractor using Conair with two AT-802F Air tractors. A total of 20 blocks were treated between June 20-28 2009, the blocks ranging in size from 173 hectares to 7,388 hectares. Application cost per ha was $4.08/hectare for the Cariboo program. The aerial spray contractor for the Kamloops and Chilliwack portions of the spray program was Western Aerial Applications Ltd., which used two 315B Lama helicopters and two Hiller UH12ET helicopters. The helicopters were loaded and fuelled at staging sites on or near spray blocks to minimize turn-around times. In the Kamloops program there were 24 blocks with 11 staging sites and 20 weather monitoring sites. Spray blocks ranged in size from 567 hectares to 2,934 hectares. Treatment commenced at first light (4:40 am) if weather conditions were suitable, and continued until conditions deteriorated (wind, low humidity or rain) on June 13 and June 20-26th, 2009 (Table 1). Application cost was $10.22/hectare for the Kamloops program, and $28.00/hectare for the Chilliwack program.

The treatment significantly decreased the populations of the western spruce budworm in the treated stands thus mitigating damage.

315B Lama taking off from staging site (left) near Kamloops and UH12ET Hiller spraying *B.t.k.*

Table 1. Hectares of western spruce budworm sprayed with Foray 48B® (*B.t.k.*) in 2009, by area, showing hectares treated, litres *B.t.k.* applied and treatment dates.

Location	Hectares sprayed	Litres *B.t.k.*	Treatment Dates
Kamloops	37,038	88,891	June 13; 20 - 26
Cariboo	34,478	82,747	June 20 - 28
Coast Region, Chilliwack District	1,474	3,538	June 24 - 27
Total	72,990	175,176	

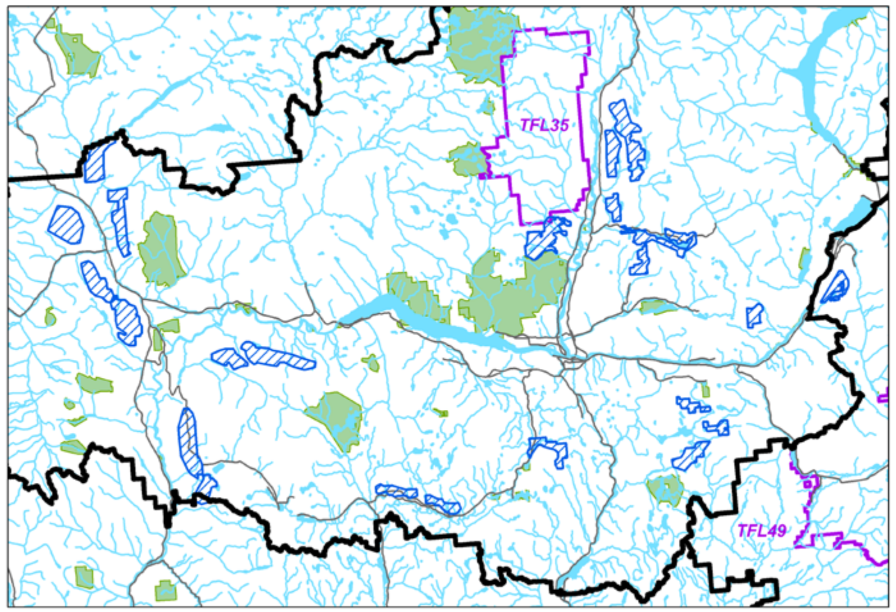


Figure 3a.

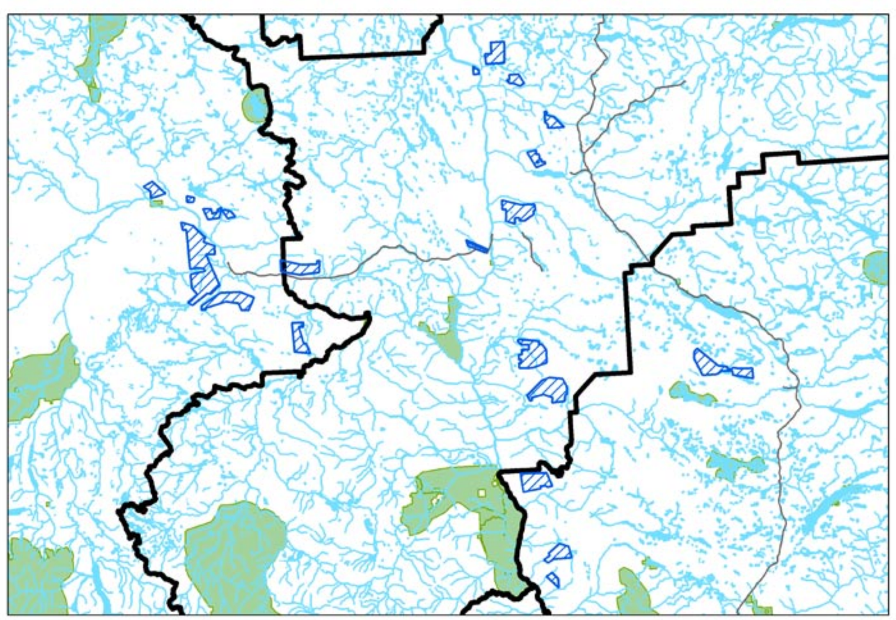


Figure 3b

Figure 3a and 3b. Spray blocks in the Kamloops (3a) and Cariboo (3b) portions of the SIR treated with *B.t.k* in 2009 to reduce impact from western spruce budworm defoliation.

Western spruce budworm projections for 2010

Western spruce budworm remained widespread across the Region in 2009, with 759,591 hectares defoliated (Fig. 4). The total area defoliated by this insect has been extremely high for the last few years, with over 750,000 hectares mapped annually since 2006 (Fig. 4). 2009 saw a slight decline in some parts of the Cariboo (100 Mile House) and a substantial decrease in the Kamloops area, in large part due to the aggressive spray programs in 2008-09. However, the outbreak is still expanding and moving through new areas in the Chilcotin Forest District and parts of the south, notably the Lillooet, Merritt and Okanagan TSA's (Table 2; Fig. 5). The most notable increases were observed in the Okanagan Shuswap District and Cascades District where we saw a 10-fold and 30-fold increase in moderately defoliated stands, respectively, from 2008 levels (Table 2; Fig. 5). There was a 13-fold increase from 2008 of moderately defoliated stands in the Kamloops District; however, overall mapped defoliation decreased by over 40% in 2009 (Table 2; Fig. 5). This decline will continue in 2010 as egg mass counts in areas throughout the Kamloops District (Table 3) were mostly of low severity.

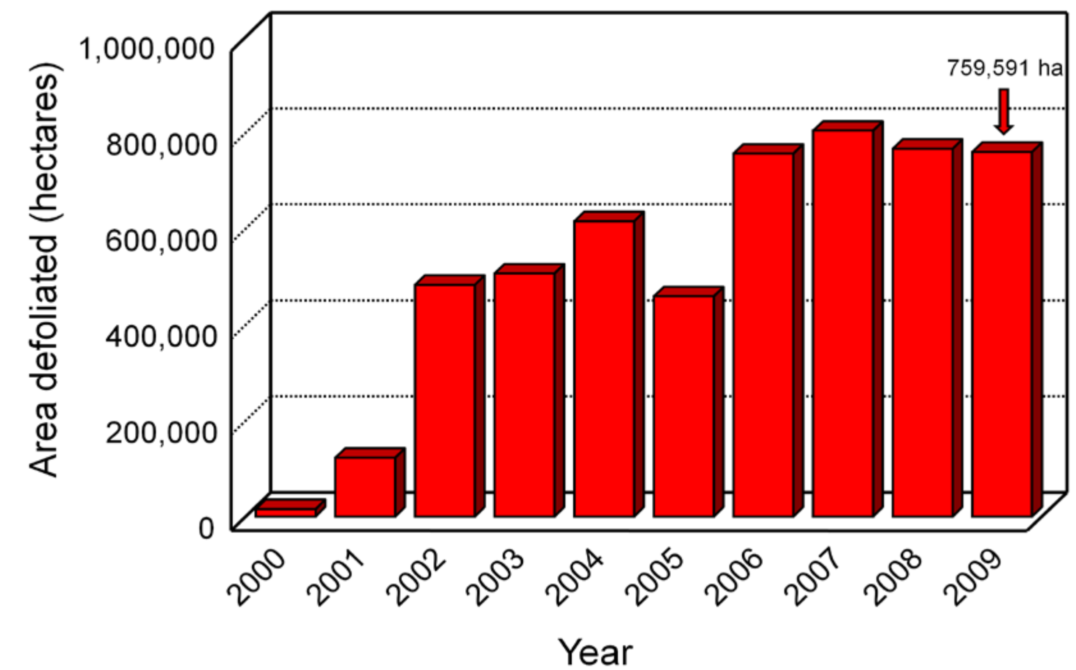


Figure 4. Annual defoliation by western spruce budworm in the Southern Interior Region, 2000-2009.

Table 2. Summary of area defoliated by the western spruce budworm in 2009, by severity, showing the percent change in hectares mapped from 2008 to 2009.

Forest	2009 defoliated area (hectares)				% change in defoliation
District	**Light**	**Moderate**	**Severe**	**Total**	**2008 to 2009**
Central Cariboo	218,579	28,812	2,646	250,037	+18.0%
Cascades	96,878	56,894	979	154,751	+21.0%
Okanagan Shuswap	101,522	19,536	326	121,383	+63.1%
100 Mile House	93,343	6,548	0	99,891	-42.8%
Kamloops	61,903	7,713	476	70,091	-43.8%
Chilcotin	38,693	20,027	2,030	60,750	+48.4%
Quesnel	2,558	0	0	2,558	+21.0%
Headwaters	93	0	0	93	-95.9%
Kootenay Lake	0	36	0	36	Slight increase
Total	**613,568**	**139,566**	**6,457**	**759,591**	

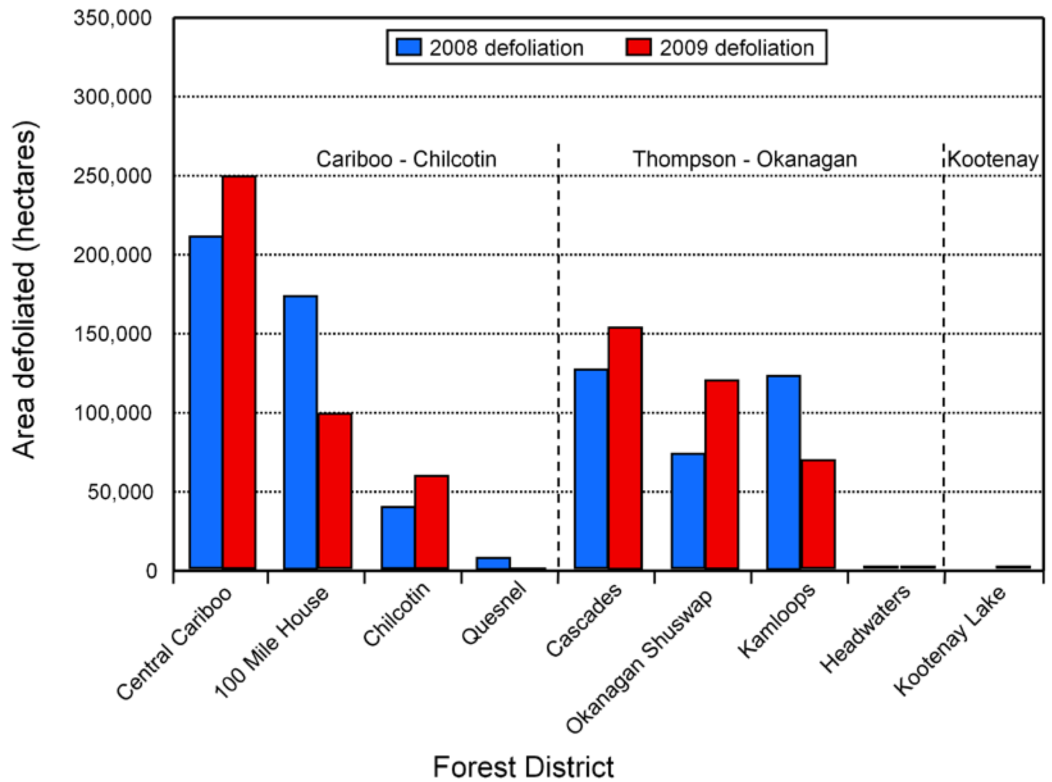


Figure 5. Total hectares of western spruce budworm defoliation mapped in 2008 and 2009 in nine Districts in the Southern Interior Region.

A total of 720 sites were sampled for budworm egg masses to predict potential defoliation in 2010 and plan control programs. Most sites indicate light to moderate defoliation for 2010, with higher populations of budworm in the Central Cariboo, Cascades and Okanagan Shuswap Districts (Table 3). Over 20% of sites visited in the Kamloops portion of the Southern Interior Region have increasing budworm populations and will suffer moderate to severe defoliation (Fig. 6). The 2009 western spruce budworm egg mass surveys, combined with the past 2-3 years of defoliation records, stand structure and other factors such as land status and management objectives, will help determine the location of 2010 spray programs.

Table 3. Summary of 2009 western spruce budworm egg mass sampling in the Southern Interior Region, showing 2010 defoliation predictions.

Forest	**# of sites in each defoliation category**				**Total number**	**Average # egg**
District	**Nil**	**Light**	**Moderate**	**Severe**	**of sites**	**masses/10m² foliage***
Cascades	20	101	12		133	19.7
Kamloops	13	90	12		115	25.4
Okanagan Shuswap	17	170	90	4	281	42.8
100 Mile House	11	83	3		96	20.2
Central Cariboo	7	62	3	2	74	33.5
Chilcotin	10	10	1		21	11.2
Total	**78**	**516**	**121**	**6**	**720**	**30.8**
percent of sites	(11%)	(72%)	(17%)	(1%)		

*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

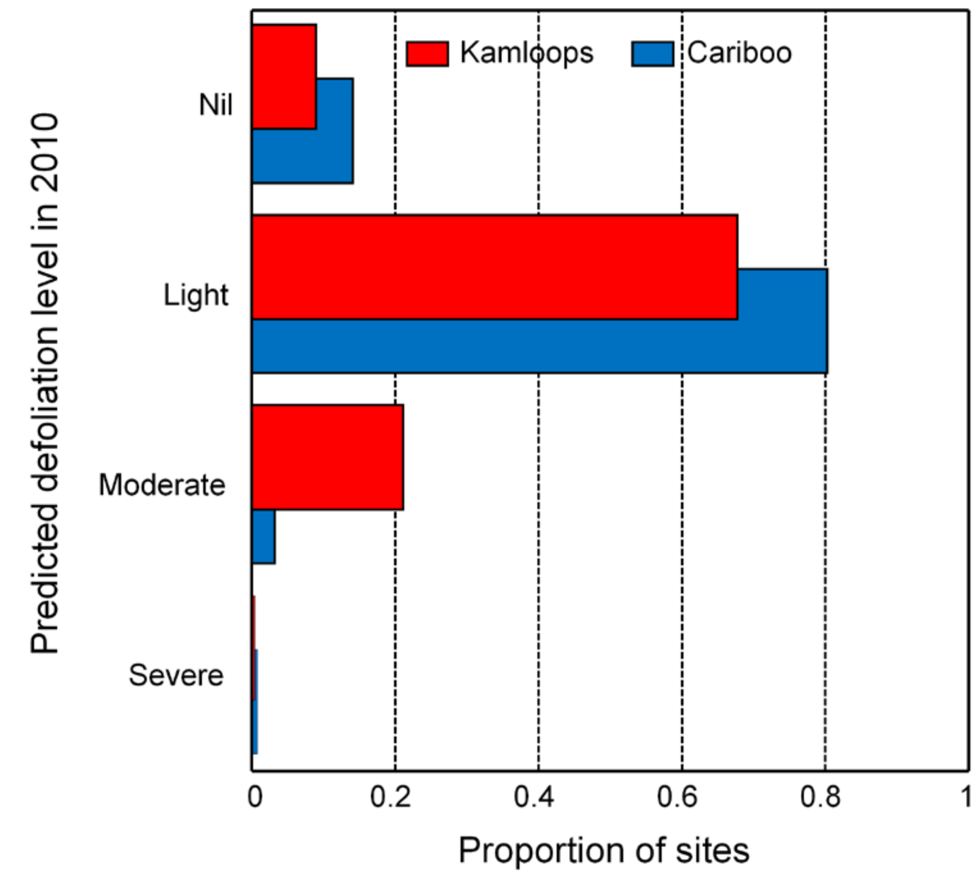


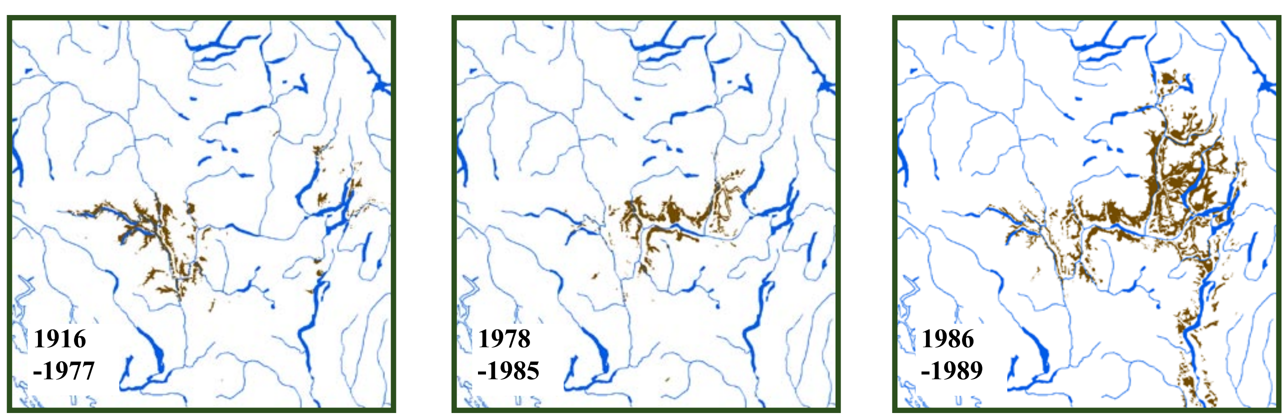
Figure 6. Comparison of the Kamloops and Cariboo portions of the SIR showing the number of sites sampled for western spruce budworm egg masses falling into nil, light, moderate or severe predicted defoliation categories.

Moderate western spruce budworm defoliation above Little Shuswap Lake, Kamloops Forest District.

Outbreak Trajectory

The budworm outbreak is following an interesting pattern in terms of spatial and temporal shifts. There is historical outbreak data from 1916 onward. The trajectory of past budworm outbreaks can be described in broad spatial terms and used to predict the path of the current outbreak. From 1916 to 1977 (Fig. 7), outbreaks were largely in the Lytton-Lillooet area, with scattered populations in the Adams Lake and Shuswap Lake area. The late 1970's to 1985 (Fig. 7) saw expansions primarily within the boundary of the Kamloops District with some movement south along Okanagan Lake (Fig. 7). The big expansion, still the largest to date, came during 1986-1989, when the outbreak encompassed the Lytton- Lillooet area; Kamloops District; north into Headwaters District; across Adams to Shuswap Lakes; and, south along Okanagan Lake to the U.S. border (Fig. 7). What is interesting in this large expansion along with prior outbreaks is that the budworm had not spread to the Merritt area or to any degree into the Cariboo, despite the availability of extensive, susceptible host trees. Between 1990-1994, there was a decline in the Kamloops District, but populations began to build in the northern portions of Merritt and Lillooet and intensified in the Okanagan Valley.

The next 15 years, 1995-2009 (Fig. 7), describe a potentially new and changing outbreak dynamic for the budworm. From 1995 through 2002 the budworm spread and intensified significantly in previously non-traditional areas: the Cariboo Chilcotin and 100 Mile House areas, as well as throughout the Douglas-fir types in Merritt, south to Princeton and Tulameen. From 2003-2005, the outbreak remained in these general geographic areas until 2006, when populations increased once again in historic areas around Kamloops, Lytton-Lillooet, and small populations started building in the Okanagan. The total area defoliated in 2007 (approximately 804,000 hectares), almost reached the high of 1987 which recorded over 821,000 hectares (within old Kamloops Region boundaries) of defoliation. The most recent years of the outbreak (2007-2009) have seen the budworm expand into most of the known historic areas albeit to different degrees of severity, primarily due to population dynamics, local host conditions, climate and control efforts. If historic patterns indicate trajectories of the population, the budworm should continue to expand into the south Okanagan and Adams-Shuswap areas, as well as the chronic areas of the Fraser canyon, while decreasing somewhat in the Cariboo Chilcotin. It will be interesting to monitor the progression of the population and determine if the budworm becomes established in these new areas.



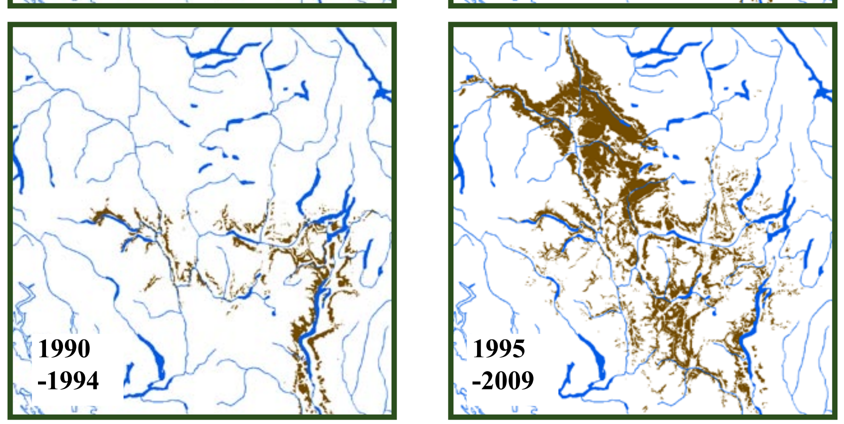


Figure 7. Seven maps showing the historic occurrence (in brown) of western spruce budworm defoliation in the southern interior of B.C. Maps from left to right show time sequences from 1916 to 2009.

Summary of the Southern Interior Region 2009 Douglas-fir Tussock Moth Program

The Douglas-fir tussock moth, *Orgyia pseudotsugata*, is a cyclical defoliator of Interior Douglas-fir that periodically erupts into localized outbreaks causing scattered to wider-spread tree mortality. This insect is typically first detected in very discrete patches in dry, hot, low elevation sites, often on private land. The tussock moth caterpillar and moth are covered in very irritating hairs that may cause allergic reactions in people, horses and dogs; and can even deter horses from grazing in pastures where there are severe outbreaks. Because of the eruptive nature of this insect, permanent trapping sites have been established in historic outbreak areas to give "early warning" of an impending outbreak (see "2010 Population Predictions" section). Each trapping site has 6 pheromone-baited traps. When the average number of moths per trap at any given site exceeds 20 moths, then an outbreak may occur within two years. Very small and discrete patches of defoliation by the Douglas-fir tussock moth were first noticed in July 2007 in the Barnhartvale-Robbins Range area and near Heffley Creek, and in a few other areas surrounding Kamloops.

Although only 88 hectares of defoliation were mapped in 2007, ground surveys conducted during the winter of 2007-2008 identified many areas that had high numbers of egg masses. As a result, 1,130 hectares were treated in early June 2008 with NPV (nuclear polyhedrosis virus) (Fig. 1). During the summer of 2008, many additional tussock moth outbreak areas were identified and numerous private landowners voiced their concern over the outbreak. Planning for the 2009 program involved cooperation with the Thompson Nicola Regional District, City of Kamloops and many private landowners. Public meetings were held in Heffley Creek, Rose Hill, and Osoyoos, and a large public forum was held on March 10, 2009, at the Interior Savings Centre in Kamloops. Approximately 300 people attended the public forum, with 96 residents signing the registry requesting follow-up communication and treatment on their land.

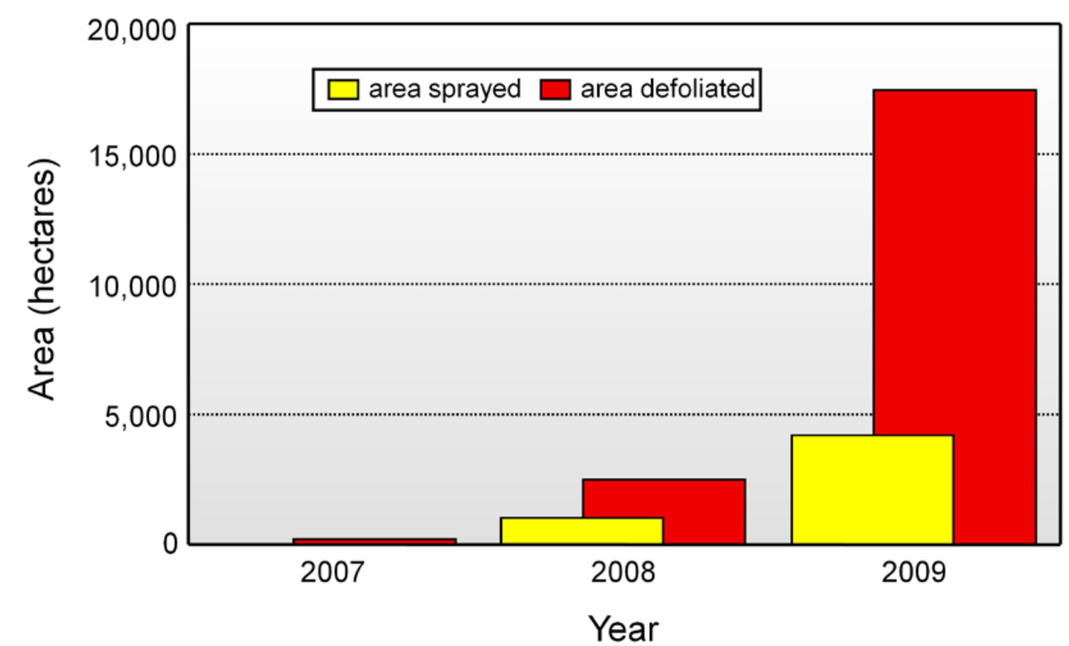


Figure 1. Area defoliated by Douglas-fir tussock moth and area sprayed with NPV, 2007-2009.

Program Planning

Planning a control (aerial spray) program for the Douglas-fir tussock moth (DFTM) is much more complex than for western spruce budworm for the reasons outlined below:

1. First, the eruptive nature of the insect means that for the most effective control, incipient populations should be found prior to any visible defoliation being noticed. This involves exhaustive ground searches for egg masses and since many outbreaks begin on private land means these populations will not be noticed until landowners actually see caterpillars or tree defoliation. Monitoring traps give us a warning of an impending outbreak; however, they do not pin-point a defined location, which must be done through egg mass sampling.
2. The nuclear polyhedrosis virus (NPV), either TM Biocontrol-1® or Virtuss®, PCP #19293 and #17786, respectively, is the Ministry of Forests & Range's (MFR) preferred pesticide against tussock moth. In areas where it is applied, the DFTM population will collapse and no further treatments will be required for the duration of that outbreak cycle. NPV is specific to tussock moths and does not affect other organisms. The only issue with using NPV is that it takes 5 or more weeks to take effect and during that time, larvae are still present and continue to feed in the treatment area. Therefore, severe damage to trees can occur and people will still encounter insects and may suffer allergic reactions.
3. The MFR has a strategy for managing the tussock moth, which includes treatment of private lands because of human health concerns and the potential for spread onto adjacent Crown forest land. The MFR uses NPV for controlling the tussock moth because it will cause the population collapse in the area where it is applied and therefore only one treatment is necessary. However, due to the slow-acting mode of action of the virus, this is often unacceptable to private landowners. Also, if trees have already been severely defoliated by one year of feeding, they require immediate and thorough protection the following year to minimize the chance of tree mortality. Therefore, other insecticides such as Foray 48B (*B.t.k.*) may be more appropriate in these circumstances.
4. The MFR prioritizes private lands for treatment based upon adjacency to Crown forest lands, area of private land portion, public health concerns (e.g. high recreation use properties are a high priority), severity of outbreak (insect density) and year of outbreak (e.g. NPV is most beneficial in years 1 and 2 of the outbreak cycle).
5. Smaller, non-contiguous parcels of private land are logistically difficult to treat aerially. Therefore, spray blocks are generally designed in larger, more uniform configurations.
6. All private land owners must give consent for treatment to occur on their land. If landowners request treatment, consent is implied. However, it is more common for the MFR to contact landowners for consent in the initial outbreak year because damage is not visible to the lay person. In order to delineate larger blocks for spraying, landowners who fall within potential treatment areas must also be notified and their consent obtained.

Table 1. List of landowners from title searches and public meetings that received information packages and numbers of landowners interested in the 2009 tussock moth spray program.

Landowner Contacts	Number
# landowners from land title searches	369
# landowners signed-up at public meeting	96
Total number of landowners	**465**
# letters mailed	97
# letters delivered door-to-door	210
Total # letters	**307**
# signed consent forms	65
# signed consent at public meeting	76
# verbal consent (phone and in-person)	34
# other consent types (petitions and emails)	55
Total # landowners expressing interest	**230**

The stages and elements of planning and implementing a control program for the Douglas-fir tussock moth are outlined in the following section. There are many small tasks that are not included in the list, but the major activities have been noted:

1. In July-August, conduct detailed aerial mapping of all patches of tussock moth defoliation. Some areas were ground checked during the mapping survey as there is a concurrent outbreak of western spruce budworm. In addition there can be defoliation by other insects as the false hemlock looper (*Nepytia freemani*), the western hemlock looper (*Lambdina fiscellaria lugubrosa*), and various species of conifer sawflies such as *Neodiprion* spp.
2. Collect and assess traps from 6-trap permanent trapping sites and singlet trapping sites. Trap catches are very reliable at predicting incipient outbreak conditions, but less accurate at predicting population trends during the outbreak collapse phase.
3. Conduct ground surveys (September - November) to locate and evaluate next season's tussock moth population level based on egg mass distribution, density and vigour (e.g. parasitism, virus). Sites with high levels of parasitism or virus may not need treatment as the population will collapse on its own.
4. Plot all defoliation and ground survey results on maps with other forest and land status information and draft preliminary spray blocks. Many areas may be near or on private land. Owners must be contacted if further action is proposed (e.g. surveys or spray).
5. In December-February, land status searches are conducted using Property Identifier Numbers (PID's) from maps covering areas of interest for the spray program. These PID's are used to conduct land title searches using BC Online to find landowner names and addresses. In reverse, landowners who had previously contacted the MoFR are put into the system to determine the location of their property in relation to proposed spray blocks.
6. Letters are mailed to landowners who fall within or are adjacent to proposed spray areas (Table 1). Landowners who had previously given consent via phone calls, emails, or attendance at public meetings were recorded on maps and in a database, and therefore do not require mail-outs. Landowners on the periphery of proposed spray blocks are also notified of the spray by way of posters and other media.
7. Information signs are posted in each of the areas where spraying is planned.

At the March 10, 2009 public meeting held in Kamloops, large laminated maps were supplied, showing private land boundaries, ownership and proposed spray blocks. This was a very successful tool as people could identify their property and easily discern if they were in or near a proposed treatment area. People wanting to be considered for inclusion in the program could then circle their property on the map and note their contact information. The next step was to ground-check new areas for inclusion into the spray plans. Spray blocks were delineated based on the combination of land status searches, door-to-door mail outs and public meetings, coupled with known priority areas on Crown forest land. The final step in public communication was to post signs in and near designated treatment areas, with small 8.5" x 11" maps of the specific geographic area and spray blocks. This activity elicited many additional calls and requests for inclusion within the treatment area. Amendments were made up to two weeks prior to spraying, at which time adjustments could no longer be made due to logistic constraints (mixing and preparation of the virus). No official records were kept of the total number of enquiries (including telephone, email, and drop-in) from concerned citizens. Figure 2 shows only the portion of enquiries by telephone voice mails and emails received by the Regional Entomologist, to give an indication of the volume of public enquiries. Regional Office front desk staff and other Forest Health staff in both the Region and in District offices, also fielded many queries, so these numbers underestimate the overall volume. July was the peak month for calls, because this was the time when larvae were prolific and consuming foliage.

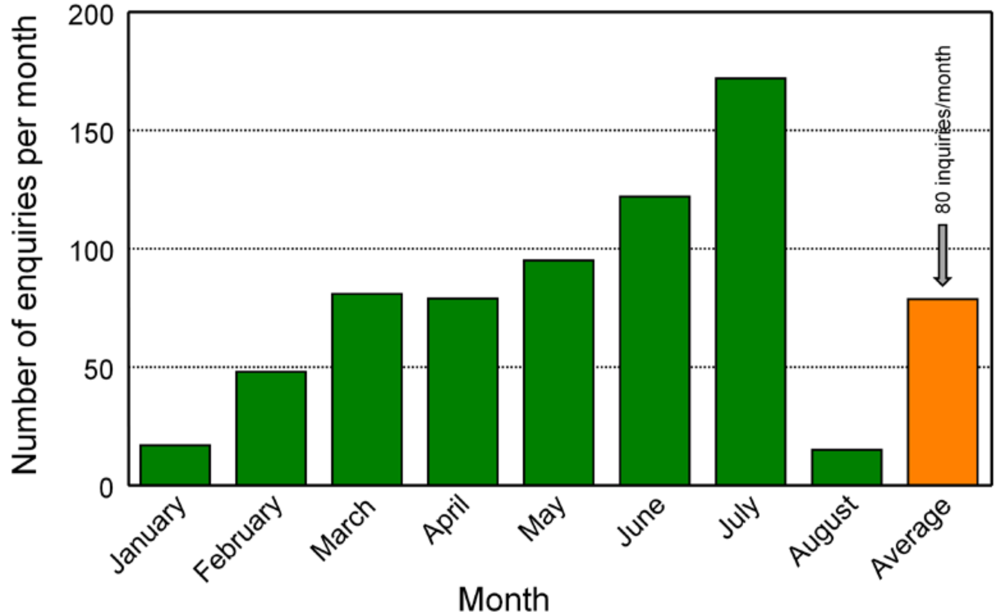


Figure 2. Estimated number of phone calls and emails received by the Regional Entomologist, from the general public regarding concerns due to Douglas-fir tussock moth between January and August 2009.

2009 Treatment

A total of 4,341.2 hectares were treated in 2009 with NPV (TM Biocontrol-1®). Areas were treated at the full dosage rate due to high insect densities (alternate swathing was done in one Pritchard block covering 22.3 ha). Approximately 60% of the area treated was on Provincial Crown land, with 38% on private land (Table 2). The Municipal Crown land was a forested Municipal Park within Kamloops city limits, directly bordering Provincial Crown Land to the south and the Juniper Ridge subdivision to the north.

Seven staging sites were used for the 2009 NPV spray and were located near Heffley Creek, Pritchard, Barnhartvale, Buse Lake, Lion's Head, Rose Hill and Stemwinder Provincial Park (Fig. 3). Forty-six 1,000 litre bulk containers were filled with water (±750 litres) and left for a few days to allow the chlorine to evaporate. Approximately two weeks before the estimated start-up date, molasses was added to the bulk containers (±400 kg per bulk, used as a "sticker"). The molasses and water mix was prepared at the Kamloops Fire Centre, where there was easy access to water and a forklift to move pallets of molasses and the bulk containers. The bulks containing the molasses and water mix were then moved to the staging areas, where sodium lignosulphonate was added 1-2 days before spraying (60 kg per bulk, used as a UV screen). Immediately prior to application, the virus was added to the mix, agitated and the final mix was aerially applied at 10 litres per hectare. Application occurred on May 27, May 30-31, and June 1-4, 2009. The aerial spray contractor was Western Aerial Applications Ltd. using two Hiller UH12ET helicopters equipped with simplex spray systems and Beecomist nozzles. All components of the spray mixture are OMRI (Organic Materials Review Institute) listed products that may be used on operations that are certified organic under the USDA National Organic Program.

Table 2. Area treated (hectares) in 2009 with NPV (nuclear polyhedrosis virus) in the Southern Interior Region.

Land Status	Area treated (hectares)	Mix volume (litres)	Virus (grams)	Proportion of spray area
Private	1,655.1	16,551	7,448.0	38.1%
Provincial Crown	2,624.0	26,240	11,808.0	60.4%
Municipal Crown	62.1	621	279.5	1.4%
Total	**4,341.2**	**43,412**	**19,535.4**	

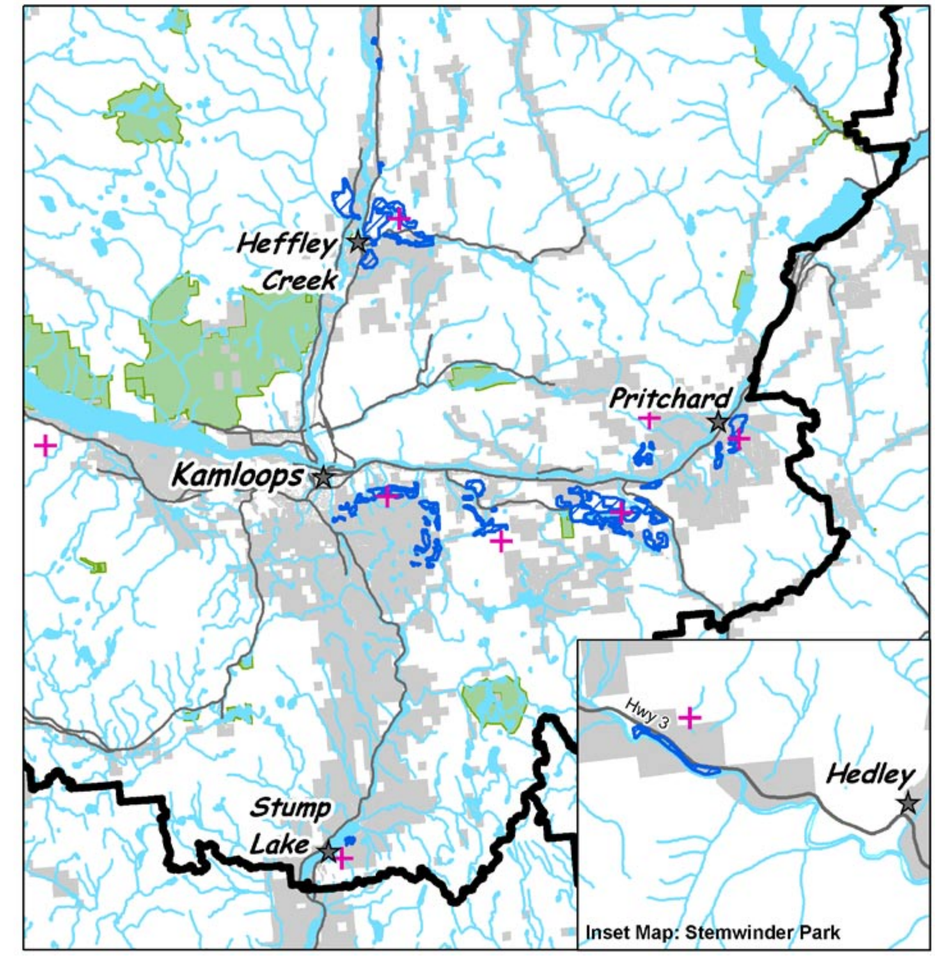


Figure 3. Map of 2009 Douglas-fir tussock moth control program areas, showing showing spray blocks, staging site locations, and private land (in grey).

Pre- and post-spray larval sampling was conducted in select areas (See low dose trial section of report) to assess the efficacy of the NPV program. Sampling was conducted the day prior to spraying and during the week of July 6-10, 2009. By July 22, the effect of the virus was widespread throughout all treatment sites (Fig. 4). A final walk-through of spray areas in the fall showed cocoons, but very few or no egg masses. The few egg masses found were very small. No defoliation is expected within the areas that were treated in 2009.

Although the virus treatment was effective in collapsing the population (Fig. 4), the larval density was so high in many of the sites that were treated, that severe defoliation and some scattered tree mortality occurred prior to the virus killing the larvae. A photograph taken July 15, 2009, of the Pritchard spray area (Fig. 5) shows an area of severe defoliation within the spray block, where severely high numbers of egg masses were located. High densities of larvae were present at the time, and even feeding on ponderosa pine (Fig. 5). However, by the end of July, very few larvae, cocoons and no egg masses were found. The Ministry of Forests and Range strategy for using virus states that it is most effective in building or light-to-moderate populations. The 2009 results emphasize that although the outbreaks have been terminated in areas treated, some site specific, severe damage still occurred. If possible, in future years, both NPV and *B.t.k.* (at 4 litres per ha applied once or twice during the feeding period) should be considered. *B.t.k.* would be a better option on private lands where high egg mass densities are present and some defoliation has already occurred.

Water and molasses mixture being prepared at the Kamloops Fire Centre.The large containers are the 1,000 litre bulks used to hold the spray mixture, and the white buckets are some of the 14,000 litres of molasses that was hand-mixed into the water.

Figure 4. Examples of Douglas-fir tussock moth larvae infected with NPV. Larvae typically catch on foliage and “droop” before falling from the tree.

Figure 5. Severe defoliation and tree mortality occurred even on sites where NPV was applied. Upper Left: severely defoliated trees. Upper Right: aerial view of Pritchard sprayed with NPV, six weeks post-spray. Middle left - high larval densities on a Douglas-fir. Middle right: tussock moth larva feeding on ponderosa pine. Lower left: tussock moth cocoons. Lower Right: Douglas-fir tussock moth egg mass.

Detailed aerial surveys were conducted on July 15th and 17th to delineate the 2009 defoliation caused by the tussock moth and the results were used to augment the aerial overview surveys. The 2009 mapping delineated 3,840 hectares light, 6,333 hectares moderate, and 7,340 hectares severe, for a total of 17,512 hectares of defoliation in the Kamloops, Okanagan Shuswap and Cascades Forest Districts (Fig. 6).

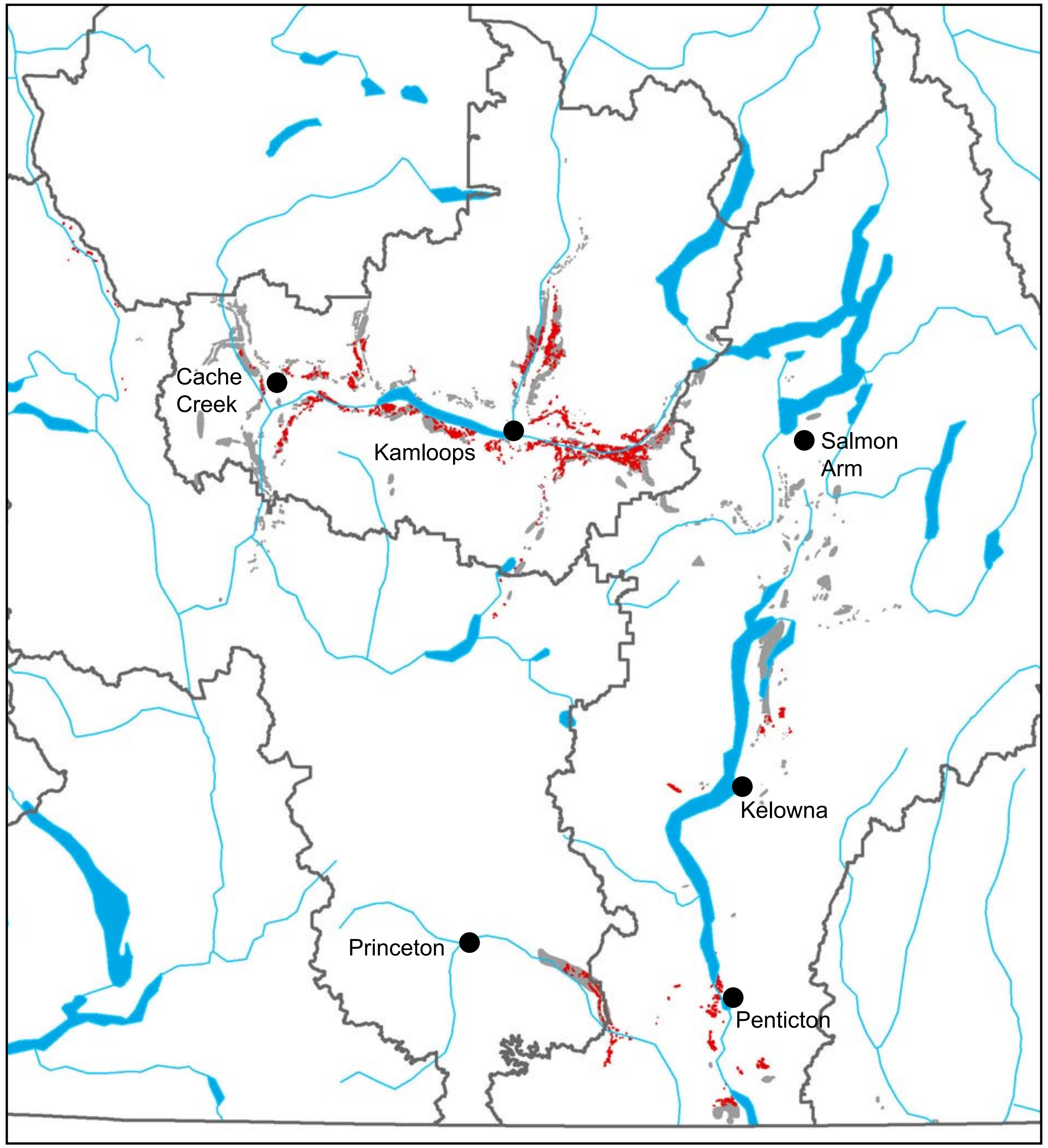


Figure 6. 2008 - 2009 defoliation by Douglas-fir tussock moth (red) overlaid on areas of historic defoliation (1916 - 2007, in grey).

2010 Population Predictions

Moth catches at the 21 permanent 6-trap monitoring sites in the Kamloops, Cascades, and Okanagan Shuswap Districts declined at most locations, although catches increased at the Wood Lake and Spences Bridge sites (see the "Regional Overview" section of this report, and Fig. 7). In most areas, trap catches at supplemental single trap sites declined, although catches remained high at a few individual sites, and increased in the Lillooet TSA. Additional six-trap clusters set up at 30 sites in the 100 Mile House District generally caught low numbers of moths, averaging 3.8 per trap; however, catches increased at several sites, which indicates building populations and the possibility of defoliation in coming years. In the Arrow Boundary District, nine more three tree beating and 6-trap cluster pheromone trapping sites were established to augment the annual monitoring program No Douglas-fir tussock moth larvae were collected at these new sites in 2009, and trap catches were low, averaging less than one moth per trap.

During September and October 2009, ground surveys were conducted to delineate areas of viable tussock moth populations by quantifying egg mass densities. Sites throughout the south Okanagan and Kamloops were surveyed. A total of 2,839 locations were checked for egg masses. Of the 334 sites surveyed near Kamloops, many sites had no viable egg masses (55% of sites visited) or very low populations due to the widespread application of NPV in 2008 and 2009. The highest concentrations of viable egg masses were located in the Kelowna area and west of Kamloops near Ashcroft and Spences Bridge (Table 3).

Table 3. Number of sites surveyed for Douglas-fir tussock moth egg masses in six broad geographic areas, showing predicted 2010 defoliation levels.

	Number of sites surveyed/predicted 2010 defoliation					
	Nil	Cocoons only	Low	Moderate	Severe	Total
Kamloops	186	55	84	9	0	334
Kelowna	362	142	363	87	100	1,054
Kootenays	48	22	44	6	2	122
Penticton/Hedley	267	34	56	2	0	359
Spences Bridge/Savona	298	48	218	98	308	970
Total	**1,161**	**301**	**765**	**202**	**410**	**2,839**

Left photograph: a new, viable Douglas-fir tussock moth egg mass (on the left) and an old, previously hatched egg mass (on the right). Right photograph: many coccoons on branches with no visible egg masses, indicating NPV-caused mortality during the pupal stage.

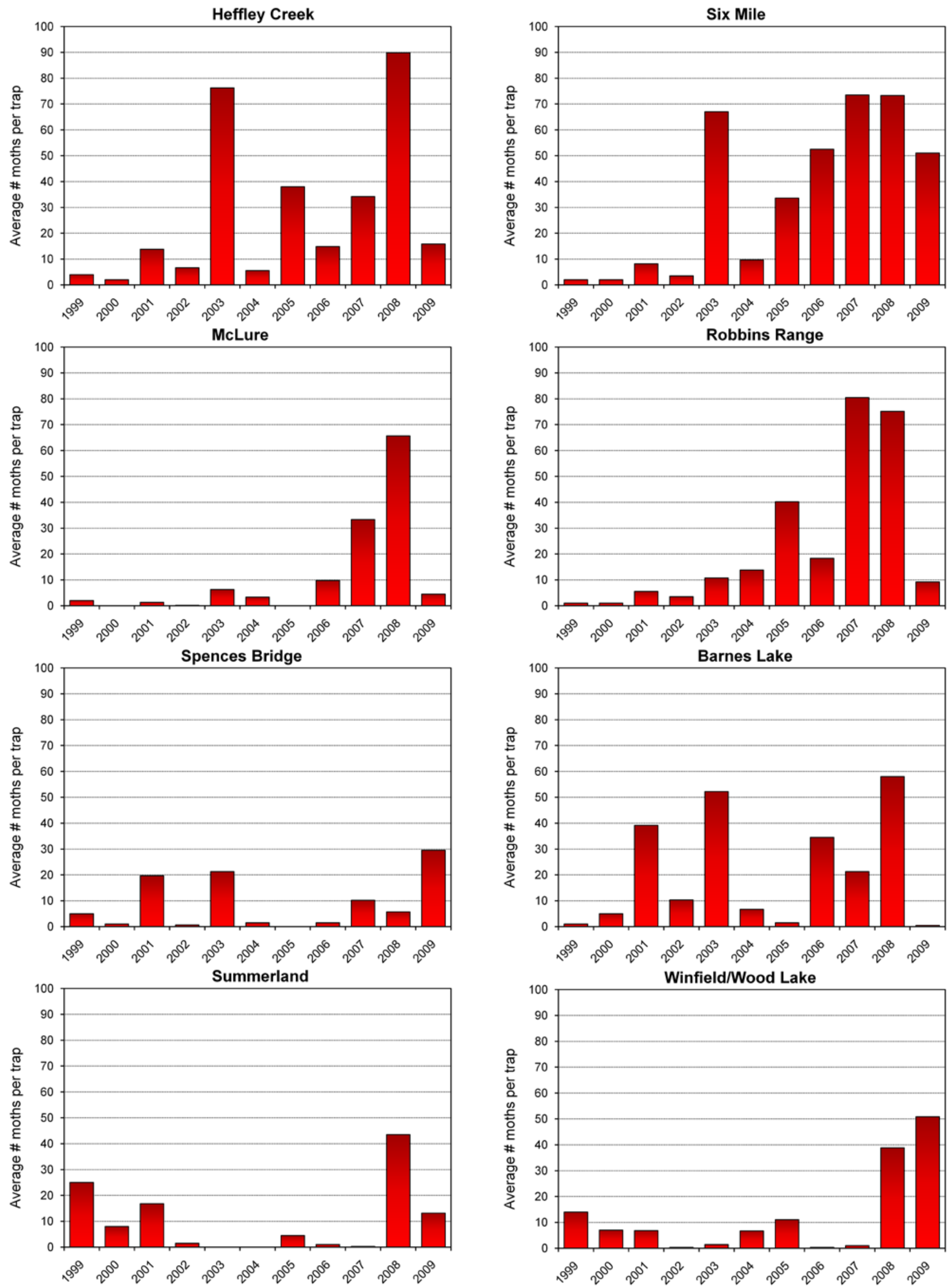


Figure 7. Graphs of 6-trap Douglas-fir tussock moth average annual trap catches (1999-2009) at eight locations in the SIR.

Effectiveness of Low-Dose Application Rates of TM – Biocontrol-1, the Natural Virus of the Douglas-fir Tussock Moth

Dr. Lorraine MacLauchlan, B.C. Ministry of Forests, Southern Interior Region, Kamloops, B.C., Canada
and
Iral Ragenovich, USDA Forest Service, Pacific Northwest Region, Portland, OR, USA

Collaborators/Industry Partners:
Imre Otvos, Canadian Forest Service, Victoria, B.C., Canada
Richard C. Reardon, USDA Forest Service, Forest Health Technology Enterprise Team, Morgantown, WV, USA

Objective and Background

The objective of this trial was to evaluate the effectiveness of low-dose application rates of TM-Biocontrol-1, the natural virus of the Douglas-fir tussock moth (DFTM). If lower dosage rates prove to be as effective as the adjusted registered rate, this would significantly extend the supply of this limited resource.

DFTM outbreaks occur on a periodic cycle throughout the western U.S. and B.C., causing significant defoliation of Douglas-fir and true firs. One of the recommended and most environmentally acceptable suppression options for DFTM is the naturally occurring nuclear polyhedrosis virus (NPV). The virus was produced for a limited amount of time in both the U.S. and Canada, and was registered under the trade names of TM-Biocontrol-1 and Virtuss, respectively. Approximately 400,000 acre (161,874 hectare) doses of TM-Biocontrol-1 were produced in the U.S. between 1980 and 1992, at which time the production facility was closed. The processed TM-Biocontrol-1 has been maintained in a freezer storage facility since 1992, and has been used on DFTM outbreaks periodically over that time. Along with a very small amount of Virtuss and TM-Biocontrol-1 currently stored in B.C., it is the only available supply of DFTM virus.

Shelf-life studies on TM-Biocontrol-1 conducted by Dr. Imre Otvos of the Canadian Forest Service, from 1999-2001, showed that although the virus is still viable, the potency has decreased (Kukan and Otvos, 2001; Otvos et. al. 2006). The shelf-life studies showed that it was necessary to increase the amount of TM-Biocontrol-1 applied in order to achieve the equivalent viability and resultant larval mortality of fresh NPV virus. Numerous DFTM populations in the U.S. and B.C. have been treated with Virtuss or TM-Biocontrol-1 since the mid-nineties, including the most recent 2009 project in B.C. (4,341 hectares treated). Between recent project uses and the reduced potency from storage over time, there now remains less than 70,000 acre (29,165 hectares) doses of TM-Biocontrol-1 and the supply of Virtuss is gone.

Otvos et. al. (1987a) conducted a test comparing the recommended dose rate; one-third the recommended rate; and, one-sixth the recommended rate, with the conclusion that the 1/3 recommended rate appeared to be as effective as the recommended application rate. Maclauchlan et. al. (2009) compared stored virus, alternate swath application and low dosage rates of Virtuss and TM-Biocontrol-1 in the 1991-1993 DFTM outbreak. These trials were successful but the low-dose trials, although showing promise, were inconclusive as the trials were conducted in the declining year of the outbreak. The current project was conducted to validate the results of these previous tests, taking into consideration the reduced potency of the NPV over time.

Methodology

Douglas-fir tussock moth populations are currently in outbreak in the Southern Interior Region. The 2009 low-dose trial was conducted to verify and test the effectiveness of applications of the virus at reduced dosage rates in conjunction with already planned operational suppression projects. The trial was a replicated study comparing reduced rate(s) of virus to the recommended adjusted rate. Lot 7 of TM-Biocontrol-1 was used. The labeled application rate for Lot 7 was 0.79 g/hectare. The adjusted registered application rate for this Lot, based on the shelf life studies, was 3.08 g/hectare. Blocks were all approximately 15 hectares in size, separated by a suitable distance and replicated three times (Table 1). Treatments included applications at the current full dose rate, referred to as the registered rate but adjusted based on the shelf life studies; ½ the adjusted registered rate; ¼ the adjusted registered rate; and an untreated control.

Table 1. Low-dose TM-Biocontrol-1 trial listing dosage rate, block number, block size (hectares) and geographic location.

Treatment	Block #	Block Size (ha)	Location
1/4 rate	I3	14.9	Lions Head
1/4 rate	I4	15.2	Lions Head
1/4 rate	I5	15.4	Lions Head
1/2 rate	I1	15.4	Lions Head
1/2 rate	I2	14.7	Lions Head
1/2 rate	I6	15	Lions Head
Registered rate	RR1*	169.6	Juniper Ridge
Registered rate	RR2*		Juniper Ridge
Registered rate	RR3	46.9	Juniper-Rose Hill
Control - no treatment	C1	15	Six Mile area
Control - no treatment	C2	15	Six Mile area
Control - no treatment	C3	15	Six Mile area

*RR1 and RR2 were separate plots, however, logistically it was expedient to treat the larger contiguous area rather than carve out the two separate 15 hectare plots.

Fifteen sample trees were established in each of the treatment blocks, selected on presence of visible egg masses. Pre-spray larval sampling was conducted once larvae had emerged and dispersed from the egg masses (June 1-4, 2009). An average of 15 - 30 larvae were collected from each sample tree in each plot and sent to the Canadian Forest Service, Pacific Forestry Centre (PFC) lab, for rearing and natural virus level determination. Post-spray larval sampling was conducted 5 weeks after virus application (July 6-9, 2009). Similarly, post-treatment larvae were collected from sample trees and sent to PFC for rearing and to determine both natural mortality, and mortality caused by the operationally applied virus. Pre- and post-spray larval sampling was conducted as follows:

1. Two branches were cut from opposite sides of each sample tree from mid-crown, using pole pruners equipped with baskets (approx. 45 cm branch tips).
2. Each branch tip and contents of the basket were emptied onto a tarpaulin, and branch length and average width were recorded to determine foliar area.
3. Defoliation estimates were made – current year defoliation (Fettes 1950), total tree defoliation (to nearest 5%), and top kill (metres).
4. The number of larvae in each sample was counted and recorded.

Spray staging sites were located near the Lions Head and Juniper Ridge blocks. 1,000 litre bulk containers were filled with water and left for a few days to allow the chlorine to evaporate. Molasses was added to the bulk containers, and then they were trucked to the staging sites. Sodium lignosulphonate was added 1-2 days before spraying (used as a UV screen). Immediately prior to application, the virus was added to the mix, agitated and the final mixture was aerially applied at 10 litres mix per hectare. Application occurred on June 4, 2009, at first light (approx. 4:45 am). Conditions were calm and average relative humidity was 75%. The aerial spray contractor was Western Aerial Applications Ltd., using a Hiller UH12ET helicopter equipped with a simplex spray system and Beecomist nozzles. The spray tank and booms were rinsed well prior to application lof the Lot 7 reseach virus.

Hiller UH12ET taking off from a staging area at dawn.

Collecting branch samples using pole pruners.

Larval sampling.

Results and Discussion

Population Monitoring/Larval Sampling: Pre-spray larval density ranged from 209 larvae/m^2 to 561 larvae/m^2 (Table 2). Due to differences in elevation and aspect among blocks the larval development varied. On average, the Lions Head reduced rate blocks and Six Mile control blocks (I1-I6 and C1-C3) were more advanced than the Juniper-Rose Hill registered rate blocks (RR1-RR3). The larvae at Juniper-Rose Hill were barely off the egg masses when treated, whereas at the other sites the larvae were feeding and comprised a mix of 1st and 2nd instars. Therefore at the post-spray sampling 5 weeks after treatment, the larvae in the registered rate blocks were less advanced than in other blocks, and less had been killed by the virus.

The larval mortality was lowest in the control blocks, ranging from 24% to 37% (Table 2). There was little difference in larval mortality between the ¼-rate and ½-rate treatments, averaging 88% and 83% respectively (Table 2), with the registered rate mortality slightly lower on average at 65%. This could be a result of the earlier larval stage when the virus was applied or an interaction of western spruce budworm feeding on these blocks. Budworm were actively feeding for a longer period of time in the registered rate blocks and therefore would have consumed some of the virus deposit which was targeted at DFTM. A similar trend was seen when Abbott's corrected % mortality was calculated with the highest mortality at 5 weeks post-application observed in the ¼-rate blocks.

Table 2. The number of live DFTM larvae per m^2, percent larval mortality and Abbott's corrected percent mortality, by block. Post spray sampling was 5 weeks after treatment.

NPV Application Rate	Block Number	Live larvae per m^2 Pre-spray	Post-spray	% Larval mortality	Abbott's corrected % mortality
1/4 rate	I3	268.7	31	82.0%	76.4%
1/4 rate	I4	208.9	13.6	91.4%	87.6%
1/4 rate	I5	561.1	32	90.0%	84.1%
Average of 1/4 rate		**346.2**	**25.5**	**87.8%**	**82.7%**
1/2 rate	I1	389.1	69.4	79.3%	72.7%
1/2 rate	I2	356.3	17.7	91.4%	87.7%
1/2 rate	I6	356.9	69.6	78.2%	65.3%
Average of 1/2 rate		**367.4**	**52.2**	**83.0%**	**75.2%**
Registered full rate	RR1	318.8	76.7	58.5%	45.4%
Registered full rate	RR2	299.6	68.7	71.1%	58.4%
Registered full rate	RR3	228.6	68.3	64.7%	43.7%
Average of full rate		**282.3**	**71.2**	**64.8%**	**49.2%**
Control - no treatment	C1	317.8	145.7	23.9%	
Control - no treatment	C2	238.9	113.7	30.5%	
Control - no treatment	C3	329.2	139.2	37.2%	
Average of no treatment		**295.3**	**132.9**	**30.5%**	

Defoliation Assessments: A defoliation assessment was conducted for each sample branch using the Fettes scale, which ranges from 0 (no defoliation) to 7 (100% defoliation with bud destruction). The registered full rate blocks (RR1-RR3) had the highest Fettes rating at the pre-spray sampling time (Table 4). Much of this defoliation is attributed to western spruce budworm feeding, as the DFTM larvae were still dispersing from the egg masses at the time of pre-spray sampling. The ½-rate blocks at Lions Head had the lowest overall Fettes rating at the pre-spray sampling. However, the lowest defoliation at post-spray was seen at the Registered Rate blocks (Table 3). Due to the time needed for the virus to affect the larvae, defoliation levels are often not affected, as seen by these assessments.

Mortality From Virus: Pre- and post-spray larvae from each plot were reared to determine levels of naturally occurring virus and mortality that could be attributed to treatments. Table 4 shows the percent of pre- and post-spray larval mortality attributed to the virus, however, statistical analysis has not yet been done on the data so the table can only be used to show relative percentages. Naturally occurring virus was present in all plots. The trend shows the percent of larvae killed by virus increased as the dose increased. Whether there is significant difference among treatments still needs to be determined. The difference in the results virus caused mortality in reared larvae, and the mortality determined from the larval sampling may be explained by the fact that the larvae in the full rate application plots were in an earlier stage of instar and at 5 weeks post-spray the virus had not spread through the population to the same degree as the plots with more advanced populations. There was very little difference overall in the percent larvae killed by virus between the ¼-rate, ½-rate and Registered rate, at 56,7%, 63.3% and 66.9% mortality, respectively.

By July 22, a walk-through of all areas showed the effect of the virus was widespread throughout all treatment sites. A final walk-through of spray areas in the fall showed cocoons widespread but very few or no egg masses. Unfortunately, I1, I2 and I3 blocks at the Lions Head site were destroyed by a wildfire in August 2009, so no further assessment is possible on those sites.

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Table 3. Average Fettes* defoliation by block and treatment at the pre-spray and post-spray sampling times. Post spray sampling was 5 weeks after treatment. The overall average Fettes defoliation for each dosage rate is shown in bold.

NPV Application Rate	Block Number	Average Fettes* Rating Pre-spray	Post-spray
1/4 rate	I3	1.37	6.41
1/4 rate	I4	1.97	6.47
1/4 rate	I5	1.2	6.60
Average of 1/4 rate		**1.51**	**6.41**
1/2 rate	I1	0.10	5.40
1/2 rate	I2	1.60	6.23
1/2 rate	I6	2.10	5.13
Average of 1/2 rate		**1.26**	**5.59**
Registered full rate	RR1	1.64	5.27
Registered full rate	RR2	1.60	5.97
Registered full rate	RR3	2.03	5.37
Average of full rate		**1.76**	**5.53**
Control - no treatment	C1	1.10	5.63
Control - no treatment	C2	1.47	5.20
Control - no treatment	C3	1.30	5.63
Average of no treatment		**1.29**	**5.49**

*Fettes scale of defoliation: 0 (no defoliation); 1(1-20% defoliation); 2 (20-40%); 3 (40-60%); 4 (60-80%); 5 (80-99%); 6 (100%); 7 (100% defoliation with bud/shoot destruction)

Table 4. Percent mortality of field-collected DFTM larvae caused by both naturally occurring and operationally applied NPV (TM BioControl-1). Results show the percent of reared larvae that were killed by virus at sites receiving applications of ¼-rate, ½-rate, and the full registered rate, and sites that received no operational treatment (controls). Post spray sampling was 5 weeks after treatment.

NPV Application Rate	Block Number	% larvae reared killed by virus Pre-spray	Post-spray
1/4 rate	I3	8.4%	51.0%
1/4 rate	I4	8.8%	59.3%
1/4 rate	I5	4.2%	61.0%
Average of 1/4 rate		**7.4%**	**58.6%**
1/2 rate	I1	23.3%	63.7%
1/2 rate	I2	10.5%	65.9%
1/2 rate	I6	5.4%	62.1%
Average of 1/2 rate		**14.7%**	**63.3%**
Registered full rate	RR1	8.1%	78.9%
Registered full rate	RR2	6.0%	66.5%
Registered full rate	RR3	4.1%	52.2%
Average of full rate		**5.6%**	**66.9%**
Average of all treated		**8.9%**	**63.2%**
Control - no treatment	C1	6.8%	12.8%
Control - no treatment	C2	20.9%	5.8%
Control - no treatment	C3	22.5%	16.3%
Average of no treatment		**16.5%**	**13.6%**

Southern Interior Region Monitoring Program

Monitoring is the highest priority function in the B.C. Ministry of Forests & Range Forest Health Program and encompasses a wide array of activities and assessments ranging from aerial overview mapping to detailed biological monitoring of insect life stage development. Spatial and temporal monitoring of pest incidence across our forested landscape will give us invaluable data on insect and disease occurrence, impacts, range expansions or changes and response to influences such as management and climate change. Over the past 20 years various trials, plots and research installations have been installed to study and monitor pests in the southern interior. A few of these installations are listed in Table 1. Every forest health survey adds to our knowledge base but permanent installations or surveys repeated at periodic intervals over the same landbase are particularly valuable. Permanent installations allow us to track and interpret the spatial and temporal changes in pest abundance and distribution in relation to many other physical and biological parameters (i.e. climate).

The plots and trials listed in Table 1, established by L. Maclauchlan between 1987 - 2008, only represent a portion of the monitoring network in the souterhn interior, yet they represent 173 plots on over 5 hectares, in seven differend biogeoclimatic zones.

Both photographs show stem defects caused by pests and how they affect tree growth and form. Left: western gall rust stem gall; Right: crook in stem caused by past lodgepole pine terminal weevil attack.

Table 1. List of permanent plots, trials and research installation established by the Forest Entomology program in the Southern Interior Region.

Description And Location	Number of plots	Plot size (ha)	Total area (ha)	BEC Classification
***Dryocoetes confusus* attack dynamics & stand succession**				
Merritt, Okanagan, Clearwater	10	1.0	10.0	ESSF
Monitoring levels of insect-caused damage & mortality post-fire				
Salmon Arm	17			IDF, ICH, MS, ESSF
Growth & yield plots established (1987) to monitor impacts of *Choristoneura occidentalis.* in managed and unmanaged stands				
Kamloops, Lillooet, Okanagan, Merritt	51	0.05	2.5	IDF, ICH, PP
PSP's in young pine - assessment of *Pissodes terminalis* attack dynamics and impact and other pest incidence				
Merritt, Penticton, Salmon Arm	17	0.035 - 0.25	3.0	IDF, MS, ESSF
Replicated Spacing Trials in young pine - Study of *Pissodes terminalis* and other pest incidence and impact in different densities				
Williams Lake, Kamloops, Penticton	5	4.0 - 5.0	21.0	IDF, MS, ESSF
Multiple-pest impacts following a controlled underburn - Swakum Mountain				
Merritt	18	0.04	0.72	IDFxh, dk
Ellis Creek - Long-term stand evaluation of pest incidence & impacts - *Cronartium comandrae*				
Penticton	16	0.25	4.0	IDF, MS
PSP's in young pine stands - Risk of young pine to *Dendroctonus ponderosae* attack				
Vanderhoof, Burns Lake, Prince George, Quesnel, Williams Lake, 100 Mile, Kamloops, Merritt, Okanagan	24	0.25	6.0	IDF, MS, SBS, SBPS
Replicated Spacing & Pruning Trial in young pine				
Merritt	15	0.25	3.75	MS
Total: 9 separate trials	**173 plots**	**0.05 - 5.0**	**50.97 ha**	**7 BEC Zones**

High elevation forest ecosystems in interior British Columbia, such as the Engelmann spruce subalpine fir (ESSF) biogeoclimatic zone, are dominated by subalpine fir and interior spruce. The ESSF represents approximately 21% (1.67 million hectares) of the forested land base in southern B.C. The western balsam bark beetle, *Dryocoetes confusus*, selectively kills subalpine fir at low levels each year, occasionally reaching outbreak populations. Although cumulative mortality may be significant in chronically infested stands, little is known of the attack and outbreak dynamics of this bark beetle. By elucidating the spatial and temporal attack patterns of *D. confusus* during all phases of an outbreak, we may better understand how to minimize or prevent future stand losses through development of more biologically appropriate management strategies.

As part of a research project and the Southern Interior Region's monitoring program, ten permanent sample plots were established to study attack patterns of *D. confusus* and its influence on stand succession (Table 1, 2). Initially plots were assessed on an annual basis to determine life history and insect biology, but they are now re-assessed on a 5-year interval. These plots have allowed an in-depth study of these high elevation stands. Tree and stand attributes such as blowdown and stem breakage were monitored; mensurational data were collected, and continuous assessment of pest occurrence was recorded and evaluated. The stands were selected based on the stage of the western balsam bark beetle progression (outbreak) within the stand (Table 2) and tree and stand attributes. They were roughly split into three categories: early phase; early to mid phase; and, mid to late phase. Later observations on the level and rate of tree mortality and blowdown helped to re-assess or clarify these categories.

Table 2. List of ten, 1 hectare western balsam bark beetle plots showing establishment year, biogeoclimatic classification (BEC), successional phase and density (stems per hectare, all species).

Plot name	Year Established	BEC Zone	Successional Phase	Density (stems per hectare)
Martin Creek	2000	ESSF wc	early	1,417
Spius Creek 1	2002	ESSF mw	early	790
Spius Creek 2	2002	ESSF mw	early	859
Buck Mountain	1999	ESSF xc	early to mid	1,310
Home Lake 1	1999	ESSF xc2	early to mid	1,207
Home Lake 2	1999	ESSF xc2	early to mid	1,331
Cherry Creek	1998	ESSF wc	mid to late	496
Sicamous Creek	1998	ESSF wc2	mid to late	927
Torrent Creek	1998	ESSF wc4	mid to late	597
Scotch Creek	2002	ESSF wc	mid to late	723

The Martin Creek and Buck Mountain plots, early and early to mid-phase stands respectively, show continuous and high levels of *D. confusus* attack over time (Table 3). Martin Creek and Buck Mountain have similar stand density, 1,417 and 1,315 sph respectively (Table 3), but differences between plots are seen in the rate of blowdown and mortality from other factors, both attributes being higher in the Buck Mountain plot (Table 3).

In the Buck Mountain plot, the number of live subalpine fir decreased by 53% in the 5 year interval between assessment (Fig. 1), from 588 sph in 2004 to 313 sph in 2009. The number of subalpine fir infested or killed by *D. confusus* increased from 23.6% (286) to 42.7% (477), from 2004 to 2009 respectively, a 67% increase (Table 3). Another key successional force in the regeneration of forests is blowdown, creating gaps for regeneration. In 2004, 27 subalpine fir were classed as blowdown (Table 3) and in 2009 this number almost tripled to 97, of which 42 (43%) contained *D. confusus* galleries and/or insects under the bark, again emphasizing the important role this insect plays in these high elevation forests.

Table 3. Data from the 2004 and 2008/2009 assessments of ten PSP's listing number of live and dead subalpine fir (Bl), percent killed by *D. confusus* (WBBB), total trees of all species and the increase in mortality over the 5 year assessment period. Number of trees = stems per ha as all plots are 1 ha in size.

Assessment	Subalpine fir		Total trees	Percent of subalpine fir			
Year	Live	Total	(all species)	killed by WBBB	dead from other factors	blowdown	Increased mortality (2004-09)
Buck Mountain							
2004	588	1,211	1,310	23.6%	25.4%	2.2%	
2009	313	1,216	1,315	42.7%	26.5%	8.0%	19.1%
Cherry Ridge							
2004	146	425	496	52.2%	11.1%	8.7%	
2009	140	425	496	52.7%	10.1%	16.2%	0.5%
Home Lake 1							
2004	356	996	1,207	40.6%	21.9%	2.0%	
2008	238	991	1,200	50.6%	22.9%	5.5%	10.0%
Home Lake 2							
2004	358	1,163	1,331	41.4%	24.2%	3.3%	
2008	289	1,149	1,314	45.0%	25.5%	6.2%	3.6%
Martin Creek							
2004	695	1,160	1,417	21.4%	18.2%	0.5%	
2009	537	1,160	1,417	30.9%	21.8%	1.5%	9.6%
Sicamous Creek							
2004	225	723	927	44.3%	21.3%	5.8%	
2009	192	723	927	48.4%	20.2%	10.5%	4.1%
Spius Creek 1							
2004	365	617	790	28.7%	11.3%	0.2%	
2008	333	612	784	32.2%	10.6%	7.4%	3.5%
Spius Creek 2							
2004	554	693	859	12.0%	5.5%	0.7%	
2008	519	680	846	15.6%	5.7%	4.6%	3.6%
Torrent Creek							
2004	316	515	597	22.1%	13.8%	5.6%	
2008	294	515	598	24.7%	14.6%	8.0%	2.5%
Scotch Creek							
2004*	289	663	723	28.1%	11.3%	3.8%	NA

* 2009 assessment not done on this plot due to access road washout.

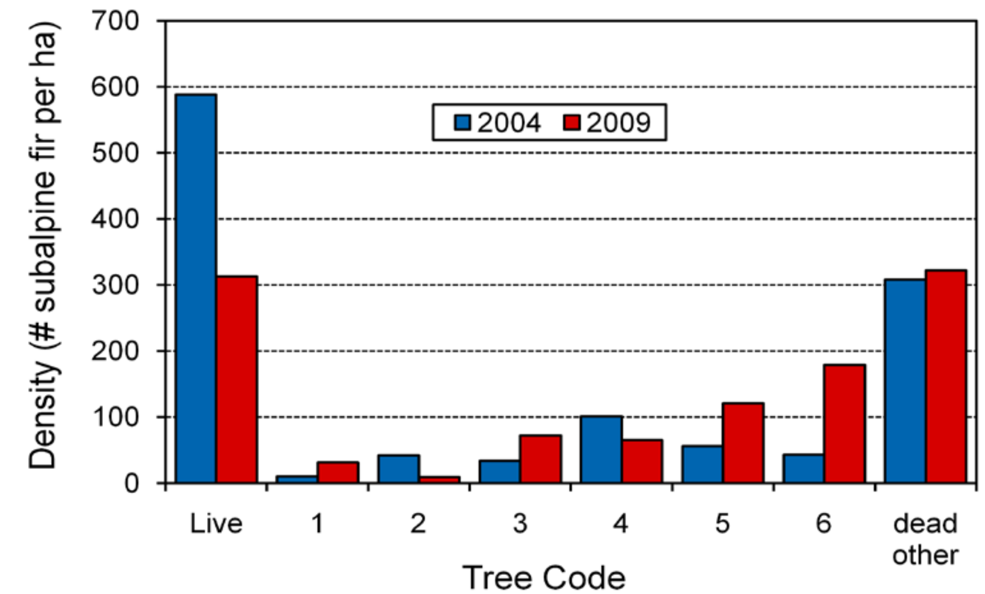


Figure 1. Density (number per hectare) of subalpine fir in the Buck Mountain plot at the 2004 and 2009 assessment dates, showing live trees and those killed by *D. confusus*. Trees attacked by *D. confusus* are divided by stage of attack (tree code) ranging from current, green attack (Code 1) to old attacks where trees have lost all their needles and are sloughing bark (Code 6). Descriptions of all tree codes used are shown in the table below.

Tree Code	Descriptions
0	healthy/unattacked
1	green/current attack
2	brick red
3	faded/dull red
4	grey with fine branches, maybe a few red needles
5	grey without fine branches, just larger branches
6	snag - losing bark
7	dead - unknown cause or other than WBBB
10	blowdown - previously attacked by WBBB
11	blowdown - not attacked by WBB

Left - code 6 balsam "snag". Above - Dryocoetes galleries. Right - tagged tree in the Buck Mountain plot.

Forest Pathology Update

FSP-FIA Project: Distribution and Impact of Phellinus Root Disease in the Southern Interior.

Michelle Cleary, Regional Forest Pathologist, B.C. MoFR, Southern Interior Forest Region
Rona Sturrock, Research Scientist, Canadian Forest Service, Pacific Forestry Centre

Phellinus root disease, caused by the fungus *Phellinus sulphurascens* (syn. *P. weirii*) is widespread throughout the southern interior of British Columbia and can impact timber supply through tree mortality, increment loss, and density and stocking reductions. In general, the presence of root disease pathogens in BC's forests and their impact on site productivity are greatly underestimated and are not being properly acknowledged in TSR. This FSP-FIA funded project was initiated in order to begin the research needed to accurately determine the incidence and impact of Phellinus root disease in the southern interior.

Using a sampling matrix of Inventory Type Group, BEC zones, and age class, surveys were conducted in Douglas-fir leading stands containing one or more growth and yield (G&Y) permanent sample plots (PSPs) which provide a representation of stand structure and volumes for growth and yield models. Assuming the widespread distribution of root disease in the southern interior, many of the G&Y inventory plots would be established on infested sites and by using these plots, we can capture information on rates of tree growth and mortality, and any change in long-term species dynamics as a result of root disease presence. To date, 110 stands and 138 PSPs have been sampled in the ICH and IDF biogeoclimatic zones in five TSAs/Districts: Kamloops, Okanagan-Shuswap, Merritt, Arrow-Boundary, and Hundred Mile House. Results of these surveys indicate areas of visible root disease infection vary between the ICH and IDF zones and even within a zone. Application of survey results to forest management, including specific guidance for TSR around estimates of endemic losses such as those caused by root disease, requires further analysis of the current disease-ecosystem database. Using both VDYP and TIPSY growth and yield models, we intend to utilize historical growth data obtained from a subset of inventory permanent sample plots with known disease incidence as well as stand level surveys with known disease incidence and distribution to demonstrate the effects and impacts of root diseases on Regional timber supply functions. Results will help formulate an Operational Adjustment Factor for root disease to be incorporated into TSR and guide on-the-ground recommendations for disease management to minimize future losses in site productivity and timber yield.

Determining the Effect of Pre-commercial Thinning on Root Disease Incidence

Michelle Cleary, Regional Forest Pathologist, B.C. MoFR, Southern Interior Forest Region
Duncan Morrison, Forest Pathologist (retired), Canadian Forest Service, Pacific Forestry Centre

Root diseases caused by *Armillaria ostoyae*, *Phellinus weirii* and *Inonotus tomentosus* cause significant losses in managed stands. With increasing emphasis on intensive and incremental silviculture to help narrow the gap in mid-term timber supply, it is important to know if pre-commercial thinning affects the epidemiology of these root diseases. This information will provide more accurate estimates for silviculture scenarios that predict the impact of management assumptions, including incremental silviculture activities, on forecast harvest.

Between 1991 and 1994, eleven installations were established across the province to determine the effect of pre-commercial thinning on mortality caused by Armillaria, Phellinus and Tomentosus root diseases. Thinning operations in infested areas has the potential to increase the amount and potential of inoculum on site and cause mortality and growth loss in trees that sustain non-lethal infections. Such losses will significantly impact timber supply.

For the last 2 years, remeasurement of these pathology-silviculture trials has taken place. To date, 6 of the 11 installations have been re-measured and clearly show some interesting effects on disease development and growth

of stands now at mid-rotation. Growth measurements and periodic mortality data collected now 15-18 years post-treatment will determine the patterns of mortality and their consequences which will help navigate potential benefits of different silviculture treatments.

White Pine Family Resistance Trials

Michelle Cleary, Regional Forest Pathologist, B.C. MoFR, Southern Interior Forest Region
Stefan Zeglen, Regional Forest Pathologist, B.C. MoFR, Coast Forest Region

A white pine seed orchard was established 20 years ago in Burton by Weststar Timber Ltd. with material collected and grafted by the U.S. Forest Service and top grafted in the field to produce rust resistant seed. Scion material represented above average families for resistance to white pine blister rust (*Cronartium ribicola*), height growth, form and cone production.

In the summer of 2007, surveys were conducted to rank families by disease severity and tree survival. Families were selected representing a variety of different resistance mechanisms against blister rust: bark reaction, short shoot, needle shed and no spot. Cones were collected and seedlings were grown at K&C Silviculture in Oliver. Four sites have been selected for testing the material, one on the coast (planted in the fall of 2009) and three in the ICH in the southern interior near Nakusp, Clearwater and north of Lumby (to be planted in the spring of 2010).

This work will help guide future silviculture investments and activities focused on planting improved stock (resistant to certain pests including white pine blister rust) to help bring second growth into timber harvesting rotation sooner, thereby helping to further reduce the gap in mid-term timber supply.

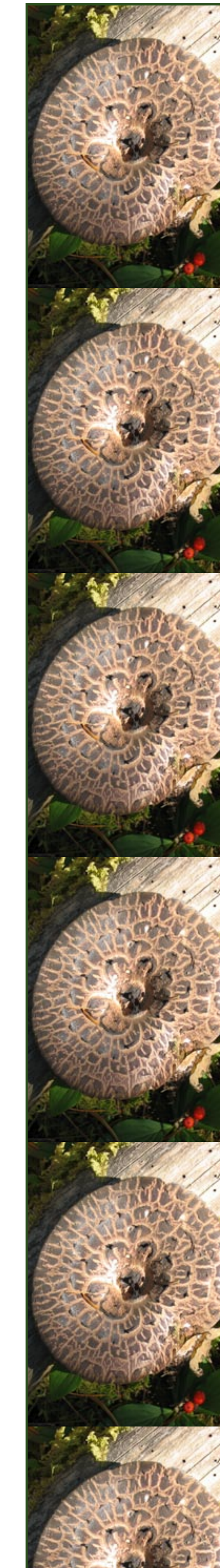
Birch Decline and Climate: An Update

Michael Murray, Forest Pathologist, B.C. MoFR, Southern Interior Forest Region

A recent die-off of paper birch is apparent within Interior BC. Substantial mortality is evident from Williams Lake south to Washington's Selkirks. The West Kootenay Region seems to be particularly impacted. This discrete event probably began 5-10 years ago and is now appearing to subside. In its wake are countless hectares of dead and top-killed trees. Mature individuals of all size classes appear to be affected. The loss of birch crowns has transformed verdant stands to stark white snags – contrasting with surrounding vegetation. Although not a major commercial species, birch tends to be situated along lower slopes and valley bottoms where private residences exist. Concerns are being voiced from landowners who prefer their birch live and healthy. Even casual observers can't help but be curious about this dramatic change.

Historic paper birch declines have been recorded elsewhere in North America. New England and adjoining Provinces experienced an event from 1930 to 1950 which killed 70% of birch in Maine. The Upper Peninsula of Michigan lost 68% of trees between 1954 and early 1960s. Although no formal surveys exist for BC, the mortality rate is probably similar here. Furthermore, our decline may have occurred over a shorter period of time.

Forest declines are typified by three elements: a complex-causal relationship; environmental stress; and two or more mortality agents. This milieu of factors can be challenging to analyze



Recent birch mortality in southeast B.C.

and eventually identify the underlying cause of forest decline events. Armillaria root disease, *Phomopsis* fungi, and bronze birch borers have been casually observed on dead and dying trees. However, no exhaustive diagnostic surveying has begun. As trees begin to rot, the evidence becomes degraded and the die-off fades into memory. Lacking direct project funding, only rudimentary investigation will occur. Since we expect a variety of mortality agents, possibly in addition to those already mentioned, the question arises – why are one or more agents successfully killing birch in such large numbers in a short period of time? This die-off may be linked to pronounced environmental stress which has weakened the trees and rendered them more vulnerable to disease and insects.

To determine whether stress preceded the decline, tree rings will be examined for growth trends and frost rings. To date, thirteen sites have been sampled between Revelstoke and Yahk during 2009. On each of ten sites, increment cores were collected from 8-12 trees. An additional three sites were used to collect a total of 24 cross-sections. Standard dendrochronology techniques will prepare data for subsequent correlation analysis incorporating historic climate data. Nelson, for example, has weather station records extending back 100 years.

Monitoring Whitebark Pine in the Nelson Area

Michael Murray, Forest Pathologist, B.C. MoFR, Southern Interior Forest Region

Whitebark pine (*Pinus albicaulis*) continues to decline mostly due to white pine blister rust and mountain pine beetle attacks. Three additional monitoring sites were added in 2009, while conversely, three pre-existing sites (established in 2003 & 2004) were not remeasured. Due to unforeseen budget shortcomings the three unsampled plots (Bluejoint –Arrow Boundary District, Pudding Burn & Findlay -Rocky Mountain District) have exceeded the five-year monitoring interval. As an alternative, three new sites were sought that would be: 1) within single day travel from Nelson (including field sampling time), and 2) accessible by vehicle. The proximity of these sites to Nelson ensures that travel funding will not be necessary to monitor – and we can avoid sampling lapses in the future.

The previous sites, established by Stefan Zeglan, Coast Forest Region Forest Pathologist, consist of .25ha plots with all size classes of trees measured every five years. These inventories provide useful information on forest health trends and tree regeneration. The three new Nelson sites support lower densities of whitebark pine trees

A population of tall (approaching 30m) whitebark pine trees were found on Mount Nelson.

which would only yield low numbers within any .25ha plot. Thus, the monitoring is not plot-based, but site-based. Specifically, between 10 and 50 cone-bearing trees were selected across each site. Each tree was assessed for health, diameter, and number of cones. At least 10 trees per site were sampled with increment boring for subsequent tree ring analysis (age, stress, etc.). The overall objective is to track each tree annually to determine health trends and cone production. The three sites being monitored are Mount Nelson, Red Mountain, and Gray Creek Pass – all in Kootenay Lake Forest District. Several more sites may be added in the future. Preliminary findings based on 75 sampled trees indicate 9% died in 2008 from mountain pine beetle and 5% are currently under attack. Dead tops, a good indicator of blister rust, occur on 11% of trees and an additional 3% are showing active cankers. Another finding – a population of tall whitebark pine on Mount Nelson which overlooks the city.

Is Stump Removal Reducing Armillaria Root Disease? The Wetask Lake Stumping Trial.

Michael Murray, Forest Pathologist, B.C. MoFR, Southern Interior Forest Region
Adrian Leslie, Royal Roads University

Armillaria root disease, a leading cause of plantation tree mortality, presents great challenges to successful forestry. The practice of removing armillaria-infected stumps before planting trees on a site can greatly reduce the amount of inoculum in the soil. This expectedly thwarts the spread of the disease to newly planted trees. To better understand the effectiveness of this treatment, a study site was established in 1994 near Revelstoke.

The Wetask Lake treatment site, approximately 12 km east of Revelstoke, is in the Thompson moist warm variant of the Interior Cedar-Hemlock subzone (ICHmw3). The purpose of this trial was to compare effects on armillaria-induced mortality based on historic stump removal. In 1993, two clearcut blocks approximately 2 hectares each were logged conventionally. Then, half of each block had all stumps exhumed, shaken (to remove most soil), then placed on the ground surface. The blocks were then planted with western larch, Douglas-fir, and paper birch. We are comparing the stump removal areas to the unstumped areas. As of 2009, it has been 15 years since the original trial was planted. This period should allow enough time for armillaria to spread and noticeably impact regeneration – as reflected by health and growth of individual trees.

Graduate student, Adrian Leslie (Royal Roads University, Victoria) has been recruited to undertake this assessment of the post-treatment stands. Our objective is to assess tree health, height and diameter growth and compare values between the two treatments. A total of 180 (3.99m radius) plots were inventoried in September-October. Preliminary findings indicate much natural regeneration has occurred. Furthermore, although the site was found to have a high incidence of armillaria in 1993, the current evidence is not pronounced. In fact, neither treatment is showing much infestation, and correspondingly the difference between them is not significant. Next, we will be looking at potential differences between regenerating species. Thus, the study is ongoing and expected to yield final results and interpretations by summer 2010.

Comparison of regenerating tree conditions for Wetask Lake stump removal study.

	# of trees	Avg. height (cm)	Avg. DBH (cm)	# trees with Armillaria
Stumps Present	1,071	475	4.18	12
Stumps Removed	1,174	421	3.83	8

Fungal fan of Armillaria root collar of sapling at Wetask Lake study site.

Upcoming Meetings

Western International Forest Disease Conference, Valemount, October 4-8, 2010.

Next year, the Western International Forest Disease Working Conference (WIFDWC) will be hosted in Valemount, in the heart of the Robson Valley. This geographic region of BC which comprises the northern Rocky Mountain Trench is a truly a forest pathologist's dream – a pure disease haven! Here, we find the most northern range of *Armillaria ostoyae*'s distribution in eastern B.C. There are several ongoing research projects that will be visited and discussed including aerial overview mapping procedures, population genetics studies, treatments (precommercial thinning and stumping operations) and long-term impacts of Armillaria on managed plantations.

Next year also marks the centennial anniversary of the introduction of white pine blister rust (*Cronartium ribicola*) into B.C., and in celebration of this, the program will host a special panel session highlighting the long-term impact of this exotic pest on BC's forest resources along with a field trip to a provenance test plantation for white pine – some of Rich Hunt's early work.

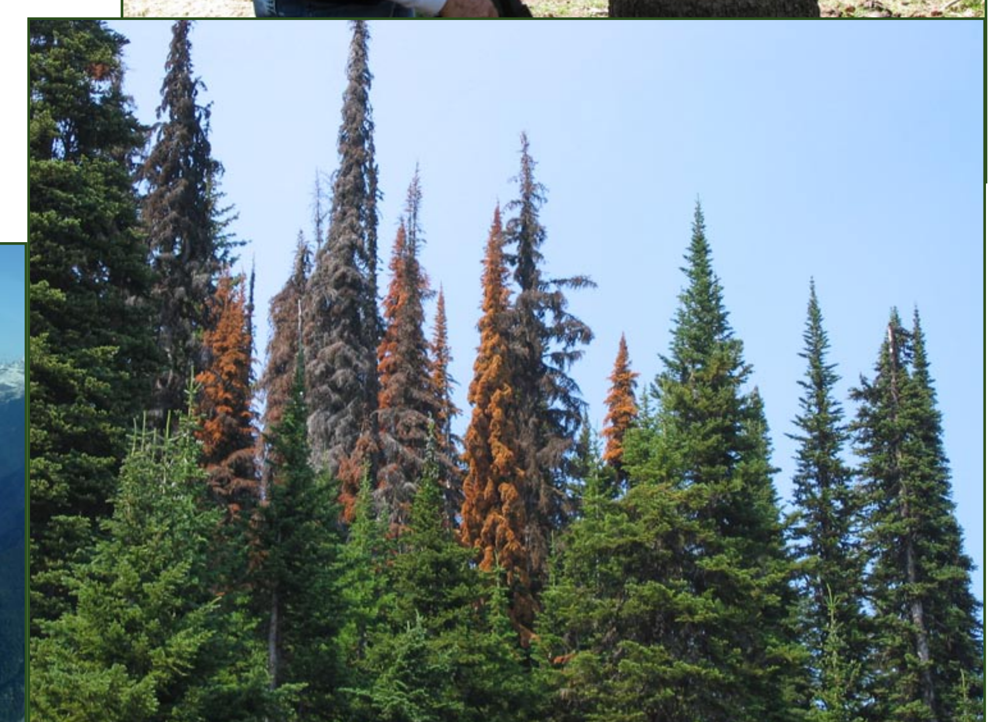
A pre-WIFDWC field trip will also be arranged into the alpine at McBride Peak to examine the status of whitebark pine threatened by blister rust and mountain pine beetle in the northern Rocky Mountain trench.

Besides the spectacular vistas in the alpine, we will visit a unique sand dune complex in the valley bottom with important and unique lichen and plant communities. This area is home to some of the most incredible lodgepole pine mistletoe (*Arceuthobium americanum*) in the southern interior of B.C., and we will hear about an ongoing yield loss simulation project for lodgepole pine mistletoe. In addition, we will view areas heavily impacted by Dothistroma needle blight and other foliage diseases and discuss the impact of forest pests on young managed plantations post-free growing,

Forest Health/Stewardship District staff are encouraged to participate and take advantage of this unique opportunity which comes around to the southern interior of B.C. about once every 20 years. This will be a unique opportunity to hear from a diverse group of pathology experts; learn about pest-complex interactions, showcase pathology research in B.C., and discuss approaches to help improve management of our forest resources.

For more information, refer to the official WIFDWC website: http://www.fs.fed.us/foresthealth/technology/wif/.

Clockwise from left: western gall rust near Golden; Hiller 12E spraying B.t.k. near Logan Lake; preparing the Douglas-fir tussock moth NPV spray mixture at a staging site; undiagnosed bark staining on spruce near Clearwater; western balsam bark beetle near Sun Peaks; Kleena Kleene glacier - view from aerial overview survey aircraft.



B.C. Ministry of Forests and Range
Southern Interior Forest Region
441 Columbia Street,
Kamloops, B.C.
V2C 2T3
(250) 828-4179

This summary was prepared by:

Lorraine Maclauchlan, Ph.D., Regional Entomologist (Kamloops)
Kevin Buxton, R.F.T., Forest Health Specialist (Kamloops)
Art Stock, Ph.D., Forest Entomologist (Nelson)
Leo Rankin, M.P.M., Forest Entomologist (Williams Lake)
Michelle Cleary, Ph.D., Forest Pathologist (Kamloops)
Michael Murray, Ph.D., Forest Pathologist (Nelson)

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