Summary of Aerial Overview Surveys for Southern B.C.

2010

2010 Overview of Forest Health for Southern British Columbia

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Introduction

The 2010 Aerial Overview Surveys for the Southern Interior were completed between July 17th and September 9th, 2010. A total of 260.7 hours of fixed-wing flying in 57 separate flights were required to complete the surveys. As usual, for logistical purposes surveys were managed as three separate areas: the Cariboo (100 Mile House, Central Cariboo, Quesnel, Chilcotin, and northern Headwaters Forest Districts), Thompson-Okanagan (Kamloops, Cascades, Okanagan Shuswap, and southern Headwaters Districts), and Kootenay-Boundary (Arrow-Boundary, Columbia, Kootenay Lake, and Columbia Forest Districts). With the creation of the Ministry of Natural Resource Operations (MNRO) in the fall of 2010, the southern interior of the Province is now re-divided into three Natural Resource Regions (Cariboo, Thompson-Okanagan, and Kootenay-Boundary). For purposes of continuity and to facilitate easier historical comparisons, this 2010 report will describe results based on the Forest Region and Forest District boundaries in place at the time the surveys were performed, prior to the formation of MNRO.

Weather conditions and visibility were generally good for most of the survey flights. However, extreme wildfire activity and heavy smoke grounded survey crews in the Cariboo for most of August, delaying the completion of the surveys until early September, when conditions became more favourable.

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.

The most damaging pest in the Southern Interior continued to be mountain pine beetle (558,118 hectares). Other pests causing large scale damage were western spruce budworm (499,105 hectares), western balsam bark beetle (183,167 hectares), Douglas-fir beetle (10,857 hectares), spruce beetle (29,922 hectares), Douglas-fir tussock moth (16,302 hectares), two-year cycle spruce budworm (70,694 hectares), aspen serpentine leaf miner (67,282 hectares), and forest tent caterpillar (37,844 hectares) (Table 2).

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

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

Table 2. Area summaries for forest health factors mapped during the 2010 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (ha)					
	Trace*	Light	Moderate	Severe	Very Severe*	Total
Mountain Pine Beetle						
Cascades	31,864.8	83,638.1	19,115.1	2,624.4	380.1	137,622.5
Chilcotin	76,154.7	26,512.2	1,150.6	49.0	0.0	103,866.4
Headwaters	51,143.6	17,663.5	11,519.2	2,659.4	1,637.1	84,622.9
Okanagan Shuswap	14,142.8	55,612.0	11,293.6	1,335.3	205.7	82,589.3
Rocky Mountain	5,056.2	21,566.9	19,810.2	4,957.9	0.0	51,391.2
Kootenay Lake	4,334.1	9,132.6	7,581.6	992.1	22.4	22,062.8
Arrow Boundary	5,462.7	8,481.9	4,726.9	59.9	0.0	18,731.4
Central Cariboo	11,051.4	4,189.2	870.1	14.1	539.0	16,663.7
Columbia	2,062.1	6,780.4	3,152.5	614.4	0.0	12,609.4
100 Mile House	5,480.7	3,570.7	311.4	0.0	0.0	9,362.8
Kamloops	4,330.6	4,164.8	816.2	21.7	0.7	9,334.0
Quesnel	6,683.4	2,432.1	145.4	0.0	0.0	9,261.0
Total	**217,767.1**	**243,744.5**	**80,492.8**	**13,328.2**	**2,785.0**	**558,117.5**
Douglas-fir Beetle						
Chilcotin	1,737.9	1,087.3	0.0	0.0	0.0	2,825.2
100 Mile House	2,474.0	330.4	0.0	0.0	0.0	2,804.4
Rocky Mountain	66.4	597.9	603.6	0.0	0.0	1,268.0
Central Cariboo	550.9	121.5	0.0	0.0	0.0	672.4
Quesnel	132.6	353.3	142.3	0.0	0.0	628.2
Kamloops	0.0	152.1	287.7	96.1	7.4	543.3
Columbia	73.3	386.4	83.3	0.0	0.0	543.0
Okanagan Shuswap	0.0	185.4	256.7	73.0	15.6	530.6
Cascades	3.9	208.6	149.7	6.1	0.0	368.3
Kootenay Lake	0.0	261.0	48.2	0.0	0.0	309.1
Headwaters	0.0	130.8	128.9	4.2	0.0	263.9
Arrow Boundary	0.0	88.2	12.5	0.0	0.0	100.7
Total	**5,039.0**	**3,903.1**	**1,712.8**	**179.3**	**23.0**	**10,857.3**
Spruce Beetle						
Central Cariboo	4,131.2	6,816.4	4,514.3	1,055.9	0.0	16,517.8
100 Mile House	638.0	3,165.3	4,817.5	535.4	38.2	9,194.3
Kamloops	448.9	927.5	695.0	165.0	51.0	2,287.4
Cascades	0.0	45.1	495.9	60.4	0.0	601.4
Headwaters	147.0	106.5	303.4	0.0	0.0	556.9
Rocky Mountain	50.7	208.4	207.3	50.8	0.0	517.2
Okanagan Shuswap	0.0	34.2	83.3	12.5	0.0	130.0
Quesnel	6.6	84.1	0.0	0.0	0.0	90.7
Chilcotin	20.0	6.3	0.0	0.0	0.0	26.3
Arrow Boundary	0.0	0.0	0.0	0.0	0.0	0.0
Columbia	0.0	0.0	0.0	0.0	0.0	0.0
Total	**5,442.4**	**11,393.8**	**11,116.7**	**1,880.0**	**89.2**	**29,922.1**
Western Balsam Bark Beetle						
Okanagan Shuswap	55,495.4	1,908.9	10.0	4.7	0.0	57,419.0
Headwaters	54,945.9	1,655.0	20.5	0.0	0.0	56,621.4
Quesnel	16,885.7	392.6	0.0	0.0	0.0	17,278.3
Kamloops	15,009.2	1,628.2	3.1	0.0	0.0	16,640.6
Central Cariboo	9,347.0	1,449.5	0.0	0.0	0.0	10,796.5
Chilcotin	5,525.9	405.8	7.7	0.0	0.0	5,939.5
Cascades	4,512.4	7.9	4.4	0.0	0.0	4,524.7
Rocky Mountain	2,329.2	1,565.7	108.4	0.0	0.0	4,003.3
100 Mile House	2,448.0	1,108.8	0.0	0.0	0.0	3,556.8
Arrow Boundary	2,090.2	586.8	0.0	0.0	0.0	2,677.0
Columbia	1,475.2	632.9	39.6	10.1	0.0	2,157.7
Kootenay Lake	1,113.4	438.7	0.0	0.0	0.0	1,552.1
Total	**171,177.5**	**11,780.7**	**193.7**	**14.8**	**0.0**	**183,166.8**

Table 2 continued. Area summaries for forest health factors mapped during the 2010 aerial overview surveys.

Forest District and Damaging Agent	Area of Infestation (ha) Light	Moderate	Severe	Total
Western Spruce Budworm				
Cascades	129,681.4	16,437.9	0.0	146,119.3
Central Cariboo	123,198.3	14,247.0	0.0	137,445.3
Kamloops	107,003.9	9,251.1	0.0	116,255.0
Okanagan Shuswap	39,071.0	1,786.2	38.9	40,896.1
100 Mile House	36,926.5	2,352.4	0.0	39,278.9
Quesnel	7,033.3	3,095.6	0.0	10,129.0
Chilcotin	5,781.7	3,126.4	0.0	8,908.1
Headwaters	72.8	0.0	0.0	72.8
Total	**448,768.9**	**50,296.6**	**38.9**	**499,104.4**
Douglas-fir Tussock Moth				
Kamloops	958.2	3,764.3	9,300.0	14,022.4
Okanagan Shuswap	50.9	1,013.4	84.0	1,148.3
Cascades	32.9	324.3	774.9	1,132.1
Total	**1,042.0**	**5,102.0**	**10,158.9**	**16,302.8**
Two-Year Cycle Budworm				
Quesnel	26,312.0	20,533.6	0.0	46,845.6
Headwaters	10,435.8	529.4	0.0	10,965.2
Central Cariboo	8,430.5	159.9	0.0	8,590.4
Rocky Mountain	952.0	2,176.0	0.0	3,128.0
100 Mile House	83.7	602.0	0.0	685.6
Kamloops	469.8	0.0	0.0	469.8
Cascades	4.9	4.2	0.0	9.1
Total	**46,688.7**	**24,005.1**	**0.0**	**70,693.7**
Western Hemlock Looper				
Headwaters	2,630.5	6.8	0.0	2,637.3
Columbia	339.9	18.5	0.0	358.4
Okanagan Shuswap	35.0	0.0	0.0	35.0
Kootenay Lake	4.9	0.0	0.0	4.9
Total	**3,010.3**	**25.3**	**0.0**	**3,035.5**
Aspen Serpentine Leaf Miner				
Headwaters	33,783.7	3,569.6	0.0	37,353.3
Quesnel	14.1	6,632.5	0.0	6,646.5
Columbia	4,046.4	1,794.5	0.0	5,841.0
Kamloops	4,573.6	358.1	0.0	4,931.7
Okanagan Shuswap	3,679.8	704.8	0.0	4,384.6
Arrow Boundary	2,125.3	884.5	0.0	3,009.8
Chilcotin	2,064.0	180.6	0.0	2,244.6
Kootenay Lake	865.9	402.3	0.0	1,268.3
Central Cariboo	106.6	0.0	999.8	1,106.4
Rocky Mountain	190.9	89.6	0.0	280.4
100 Mile House	132.2	0.0	83.0	215.3
Total	**51,582.6**	**14,616.5**	**1,082.8**	**67,282.0**
Forest Tent Caterpillar (IDF)				
Quesnel	19,833.2	14,206.0	823.4	34,862.6
Okanagan Shuswap	52.2	1,795.7	352.5	2,200.3
Headwaters	320.3	293.2	0.0	613.5
Central Cariboo	167.3	0.0	0.0	167.3
Total	**20,372.9**	**16,294.9**	**1,175.9**	**37,843.7**
Birch Leaf Miner				
Arrow Boundary	947.6	1,800.4	0.0	2,748.1
Okanagan Shuswap	453.0	1,606.5	33.4	2,092.8
Kootenay Lake	953.6	843.2	0.0	1,796.9
Columbia	442.8	396.1	0.0	838.8
Kamloops	169.3	360.8	0.0	530.1
Headwaters	99.3	306.2	0.0	405.5
Rocky Mountain	5.9	0.0	0.0	5.9
Total	**3,071.4**	**5,313.2**	**33.4**	**8,418.1**

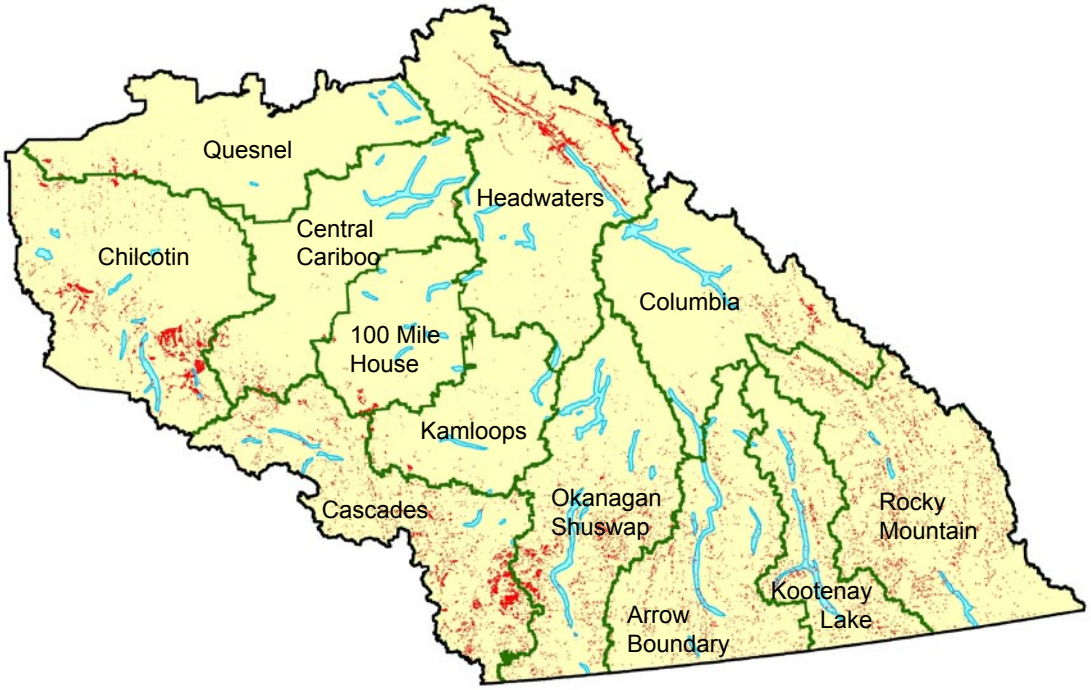


Figure 1. Mountain pine beetle infestations and Forest District locations in the Southern Interior in 2010.

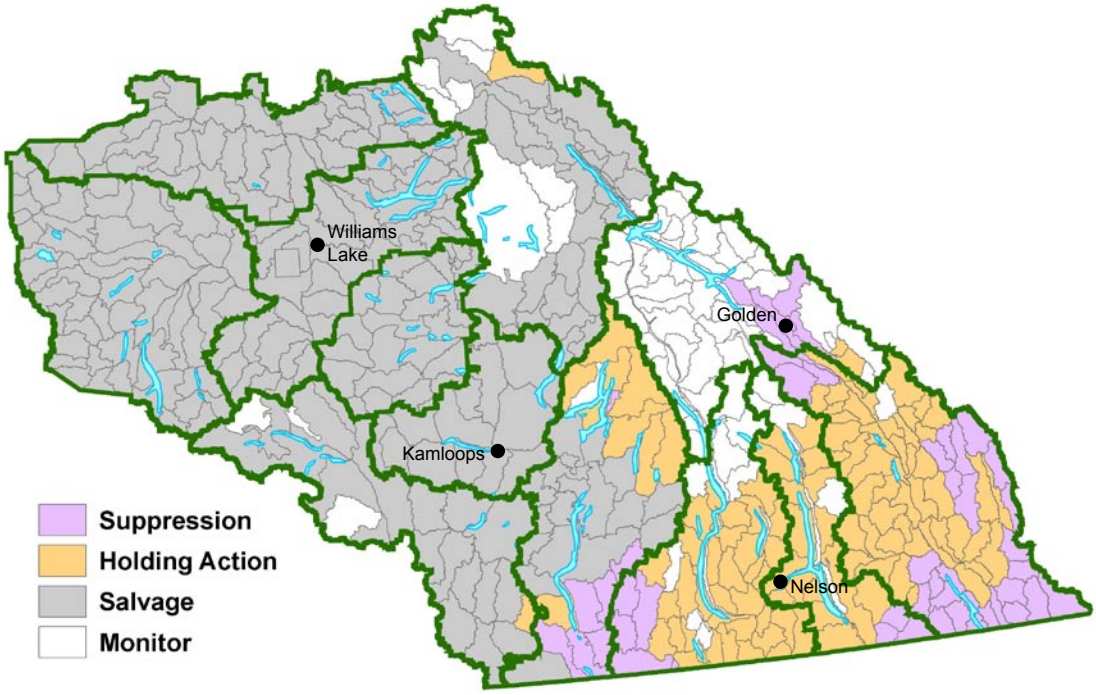


Figure 2. Beetle Management Unit (BMU) boundaries, and associated mountain pine beetle strategies, as of February 2011.

Regional Overview

Mountain Pine Beetle, *Dendroctonus ponderosae*

Area affected by mountain pine beetle declined by 76%, to 558,118 hectares (Figure 3). Populations in most of the Cariboo, Kamloops, and Clearwater areas have collapsed to endemic levels, with red attack area falling by over 90%. Significant drops in red attack area were noted in most other areas, with the exception of the Rocky Mountain District, where the area affected remained nearly unchanged, and the Kootenay Lake District, where the decrease was just over 10%. Despite the general decline in total area, red attack remained widespread over most of the Kootenays, south and central Okanagan, south Chilcotin, Robson Valley, Lillooet TSA, and south-central Merritt TSA (Figure 1). The number of spot infestations (small pockets of less than 50 trees) increased to 6,573, 85% of which were in the Kootenays and Okanagan (Table 3). Significant potential for population expansion exists in much of the south and southeast of the Region, especially in the south Okanagan and the Kootenays, due to large inventories of susceptible lodgepole pine.

Mountain pine beetle attack in young stands continued, although levels have declined sharply, from 52,180 hectares in 2009, to 7,595 hectares in 2010. Over half of the affected young stands, and most of the 630 hectares of youngs stands suffering moderate or severe mortality, were in the Okanagan Shuswap District.

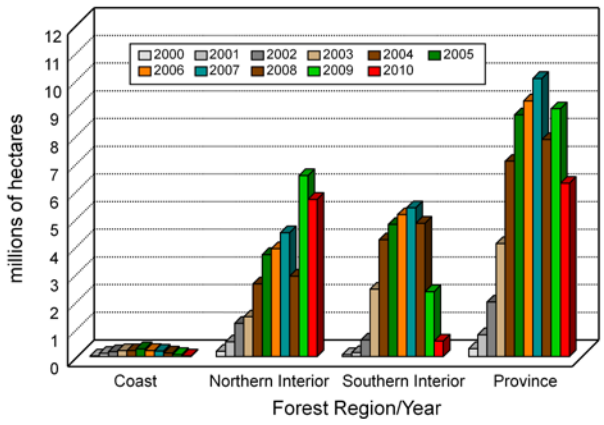


Figure 3. Area affected by mountain pine beetle from 2000 - 2010 in British Columbia, by Forest Region.

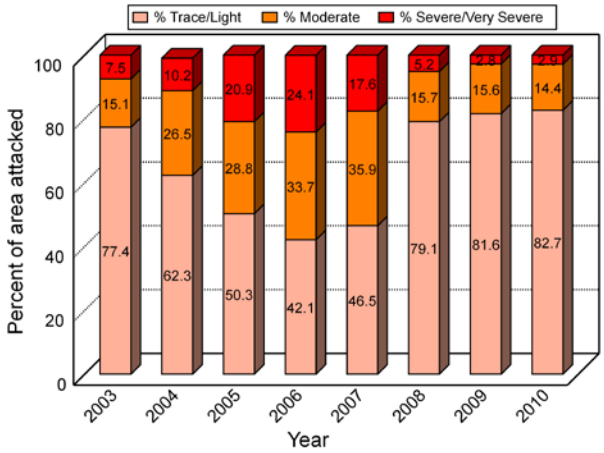


Figure 4. Proportion of mountain pine beetle infested area by infestation severity level, from 2003 - 2010, in the Southern Interior Forest Region.

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, 2001-2010.

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

Table 4. Number of spot infestations of mountain pine beetle in the Southern Interior Forest Region in 2010.

District	# spot infestations	# trees
Rocky Mountain	2,366	37,983
Arrow Boundary	1,288	17,243
Kootenay Lake	802	12,051
Okanagan Shuswap	704	6,294
Cascades	512	5,538
Columbia	402	5,547
Chilcotin	240	3,246
Headwaters	125	798
Kamloops	79	600
Central Cariboo	26	193
Quesnel	21	240
100 Mile House	8	14
Total	6,573	89,747

Mountain pine beetle "spot" infestation.

Beetle Management Unit (BMU) strategies are re-assessed annually for the three major bark beetle species, after the completion of the aerial overview surveys, and any detailed surveys and/or ground surveys. Strategies for mountain pine beetle remained unchanged in most areas (see Figure 2 and Table 5) due to static or declining populations. Nearly 60% of the land base of the Southern Interior continues to be in Salvage for mountain pine beetle. Suppression activities are confined to 8% of the land base, in the south and southeast of the Rocky Mountain District, the southwest of the Columbia District, and the southern Okanagan and Boundary areas. Douglas-fir beetle strategies have been upgraded to Suppression for several BMU's in the Chilcotin District, as a result of significantly reduced beetle populations across these areas.

Table 5. 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	0	1 (72,266)	34 (1,801,170)	9 (1,040,938)	44 (2,914,375)
Columbia	6 (233,189)	2 (44,249)	0	50 (1,866,870)	58 (2,144,309)
Arrow Boundary	5 (279,923)	35 (1,297,539)	0	10 (419,063)	50 (1,996,524)
Kootenay Lake	3 (102,915)	17 (884,511)	0	7 (253,430)	27 (1,240,857)
Rocky Mountain	28 (1,062,081)	48 (1,696,993)	0	1 (41,458)	77 (2,800,531)
Total	**49 (2,050,599)**	**113 (4,815,063)**	**317 (14,630,532)**	**81 (3,867,969)**	**560 (25,364,163)**

Area of red attack within provincial parks and other protected areas has declined by nearly 70%, to 61,957 hectares. Eighty-four separate parks and protected areas were affected, with 36 sustaining over 100 hectares of red attack. The most affected parks were Mount Robson Park (15,089 ha), Ts'yl-os Park (7,108 ha), Itcha Ilgachuz Park (6,363 ha), and South Chilcotin Mountains Park (4,131 ha). Infestation levels in the four National Parks declined to 15,160 hectares, most of which was in Yoho and Kootenay National Parks (Table 6). Most of the mitigation by B.C. Parks has focused on reducing fire hazard and danger tree hazards to Park users, often under partnership with the Wildfire Management Branch. Removal of green attacked trees has continued in Lac Le Jeune, Kentucky Alleyne, Monck, and Skihist Parks. As well, verbenone was deployed in Monck and Skihist Parks in an effort to reduce attack levels.

Extensive grey attacked pine in Tunkwa Park, west of Kamloops.

Table 6. Area (hectares) of mountain pine beetle in Provincial Parks, Protected Areas, Ecological Reserves, and Recreation Areas in the Southern Interior Region in 2010. 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)
Headwaters	46	10	16,119	850,015
Chilcotin	15	6	11,657	391,578
Cascades	35	13	8,374	209,919
Okanagan Shuswap	109	27	6,918	196,933
Kootenay Lake	22	8	4,671	216,307
Arrow Boundary	33	4	3,505	170,615
Rocky Mountain	34	8	2,851	272,415
Central Cariboo	15	3	2,754	196,116
100 Mile House	27	2	2,506	48,042
Quesnel	18	2	2,483	204,803
Kamloops	47	6	102	66,716
Columbia	14	1	16	50,933
Total	**356****	**84 (4)***	**61,957 (15,160)**	**2,874,393 (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.

Ponderosa pine mortality, caused by mountain pine beetle, western pine beetle, and *Ips* (engraver beetles), has declined by nearly 75% to 24,190 hectares. Most of the ponderosa pine mortaltiy was in the Cascades District and Okanagan Shuswap Districts, with scattered areas in the Kamloops District and the southern Rocky Mountain Trench. Most ponderosa pine stands in the 100 Mile House, Kamloops, and north-central Cascades Districts have now sustained high levels of cumulative mortality.

Whitebark pine mortality declined, from 18,165 ha in 2009, to 9,762 hectares in 2010. Scattered pockets of red attack were observed in the Lillooet and Robson Valley TSA's, and throughout the Selkirk and Purcell Mountains of the Kootenays. Western white pine was killed at trace to light levels on 356 hectares in the Headwaters and Okanagan Shuswap Districts.

Lodgepole pine killed by mountain pine beetle near Willowgrouse Lake, Kamloops District. The upper photograph was taken in July 2007, the lower photograph of the same location was taken in July 2010.

Douglas-fir Beetle, *Dendroctonus pseudotsugae*

Douglas-fir beetle attack declined by nearly 90%, to 10, 860 hectares. Infestations collapsed across most of the Cariboo. Some of the most impacted areas, such as the Chilcotin River corridor, have declined significantly and although host depletion is definitely a factor in many areas, there appears to be a general decline in size and number of new infestations overall. This may be caused by increased fungal disease within the population. Douglas-fir beetle was observed to have ineffectively colonized trap trees in a number of locations, suggesting other factors impacting the population besides host resistance. Infested area increased in the Rocky Mountain, Kootenay Lake, Columbia, and Okanagan Shuswap Districts. The number of small spot infestations declined slightly, from 2,417 (19,250 trees) to 2,097 (14,045 trees) (Table 7).

There is concern that in the vicinity of the large Alexis Creek and Meldrum Creek fires, fire damaged Douglas-fir, especially along the fire perimeters, could be at an increased risk of Douglas-fir beetle attack in 2011. During the construction of fire guards, hundreds of Douglas-fir trees were pushed over, essentially creating an extensive unmanaged trap tree program. These trees could provide ideal habitat for Douglas-fir Beetle which prefers downed trees over standing trees. The aftermath of the fires may precipitate a rebound of the Douglas-fir beetle populations.

Table 7. Number of spot infestations of Douglas-fir beetle in the Southern Interior Forest Region in 2010.

District	# spot infestations	# trees
Kamloops	363	2,891
Central Cariboo	343	1,001
Chilcotin	285	1,745
100 Mile House	267	817
Okanagan Shuswap	245	1,891
Cascades	197	1,925
Quesnel	100	594
Headwaters	75	538
Rocky Mountain	75	843
Arrow Boundary	67	834
Columbia	40	424
Kootenay Lake	40	541
Total	2,097	14,044

Douglas-fir beetle attacking a Douglas-fir windfall.

Spruce Beetle, *Dendroctonus rufipennis*

Spruce beetle was mapped on 29,922 hectares, up 17% from 2009 area. Populations continued to expand in the Central Cariboo and 100 Mile House Districts, which between them accounted for over 85% of all new attack. Populations also appear to be generally increasing in the Rocky Mountain District, where affected area increased nearly four-fold to 517 hectares. Visible attack area and severity declined in the Kamloops, Headwaters, Cascades, and Okanagan Shuswap Districts, mainly due to host depletion.

Grey attacked spruce, Snehumption Creek, Okanagan Shuswap District.

Western Balsam Bark Beetle, *Dryocoetes confusus*

Mortality due to western balsam bark beetle activity continues to be widespread across most high elevation areas in the Region, although overall affected area decreased by over 50,000 hectares, to 183,167 hectares. Infestations in the Headwaters and Okanagan Shuswap Districts accounted for over 60% of the red attack mapped.

Western Spruce Budworm, *Choristoneura occidentalis*

Reduced damage levels were seen across much of the Chilcotin, Central Cariboo, 100 Mile House, and central Okanagan Shuswap Districts, and overall defoliated area declined, from 760,000 hectares in 2009, to 499,100 hectares in 2010. Populations expanded in the Kamloops and Quesnel Districts. Unseasonable weather led to poorly sychronized larval and foliage development in many areas, with resulting lowered damage levels. The proportion of defoliated area classified as moderate or severe fell to just over 10%. No defoliation was mapped in the Kootenays, although trace defoliation was visible from the ground in several locations between Midway and Bridesville.

Predictive egg mass sampling was carried out in the fall at 643 sites in the Region. 89% of all sites were positive for egg masses, indicating that defoliation should remain widespread in 2011 (Table 8). The highest budworm populations in 2011 are expected to be in the Marguerite, Tingley Creek, Mackin Creek, Alexis Creek, Spences Bridge, Monte Creek, Tulameen, McCulloch Road, Peachland Creek, Trout Creek, and Belgie Creek-Sunday Summit areas.

47,687 hectares of high-priority stands were treated with Foray 48B (active ingredient *B.t.k.*) between June 22 - 27. A comprehensive report on the 2010 spray program can be found in the Special Projects section of this report.

Table 8. Summary of 2010 western spruce budworm egg mass sampling in the Southern Interior Region, showing 2011 defoliation predictions.

Forest	# of sites in each defoliation category				Total number	Average # egg
District	Nil	Light	Moderate	Severe	of sites	masses/10m² foliage*
100 Mile House	17	72	3	0	92	18.0
Central Cariboo	6	51	15	1	73	35.0
Chilcotin Forest	5	7	3	0	15	24.8
Quesnel Forest	0	1	2	2	5	110.8
Cascades Forest	16	130	39	1	186	32.0
Kamloops Forest	23	165	14	0	202	19.3
Okanagan Shuswap	0	37	20	0	57	46.7
Chilliwack	1	10	2	0	13	24.4
Total	**68**	**473**	**98**	**4**	**643**	**38.9**
percent of sites	(11%)	(74%)	(15%)	(<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

Douglas-fir stand heavily defoliated by western spruce budworm near Richter Mountain, Okanagan Shuswap District.

Western Hemlock Looper, *Lambdina fiscellaria lugubrosa*

Scattered defoliation was detected in Wells Gray Park, and in isolated locations around the Albreda River, Blue River, and Lake Revelstoke areas. Most of the 3,035 hectares of defoliation was very light, barely visible from the air.

Traps at the 6-trap cluster sites are deployed in mid- July at the time of tree-beatings in 27 of 41 Permanent Sampling Sites established to monitor western hemlock looper populations. Traps are collected in late September/early October. Hemlock looper moth catches increased at all eleven 6-trap cluster sites in the Columbia District, increasing from a district average of 69.5 moths/trap to 346.5 moths/trap (Figure 5; Table 9). Trap catches remained static overall in the Okanagan but individual sites showed significant change from 2009 (Table 9). The Three Valley Lake site had the most noticeable increase from 85 moths/trap to 849 moths per trap in 2009 and 2010, respectively. Moths caught at the Yard Creek Site decreased by about half from 2009 to 2010 and the two Perry River sites saw an increase at the lower site (623 to 801 moths/trap in 2009 and 2010, respectively), and a decrease at the upper site (714 to 510 moths/trap in 2009 and 2010, respectively). 2010 trap catches declined at all 6 sites in the Headwaters District (Figure 5; Table 9).

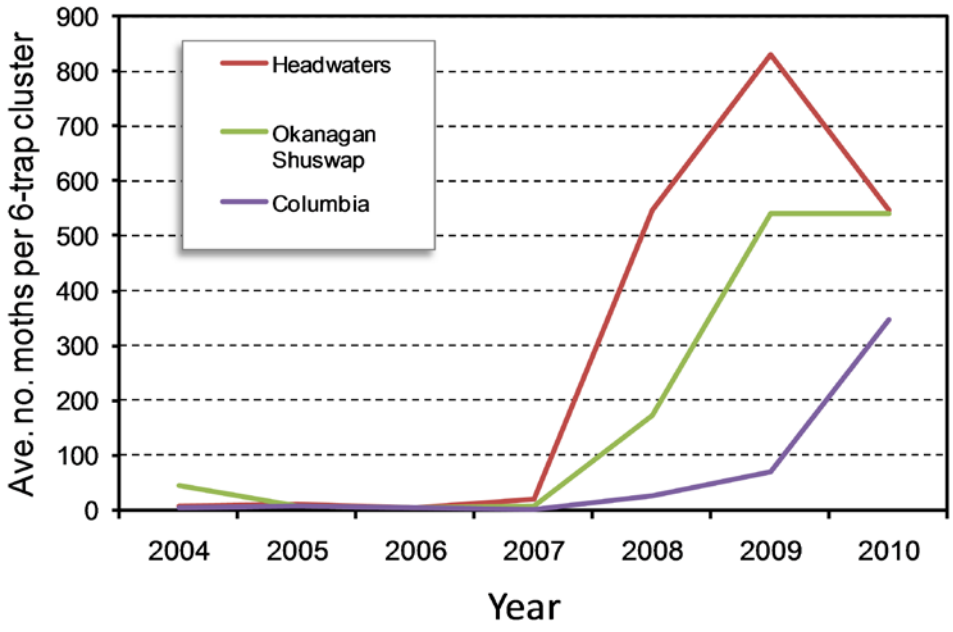


Figure 5. Trend over time of hemlock looper moths caught per trap at 6-trap cluster sites, averaged by District.

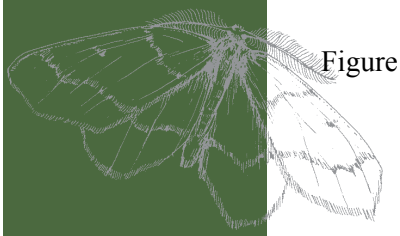


Table 9. Average number of western hemlock looper moths caught per trap at permanent trapping sites (6-trap clusters at each site) from 2004 to 2010.

			Average Trap Catches						
Site	**District**	**Location**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
1	Headwaters	Serpentine Creek	3.5	11.7	2.2	14.0	232.3	897.7	325
2	Headwaters	Thunder River	10.8	8.8	3.0	44.0	864.0	729.5	575
3	Headwaters	Mud Lake	13.2	7.0	4.0	14.2	310.3	1,070.4	574
4	Headwaters	Murtle Lake Road	8.5	11.3	12.0	21.2	575.7	1,218.5	968
5	Headwaters	Finn Creek	1.7	7.0	3.8	6.2	781.0	449.7	312
17	Headwaters	Adams River	1.3	9.7	3.2	13.2	512.2	612.7	534
	District average		**6.5**	**9.3**	**4.7**	**18.8**	**545.9**	**829.7**	**548.0**
7	Okanagan	Scotch Creek	4.5	0.8	2.8	6.2	106.8	621.0	610
8	Okanagan	Yard Creek Road	0.2	0.7	11.7	3.5	66.3	804.5	417
9	Okanagan	Crazy Creek Road	4.2	4.5	0.5	6.7	153.7	logged	438
10	Okanagan	Perry River North	75.0	8.2	6.0	18.0	206.2	713.7	510
11	Okanagan	Three Valley Lake	25.5	21.3	4.5	9.2	169.2	85.3	849
12	Okanagan	Perry River South	30.0	6.0	3.7	9.2	82.5	623.3	801
13	Okanagan	Kingfisher Creek	8.7	10.2	3.3	5.3	227.0	535.2	316
14	Okanagan	Noisy Creek	4.8	24.8	1.7	10.2	605.8	697.7	525
15	Okanagan	Shuswap River ER	107.3	3.0	1.7	2.8	72.3	340.8	416
16	Okanagan	Greenbush Lake	192.3	0.3	1.8	0.0	29.3	450.3	533
	District average		**45.3**	**8.0**	**3.8**	**7.1**	**171.9**	**541.3**	**541.5**
66	Columbia	Sutherland Falls	2.5	2.5	1	1.2	28.8	30.3	221
72	Columbia	Tangier FSR/Trout Lake	7	6.2	2	1.2	22.2	75.3	383
73	Columbia	Martha Creek	16.6	7.7	2.2	0.8	8.0	6.0	259
74	Columbia	Goldstream River	2.2	5.3	3.8	2.8	4.0	80.5	302
75	Columbia	Downie Creek	no traps	1.3	1.3	1.0	29.5	60.2	372
76	Columbia	Bigmouth Creek	2.3	8.5	13.4	0.7	9.3	29.5	318
78	Columbia	Carnes Creek	1.2	4.3	1.5	1.2	16.2	30.5	312
83	Columbia	Begbie Creek	9.2	12.7	2.5	1.2	24.5	55.0	550
84	Columbia	Pitt Crk Rec Site	1.8	1	2.6	1.8	15.7	130.2	431
85	Columbia	Kinbasket Lk/Redrock	1.8	22.7	17.3	7.5	89.2	237.2	468
87	Columbia	Jumping Creek	3.3	9.4	0.5	1.0	27.3	30.0	196
	District average		**4.8**	**7.4**	**4.4**	**1.9**	**25.0**	**69.5**	**346.5**

Western hemlock looper moths.

In addition to the trapping, three-tree beatings are conducted at 41 permanent sample plots when western hemlock looper is in the late larval instar. A 2.1m by 2.75m tarp is placed under a tree and three lower branches are beaten with a 2.5m pole. This sampling technique is conducted on three trees of the leading species for the area that are in close proximity to each other. Insects caught on the beating sheet are recorded by species and quantity.

The most common and abundant defoliator was sawflies, found in 83% of the sites with an average of 40.2 larvae per positive site. Sawflies have been found in more abundance over the past three years in the 3-tree beatings within the Region (Figure 6); more so than the western hemlock looper. This could be in part due to the feeding habits of the two insects. Defoliation was only recorded at 2 sites, Yard Creek and Greenbush Lake, where sawfly feeding led to trace defoliation. Very few other defoliators were recorded at any of sites. Western hemlock looper larvae were recorded at 78% of the sampled sites with an average of 8.9 larvae per positive site (Figure 6). The highest levels were at Thunder River where 67 larvae were recorded. Larvae were found at all 6 sites in the Headwaters District, 9 out of 10 sites in the Okanagan, and 17 out of 25 sites in the Selkirk District. Larval numbers increased at most of the positive sites, with the highest numbers found in the North Thompson, Scotch Creek, Crazy Creek and 3 Valley Lake areas (ranging from 12 to 67 larvae per site) (Table 10). Additional defoliation from western hemlock looper and sawflies may occur in 2011.

Birch leaf miner(s) activity was noted while conducting the 3-tree beating sample. Symptoms of birch leaf miner(s) were prevalent throughout the host range in the Kootenay-Columbia area, with the majority of defoliation being either moderate or severe. Thinning crowns were noted in stands of semi-mature to overmature western red cedar from Downie Creek south to Revelstoke. Causal agent was not determined but symptoms appear typical of that induced by drought, or foliar disease.

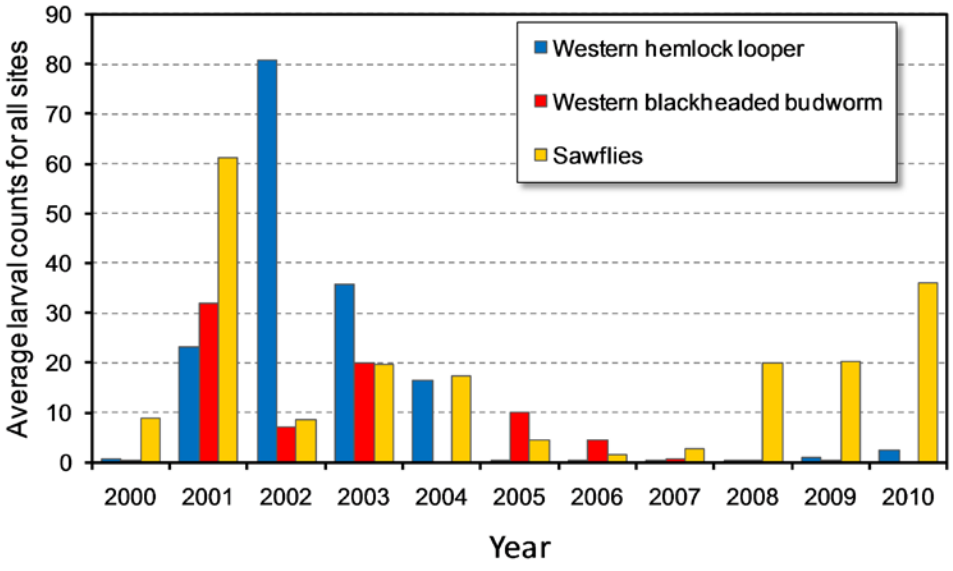


Figure 6. Trends of the three most common defoliators found in the 3-tree beatings (2000-2010) showing average larvae per 3-tree beating, averaged for all sites by year.

Table 10. Summary of defoliators collected at 41 western hemlock looper monitoring sites in the southern interior in the 2010 3-tree beating surveys.

Site #	Location	Western Hemlock Looper	Blackheaded budworm	Sawflies	Greenstriped forest looper	Western false hemlock looper	Grey spruce looper	Saddleback Looper
1	Serpentine Creek	25	0	0	1	0	0	1
2	Thunder River	67	0	14	0	0	0	1
3	Mud Lake	16	0	19	0	0	0	0
4	Murtle Lake	25	0	87	0	0	0	2
5	Finn Creek	15	0	0	0	0	0	0
7	Scotch Creek	12	0	1	0	0	0	0
8	Yard Creek	0	0	48	0	0	0	0
9	Crazy Creek	13	0	1	0	0	0	0
10	Perry River North	4	1	1	0	0	0	0
11	3 Valley Lake	26	2	6	0	1	0	1
12	Perry River South	4	0	2	0	0	0	0
13	Kingfisher Creek	1	0	1	0	0	0	0
14	Noisy Creek	7	0	2	0	0	0	2
15	Shuswap River	1	0	28	0	0	0	2
16	Greenbush Lake	6	0	252	0	0	0	0
17	Tum Tum	6	0	0	0	0	0	0
Kamloops Region Total		**228**	**3**	**462**	**1**	**1**	**0**	**9**
30	Keen Creek	0	0	75	0	0	1	0
38	Hills	1	0	15	0	0	0	0
58	Halfway River	0	0	0	0	0	0	0
61	Box Lake	1	0	176	0	0	0	1
62	Kuskanax Creek	7	0	2	0	3	0	0
65	Shelter Bay Ferry	0	0	34	0	0	0	0
66	Sutherland Falls	2	0	0	1	1	0	0
69	Quartz Creek	1	0	22	0	0	0	0
70	Gerrad	1	0	31	0	0	0	0
71	Trout Lake	0	0	116	1	0	0	0
72	Tangier FSR	10	0	11	0	0	0	0
73	Martha Creek	1	0	43	0	0	0	0
74	Goldstream River	2	0	17	0	0	0	0
75	Downie Creek	0	0	13	0	0	0	0
76	Bigmouth Creek	5	0	1	0	0	0	0
78	Carnes Creek	7	0	0	0	0	0	0
79	Lardeau FSR	0	0	22	0	0	0	0
80	Meadow Creek	0	0	12	0	0	0	0
81	Schroeder Creek	0	0	2	0	0	0	0
82	Beaton	2	0	0	0	0	0	0
83	Begbie Creek	1	0	26	0	0	0	1
84	Pitt Crk Rec Site	1	0	31	0	0	0	0
85	Kinbasket Lake	5	0	12	0	0	0	0
86	Beaver River	11	0	200	0	0	0	0
87	Jumping Creek	1	0	38	0	0	0	0
Kootenay-Columbia Total		**59**	**0**	**899**	**2**	**4**	**1**	**2**

Douglas-fir Tussock Moth, *Orgyia pseudotsugata*

After three years of outbreak, the Douglas-fir tussock moth infestation appears to have peaked. Total infested area declined slightly, to 16,303 hectares, although damage levels increased, with 94% of the defoliation being rated as moderate or severe. New infestations were seen throughout the Deadman River, Sabiston Creek, Battle Creek, Cache Creek, Hat Creek, Veasy Lake, and Marble Canyon areas. Extensive severe defoliation and additional tree mortality was seen in most of these areas. The current outbreak has now become the largest on record in B.C., with 36,500 hectares of defoliation mapped since 2007, despite aggressive spray programs in 2008 - 2010. The 1981 - 1984 outbreak resulted in 31,844 hectares of defoliation. There will probably be defoliation in 2011 but it will likely be more sporadic than previous years. 2011 should be the last year of significant damage.

Extensive severe Douglas-fir tussock moth defoliation, Deadman River, Kamloops District.

An aggressive spray program treated 7,023 hectares with nuclear polyhedrosis virus (NPV) and/or *B.t.k.*, which reduced larval populations and tree mortality in the Kelowna, Trepanier Creek, Indian Gardens Creek, Cherry Creek, Barnes Lake, Venables Lake, and Rock Creek areas. The Region's spray programs over the past three years have significantly reduced the size, severity, and length of infestations in the areas treated (14,555 ha sprayed with NPV or *B.t.k.* in current outbreak period). Moth trap catches at the 21 permanent monitoring sites in the Kamloops, Okanagan, and Similkameen declined at most locations, although catches remained relatively high at sites west of Kamloops and near Kelowna. Twenty-two new permanent monitoring sites were established in the Cache Creek - Ashcroft and Similkameen areas. Additional trapping sites in the 100 Mile House District (31 sites) and the Arrow Boundary District (9 sites) caught low numbers of moths, averaging 1.7 and 2.5 moths per trap, respectively, down from 3.9 and 4.5 in 2009. A more detailed account of the 2010 spray program can be found in the Special Projects section at the end of this report.

Two-Year Cycle Budworm, *Choristoneura biennis*

Due to the life cycle of this defoliator, most of the damage is visible in alternating years. When comparing to the last "on" year of 2008, defoliation levels have increased substantially in the Quesnel and Central Cariboo Districts, and declined in the Headwaters District. For the first time since the 1990's, defoliation has been recorded in the Rocky Mountain District, on 3,130 hectares in the Flathead Valley. Total defoliated area in 2010 was 70,694 hectares.

Aspen Serpentine Leaf Miner, *Phyllocnistis populiella*

Aspen serpentine leaf miner defoliation was again very widespread. Affected area totaled 67,282 hectares, an increase of 30% from 2009. Generally, defoliation is only mapped when it becomes more pronounced and is readily visible from the air. The actual incidence of this insect at lower defoliation levels is much greater than that indicated by the overview survey results. Over half of all mapped areas were in the southern half of the Headwaters District.

Larch Needle Blight, *Hypodermella laricis*

Larch needle blight damage increased, from 1,840 hectares in 2009, to 3,317 hectares in 2010. Most of the affected stands were scattered through the Purcell and Selkirk Ranges in the Rocky Mountain, Arrow Boundary, and Kootenay Lake Districts. Despite some stands sustaining several years of damage, little mortality has occurred in either western or alpine larch.

Severely defoliated alpine larch in 2008 typical of areas identified in the Doctor, Alton, Findlay, and Dutch drainages. The areas have recovered as of 2010, with little mortality noted.

Forest tent caterpillar pupal case.

Forest Tent Caterpillar, *Malacosoma disstria*

Forest tent caterpillar was recorded on 37,844 hectares in 2010, up from 28,642 hectares in 2009. The outbreak east of Quesnel continued to expand in both extent and severity. Defoliation was recorded on 34,863 hectares at this location, over 15,000 of which were classified as moderate or severe. Two other small outbreaks were detected near Shuswap Lake in the Okanagan Shuswap, and Mount Robson Park in the Headwaters District. Little permanent damage is expected.

Birch Leaf Miner, *Fenusa pusilla*

Birch leaf miner defoliation was mapped on 8,418 hectares, the highest level since 2003. Damage was quite scattered throughout the West Kootenays and the Monashees, with the majority in the Arrow Boundary, Okanagan Shuswap, and Kootenay Lake Districts.

Gypsy Moth, *Lymantria dispar*

The BC Government, in co-operation with the Canadian Food Inspection Agency and the Canadian Forestry Service, monitors for occurrence of European gypsy moth at many sites throughout the southern interior, such as woodland recreation sites and other small venues. One European gypsy moth was confirmed from a pheromone trap site at Kokanee Creek Park in 2009. A subsequent delimit trapping grid (16 traps in a square mile) at that site in 2010 did not catch any moths, however two were caught outside the grid in two other nearby traps - one along Kokanee Glacier Road, and one along Busk Creek Road. Delimiting grids should be installed at each of these two sites in 2011.

Windthrow

Scattered pockets of windthrow were mapped in most Districts, with the highest areas in the Columbia and Rocky Mountain Districts. There is an expanding spruce beetle population near Fenwick Creek (in the Rocky Mountain District), which may be exacerbated by windthrow.

Drought Damage

Drought related mortality and top-kill was mapped on 388 hectares near Lillooet. Douglas-fir was the most commonly affected species, although western red cedar was killed in a small area near the Bridge River Canyon.

Slides/Avalanche Tracks

Slide and avalanche damage was mostly limited to higher elevation spruce-balsam stands in the Kootenays. While there was little impact as far as direct timber volume losses due to the low total affected area (271 hectares), there is potential for localized spruce beetle populations to build up near these sites.

Wildfire

Widfire activity was high again in 2010, with over 150,000 hectares affected. The vast majority of the burned area was in the Cariboo, where several very large fires occurred in the Alexis Creek, Mackin Creek, Anahim Lake, and Blackwater River areas. Most of the burned stands were grey lodgepole pine, killed by the mountain pine beetle over the previous several years; however, there were also large areas of burned and fire-damaged Douglas-fir, which may lead to increases in Douglas-fir beetle populations.

Other

Other forest health agents observed during the aerial overview surveys included 220 hectares of light false hemlock looper south of Canal Flats, 155 hectares of light western blackheaded budworm north of Creston, 6 hectares of larch casebearer in the upper Elk River, 10 hectares of satin moth in the Kamloops and Okanagan Shuswap Districts, 20 hectares of pine needle cast in the Cascades District, 82 hectares of black bear damage, and 2 hectares of porcupine damage.

Kootenay Boundary Area Summary

The Kootenay-Boundary portion of the 2010 aerial overview survey was conducted between July 17, 2010 and August 11, 2010. Total flying time was 88 hours, conducted over 18 flight days. Surveys covered the entire land base, including National Parks, within the Arrow Boundary, Columbia, Kootenay Lake, and Rocky Mountain Forest Districts. Approximately 6.2 million hectares were surveyed. The surveyors were Dave Robertson of Purcell Resources Inc., and Neil Emery of Nazca Consulting Ltd.

Arrow Boundary Forest District

Mountain Pine Beetle

Area affected by mountain pine beetle has continued to decline, for the second year in a row. A total of 18,731 hectares of red attack were mapped, down significantly from 2009 levels of 42,723 hectares. The number of spot infestations also declined, from 1,650 (20,215 trees) to 1,288 (17,250 trees). Despite this general decline, beetle populations are still active in nearly all areas of the District. The heaviest attack was seen in the upper Granby River and Inonoaklin Creek areas. Damage to young stands and other species of pine remains rare - only a single young stand, 50 hectares of whitebark pine, and scattered spots of ponderosa pine were recorded as being attacked.

Douglas-fir Beetle

Douglas-fir beetle was recorded on just 100 hectares, with a further 67 spot infestations. The most active area of Douglas-fir beetle continued to be north of Midway, in the Ingram and Copper Creek Forest Service Road areas. The east slopes of Trout Lake also had a significant amount of Douglas-fir beetle activity.

Douglas-fir beetle was well established and current green attack was easily found at most locations checked in the field, despite the generally low beetle populations in the District.

Western Balsam Bark Beetle

Western balsam bark beetle damage was down almost 65% from 2009 levels, to 2,677 hectares. Mortality was nearly all classified as trace (<1% red attack), and was scattered across the northern two-thirds of the District.

Aspen Serpentine Leaf Miner

Damage caused by aspen serpentine leaf miner more than doubled, to 3,010 hectares. The majority of this occurred in the Arrow TSA, with the largest concentrations occurring in the Wilson Creek, Beaton Creek, and Halfway River areas. Only scattered small polygons occurred in other areas of the TSA. Little damage was seen in the Trail - Rossland area, where was prevalent in 2009.

Birch Leaf Miner

Birch leaf miner was common throughout host range in the survey area, affecting 2,748 hectares, up substantially from the 187 hectares reported in 2009. Areas most affected were west of Little Slocan Lakes in Hoder and Bannock Burn Creeks. Smaller polygons were observed on the slopes of Slocan Lake as well as in the Wilson Creek area. Areas with severe defoliation and top-kill were noted on Highway 3 between Christina Lake and the Blueberry Paulson Bridge, particularly near Josh Creek, and near Blazed Creek just west of Creston.

Douglas-fir Tussock Moth

Defoliation by Douglas-fir tussock moth has occurred in the Rock Creek area since 2008, with some mortality of mature trees. Defoliation levels increased in 2009, and occuring in Rock Creek, two larger patches west of Rock Creek, and east of Midway. Ground surveys were conducted in these areas in the fall of 2009 to determine egg mass levels and predict defoliation in 2010. Although some naturally occurring Nuclear Polyhedrosis Virus (NPV) disease was noted in ground surveys in the fall of 2009, populations appeared generally healthy. Consequently, a spray program was conducted in June 2010 to treat 164 hectares of the most seriously infested areas with NPV. Subsequent to the spray, populations appeared to have declined, with only a few trees visibly defoliated on private property just east of Rock Creek. None of the defoliation was visible during the aerial overview surveys.

In addition to the overview flight, nine permanent sample sites were monitored for defoliators in the southern part of the Arrow Boundary District, using three-tree beatings and pheromone traps. These sites were formerly maintained by the Forest Insect and Disease Survey unit of the Canadian Forest Service, and were re-established by the Ministry of Forests in 2009. These sites now augment our annual monitoring program for defoliators. Douglas-fir tussock moth larvae were not found in 3-tree beatings at any of the permanent sample sites in 2010. Total moth catch declined from 128 in 2009 to only 19 in 2010, suggesting a significant population decline.

Larch Needle Blight

Larch needle blight damage was mapped on 948 hectares, up from 413 hectares in 2009. The majority was scattered throughout the Arrow TSA, primarily on western larch in older cutblocks. It was recorded in Smallwood Creek, Coffee Creek, Keen Creek, and the Slocan Valley, scattered in a few cutblocks in each area. Occurrence elsewhere in the District was not extensive or severe. Ground surveys indicated light infections on some cutblocks in the Castlegar area.

Douglas-fir tussock moth pheromone trap, Kettle River Provincial Park, Arrow Boundary Forest District.

Windthrow

Windthrow damage was recorded on 318 hectares, predominantly in the Arrow TSA. The largest area was on the southwest side of Slocan Lake between Evans and Gwilliam Creeks, in beetle-killed pine. The remaining new windthrow was scattered throughout the District in small insignificant patches.

Other

Other damage recorded by the aerial overview surveys included 147 hectares of wildfire, and 6.2 ha flooding. Scattered single tree mortality of mature Douglas-fir was evident during ground surveys, along Highway 3 between Eholt and Grand Forks. The symptoms were somewhat indicative of root disease but may also be due to drought and/or secondary insects. The pattern was not typical of Douglas-fir beetle.

Columbia Forest District

Mountain Pine Beetle

Area affected by mountain pine beetle has continued to decline, from 18,740 hectares in 2009, to 12,609 hectares in 2010. The severity of attack has also declined, with the proportion of moderate and severe attack dropping from 44% to 30%. Although overall area and severity was down, there are still large continuous areas of red attack in Yoho and Kootenay National Parks, and there was an increase in small spot infestations in the Golden, Donald, and Arrow Lake areas.

Whitebark pine was killed on 377 hectares, primarily at high elevations along the southern reaches of Kinbasket Lake.

Western Balsam Bark Beetle

Mortality in subalpine fir from western balsam bark beetle has declined, from 6,800 hectares in 2009, to 2,158 hectares. Although mortality is widespread across most high elevation areas of the District, populations are relatively low and mortality is scattered in small patches and spots.

Douglas-fir Beetle

Douglas-fir beetle incidence more than doubled, to 543 hectares. Most of the increased mortality was in the Revelstoke, Beaverfoot River, and Kootenay Crossing areas. Most infestations were scattered in small polygons or spot infestations of 5-50 trees.

Spruce Beetle

Spruce beetle activity was limited to two spot infestations on the west side of Lake Revelstoke.

Douglas-fir beetle on the upper west facing slopes of the Beaverfoot River valley, Columbia District.

Western Hemlock Looper

Ten small pockets of light defoliation, totalling 358 hectares, were mapped along the east side of Lake Revelstoke. Ground checks of larval population levels were not done, as the sites were limited to boat access. Trap catches at the 11 permanent pheromone trapping sites increased five-fold, from 69.5 to 346.5. The largest increases were noted in traps near Revelstoke, Carnes Creek, Martha Creek, Begbie Creek, and Sutherland Falls. Three-tree beatings were also conducted at these sites as well as 14 additional sites. 17 of the 25 sites were positive for western hemlock looper larvae, although absolute numbers remained low at and averaged 1.9 larvae per site. No defoliation was visible from the ground at any of the sites.

Aspen Serpentine Leaf Miner

For the second year in a row there was a significant increase in the occurrence of aspen serpentine leaf miner, affecting 5,840 hectares, up 66% from the 3,516 hectares recorded in 2009, and 240 hectares recorded in 2008. The most significant areas affected were the slopes on the east shore of Lake Revelstoke from Revelstoke to Downie Loop, the slopes on the east shore of Upper Arrow Lake from Revelstoke to the Beaton Arm, the Incomappleux River, and the Blackwater Creek area on the southeast side of Kinbasket Lake, northwest of Bluewater Creek.

Extensive blowdown, headwaters of the Kootenay River, Columbia District.

Windthrow

The overview flights recorded a total of 942 hectares of new windthrow. The more extensive areas included Carnes Creek, the western side of Kinbasket Lake, northwest of Donald, the Illecillewaet River west of Rogers Pass, and the headwaters of the Kootenay River. The most common species affected was Douglas-fir, which could lead to increased Douglas-fir beetle populations, as several of the sites were in close proximity to stands with active beetle.

Other

Other forest health factors mapped during the surveys were 839 hectares of birch leaf miner, 65 hectares of slide damage, and 181 hectares of larch needle blight.

Ground observations noted small patches of trembling aspen defoliated by satin moth along the Columbia River corridor, from Harrogate to just south of Golden. Discoloration of willow foliage was also significant in this area, possibly caused by a leaf miner. Thinning crowns were noted in stands of semi-mature to overmature western red cedar between Downie Creek and Revelstoke. Causal agent was not determined but symptoms appear typical of that induced by drought.

Satin moth pupa near Golden, Columbia District.

Mountain Pine Beetle

Area affected by mountain pine beetle has remained virtually unchanged, at 51,391 hectares. The proportion of area in each severity category has also remained similar to 2009. Beetle populations are active in most areas of the District, with new red attack being mapped nearly everywhere. The attack pattern in most areas is very widespread and scattered - the average polygon size was just 14.9 hectares, the lowest in the South, with 3,457 separate polygons and an additional 2,366 spot infestations. Significant mountain pine beetle populations occurred in Redding, Meachan, Hellroaring, and Perry Creeks, north to Toby Creek, and all other areas on the west side of the Kootenay/Columbia valley from Kimberly to Invermere; from Sparwood north up the Elk River valley; sections of the Kootenay River/Cross River/Mitchell Creek area; and the Bull River. The only areas still experiencing low levels of red attack were The Flathead River - Wigwam River area, and the extreme southern portions of the District, where most beetle activity was limited to very scattered spot infestations. Ground surveys conducted so far during the fall of 2010 have found green: red ratios averaging 1:1 (range 0.4 – 2.1), which indicates population spread has slowed this year. This will increase the effectiveness of suppression activities in the District.

Trace and light red attack was recorded on 49 hectares in young lodgepole pine stands, near Canal Flats,White River, and St. Marys River. Very little beetle activity was observed in plantations during ground checks in other areas.

Whitebark pine was killed on 1,084 hectares, and ponderosa pine were killed in scattered spots in the Rocky Mountain Trench between Wardner and Roosville.

Douglas-Fir Beetle

Total area affected by Douglas-fir beetle has nearly tripled, from 433 hectares in 2009, to 1,268 hectares in 2010. An additional 75 spot infestations were mapped. The most significant increase occurred in Kootenay National Park, where 70% of the attacked area was located. Other areas of significant red attack were near Elkford, Grasmere, Whiteswan Lake, and Kishinena Creek.

Spruce Beetle

The spruce beetle infestation in Fenwick Creek has continued to expand, and total affected area increased to 517 hectares. Most host polygons in this drainage have been attacked, and the beetle population has spread into the neighbouring drainage of the North White River. Ground surveys have found an average green:red ratio of 2:1 (range 0.7 - 3.1), and an additional 50 hectares of green attack in other areas of the District. The increased spruce beetle activity has resulted in the strategies for 13 Beetle Management Units being changed from Monitor to Suppression, and the Fenwick Creek unit to Holding Action.

Current spruce beetle attack at the north-west end of Fenwick Creek, Rocky Mountain District.

Western Balsam Bark Beetle

Western balsam bark beetle infestations have remained relatively constant, at 4,003 hectares. Most of the attack was in small polygons and spot infestations at high elevations, and was scattered throughout the District in high elevation balsam-spruce stands.

Two-Year Cycle Budworm

A significant infestation of a spruce budworm was detected in the Flathead Valley. A total of 952 hectares of low severity and 2,175 hectares of moderate severity defoliation were mapped, with 4 drainages having the majority of attack: Couldrey; Cabin; Howell; and the Flathead River from Howell in the south to Tombstone Mountain in the north. The area was ground checked and pupal samples were collected, however definitive identification of the budworm species, which is likely two-year cycle budworm but may be western spruce budworm, will not be made until further samples can be collected in 2011.

Moderate defoliation from two-year cycle Budworm, Flathead Valley, Rocky Mountain District, August 2010.

Larch Needle Blight

Larch needle blight damage has remained at low levels compared to the 2006-2008 period. Lightly defoliated stands were scattered at both high elevations and valley bottoms, mainly in the Brewer Creek, Findlay Creek, Skookumchuck Creek, St. Marys River, and Lamb Creek areas. Both immature and mature stands were affected, and no mortality was seen.

Larch Casebearer

Larch casebearer caused 6 hectares of light defoliation in an immature western larch stand in the upper Elk River valley. This is the first visible damage in British Columbia since 1994. Populations of larch casebearer have remained at endemic levels in British Columbia since the early 1990's, after a successful parasitoid introduction program that was carried out between 1969 and 1984.

Western False Hemlock Looper

Western false hemlock looper defoliated 220 hectares of Douglas-fir near Fairmont and Canal Flats. Damage levels were light.

Windthrow

Windthrow was recorded on 681 hectares. The most impacted areas were the North White River, Lussier River, Albert River, and Wigwam River areas. Several of the damaged stands are near active spruce beetle and Douglas-fir beetle populations and may promote population increases.

Other

Other forest health factors observed were 280 hectares of aspen serpentine leaf miner defoliation, 6 hectares of birch leaf miner defoliation, 63 hectares of slide damage, 17 hectares of flooding mortality, and 70 hectares of animal damage (bear and porcupine feeding) in young lodgepole pine stands.

Bear damage in lodgepole pine, Fenwick Creek, Rocky Mountain District.

Slide and subsequent flooding damage, Blackfoot Creek, Rocky Mountain District.

Kootenay Lake Forest District

Mountain Pine Beetle

Although the overall red attacked area fell only slightly (from 24,758 hectares in 2009 to 22,063 hectares in 2010), the intensity of attack declined significantly. The proportion of attack classed as severe and very severe fell from 16.7% to 4.6%. Areas that continued to experience significant mountain pine beetle attack included West Arm Park and Grohman Creek near Nelson, Stagleap and Sheep Creeks East of Salmo, the west side of Kootenay Lake from Elmo Creek north to Midge Creek, the east side of Kootenay Lake from Sanca Creek north to Argenta, and Glacier Creek north of Argenta. Lower levels of activity were seen south of Highway 3, where most attack was in scattered small polygons and spot infestations. The Hawkins Creek, Kid Creek, and Yahk area continued to have very low levels of scattered beetle activity. This was of particular note given the high percentage of mature pine in these stands. Green:red attack ratios averaged 1:1 in the District, which indicates a stable population.

Whitebark pine was killed on 472 hectares, and ponderosa pine was killed in a few scattered spots near Nelson and Crawford Bay. No attack was observed in young lodgepole pine.

Western Balsam Bark Beetle

Western balsam bark beetle attack continues to be quite scattered, and was recorded on 1,552 hectares. All of the damage was trace or light.

Douglas-Fir Beetle

Red attack levels were up in the Trout Lake, Argenta, Kaslo, and Ainsworth areas. The overall area affected nearly tripled, from 106 hectares in 2009, to 309 hectares in 2010. An additional 40 spot infestations of 5-50 trees were mapped.

Birch Leaf Miner

Birch leaf miner affected 1,797 hectares of paper birch, in areas scattered throughout the District. The foliage discoloration was quite noticeable from the air; about half of the area was rated moderate, while the other half was low.

Birch leaf miner defoliation, Duncan River, Kootenay Lake District.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner defoliated 1,268 hectares of trembling aspen near Meadow Creek and Kaslo Creek. Defoliation was also common in these areas in 2009, but no tree mortality has been noted.

Gypsy Moth

One European gypsy moth was confirmed from a pheromone trap site at Kokanee Creek Park in 2009. A subsequent delimit trapping grid (16 traps in a square mile) at that site in 2010 did not catch any moths, however two were caught outside the grid in two nearby traps - one along Kokanee Glacier Road, and one along Busk Creek Road. Delimiting grids should be installed at each of these two sites in 2011.

Larch Needle Blight

There was an increase from just 17 hectares in 2009 to 337 hectares in 2010, but this is low compared to levels mappd in 2006-2008. To date no significant mortality of larch at either low elevations or high alpine has been noted from the air or the ground.

Western Blackheaded Budworm

Western blackheaded budworm defoliation was mapped on 155 hectares in the Duck Creek area, just north of Wyndell.

Other

Other forest health agents recorded during the aerial surveys were 5 hectares of light western hemlock looper defoliation on the southwestern side of Trout Lake; 337 hectares of larch needle blight; 262 hectares of windthrow (mostly near Yahk); 31 hectares of slide and avalanche damage; 13 hectares of bear damage in plantations; and, 3.5 hectares of flooding mortality.

Kamloops Area Summary

The Kamloops portion of the aerial overview surveys was conducted between July 19th and 29th, 2010, and required 52.0 hours of flight time over 10 days. Surveys covered the Kamloops, Lillooet, Merritt, and Okanagan TSA's. One small portion of the Lillooet TSA was not covered due to an aircraft restriction in place around the Jade Fire in the Yalakom Valley. Weather conditions for the surveys were generally good, with most days being clear and cloud-free. The timing of the surveys proved optimal, as extremely thick smoke from a series of large fires in central B.C. moved into the survey area at the end of the last day of surveys. All surveys were conducted by Kevin Buxton (Ministry of Natural Resource Operations) and Janice Hodge (JCH Forest Pest Management), and utilized both Cessna 206 and 205 aircraft, operated by Westair Aviation (Kamloops) and Southern Skies Aviation (Penticton), respectively.

Mountain Pine Beetle

Mountain pine beetle populations have declined to very low levels throughout most of the District, and new red attack was only mapped on 9,334 hectares. The current outbreak peaked in the District in 2006 and 2007, when infested area was over 320,000 hectares. Most susceptible stands sustained high levels of attack over this period and these areas now have a very high component of grey pine. Most of the areas with currently active beetle populations were in the Hat Creek, Two Springs Creek, and Maiden Creek areas. Attack in lodgepole pine plantations has declined sharply, to just 372 hectares, from a high of over 18,000 hectares in 2008. Ponderosa pine stands have also sustained high levels of mortality over the last several years, but infestation levels are down to just 1,778 hectares of mostly trace and light attack near the west end of Highland Valley.

Extensive grey attack stage pine, Mollimarn Lake area, Kamloops District, July 2010.

Same location as above photograph, taken in July 2007, showing extensive red attack stage pine.

Spruce Beetle

Spruce beetle attack declined by 25%, to 2,287 hectares. Most of the new attack was seen in areas that have been active over the last few years - Porcupine Meadows Provincial Park, Cahilty Creek, Tod Mountain, and Hat Creek - and these areas now have a high component of standing grey with declining rates of red attack. Ground checks in these locations found very low levels of fresh green attack. Aggressive salvage and sanitation harvesting has continued in the Cahilty Creek area. Other smaller infestations were noted in the Fadear Creek and Taweel Lake areas.

Western Balsam Bark Beetle

Western balsam bark beetle remain prevalent in the northern and eastern sections of the District. A total of 16,640 hectares of trace and light attack was mapped, most of which was in the Porcupine Meadows Park, Chu Chua Creek, Harp Mountain, Johnson Lake, Nikwikwai Creek, and Louis Creek areas.

Douglas-fir Beetle

The District has conduced an aggressive trap tree program over the past four years, and the salvage harvest clients have been very aggressive in harvesting as many accessible red and green attacked Douglas-fir as possible. As a result, attack levels have declined in the Scuitto Lake, Durand Creek, Deadman River, Criss Creek, Red Lake, Jamieson Creek, and Dairy Creek areas. Overall area attacked dropped from 1,554 hectares in 2009 to 543 hectares in 2010. The number of spot infestations has remained high, however, at 363 (2,890 trees), due to increases in the Barriere River, Adams Lake, Darfield, Little Fort, and Hat Creek areas. Green attack rates appear to be low, generally under 1:1, across much of the District.

Douglas-fir beetle attack centre near Louis Creek, Kamloops District.

Western Spruce Budworm

The declining trend seen in 2008-2009 was reversed in 2010, as western spruce budworm defoliation increased from 70,090 hectares to 116,255 hectares. Populations increased in several areas which have been treated with aerially applied *B.t.k.* in the past, especially Criss Creek, Red Lake, and Scuitto Lake; as well as in the Roche Lake, Stump Lake, and lower Hat Creek areas. Damage was likely even more widespread than indicated by the surveys, as weather patterns and host-insect synchrony were such that in many areas, much of the damage occurred in the lower crown of the trees, which is difficult to detect from the air.

Egg mass sampling surveys conducted in the fall of 2010 indicate that populations will remain at damaging levels in most areas in 2011, with the highest populations expected at Monte Creek, Whitecroft, Sabiston Creek, Deadman River, Tranquille River, and along Highway 5 beween the Walloper exit and the Timber Lake Road underpass.

Douglas-fir Tussock Moth

Overall area affected by the Douglas-fir tussock moth increased slightly, from 13,546 hectares in 2009, to 14,022 hectares in 2010. However, most of the defoliation occurred in new areas not previously infested, while populations crashed in many areas that were defoliated in 2008 and 2009. Defoliation was extensive and severe throughout the Sabiston Creek, Deadman River, Battle Creek, Walhachin, Pennie Lake, and Cache Creek areas, with additional but less extensive damage in the Tranquille River, Mara Hill, Cornwall Creek, Veasey Lake, and Venables Lake areas. The current outbreak is at the least, on par with the 1981 - 1984 outbreak in terms of extent and severity, and at least one more year of high populations is expected.

An aerial spray program conducted in June treated 1,112 hectares with nuclear polyhedrosis

Severe Douglas-fir tussock moth defoliation near Tsotin Lake, Kamloops District.

Understorey layers severely defoliated by Douglas-fir tussock moth near Pennie Lake, Kamloops District.

virus (NPV, TM Biocontrol-1), and 3,406 hectares with *B.t.k.* (Foray 48B) (2,186 hectares at Barnes Lake were treated with a double application). Good population reduction and foliage protection was achieved in most of the areas treated.

Egg mass ground surveys were conducted in the fall to assess population trends. High populations and heavy defoliation are expected to occur in the lower Hat Creek, Veasy Lake, and Cache Creek areas, while defoliation should be patchy, although locally heavy, in the Tsotin Lake, Battle Creek, Cultus Lake, and Sabiston Creek areas. Addtitional less severe defoliation may occur in the Durand Creek and lower Tranquille River areas. High priority areas will be considered for *B.t.k.* treatments in 2011.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner was common near Lemieux Creek, Taweel Lake, Eakin Creek, Harper Creek, and Louis Creek. Although individual trees were often heavily defoliated, trembling aspen was generally a scattered, minor component of the stands; as such, most polygons were classified as lightly defoliated.

Other

Other forest health agents detected during the surveys included 470 hectares of light two-year cycle budworm defoliation at Fadear Creek and upper Cahilty Creek, 530 hectares of light to moderate birch leaf miner defoliation near Adams Lake and Barriere Lake, and 1.2 hectares of satin moth damage near Oregon Jack Creek.

Cascades Forest District

Mountain Pine Beetle

Attack has declined to very low levels across the northern half of the Merritt TSA and much of the southern and southeastern portion of the Lillooet TSA, where host material has been largely depleted. Attack is still widespread across the southern half of the Merritt TSA, with extensive red attack in the Finnegan Creek, Shinish Creek, Spukunne Creek, Red Creek, Asp Creek, and Coldwater River areas. In the central, northern, and western portions of the Lillooet TSA, attack is still widespread, but is scattered and of lower intensity as the most suitable host material has been consumed, and beetle populations are increasingly pushed into areas with smaller trees, higher stem densities, and higher elevations. Overall affected area has dropped by nearly 60%, to 137,623 hectares.

Extensive grey attack mountain pine beetle in the mature component of a multi-aged lodgepole pine stand alongside the Coquihalla Connector, Cascades District.

Attack intensity also declined, with the proportion of attack classified as moderate, severe, or very severe down from 45% to 16% of the total affected area. The number of spot infestations doubled, to 512, which reflects the more diffused, scattered attack pattern that was seen in 2010.

Attack in ponderosa pine remains common, especially along the Fraser, Thompson, Nicola, and Coldwater Rivers, as well as in the Aspen Grove and Princeton areas. Just over 19,000 hectares were affected.

In the Lillooet TSA, whitebark pine was killed on 4,755 hectares. Affected stands were scattered at high elevations throughout the Stein River, Texas Creek, Cayoosh Creek, upper Bridge River, Slim Creek, Gun Creek, and Tyaughton Creek areas. Most of these whitebark pine stands have sustained high levels of mortality from mountain pine beetle over the last several years.

Ponderosa pine killed by mountain pine beetle south of Spences Bridge, Cascades District.

Attack in young lodgepole pine plantations has declined as a result of reduced beetle pressure, from 985 hectares in 2009, to 653 hectares in 2010. Most of the activity was near Helmer Lake, Pothole Creek, and Ketchan Lake. Additional red attack will likely be detected in the southern Merritt TSA in 2011, as ground surveys in the fall detected scattered fresh green attack.

Spruce Beetle

Attack levels have declined in most areas, especially in the Seton Lake, Lost Valley Creek, Downton Creek, Smith Creek, and Crater Mountain areas. A combination of host depletion, and an aggressive salvage harvesting program conduced by licensees in the south, have contributed to this general decline. As a result, overall affected area dropped from 2,960 hectares in 2009, to 601 hectares in 2010. Attack intensity remains high in most of the active areas, however, with over 96% of the areas being classified as moderate or severe.

Western Balsam Bark Beetle

Western balsam bark beetle remains in scattered pockets, across the western edge of the District. Overall affected area totalled 4,525 hectares, which is a decrease of nearly 50% from 2009 levels of 8,370 hectares. Nearly all areas were classified as trace (less than 1% current attack).

Douglas-fir Beetle

Douglas-fiir beetle remained active in the Lillooet TSA, especially in the Yalakom River, Seton Lake, Lillooet, Pavilion Lake, Fountain Valley, Stein River, and Siwhe Creek areas, and along the Fraser River between Leon Creek and French Bar Creek. Although the overall affected area decreased to 368 hectares, the number of spot infestations more than doubled, from 93 to 197. In most of the Merritt TSA, Douglas-fir beetle has remained at low levels, with only occasional small spot infestations.

Western Spruce Budworm

Overall area defoliated by western spruce budworm has remained relatively unchanged, at 146,120 hectares. Defoliation intensity declined in most areas, however, as the area classified as moderately or severely defoliated fell from 58,000 hectares to 16,438 hectares. The most heavily defoliated areas were in the Tulameen, Shakan Creek, Soap Lake, Murray Creek, Quilchena Creek, Mill Creek, Swakum Mountain, and Gun Lake areas. An aggressive spray program was conducted on 21,693 hectares, to reduce larval popualtions in chronically defoliated stands near Princeton, Otter Creek, Allison Creek, Merritt, and Mamit Lake. The spray program was successful, and reduced levels of defoliation were seen in all spray blocks, compared to surrounding untreated areas.

Egg mass survey efforts in the fall of 2010 were concentrated in the Merritt TSA, where 91% of sites sampled were positive for egg masses. In 2011, larval populations and defoliation levels defoliation are expected to be variable, with higher population levels and heavy defoliation near Tulameen, Quilchena Creek, Mount Hamilton, Spahomin Creek, Swakum Mountain, Mill Creek, Shackan, Soap Lake, Prospect Creek, and the Similkameen River corridor south of Princeton.

Chronic defoliation of Douglas-fir by western spruce budworm near Shackan Creek, Cascades District.

Douglas-fir Tussock Moth

Defoliation extent and intensity expanded in the Pavilion Lake, Fountain, Lillooet, Leon Creek, and Watson Bar-French Bar areas, while larval populations crashed in previously defoliated stands near Hedley and Nicola Lake. Egg mass surveys were conducted in the fall around Pavilion Lake, and the results predict continued heavy, but localized, defoliation in 2011. Naturally occurring nuclear polyhedrosis virus (NPV) activity was noted around the northern end of the lake, which may contribute to population declines in 2011. Aerial spraying using *B.t.k.* may be considered by the Ministry in 2011.

Douglas-fir tussock moth defoliation near Pavilion Lake, Cascades District.

Wildfire

Wildfire activity was relatively low in 2010, with a single large fire in the Yalakom Valley (near Shulaps Creek) accounting for the vast majority of the 2,810 hectares burned. Due to aircraft restrictions in the area around the fire, a small section of the District around Marshall Lake, Shulaps Creek, and Burkholder Creek could not be surveyed.

Drought

Light and scattered drought-related mortality was mapped on 388 hectares. Douglas-fir was the primary species affected in areas near Lillooet, Laluwissin Creek, and Texas Creek, while a mix of Douglas-fir and western red cedar was killed in the Bridge River canyon, just downstream of the Terzaghi Dam.

Other

Other forest health agents detected during th aerial surveys were 20 hectares of pine needle cast, 9 hectares of slide damage and 3 hectares of windthrow.

Okanagan Shuswap Forest District

Mountain Pine Beetle

Overall red attack area and intensity has dropped in the District, from 135,913 hectares (28% of which was moderate or greater), to 82,590 hectares (16% of which was moderate or greater). This was due to a combination of host depletion and salvage harvesting across the northern and west-central portions of the District. The beetle is still very active and expanding in other areas, such as the Trout Creek, Aberdeen Plateau, Mission Creek, and West Kettle River areas. A large increase in the number of small scattered infestations across the entire southeast, between Chute Lake and Anarchist Mountain, contributed to the 50% increase in the number of spot infestations, from 475 to 704.

A mix of new and old mountain pine beetle attack, Monashee Pass, Okanagan Shuswap District.

182 separate young stands, totalling 3,882 hectares, had visible red attack. Of these, 36 stands totalling 577 hectares experienced moderate or greater levels of attack. Most of the affected young stands were in the Terrace Mountain, Shorts Creek, Equesis Creek, Oyama Lake, and Aberdeen Plateau areas.

Ponderosa pine continues to be affected throughout the valley bottom areas, from Falkland south to the U.S. border, although overall attacked area declined from 10,775 hectares to 3,245 hectares. A few small pockets of western white pine mortality were observed in the Eagle River area.

Douglas-fir Beetle

Affected area, attack intensity, and spot infestation occurrence increased between 2009 and 2010. Expansions were seen in the Salmon River, Falkland, Shuswap Lake, Mabel Lake, and Ashnola River areas, while attack levels decreased near Cherryville, Sugar Lake, and Highway 33. The total area of red attack was 531 hectares, 62% of which was classified as moderate and severe. An additional 245 spot infestations were mapped, which killed an additional 1,890 trees. MCH was deployed in Darke Lake Provincial Park in an effort to reduce spread in the area.

Western Balsam Bark Beetle

Western balsam bark beetle remains active throughout much of the District, although overall area fell by 20% to 57,420 hectares. The most extensive areas were in the Greystokes, Pearson Creek, Mount Mara, Hunters Range and Shuswap Highlands areas. Nearly all of the attack was at trace levels.

Spruce Beetle

Several years of heavy tree mortality in and around Cathedral Park, Snowy Protected Area, and Crater Mountain has depleted most of the suitable host material in the area, and spruce beetle populations appear to have crashed. Just 130 hectares of new attack was observed in 2010, down from 5,240 hectares in 2009.

Grey attack stage spruce beetle, Cathedral Park, Okanagan Shuswap District.

Western Spruce Budworm

After two years of population expansion, the extent and severity of defoliation declined in 2010, from 70,090 hectares (16.3% of which was moderate or severe), to 40,896 hectares (4.4 % of which was moderate or severe). This decline was most evident near Vernon, Lake Country, and Chase Creek. Limited areas of moderate defoliation were seen near Reinecker Creek, Mount Kobau, and lower Snehumption Creek. Throughout much of the southern Okanagan, damage to the upper crowns of dominant trees was limited; this pattern of defoliation greatly restricts visibility from the air. Egg mass sampling was conducted in the fall at 57 sites, all of which were positive for egg masses. Moderate defoliation is expected in 2011 in the Trout creek, Peachland Creek, KLO Creek, Hydraulic Creek, Monte Lake, and Shuttleworth Creek areas.

Douglas-fir Tussock Moth

Douglas-fir tussock moth populations have crashed due to nuclear polyhedrosis virus (NPV) in most areas in the south of the District. New defoliation in and around Kelowna and Trepanier Creek was minimal, after 2,243 hectares in these areas were treated with *B.t.k.* (Foray 48B) and NPV (TM-Biocontrol 1). New defoliation was observed in the Wood Lake, Kalamalka Lake, Peachland Creek, Darke Creek, and Penticton areas. Ground sampling at 262 sites indicates

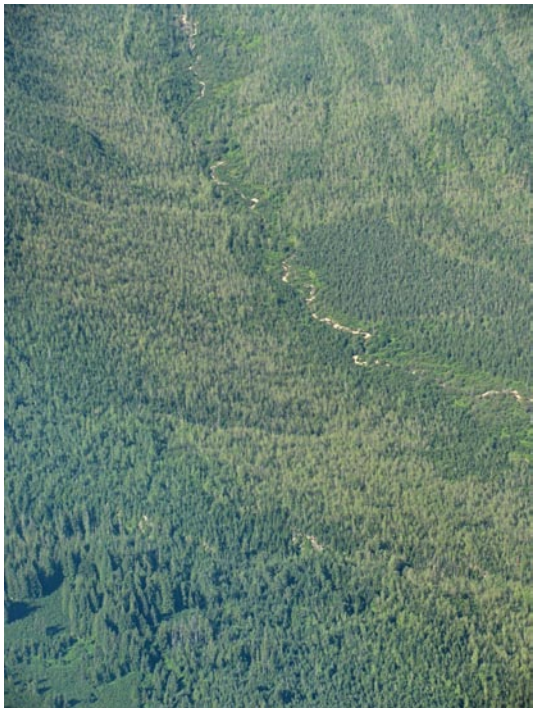
moderate to severe defoliation should occur in 2011 at the Kalamalka Lake and Peachland Creek sites, with little to no new defoliation in the areas near Penticton, Shingle Creek, Trepanier Creek, and Kelowna. High priority areas may be considered for treatment with *B.t.k.* in 2011.

Western Hemlock Looper

Light defoliation occurred on 35 hectares near Seymour Arm. Three tree beatings were positive but low for larvae at all sites, except for Yard Creek. Adult moth catches at the 10 permanent sampling sites remained similar to 2009 levels, with the exception of the Three Valley Lake site, where there was a 10-fold increase, to an average of 850 moths per trap. Defoliation may become visible in and around Three Valley Lake in 2011.

Forest Tent Caterpillar

Forest tent caterpillar defoliated 2,200 hectares of mixed aspen, cottonwood, and birch in the Ross Creek area, near Anglemont. Defoliation in the same location in 2009 was attributed to satin moth, however a ground check was not done, due to access difficulties. Some top dieback of affected tree species was observed during a ground check in 2010.



A mixed stand of aspen, birch, and cottonwood defoliated by forest tent caterpillar, Ross Creek, Okanagan Shuswap District.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner continued to be active in the northern and northeastern wetbelt areas. A total of 4,384 hectares of trembling aspen were defoliated, but no permanent damage is expected.

Birch Leaf Miner

Birch leaf miner damage expanded, and was mapped on 2,093 hectares in the Cherryville and Sugar Lake areas. Most of the defoliation was classified as moderate.

Other

Other forest health agents detected were 28 hectares of larch needle blight, 8 hectares of satin moth near Shorts Creek, 500 hectares of wildfire damage, 119 hectares of windthrow, and 5 hectares of flooding mortality.

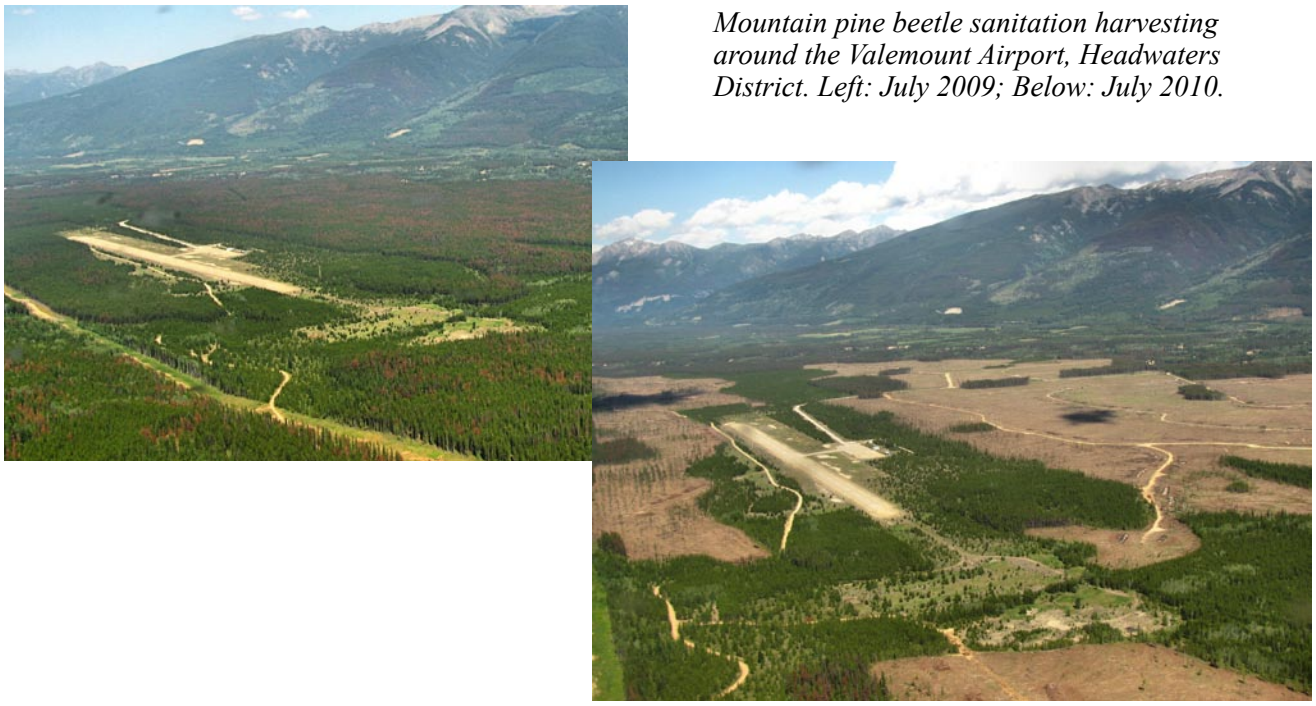
Thinning crowns and occasional mortality were noted in stands of semi-mature to overmature western red cedar and Douglas-fir along Sugar Lake Road, particularly in the drier ICH. The symptoms and characteristics appear typical of drought, however a foliar disease may also be responsible for thinning crowns. Although Armillaria root disease is prevalent throughout these areas, the signature was not consistent with that of root disease.

Mountain Pine Beetle

Mountain pine beetle continues to be very active in the Robson Valley, upper Fraser River, and Kinbasket Lake areas, where the vast majority of the 84,623 hectares of new red attack was found. The most intense attack was in the southern section of the Robson Valley, around Albreda, Valemount and Tete Jaune Cache. Significant areas of large, mature pine remain across much of this area. Mortality has expanded up into the headwaters of the Fraser River, although only at trace levels. Beetle populations in the southern half of the District have declined to very low levels, with only 665 hectares of new attack being mapped in the Raft River, Otter Creek, Adams River, and Cayenne Creek areas.

Young pine stands were attacked near Castle Creek, Holmes River, and Albreda. Most of this was in naturally fire-regenerated stands located on steep side slopes, and mortality was for the most part at trace levels.

There was ongoing mortality in both whitebark pine and western white pine, although affected area has declined, to 3,024 hectares and 313 hectares, respectively. Most of the attack in these two species was at trace and light levels.



Mountain pine beetle sanitation harvesting around the Valemount Airport, Headwaters District. Left: July 2009; Below: July 2010.

Western Balsam Bark Beetle

Area affected by western balsam bark beetle has remained nearly unchanged, at 56,621 hectares. However, there were declines in the West Twin Creek and Dore River areas, and some increases in the Stevens Lakes, Raft River, and West Raft River areas.

Spruce Beetle

Spruce beetle activity declined in the Dawson Creek and Wells Gray Park areas, and as a result the overall affected area fell by 61% to 557 hectares. Other small infestations were found in Forgetmenot Creek, Castle Creek, Cariboo River, and Gollen Creek.

Douglas-fir Beetle

Douglas-fir beetle remained active near Mahood Lake, Vavenby, and Mount MacLennan. New attack was found along the east side of Adams Lake, while a previoulsly infested area at Dawson Creek showed no signs of new attack. Overall infested area declined slightly, to 264 hectares, while an additional 540 trees were killed in 75 spot infestations.

Western Spruce Budworm

Populations remained low in the District, with the only defoliation being on 73 hectares southwest of the Clearwater Ski Hill.

Two-Year Cycle Budworm

2010 was an "on" year in the life cycle of this defoliator. Damage has declined from the last "on" year (2008), from over 51,000 hectares, to 10,965 hectares. Light defoliation was scattered across much of Wells Gray Park, as well as in the Raush River, Horsey Creek, and Moose Lake areas.

Western Hemlock Looper

Small pockets of very light defoliation were scattered throughout Wells Gray Park and the upper North Thompson River. Three-tree beatings at the six permanent sample sites in the District collected an increased number of larvae, with the highest numbers at the Thunder River site, at 67 larvae. Moth catches at these permanent sample sites remained high, averaging 548 moths per trap.. It is unclear whether population levels have peaked and will decline next year, or if they will continue to increase and lead to more widespread defoliation.

Aspen serpentine leaf miner damage in Wells Gray Park, Headwaters District.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner remains present at low levels in most birch stands in the District. Defoliation visible from the air was mapped on 37,353 hectreas, which is nearly double the area mapped in 2009. Most of the visible damage was in Wells Gray Park, along the Clearwater River corridor and around Hemp Creek; defoliation was also visible in the Raft River, Mad River, Adams River, and Mann Creek areas.

Other

Other forest health agents found during the surveys were 614 hectares of forest tent caterpillar in Mount Robson Park, 406 hectares of birch leaf miner, and 680 hectares of wildfire.

Cariboo Area Summary

The Cariboo portion of the aerial overview surveys were conducted between July 19th and September 9th, and required 137.3 hours of flight time over 29 crew-days. Survey progress went well until severe fire activity caused excessive smoke and aircraft conflicts at the start of August. This situation impeded work progress until August 24th when air quality improved and fire activity subsided. 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. The surveys also included small portions of the North Island - Central Coast, Kalum, Sunshine Coast, Prince George, and Vanderhoof Forest Districts. The easterly crew, comprised of Don Wright, Mikko Sipponen and Darryl Wright operated from Williams Lake and surveyed to a north-south line just west of Riske Creek. The westerly crew comprised of Joe Cortese, Bob Erickson and Leo Rankin surveyed west of the same line and operated out of Bluff Lake and Puntzi Lake. Surveys utilized Cessna 180, 185, and 206 aircraft, both on and off floats.

Quesnel Forest District

Mountain Pine Beetle

Beetle populations have collapsed over nearly all areas of the District. New red attack, the majority of which was trace or light, was limited to a few areas near the upper Baezaeko River and Tundra Mountain. A few pine plantations near Pantage Creek sustained trace levels of new attack.

Spruce Beetle

Very little new spruce beetle activity was found. Small pockets of killed spruce were mapped in the Lightning Creek, Antler Creek, and Sardine Creek areas. Affected area totalled just 91 hectares. In some areas, beetle populations have built up in scattered windthrow, but not enough to attack much standing timber.

Douglas-fir Beetle

Douglas-fir beetle populations have declined, although it is still active in the Nazko and Blackwater River areas. A total of 628 hectares of trace to moderate attack was mapped; an additional 100 small spot infestations were also recorded.

Western Balsam Bark Beetle

Western balsam bark beetle has continued to increase in the Lightning Creek and Willow River areas. A total of 17,278 hectares of trace and light attack were mapped.

Western Spruce Budworm

Western spruce budworm has increased to 10,129 hectares in the District, and defoliation was detected along both sides of the Fraser River as far north as Alexandria. A third of this area was moderately defoliated. Egg mass sampling predicts high populations and moderate to severe defoliation in 2011, which will be a high priority for treatment with aerially applied *B.t.k.*

Two-Year Cycle Budworm

Two year cycle budworm was mapped at significant levels for the first time in several years in the District. 46,845 hectares of spruce-balsam stands in the Willow River, Swift River, Wells, and Bowron Lakes area were visibly damaged, with nearly half of the area moderately defoliated. Ground checks in stands in the eastern half of the Cariboo indicate widespread levels of light defoliation below the threshold visible from the air.

Forest Tent Caterpillar

Forest tent caterpillar continues to infest a large area around Quesnel, Cottonwood River, Benson Lake, Gravelle Ferry, Ten Mile Lake, and Bouchie Lake. A total of 34,863 hectares of defoliation was mapped, nearly 45% of which was classified as moderately or severely defoliated.

Aspen Serpentine Leaf Miner

Aspen serpentine leaf miner was again common in the District. In general, only areas with higher levels of damage were visible from the air. A total of 6,645 hectares of moderate defoliation were mapped, in the Quesnel River area.

Wildfire

Several large wildfires and wildfire complexes burned just over 55,800 hectares. Most of the fire activity was in dead, standing mountain pine beetle - killed lodgepole pine.The bulk of the burned area was in the Pelican Lake Complex, Meldrum Creek Complex, Batnuni Lake, and Tsacha Lake fires.

Other

Other forest health agents found were 98 hectares of windthrow (most of which was in beetle killed pine), and 21 hectares of flooding mortality.

Windthrow damage on T.F.L. # 52, Quesnel District.

Slide damage along the Fraser River, Quesnel District.

Mountain Pine Beetle

Mountain pine beetle populations have now collapsed in most areas of the District, with some residual activity at high elevations in the southwest, in the Bambrick Creek, Big Creek, Dash Creek, Lone Valley Creek, and Poison Mountain areas. Although host depletion has been the main contributor to the rapid decline in beetle populations, most of these residual areas are at higher elevations where reproduction can be limited. This has led to rapid population declines even with considerable mature pine remaining.

Attack in young pine was limited to 310 hectares of trace attack just south of Dog Creek.

Western Balsam Bark Beetle

Western balsam bark beetle was recorded on 10,796 hectares in the northeast of the District, most of which was classified as trace attack. Attack rates fell in the Little River - Three Ladies Mountain area, and increased in the Molybdenite Creek area.

Spruce Beetle

Spruce beetle is active and increasing in the Molybdenite Creek, Crooked Lake, Mackay River, Watchman Mountain, Niagra Creek, and West Arm Quesnel Lake areas. Attack was recorded on 16,518 hectares, and increase of nearly 2-fold from 2009 levels of 9,520 hectares. 35% of the current attack was rated as moderate or severe.

Spruce beetle near Molybdenite Creek, Central Cariboo District.

Douglas-fir Beetle

A sharp decline in beetle populations was seen across the District. Infested area has dropped from over 51,000 hectares in 2009, to just 672 hectares in 2010. The number of spot infestations has also dropped, from 655 to 343. Overwinter mortality sampling undertaken in March 2010 found that many sites had low populations, and locating a sufficient number of trees for sampling was difficult. Predators and parasites recorded from bark samples were at elevated levels, indicating that natural controls were having a limiting effect on brood success. Ground checks performed in the fall of 2010 indicate that many infested areas have little to no new attack. Of potential concern, is the large number of fires that occurred in August. The high number of fire-damaged Douglas-fir, especially along the fire perimeters, could mean an increased risk of Douglas-fir beetle attack next year and may precipitate a rebound of the Douglas-fir beetle populations.

Western Spruce Budworm

Western spruce budworm populations and resulting defoliation declined across most of the Gaspard Creek, Farwell Creek, Riske Creek, and Dog Creek areas. This resulted in the overall defoliated area dropping from 250,000 hectares in 2009, to 137,445 hectares in 2010. Despite this, defoliation was still widespread in the CcLeese Lake, Williams Lake, Soda Creek, Meldrum Creek, and Chimney Creek areas. The most heavily defoliated areas were along the Fraser River between McCallister and Meldrum Creek, and around Williams Lake. 21,115 hectares of high-priority stands were treated with *B.t.k.* in June. Results were positive and although most treated areas still suffered defoliation, immediately neighbouring untreated stands were much more heavily defoliated. Egg mass surveys predict, for 2011, severe defoliation near Soda Creek and Dome Mountain, and moderate defoliation around McCleese Lake, Alkali Creek, Chimney Lake, Word Creek, and Meldrum Creek.

Western spruce budworm spray operations near Bull Mountain, Central Cariboo District.

Wildfire

Several large wildfires burned a combined 43,845 hectares in the Meldrum Creek, Bald Mountain, and Dog Creek areas. There is concern that Douglas-fir beetle populations will re-build in the large number of fire-scorched trees, and the many kilometers of fire guard with felled and unsalvaged Douglas-fir.

Wildfire damage in a plantation near Riske Creek, Central Cariboo District.

Other

Other forest health factors were found, including 8,590 hectares of light two-year cycle budworm defoliation near Keithley Creek, 1,106 hectares of aspen serpentine leaf miner around Horsefly Lake, 167 hectares of forest tent caterpillar near Beaver Creek, and 47 hectares of windthrow on the north side of Quesnel Lake, near Grain Creek.

Chilcotin Forest District

Mountain Pine Beetle

The total area of red attack dropped by nearly 90%, to 103,866 hectares. Only 1% of this was classified as moderate or severe. Some of the last significant beetle populations in the Cariboo are still active in the Chilcotin Mountains, mainly at higher elevations in the Klinaklini River, Brittany Creek, Elkin Valley, Taseko Lake, and Tete Hill areas. Although there is abundant healthy lodgepole pine remaining in these high elevation areas, overwinter mortality of the beetle tends to be high. This, combined with the lack of influx of new beetles from neighbouring areas, appears to have limited the spread of beetle populations. Very little red attack was recorded outside of these high elevation valleys.

Western Balsam Bark Beetle

Western balsam bark beetle populations remain confined to the Coast and Chilcotin Mountains. The area of new tree mortality was down substantially, to 5,940 hectares, due to decreased attack around Chilko Lake, Yohetta Creek, and the Taseko River.

Douglas-fir Beetle

There has been a sharp decline in Douglas-fir beetle activity along the Chilcotin River corridor, and the total affected area fell by over 80% to 2,825 hectares. Host depletion was a factor in many areas, and there was a decline in size, number, and severity of new infestations overall. Many historical areas showed little to no new attack. Overwintering surveys conducted in March 2010 found low green:red ratios at all sampling sites. Many sites did not have enough fresh attack to allow for sampling. There is concern over the large number of fire-scorched Douglas-fir around the edges of the Bull Canyon fires, which may create conditions for a population rebound.

Western Spruce Budworm

Population levels and defoliation were much reduced in 2010, even more so than predicted by fall 2009 egg mass sampling. Defoliation was down by 8,908 hectares, and was limited to a narrow band along Highway 20 between Alexis Creek and Lees Corner, and along the south side of the Chilcotin River between Minton Creek and Big Creek. Although defoliated area was much reduced, considerable damage was still done to over 3,100 hectares of Douglas-fir that was moderately defoliated. Populations are predicted to remain at damaging levels around Alexis Creek, in 2011.

Wildfire

Wildfire activity was significant again in 2010, with 53,548 hectres burned in the a complex of fires north and south of Bull Canyon, and near Alexis Lake. These fires burned in stands with high components of grey, beetle-killed lodgepole pine and Douglas fir.

Other

Other forest health factors mapped in the Chilcotin District were 2,245 hectares of aspen serpentine leaf miner, 36 hectares of drought mortality, 27 hectares of flooding, 26 hectares of spruce beetle, and 18 hectares of slide and avalanche damage.

Wildfire damage near Alexis Creek, Chilcotin District.

100 Mile House Forest District

Mountain Pine Beetle

Beetle populations have completely collapsed in most areas of the District, with only 9,363 hectares of red attack mapped. This is a decline from a high of nearly 750,000 hectares just two years ago, and is the result of a nearly complete depletion of mature lodgepole pine. The only areas with significant activity were in the southern end of the Marble Range, and around Kelly Lake and Pavilion Mountain. Scattered attack was found in a few young pine stands north of Onion Lake, but the 1,163 hectares mapped here was nearly all at trace levels.

Douglas-fir Beetle

As in other areas of the Cariboo, Douglas-fir beetle populations have dropped sharply over the last year. The area of red attack fell by 88 % to 2,804 hectares, most of which was classified as trace. The number of spot infestations has remained high, at 267. These results show that while Douglas-fir beetle remains active in many areas of the District, populations are spotty and recent tree mortality has been low.

Spruce Beetle

Spruce beetle activity is up significantly, from 2,984 hectares in 2009, to 9,194 hectares in 2010. Attack intensity is high, with nearly 60% of all attack being classified as moderate or greater. Most of the new attack was in the upper Boss Creek drainage, and around Mount Hendrix and Deception Creek. Sporadic, scattered windthrow in this area over the last few years likely contributed to the beetle population increases.

Western Balsam Bark Beetle

Mortality due to western balsam bark beetle has continued to decline, and is now down to 3,557 hectares, scattered across the Boss Creek, Deception Creek, and Windy Mountain areas.

Western Spruce Budworm

Following aggressive *B.t.k.* spray programs in 2007, 2008, and 2009, western spruce budworm populations and damage declined significantly in the District. Defoliation was mapped on 39,280 hectares, down from 100,000 hectares in 2009, and 175,000 hectares in 2008. Most of the defoliation was light, with 2,352 hectares moderately defoliated in the Hart Ridge area. Egg mass sampling predicts that populations will remain low across much of the District in 2011, although moderate defoliation may occur in the 108 Mile House, Canoe Creek, and Jesmond areas.

Douglas-fir Tussock Moth

Pheromone traps were deployed in 6-trap clusters, at 31 sites in the District. The average catch decreased from 3.9 to 1.7 moths per trap, and only a single site averaged more than 5 moths per trap (5.2, south of Clinton). Thus, populations have remained low and no defoliation should occur in 2011. Douglas-fir tussock moth has been causing pockets of moderate and severe defoliation in the Lillooet TSA as far north as Big Bar Creek, which is just across the Fraser River from several trapping sites in the 100 Mile House District.

Other

Other forest health factors were 686 hectares of two-year cycle budworm near Boss Creek, 215 hectares of aspen serpentine leaf miner near Deka Lake and Phinetta Creek, and 1,406 hectares of wildfire, near Dog Creek.

Forest Health - Special Projects

Summary Of PSP 3-Tree Beatings in the Kootenay-Boundary

2010 East Kootenay Permanent Sample Plot Results
Janice Hodge, JCH Forest Pest Management, Coldstream, BC

In 2007 thirteen permanent sample plots formerly monitored by the Forest Insect and Disease Survey Unit of Forestry Canada were re-established in the East Kootenays to monitor the incidence of western false hemlock looper, *Nepytia freemani* and western spruce budworm, *Choristoneura occidentalis*. Three-tree beatings were used to monitor larval populations. The East Kootenays do not have history of visible defoliation by western spruce budworm. It is possible however, that given climate change and Douglas-fir encroachment throughout the Rocky Mountain Trench, that conditions may become favorable to the expansion of western spruce budworm populations either from the west, or from the south.

Only 15% of the plots (2) were positive for western spruce budworm, compared to 53% (7) in 2009. For the second consecutive year, the highest number was recorded in the most southerly plot near Grasmere, with 18 western spruce budworm larvae. Only 1 site was positive for western false hemlock looper compared to 3 in 2009, and 2 in 2008. The most abunant larval defoliator was western spruce budworm; the most commonly found one was sawflies (*Neodiprion*) A defoliating scarab beetle, *Dichelonyx backi*, was abundant at the Grasmere plot and also recorded in 2 other plots. The number of larvae at any one permanent sample plot was not significant, nor was there any defoliation noted in any of the plots.

2010 West Kootenay Permanent Sample Plot Results
Janice Hodge, JCH Forest Pest Management, Coldstream, BC

In 2009 nine permanent sample plots formerly monitored by the Forest Insect and Disease Survey Unit of Forestry Canada were re-established in the West Kootenays to monitor the incidence of Douglas fir tussock moth, *Orgyia pseudotsugata*. Both three-tree beatings and pheromone traps were used to monitor populations. Historical records indicate that Douglas-fir tussock moth defoliation has been noted near Grand Forks, Rock Creek, Kettle Valley, Christina Lake, and Cascades. The last major defoliation event was recorded in 1983, when approximately 2,275 ha of light to severe defoliation were recorded between Johnstone Creek and Midway and north towards Westbridge.

Similar to 2009, Douglas-fir tussock moth was not found at any of the plots sampled in 2010. The only notable defoliation at any of the plots was that caused by western spruce budworm at the Conkle Lake Road plot, where light to moderate defoliation occurred. Western false hemlock looper was more widespread than in 2009; found in 4 plots from Kettle Valley Provincial Park to Waneta. Western hemlock looper was also up from 2009, found in 5 plots, compared to 1 in 2009. The most common defoliators were *Neodiprion* spp, and western spruce budworm, both recorded in 6 of the 9 plots. The diversity of defoliators was up slightly from 2009, with 14 unique species tallied including a defoliating scarab beetle, *Dichelonyx backi*.

Only 1 trap site was positive for Douglas-fir tussock moth, at Kettle Provincial Park. The average number of moths per site was 2.5, down from 4.5 in 2009. This is likely indicative of decreasing populations as NPV was noted in ground surveys in the fall of 2009.

Current Spruce Weevil, (*Pissodes strobi*) Attack in ICHwk2 in Central Cariboo Forest District

Leo Rankin, Forest Entomologist, Cariboo Region

Eleven spruce plantations were surveyed for current spruce weevil attack. The plantations were located around Tasse Lake, Spanish Lake, Bouldery Creek, Bill Miner Creek and Teapot Mountain. Stands ranged from 15 years to 28 years of age. Only current attack of spruce leaders from 2010 was considered. Attack previous to 2010 was not assessed. The average current attack was 9.4% for all the stands, with a range of 3.8% to 16.5%.

Summary Of 2009-2010 Bark Beetle Overwintering Mortality Estimates

Overwintering mortality sampling has been done in past years for both mountain pine beetle and Douglas-fir beetle to provide an estimate of beetle population trends through brood success and survival. Over the winter of 2009-2010, estimates were produced were for Douglas-fir beetle in the Quesnel, Central Cariboo, 100 Mile House, and Chilcotin Districts.

Two numbers are generated for each sample, the R-value and the percent 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 Douglas-fir beetle, any value above 1.3 indicates an increasing population. The percent mortality is a direct measure of brood mortality up to the time of sampling, which is usually conducted in March, after most winter larval mortality has occurred.

Douglas-fir Beetle

Overall, beetle populations were down sharply as demonstrated by the significant reductions in mortality mapped by the 2010 overview surveys. Management operations (including sanitation harvesting, fall and burn, and anti-aggregation pheromones) augmented by the positive effects of natural control agents (predators and parasites), have lowered the number and size of current infestations. Locating current attack in most areas was difficult, and the target number of overwinter mortality sampling sites was only reached in the Chilcotin. The size and number of new infestations was much lower than in previous years and the ratio of green attack to red attack was less than one at all sites. However, brood success was high at the few sites that did have current attack, with R-value numbers well above the population increase threshold of 1.3 in all Districts except Quesnel (Table 1). Control efforts this winter (2010-2011) will attempt to further reduce remaining beetle populations to endemic levels.

Table 1. Percent mortality of Douglas-fir beetle progeny during the winter of 2009-2010, with associated R-values and green:red attack ratios.

District or TSA	Number of Sites	Number of Samples	Average % mortality	Average R-Value	Green:Red Ratio
Central Cariboo	7	118	75.0	2.6	0.97:1
Chilcotin	10	200	64.7	3.3	0.76:1
100 Mile House	2	24	66.9	5.2	0.50:1
Quesnel	1	20	89.9	0.8	0.15:1
Totals/Averages	20	362	74.1	3.0	0.60:1

Summary of the Southern Interior Region 2010 Douglas-fir Tussock Moth Program

Lorraine Maclauchlan, Ministry of Natural Resource Operations, Forest Health
441 Columbia Street, Kamloops, B.C.

Background

The Douglas-fir tussock moth (DFTM) is currently at outbreak levels in numerous locations throughout the Southern Interior Region. At the onset of this outbreak, very small and discrete patches of defoliation by DFTM were first noticed in July 2007 in Barnhartvale, Heffley Creek and other areas near Kamloops (Table 1). Ground surveys and moth trapping conducted in the fall of 2007 identified approximately 1,130 hectares of incipient populations that were subsequently treated in 2008 (Table 1; Fig. 1). The outbreak continued to expand in 2009, with over 17,500 hectares of defoliation visible by the end of that year (Table 1). In 2009, NPV (nuclear polyhedrosis virus) was applied to 4,341 hectares of high priority Douglas-fir stands. That same year, the Foray 48B (*B.t.k.)* label was expanded to include the Douglas-fir tussock moth, therefore both virus and *B.t.k.* were considered when planning the 2010 control program. The 2010 Southern Interior's program included the application of virus, *B.t.k.* (Table 1) and combinations of both insecticides.

NPV is most effective in new and building populations where minimal defoliation has been observed or where there is potential for spread to nearby high value stands. The application of NPV will cause populations to collapse in the stands where it is applied thus preventing the need for follow-up treatment in subsequent years. *B.t.k.* was targeted at stands where significant defoliation had already occurred, where foliage protection was the primary objective and where the outbreak was in a high use, residential or recreational area. This outbreak has been building for the past 3-4 years throughout its range. Some sites have already collapsed either naturally or through the NPV spray application, while other areas are in year one of the cycle (Figs. 2 and 3). Overall, it is projected that 2011 will be the final outbreak year over most of the tussock moth range. A total of 7,124 hectares were treated with NPV, *B.t.k.* or a combination of both (Table 1; Figs. 1 and 3) in 2010.

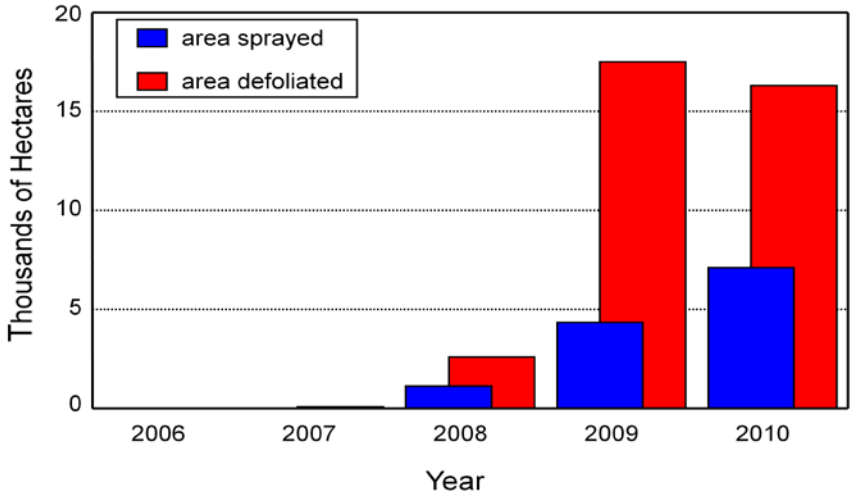


Figure 1. Total annual defoliation (hectares) compared to total area sprayed (area of NPV and *B.t.k.* combined) for the current Douglas-fit tussock moth outbreak (2007-2010).

Table 1. Area of Douglas-fir tussock moth defoliation mapped in aerial surveys (2006-2010) and total area treated with nuclear polyhedrosis virus (NPV) or *Bacillus thuringiensis* var. *kustaki* (*B.t.k.*) (2008-2010).

Year	Ha defoliated	Area sprayed (hectares) NPV	*B.t.k.*
2006	0		
2007	88		
2008	2,597	1,130	
2009	17,512	4,341	
2010	16,304	1,447	5,677
			(7,863 ha-equivalents)

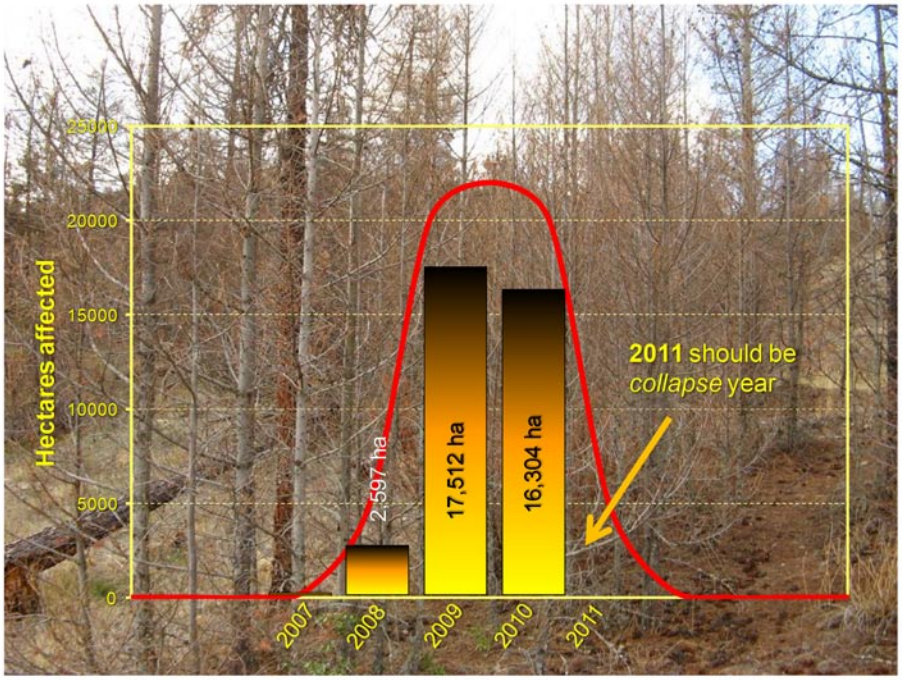


Figure 2. Graph comparing actual hectares of defoliation from the current Douglas-fir tussock moth outbreak (2007-2010) to the classic eruptive cycle of this insect (red line).

A young Douglas-fir tree recovering after being severely defoliated in the previous year.

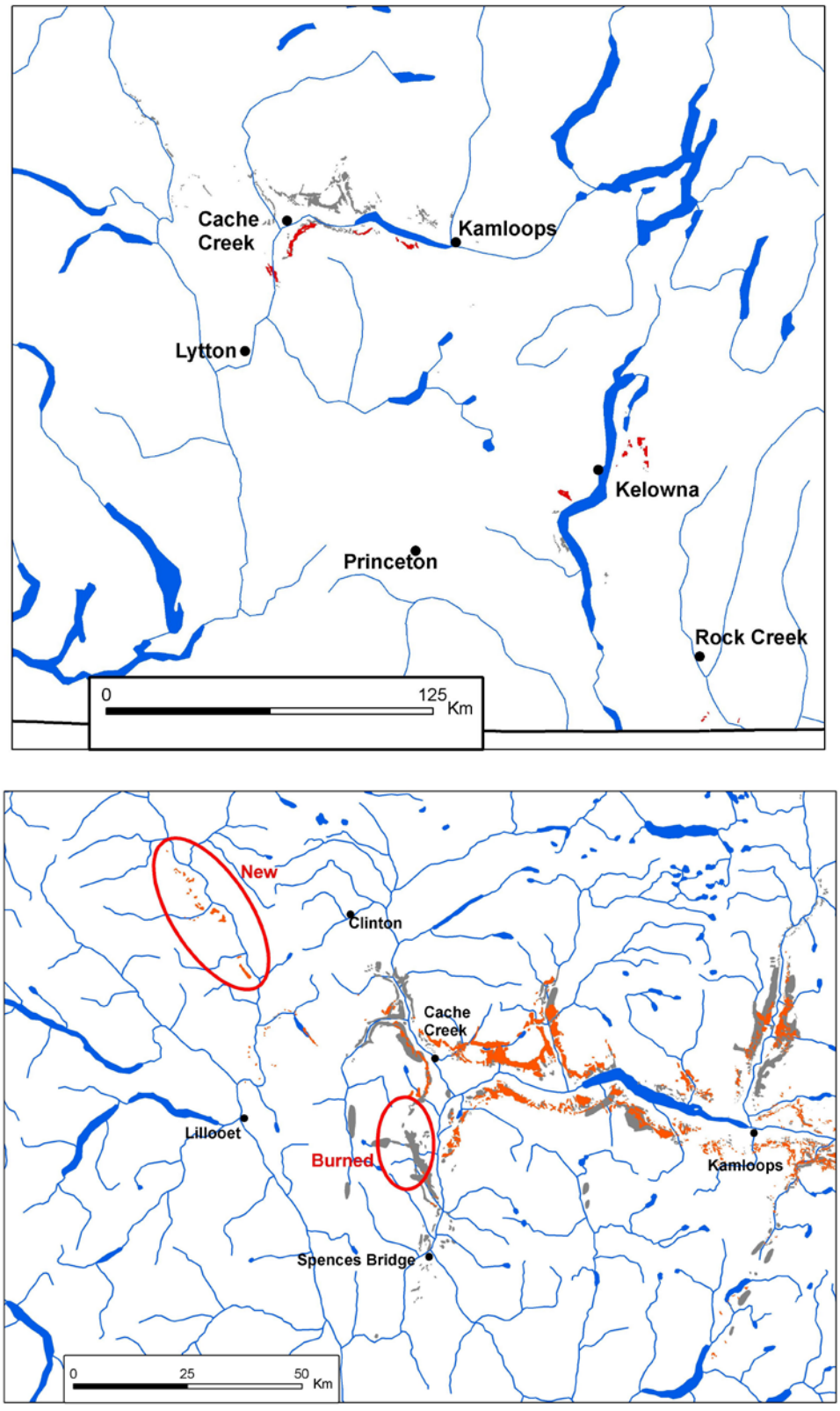


Figure 3. Top map: 2010 DFTM defoliation and spray blocks; Lower map: DFTM defoliation from the current outbreak in red (2007-2010) compared to areas of historic defoliation in grey. The area circled in the north has not had tussock moth in the past and the area in the south was burned so there is sparse host resource.

2010 Spray Operations and Assessment

The 2010 DFTM program was multi-faceted due to the eruption of the outbreak and the diversity of lands that the outbreak was now impacting. The City of Kelowna and Regional District of the Central Okanagan (RDCO) partnered to deliver a cohesive and targeted program in 2010. The program encompassed Crown land, Regional and Municipal Parks, private lands and woodlots, spanning from Rock Creek and Midway in the southeast, Kelowna and area in the Okanagan, to Ashcroft in the west. Initially the entire program was going to be covered under the Ministry's Pest Management Plan but due to the diverse jurisdictions, the Ministry of Environment required Pesticide Use Permits for both the City of Kelowna and RDCO. Therefore, we carried out the spray operations under three distinct authorizations (Pesticide Use Permits for the City of Kelowna and Regional District's portion; Pest Management Plan for the Crown land portion). The City of Kelowna and RDCO staff were extremely efficient and professional in obtaining the private land permissions and covering the communications required for such a high profile project in such a short time frame. Over 20 public meetings and briefings to local and municipal governments were delivered in advance of the 2010 program and hundreds of letters were mailed to, and received from, private land owners.

Western spruce budworm was also present in many of the areas treated for tussock moth, particularly in the Kelowna areas spray blocks. Budworm larvae were in 6th instar or pupating at the time of *B.t.k.* application for tussock moth, which was in the 2nd-3rd instar.

Figure 4. Early instar tussock moth (top) and late instar western spruce budworm larva feeding on the same Douglas-fir branch.

Tussock moth outbreaks elicit much concern from the general public because the natural range of this insect is in low elevation, hot and dry ecosystems where there are significant private land parcels and residential areas. The overwhelming number of caterpillars that occur in these populated settings, causing damage to trees as well as allergic reactions suffered by some people (tussockosis) ignited local residents. From late winter through to the timing of treatments, hundreds of phone calls and emails were received from landowners, public officials and reporters. Public meetings were held in a number of locations prior to the 2010 program including Kelowna, Joe Rich, Ellison, Glenmore, Midway, Chase, Kamloops, Lillooet, Merritt and Lower Nicola among others.

Twenty-three blocks covering a total of 7,023 hectares were delineated for treatment in 2010 (Table 2). All areas had tussock moth egg mass densities that would result in moderate to very severe defoliation, or tree mortality. The early summer weather was very cool and wet, so insect development was delayed. The molasses and water mixing was conducted at the Kamloops Fire Centre and from there, the 17 bulk containers were trucked to 7 staging sites in the Kamloops and Okanagan. Each 1,000 litre bulk was filled with approximately 725 litres of water and let stand for a few days. About 20 pails of agriculture feed grade molasses (13.5 kg pails) were added to each bulk and sealed for transport to staging sites (Fig. 5). At each staging site approximately 1.5 to 2 bags of lignosulphonate (25 kg bags) were mixed into each bulk using a paint mixer to thoroughly mix in the lignosulphonate (Fig. 5). The virus was pre-weighed in the SIR laboratory for each spray block and added the morning of spray. Three 1,000 litre empty bulks were taken to Nelson where they were filled with water, and then moved to the Rock Creek staging site. Approximately 1,700 litres of mix (molasses, water, TM Biocontrol-1® and lignosulphonate) was prepared on-site.

Figure 5. Top photograph: Mixing water and molasses in bulk containers at Kamloops Fire Centre showing pallets of molasses in foreground. Lower photograph: mixing lignosulphonate into molasses mix at Venables Valley staging site.

The first virus treatment was conducted June 4-5, 2010, in the Knox Mountain and Glenmore blocks near Kelowna. The virus application to Knox Mountain Park (under the City of Kelowna Permit) was a pre-emptive treatment to protect the Park and Park users from the tussock moth, as this area has a history of outbreaks and was close to other known, more severe populations. This is the only spray block (10 hectare block) where only low or incipient numbers were located. Treatment was done by Western Aerial Applications Ltd. using Hiller and Lama helicopters equipped with beecomist nozzles and a simplex spray system. The planning, block set-up, mixing and spray monitoring and sampling was done by Regional staff (Art Stock, Leo Rankin, Kevin Buxton and Lorraine Maclauchlan), Skyline Forestry, Forest Health Management, Barbara Zimonick, JCH Forest Pest Management as well as Regional District, and City staff in the Okanagan. Lignosulphonate was mixed into the water-molasses mix prior to the anticipated spray date. TM Biocontrol-1 (NPV) was added the morning of the spray. The tussock moth was in 1st instar and dispersed from egg masses (Fig. 6). The Venables blocks, west of Ashcroft, were treated on June 7th and the Rock Creek/Midway area was treated on June 8th. Conditions were calm and warm for these applications. Development on the remaining blocks west of Kamloops and near Barnes Lake was slow due to cool weather, plus *B.t.k.* is targeted at later instars (peak 3rd instar) so this phase of the program was conducted June 15 through June 18th. For logistical reasons, the virus and *B.t.k.* was applied on the same day at Indian Gardens (Table 2).

Table 2. Douglas-fir tussock moth 2010 spray blocks showing hectares treated with NPV (virus) and Foray 48B (*B.t.k.*), the litres of product used on each block and the date sprayed. Those blocks receiving both NPV & *B.t.k.* were treated with NPV first (earliest date).

	Block	Area treated (ha)		Litres sprayed		Date sprayed
Location	**Size (ha)**	**NPV**	***B.t.k.***	**NPV**	***B.t.k.***	**(2010)**
Barnes Lake (2 applications @ 4 litres/ha)	2,186		2,186	17,488		June 17,18
Indian Gardens*	333	100	333	1,332		June 17
Indian Gardens West	98		98	1,000	392	June 17
Cherry Creek-1	570		570		2,280	June 17-18
Cherry Creek-2	81		81		324	June 17-18
Cherry Creek - NW side Hwy	136		136		544	June 18
Venables Valley east	787	787		7,870		June 7
Venables Valley NW	225	225		2,250		June 7
Knox Mountain Park	10	10		100	0	June 4
Glenmore/Union Road Area	279	70	200	700	1,116	June 5, 16
Glenmore Road	58	30	30	300	100	June 4, 16
Glenmore Road	95	45	50	450	160	June 4, 16
Glenmore Road	15	15	10	150	60	June 4, 16
Postill Lake Road N.	571		571		2,284	June 16
Farmers - Dead Pine Drive	417		417		1,668	June 16
Woodlots #1499, 344, private	225		225		900	June 16
Trepanier Creek	770		770		3,080	June 15
West of Midway-1	8.7	8.7		87		June 8
West of Midway-2	19.4	19.4		194		June 8
Rock Creek-Bridesville Road	72.9	72.9		729		June 8
Rock Creek-1	46.6	46.6		466		June 8
Rock Creek-2	15.2	15.2		152		June 8
Rock Creek-3	1.8	1.8		18		June 8
Total	**7,021**	**1,447**	**5,677**	**14,466**	**31,728**	**June 4 - 18**

* 100 hectares of the 433 hectare block at Indian Gardens was sprayed with both *B.t.k.* and NPV

Figure 6. Upper photograph: early-instar Douglas-fir tussock moth larva on needle. Lower photograph: damage symptoms typical of feeding by early-instar Douglas-fir tussock moth larvae.

Spray Assessment and Results

In order to fine tune our management of Douglas-fir tussock moth, various combinations of NPV and *B.t.k.* were sprayed and assessed in the 2010 program. The spray comparisons were:

1) NPV alone – applied at full hatch and 80% dispersal from egg masses (full dose)
2) NPV plus *B.t.k.* – applied at 2nd-3rd instar (one application of *B.t.k.* at 4 litres per hectare)
3) One application of *B.t.k.* - applied at 2nd-3rd instar (4 litres per hectare)
4) Two applications of *B.t.k.* - applied at 2nd-3rd instar , treatments on consecutive days (2 applications of *B.t.k.* each @ 4 litres per hectare)

Due to cool and wet weather, insect development was slow in 2010 and thus timing of treatments was adjusted. Optimally, the virus is applied at full larval hatch when the insects have dispersed from the egg masses. When insects are 2nd - 3rd instar, 3-4 days after the virus treatment, *B.t.k.* should be applied (on the block receiving both insecticide treatments). However due to the weather delays, the virus and *B.t.k.* were applied on the same day at the Indian Gardens block (Table 2). Also, when applying 2 applications of *B.t.k.* (Barnes Lake block) it is preferred to have 2-4 days between applications. However, the application sequence and timing noted achieved our desired results for this comparison (Table 2).

Ten sample trees per treatment regime were selected in the spring (11 tress were sampled in the single application *B.t.k.* block). Trees were intermediate in size and had high numbers of viable egg masses visible on lower branches. All trees in all treatment regimes were sampled 1-2 days prior to treatment (pre-spray). Using pole pruners equipped with baskets, two 45 cm branch tips were cut from each tree and assessed. The numbers of tussock moth larvae were tallied (noting average instar), Fettes defoliation recorded, plus any other insects noted. An assessment of total tree defoliation was done at this time. Due to the different mode of action of the two insecticides, post-spray assessments were only conducted once at 5 weeks post-spray on blocks treated with virus only, and virus + *B.t.k.* Blocks treated with one or two applications of *B.t.k.* were sampled at 3 weeks post-spray and 5 weeks post spray.

Pre-spray larval density ranged from 126 larvae/m^2/tree in the Venables block to 368 larvae/m^2/tree in the Barnes Lake control area (Fig. 7). The Venables block was best suited to virus treatment because there was no visible defoliation prior to 2010 and surveys identified scattered, moderate egg mass density. All other blocks had higher larval densities and some degree of prior defoliation. Larval density, percent mortality and corrected mortality were calculated for each sampling date and treatment (Figs. 7 and 8; Table 3).

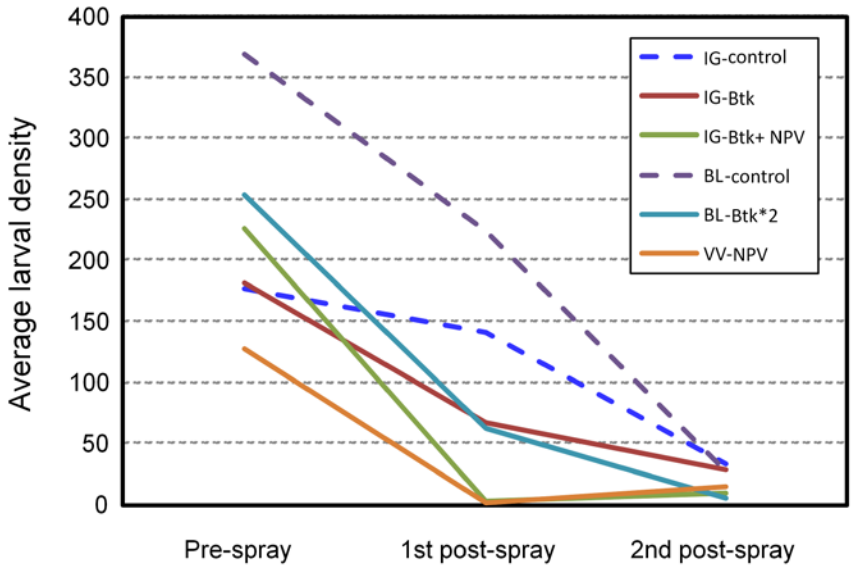


Figure 7. Average number of larvae/tree (averaged by site) for each treatment and control block at the pre-spray and two post-spray sampling dates. Dashed lines represent control blocks and solid lines are treatment blocks.

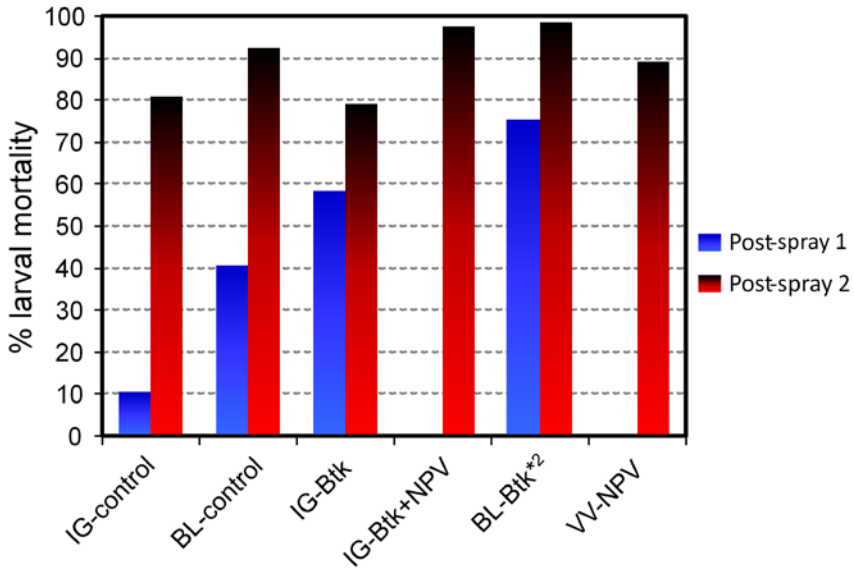


Figure 8. Percent larval mortality (averaged by site) for all treatment and control blocks at the two post-spray sampling dates.

Table 3. Abbott's Corrected percent mortality for the four treatment regimes at the two post-spray sampling times.

		Corrected mortality (%)	
Location	Treatment	Post-spray 1	Post-spray 2
Indian Gardens	*B.t.k.*	53.9%	14.8%
Indian Gardens	*B.t.k.* + NPV		78.8%
Barnes Lake	*B.t.k.* x2	72.6%	88.3%
Venables Valley	NPV		58.4%

Figures 7 and 8 clearly show the effect of insecticide treatment when compared to the larval density and percent larval mortality at the first post-spray sample. Larval density was still high in the control blocks, averaging 140 and 223 larvae per m2 foliage in the Indian Gardens and Barnes Lake control blocks, respectively (Fig. 7). The Indian Gardens and Barnes Lake blocks, which received a single and double application of Foray 48B respectively, showed the sharpest decline in larval numbers at the first pre-spray sample (Figs. 7 and 8; Table 3). The single application block at Indian Gardens showed a slight increase in insect numbers by the final post-spray sample (Fig. 8; Table 3). This could be due to some larvae not feeding on needles with *B.t.k.* or a late larval hatch (14.8 % corrected mortality, Table 3). The Barnes Lake block, which received two applications of Foray 48B (Fig. 9), had the best foliar protection due to rapid larval mortality. All spray blocks showed good foliage protection and significant declines in larval density. By the end of the feeding cycle, the populations in both the sprayed and unsprayed blocks were collapsing. There was significant damage (defoliation and tree mortality) in areas that were not treated (Fig. 9).

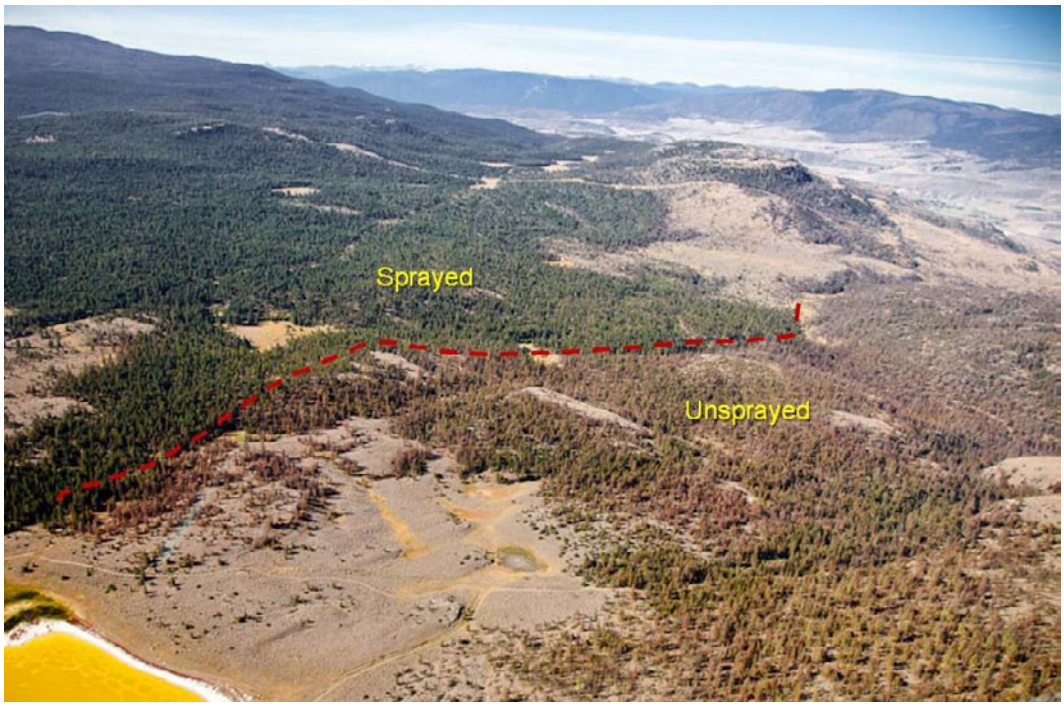


Figure 9. Aerial photograph taken of the Barnes Lake spray block, showing the difference in defoliation between the sprayed and unsprayed area.

2011 Projections for the Douglas-fir Tussock Moth

Planning for the 2011 operational control program began in late July 2010 when defoliation was at its peak visibility. Detailed mapping, using a 206B helicopter, was conducted in all areas known to have active tussock moth populations with current defoliation. Detailed mapping is required to delineate new and expanding areas of defoliation and to help designate potential treatment sites. Many low elevation Douglas-fir stands also had active western spruce budworm, so occasionally ground checks were required to differentiate between the two insects. Although the two insects have a distinct defoliation signature, when tussock moth defoliation is light, it is often very hard to distinguish it from budworm from the air. Detailed and overview survey results were compared and amalgamated. Ground reconnaissance was conducted to verify DFTM populations and to help prioritize geographic areas for fall egg mass sampling (Fig. 10) and 2011 spray treatments.

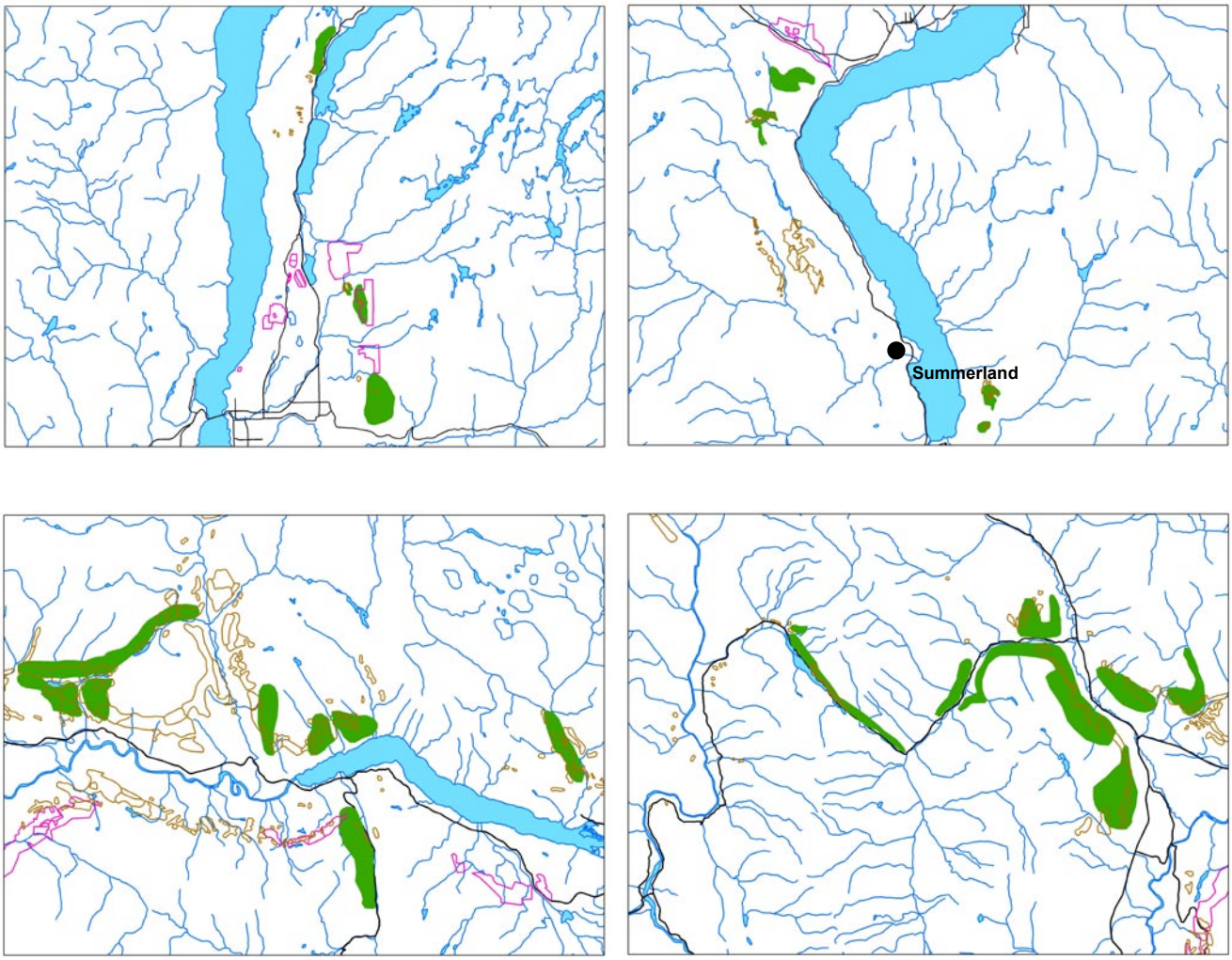


Figure 10. 2010 Douglas-fir tussock moth egg mass sampling locations in four geographic areas. Brown lines show 2010 mapped defoliation; pink lines show 2010 spray blocks; and, solid green polygons indicate where egg mass surveys were conducted in the fall of 2010.

Egg mass surveys are loosely based upon the protocol for the sequential egg mass surveys developed by Shepherd *et al*. (1985). Areas of interest are selected based upon aerial mapping, preliminary ground checks and trapping results. Table 3 and Figure 11 show, by geographic area, the number of sites falling into each defoliation prediction category and the percent sites with viable DFTM populations. The defoliation categories are loosely based on the sequential egg mass survey as follows: Nil=no cocoons or egg masses; Cocoons only= only cocoons found, no egg masses; very low=only 1 egg mass in area; low=1-2 egg masses per tree on scattered trees throughout area; moderate=3-5 egg masses per tree on several trees in area; high=>5 egg masses per tree on many trees in area; Unsuccessful adults=some eggs on cocoon.

Egg mass surveys were also conducted by the Penticton Indian Band on their Reserve lands near Summerland-Penticton. They found scattered populations of light to moderate density. No plans have yet been formulated for this area. The main areas of activity are west of Kamloops in the McLean Lake-Bonaparte Plateau, Cache Creek area and along the highway corridor to Pavilion Lake. In the Okanagan, there were pockets of tussock moth throughout the central and south Okanagan, with the primary area of concern in the Peachland-Summerland area. Additional ground surveys near Summerland identified further sites that may warrant treatment near Darke Lake.

Table 3. Results of fall 2010 DFTM egg mass sampling surveys. The table shows, by broad geographic area, the number of sites surveyed falling into each defoliation prediction category. See text for definitions.

Defoliation prediction for 2011	Number of Sites					
	Barnes Lake	Bonaparte River	Cache Creek	Central Okanagan	Pavilion Lake	Total
Cocoons only – no defoliation	-	25	8	35	11	79
Old egg masses only	2	23	18	57	11	111
Nil – no defoliation	-	44	4	73	14	135
Low	-	64	66	59	16	205
Very Low	-	57	57	94	37	245
Moderate	-	53	49	40	11	153
Severe	-	111	64	15	26	216
Total	-	377	266	373	126	1,144

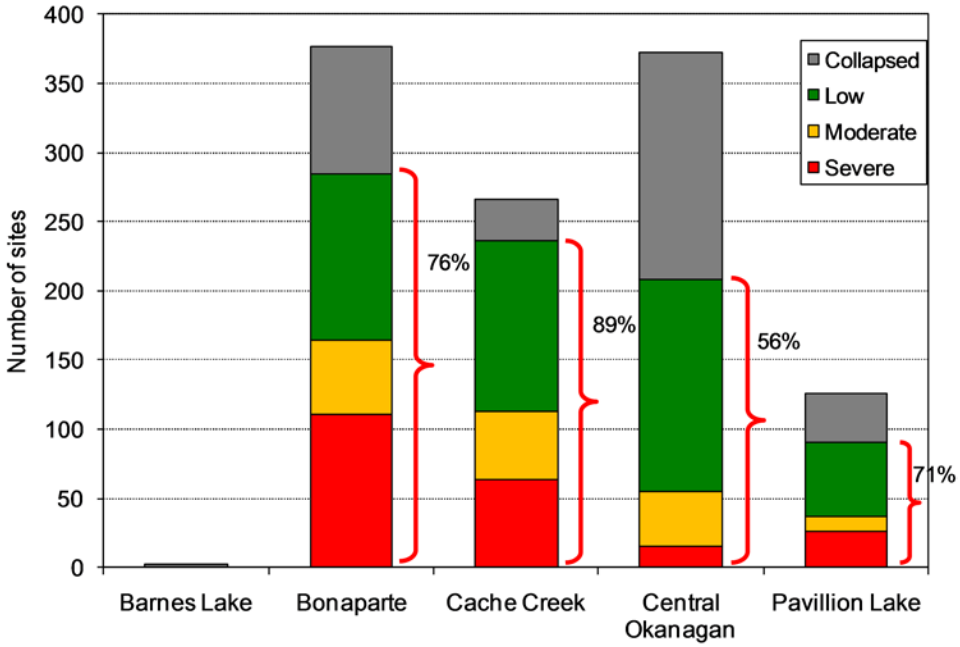


Figure 11. Stacked graph showing number of sites in each geographic area with predicted defoliation of low moderate, severe or nil (collapsed) in 2011 based on results of egg mass surveys. Red brackets show percent of sites in each area that will have some level of defoliation in 2011.

2010 DFTM Trapping and Three-tree Beating Results

Traditionally, DFTM populations have been monitored using a combination of 6-trap clusters and three-tree beatings at 21 established historic sites (site 15, burnt in the Kelowna fire, was relocated in 2010) (Table 4). In 2010, an additional 22 trapping sites (6-trap clusters) were established, for a total of 43 sites, to give better coverage of the potential range of the tussock moth. In late June to early July, three-tree beatings were conducted at 30 of these sites to assess the diversity and abundance of defoliating insects (Table 5). Traps were also deployed at this time and collected in late September 2010.

Within the Southern Interior Region we have identified four outbreak areas (modified from Harris *et al.* 1985) seen in Figure 12. The outbreaks dynamics are more temporally synchronized in these geographic areas and thus make it easier to identify trends. The outbreak areas are: West Kamloops; Kamloops; Okanagan; and, Similkameen. Tussock moth trap catches generally decreased in the Okanagan and Similkameen, increased west of Kamloops Lake, and remained static near Kamloops (Table 4; Fig; 12). Decreases occurred in 10 of the 20 original sites, 7

increased, and 3 remained static. In the Kamloops area adult trap catches were down significantly from 2008 levels, but up slightly from 2009 levels at McLure (Fig. 13), Stump Lake and Monte Creek (Table 4; Fig. 12). This resulted in an overall average trap catch for the Kamloops area similar to 2009. West of Kamloops Lake, adult trap catches have more than doubled at all established locations, with the exception of Pavilion where trap catches are decreasing despite high egg masses still present in the area. The Six Mile trap catches have remained high for the past six years with catches averaging 55.5 ± 15.5 moths (± SD) annually (Fig. 13). Vernon, Winfield (Fig. 13) and Kelowna were the only sites in the Okanagan or Similkameen that had significant catches in 2010 (Fig. 12).

Douglas-fir tussock moth larvae were found in 66% of the sites where three-tree beatings were conducted. The highest counts were in the western portion of the Kamloops District, near Cache Creek, Ashcroft and Pavilion, where an average of 147 larvae was found per beating site (Table 5). Populations in the North Thompson, Okanagan, and Similkameen were low, with the exception of sites near McLure, Kelowna (June Springs), and Summerland where 48, 57 and 21 larvae were found, respectively. A total of 27 defoliator species were recorded across all plots. Many of these are solitary feeders and generally do not lead to any visible levels of defoliation. Western spruce budworm was the most commonly found defoliator, followed by sawflies and green-striped forest looper. Three-tree beatings are a sound monitoring technique that provide temporal trends of the richness and diversity of insect defoliators, as well as an early warning system of future defoliation events.

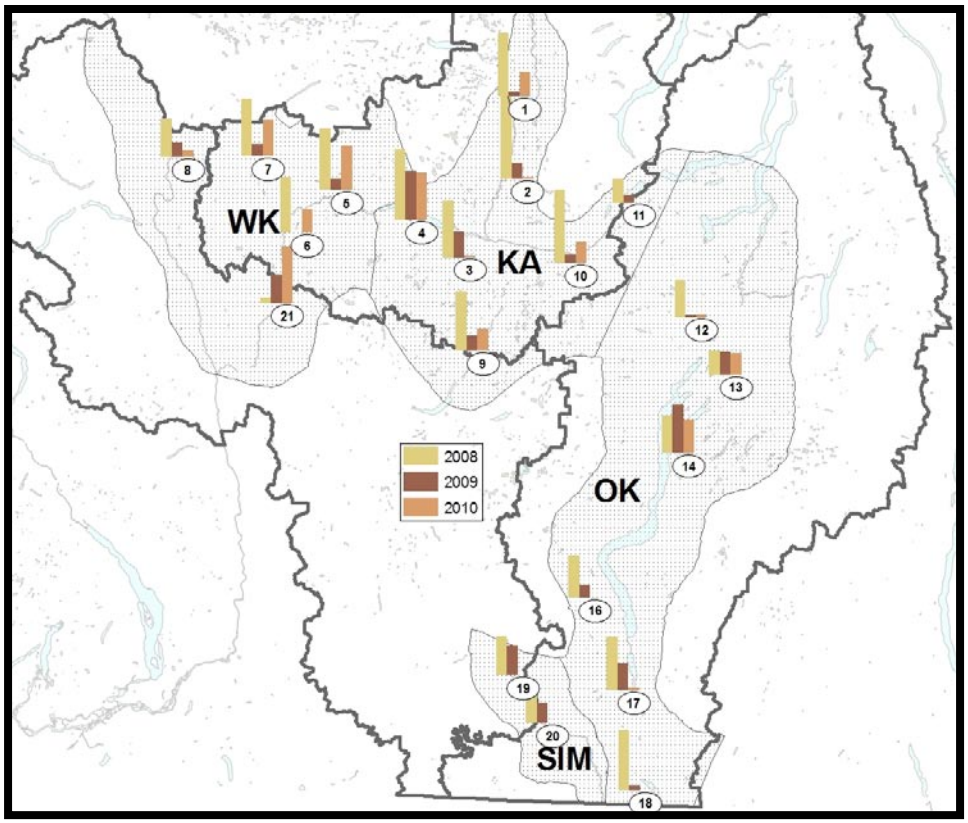


Figure 12. Average Douglas-fir tussock moth trap catches at established (historic) monitoring sites for the period 2008-2010, by outbreak region (WK=West Kamloops, KA=Kamloops, OK=Okanagan, SIM=Similkameen).

References:

Harris, J.W.E., A.F. Dawson and R.G. Brown. 1985. The Douglas-fir tussock moth in British Columbia 1916-1984. Canadian Forestry Service, Pacific Forestry Centre BC-X-268.

Shepherd, R.F., I.S. Otvos and R.J. Chorney. 1985. Sequential sampling for Douglas-fir tussock moth egg masses in British Columbia. Joint Report No. 15. Canadian Forest Service and BC Ministry of Forests, Victoria, B.C.

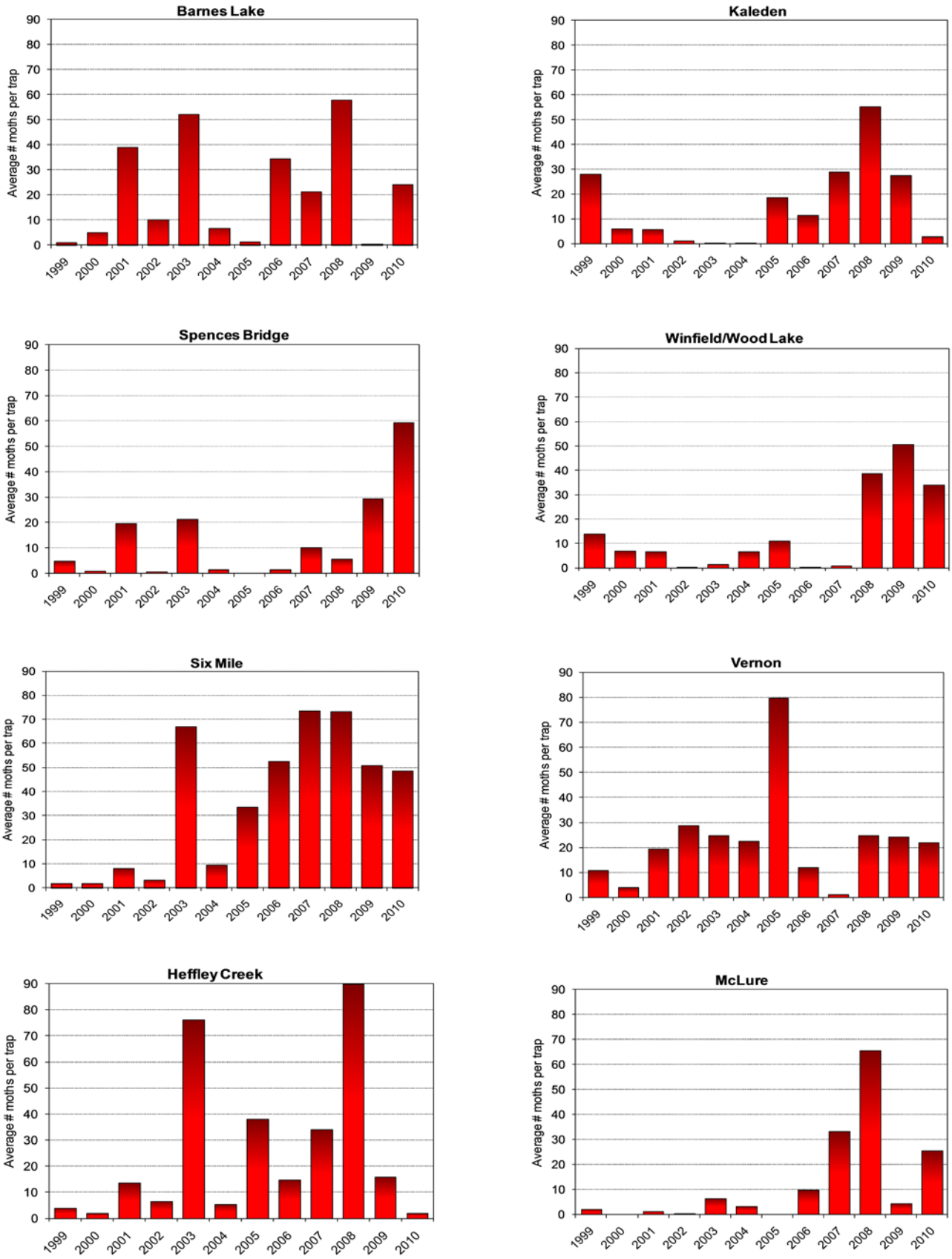


Figure 13. Average annual Douglas-fir tussock moth trap catches (1999 – 2010) at eight permanent trapping locations in the Southern Interior, 6 traps per site.

Table 4. Average number of Douglas-fir tussock moths caught per trap at 6-trap clusters in the Kamloops, Cascades, and Okanagan Shuswap Districts. Traps catches from 2005-2010 are shown for the 21 original 6-trap sites and the 22 new sites show 2010 catches. All trap locations are sorted by general outbreak area.

		Average Trap Catches per trap						2011 Predicted
Site	**Location**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Defoliation**
Kamloops								
1	McLure	0	9.8	33.3	65.7	4.5	25.6	Light
2	Heffley Creek	38	14.8	34.2	89.8	15.8	2.0	Very Light
3	Inks Lake	0.3	10.2	5.6	58.8	26.6	1.0	Very Light
4	Six Mile	33.6	52.5	73.5	73.3	51	48.8	Light-Mod
9	Stump Lake	3.8	2.8	8.7	61.8	15.6	22.7	No Defoliation
10	Monte Creek	40.2	18.3	80.5	75.2	9.2	21.7	Light
11	Chase	9.3	0	0	25.3	7.8	0	Nil
	Average of sites	**17.9**	**15.5**	**33.7**	**64.3**	**18.6**	**17.4**	
Okanagan								
12	Yankee Flats	2	0	0	38.5	2.2	3.0	Very Light
13	Vernon	79.8	12.2	1.3	24.8	24.3	22.0	Very Light
14	Winfield/Wood Lake	11	0.3	1	38.8	50.8	34.0	Light
15	Kelowna/June Springs	-	-	-	-	-	46.8	Moderate (IDT/IDW)
16	Summerland	4.5	1	0.3	43.5	13.2	0	Nil
17	Kaleden	18.6	11.6	29	55.4	27.7	2.9	Nil
18	Blue Lake	39.8	8.3	1.3	63.2	5.2	0	Nil
	Average of sites	**26.0**	**5.6**	**5.5**	**44.0**	**20.6**	**15.5**	
Similkameen								
19	Stemwinder Park	29.5	1.5	17.8	40.2	30.7	0	Nil
20	Ashnola River	14.3	0	12.3	43.3	20.5	0	Nil
32	Olalla	-	-	-	-	-	5.7	Nil
33	Red Bridge Rec Site	-	-	-	-	-	0.3	Nil
34	12.7 km Ashnola R Road	-	-	-	-	-	0	Nil
36	Hwy 3 Lawrence Ranch	-	-	-	-	-	0	Nil
37	Hwy 3 Willow Heights	-	-	-	-	-	0	Nil
38	Hwy 3 Bradshaw Creek	-	-	-	-	-	0	Nil
39	Hwy 3 Winters Creek	-	-	-	-	-	0	Nil
40	Hwy 3 Nickelplate Road	-	-	-	-	-	0	Nil
41	Stemwinder FSR	-	-	-	-	-	0	Nil
42	11.8 km Old Hedley Road	-	-	-	-	-	0	Light (IDW)
43	Pickard Creek Rec Site	-	-	-	-	-	0.3	Light (IDW)
44	5.7 km Old Hedley Road	-	-	-	-	-	5.7	Nil
	Average of sites	**21.9**	**0.8**	**15.1**	**41.8**	**25.6**	**0.9**	
West Kamloops								
5	Battle Creek	1.2	14	34.8	64.5	12.3	46.5	Severe
6	Barnes Lake	1.5	34.5	21.3	58	0.5	24.3	Severe
7	Carquille/Veasy Lake	0	13.8	22.5	59	13	38.2	Light
8	Pavilion	0	1.5	15.7	40	15.7	7.8	Mod-Severe
21	Spences Bridge	0	1.5	10.2	5.7	29.5	59.3	Very Light
22	Veasy Lake	-	-	-	-	-	27.8	Light-Mod
23	Veasy Lake	-	-	-	-	-	5.6	Very Severe
24	Veasy Lake	-	-	-	-	-	6.8	Moderate
25	Hwy 99	-	-	-	-	-	11.0	No Defoliation
26	Venables Valley	-	-	-	-	-	24.3	Very Light
27	Maiden Creek	-	-	-	-	-	3.5	Very Light
28	Hwy 99	-	-	-	-	-	3.0	No Defoliation
29	Cornwall 79	-	-	-	-	-	28.8	Light
30	Cornwall 80	-	-	-	-	-	2.0	Very Light
31	Barnes Lake	-	-	-	-	-	7.7	Moderate
	Average of sites	**0.5**	**13.1**	**20.9**	**45.4**	**14.2**	**19.8**	
Cariboo (average of 31 sites)				0.9	2.3	3.9	1.7	Nil

Note: Site 35 is in the same location at Site 20

Table 5. Total number of larvae per three-tree beating for the top eight defoliators found in Douglas-fir tussock moth monitoring sites in 2010, by general outbreak area.

Site #	Outbreak Area & Location	Douglas-fir tussock moth	Western spruce budworm	Western Hemlock Looper	Western False Hemlock Looper	Sawflies (*Anoplonyx laricivorus*)	Sawflies (*Neodiprion sp.*)	Greenstriped forest looper	*Dioryctria pseudotsugella*
Kamloops									
1	McLure	48	1	0	0	0	0	3	0
2	Heffley Creek	4	1	0	0	0	0	0	0
3	Inks Lake	0	25	0	0	0	0	0	10
4	Six Mile	10	4	0	0	0	4	0	0
9	Stump Lake	11	18	0	1	0	38	1	4
10	Monte Creek	8	0	0	0	0	0	3	0
11	Chase	3	5	2	10	1	0	2	0
Kamloops Total		84	54	2	11	1	42	9	14
Okanagan									
12	Yankee Flats	0	0	0	0	0	2	2	0
13	Vernon	1	1	1	1	0	2	0	0
14	Winfield/Wood Lake	1	1	0	0	0	0	1	0
15	Kelowna/June Springs	57	36	14	3	0	0	1	0
16	Summerland	21	14	0	0	0	2	3	0
17	Kaleden	5	2	0	1	2	0	4	0
18	Blue Lake	0	17	1	3	1	0	0	1
Okanagan Total		85	71	16	8	3	6	11	1
Similkameen									
20	Ashnola River	1	0	0	0	28	0	2	0
33	Red Bridge Rec Site	0	0	0	0	3	0	3	0
36	Hwy 3 Lawrence Ranch	3	1	0	0	5	0	6	0
39	Hwy 3 Winters Creek	0	5	0	0	2	0	4	0
40	Hwy 3 Nickelplate Rd.	0	2	0	0	1	0	0	0
41	Stemwinder FSR	0	15	0	0	0	0	7	0
42	11.8 km Old Hedley Rd.	0	16	0	0	0	0	0	0
43	Pickard Creek Rec Site	0	8	0	0	0	0	0	0
Similkameen Total		4	47	0	0	39	0	22	0
West Kamloops									
5	Battle Creek	302		0	0	0	1	1	0
6	Barnes Lake	166	4	0	0	4	1	0	0
7	Carquille/Veasy Lake	146	4	0	0	1	5	0	0
8	Pavilion	204	3	0	0	6	1	0	1
21	Spences Bridge	44		0	0	3	0	0	0
26	Venables Valley	7	16	0	0	0	2	3	4
27	Maiden Creek	0	58	0	0	0	0	0	16
29	Cornwall 79	309	9	0	0	5	2	0	1
West Kamloops Total		1,178	94	0	0	19	12	4	22
Grand Total		**1,351**	**266**	**18**	**19**	**62**	**60**	**46**	**37**

Douglas-fir tussock moth, *Orgyia pseudotsugata*

Western spruce budworm, *Choristoneura occidentalis*

Western hemlock looper, *Lambdina fiscellaria lugubrosa*

Western false hemlock looper, *Nepytia freemani*

Greenstriped forest looper, *Melanolophia imitata*

Sawflies, *Neodiprion sp.*

Six of the most common insect defoliator larvae encountered during three-tree beatings at the Douglas-fir tussock moth permanent sampling sites.

Summary of the Southern Interior Region 2010
Western Spruce Budworm Program

The western spruce budworm, *Choristoneura occidentalis* Freeman, is one of the key disturbance factors of Interior Douglas-fir (*Pseudotsuga menziesii*) in the southern interior. Both chronic and outbreak populations of budworm can cause growth loss, topkill, stem deformities and mortality. Trees stressed by feeding larvae may predispose trees to attack by Douglas-fir beetle and other forest health agents. With increasing drought stress in fir dominated ecosystems and other extreme physical and biotic events, these forests are becoming more susceptible to budworm damage. One of the most noticeable disturbances in the past 20 years has been the reduction of pine due to the mountain pine beetle from fir ecosystems (e.g. predominantly the Interior Douglas-fir biogeoclimatic unit).

The budworm's geographic range often overlaps with other defoliators such as the Douglas-fir tussock moth, *Orgyia pseudotsugata*, and false hemlock looper, *Nepytia freemani* thus compounding the negative impacts on trees and stands. All three of these insects have been in outbreak mode during the past decade and appear to be changing and expanding their ranges. Budworm outbreaks are generally of longer duration than tussock moth and false hemlock looper, yet historically very few stands sustain budworm populations for more than 3-4 consecutive years. Rather the western spruce budworm continually changes its range or population abundance. The budworm seems to be steadily expanding north, north-east and southeast. With these range changes, there are differences in aspects of insect-host phenology and host response to defoliation; perhaps a response to climatic trends and changed forest structure and composition. Small refugia of western spruce budworm have most likely existed historically throughout the Cariboo. However, there are no historical records of such expansive and severe outbreak populations as have been recorded during this decade in this area.

Current status

Western spruce budworm defoliation was mapped on 499,104 hectares in 2010 (Fig. 1) compared to 759,691 hectares in 2009 representing a 34% reduction in area affected (Table 1). Only two districts, Kamloops and Quesnel, saw an increase in area defoliated by budworm in 2010 compared to 2009. There was a 66% increase in area defoliated in the Kamloops District (Table 2) with the majority of the increase in the light defoliation category. In the Quesnel District, defoliation doubled in 2010 to 10,129 hectares, extending up to Castle Rock. Populations decreased by 85% in the Chilcotin District, with the only notable areas of defoliation noted along the Chilko and Chilcotin River drainages east of Alexis Creek. The total area of defoliation remained fairly static in the Cascades District, decreasing by 6%. The highest decrease was in the moderate category and there was a 34% increase in the area of light defoliation mapped. An aggressive spray program was conducted in the Merritt TSA in 2010 and this greatly influenced the level and extent of budworm activity in this part of the District. Overall, the most extensive budworm activity in 2010 was recorded in the Kamloops, Central Cariboo and Cascades Districts where hectares affected ranged from 116,255 hectares in Kamloops to 146,119 hectares in Cascades (Figs. 1 and 2; Table 1). The main areas of expansion were in the Sabiston-Criss Creek drainages west of Kamloops and Scuitto-Monte Creek area southeast of Kamloops.

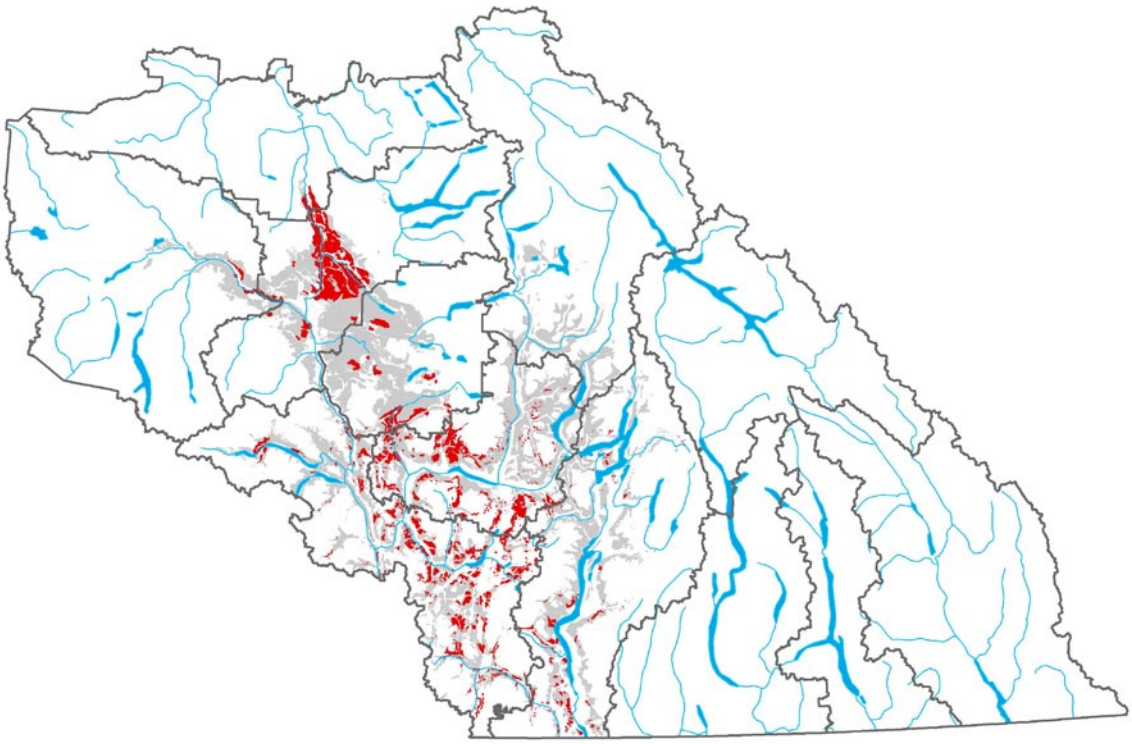


Figure 1. Area of 2010 western spruce budworm defoliation (499,104 hectares) in the Southern Interior Region. The red denotes 2010 defoliation and the grey is historical defoliation 1906-2009.

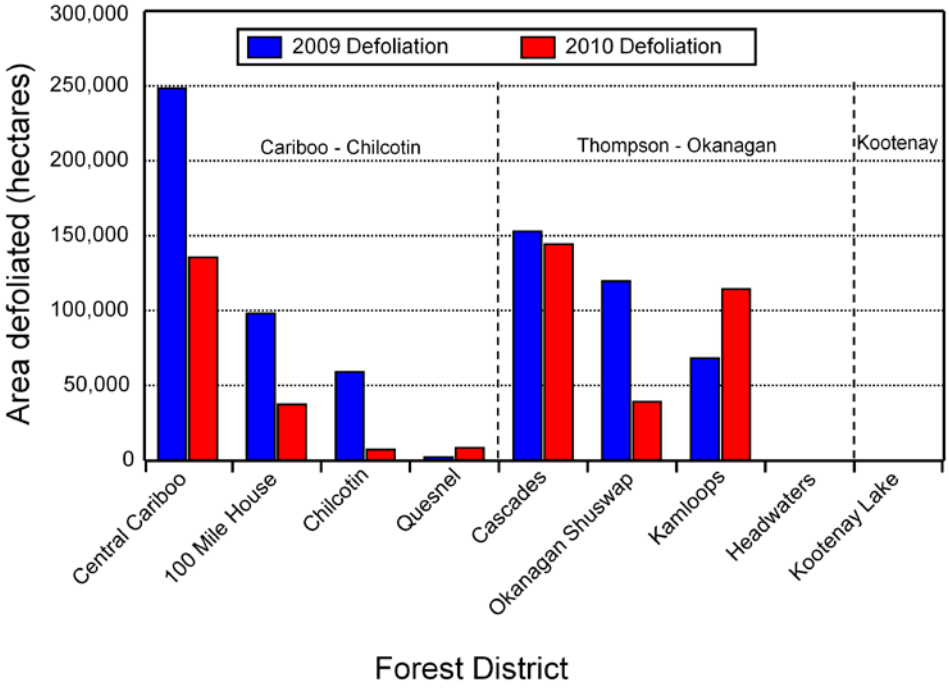


Figure 2. Comparison of 2009 and 2010 defoliation by western spruce budworm in nine Districts in the Southern Interior Region.

Table 1. Summary of area defoliated by the western spruce budworm in 2010, by severity, showing the percent change in hectares mapped from 2009 to 2010.

	2010 defoliated area (hectares)				% change in defoliation
Forest District	Light	Moderate	Severe	Total	2009 to 2010
100 Mile House	36,927	2,352	0	39,279	-60.7%
Cascades	129,681	16,438	0	146,119	-5.6%
Central Cariboo	123,198	14,247	0	137,445	-45.0%
Chilcotin	5,782	3,126	0	8,908	-85.3%
Headwaters	73	0	0	73	-21.8%
Kamloops	107,004	9,251	0	116,255	65.9%
Kootenay Lake	0	0	0	0	-100.0%
Okanagan Shuswap	39,071	1,786	39	40,896	-66.3%
Quesnel	7,033	3,096	0	10,129	296.0%
Total	**448,769**	**50,296**	**39**	**499,104**	**-34.3%**

Outbreak dynamics and hazard and risk systems

The Southern Interior Region has a well established, science-based management strategy for defoliators. The strategy includes hazard and risk rating, stand treatments from harvest to regeneration, and targeted direct control using *B.t.k.* The goal of aerial spray programs is to minimize damage caused by western spruce budworm by reducing populations in treated areas thus protecting foliage and lowering the risk of defoliation in subsequent years. Treatments are seldom applied to the same stands more than once in a five year period (Figure 3). Analysis of spray treatments in three districts (Cascades, Kamloops and Okanagan Shuswap Districts) since 1997 showed 74-100% of all spray blocks were treated in only one year of this 13-year time period (Note: there was no spray program in these Districts in 2000). Only 22,591 hectares in the Cascades and Kamloops Districts were sprayed twice in this time period, representing 33% of total forest treated, and never in consecutive years (Figure 3). Only 5% of stands targeted for treatment in this 13 years were treated twice (3,254 hectares; Fig. 3) and less than 1% treated three times (358 hectares). It is likely that the areas receiving 4 or 5 years of treatment are actually edge overlaps of blocks placed adjacent to past treatment locations.

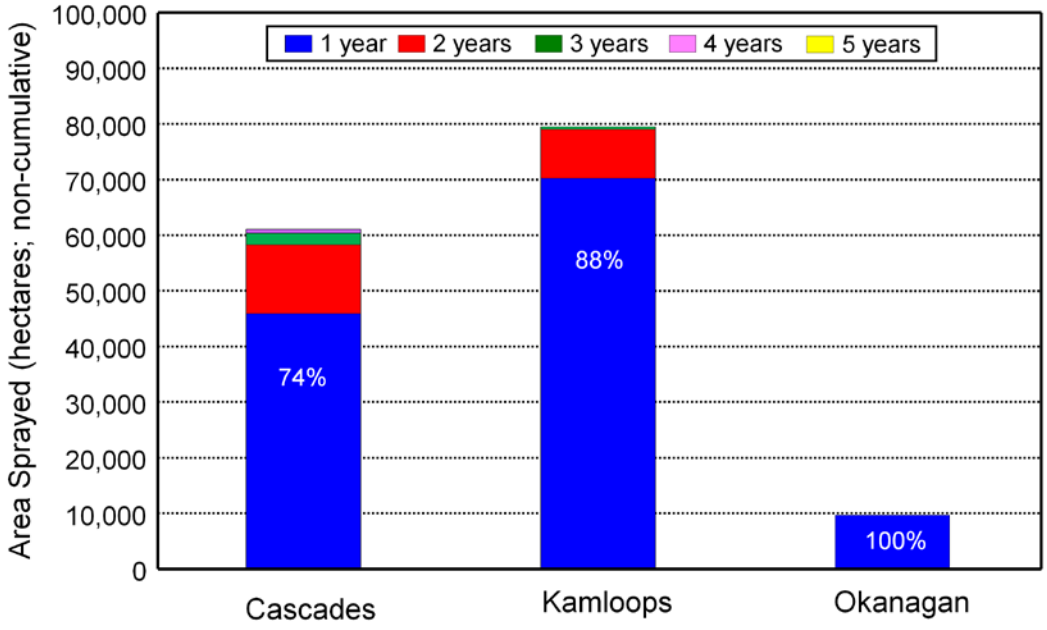


Figure 3. Area of forest sprayed with *B.t.k.* in the Cascades, Kamloops and Okanagan Shuswap Districts 1997-2010. The stacked graph shows the area treated from 1 year, up to 5 years in this 13 year period (no spraying in 2000).

Area of forest treated annually since 1987 has steadily increased and there is pressure to treat a higher proportion of the budworm impacted area to help mitigate mid-term timber supply losses resulting from the mountain pine beetle. Since the inception of the defoliator program in 1987, only in 1996 was there no treatment in the Cariboo or Kamloops. From 1987-1995 all treatments were in the Kamloops Region. In 1997 the Cariboo initiated their first aerial spray program as the budworm expanded and intensified throughout this Region (Figure 4).

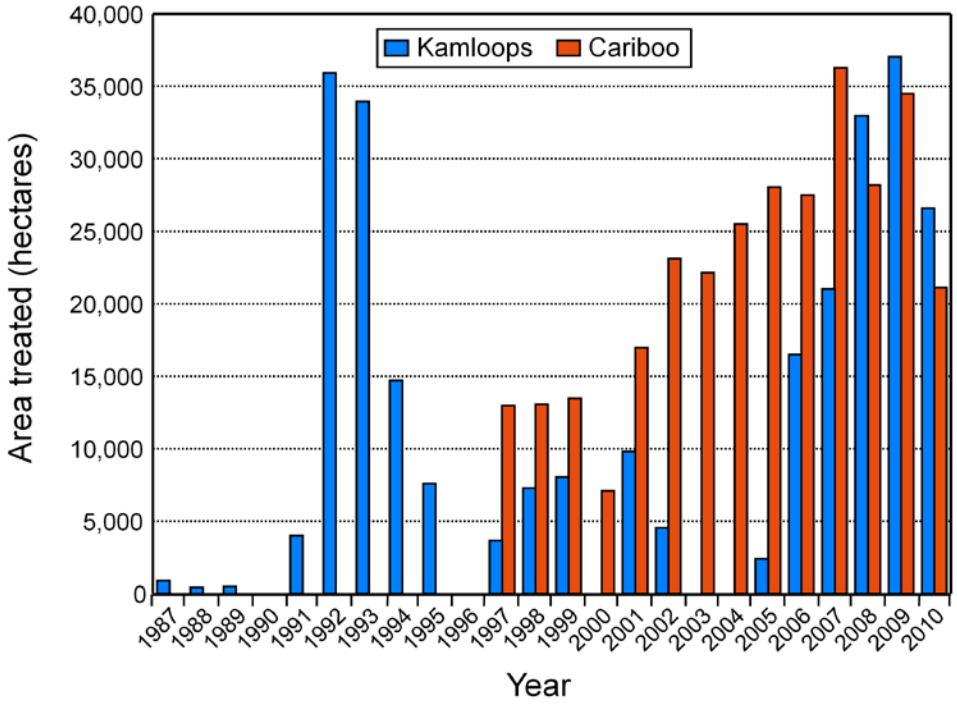


Figure 4. Area sprayed with *B.t.k.* for western spruce budworm in the Kamloops and Cariboo programs. The 2008-2009 data includes the Chilliwack Forest District.

Given the large and increasing scale of the defoliator spray program in the Southern Interior Region, it is imperative to have the best predictive tools available to assist in identifying and selecting stands that will benefit the most from treatment. A hazard and risk rating tool for western spruce budworm and Douglas-fir tussock moth is currently under revision. An improved hazard and risk rating system for the budworm would enable managers to better understand the periodicity and movement of populations across the landscape, as well as to better determine when to apply treatments such as aerial spraying. The data sources for these systems include:

•Federal (FIDS archives) and provincial aerial overview data;
•forest cover, climate and geophysical attributes;
•forest health program data;
•biological and population dynamics literature.

Hazard and risk systems will assist planning and targeting priority stands for spray and silviculture treatments by:

•identifying high priority stands;
•identifying stands most susceptible to damage;
•targeting incipient populations; and,
•identifying change in stand impacts, insect populations or range, and outbreak dynamics.

Defoliation records date back to 1906 (Forest Insect and Disease Survey data, Canadian Forest Service). Although the actual area affected in each outbreak may be less accurate in these older outbreak periods, they give an indication of relative severity and geographic location (Fig. 5). The budworm is becoming more established and predominant in the interior of the province, and most recently north into the Cariboo (Figs. 5 and 7). The budworm is found predominantly in the Interior Douglas-fir ecosystem (IDF) with more than 2.3 million hectares affected (Fig. 6). It has been mapped in over 55% of the IDF, therefore, the question exists: is the remaining 45% *at risk*? This will depend on the condition of the forest in terms of stand structure, species mix, density and level of defoliation (if any) plus the insect's rate of dispersal and response to climatic events. Budworm larvae emerge in the spring prior to foliar bud expansion to spend a variable amount of time foraging on branches, and mining needles and cones (Fig. 8). Losses of dispersing budworms during this needle-mining period are directly related to defoliation severity in previous years, and inversely related to foliage biomass, temperature and rainfall during the needle-mining period.

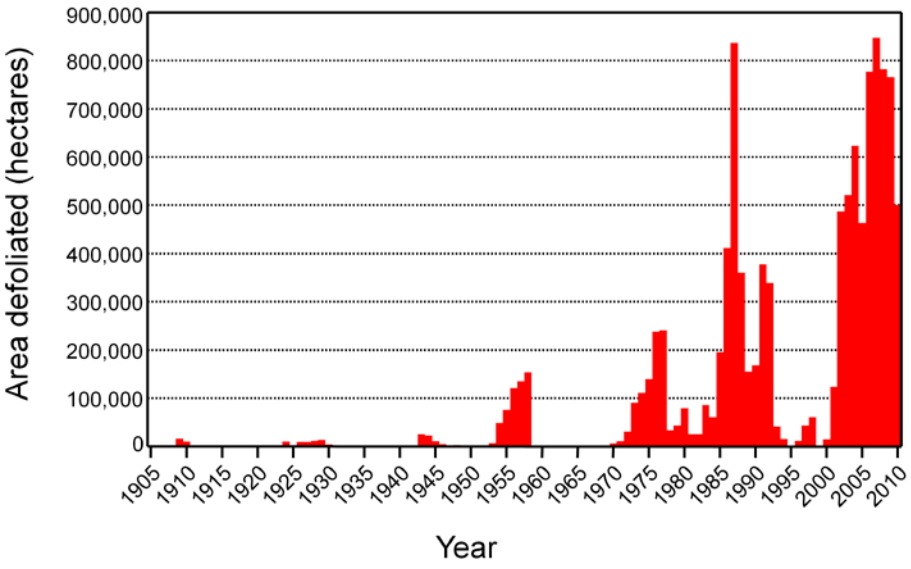


Figure 5. History of western spruce budworm defoliation in B.C. (data from 1909-2010).

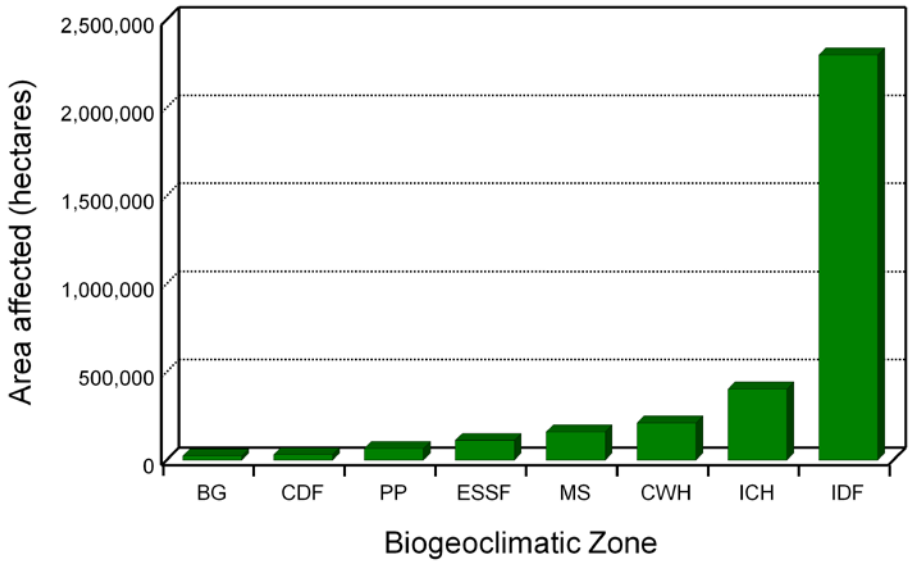


Figure 6. Area of western spruce budworm defoliation occurring in 8 biogeoclimatic zones (BEC's) in B.C. (using historic data from 1906-2010).

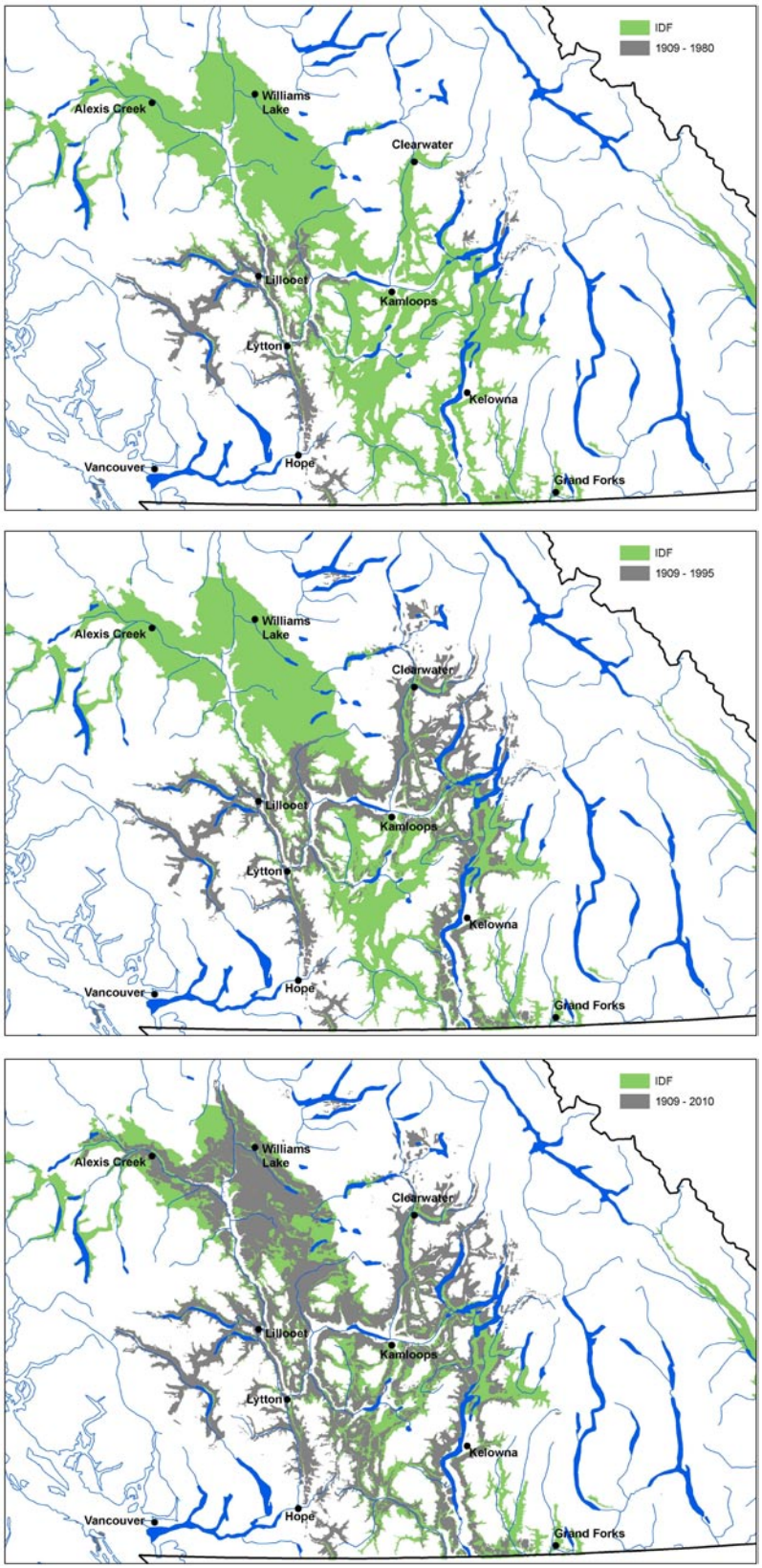


Figure 7. History of western spruce budworm defoliation in B.C. overlaid on the range of the Interior Douglas-fir ecosystem (IDF) from 1909-1980 (top); 1909-1995 (middle); and, 1909-2010 (lower).

Figure 8. Early instar western spruce budworm larvae dispersing (left) and late instar larva feeding in cone (right).

Another critical aspect to better understanding and managing the budworm is the duration (number of years) that a population will remain in a stand. This depends on a number of criteria as mentioned above, both biological and physical. The budworm is a very mobile insect and fluctuates in both abundance and distribution annually. Figure 9 shows the maximum number of consecutive years that defoliation was recorded throughout the range of historic defoliation. The northern reaches, Cariboo-Chilcotin area, seems to have larger areas of more sustained defoliation than seen in the south where the budworm is more chronic and has a longer *known* history (Figure 9).

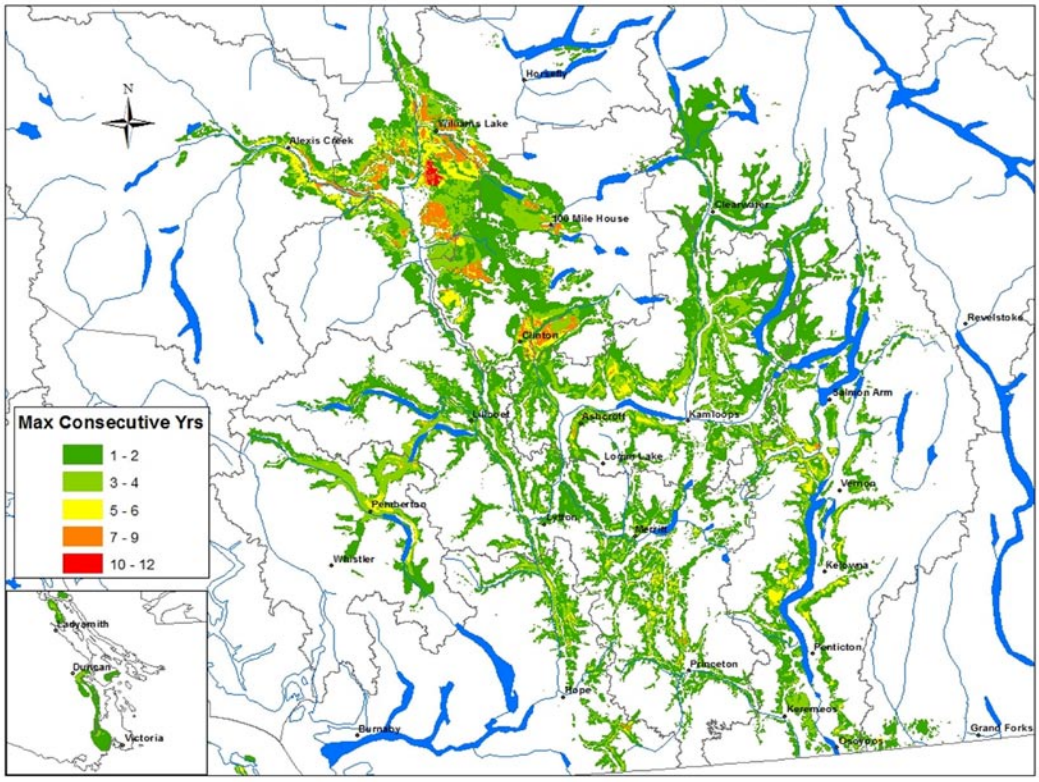


Figure 9. Overlay of historic area of western spruce budworm defoliation highlighting the maximum consecutive years of defoliation through the range, up to 12 consecutive years of defoliation. Inset shows the occurrence of budworm on southern Vancouver Island.

Outbreak cycles of the western spruce budworm are depicted by Forest District in Figure 10. For a more thorough understanding of these cycles, the biological, geographic and physical parameters involved must be delineated. Once they have been established, we will have a much better predictive tool for anticipating and managing future outbreak cycles.

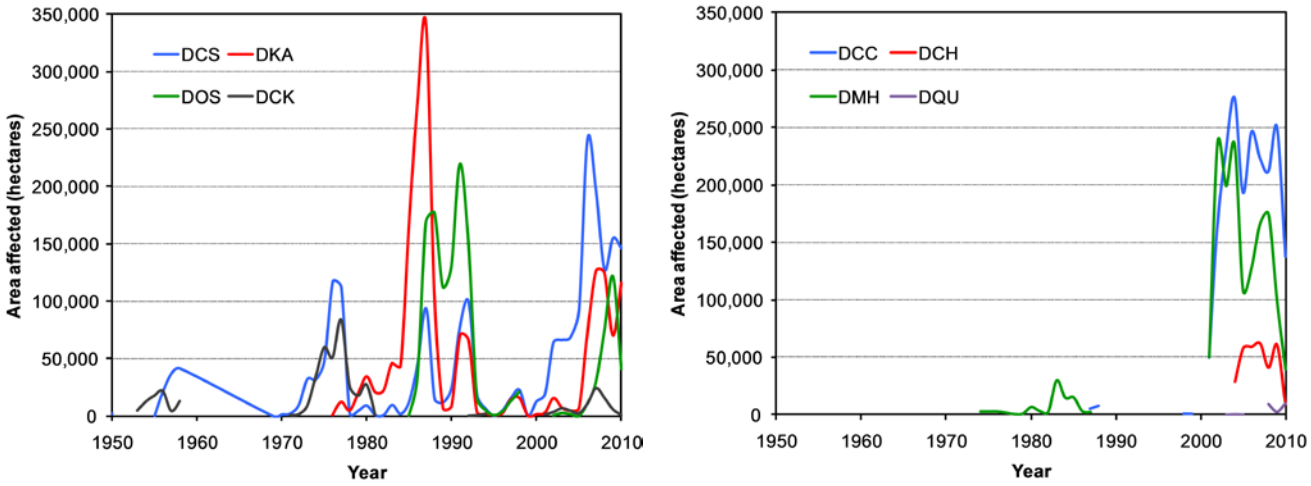


Figure 10. Outbreak trends of the western spruce budworm in the Kamloops and Chilliwack area Districts (upper graph) and Cariboo area Districts since 1950. DCS=Cascades; DOS=Okanagan Shuswap; DKA=Kamloops; DCK=Chilliwack; DCC=Central Cariboo; DCH= Chilcotin; DMH=100 Mile House; DQU=Quesnel.

2010 western spruce budworm spray program

A total of 47,688 hectares of high priority Douglas-fir forest infested with western spruce budworm were treated with Foray 48B (*Bacillus thuringiensis* var. *kurstaki*, P.C.P. No. 24977) in the Southern Interior Region in 2010 (Table 2). The program was divided between the Cariboo and Kamloops areas. 21,115 hectares were treated in the Cariboo and 26,573 hectares were treated in Kamloops (Table 2; Fig. 11). The treatment significantly decreased the populations of the western spruce budworm within the treated stands,thereby mitigating damage in 2010 and beyond. The aerial applications of *B.t.k.* occurred from June 22 through June 27, 2010 (Table 2).

Western Aerial Applications Ltd. was the aerial spray contractor for the Kamloops spray program, employing two 315B Lama helicopters and two Hiller UH12ET helicopters. The Southern Interior Region forest health staff, local forest health contractors (Skyline Forestry, JCH Forest Pest Management, and Barb Zimonick) and others assisted in the delivery of the program from spray planning and population assessments to weather monitoring. The aerial spray contractor for the Cariboo portion of the program was Conair, using two AT-802F Air tractors. The project was a joint effort between the Ministry of Forests & Range (Central Cariboo District, Southern Interior Region staff and the Provincial Air Tanker Center), Conair Aviation, Highland Helicopters and several forest health consultants (EntoPath Management, Timber Wright Management and Alta Vista Management). The *B.t.k.* was delivered to the Cariboo in tanker trucks, where it was transferred to 2,500 US gallon storage tanks located at the Williams Lake airport (Fig.12). This was used as the 2010 staging area for all of the Cariboo's spray blocks. The *B.t.k.* was delivered in 1,000 litre bulks to Kamloops and Merritt, where it was then trucked to 10 staging sites located on or near 21 spray blocks designated for treatment (Fig. 12). Two blocks, totalling 5,130 hectares, were deleted from the spray program due to low larval densities when checked prior to treatment.

The Cariboo program spanned six days, from June 22nd to June 27th and the Kamloops program was completed in four days, from June 23rd to June 26th, 2010. This is the normal spray window for budworm and insect development was peak fourth instar. Defoliation was significantly reduced in the treated blocks.

Table 2. Summary of area sprayed, litres of Foray 48B (*B.t.k.*) and date sprayed for western spruce budworm in 2010, broken down by geographic area.

Block #	Location	Area sprayed (ha)	Litres Foray 48B (*B.t.k.*)	Date sprayed (2010)
Cariboo Program				
6	Mayfield	4,505	11,037	June 27
9	Buckskin Lake	6,317	15,477	June 22, 25, 26
10	Yorston	2,147	5,260	June 25
11	McLeese Lake	2,167	5,310	June 23
12	Bull Mountain	3,777	9,253	June 23, 26
14	South Lakeside	2,031	4,977	June 22
15	Blue Lake	170	418	June 22
Cariboo total		21,115	51,732	
Kamloops Program				
P1	Princeton	860	2,064	June 24
P2	Princeton	1,265	3,035	June 24
P3	Princeton	335	804	June 24
P4	Princeton	1,440	3,456	June 24
P5	Princeton	2,320	5,568	June 24
P8	Allison Lake	1,085	2,604	June 25
P9	Allison Lake	838	2,011	June 25
P10	Brookmere - east	1,330	3,192	June 26
P11	Allison Lake	430	1,032	June 26
P12	Brookmere - east	2,240	5,376	June 26
P13	Otter Creek	2,015	4,835	June 25, 26
P14	Otter Creek	870	2,087	June 26
P15	Otter Creek	445	1,068	June 26
M1	Merritt - Lower Nicola	1,560	3,744	June 24
M2	Merritt - Lily Lake	1,515	3,636	June 24
M3	Merritt - Godey Creek	636	1,525	June 24
M4	Mamit Lake	520	1,248	June 25
M5	Mamit Lake	1,400	3,360	June 25
M6	Mamit Lake	590	1,417	June 25
OK1	Kelowna Woodlots	4,204	10,090	June 23
OK2	Joe Rich	675	1,620	June 23
Kamloops total		26,572	63,772	
Total		**47,687**	**115,504**	**June 22 - 27**

Figure 12. Storage tanks positioned at the Williams Lake airport (left) and mini-bulks at Brookmere staging site.

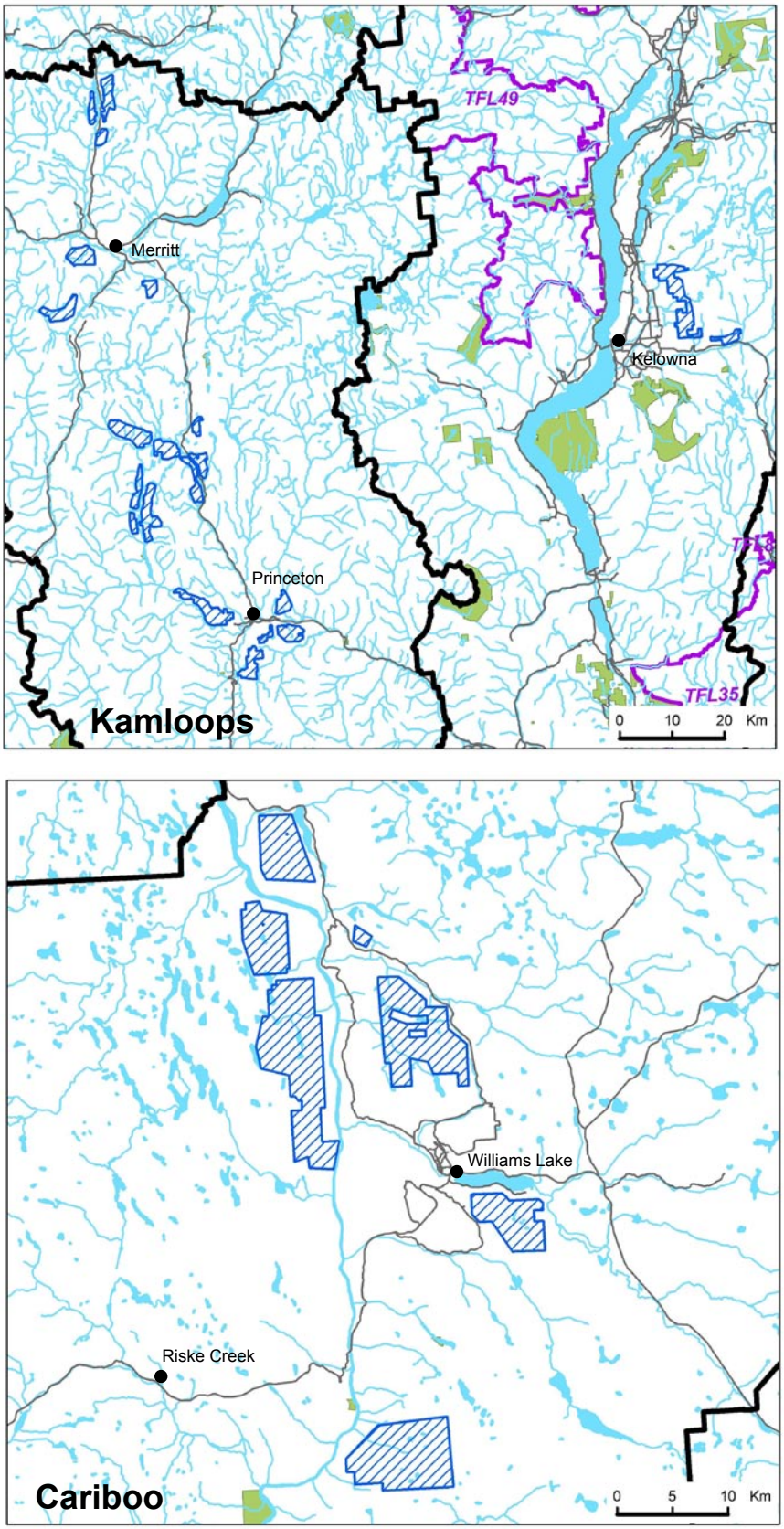


Figure 11. Location of the 2010 western spruce budworm spray blocks in the Kamloops (upper map) and Cariboo (lower map) portions of the Southern Interior.

Western spruce budworm 2011 defoliation predictions and treatment plans

A total of 642 sites were surveyed for budworm egg masses in the fall of 2010 throughout the Region in targeted areas (Fig. 13). In the Cariboo, 184 sites across the Central Cariboo, 100 Mile House, Chilcotin and Quesnel Districts were surveyed and in Kamloops, 445 sites across the Cascades, Kamloops and Okanagan Shuswap Districts were surveyed (an additional 13 sites were surveyed in the Chilliwack District). The highest egg mass counts were found in the northern portion of the Central Cariboo District and into the southern portion of the Quesnel District along the Fraser River. Budworm population predictions in the 100 Mile House Forest District, particularly in the southern half, is down significantly to levels seen in the past. Approximately 35% and 21% of sites in the Okanagan Shuswap and Cascades Districts respectively, had egg mass densities indicating moderate defoliation in 2011. In the Kamloops District, 82% of the sites visited had egg mass densities predicting light defoliation.

A combination of natural and applied controls (listed below) has contributed to a general decrease in severity of defoliation, albeit the range of the outbreak is still expansive (499,104 hectares of mapped defoliation in 2010):

- parasites, disease, predation;
- insect mortality from dispersal and uneven tree/insect development phenology;
- insect mortality due to a combination of early instar dispersal and tree condition (foliar biomass);
- climatic events (e.g. unseasonable precipitation or cool weather);
- insect mortality from *B.t.k.* treatments.

Up to 75,000 hectares of Interior Douglas-fir forests are scheduled for treatment in 2011 with Foray 48B® (*Bacillus thuringiensis* var. *kurstaki*, *B.t.k.*; PCP #24977) under the "2008-2013 Southern Interior Pest Management Plan". The treatment is aimed at decreasing damage caused by the western spruce budworm, and will be targeted at high priority stands within the Thompson Okanagan and Cariboo Regions (Table 3). The application rate will be 2.4 litres per hectare and will be conducted between June 5th and June 30th, 2011. Approximately 25,000 hectares will be treated within the Kamloops, Cascades and Okanagan Shuswap Districts, even though nearly 50,000 hectares of high priority forest have been delineated. In the spring, budmining assessments of early stage larvae will be conducted to determine treatment priority. Up to 22,500 hectares will be treated in the Cariboo Region under the same Pest Management Plan (Table 3).

Table 3. Hectares planned for treatment with Foray 48B (*B.t.k.* applied at 2.4 litres per hectare) in the Thompson Okanagan and Cariboo Regions against western spruce budworm.

Region/District	Hectares planned	Litres of Foray 48B (*B.t.k.*)
Thompson Okanagan		
Cascades	13,104	31,450
Okanagan Shuswap	10,662	25,590
Kamloops	28,050	67,319
Cariboo		
100 Mile House	2,500	6,000
Quesnel	5,846	14,030
Central Cariboo	13,470	32,328
Program Total	73,632	176,718

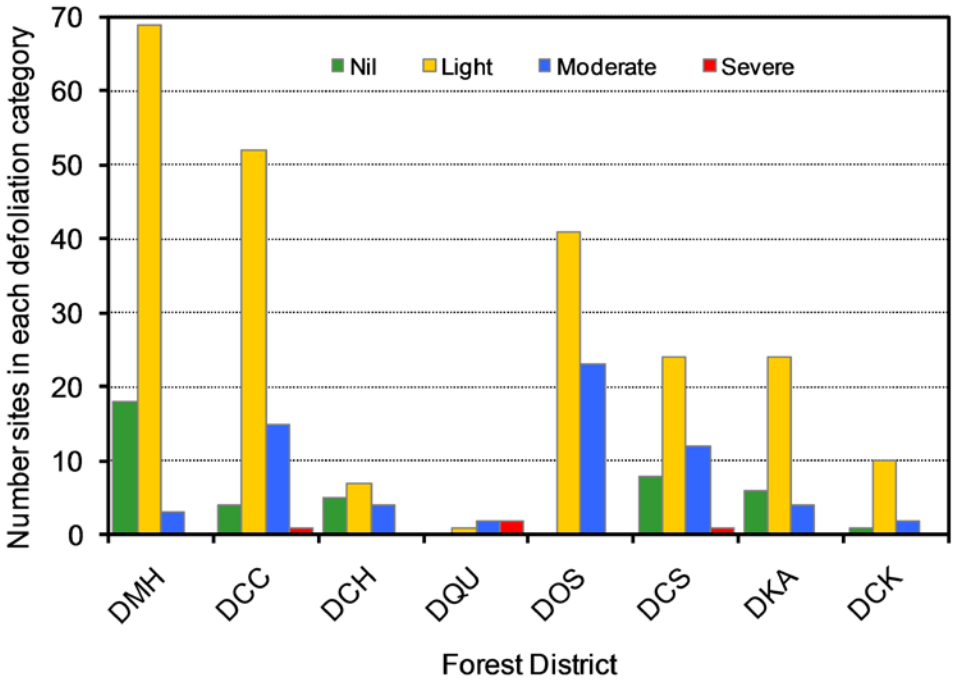


Figure 13. Results of the fall 2010 western spruce budworm egg mass surveys in affected Districts within the Southern Interior region and the Chilliwack District (DCK) showing the number of sites surveyed falling into each defoliation prediction category (nil, light, moderate or severe defoliation predicted for 2011 based on number egg masses found). DMH=100 Mile House; DCC=Central Cariboo; DCH= Chilcotin; DQU=Quesnel; DOS=Okanagan Shuswap; DCS=Cascades; DKA=Kamloops; DCK=Chilliwack.

AT-802F Air Tractor spraying B.t.k.

Forest Health of Young Pine Stands - Monitoring Plots Update

Monitoring and treatments are the cornerstones of the forest health program. Monitoring is accomplished in a number of ways by regional and district specialists to give different, but equally valuable information with which to develop new management strategies and treatments and monitor change. A set of 16 permanent sample plots were established in young pine stands to monitor abundance, diversity, and impacts of pests, and track stand development. These plots are located in the Merritt and Okanagan TSA's in young pine ranging from 25-35 years old. Six plots were re-assessed in 2007 by A.P.C. Consulting and six plots were assessed in 2010 by regional staff.

Plots range in size from 0.05 hectares to 0.25 hectares with a range of stem densities and pest issues. Some very brief summary statistics from the six plots assessed in 2007 are highlighted in Table 1. Stem density ranged from 1,188 stems per hectare in the Ketchan Pruned plot (Table 1) to 3,170 stems per hectare in the Ketchan Creek plot. Tree mortality ranged from 1% to over 30% (Table 1) since plot establishment about 15 years ago. The mortality agents were stem rusts (comandra and stalactiform), to a lesser degree western gall rust, and more recently mountain pine beetle. The pests still active in the stand are lodgepole pine terminal weevil, western gall rust, Lophodermella needle cast and others (Table 1). The weevil does not cause mortality but can influenced tree form (Fig. 1) and volume, whereas western gall rust can kill stems or cause stem breakage.

Table 1. Summary statistics for six plots that were re-assessed in 2007. All plots are located within the Merritt TSA in the Ketchan-Dillard Creek area. Pest codes: IWP=lodegpole pine terminal weevil; DFL=Lophodermella needle cast; DSG=western gall rust; DSA=Atropellis canker; DMP=dwarf mistletoe; VT=tree competition.

Plot	Plot size (ha)	Density (sph)	Avg. ht (m)	Avg. DBH (cm)	Tree mortality since plot establishment (%)	Primary pests on live trees
Dillard Creek 1	0.16	1,743	8.7	11.7	31	IWP/DFL/DSG
Dillard Creek 10	0.16	1,631	5.5	5.5	10	DSG/DSA/IWP
Dillard Creek 11	0.0375	3,067	5.7	6.4	20	DSG/IWP
Ketchan Creek	0.1	3,170	9.7	9.1	17	DSG/IWP/DSA/ DMP/VT
Ketchan Lake 9	0.05	2,540	8.0	8.1	22	DSG/DMP/VT (scattered IBM)
Ketchan Pruned	0.25	1,188	11.3	5.7	1	IWP/DSG

Multiple leaders attacked by lodgepole pine terminal weevil showing early stage of defect formation.

Deformity on pine from 1982 attack by lodgepole pine terminal weevil.

Ketchan Creek - animal feeding on pine and rust.

Western gall rust stem gall.

Ketchan Creek - Dwarf mistletoe plant.

Ellis Creek - mortality due to comandra blister rust.

Forest Pathology Update

Whitebark Pine: Trends In the Kootenays Revealed

Michael Murray, Forest Pathologist, Kootenay-Boundary Region

The first re-measurements of several long-term whitebark pine forest health monitoring plots reveal that 2 of 3 locations are experiencing increases in dead and dying trees while healthy trees decline. The plots were originally installed in 2003 and 2004: Puddingburn Mountain (Cranbrook), Findlay (Canal Flats), and Bluejoint Mountain (Grand Forks) (Figure 1). Since establishing the plots, an epidemic of mountain pine beetle has impacted whitebark pine forests Province-wide. However, based on these results, the non-native white pine blister rust disease is the leading cause of mortality. It is uncertain how representative these three plots are of forest health Province-wide, or even of the Kootenay region (enhanced sampling of whitebark pine would yield better insight).

Disease is most pronounced at Puddingburn Mountain where almost three-quarters of trees are infected (Table 1). Of the infected individuals, 63% have more than one canker. This forest is nearly pure whitebark pine and represents a younger stand (primarily <100 years) that has naturally regenerated after a fire. With such high incidence, blister rust is impacting re-establishment of this forest. The stand is bordered by old-growth whitebark pine which is being decimated by mountain pine beetle (Figure 2). Easily accessible from Cranbrook, Puddingburn Mountain is an ideal location for demonstrations, monitoring, and restoration of forest health amidst diverse whitebark pine stands. I wish to thank Rocky Mountain District Staff, Liz Goyette and Lyn Konowalyk, for their valuable assistance with surveys.

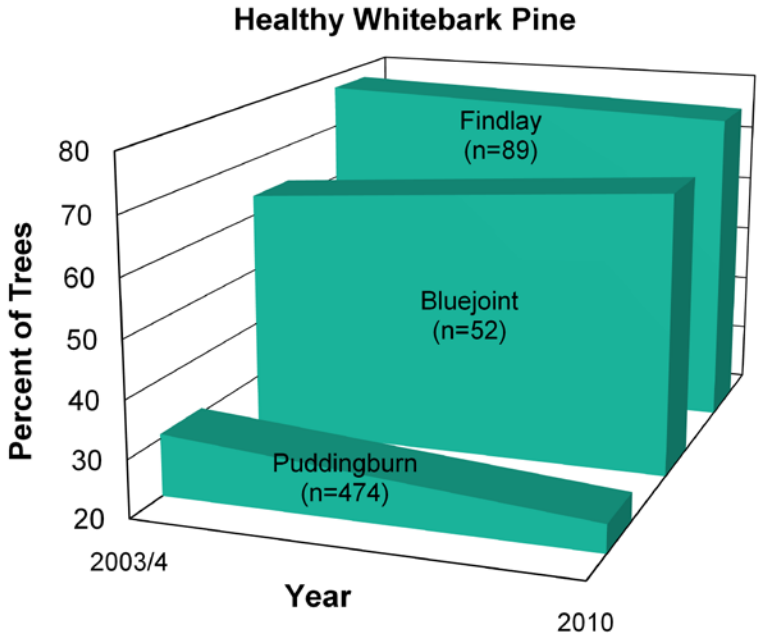


Figure 1. Changes in the number of healthy whitebark pine in three long-term forest health monitoring plots in the Kootenay Boundary Region.

Table 1. Disease incidence on whitebark pine in the Kootenays, 2010.

Location	White Pine Blister Rust Incidence
Puddingburn Mountain (Cranbrook)	71%
Red Mountain (Nelson)	23%
Bluejoint Mountain (Grand Forks)	18%
Findlay (Canal Flats)	15%

Figure 2. Whitebark pine afflicted with mountain pine beetle at Puddingburn Mountain (near Cranbrook), 2010.

Risks to Conifers from Birch Decline

Michael Murray, Forest Pathologist, Kootenay Boundary Region

Mature forest stands composed of a mix of paper birch and conifers are common in the interior regions of BC. Birch can provide both benefits and burdens to associated conifers through nitrogen fixation, competition, and nutrient-rich litter deposition. A particularly important aspect of forest health relates to birch's resistance and tolerance of armillaria root disease. In fact, birch roots often provide a barrier to disease spread, thus protecting neighbouring conifers such as Douglas-fir and lodgepole pine from infection. When birch are harvested, or killed by other causes, the armillaria fungus is able to quickly spread along dead birch roots and transfer to conifers. Overall, the incidence accelerates.

During the past decade, extensive die-back and decline of birch trees has been observed in the interior. While the causes are not well-understood, a variety of agents have been observed including bronze birch borer (*Agrilus anxius*), non-native birch leaf miners (*Fenusa pusilla* and *Profenusa thomsoni*) and armillaria. Climatic perturbations may be a pre-disposing factor – and are currently under investigation using dendrochronology methods. While surveying stands in the Kootenays impacted by birch decline in 2010, I found pronounced signs of armillaria on birch trees and associated regenerating conifers. In October, I observed armillaria mushrooms on 34% of dead birch trees (Figure 3). Since above-ground symptoms are naturally uncommon on birch, it is estimated the actual incidence is much higher.

The extensive mortality of birch in birch-conifer stands places conifers at high risk of infection by armillaria root disease. We can expect larger conifers to become infected initially due to their relatively more expansive root systems. Small regenerating trees, once infected will typically die within several years. Larger trees may survive, but with noticeably reduced growth rates.

Figure 3. Armillaria root disease on a recently killed paper birch tree in a birch-conifer stand.

Staining on lodgepole pine by atropellis canker disease

John King (MNRO Research Branch) describes whitebark pine research on McBride Peak to participants of the Western International Forest Disease Work Conference, October 2010.

Wildlife Damage, White Pine Blister Rust, and Other Important Agents in Young Stands: New Findings from Kootenay Lake TSA

Michael Murray, Forest Pathologist, Kootenay Boundary Region

An intensive survey of 58 cut blocks has yielded useful insight on the health of regenerating stands (16-40 years old). This analysis is patterned after similar efforts (e.g. Lakes TSA) which aim to assess the stocking character and forest health of young stands throughout the Province. As part of the Stand Development Monitoring (SDM) protocol, results provide insight for determining how well plantations are progressing after formal free-growing designations.

The Kootenay Lake TSA is predominantly Interior Cedar-Hemlock (ICH) and Engelmann Spruce – Subalpine Fir (ESSF). A total of 12,121 regenerating trees from 58 plantations were sampled. Within the sampled units, leading species were lodgepole pine, western hemlock, subalpine fir, and Engelmann spruce.

Preliminary findings indicate more trees have been impacted by wildlife damage than by any other biotic agent (Table 2). The incidence on pines is notable. As plantation trees have grown, their greater size has become more attractive to mammals which feed on the cambium. Thus, trees which have passed the free-growing landmark appear more vulnerable.

Whitebark pine killed by bear and mountain pine beetles, Mount Nelson.

White pine blister rust and root diseases are affecting more trees than all other diseases combined. Of note - the high incidence of white pine blister rust compared to root disease. This may partly reflect that root diseases are more challenging to recognize with field surveys.

Table 2. Percent of affected trees in the Kootenay Lake TSA. Only agents which totalled ≥0.01% are provided.

Forest Health Factors	Percent of Trees Observed
Abiotic Damage	4.27
Wildlife Damage	2.40
Vegetative Competition	1.16
White Pine Blister Rust (all conifers)	1.11
All Root Diseases	0.96
Native Rusts (Gall, Comandra, Stalactiform)	0.74
Mistletoe	0.06
Foliar Disease	0.01
TOTAL	10.7

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