Summary of Aerial Overview Surveys in the Southern Interior Forest Region - 2004

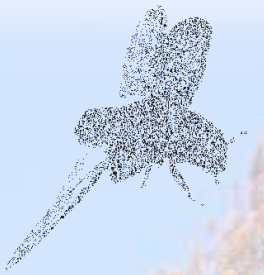
This summary was prepared by:

Lorraine Maclauchlan, Regional Entomologist (Kamloops)

Leo Rankin, Forest Entomologist (Williams Lake)

Kevin Buxton, Forest Health Technician

2004 Overview of Forest Health in the Southern Interior Forest Region



INTRODUCTION

The 2004 Aerial Overview Surveys were carried out between July 15 and September 29, 2004. Separate survey crews were responsible for each of: the Cariboo (consisting of the Quesnel, Central Cariboo, Chilcotin, and 100 Mile House Districts), Kamloops (consisting of the Kamloops, Cascades, and Okanagan Shuswap Districts, and the Clearwater portion of the Headwaters District), and Nelson (consisting of the Columbia, Arrow Boundary, Kootenay Lake, and Rocky Mountain Districts) areas of the Southern Interior Region. The Robson Valley portion of the Headwaters Forest District was surveyed by the personnel responsible for the Northern Interior Region (ProTech Forest Resources Ltd. of Prince George, BC).

Surveys were carried out using the standardised Aerial Overview Survey protocols **(http://srmwww.gov.bc.ca/risc/pubs/teveg/foresthealth/index.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. Severity ratings for major bark beetles were expanded in 2004 to include two additional categories: trace (less than 1% current mortality), and very severe (greater than 50% current mortality), to provide more accurate estimations of volume losses.

Bark beetle intensity class	Current mortality	Defoliation intensity class	Attributes
Trace	< 1%	Light	some branch tip and upper crown defoliation, barely visible from the air
Light	1-10%		
Moderate	11-29%	Moderate	thin foliage, top third of many trees severely defoliated, some completely stripped
Severe	30-50%	Severe	bare branch tips and completely defolated tops, most trees sustaining >50% total defoliation
Very Severe	50-100%		

Weather conditions were generally good, especially in the Kamloops and Nelson survey areas. Due to a later than normal start date, surveys in the Cariboo area were somewhat hampered by intermittent poor weather in August. As well, wildfire activity in the western Chilcotin produced significant amounts of smoke and haze during July and early August.

The most damaging pest in the Southern Interior Region continued to be mountain pine beetle (4,183,746 ha); other pests causing large scale damage were western spruce budworm (614,787 ha) western balsam bark beetle (290,245 ha), spruce beetle (76,669 ha), Douglas-fir beetle (30,685 ha), and two-year cycle spruce budworm (51,171 ha) (Tables 1, 2).

Table of Contents

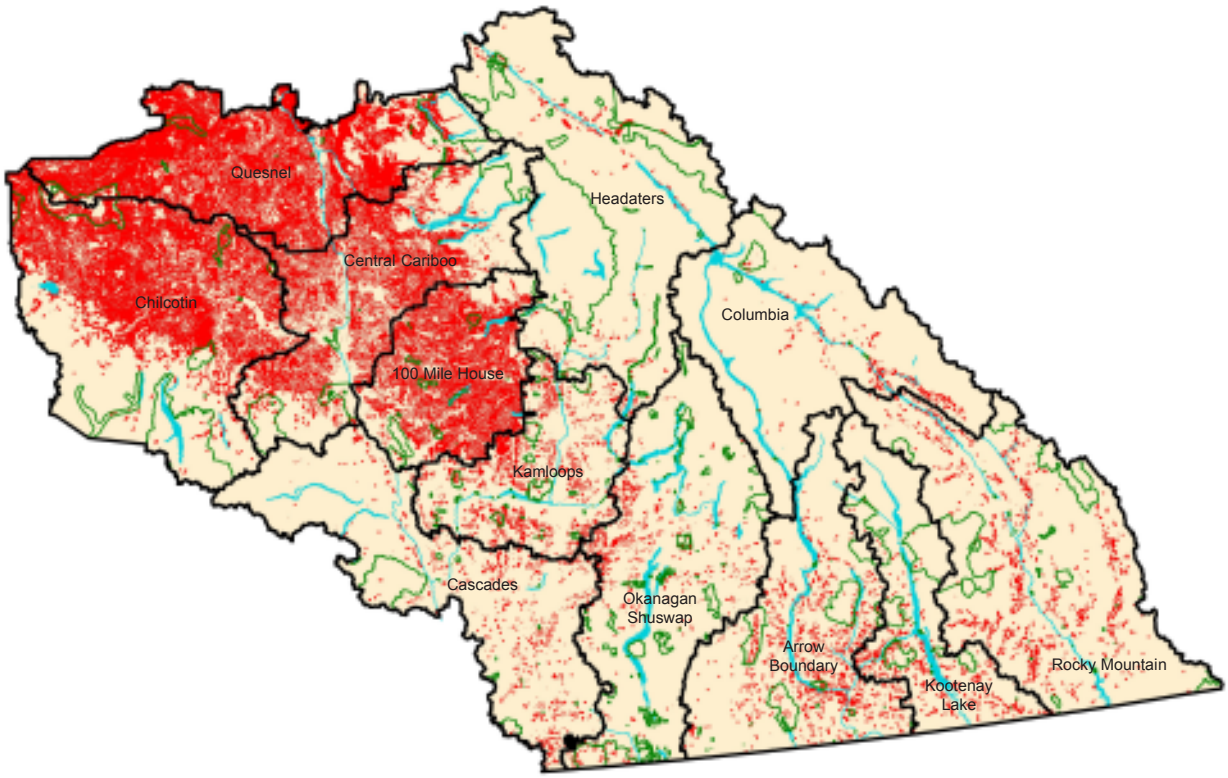


Figure 1. Mountain pine beetle infestations mapped during the 2004 aerial overview surveys.

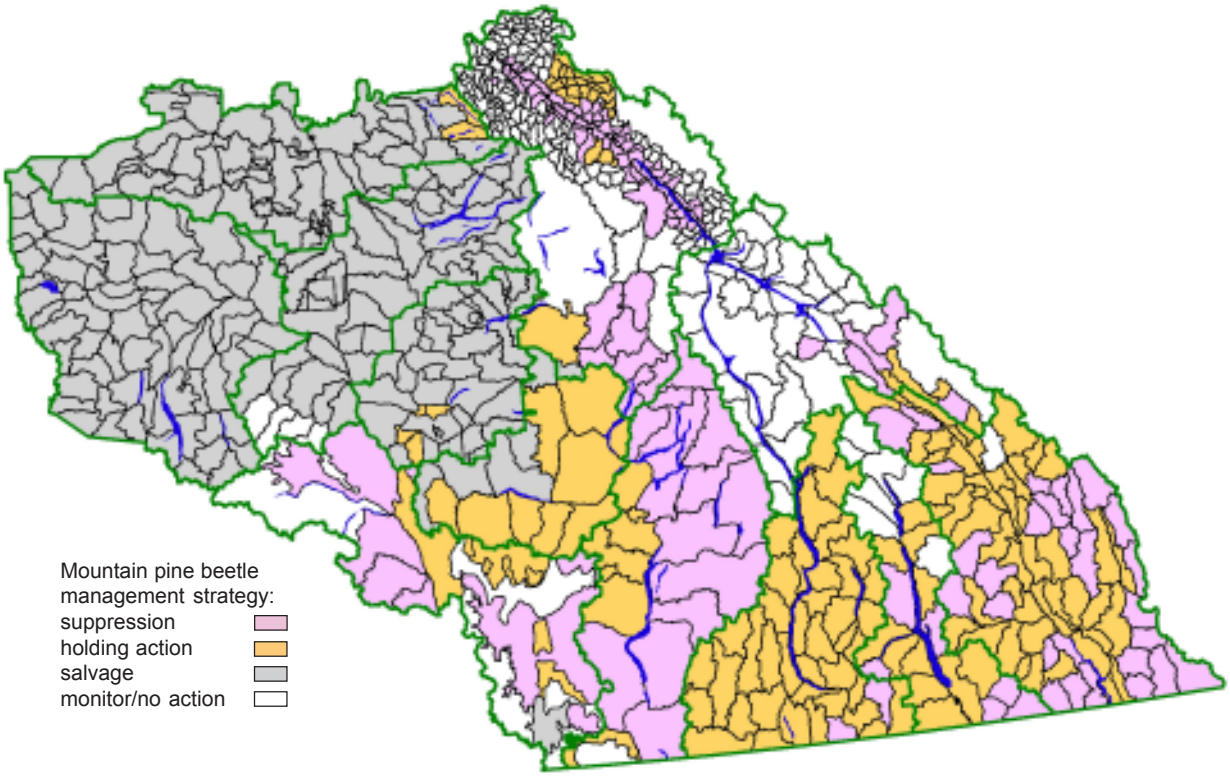


Figure 2. Beetle management unit boundaries and mountain pine beetle strategies as of January, 2005.

Table 1. Area summaries for major bark beetles mapped during the 2004 aerial overview.

Forest District and bark beetle species	Area of Infestation(ha) Trace	Light	Moderate	Severe	Very Severe	Total
Mountain Pine Beetle						
Quesnel	148,478.6	326,077.5	619,518.6	202,369.9	62,548.2	1,358,992.9
Chilcotin	352,126.0	583,420.9	177,063.6	25,688.5	0.0	1,138,299.1
Central Cariboo	229,587.0	219,109.9	149,884.1	79,503.1	28,703.4	706,787.6
100 Mile House	292,302.2	296,490.2	57,804.4	8,142.8	1,150.6	655,890.2
Okanagan Shuswap	6,679.5	19,386.6	12,486.2	2,785.2	2,626.6	43,964.2
Kamloops	10,864.9	46,771.6	32,146.8	17,005.0	10,652.3	117,440.6
Headwaters	10,275.6	17,214.6	2,580.3	349.5	508.6	30,928.6
Cascades	2,436.6	16,761.6	9,502.4	3,224.3	1,649.1	33,574.0
Rocky Mountain	0.0	7,796.8	16,333.8	5,703.4	0.0	29,834.0
Kootenay Lake	0.0	5,200.8	4,343.4	1,571.1	0.0	11,115.3
Columbia	0.0	1,654.8	4,034.1	245.4	0.0	5,934.3
Arrow Boundary	0.0	16,139.3	22,240.2	12,047.5	558.4	50,985.4
Total	**1,052,750.4**	**1,556,024.6**	**1,107,937.9**	**358,635.7**	**108,397.2**	**4,183,746.2**
Douglas-fir Beetle						
Quesnel	2,210.6	203.1	0.0	0.0	0.0	2,413.7
Chilcotin	1,389.8	1,249.1	400.5	0.0	0.0	3,039.4
Central Cariboo	14,963.4	2,751.6	442.3	0.0	0.0	18,157.3
100 Mile House	1,096.2	2,941.0	926.5	10.5	0.0	4,974.2
Okanagan Shuswap	66.5	293.2	17.2	28.7	22.6	428.2
Kamloops	0.0	177.4	118.1	52.1	0.0	347.7
Headwaters	63.9	159.3	20.5	0.0	9.0	252.6
Cascades	0.0	252.4	158.4	13.9	0.0	424.7
Rocky Mountain	0.0	429.3	20.4	65.2	0.0	514.8
Kootenay Lake	0.0	64.3	58.6	0.0	0.0	122.9
Columbia	0.0	0.0	5.1	0.0	0.0	5.1
Arrow Boundary	0.0	0.0	0.0	4.7	0.0	4.7
Total	**19,790.4**	**8,520.7**	**2,167.6**	**175.1**	**31.6**	**30,685.3**
Spruce Beetle						
Quesnel	20,649.0	783.1	587.9	531.5	0.0	22,551.4
Chilcotin	87.2	41.3	142.8	0.0	0.0	271.3
Central Cariboo	6,994.0	5,733.9	5,786.8	5,614.3	4,659.8	28,788.8
100 Mile House	1,478.7	4,304.1	4,047.0	2,750.6	4,671.6	17,252.1
Okanagan Shuswap	0.0	462.2	370.8	631.8	88.3	1,553.1
Kamloops	0.0	0.0	5.7	0.0	0.0	5.7
Headwaters	1.2	400.9	270.0	477.1	1,863.0	3,012.1
Cascades	0.0	677.1	2,092.3	257.3	16.5	3,043.1
Rocky Mountain	0.0	6.1	307.0	55.4	0.0	368.5
Kootenay Lake	0.0	14.5	26.3	0.0	0.0	40.7
Columbia	0.0	0.0	13.0	0.0	0.0	13.0
Arrow Boundary	0.0	19.1	0.0	0.0	0.0	19.1
Total	**29,210.1**	**12,442.3**	**13,649.6**	**10,318.0**	**11,299.2**	**76,919.0**
Western Balsam Bark Beetle						
Quesnel	68,208.9	5,040.8	537.5	0.0	0.0	73,787.2
Chilcotin	9,604.7	4,315.4	110.5	22.8	0.0	14,053.5
Central Cariboo	18,226.7	9,736.7	2,654.4	105.2	0.0	30,723.0
100 Mile House	10,914.2	12,723.6	2,966.7	117.7	0.0	26,722.2
Okanagan Shuswap	0.0	29,780.8	3,697.2	8.4	0.0	33,486.3
Kamloops	33.7	2,347.4	132.3	80.4	0.0	2,593.8
Headwaters	60,766.9	29,120.7	6,760.5	75.7	0.0	96,723.8
Cascades	405.8	2,734.4	227.7	0.0	0.0	3,367.8
Rocky Mountain	0.0	2,134.7	233.2	24.2	0.0	2,392.1
Kootenay Lake	0.0	2,143.8	158.2	61.8	0.0	2,363.8
Columbia	0.0	299.4	18.1	0.0	0.0	317.5
Arrow Boundary	0.0	3,290.5	382.4	40.9	0.0	3,713.7
Total	**168,160.9**	**103,668.2**	**17,878.7**	**537.1**	**0.0**	**290,244.7**

Table 2. Area summaries for major defoliators and abiotic factors mapped during the 2004 aerial overview.

Forest District and defoliator species	Area of Infestation (ha) Trace	Light	Moderate	Severe	Very Severe	Total
Western Spruce Budworm						
Quesnel	0.0	322.8	0.0	0.0	0.0	322.8
Chilcotin	0.0	21,192.3	7,343.3	0.0	0.0	28,535.5
Central Cariboo	0.0	231,601.9	42,428.8	1,854.8	427.0	276,312.5
100 Mile House	0.0	207,014.4	24,084.0	3,557.1	0.0	234,655.6
Okanagan Shuswap	0.0	1,476.1	34.2	0.0	0.0	1,510.3
Kamloops	0.0	4,579.4	26.4	0.0	0.0	4,605.8
Cascades	0.0	55,473.4	13,075.9	295.7	0.0	68,844.9
Total	**0.0**	**521,660.2**	**86,992.6**	**5,707.6**	**427.0**	**614,787.4**
Western Hemlock Looper						
Chilcotin	0.0	412.0	242.4	21.2	0.0	675.6
Okanagan Shuswap	0.0	953.3	46.7	0.0	0.0	1,000.0
Kamloops	0.0	152.3	170.5	80.3	0.0	403.1
Headwaters	0.0	0.0	22.8	0.0	0.0	22.8
Columbia	0.0	2,767.7	615.6	24.5	0.0	3,407.9
Total	**0.0**	**4,285.3**	**1,098.0**	**126.0**	**0.0**	**5,509.3**
Two-Year Cycle Budworm						
Quesnel	0.0	15,252.3	0.0	0.0	0.0	15,252.3
Central Cariboo	0.0	6,381.7	0.0	0.0	0.0	6,381.7
Kamloops	0.0	70.6	0.0	0.0	0.0	70.6
Headwaters	418.8	27,257.7	1,789.6	0.0	0.0	29,466.0
Total	**418.8**	**48,962.3**	**1,789.6**	**0.0**	**0.0**	**51,170.7**
Drought Mortality						
Chilcotin	0.0	0.0	0.0	0.0	421.1	421.1
Central Cariboo	0.0	0.0	0.0	0.0	8.1	8.1
100 Mile House	148.3	208.6	0.0	0.0	0.0	356.8
Okanagan Shuswap	0.0	3,546.9	241.9	60.5	0.0	3,849.2
Kamloops	2.5	4,482.8	1,039.4	56.8	0.0	5,581.4
Headwaters	0.0	151.2	0.0	0.0	0.0	151.2
Cascades	0.0	679.6	146.2	20.2	0.0	846.0
Rocky Mountain	0.0	6.7	0.0	0.0	0.0	6.7
Arrow Boundary	0.0	12.8	89.5	0.0	0.0	102.3
Total	**150.8**	**9,088.5**	**1,516.9**	**137.4**	**429.2**	**11,322.7**
Windthrow						
Quesnel	0.0	0.0	0.0	0.0	1,174.6	1,174.6
Central Cariboo	240.2	0.0	0.0	0.0	1,852.5	2,092.7
100 Mile House	0.0	0.0	754.0	244.1	852.7	1,850.7
Headwaters	0.0	0.0	0.6	0.0	0.0	0.6
Rocky Mountain	0.0	42.5	0.0	0.0	0.0	42.5
Kootenay Lake	0.0	12.0	0.0	0.0	0.0	12.0
Arrow Boundary	0.0	8.7	38.2	0.0	0.0	46.8
Total	**240.2**	**63.1**	**792.8**	**244.1**	**3,879.7**	**5,219.8**
Redbelt						
Chilcotin	0.0	7,096.8	0.0	42.0	74.1	7,213.0
Central Cariboo	0.0	1,293.1	0.0	0.0	0.0	1,293.1
Total	**0.0**	**8,390.0**	**0.0**	**42.0**	**74.1**	**8,506.1**
Wildfire						
Quesnel	0.0	0.0	0.0	0.0	2,068.5	2,068.5
Chilcotin	0.0	0.0	0.0	0.0	19,088.7	19,088.7
Central Cariboo	0.0	0.0	0.0	0.0	154.0	154.0
100 Mile House	0.0	0.0	0.0	0.0	88.5	88.5
Okanagan Shuswap	0.0	0.0	0.0	0.0	489.7	489.7
Kamloops	0.0	0.0	0.0	0.0	355.6	355.6
Headwaters	0.0	0.0	0.0	0.0	14,802.2	14,802.2
Cascades	0.0	0.0	0.0	0.0	7,292.0	7,292.0
Rocky Mountain	0.0	0.0	0.0	0.0	38.1	38.1
Kootenay Lake	0.0	0.0	0.0	0.0	314.7	314.7
Columbia	0.0	0.0	0.0	0.0	352.0	352.0
Arrow Boundary	0.0	0.0	0.0	0.0	55.4	55.4
Total	**0.0**	**0.0**	**0.0**	**0.0**	**45,099.4**	**45,099.4**

Regional Overview

Mountain Pine Beetle, *Dendroctonus ponderosae*

Mountain pine beetle infestations continued to expand this year, and now cover 4,183,746 ha in the Southern Interior Region (Table 1, Figure 1), approximately 59% of the total infested area in the Province (Figure 3). This is an increase of 1.6-fold over 2003 totals. As in 2003, approximately 90% of the total infested area lies within the Quesnel, Central Cariboo, Chilcotin, and 100 Mile House Forest Districts. The rate of spread has slowed in the Quesnel, Central Cariboo and Chilcotin Districts, as infestations are now present in the majority of susceptible stands. However, infestation intensity increased within many of these Districts in 2004, as stands previously mapped as low or moderate now rate as severe. Nearly all other Districts in the SIR experienced increases in the range of 3 - 6-fold. Attack intensity also increased, with the proportion of attack classified as moderate or above rising from 22.5% in 2003, to 38% in 2004. The area classified as moderate rose by over 760,000 ha to 1,107,938 ha, and the area classified as severe and very severe rose by over 275,000 ha, to 467,033 ha.

Overall, the number of polygons mapped has risen, from just over 13,000 in 2003, to 41,057 in 2004, while the average polygon size has decreased to just over 102 ha, from 192 ha in 2003. This is partly an artifact of post-digitizing data processing in the Cariboo, where forest cover data is used to clip out all non-forest types, which results in many smaller polygons. In actuality, the average polygon size in much of the Region is increasing, and the number of polygons is decreasing. Most areas of the Region are experiencing a significant increase in the number of infested polygons, as the mountain pine beetle continues to spread into new stands at a very high rate. Attack is nearly continuous over large areas of the Quesnel, Chilcotin, Central Cariboo, and 100 Mile House Districts. Overwinter mortality surveys conducted during the spring of 2004, indicated that populations in all areas of the Region exhibited very large R-values (population trend ratios), and low mortality rates over the winter of 2003-2004 (see page 32 for a detailed account). Green:red attack ratios collected from areas throughout the Region during the fall of 2004 were also very high (Table 3), indicating that barring unseasonably cold weather during the remainer of the winter, this exponential rate of spread will continue in 2005.

During 2003 and 2004, in several areas throughout the Southern Interior Region, mountain pine beetle attack was observed in lodgepole pine plantations, as young as 27- 30 years old. In many instances, this attack killed a significant number of trees, and successful brood development was common. Research is planned for 2005-2006 to investigate the susceptibility of young lodgepole pine plantations, and the possible consequences of large-scale mortality in young pine stands. An in-depth description of the proposed research is located on page 34 of this report.

Table 3. Green:red mountain pine beetle ratios for the Southern Interior Forest Region, 2004.

Forest District	Average Green:red Ratio	Range
Kamloops	5	1 - 20
Cascades	5	1 - 68
Okanagan Shuswap	4	<1 - 15
Headwaters	5	<1 - 14
Columbia	6	1 - 10
Rocky Mountain	5	<1 - 14
Kootenay Lake	6	3 - 25
Quesnel	10	<1 - 25
Chilcotin	18	4 - 50
Central Cariboo	12	1 - 25
100 Mile House	10	3 - 25
Regional Average	7.8	

Many Beetle Management Units (BMU's) were down-graded from Suppression in 2004 due to the expansion of the outbreak. By definition, >80% of infested trees must be addressed within Suppression BMU's; this strategy is usually applied to incipient (building) populations. In most areas the outbreak is beyond the incipient stage and single tree control efforts are no longer a viable tool to curb either the extent or intensity of infestation. Localised single tree treatments are still being conducted in select suppression BMU's, usually when these efforts are effectively combined with harvesting. The majority of the remaining Suppression BMU's are located in areas within parts of the former Nelson and Kamloops Regions (Table 6, Figure 2).

Table 4. Area infested, number of polygons, and average polygon size, for mountain pine beetle in the Southern Interior Forest Region, 2001-2004.

Year	Area infested	# polygons	Average polygon size (ha)	# of spot infestations	# 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	4,220,498.5	41,057	101.9	4,932	63,410

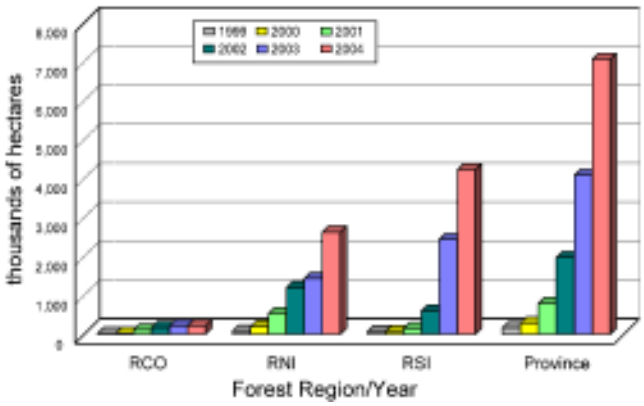


Figure 3. Area affected by mountain pine beetle 1999 - 2004 in British Columbia. (RCO = Coast Forest Region; RNI = Northern Interior Forest Region; RSI = Southern Interior Forest Region)

mountain pine beetle

Table 5. Number of spot infestations of mountain pine beetle in the Southern Interior Forest Region over time, by District.

District	#spots 2003	#trees 2003	# spots 2004	# trees 2004
Kamloops	262	2,905	410	5,090
Cascades	374	3,407	469	6,365
Okanagan Shuswap	407	3,992	352	3,470
Headwaters	547	5,675	136	1,557
Columbia	177	2,655	258	3,870
Rocky Mountain	428	6,420	1,041	15,615
Arrow Boundary	311	4,665	867	13,005
Kootenay Lake	137	2,055	537	8,055
Quesnel	99	528	1	40
Chilcotin	1,245	5,546	683	4,756
Central Cariboo	711	2,355	145	1,149
100 Mile House	572	2,169	33	438
Total	**5,270**	**42,372**	**4,932**	**63,410**

Attack in provincial parks more than doubled from 2003 levels, to just over 194,720 ha, in 100 separate provincial parks (Table 7). Most of this is in the Chilcotin and Quesnel Districts. The largest areas of infestation are within Itcha Ilgachuz and Bowron Lake Parks, which account for just over half of all attack in parks in the Southern Interior Region. Due to the extensive range now covered by the mountain pine beetle and the change in status in many areas from Suppression to Holding or Salvage, minimal control work is being conducted in parks. Some exeptions include Robson Provincial Park and Silver Star Provincial Park. High priority stands within Silver Star Provincial Park are currently being harvested to reduce both the beetle population and potential fire hazard. A controlled burn was conducted in Mount Robson Provincial Park in August 2004, where approximately 2,900 ha were burned on the east side of the Park. The objectives of the burn were to reduce mountain pine beetle infestations, restore wildlife habitat and create a natural fire guard. This was a cooperative project with staffing and resources supplied by BC Ministry of Forests, Alberta Sustainable Resource Development, BC Ministry of Water, Land and Air Protection (BC Parks), Parks Canada, and the Canadian Forest Service. The east side of the Park, leading into Alberta, is a high priority for continued suppression activities, including fall and burn, which will be conducted throughout the 2004-2005 winter months.

Table 6. Beetle management unit designations in the Southern Interior Forest Region as of January 2005.

District	suppression	holding action	salvage	monitor	no action	total
Quesnel	0	2	41	0	0	43
Central Cariboo	0	0	44	0	4	48
100 Mile House	0	2	31	0	0	33
Chilcotin	0	0	59	0	0	59
Kamloops	0	9	5	0	0	14
Cascades	4	8	1	7	0	20
Okanagan Shuswap	16	5	0	1	0	22
Headwaters	72	27	7	169	0	275
Columbia	6	2	0	37	11	56
Arrow Boundary	2	40	0	0	0	42
Kootenay Lake	6	11	0	7	0	24
Rocky Mountain	30	46	0	0	1	77
Totals	**136**	**150**	**191**	**221**	**15**	**713**

salvage BMU in the Kamloops District.

mountain pine beetle in Arrowstone Provincial Park.

Table 7. Area of mountain pine beetle in provincial parks in the Southern Interior Region.

Forest District	total number of parks	number of parks with MPB	total park area	hectares MPB in parks
Quesnel	18	13	317,141.6	77,682.7
Chilcotin	13	9	391,551.1	66,077.3
Kamloops	49	16	93,211.4	10,317.0
100 Mile House	29	24	48,342.6	10,119.6
Central Cariboo	11	9	184,656.4	8,020.0
Headwaters	40	7	861,947.6	6,805.3
Okanagan Shuswap	110	7	243,030.5	5,151.6
Columbia	21	4	631,744.5	3,276.0
Arrow Boundary	33	7	169,813.3	2,966.9
Kootenay lake	23	5	216,704.5	2,071.2
Rocky Mountain	35	5	396,683.9	2,022.2
Cascades	35	7	130,170.2	210.7
Total	**417**	**100***	**3,684,998**	**194,720**

* several Parks cross over District boundaries, hence the total number of Parks in the Southern Interior region is 100, rather than 113, as indicated by the data presented in this table.

Western Balsam Bark Beetle, *Dryocoetes confusus*

Western balsam bark beetle infestations expanded by 40%, to 290,245 ha (Table 1). Most of this increased area was mapped in the northern portion of Headwaters Forest District, where the area increased from 10,500 ha in 2003, to 96,724 ha in 2004. Most of the area mapped in the Headwaters and Quesnel Districts, and a significant proportion of the area mapped in the Central Cariboo, Chilcotin, and 100 Mile House Districts, was classified as trace. Almost none of the area within the other Districts was classified as trace; this reflects differing survey methodologies between survey crews. Historically, within the old Kamloops and Nelson Regions, western balsam bark beetle was not mapped unless there was evidence of greater than the typical, endemic <1 – 1% mortality normally observed in a large proportion of balsam stands.

Douglas-fir Beetle, *Dendroctonus pseudotsugae*

Infestations continue to expand, up from 8,177 ha in 2002, and 22,944 ha in 2003, to 30,685 ha in 2004 (Table 1). The greatest increases were seen in the Central Cariboo, Chilcotin, and Quesnel Districts; the area of infestation decreased significantly in the 100 Mile House District, however 100 Mile House still contains the second-highest total infested area. Significant infestations were observed in most other Districts, except for Columbia and Arrow Boundary Districts, where mortality declined markedly. The number of spot infestations fell dramatically, from 1,870 (13,533 trees) to 1,038 (11,512 trees)(Table 8). It is likely that extensive use of 'trace' polygons accounted for both the increase in overall area, and the decrease in spot infestations.

Table 8. Number of "spot" infestations of Douglas-fir beetle in the Southern Interior Forest Region, by District.

District	# spots	# trees
Kamloops	46	410
Cascades	119	1,138
Okanagan Shuswap	195	1,290
Headwaters	37	380
Columbia	1	15
Rocky Mountain	188	2,820
Arrow Boundary	41	615
Kootenay Lake	10	150
Quesnel	4	35
Chilcotin	104	1,166
Central Cariboo	106	1,571
100 Mile	187	1,922
Total	**1,038**	**11,512**

spruce beetle mortality.

Spruce Beetle, *Dendroctonus rufipennis*

Total infested area has more than doubled from 2003 levels, to 76,910 ha (Table 1). Most of the increases were in the Quesnel and Central Cariboo Districts, where infestations increased from 296 ha to 28,790 ha, and from 4,176 ha to 22,550 ha, respectively. Nearly 90% of all area mapped was in the Central Cariboo, Quesnel, and 100 Mile House Districts. Most increases are attributed to successive years of scattered windthrow throughout susceptible stands in these areas. Much of this area is experiencing only trace levels of mortality.

Western Spruce Budworm, *Choristoneura occidentalis*

Populations of the western spruce budworm expanded in 2004, resulting in an increase in defoliated area, from 506,000 ha in 2003, to nearly 615,000 ha (Table 2, Figure 4). The majority of the defoliation was in the Central Cariboo and 100 Mile House Districts, with significant areas of defoliation also observed in the Cascades and Chilcotin Districts. Less extensive areas were observed in the Kamloops and Okanagan Shuswap Districts, where area affected declined. The majority of the defoliation was classified as light, with just under 93,000 ha of moderate and severe defoliation. Direct control with *B.t.k.* in the 100 Mile House and Central Cariboo Districts significantly reduced budworm populations in high priority areas, thus decreasing the severity and impact of defoliation in treated stands.

Egg mass population sampling was carried out during September 2004, at 249 sites in several Districts (Table 9). In general, population levels are higher in the Cascades and Chilcotin, but more widespread in the 100 Mile House and Central Cariboo Districts. Widespread defoliation is expected again in 2005.

Table 9. Summary of Southern Interior Forest Region fall 2004 western spruce budworm egg mass sampling results, showing predicted 2005 defoliation.

District	Number of sites in each defoliation category				Total number of sites	Average # egg masses/10m² foliage
	Nil	Light	Moderate	Severe		
Cascades						
Lillooet	0	1	10	4	15	120.6
Merritt	0	4	24	18	46	144
Chilcotin	0	1	3	1	5	146.4
Central Cariboo	3	35	30	3	71	60.8
100 Mile House	1	70	40	1	112	52.3
Total	**4**	**111**	**107**	**27**	**249**	

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

Western spruce budworm larva.

Western spruce budworm 2004 aerial spray program

A total of 25,504 ha of high priority Douglas-fir stands were aerially treated with *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) between June 13 and June 18, 2004. The product, Thuricide 48LV, was applied using two AT-802F Air Tractors (a single engine, fixed-wing turbine aircraft) using a T-Jet spray system, at a rate of 2.4 litres/ha (30 BIU/ha). 18,527 ha (in 6 separate blocks) were treated in the 100 Mile House District, in the 100 Mile House, Chasm, Big Bar Lake, and Meadow Lake areas; 6,977 ha (in 6 separate blocks) were treated in the Central Cariboo District, west of Williams Lake (Table 10). Final costs of the entire program were just under $22.50 per hectare treated. Over half of this was due to the cost of the product. The spray program was deemed successful, as egg mass population sampling conducted in the fall showed decreased population levels in all treated areas.

Table 10. Spray blocks treated with *B.t.k.* in the Cariboo for western spruce budworm.

Block	District	Location	ha sprayed	date treated
1	Central Cariboo	Riske Creek	1,510	June 13, 2004
2	Central Cariboo	Meldrum Creek	2,026	June 13-14, 2004
3	Central Cariboo	Felker Lake	136	June 13, 2004
4	Central Cariboo	Brigham Lake	886	June 18, 2004
5	100 Mile House	Demo Forest	568	June 14, 2004
6	100 Mile House	Alberta Lake	1,425	June 14, 2004
7	Central Cariboo	Gun-A-Noot Subdivision	34	June 13, 2004
8	Central Cariboo	Farwell Creek	2,386	June 13, 2004
11	100 Mile House	Clink Lake	4,359	June 14-15, 2004
12	100 Mile House	83 Mile	6,747	June 16, 17, 18, 2004
13	100 Mile House	Chasm	3,897	June 17, 2004
16	100 Mile House	Big Bar Lake	1,532	June 15-16, 2004
Total			25,504 ha	

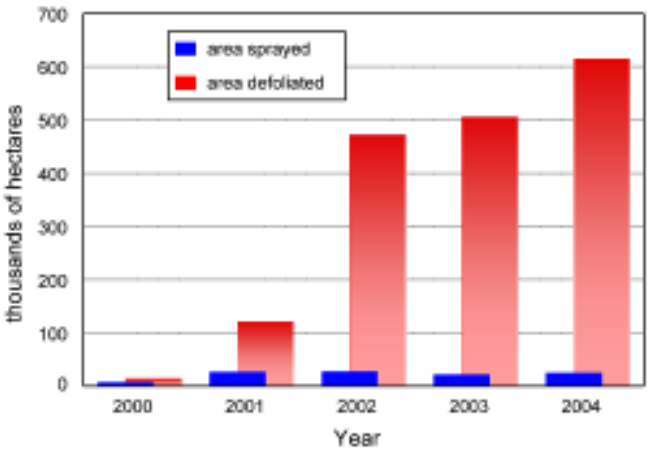


Figure 4. Area defoliated by western spruce budworm and area treated with *B.t.k.* in the Southern Interior Forest Region from 2000 - 2004.

Two-Year Cycle Budworm, *Choristoneura biennis*

Defoliation was mapped on just 51,171 ha in 2004 (Table 2), down from 142,525 ha in the last "on" year (2002). In several areas of the Quesnel and Central Cariboo Districts, populations appear to be either partially in a one-year life cycle, or not synchronized. Populations appear to be declining in most areas of the Headwaters, Central Cariboo, and 100 Mile House Districts, although defoliation was still observed across a broad geographical area.

Western Hemlock Looper, *Lambdina fiscellaria lugubrosa*

The current outbreak has largely subsided, and defoliation was mapped on only 5,504 ha in 2004 (Table 2). The bulk of hemlock looper activity occurred in the Columbia District, where defoliation declined to just over 3,400 ha. Infestations declined in all other areas as well, with the exception of the infestation in the Homathko River area in the Chilcotin District, which expanded from 152 ha to 675 ha. Populations in low-elevation Douglas-fir in the Kamloops area collapsed for the most part this year (personal observation), but defoliation was still visible on just over 400 ha.

The number of male moths caught in 6-trap clusters in the Headwaters and Okanagan Shuswap Districts was down sharply, from an average 617 moths/trap in 2003, to just 30.7 moths/trap in 2004. The only locations with significant catches were at the Shuswap River Ecological Reserve and Greenbush Lake sites, at 107 and 192 moths/trap, respectively. This year, permanent 6-trap cluster sites were established at 10 locations in the Columbia District. The average number of moths caught per trap at these sites was only 4.8 (Table 11). 3-tree larval beatings were carried out in several areas; positive collections were made at 15 of 18 sites in the old Kamloops Region (average 2.4 larvae/site), and at 12 of 25 sites in the old Nelson Region (average 5.7 larvae/site). Egg sampling at 21 sites in the Columbia District indicates that little defoliation will be visible in 2005, except at Martha Creek and Tangier River, where light defoliation is possible. Parasitism rates were very high at all sites where eggs were found.

Areas in Revelstoke and Kamloops that were sprayed with *B.t.k.* in 2003, were monitored for hemlock looper defoliation in 2004. Frass traps were placed in the sprayed areas (double and single treatment) and control areas. These traps give an indication of the level of larval feeding as represented by the amount of frass collected in the traps. Nil to trace defoliation was observed at all sites. There was very minimal frass collected in any of the traps as noted in Table 12. All collections at the Kamloops sites were less than 0.1 gram compared to over 3 grams per trap on average collected at the control sites in 2003. Similar results were observed at all Revelstoke sites, both sprayed and control.

western hemlock looper defoliation near Revelstoke, Columbia District.

Douglas-fir Tussock Moth, *Orgyia pseudotsugata*

No defoliation was observed from the air in 2004; however, populations are still somewhat active in the Scottie Creek area in the Kamloops District (personal observation, and information from Dr. Imre Otvos, Pacific Forestry Centre, Canadian Forest Service). 6-trap clusters were placed at 21 permanent sites in the Kamloops, Cascades, and Okanagan Shuswap Districts; catches were down sharply, from an average of 30 moths/trap in 2003, to just 5.1 in 2004 (Table 13). Over the past few years, an extensive monitoring program has been carried out in the 100 Mile House District, with 51 trapping sites. The number of traps placed at each of these sites has ranged between 1 and 6, depending on previous years' catches. Trap catches continue to be very low, down from an average of only 2.0 moths/trap in 2003, to just 1.1 moths/trap in 2004. In addition to these multi-trap monitoring sites, single traps were placed at approximately 230 sites within the Kamloops, Cascades, and Okanagan Shuswap Districts; average single trap catches were down in all of these Districts (Table 14). Three-tree beatings were performed at all 6-trap cluster sites in the Kamloops, Cascades, and Okanagan Shuswap Districts during July; only one larva was collected. No annual population monitoring activities were conducted in other areas of the SIR.

No defoliation is expected in 2005, and it is not likely that significant populations of this defoliator will be encountered until the next outbreak cycle, anticipated to occur between 2010 and 2012.

Table 11. Average number of western hemlock looper moths caught per 6-trap cluster over time in the Southern Interior Forest Region.

Site	District	Location	2002 average trap catches	2003 average trap catches	2004 average trap catches
1	Headwaters	Serpentine	156	77	3.5
2	Headwaters	Thunder River	172	69	10.8
3	Headwaters	Mud Lake	505	71	13.2
4	Headwaters	Murtle Lake Road	433	150	8.5
5	Headwaters	Finn Creek	271	29	1.7
6	Headwaters	Tumtum	207	no traps	no traps
	District Average		**291**	**79**	**7.5**
7	Okanagan Shuswap	Scotch Creek	954	567	4.5
8	Okanagan Shuswap	Yard Creek	273	780	0.2
9	Okanagan Shuswap	Crazy Creek	315	1110	4.2
10	Okanagan Shuswap	Perry River North	1,294	1471	75
11	Okanagan Shuswap	Three Valley Gap	374	238	25.5
12	Okanagan Shuswap	Perry River South	1,084	958	30
13	Okanagan Shuswap	Kingfisher Creek	1,203	203	8.7
14	Okanagan Shuswap	Noisy Creek	128	145	4.8
15	Okanagan Shuswap	Shuswap River E.R.	347	457	107.3
16	Okanagan Shuswap	Greenbush Lake	302	2860	192.3
17	Okanagan Shuswap	Adams River	189	no traps	1.3
	District Average		**588**	**806**	**38.4**
66	Columbia	Sutherland Falls			2.5
72	Columbia	Trout Lake - Tangier FSR			7.0
73	Columbia	Martha Creek			16.6
74	Columbia	Goldstream River			2.2
76	Columbia	Bigmouth Creek			2.3
78	Columbia	Carnes Creek			1.2
83	Columbia	Begbie Creek			9.2
84	Columbia	Pitt Creek Rec Site			1.8
85	Columbia	Redrock - Kinbasket Lake			1.8
87	Columbia	Jumping Creek			3.3
	District Average				**4.8**
	Average for all sites		**483**	**612**	**19.7**

Table 12. Average frass collections, in grams dry weight, by location and treatment.

Location and treatment	# traps	Avg. grams frass/trap 2004	2003
Kamloops			
double spray	63	0.06	0.3
single spray	57	0.02	0.2
control (no spray)	114	0.06	3.1
Revelstoke			
sprayed	23	0.57	0
control (no spray)	8	0.03	1.8

Table 13. Average number of Douglas-fir tussock moths caught per 6-trap cluster over time in the Southern Interior Forest Region.

Site	Location	Average trap catches			
		2001	2002	2003	2004
1	McLure	1.3	0.2	6.3	3.3
2	Heffley Creek	13.8	6.7	76.3	5.5
3	Inks Lake	9.7	7.8	30.0	1.5
4	Six Mile	8.2	3.5	67.0	9.7
5	Battle Creek	17.2	10.7	67.7	5.6
6	Barnes Lake	39.2	10.3	52.2	6.7
7	Veasey Lake	56.7	16.3	83.0	2.7
8	Pavilion	17.7	1.0	9.7	0.3
9	Stump Lake	3.8	0.0	3.2	1.2
10	Monte Creek	5.5	3.5	10.7	13.8
11	Chase	14.2	28.0	36.3	11.2
12	Yankee Flats	0.7	1.7	1.0	0.3
13	Vernon	19.6	28.8	24.8	22.7
14	Wood Lake	6.8	0.3	1.1	6.7
15	Kelowna	6.2	0.5	no traps - fire	no traps
16	Summerland	16.8	1.5	0.0	0
17	Kaleden	5.7	1.2	0.3	0.3
18	Blue Lake	4.2	2.7	9.2	8.4
19	Stemwinder Park	49.3	2.5	1.2	1
20	Ashnola River	46.7	1.2	0.5	0
21	Spences Bridge	19.7	0.7	21.3	1.5
	Regional Average	**6.0**	**17.3**	**25.1**	**5.1**

Table 14. Average number of Douglas-fir tussock moths caught per trap (single trap per site) over time in the old Kamloops Forest Region.

	Forest District					
		Okanagan Shuswap			Cascades	
Year	Kamloops (±100 traps)	Salmon Arm (9 traps)	Vernon (±46 traps)	Penticton (27-30 traps)	Merritt (±30 traps)	Lillooet (15 traps
1994	19.5	NT	NT	NT	0.1	8.0
1995	10.4	NT	0.9	3.6	2.6	NT
1996	1.9	NT	1.5	4.4	1.9	1.2
1997	17.0	0.0	2.5	9.3	17.0	1.6
1998	25.8	0.0	10.6	24.4	25.8	4.9
1999	4.8	0.0	6.8	27.0	19.7	2.5
2000	3.6	2.9	5.9	19.3	17.0	2.0
2001	3.1	0.1	1.9	4.9	4.8	1.0
2002	15.2	2.0	5.6	6.6	13.8	2.4
2003	25.8	11.9	11.9	5.0	5.9	5.4
2004	18.7	6.0	9.8	4.9	4.2	2.0

NT= no traps placed

Gypsy Moth, *Lymantria dispar*

No gypsy moth adults were caught in any of the 467 (144, 150, and 173 in each of the old Nelson, Cariboo, and Kamloops Regions) permanent pheromone trapping sites in the SIR.

Fir Engraver Beetle, *Scolytus ventralis*

Fir engraver beetle mortality in grand fir continues to increase in the Pend d'Oreille River area, and has expanded into the Rossland – Little Sheep Creek area. Minor tree mortality was also observed in the Creston area. In total, 1,353 ha were affected. In the 2003 Aerial Overview Report, this mortality was reported as being due to *Ips* beetles; however, subsequent investigation has determined the cause of mortality to be *Scolytus*.

Satin Moth, *Leucoma salicis*

Defoliated area declined sharply, from 36,578 ha in 2003, to just 2,961 ha in 2004. Most defoliation was in the Chilco Lake – Tatlayoko Lake area of the Chilcotin District. Population levels appear to have fallen dramatically in most areas, and little defoliation is expected in 2005.

Birch Leaf Miner, *Fenusa pusilla*

Birch leaf miner populations continued to decline, and mapped defoliation was down sharply, from 11,300 ha in 2003, to just 672 ha in 2004. All activity was in the Fadear Creek area of the Kamloops District.

Drought

Drought mortality was mapped on 11,323 ha in the Region in 2004. Most damage was observed in the Kamloops and Okanagan Shuswap Districts, mainly in low elevation, dry, exposed Douglas-fir – ponderosa pine stands, although mortality was observed in many of the drier areas of the Region, including higher elevation sites. The actual extent of mortality was much greater than observed during the overview surveys, since much of the mortality occurred in young or sub-dominant trees and in young stands, and foliage faded during the fall of 2003 and early spring of 2004 (personal observation). For these reasons, drought mortality is often difficult to see during aerial overview surveys. Nearly every low elevation stand observed during ground work in the Kamloops and Okanagan Shuswap Districts, and in many parts of the Cascades District, showed at least some level of mortality. In much of this, the majority of the damage was to understory trees. There is a concern that Douglas-fir beetle and western pine beetle populations may increase in some areas, especially where high numbers of mature trees have been killed.

Windthrow

5,220 ha of windthrow were mapped in 2004. Most was in the eastern areas of the Central Cariboo, 100 Mile House, and Quesnel Districts. Intermittent, scattered windthrow events in high elevation spruce – balsam stands in this area over the last few years appear to be contributing to a population buildup of spruce beetle in several areas.

Wildfire

While 2004 was not as severe as 2003 as far as area burned in the Southern Interior Region, a relatively large area was still affected. Just under 45,100 ha of forest were burned in 1,435 fires, the second highest total in over 10 years. Most of the burned area was in the Chilcotin, Headwaters, Quesnel, and Cascades Districts. Cool weather and significant precipitation in August was likely a limiting factor in fire activity.

drought mortality near Cache Creek, Kamloops District.

Redbelt

Just over 8,500 ha of lodgepole pine stands were affected by redbelt in the Chilcotin and Central Cariboo Districts. Redbelt is a form of winter damage common to lodgepole pine, which results from rapid temperature changes. It occurs when trees in frozen ground are subjected to sudden warm, drying winds, followed by a rapid drop in temperature. Tree foliage then loses moisture faster than it can be replaced, due to the cold soil. Trees affected by redbelt usually recover; however, they may suffer major foliage loss, and/or crown/branch dieback. Redbelt generally occurs along a discrete elevational band.

Other

Other forest health factors mapped include flooding (490 ha in Quesnel, Headwaters, and Columbia); western pine beetle (349 ha in Rocky Mountain, Kamloops, and Arrow Boundary); *Lophodermella* (152 ha in Okanagan Shuswap); bear damage (125 ha in Chilcotin and Kootenay Lake); and, western blackheaded budworm (139 ha in Kootenay Lake and Columbia Districts). Over 1,500 trees have been harvested in Mission Creek Park in Kelowna that were infested with western pine beetle. Western pine beetle are also increasing in ponderosa pine near residential areas impacted by the 2003 Okanagan Mountain Park fire. These infestations were not noted during the overview surveys, as they were difficult to distinguish from drought and post-fire mortality within the same area.

Mourning Cloak, Nymphalis antiopa.

Nelson Summary

The Nelson portion of the Aerial Overview Survey was conducted between July 21-30, 2004, and required 53.4 hours of flight time over 9 days of flying. The surveys covered the area of the old Nelson Forest Region (Arrow Boundary, Columbia, Kootenay Lake, and Rocky Mountain Forest Districts). National Parks (Yoho, Kootenay, Glacier, and Mount Revelstoke) within the survey area were not fully covered; these areas are surveyed by Natural Resources Canada. The timing of the survey was critical again this year, as drought conditions and the subsequent high fire hazard left a narrow window between completion of tree fade, and anticipated onset of poor air conditions. Some smoke and haze were encountered, due to large forest fires burning in the Cariboo and south of the survey area. Visibility varied from good to poor, progressively getting worse as the project proceeded. Surveys were conducted by contract personnel (M.E. Ferguson Forestry Consulting, and Sattva Consulting).

Arrow Boundary Forest District

Mountain Pine Beetle

The total area of infestation has risen by over 4-fold, from 11,591 ha. in 2003 to 50,985 ha in 2004. Average polygon size remained almost unchanged from 2003, however the number of individual polygons increased over 4-fold to 707. As well, the number of spot infestations has risen from 311 (4,665 trees) to 867 (13,005 trees). Expansions were seen in all areas of the District, especially in the central and southeast portions. The most extensive mortality was concentrated along both sides of Lower Arrow Lake – Slocan River areas, and in the Castlegar, Big Sheep Creek, Ladybird Creek, Koch Creek, Trout Creek, Barnes Creek, Ymir Creek, Sheep Creek, Little Slocan River, and Slocan Lake areas. Significant mortality was also observed in several provincial parks, including Syringa Park, Granby Park, Gladstone Park, and Valhalla Park. Nearly all other areas of the District have scattered infestations. Overwintering mortality sampling during March and April of 2004 indicated an average brood mortality of only 66.3%, with an R-value of 10.3.

Western Balsam Bark Beetle

Total area of infestation has continued to increase, from 2,642 ha in 2003 to 3,714 ha in 2004. Infestations in the Grassy Mountain area declined, but increased mortality was seen in the Gable Creek, Trapping Creek, Whatsan River, and Granby Park areas, and in several areas along the east side of Lower Arrow Lake.

Douglas-fir Beetle

Nearly all infestations declined, due to a combination of control activities and natural population decline. Only 5 ha of polygon infestations were observed (down from 485 ha); 615 trees were killed in 41 spot infestations (down from 1,785 trees in 119 spots).

Fir Engraver Beetle

Mortality in grand fir continues to expand in the Pend D'Oreille River area, and has spread into the Rossland and Montrose areas. Infested area is up from 258 ha in 2003, to 1,245 ha in 2004. A further 285 trees were killed in 19 spot infestations.

Other forest health factors observed were: western pine beetle (10.5 ha and a few spot infestations in the Granby River area), spruce beetle (19 ha in the Little Slocan River area), windthrow (47 ha), drought mortality (102 ha), and wildfire (55 ha).

Columbia Forest District

Mountain Pine Beetle

Mountain pine beetle mortality in Yoho National Park.

Total area of infestation has risen from 4,250 ha in 2003 to 5,935 ha in 2004. The number of spot infestations increased as well, from 177 (2,665 trees) in 2003, to 258 (3,870 trees). Most of the infested area is near Golden, in the Columbia River and Kicking Horse River areas. Other significant infestations were observed in the Blaeberry River, Beaver River, Bachelor Creek, Bluewater Creek, the southern end of Columbia Reach, and in Cummins Lakes Park. As well, the number of spot infestations has increased significantly in the Kootenay River area. Infestation levels in Yoho National Park total just over 1,000 ha, an increase of 8-10 fold over 2003 (Leo Unger, personal communication). Infestations in Kootenay National Park, in the Vermillion River and Kootenay Crossing areas, now total 469 ha (Leo Unger, personal communication). Green:red ratios obtained during ground surveys in the fall of 2004 in the Golden area ranged from <1:1 to 10:1, and averaged 6:1.

Western Balsam Bark Beetle

Infested area remained low, at 318 ha, most of which sustained light mortality. Most beetle activity was in the Beaver River and Blaeberry River areas, with mortality scattered in several other high-elevation areas of the District.

Douglas-fir Beetle

The only significant mortality was mapped on a 5 ha area west of Revelstoke; 16 ha were also mapped by Natural Resources Canada staff in Yoho National Park. This represents a decrease from 2003 levels of 126 ha.

Spruce Beetle

Mapped spruce beetle mortality fell to 13 ha, from 95 ha in 2003. However, new infestations were found throughout the Revelstoke area during ground surveys. Most visible activity continued to be in the Sullivan River and Cummins Lakes Park areas.

Western Hemlock Looper

Defoliation was mapped on 3,408 ha, most of which was classified as light. This is a decrease from the 2003 high of 18,558 ha. Most activity was in the Lake Revelstoke area, opposite Downie Creek. An additional 2,000 ha of defoliation was also mapped in Mount Revelstoke National Park by Natural Resources Canada staff. 6-trap cluster pheromone trap catches in the area were low, with all but one site in the District catching less than 10 male moths per trap. Egg counts were generally low, with high parasitism levels. It is expected that negligible defoliation will be recorded in 2005.

Other forest health factors observed were western blackheaded budworm (34 ha in the Bush Arm area of Kinbasket Lake, and 895 ha mapped by Natural Resources Canada staff in Glacier National Park), satin moth (13 ha), two-year cycle budworm (1,277 ha mapped by Natural Resources Canada staff in the Vermillion River area in Kootenay National Park), and wildfire (352 ha).

Rocky Mountain Forest District

Mountain Pine Beetle

Mortality expanded by 350%, to 29,834 ha, nearly three-quarters of which was classed as either moderate or severe. The average polygon size more than doubled, from 26.6 ha, to 57.7 ha. The number of spot infestations also rose dramatically, from 428 (6,420 trees) in 2003, to 1,041 spots (15,615 trees) in 2004. The most extensive infestations are in the south-central portion of the District, in the St. Mary River, Hellroaring Creek, Lost Dog Creek, Perry Creek, Wild Horse River, Teepee Creek, Moyie, and Cranbrook areas; most of the Elk River valley is also infested, from Forsyth Creek south to Elko. Mortality is also widespread in the northern portion of the District, in the Skookumchuck, Buhl, Doctor, Fir, Dutch, Toby, Horsethief, and Bobbie Burns Creek areas; in the Kootenay and Cross River areas; as well as most areas of the Columbia River valley and its other minor side-drainages. Mortality in Kootenay National Park is increasing, where Natural Resources Canada staff recorded attack on an additional 1,086 ha.

Overwinter mortality estimates completed in the spring of 2004 showed an average brood mortality of 78.7%, with an R-value of 5.7. Green:red ratios obtained from surveys during the fall of 2004 averaged 5:1 in the District.

Mountain pine beetle in Kootenay National Park, Rocky Mountain District.

Western Balsam Bark Beetle

Infestations continue to expand, up from 605 ha in 2002, and 1,800 ha in 2003, to 2,392 ha in 2004. Most activity continues to be in the upper Spillimacheen River, Bugaboo Creek, Buhl River, Quinn Creek, Yahk Mountain, and Lussier River areas.

Douglas-Fir Beetle

Douglas-fir beetle mortality has declined, from 816 ha in 2003, to only 515 ha in 2004. However, the number of trees killed in spot infestations has risen, from 1,830 trees (122 spots), to 2,820 trees (188 spots). Most activity was observed in the Grasmere – Roosville, Lake Kookanusa, Gold Creek, Wardner, Lussier River, White River, and Palliser River areas. Increased mortality was observed by Natural Resources Canada staff in Kootenay National Park (95 ha).

Spruce Beetle

Spruce beetle infestations were mapped on 369 ha, up from 91 ha in 2003. Most activity was in the Flathead River area, with some activity also noted in Sage Creek and Fenwick Creek. Natural Resources Canada staff observed scattered mortality in Kootenay National Park, along the Kootenay River valley.

Western balsam bark beetle attack.

Liz Goyette, Stewardship Technician, with northern pitch twig moth (Petrova albicapitana) damage.

Western Pine Beetle

Western pine beetle caused mortality on 304 ha, mostly around Elko. Some activity was also noted in the Findley Creek area, near Canal Flats.

Other forest health factors observed included 7 ha of light drought mortality, 43 ha of light windthrow mortality, and 38 ha of wildfire. As well, *Petrova* pitch moth populations persist in many lodgepole pine plantations, causing stunted and deformed tree growth.

Kootenay Lake Forest District

Mountain Pine Beetle

Mountain pine beetle in West Arm Park near Nelson.

Mountain pine beetle mortality has expanded by nearly 5-fold, from 2,499 ha in 2003, to 11,115 ha in 2004, while the average polygon size has continued to increase, from 33.3 ha to 48.3 ha. As well, the number of spot infestations has increased, from 137 (2,055 trees), to 537 (8,055 trees). Most of the increases in area have been in the light and moderate mortality levels. The greatest increases were seen in the West Arm – Kootenay River – Nelson area. Significant expansions were also seen in most other areas in the southern half of the District. Small, very widespread polygons, and numerous small spot infestations, were mapped throughout the area west of Kootenay Lake and south of Procter, which indicates that the population in this area is particularly robust. Significant mortality was also observed throughout the high hazard stands in the southeast portion of the District, especially in the Moyie River, Hawkins Creek, Kitchener Creek, and Goat River areas. As well, mortality in the Kuskanook, Summitt Creek, Leach Lake, and Sanca areas continues to increase, and new infestations were observed in several areas west of Kootenay Lake, between Meadow Creek and Ainsworth. Overwinter mortality estimates completed in the spring of 2004 showed an average winter brood mortality of 81.1%, with an R-value of 6.0. Green:red ratios collected during fall 2004 ground surveys ranged from 3:1 to 25:1, and averaged 6:1.

Western Balsam Bark Beetle

Infested area was down to 2,364 ha in 2004, from 3,625 ha in 2003. Mortality declined in the West Arm Park, Sitkum Creek, Elmo Creek, and Leach Lake areas, and increased in the Leadville Creek and Blazed Creek areas.

Douglas-Fir Beetle

Mortality expanded to 123 ha in 2004, up from 18 ha in 2003. Spot infestations continue to decline, however, from 33 (495 trees) to 10 (150 trees). Most activity was in the Arrow Creek area, and was split equally between light and moderate mortality.

Fir Engraver Beetle

Three small infestations in the Balfour, Arrow Creek, and Kamma Creek areas, totalling 108 ha, were noted.

Western Blackheaded Budworm

Total defoliated area fell slightly, to 106 ha; however, a new small infestation was observed in the Arrow Creek area. The small infestation in Gray Creek also continued.

Other forest health factors observed included 41 ha of spruce beetle (mainly in the Meadow Creek and Five Mile Creek areas), 315 ha of wildfire, and 12 ha of windthrow near Ymir Mtn.

Kamloops Summary

The Kamloops portion of the 2004 Aerial Overview Survey was conducted between July 15 – July 25, 2004. The surveys required 43.7 hours of flight time, over 9 days of flying. All flights were conducted from the Kamloops Airport, and covered the Kamloops, Okanagan Shuswap, and Cascades Forest Districts, and the portion of Headwaters District within the Kamloops TSA (the former Clearwater Forest District). Flying conditions were generally good. Surveys were a co-operative effort between Ministry of Forests and contract personnel (JCH Forest Pest Management).

Kamloops Forest District

Mountain Pine Beetle

Mountain Pine Beetle mortality increased over 4-fold, to 117,441 ha (up from 27,492 ha in 2003). Almost all previously infested areas experienced significant, and often exponential, increases in both affected area and number of trees killed. Some level of infestation is now present in most areas of the District. The largest increases in affected area occurred in the upper Deadman River, Criss Creek, and Tunkwa Lake areas; nearly a third of all infested stands in the District are in these areas. Infestations also expanded greatly in the northwestern portion of the District, in the area between Allan Lake and the northern District boundary; in the Arrowstone Creek – Battle Creek area; and in the area around Greenstone and Chuwhels Mountains.

Mountain pine beetle in the upper Scuitto Creek drainage, Kamloops Forest District.

Average polygon size has nearly doubled, up from 24.4 ha in 2003, to 45.0 ha. The total number of polygons has risen, from 1,128 to 2,608. The number of spot infestations increased from 262 (2,905 trees) in 2003, to 410 (5,090 trees). This indicates 2 trends – one, where large numbers of smaller, more scattered attacks are coalescing into large areas of attack, and another, where the number of small, scattered attacks are increasing, especially in areas around the fringe of larger infestations, as well as in new areas.

Overwinter mortality estimates completed in the spring of 2004 showed an average winter brood mortality of only 62%, with an extremely high R-value of 17.5. Green:red attack ratios collected during ground surveys during the fall of 2004 averaged 5:1, and ranged from 1:1 to 20:1.

mountain pine beetle in mixed stands and private land in Criss Creek, Kamloops District.

Western Balsam Bark Beetle

Western balsam bark beetle mortality levels remained fairly similar to 2003 levels, at 2,560 ha. Most activity continued to be in the Tsintsunko Lake – upper Wentworth Creek and Chu Chua Creek areas.

Western Hemlock Looper

Western hemlock looper populations crashed in most areas in 2004; however, damage still occurred. Light defoliation was observed in the Sugarloaf Hill, Goose Lake, and Shumway Lake areas near Kamloops. As well, small scattered pockets of defoliation were observed in the Paul Creek and Scheidam Flats areas northeast of Kamloops. In total, 403 ha of defoliation were mapped, down from 725 ha in 2003.

scattered mountain pine beetle attack near Tunkwa Lake.

Western Spruce Budworm

Defoliated area decreased by 35% to 4,606 ha. Most defoliation was in the Scottie Creek – Veasy Lake area. Little defoliation was visible from the air in the Campbell Creek – Roche Lake area, although trace levels were observed during ground reconnaissance.

Douglas-fir Beetle

Douglas-fir beetle mortality more than doubled, from 115 ha in 2003, to 348 ha in 2004. However, the number of spot infestations remained almost unchanged, at 46 spots (410 trees). Mortality declined in the Durand Creek and upper Deadman River areas. This was possibly the result of a relatively small number of red attacked Douglas-fir trees being 'lost' in amongst the very large, severe mountain pine beetle infestations occurring in the same locations. Increased activity was noted in several areas – Battle Creek, Barricade Creek, East Barriere Lake, and Adams Lake.

Birch Leaf Miner

Birch leaf miner defoliation decreased substantially, from 3,850 ha in 2003, to 672 ha in 2004. Damage was limited to the Fadear Creek and Spillman Creek areas.

Birch leaf miner.

Drought

Light to moderate levels of drought-induced mortality occurred in several areas of the District, especially in low elevation areas with shallow, rocky soils. Damage was mapped on 5,581 ha. However, drought mortality at low levels is difficult to detect aerially, especially when sub-canopy trees are affected. Therefore, it is likely that the detected damage is an underestimate of the total area affected by drought in this District. Species affected were mostly Douglas-fir and ponderosa pine. The largest areas of mortality were in the Bonaparte River area north of Cache Creek, and in the Kamloops Lake area. Scattered mortality was also observed along the North and South Thompson Rivers, and around Shumway Lake.

Other forest health factors observed included small areas of western pine beetle (34 ha), spruce beetle (6 ha), 2-year cycle budworm (71 ha), and wildfire (356 ha).

western pine beetle mortality in ponderosa pine.

Cascades Forest District

Mountain Pine Beetle

Mountain pine beetle mortality increased by more than 3.5-fold, from 9,069 ha in 2003, to 33,574 ha in 2004. The number of spot infestations also increased, from 374 (3,400 trees) to 469 (6,365 trees). The largest expansions were seen in the northern portion of the old Merritt District, in the Range Creek – Plateau Lake, Mellin Creek, Moore Creek, upper Clapperton Creek, Guichon Creek, Skuhun Creek, and Pimainus Creek areas. Significant increases were seen in several other areas as well, including the Otter Creek, Brookmere, Kentucky-Alleyne, Missezula Lake, Quilchena Creek, Nicoamen River, Murray Creek, and Fountain Lake areas. A significant increase in small, scattered polygon and spot infestations also occurred along the west side of the Fraser River, in the French Bar Creek, Watson Bar Creek, Mckay Creek, and Slok Creek areas. Infestations decreased in a few areas, including the lower Pasayten River, the Friday Creek area, and lower Red Creek (mainly due to host depletion in the last two areas). Limited overwinter mortality sampling was conducted, therefore estimates for the Cascades District are unreliable.

Mountain pine beetle in Manning Provincial Park.

Green:red ratios observed during the fall of 2004 averaged 5:1.

Western Balsam Bark Beetle

Infestation area remained nearly unchanged from 2003 levels, at 3,368 ha. Most mortality continues to be in the Spius Creek - Prospect Creek area, with scattered infestations occurring in several other high-elevation areas in the southern portion of the District.

Douglas-fir Beetle

Mortality levels remained generally stable, at 425 ha (376 ha in 2003). A further 1,138 trees were killed in 119 spot infestations. Most activity continued to be scattered throughout the Fraser River and Thomson River areas, and in the dry side-valleys, with a few scattered infestations in the Nicola River, Similkameen River, and Stein River areas.

Spruce Beetle

Spruce beetle mortality continued to expand in the District, from 1,200 ha in 2003, to 3,043 ha in 2004. Infestations continue to be confined mainly to the Lost Valley Creek, Downton Creek, Tommy Creek, Bob Creek, and Keary Creek areas. Most of these areas are inaccessible, and no control activities are being undertaken.

Western Spruce Budworm

Overall, defoliation levels remained stable, at 68,845 ha (66,645 ha were defoliated in 2003). Infestations increased substantially in the Carpenter Lake, Downton Lake, Seton Lake, Anderson Lake, and Bridge River areas west of Lillooet, and in the Skuhun Creek, Lily Lake, Allison Creek, and Summers Creek areas south and west of Merritt. Defoliation levels dropped off in the Glimpse Lake, Peter Hope Lake, Douglas Lake, and Kentucky-Alleyne areas. There was an increase in the amount of moderate and severe defoliation, most of which was seen in the areas west of Lillooet, in Spius Creek, and in scattered areas around Merritt and Princeton.

Wildfire

Just under 7,300 ha were burned, mostly in 4 large, early-season fires in the northern part of the District. The 1,514 ha Town Creek fire, near Lillooet, resulted in 3,900 people being on evacuation alert for over 1 week. The largest fire was in the Whitecap Creek area, at 2,414 ha. Other large fires were in the Botanie Creek (1,493 ha), Seton Lake (954 ha), and Stein River (300 ha) areas.

Spruce Beetle mortality near Carpenter Lake, Cascades Forest District.

Drought

Drought mortality was observed in several scattered areas of the District - the Watson Bar – Leon Creek area, a few areas around Nicola Lake and Merritt, and along the Similkameen River, between Princeton and Hedley. Significant levels of understory mortality were noted during ground reconnaissance, along Highway 99 between Lillooet and Pavilion Lake, and in several other low elevation, dry sites in the District, which was not visible during the aerial surveys. Visible mortality during the aerial surveys totalled just under 850 hectares.

Other insect damage noted during the surveys included just under 25 hectares of satin moth defoliation in the Maka Creek and Prospect Creek areas.

Okanagan Shuswap Forest District

Mountain Pine Beetle

Mountain pine beetle infestations expanded by over 4-fold, from 10,495 ha in 2003, to 43,964 ha in 2004. The total number of polygons increased significantly as well, from 558 to 854, while the average polygon size more than doubled, from 19.8 ha to 52.0 ha. The number of spot infestations decreased slightly, from 407 (3,990 trees killed) in 2003 to 352 (3,470 trees killed) in 2004. Beetle activity increased in nearly all areas of the District; the most significant expansions were in the west-central part of the District, at Ingram Creek, Sucker Lake, Pinaus Lake, on TFL #49, and in the Chase Creek – Charcoal Creek – Squilax Mountain area. Other significant expansions were seen at Silver Star Mountain, Paxton Valley, the upper Kettle River/Monashee Pass, Ashnola River, Ewart Creek, upper Trout Creek, and the Aberdeen Plateau. Limited overwinter mortality sampling during the spring of 2004 indicated a low brood mortality rate of 52.8%, and an R-value of 8.4. Green:red ratios in the fall of 2004 averaged 4:1 in the District, and ranged from <1:1 to 15:1.

Western Balsam Bark Beetle

Affected area increased by over 50% to 33,486 ha, nearly 90% of which was classified as sustaining light mortality. Most activity continues to be in the Graystokes – Buck Mountain, Hunters' Range, and Pukeashun Mountain areas. Increased mortality was seen in the Sugar Lake – Mabel Lake and Tahaetkun Mountain areas. Other areas of significant mortality were scattered throughout high elevation areas of the District.

Drought mortality on an exposed site near Trout Creek, Okanagan Shuswap District.

Spruce Beetle

Spruce beetle mortality increased from 806 ha in 2003, to 1,554 ha in 2004. Nearly all activity was in the Snowy Mountain Protected Area.

Douglas-fir Beetle

Douglas-fir beetle mortality remained at a low level in the District, falling slightly from 491 ha in 2003, to 428 ha in 2004. A further 1,290 trees were killed in 195 spot infestations. Infestations are scattered throughout the District.

Western Spruce Budworm

Western spruce budworm defoliation remained at a low level in the District, falling from 2,616 ha in 2003, to 1,510 ha in 2004. This was anticipated, as egg mass population sampling conducted in the spring of 2004 indicated that population levels should remain relatively stable.

Western Hemlock Looper

Defoliated area fell to 1,000 ha, down from 4,400 ha in 2003. The majority of the defoliation was classified as light. Small infestations were scattered through the eastern wet belt portion of the District, in Crazy Creek, Derry Creek, Vanwyk Creek, Vigue Creek, and Cherry Creek.

Drought

Drought mortality was observed on 3,850 ha of low elevation forest. The most extensive areas of damage were along the north end of Okanagan Lake, in the Trout Creek area, and in the Ashnola River area. Actual area sustaining mortality was greater than mapped, due to the difficulty of detecting low level drought mortality from the air. Widespread damage was observed via ground reconnaissance throughout low elevation areas in the District. Most damage occurred on dry, rocky outcrops, with poor or thin soils.

Other forest health factors mapped included 40 ha of satin moth defoliation, 490 ha of wildfire, and areas of western pine beetle in ponderosa pine near Kelowna and other scattered locations throughout the District.

Headwaters Forest District

Mountain Pine Beetle

Mountain pine beetle mortality increased 6-fold, from 5,122 ha in 2003, to 30,921 ha in 2004. A further 1,560 trees were killed in 136 spot infestations. The number of polygons has dincreased slightly from 301 in 2003, to 322 in 2004, while the average polygon size has increased sharply from 14 ha to 96 ha. Expanding populations have resulted in the coalescing of many smaller polygons into large, continuous areas of attack, especially in the Mount Robson Park and Tete Jaune Cache areas. Increased mortality was also observed near Crescent Spur, in many areas of the Fraser River valley, the Raush River, and Kinbasket Lake - Canoe Reach. Increases were also observed in the southern portion of the District, in the Joseph Creek, Mann Creek, Mahood Lake, Raft River, Mad River, Adams Lake, and upper Adams River areas. Significant mortality was also observed in the southern portion of Wells Gray Park. Overwintering mortality sampling during March and April of 2004 indicated an average brood mortality of only 43.7%, with an R-value of 10.0. Green:red ratios following the 2004 beetle flight averaged 5:1.

Western Balsam Bark Beetle

Mortality was mapped on 96,724 ha (60,767 ha of which was trace), up from 10,386 ha in 2003. The most extensive mortality occurred in the northwest portion of the District, in the Castle Creek, Cariboo River, Milk River, Betty Wendle Creek, McKate River, Chalco Creek, and Raush River areas. Scattered mortality also occurred throughout the southern portion of the District.

Spruce Beetle

Spruce beetle mortality was mapped on 3,012 ha in the District, down from 3,542 ha in 2003. Most activity was observed in the Mahood lake, Lickskillet Creek, and Cariboo River areas. Mortality is likely more widespread in these areas than indicated by the results of the overview surveys, as recent greys were visible during the surveys. Spruce trees often show little colour change, or show colour for only a very limited time window, following attack.

3,000 hectare prescribed burn in Mount Robson Provincial Park, August 2004.

Douglas-fir Beetle

The decline in Douglas-fir beetle mortality continued, down from 823 ha in 2003, to 253 ha in 2004. A further 380 trees were killed in 37 spot infestations. Most activity was in the south end of Wells Gray Park, in the Helmcken Falls and Clearwater Lake areas. Scattered mortality was also mapped in the Canim Lake, Raft River, and Mowich Lake areas.

Two-Year Cycle Budworm

Defoliation was mapped on 29,466 ha, down from 62,875 ha in the last 'on' year (2002). Infestations were scattered throughout the southern portion of the District, and were observed in nearly all areas which showed defoliation in 2002; however, the overall extent of damage has decreased. The most extensively damaged areas noted this year were on TFL #18, and in Wells Gray Park, in the Clearwater Lake – Lickskillet Creek, Hobson Creek, upper Clearwater River, and Silence Lake areas.

Wildfire

Just over 14,800 ha were burned in 2004, in 154 fires (only 34 of which were over 5 ha). An additional, 2,900 hectares of prescribed burn took place in Mount Robson Park to reduce fuel build-up. The largest wildfires were in Wells Gray Park, and in Mount Robson Park near Moose Lake (close to the Mount Robson Prescribed Burn).

Other forest health factors observed included 151 ha of light drought mortality, and 23 ha of moderate western hemlock looper defoliation.

Cariboo Summary

The Cariboo portion of the aerial overview survey was conducted between July 19 and September 29, 2004. The surveys required a total of 170.6 hours of flight time over 36 days of flying (surveys were conducted by several different survey crews, which were often in the air at the same time). Survey conditions were difficult, with smoke from large wildfires in the Charlotte Lake area causing widespread visibility problems. As well, poor weather hampered survey efforts through much of the survey window. Surveys were conducted mainly by contract personnel.

Quesnel Forest District

Mountain Pine Beetle

Mountain pine beetle infestations were mapped on 1,358,993 ha, an increase of nearly 40% from last years total of just over 1,000,000 ha. The rate of infestation area increase has slowed, due to the fact that the beetle is now active in most areas of the District with a significant lodgepole pine component. In general, most increases were seen in the severity of attack, rather than in increased area – nearly two-thirds of infested area is now classed as moderate, severe, or very severe. Two-thirds of the total land mass of the District are now infested. The average polygon size has decreased to 145.6 ha, from the 2003 average of 240 ha, while the total number of polygons mapped has increased from 4,207 to 9,337. This is largely an artifact of post-digitizing data processing (see page 6).

Spot infestation occurrence has dropped to virtually nil. The most severe infestations are in the central portion of the District, in the Narcosli Creek, Tingley Creek, Baker Creek, Mt. Milburn, Green Mountain, and Swift River areas, and in the extreme western end of the District, in the area between Itcha Mountain and the Blackwater River. Overwintering mortality sampling during March and April of 2004 indicated an average brood mortality of only 42.1%, with an R-value of 12.9. Green:red ratios observed in the fall of 2004 averaged 10:1 in the District. All of these values indicate that population are continuing to build, and increases in infestation severity can be expected for 2005.

Blackwater River area, Quesnel District.

Western Balsam Bark Beetle

Infestation area declined slightly, from 84,550 ha in 2003, to 73,787 ha in 2004. All infestations were in the eastern portion of the District, in the Swift River, Willow River, Matthew River, Cunningham Creek, and Bowron River areas. The majority of the infestations (92%) were classified as trace.

Spruce Beetle

Spruce beetle infestations increased to 22,551 ha, up from just 296 ha in 2003. Over 91% of the mapped areas were classified as trace. Active areas included the Umiti Creek, Pundata Creek, Willow River, Bowron River, and Matthew River areas.

Douglas-fir Beetle

Douglas-fir beetle activity was mapped on 2,414 ha in 2004, up from only 41 ha in 2003. The majority of the mortality was classed as trace. Most of the activity was along the Quesnel River, between Beavermouth and Quesnel Forks, and in the Black Stuart Mountain area along the Cariboo River. Small pockets of mortality were also detected along the Fraser River, in the Marguerite, Quesnel, and Cottonwood River junction areas.

Two-Year Cycle Budworm

Defoliation levels have decreased slightly from 2003 levels, to 15,252 ha (all light). As in the past, different populations in the District appear to be non-synchronized in their life cycles; as a result, significant defoliation has been observed in most years. Most of this years' activity was in the Lightning Creek, Willow River, and Wells areas.

Wildfire

2,069 ha were burned in the District in 2004, primarily as a result of 2 large early season fires in the Kluskus Lakes area. There was a high level of standing dead timber in this area, due to mountain pine beetle mortality, which would have provided fuel for wildfire.

Windthrow

Windthrow was observed on 1,174 ha, scattered throughout the Willow River, Lightning Creek, and Swift River areas, mainly in mid-to-high elevation stands in the SBS (Sub-boreal Spruce) and ESSF (Engelmann Spruce Subalpine Fir) ecosystems. This is of particular concern, as spruce beetle populations appear to be increasing in this area of the District.

Other forest health factors mapped were 323 ha of light western spruce budworm defoliation in the Soap Lake area, and 380 ha of flooding near Narcosli Lake.

Central Cariboo Forest District

Mountain Pine Beetle

Total area affected has continued to increase; however, not at the same rate as the past few years, as a high proportion of the lodgepole pine stands within the District are now infested. The total area has increased 1.6-fold, to 706,788 ha. The proportion of attack that is classified as moderate or greater is also increasing. The number of spot infestations has decreased sharply, from 710 (2,355 trees), to 145 (1,149 trees). As in other areas, it is evident that outbreaks are continuing to expand and coalesce. The greatest area increases were seen in the southwest portion of the District, in the Big Creek – Gaspard Creek area, where very large areas of trace and light attack were observed. The most severe mortality was observed in the central portion of the District, between the Chilcotin River, the Fraser River, and the Quesnel District boundary. Overwintering mortality sampling during March and April of 2004 indicated an average brood mortality of only 44.7%, with a very high R-value of 16.0. Green:red ratios collected during the fall of 2004 averaged 12:1. Further increases in both area infested, and attack severity can be expected in 2005.

Western Balsam Bark Beetle

Infestations continued to decline, to 30,723 ha, down from 61,350 ha in 2002, and 47,500 ha in 2003. All activity continues to be in the eastern high-elevation areas, in the Quesnel Lake area. Nearly 60% of the area mapped was classified as trace mortality.

Douglas-fir Beetle

Infestations of Douglas-fir beetle continue to increase, up from 12,211 ha in 2003, to 18,157 ha in 2004. The number of spot infestations decreased to 106, while the number of trees killed in spot infestations increased slightly to 1,571 trees. The majority (82%) of the mapped infestation area was classified as trace attack; it is likely that significant portions of this would have been covered by spot infestations last year, before the trace category was instituted. Extensive areas of activity were observed along the south side of the Chilcotin River (in the Farwell Creek area), along the Fraser River between McLeese Lake and Riske Creek, in the Williams Lake – 150 Mile House area, in the Gaspard Creek area, and in the Dog Creek area. Infestations in the 140 Mile House – Enterprise area collapsed, and no mortality was observed. Infestations in the Churn Creek – Empire Valley area also declined dramatically.

Spruce Beetle

Spruce beetle mortality has expanded by almost 7-fold, to 28,789 ha, with an even distribution between severity classes. Most activity was in the Rollie Creek, Penfold Creek, Niagara Creek, upper Horsefly River, Horsefly Mountain, upper Moffatt Creek, McKusky Creek, and Molybdenite Creek areas. It is unknown whether this increased area is due mainly to actual increased mortality, or to more visible fade than usual, or a combination of these factors.

Western Spruce Budworm

Defoliation has continued to increase, and was mapped on a total of 276,313 ha in 2004. The majority of the defoliated areas were classified as light; some moderate to severe defoliation was observed in the Riske Creek, Farwell Creek, Meldrum Creek, and Williams Lake areas. 6,977 ha were treated with *B.t.k.* in mid June to reduce population levels in high value stands. Egg mass sampling results indicate that continued widespread defoliation will continue in 2005, and several areas may require treatment with *B.t.k.*

Two-Year Cycle Budworm

2-year cycle budworm defoliated 6,382 ha of high elevation stands in 2004. As 2004 was an "on" year in the feeding cycle of this insect, more extensive defoliation was expected. Therefore, it appears that population levels are falling in the District. Visible defoliation was mapped in the Quesnel Lake West Arm, and Mitchell Lake areas.

Windthrow

Scattered pockets of windthrow were detected in several areas in the western SBS and ESSF forests, including Grain Creek, Moffatt Lakes, and the Summit Lake – Niagara Creek area. This could be a concern, as spruce beetle populations are active in these areas. Area totalled 2,093 ha.

Redbelt

Nearly 1,300 ha of severe redbelt (a type of winter damage) was observed in the Bambrick Creek area, at the 1,400 – 1,500 metre elevation band.

Other forest health factors included 154 ha of wildfire, and 8 ha of drought damage north of Gang Ranch.

Windthrow in spruce near Taweel Lake, Kamloops District.

Chilcotin Forest District

Mountain Pine Beetle

Mountain pine beetle infestations continue to spread, up from 880,000 ha in 2003, to 1,138,299 ha in 2004. The number of spot infestations has dropped, from 1,245 (5,546 trees) in 2003, to 683 (4,756 trees) in 2004. The rate of spread has slowed considerably, as compared to the 2002 – 2003 spread rates, as mountain pine beetle is now present in most areas of the District with a significant susceptible pine component. The largest area increases were in the west-central portion of the District, in the Chilanko River, Jorgensen Creek, and Tatla Lake areas, where large areas of new, trace attack were mapped. The most severely attacked areas are in the western, north-central, and eastern areas of the District, in the Dean River – Anahim Lake, Clusko River, Alexis Creek, and Stum Lake areas. Overwintering mortality sampling during March and April of 2004 indicated an average brood mortality of only 56.8%, with an R-value of 10.7. Fall 2004 green:red attack ratios averaged 18:1; the lowest ratios observed were 4:1. Significant increases in mortality severity levels are expected in 2005.

Western Balsam Bark Beetle

Western balsam bark beetle infestations have expanded slightly, from 10,465 ha in 2003, to 14,054 ha in 2004. Mortality is scattered throughout high elevation stands in the southern and southwestern parts of the District, especially in the Chilko Lake, Tatlayoko Lake, Yohetta Valley, Lord River, and Klinaklini River areas.

Douglas-fir Beetle

Douglas-fir beetle activity expanded greatly, rising from 289 ha in 2003, to 3,040 ha in 2004. The number of spot infestations decreased from 142 to 104, while the number of trees killed in spot infestations rose from 573 to 1,166. Most of the mortality was along the south side of the Chilcotin River east of Hanceville, where a number of smaller polygons and spot infestations coalesced into larger, more continuous areas; as well, a large number of spot infestations were mapped between Hanceville and the Chilko River junction.

Spruce Beetle

Spruce beetle was mapped on 271 ha near the south end of Chilko Lake, down from 418 ha in 2003.

Western Spruce Budworm

Western spruce budworm populations expanded along the Chilcotin River valley, resulting in 28,536 ha of light to moderate defoliation between the Chilko River junction and the eastern District boundary. Egg mass sampling results indicate that populations are expanding, and high priority areas may receive aerial *B.t.k.* treatment in 2005.

Satin Moth

Defoliation was recorded on 2,885 ha, down from 8,265 ha in 2003, in the Nemaiah Creek, Tatlayoko Lake, Mosley Creek, and Gunn Valley areas.

Western Hemlock Looper

Defoliation expanded slightly in the Mosley Creek – Homathko river area, to 676 ha. No population sampling or control measures are planned.

Redbelt

Redbelt damage was mapped on 7,213 ha, in the Beece Creek, Taseko River, Bidwell Creek, Lingfield Creek, Sapeye Lake, and McClinchy Creek areas. Most damage was at 1,400 – 1,600 metres in elevation.

Wildfire

Wildfire damaged 19,089 ha of forested areas in the Charlotte Lake, Klinaklini River, and McClinchy Lake areas. There was very little current mountain pine beetle activity in these areas; however, extensive mortality occurred between 1978-1985; remaining standing and felled dead timber contributed to the heavy fuel loads within the fire areas.

Drought

Drought mortality was recorded on 421 ha in the upper Chilko River area. The damage was classified as very severe.

Other forest health factors mapped were 89 ha of flooding and 102 ha of bear damage in the Chilko Lake area.

Mountain Pine Beetle

Infested areas continued to expand at a very high rate. Affected area now totals 657,890 ha, up from 2003 levels of 106,347 ha. This is the fourth consecutive year of annual increases in the range of 6 – 7-fold; in 2001, only 200 ha of attack were detected by the overview surveys within the District. Overall, spread of the beetle has been very rapid throughout all areas. The number of spot infestations has decreased dramatically since last year, down from 572 (2,169 trees), to just 33 (438 trees). Nearly 45% of all mapped areas were classified as trace; another 45% was classified as light. This type of diffuse, wide-ranging attack is challenging to manage effectively. Increases were seen in all areas of the District; especially in the eastern portions, where very large areas of trace attack were mapped where very little activity was seen in 2003; and in the south-central portion, where large areas of trace to light attack were mapped. The most severe attack is in the northern areas of the District, in Forbes Creek, Eagle Creek, and Bradley Creek, and in the southeast, near Tobacco Creek and Chartrand Lake. Overwintering mortality sampling during March and April of 2004 indicated an average brood mortality of only 42.7%, with a very high R-value of 16.5. Green:red ratios observed during fall 2004 ground surveys averaged 10:1. All of these values reflect a population that is building very rapidly, and large increases in attack severity levels will be seen in 2005.

Western Balsam Bark Beetle

Western balsam bark beetle infestations spread slightly, up from 20,935 ha in 2003, to 26,722 ha in 2004. Nearly 40% of this area was classified as trace. Activity continues to be mainly in the Hendrix Mountain, Boss Creek, Windy Creek, Jim Creek, and Deception Creek areas.

Spruce Beetle

Total area mapped has decreased slightly, form 20,935 ha in 2003, to 17,252 ha in 2004. Most activity continues to be in the Boss Creek, Hendrix Mountain, McKinley Creek, and Mahood Lake areas, with smaller infestations in the Eagle Creek, Windy Mountain, and upper Bridge Creek areas. Windthrow was also observed in some of these areas, which is a concern, as windthrow can promote spruce beetle population build-up.

Douglas-fir Beetle

Douglas-fir beetle infestations declined, from 7,183 ha in 2003, to 4,974 ha in 2004. As well, the number of spot infestations dropped significantly, from 500 (2,677 trees) in 2003, to 187 (1,922 trees) in 2004. Decreases were seen in the Canim Lake, Drewry Lake, Deception Creek, and 130 Mile House areas; increased activity was noted in the upper Jim Creek, Lac des Roche, Loon Lake, and Coal Creek areas. Mortality levels remained relatively unchanged in the Fraser River area.

Western Spruce Budworm

Total defoliated area rose slightly, from 199,108 ha in 2003, to 234,656 ha in 2004; however, the area of moderate and severe defoliation fell. Populations in the Lac la Hache area fell, with a corresponding reduction in defoliation levels, while increasing populations in the southwest portion of the District led to expanded defoliation in the China Gulch, Big Bar Creek, Big Bar Mountain, Gustafsen Lake, and 70 Mile House areas. 18,527 ha of high value stands were treated with *B.t.k.* in mid June. Egg mass sampling conducted in the fall of 2004 indicated that populations were high in several other areas, and further treatments are planned for 2005.

Western spruce budworm defoliation on understorey trees.

Windthrow

Windthrow was observed on 1,851 ha in the eastern portion of the District, in the Deception Creek, Hendrix Mountain, and Eagle Creek areas. This could exacerbate locally active spruce beetle populations.

Other forest health factors observed during the surveys included 357 ha of trace to light drought mortality along the Fraser River north of Kelly Creek, and 88.5 ha of wildfire.

Forest Health Projects

Mountain pine beetle overwintering mortality

Extensive winter mortality and R-value estimates were conducted for the mountain pine beetle (MPB) in the Cariboo and portions of the Kamloops and Nelson sections of the Southern Interior Region in March and early April of 2004. Bark samples were collected from select sites to determine winter mortality and to estimate beetle population trends based on brood success. The R-value is the ratio of successful beetle progeny to initial attack and is a reliable indicator of population trends (Table 1).

Table 1. R-value interpretation.

R value	Interpretation
0-2.5	population decreasing
2.6-4.0	population static
> 4.1	population increasing

R = the average number progeny per sample divided by average number entrance holes.

Methods

Systematic sampling occurred in the Quesnel, Central Cariboo, Chilcotin, 100 Mile House, Kamloops, Rocky Mountain, Arrow Boundary and Kootenay Lake Districts, with occasional sampling conducted in the Okanagan Shuswap and Cascades Districts. A total of 77 sites, and 817 trees, were sampled in March-April 2004. Two samples per tree were collected (with the exception of the Cascades District, where only 1 sample per tree was collected), for a total of 1,631 samples. Samples from the Kamloops, Okanagan Shuswap, Cascades, and Rocky Mountain Districts were dissected and assessed in the Southern Interior Region Forest Health Laboratory in Kamloops; all other samples were dissected by contract staff.

Sample collections began in early March 2004. Where possible, an estimate of the green:red ratio near sampling sites (from observations on 50 trees or probe data from the area) was collected. Two samples per tree were cut at 1.3 m on north and south aspects of lodgepole pines with 2003 MPB mass attack. Samples consisted of cut-out portions of tree boles with bark attached. The diameter at breast height (dbh), date sampled, site number, location and tree number were recorded. Trees with woodpecker activity were included in the random sampling of currently attacked trees.

Samples were warmed at room temperature for two or more days prior to dissection. Before removing the bark from the sample, a 10 by 10 grid covering a 15 x 15 cm area was overlaid on the sample to estimate the percentage of woodpecker activity on the sample. The bark was then carefully removed and the numbers of live and dead larvae and adults (or other life stages) were recorded within the sample area. The number of entry holes at the bottom end of the gallery was used as the indicator of attack. Dissections occurred from March 15 through April 28, 2004. The R-value was determined by calculating the average number of larvae, from the minimum 5 tree sample and computing the rating values (R) as in table 1. The numbers of dead larvae, pupae and adults were not included in calculations of the R-value.

Results

Overall, mountain pine beetle winter mortality rates were low, with 9 of 11 Districts averaging between 40-70% overwintering mortality (Table 2). In general, brood mortality throughout the life cycle must reach levels of approximately 97% in order for populations to remain static or decline. Winter mortality normally makes up a large proportion of this yearly mortality, and in general is required to reach levels of at least 70% to have a significant effect on population growth rates. R-values were very high, with 8 of 11 Districts having average values greater than 10, and all having average values of 5.7 or more. R-values greater than 4 generally indicate a growing population; values over 10 are considered to be extremely high. These results continue the trend of low mortality and high R-values that has been observed for several years. Figures 1 and 2 show historical overwinter mortality rates and R-values in the Cariboo from 1996-2004.

The only Districts with higher overwinter mortality rates were Kootenay Lake and Rocky Mountain, with average mortality of 78.7% and 81.1%, respectively. R-values were also lower in these Districts, at 6.0 and 5.7. Individual sites, such as Gold Creek and Grundy in Rocky Mountain District, showed decreasing populations (R-values of 1.33 and 0.88, respectively). Two sites in Kootenay Lake District had static populations, Redfish Creek (R=3.88) and Anderson Creek (R=4.04). However, the District-wide average mortality and R-values still reflect growing populations, which was observed by increased areas of attack during the 2004 Aerial Overview Surveys. The MPB winter mortality in the Okanagan Shuswap District was 52.78%, and the R-value was 8.38; however, due to a limited number of sample locations, these values may not represent the entire District. In the Cascades District, only 3 samples were collected from a single site; thus, the mortality rate of 15.1% and the R-value of 17.7 are not representative of the District.

Table 2. Percent mortality (corrected for woodpecker activity) of mountain pine beetle progeny during the winter of 2003-2004, with associated R-values.

District	sites	# trees	# samples	% mortality	R-value
100 Mile House	10	120	240	42.7	16.5
Central Cariboo	11	132	264	44.7	16.0
Quesnel	10	120	240	42.1	12.9
Chilcotin	10	120	240	56.8	10.7
Headwaters	12	144	288	43.7	10.0
Kamloops	5	60	120	62.2	17.5
Okanagan Shuswap	3	18	36	52.8	8.4
Cascades	1	3	3	15.1	17.7
Rocky Mountain	5	50	100	78.7	5.7
Arrow Boundary	5	25	50	66.3	10.3
Kootenay Lake	5	25	50	81.1	6.0

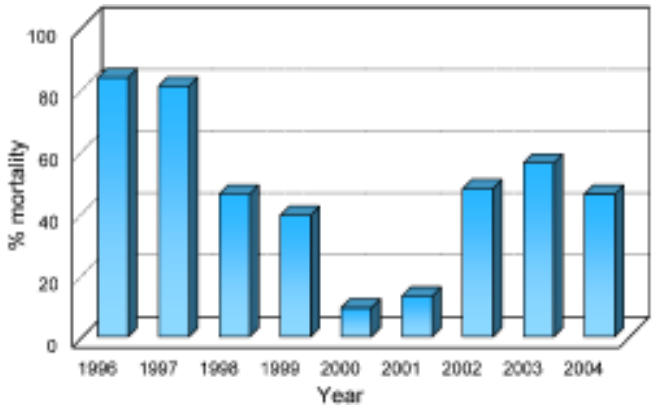


Figure 1. Historical average overwinter mortality rates in the Cariboo from 1996-2004.

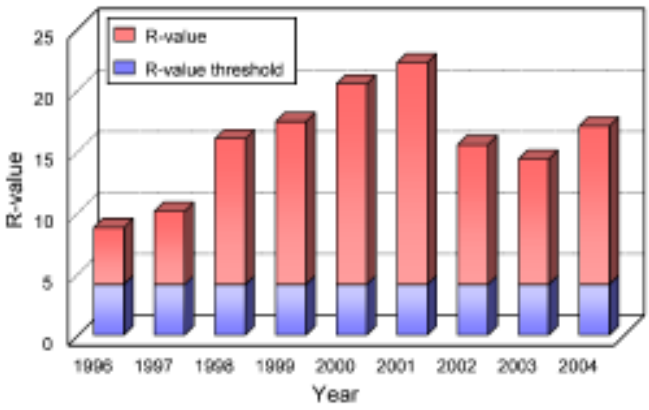


Figure 2. Historical average mountain pine beetle R-values in the Cariboo from 1996-2004.

Summary

The average R-values and overwinter mortality rates for all Districts in the Southern Interior Region continued to follow recent historical trends, predicting increasing mountain pine beetle populations for 2004, and significant expansions and new infestations throughout the Region. High R-values and low mortality during the winter of 2002-2003, combined with high green:red attack ratios during the fall of 2003, resulted in the large increases in both area attacked and severity of attack in 2004. The continued high R-values, low mortality rates, and high green:red attack ratios observed during the spring and fall of 2004, indicate that infested area and tree mortality rates will continue to increase in all Districts in the Southern Interior Region in 2005.

Mountain pine beetle attack in young stands

There are thousands of hectares of young pine (natural regeneration and managed plantations) in BC that are nearing 30 years or older. These stands represent future harvests, habitat and forest structure. The phenomenon of MPB attacking young pine, the future forest inventory, is a major concern to forest industry and government alike. Nearly 79% of the Canadian inventory of lodgepole pine (Pl) is found in BC (14.9 million hectares of various ages) of which approximately 6.9 million hectares is under 80 years of age (Chief Forester Internal Report 2003). Given the scope of the current MPB outbreak, and projected rates of harvest, the area of young pine has the potential to expand exponentially over the next decade. Over 7 million hectares of mature pine were red attacked by MPB in 2004. In 2003 and 2004, MPB attack was noticed in pine stands 30 years of age and younger throughout northern and southern BC. Some of these young stands suffered up to 30% stem mortality each year. MPB successfully colonised some young trees, adding to subsequent beetle pressure, whereas in other trees there was no sign of brood success (e.g. emergence). Surrounding beetle pressure from mature stands varied among areas.

28 year old spaced and pruned lodepole pine plantation sustaining mountain pine beetle mortality, Quesnel District.

28 year old lodgepole pine successfully attacked by mountain pine beetle, Quesnel Forest District.

Although recent drought conditions could have increased vulnerability of these young trees, it was noticed that bark attributes of successfully attacked plantation trees more closely resembled mature bark than bark typical of young, densely grown trees. Trees in spaced stands reach diameters that are acceptable to MPB and other beetles at an earlier age than trees in naturally regenerated, unmanaged, and more densely grown stands. Bark and phloem attributes could be factors in the acceptability of young trees to MPB. Existing plantations are likely somewhat different than naturally regenerated and fire regenerated stands.

Also at risk are high-value seed orchards which are approaching 25 years of age or greater, and have bark and stem diameter attributes similar to mature stands. Specifically, blister rust-resistant white pine orchards at Skimikin Seed Orchard may be at risk. These orchards represent a significant investment and their loss would set the tree improvement effort back many years.

Continuing serious problems with MPB infestations in and around the Prince George area have led to concerns over the safety of lodgepole pine trees at the Prince George Tree Improvement Station. In 2003, although no Pl seed orchard trees were affected, Pl provenance and wide cross trials, as well as natural stand and urban Pl trees were attacked, with significant levels of mortality. For these reasons an initial susceptibility and risk assessment was performed at the PGTIS on 26 August 2003 and again on 24 November 2004 by Drs. Robb Bennett and Ward Strong (BC Ministry of Forests, Seed Pest Management) and MPB expert Dr. Staffan Lindgren (University of Northern BC).Their conclusions were that MPB pressure was significant, occurring over the entire site, with the level of MPB-induced mortality still relatively low. However, brood survival in MPB-attacked provenance and wide cross trials was significant and may result in increased attacks in 2005. MPB attacks were observed in seed orchard 228; August pruning likely induced attack. The trees in the seed orchard successfully repelled all beetle attacks.

Leo Rankin (BCMOF, Forest Entomologist, Williams Lake) initiated a preliminary survey in the fall of 2004 to determine the incidence and severity of MPB in young stands. A total of 46 stands were surveyed in the Quesnel Forest District, ranging in age from 24 to 43 years (average = 30 years). Seventy-six percent of the stands were affected by MPB. On average, 16% of the stems were attacked in the 46 stands surveyed, with attack levels ranging from 1% to 64%. Not all the attacks caused tree mortality; approximately 1.7% of the trees survived.

Cross section of 28 year old lodgepole pine attacked by mountain pine beetle.

Dr. Lorraine Maclauchlan (BCMOF Forest Entomologist, Kamloops) and Rick Specht (BCMOF Forest Health Officer, Okanagan Shuswap District) assessed a number of young stands (±25 years) near Falkland in the Okanagan Shuswap District and found evidence of both 2003 and 2004 MPB attack. Attack levels varied within stands as in the Quesnel study, but surrounding beetle pressure was much less than is found in the Cariboo.

Dr. John McLean (University of British Columbia, Professor, Faculty of Forestry) received young and mature, lodgepole pine logs attacked in 2003 at the Alex Fraser Research Forest, near Williams Lake. Dr. McLean reared and collected all mountain pine beetles emerging from these logs and determined the size of the beetles by measuring the pronotum. The males and females from the large logs averaged 1.8 mm and 1.95 mm, respectively. The males and females from the young trees averaged 1.69 mm and 1.92 mm, respectively. These numbers are comparable to those published by Safranyik and Jahren (1970). The size of the pronotum of 42 parental and 42 brood adults was measured; the brood adults were significantly smaller than the parental adults.

References

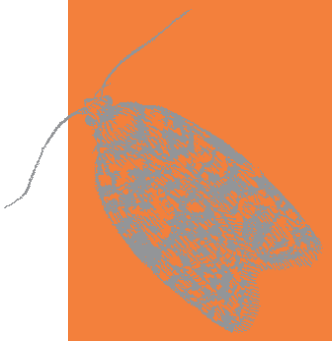
Safranyik, L. 1978. In: Kibbee, D.L., Berryman, A.A., Amman, G.D., Stark, R.W. (Eds.) Proceedings of the Symposium on Theory and Practice of Mountain Pine Beetle Management in Lodgepole Pine Forests, Pullman, Washington, April 25-27, 1978. College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, Idaho, pp. 77-84.

Safranyik, L. and R. Jahren. 1970. Dept. Fish. For. Can., Bimonthly Res. Notes 26:35-36.

Shore, T.L. and L. Safranyik. 1992. Forestry Canada, Pacific and Yukon Region, Pacific Forestry Centre, Information Report BC-X-336.

Proposed work and research for 2005-2006

Normally, lodgepole pine < 30 years old would not be considered at risk to MPB because of their age, diameter and other physical attributes (Shore and Safranyik 1992). However, many young stands in these putatively low susceptible classes are currently under attack. A project has been designed to determine the physical attributes of young lodgepole pine under attack, and site characteristics and proximity to mature stand infestations and compare this to the current standards of susceptibility. Stand and tree characteristics of managed young stands *versus* natural young stands will be compared to determine if our management regimes influence susceptibility to MPB. Risk to these young stands will be quantified, tested, and again compared to current standards. The fitness level of bark beetle populations attacking and developing in young trees will be assessed. This work will address whether current mortality is solely the result of extreme beetle pressure, or whether tree and stand attributes have changed to produce more susceptible hosts. Drought stress or climatic change could also be influencing factors (Safranyik 1978). One product of this proposed work will be a summary matrix of pine stands in BC that are currently under attack, by geographic region and ecosystem. Stand and tree attributes will also be collated and analysed to assess susceptibility (Shore and Safranyik 1992). Success of the MPB in these stands will be correlated with stand attributes, spatial location, and proximity to "risk" factors.



Western spruce budworm trapping trial

Introduction

The western spruce budworm (WSB), *Choristoneura occidentalis* Freeman (Lepidoptera: Tortricidae), is an important defoliator of interior Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, forests in the southern interior of BC. It can have extremely devastating effects on Douglas-fir by reducing growth and yield, causing stem defects and mortality and disrupting harvest schedules. Historically, most WSB outbreaks have occurred in three IDF subzones: the IDFdk (Dry Cool Interior Douglas-fir), the IDFmw (Moist Warm Interior Douglas-fir), and the IDFxh (Very Dry Hot Interior Douglas-fir) (Maclauchlan *et al.* 2004). Infestations have extended into other less susceptible zones during outbreak years.

Western spruce budworm larvae preferentially feed on developing buds and new foliage, severely reducing or eliminating height and diameter growth during each year of defoliation. In addition, severe defoliation over several years can cause upper crown mortality, known as top-kill, which may lead to the formation of stem defects (Van Sickle et al. 1983; Alfaro and Maclauchlan 1992).

Adult moths emerge from pupal cases from mid- to late July, mating within a day of emergence. Egg masses, containing a few to over one hundred eggs, are deposited on the underside of conifer foliage in a shingle-like mass. The female usually deposits at least one egg mass at the site of emergence to reduce her egg compliment, which enables her to fly and disperse to new sites within the stand or in adjacent stands. The western spruce budworm is capable of massive dispersal flights; one mechanism by which new stands and drainages are infested. Egg hatch occurs within ten days. First instar larvae are non-feeding, and move within and between trees to the underside of bark scales or lichen where they spin silken tents to overwinter.

Western spruce budworm egg mass.

Larvae emerge from their overwintering sites in the spring and rain down on silk threads to adjacent or understory trees. Second and third instar larvae will mine old needles or pollen cones until buds begin to flush. Larvae then mine and feed on buds and new foliage. The damaged new growth, webbed together in clumps, turns reddish brown and is highly visible. As the new foliage is depleted, the insect may move onto older needles. Feeding continues for up to 7 weeks. During this time, the affected trees acquire a reddish hue. Pupation occurs from early to mid July, lasting about 10 days, after which adult moths begin to emerge.

Budworm defoliation causes tree mortality, reduction of growth rates, reduced lumber quality, and may limit management options. Fall egg mass sampling is the current method used to predict budworm populations in the coming season and to plan any necessary control measures such as spraying with *B.t.k*. The ability to determine which sites would be a priority for egg mass sampling based on moth catches in pheromone baited traps would potentially reduce the number of egg mass sampling sites. Trapping moths is a much less labour intensive sampling method than egg mass sampling. Therefore, more sites could be monitored, thus streamlining and improving the effectiveness of monitoring and detection phase of our program. An efficient and reliable population prediction survey would be beneficial in targeting stands requiring treatment either in the form of silviculture manipulation or direct control using *B.t.k*.

The objective of this study was to test the predictive capability of trapping moths in pheromone baited traps compared to the standard method of fall egg mass sampling.

Methods

Population Sampling

The presence and abundance of defoliator life stages are often used to quantify populations and predict the next season's population and defoliation levels. Egg masses are one life stage used to predict the population of western spruce budworm (MOF 1995). Egg mass surveys tend to underestimate populations in the building phase of a budworm outbreak and overestimate the population in the declining phase of an outbreak. Defoliation forecasts based on egg mass sampling during the outbreak phase are generally reliable. Other methods, such as 2nd instar larval sampling, budmining assessments and late instar larval sampling can be done to verify or quantify population densities. Aerial mapping of defoliation (Maclauchlan *et al.* 2004) is also used to estimate budworm populations and damage to trees and stands. Defoliation assessments (Fettes 1950), late instar larval sampling and fall egg mass sampling were conducted to determine damage levels and predicted defoliation and budworm population levels. Results from all of these estimates were compared to the results of the moth trapping.

Moth trapping

Three pheromone lures and dosage levels were deployed in this trial in three population levels of budworm (nil to low, moderate, and high). The active ingredient contained in all lures was 95% E-11 tetradecenal/5% Z-11 tetradecenal, and all lures were supplied for this trial by Phero Tech Inc. The lure dosages were 180 micrograms (western spruce budworm lure RD0713/000), 330 micrograms (eastern spruce budworm lure L34047/000) and 53 nanograms (low dosage western spruce budworm lure L34046/000). Sites were initially selected from the 2003 aerial overview survey results and then populations were verified in early summer by conducting budmining assessments, with less than 5% buds mined indicating a low population and over 50% mined indicating severe defoliation. Ten sites in each defoliation category were selected for a total of thirty sites (Table 1). Three traps (milk carton traps) were placed at each site with each containing a different pheromone lure:

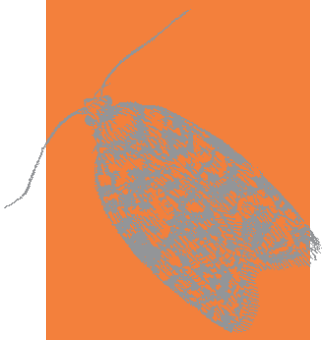
1) 180 micrograms (western spruce budworm lure);
2) 330 micrograms (eastern spruce budworm lure); and,
3) 53 nanograms (low dosage western spruce budworm lure).

Traps were placed and larval sampling was conducted when the budworm was in its 4th to 6th instar. Two 45 cm branches were cut from the north and south aspects of 10 trees at each site. Foliar area was measured and the number of budworm larvae counted, by instar. Fettes current year defoliation estimate (Fettes 1950) was done on each branch sampled. All traps were placed by July 14, 2004. Traps were retrieved and egg mass sampling conducted between August 5-13, 2004. Ten trees from each site were sampled for egg masses. Two 45 cm branches were clipped from mid-crown on the north and south aspect of each tree, the foliar area was calculated and the number of new egg masses was counted. All moths caught in the pheromone traps were counted.

The numbers of moths caught were compared to the other population parameters collected at each site to determine the reliability of trapping and the difference, if any, between pheromone lures.

Table 1. Location of trap sites showing predicted level of budworm defoliation (population), and dates of trap placement, trap retrieval, and population sampling.

Location	Predicted WSB population	Number of sites sampled	Trap placement & larval sampling	Egg mass sampling & trap collection
Vinsulla	Low	2	June 28	August 5
Greenstone	Low	4	June 28-29	August 5
Six Mile	Low	4	July 5	August 6
Highland Valley	Moderate	3	July 7 & 12	August 13
Kentucky-Alleyne	Moderate	4	July 9 &12	August 6
Tillery	Moderate	3	July 9 & 14	August 6 & 10
Sunshine Valley	High	3	July 6	August 10
Petit Creek	High	2	July 6	August 10
Tom Cole	High	5	July 7 &13	August 13



Results and Discussion

The Fettes defoliation estimates of current year defoliation showed a trend among sites corresponding to the original designation of expected low to high populations or defoliation levels (Table 2). However, even at sites designated high, average Fettes defoliation only averaged 4.2 ± 0.13 (60-80% current year defoliation). Similarly, the larval sampling of 10 trees per site also showed an increasing trend from low to high populations among sites but there was much variability within the population categories. Therefore, this estimation parameter is not as reliable an estimate of future populations as egg mass counts (Table 2). As with the Fettes estimate, there was little difference seen in average number of larvae between sites designated as moderate and high. The egg mass sampling results showed the strongest correlation with moths caught in traps and there was a clear delineation among the three population levels (Tables 2 and 3). Accepted sampling methodology (MOF 1995) defines expected high levels of defoliation as >150 egg masses per 10 m^2 foliage. At sites designated as high, the average egg masses per 10 m^2 foliage was 149.5 ± 15.74, just below this level (Table 2). The low and moderate category sites have average egg mass numbers that substantiate these designations.

The 330 microgram eastern spruce budworm lure showed a significant difference between sites designated as low and high WSB populations catching on average 40.3 ± 6.38 and 71.2 ± 9.86 moths per trap in each population category respectively (Table 3). There was no significant difference in the average number of moths caught per trap between the low and moderate populations (40.3 moths/trap and 52.6 moths/trap, respectively) and moderate and high populations (52.6 moths/trap and 71.2 moths/trap, respectively) (Table 3).

The 180 microgram WSB lure showed no significant difference in moth catches among any of the three population categories (Table 3) ranging from an average of 45.1 ± 6.33 moths/trap in the moderate population category to 59.7 ± 2.55 moths/trap in the high category. The average number of moths per trap in the low population category was 49.6 ± 5.63 moths/trap (Table 3) which was mid-way between the average caught in the moderate and high categories. The low dosage WSB lure (53 nanograms) also did not reflect the population categories consistently with the highest average moth catch occurring in sites designated as moderate (28.4 ± 5.66 moths/trap) compared to 17.9 ± 4.44 moths/trap caught in sites designated as high.

Further trapping trials are necessary to fine-tune this defoliation prediction method. In order to reduce the variance around the trapping, 6 traps of each lure type should be placed at each site with adequate distance between lure types so that there is no cross attraction. Six traps per site is the standard number used for other defoliator species when monitoring population trends (e.g. western hemlock looper, Douglas-fir tussock moth). The sites selected as "high" in 2004 were only marginally in this category. If possible in 2005, sites in the "high" category should be selected from areas with very high egg mass sampling results to more easily test the efficacy of the pheromone lures' ability to distinguish between population levels. The eastern spruce budworm lure appears to have the most promise of the three lures tested in 2004.

Table 2. Average Fettes defoliation estimate, number of larvae, and egg masses per 10 m².

WSB population level	# trees sampled	Average (± SE) Fettes defoliation	# larvae /10m²	# egg masses /10m²
Low	100	1.0 ± 0.06	93.4 ± 17.79	4.0 ± 1.78
Moderate	100	3.4 ± 0.16	1,143.8 ± 103.40	74.6 ± 11.42
High	100	4.2 ± 0.13	1,303.2 ± 106.36	149.5 ± 15.74

Table 3. Average number of moths caught per pheromone-baited trap (3 lure types) at three population levels (Low, Moderate and High). Numbers followed by the same letter indicate no significant difference ($p < 0.05$).

WSB population level	No. traps per lure type	Lure type (Avg. moth catch ± SE) 330 microgram ESB	180 microgram WSB	53 nanogram WSB
Low	10	40.3 ± 6.38a	49.6 ± 5.63a	8.9 ± 4.44a
Moderate	10	52.6 ± 5.67ab	45.1 ± 6.33a	28.4 ± 5.66b
High	10	71.2 ± 9.86b	59.7 ± 2.55a	17.9 ± 4.44ab

References

Alfaro,R.I.; Maclauchlan, L.E. 1992. Forest Ecology and Management 55: 295-313.

Fettes, J.H. 1950. For. Insect Lab. Sault Ste. Marie, Ont. Ann. Tech. Rep.

Maclauchlan, L.E., J.E. Brooks and J. Hodge. 2004. Submitted to J. Forest Ecology and Management.

Maclauchlan, L.E., L. Rankin and K. Buxton. 2004. Overview Report 6, Kamloops, B.C.

Ministry of Forests. 1995. Defoliator Management Guidebook. Ministry of Forests, Forest Practices Branch, Victoria, B.C.

Van Sickle, G.A.; Alfaro, R.I.; Thomson, A.J. 1983. Canadian Journal of Forest Research 13:445-450.

B.C. Ministry of Forests
Southern Interior Forest Region
515 Columbia Street,
Kamloops, B.C.
V2C 2T7
(250) 828-4179

Acknowledgements:

The authors would like to acknowledge the 2004 aerial surveyors:

Mike Ferguson (M.E. Ferguson Forestry Consulting) and Julie Castonguay (Sattva Consulting) - Nelson area
Leo Rankin, Joe Cortese, Don Wright, Mikko Sapponen, Bob Erickson, Mel Dodge - Cariboo area
Kevin Buxton (BC Ministry of Forests) and Janice Hodge (JCH Forest Pest Management) - Kamloops area

We would also like to acknowledge the Forest Health District and Region staff,
and forest industry personnel, that made contributions to, and provided data for, this report.

photo credits:

Lorraine Maclauchlan - front cover; pp. 12, 16, 17, 18, 19 (lower), 20, 22 (upper),
23 (upper), 27, 31, 34 (upper), 35.
Kevin Buxton - pp. 7, 8, 10, 15, 19 (upper), 21, 22 (middle), 23 (lower),
24 (upper), 25, 34 (lower), back cover.
Dion Manastyrski - pp. 10 (lower), 22 (lower), 24 (lower), 36.

Line Drawings by Lynn Kristmanson.

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