2009 Summary of Forest Health Conditions in British Columbia

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2009 Summary of Forest Health Conditions in British Columbia

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Table of Contents

Summary

The *2009 Summary of Forest Health Conditions in British Columbia* (BC) is based on the current provincial forest health aerial overview survey data in conjunction with insect population prediction assessments, ground observations from trained personnel and special projects undertaken by the Ministry of Forests and Range (MFR) entomologists, pathologists and their associates.

Over 13 million hectares of BC forests were damaged by a large variety of forest health agents in 2009. Mountain pine beetle continued to be the most widespread and severe disturbance factor, with affected area up to almost 9 million hectares. For the first time in several years attack levels were highest in the Northern Interior Forest Region (NIFR), more than double last year with 6.5 million hectares affected. About 90% of the attack was located in the Peace, Mackenzie, Nadina and Fort St. James Forest Districts. Infestations in the Southern Interior Forest Region (SIFR) dropped by half since 2008 to 2.3 million hectares. Minor to drastic declines were recorded in all SIFR districts. All districts still have mountain pine beetle activity, but three quarters of the attack occurred in the Chilcotin, Cascades, Quesnel and Central Cariboo Forest Districts. Mountain pine beetle infestations in the Coastal Forest Region (CFR) declined for the fourth year in a row to 70,961 ha of attack.

Mortality caused by western balsam bark beetle more than tripled from 2008 to 1,727,719 ha. Most areas of IBB mortality were mapped as trace (94%) which reflects the attack dynamics of this particular bark beetle. The majority (86%) of the infestations continued to occur in the NIFR with the Skeena Stikine Forest District most affected. In the SIFR a total of 234,683 ha were recorded as attacked with infestations primarily delineated in the Okanagan Shuswap and Headwaters Forest Districts. Douglas-fir beetle was the other bark beetle significantly impacting the province in 2009 with mapped infestations rising for the seventh consecutive year to 100,726 ha. The Central Cariboo, Chilcotin, 100 Mile House and Quesnel Forest Districts of the SIFR continued to have most (93%) of the attack.

Defoliators were plentiful throughout the province in 2009 and western spruce budworm continued to affect the largest area with 766,125 ha of damage recorded. Most of the defoliation occurred in the SIFR Central Cariboo, Cascades, 100 Mile House, Okanagan Shuswap and Kamloops Forest Districts. A record 72,990 ha of high value stands were successfully treated aerially with the biological pesticide *Bacillus thuringiensis* var. *kurstaki* (*Btk*) to reduce damage and budworm populations. Infestations by the two year cycle budworm were by far the highest ever recorded since the MFR became responsible for the aerial overview surveys, with 392,316 ha of defoliation detected. Almost all the disturbances were located in the NIFR, with the Fort St James and Nadina Forest Districts most affected. A third budworm, the western blackheaded budworm, reached outbreak proportions in the NIFR and the CFR Haida Gwaii Forest District with 24,656 ha of defoliation.

The Bruce spanworm outbreak in the Peace Forest District continued to expand with some defoliation also recorded in the Prince George Forest District. A total of 637,347 ha were mapped as damaged. Another aspen defoliator, the aspen leaf miner, caused 102,609 ha of damage, primarily split between the NIFR and SIFR.

The Douglas-fir tussock moth was in the second year of an outbreak cycle in 2009 with 17,512 ha of damage recorded. Defoliation continued in the Kamloops Forest District, with expansions in the Okanagan Shuswap and Cascades Forest Districts. Nucleopolyhedrosis virus and *Btk* was used to treat 4,341 ha of Crown and private land (33% of total treatment area was private land). Traps placed to monitor the North American strain of European gypsy moth caught 16 moths in 2008 in the Harrison Hot Springs area, resulting in a 329 ha aerial application of *Btk*. In 2009, 11 moths were caught in downtown Richmond and a treatment of 766 ha is planned for the spring of next year. There will also be a small ground spray of 25 hectares in the Harrison Hot Springs area.

Of the tree diseases that are discernable from the aerial overview survey, Dothistroma needle blight continued to be most often detected. A total of 27,255 ha of damage were recorded in the NIFR, primarily in the Skeena Stikine Forest District. Damage caused by aspen and poplar leaf and twig blight resurged in 2009 with 8,584 ha affected, mainly in the Fort Nelson Forest District. Disturbances caused by pine needle cast were recorded over 7,022 ha, with almost all the damage observed in the NIFR. Delphinella needle cast, which is rarely discernable from the air, was recorded as damaging 3,383 ha in the Kalum Forest District.

Due to the hot dry conditions that most of the province experienced this summer, the leading abiotic damage was wildfire, with a total of 283,992 ha burnt. The SIFR had the majority (70%) of the wildfire activity. Another consequence of this weather pattern was 65,817 ha of drought damage, primarily to western redcedar. Observed yellow cedar decline damage along the BC coastline was down to 8,009 ha.

A variety of other damaging agents such as spruce beetle, windthrow, hail, larch needle blight, western hemlock looper and hemlock sawflies affected smaller areas of forest throughout the province.

2009 Summary of Forest Health Conditions in British Columbia

Introduction

British Columbia (BC) is a very biologically diverse province with a wide variety of tree species. These varied forest types can be affected by many different damaging agents such as insects, diseases, animals and abiotic factors. Intensity of resulting damage as well as locations and size of disturbances can change considerably from year to year. Therefore, monitoring and recording of forest disturbances is undertaken on an annual basis with the aerial overview survey. This survey has been the responsibility of the BC Ministry of Forests and Range (MFR) for the past thirteen years. Prior to this, the Canadian Forest Service (CFS) delivered the program.

The primary objective of the aerial overview survey is to capture forest disturbance information quickly and cost effectively over large areas. Information is collected for each forest health factor encountered by size and severity of damage, which is then summarized by forest districts (Figure 1). Each forest region is responsible for surveying their area and then the data is collated at the provincial level by Forest Practices Branch for inclusion in the provincial Land and Resource Data Warehouse.

Information from this survey is used by diverse groups for a variety of important purposes such as: contributing to the National Forest Pest Strategy, input for Timber Supply Analysis, setting of Government strategic objectives, directing management and control efforts, contributing to national indicators for sustainable forest management and providing support for research projects.

This report is prepared annually and summarizes damage sustained by the forests of BC over the past year. Hectares affected by various agents as quoted in this report were obtained directly from the aerial overview survey results. This includes all disturbances that were visible during the survey such as tree mortality and defoliation damage. Other forest health concerns that are not easily visible from the air are not captured by this survey, such as terminal weevil attack and many of the diseases such as rusts, cankers and dwarf mistletoes. Information collected by other methods for these damage agents was included if damage conditions changed since last reported. For consistency, this additional information was not added to the overview data. Assessments conducted to determine population levels and trends such as pheromone trapping, egg mass surveys and three tree beatings are undertaken for some insects. Where appropriate, this information was also provided.

Some key forest health presentations, projects and publications undertaken last year by MFR entomologists, pathologists and their associates were also included. The intent of this report is to summarize BC forest health conditions from a MFR perspective: this does not necessarily include associated research and management conducted by other agencies.

RSI · Southern Interior Forest Region (Kamloops)

DMH · 100 Mile House Forest District **(100 Mile House)**
DAB · Arrow Boundary Forest District **(Castlegar**, Grand Forks, Nakusp)
DCS · Cascades Forest District **(Merritt**, Lillooet, Princeton)
DCC * Central Cariboo Forest District **(Williams Lake**, Horsefly, Likely)
DCH · Chilcotin Forest District **(Alexis Creek)**
DCO · Columbia Forest District **(Revelstoke**, Golden)
DHW · Headwaters Forest District **(Clearwater**, McBride)
DKA * Kamloops Forest District **(Kamloops)**
DKL * Kootenay Lake Forest District **(Nelson)**
DOS * Okanagan Shuswap Forest District **(Vernon**, Penticton, Salmon Arm)
DQU · Quesnel Forest District **(Quesnel)**
DRM · Rocky Mountain Forest District **(Cranbrook**, Invermere)

* Denotes BC Timber Sales Location

RNI · Northern Interior Forest Region (Prince George)

DFN · Fort Nelson Forest District **(Fort Nelson)**
DJA · Fort St. James Forest District **(Fort St. James)**
DKM * Kalum Forest District **(Terrace)**
DMK · Mackenzie Forest District **(Mackenzie)**
DND * Nadina Forest District **(Burns Lake**, Houston)
DPC * Peace Forest District **(Dawson Creek**, Fort St. John)
DPG * Prince George Forest District **(Prince George)**
DSS · Skeena Stikine Forest District **(Smithers**, Dease Lake, Hazelton)
DVA * Vanderhoof Forest District **(Vanderhoof)**

RCO · Coast Forest Region (Nanaimo)

DCR * Campbell River Forest District **(Campbell River)**
DCK * Chilliwack Forest District **(Chilliwack)**
DQC · Haida Gwaii Forest District **(Queen Charlotte City)**
DNC · North Coast Forest District **(Prince Rupert)**
DIC * North Island - Central Coast Forest District **(Port McNeill**, Hagensborg)
DSI · South Island Forest District **(Port Alberni**, Duncan)
DSQ · Squamish Forest District **(Squamish)**
DSC · Sunshine Coast Forest District **(Powell River**, Sechelt)

Figure 1. Map of British Columbia outlining Ministry of Forests and Range regional and district boundaries as of April 1, 2003.

Methods

Small fixed wing aircraft are used to conduct the aerial overview surveys. Two experienced observers sit on opposite sides of the plane and sketch forest health disturbances on 1:100,000 scale maps. Colour Landsat 5 satellite images with some features digitally enhanced are used as the base maps. After the flight, the two maps are collated onto one complete mylar which is then digitized to obtain the final spatial data set. Details of survey methodology and digitizing standards can be found at http://www. for.gov.bc.ca/hfp/health/overview/methods.htm.

Aerial observers recording forest health damage

When flying and weather conditions permit, flights are conducted while damage caused by the primary forest health factors are most visible. This survey window varies by types of priority damage agents and general provincial location. Flights in 2009 started July 2nd with completion by October 8th (Table 1). Conditions at the beginning of the flights were very good and mapping progressed smoothly, aside from some budget constraints in the SIFR. As the summer progressed however, dry conditions across the majority of the province resulted in poor visibility due to smoke from wildfires. This became the primary challenge faced by all the survey crews. The surveys in the Southern Interior Forest Region (SIFR) were completed first. In addition to smoke issues, some areas of the Coast Forest Region (CFR) are perennially fogged in and thus it took a longer period to complete their share of the project. The Northern Interior Forest Region (NIFR) has the largest portion of the province to cover with weather that is often poor and with aircraft/surveyor limitations. Hence, surveys often take the longest to complete in the NIFR. Also, after smoke impeded visibility in the summer the fall weather turned stormy in the north and several flights were delayed due to poor weather. A total of 770.1 hrs of flying time was logged provincially to complete the high priority areas for the program in 2009.

Table 1. Flying hours and survey dates by region undertaken for the 2009 provincial aerial overview survey.

Region	Zone	Flight hours	Survey Dates
Southern Interior Forest Region	Cariboo	131.5	July 11th – Aug 15th
	Kamloops	61.2	July 23rd – Aug 19th
	Nelson	106.3	July 16th – Aug 19th
Northern Interior Forest Region	Prince George	227.7	July 20th – Oct 8th
	Smithers	188.5	July 2nd – Sept 11th
Coast Forest Region		54.9	July 15th – Sept 22nd
Total		**770.1**	**July 2nd – Oct 8th**

All flight lines were recorded with Global Positioning Satellite (GPS) receiver units (Figure 2). Survey progress and coverage intensity were monitored with this spatial information. Flights were conducted between 450m to 1000m above ground. Where topography was relatively flat, a grid pattern was flown 7 km to 9 km apart in areas with moderate or higher disturbance levels and up to 14 km apart where damage was very low. In mountainous terrain, drainages were flown. Flying height and plane speed depended on visibility and the extent and variety of damage.

The annual goal is to survey all forested land in the province, time and funding permitting. This isn't always possible, especially in lower priority areas with less forest health factors such as some areas of the CFR and NIFR. To assist the Yukon Government's development of a risk assessment for mountain pine beetle, and with financial support from implementation funding for the National Forest Pest Strategy from the Canadian Forest Service, major drainages containing lodgepole pine in the northwest portion of the province were surveyed in 2009. These areas were not flown in 2008. The entire Peace and Prince George Forest Districts were flown this year (incomplete in 2008). However, the northern most portion of the Mackenzie Forest District still wasn't completed, and less of the northern tips of Kalum and Fort St. James Forest Districts were flown than in 2008. Major drainages were flown in the CFR, but at a lower intensity than last year. In total, an estimated 82% of the province was flown, up from 76% last year. This percentage is derived by use of a digital planimeter to roughly determine how much of the entire province is surveyed. It does not factor in whether areas (flown or not) contain non-forested types such as large lakes, grasslands and alpine. All forests that are flown are examined for all visible forest health disturbances, regardless of timber type or land ownership. No judgements are made on what damage is deemed "important": all current disturbances are recorded.

Recent tree mortality is identified by observations of foliage colour. Dying conifer tree foliage generally turns yellow to bright red (depending on tree species and forest health factor) then over time colour intensity fades and foliage is shed. Only recently killed trees are mapped each year. Clumps of dead trees up to 50 are recorded as spots. To include these spots in total hectares affected, 1 to 30 trees are given a size of 0.25 ha and 31 to 50 trees 0.5 ha at a severe intensity rating. Larger disturbances are mapped as polygons by five intensity classes (Table 2).

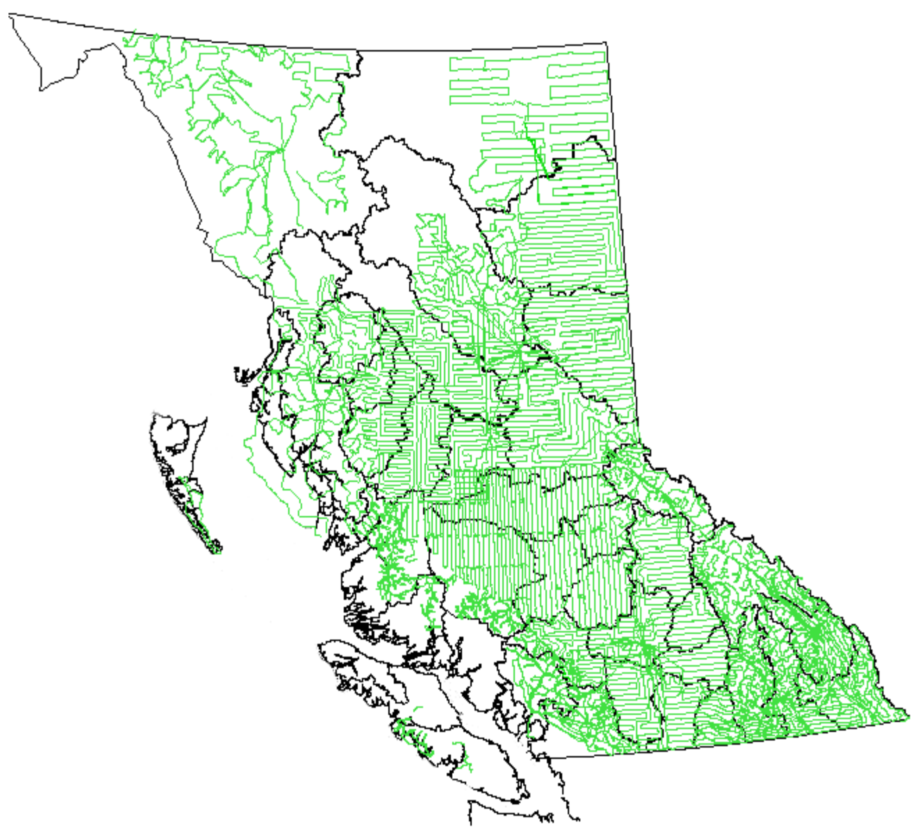
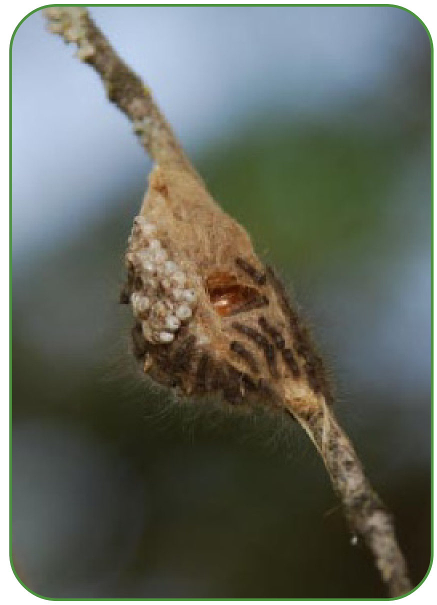


Figure 2. Flight paths flown while conducting the 2009 aerial overview surveys.

Table 2. Intensity classes used in aerial overview surveys for recording current forest health damage.

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



Douglas-fir tussock moth larvae hatching

Trees with foliage damage (caused by insect feeding, foliage diseases or abiotic factors) tend to cover fairly large areas and all age classes are affected. Therefore, only polygons are mapped under three intensity classes and they are assessed as a percentage of foliage defoliated in the past year over the entire polygon (Table 2).

In addition to limitations of certain damages not being visible at the height or time of the aerial overview survey, the collected data is limited for certain applications. Hectares affected from past surveys by the same forest health agent cannot be added cumulatively, as new damage can appear in all or a portion of the same stands that were previously disturbed. Fairly broad intensity classes and known errors of omission also must be considered when manipulating the data. For example, calculating accurate mortality volume estimations are not possible since the actual number of trees killed (and consequently, volume) is not precise.

Bruce spanworm defoliation

General Conditions

During the 2009 aerial overview surveys, a total of 13,246,896 ha of damage to BC forests were recorded (Table 3). Mortality due to mountain pine beetle peaked in 2007 with 10.1 million hectares affected, declined in 2008 to 7.8 million ha and rose again to 9 million hectares in 2009. This increase was not necessarily due to the outbreak expanding (although it did in some areas) but more from logistical factors of the survey including some areas not flown or flown late in 2008 and mapping of larger but lighter intensity polygons. These were also factors in a large increase in western balsam bark beetle damage, from 0.5 million hectares infested last year to 1.5 million hectares in 2009. Another contributing aspect of the dramatic increase in western balsam bark beetle mortality was the masking affect caused by high levels of red mountain pine beetle damage which was no longer evident as the dead pine is now mostly grey. Douglas-fir beetle damage continued to rise slightly to 100,726 ha affected and spruce beetle infestations remained low at 30,791 ha of attack.

Insect caused defoliation in BC more than doubled over last year to 2 million hectares affected. Western spruce budworm continued to be the most damaging defoliator, with 766,125 ha recorded in the southern half of the province. A Bruce spanworm outbreak in the Peace Forest District grew substantially, with 637,347 ha mapped. Two year cycle budworm damaged 396,855 ha primarily (99%) in the NIFR: this is the highest level observed since the MFR has been responsible for aerial overview surveys. Haida Gwaii Forest District sustained 24,656 ha of western blackheaded budworm defoliation and forest tent caterpillar damaged 29,821 ha, mainly in the Quesnel Forest District. The Douglas-fir tussock moth outbreak expanded in 2009 with 17,512 ha of defoliation in the southwest portion of the SIFR.

Damage caused by abiotic factors increased substantially this year to 372,567 ha. The majority of the disturbances were wildfire (283,992 ha), a result of a very dry hot summer across most of the province. This weather also contributed to 64,817 ha of drought damage, primarily to western red cedar. Yellow cedar decline disturbances dropped to 8,009 ha, with the decrease due at least in part to the reduced intensity of coastal flight lines. One bad hailstorm located at the boundary of the Prince George and Quesnel Forest Districts caused significant damage to a variety of tree species over 4,230 ha.

Injuries caused by disease infections were less noticeable this year with only 48,580 ha in total recorded during the surveys. This was primarily due to half the amount of Dothistroma needle blight damage being observed as last year at 27,255 ha affected in the NIFR. A similar drop in pine needle cast disturbances was noted, with 7,022 ha of damage. Aspen and poplar leaf and twig blight damage was up however, with 8,584 ha affected and damage by Delphinella needle cast, which is rarely observable during this survey, affected 3,383 ha in the Kalum Forest District. Locations, extent and intensity of damage by host tree species are documented in the next section of this report.

Table 3. Summary of hectares affected by forest damaging agents as detected in 2009 aerial overview surveys in British Columbia.

Damaging Agent	**Hectares Affected**
Bark Beetles:	
Mountain pine beetle[a]	8,953,441
Western balsam bark beetle	1,727,719
Douglas-fir beetle	100,726
Spruce beetle	30,791
Engraver beetles	465
Misc. beetles	9
Total Bark Beetles:	10,813,151
Defoliators:	
Western spruce budworm	766,125
Bruce spanworm	637,347
Two-year-cycle budworm	396,855
Aspen leafminer	102,609
Forest tent caterpillar	29,821
Western blackheaded budworm	24,656
Unknown defoliators	20,454
Douglas-fir tussock moth	17,512
Hemlock sawfly	10,646
Western hemlock looper	3,990
Satin moth	1,608
Birch leafminer	735
Eastern spruce budworm	99
Conifer sawflies	85
Large Aspen Tortrix	45
Total Defoliators:	2,012,587
Abiotics:	
Fire	283,992
Drought	65,817
Yellow cedar decline	8,009
Hail	4,230
Flooding	3,913
Windthrow	3,425
Redbelt	1,185
Snow/Ice	917
Slide	833
Birch decline	245
Total Abiotics:	372,567
Diseases:	
Dothistroma	27,255
Aspen/poplar leaf/twig blight	8,584
Pine needle cast	7,022
Delphinella needle cast	3,383
Larch needle blight	1,886
Unknown disease	228
Laminated root disease	192
White pine blister rust	29
Armillaria root disease	1
Total Diseases:	48,580
Animals:	
Porcupine	11
Total Animals:	11
Provincial Total	13,246,896

[a] Includes infestations in parks totalling 1,116,473 ha.

Damage to lodgepole pine leader caused by hail

Lodgepole pine mortality caused by mountain pine beetle

Damaging Agents of Pines

Mountain pine beetle, *Dendroctonus ponderosae*

Provincial Situation

Mountain pine beetle mortality peaked at 10,051,919 ha in 2007, but after a decline to 7,841,993 ha in 2008, an increase to 8,953,441 ha of damage was recorded in 2009 (Figure 3). Of this, 1,116,473 ha were located in provincial parks and protected areas. In many areas an unusually high amount of red needle retention from 2007 attack (recorded as current red in 2008) made it difficult to delineate old attack from the most recently faded red trees this year during the aerial overview surveys. This needle retention was a result of late colour change, which probably resulted in some attack being missed during last year's surveys.

Infestations continued to be observed throughout the range of pine in BC (Figure 4) but the intensity of attack was down substantially for the second consecutive year. Severity levels were delineated as 4,562,710 ha trace (51%), 2,801,910 ha (31%) light, 1,012,768 ha (11%) moderate, 501,352 ha (6%) severe and 74,701 ha (1%) very severe. Severe to very severe levels of attack were similar to last year, but trace rose from 37% to 51%, with corresponding drops in the light to moderate categories. Mapping of larger polygons of scattered trace mortality, particularly where the beetle is significantly declining, contributed to the appearance of an increase in damage.

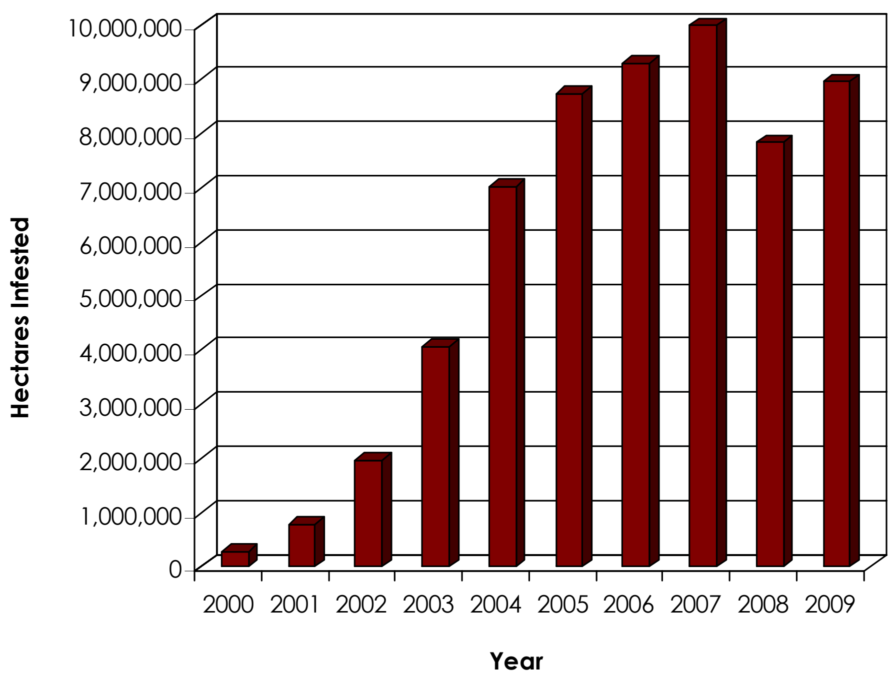


Figure 3. Hectares infested (all severity classes) by mountain pine beetle from 2000 – 2009 in British Columbia.

Mountain pine beetle infestations are still advancing northward and to a lesser extent into some southern areas of the province. In the central portion of BC, most of the beetle mortality has turned grey with the scattered trace effect occurring primarily in suppressed understory trees. It is likely that these trees are being attacked by remnants of the mountain pine beetle population in conjunction with other secondary beetles.

In addition to the primary host (mature lodgepole pine), other hosts are being killed in unprecedented numbers, particularly as the beetles run out of the preferred host. These secondary hosts include ponderosa, whitebark and western white pine, younger age classes of lodgepole pine and to a lesser extent spruce trees.

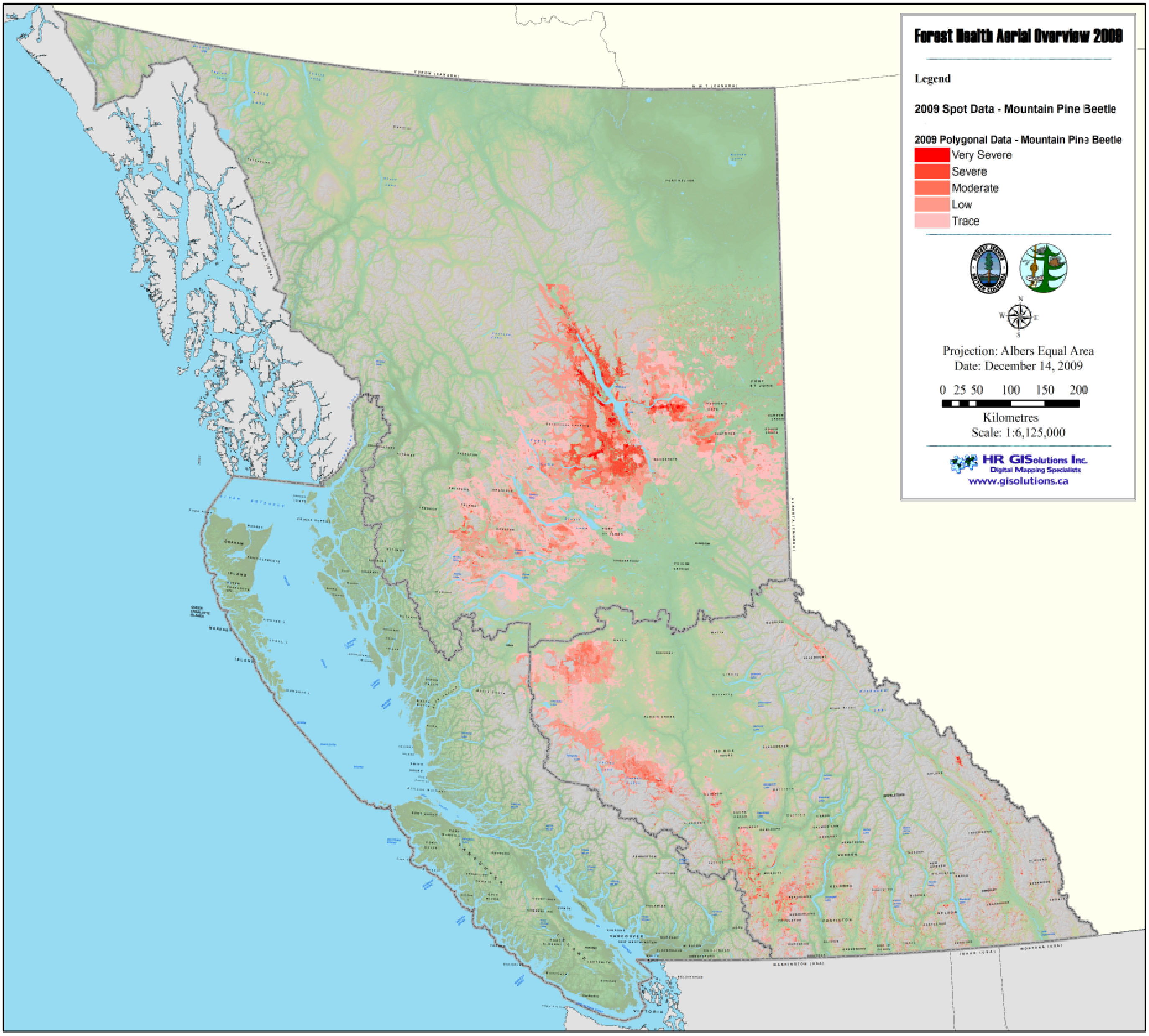


Figure 4. Mountain pine beetle infestations recorded in British Columbia in 2009.

Northern Interior Forest Region Damage

After a significant drop to 2,904,234 ha last year, mountain pine beetle attack in the NIFR climbed to the highest level ever recorded at 6,538,769 ha. Total area affected increased in all districts except for Prince George Forest District (Figure 5), but for a variety of reasons.

Infestations in the Peace Forest District increased by two-thirds over 2008 to 1,735,175 ha affected. Although attack expanded this year, part of the increase was due to a much larger portion of the district being surveyed this year. Damage severity was down substantially as well, with the trace category rising from 44% to 62% and a corresponding drop in severe mortality down to moderate. Infestations expanded northward almost to the extent of pine in the area. The furthest occurrence was along Gutah Creek, where pine pushes northward along the creek but is surrounded by bog.

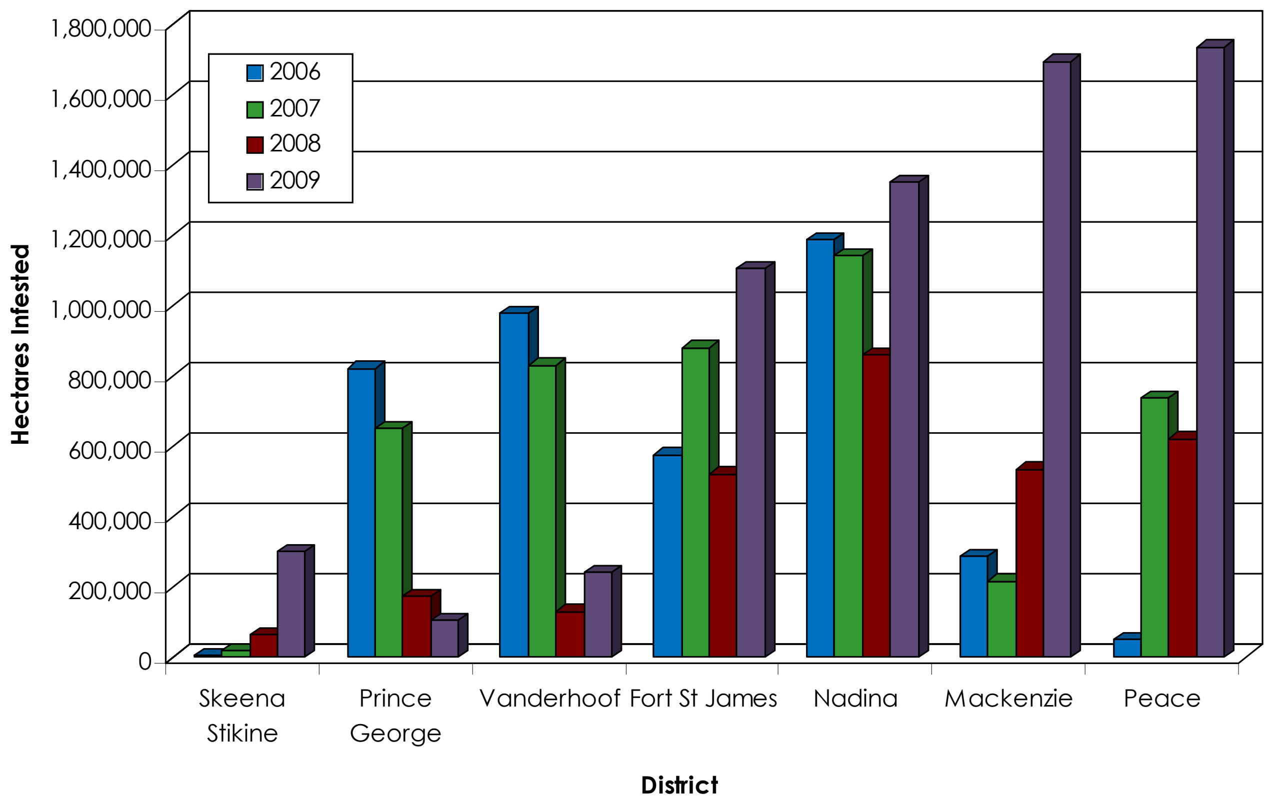


Figure 5. Hectares infested by mountain pine beetle from 2006 – 2009 in the Northern Interior Forest Region (districts with more than 100,000 ha affected in 2009).

In the southern portion of the district, most (estimated 80% or more) of the mature pine has already been killed by mountain pine beetle.

Infestations in the Prince George Forest District declined for the third year in a row, despite more of the district being flown this year. A total of 103,497 ha of mainly trace intensity were delineated. Disturbances were only mapped along the far western edge of the district, primarily near the north tip. While the outbreak is virtually over in the Prince George Forest District (most of the mature pine is dead), it is still active in the Kalum Forest District. Affected area more than doubled in this district since last year to 4,057 ha. Infestations continued to expand along most drainages radiating out from Terrace, particularly near Pillar Peak and along the Kitimat and Zymoetz Rivers. Intensity levels remained light, indicative of new populations and also the mixed species stands that are common in this district.

Mackenzie Forest District experienced the largest increase with an area over triple that mapped in 2008 to 1,694,874 ha affected. Although some of this can be attributed to more of the northern portion of the district being surveyed this year, substantial increases in severity levels indicate that this increase reflects that beetle populations are still active: severe to very severe has increased from 1% in 2008 to 24% this year. Ground observations support this increase. Attack began in the southern part of the district and has rapidly spread north and west. Infestations go up to Chase Provincial Park and north past the communities of Fort Ware and Tsay Key. The aerial survey did not cover the most northerly portion of the district which likely had areas under attack that would have increased the district total.

After a large decrease in infested area last year, attack in the Vanderhoof Forest District almost doubled to 240,317 ha. This was still far below the peak recorded in 2006 and represents a declining mountain pine beetle population. The increase is somewhat artificial, as the late completion of the aerial survey last year in this district likely underestimated the area of new red. Also, the southwest tip of the district was not flown in 2008. Most of the infestations this year were noted in that southwest tip and at the northern edge of the district. Intensity of mortality continued to decline, with 81% trace, 17% light and 2% moderate, as scattered pine in areas of high mortality were attacked.

In the Fort St. James Forest District, area of attack rebounded from a drop to 502,969 ha last year to a peak of 1,105,660 ha in 2009. The majority of the expansion was northward from the north end of Takla Lake to Aquklotz Lake and north along the Omineca and Sikanni Range Rivers. Almost all the new disturbances were mapped at trace intensity, therefore the overall intensity recorded for this district was reduced: trace increased from 37% last year to 68%, while infestations delineated as moderate and greater correspondingly were reduced.

Old mountain pine beetle mortality in the NIFR

Only 24 ha of moderate attack were observed in one small disturbance North of Muskwa River in the southwest corner of the Fort Nelson Forest District. This is the first time mountain pine beetle mortality has been recorded during the aerial overview surveys in this district, and it represents the northern-most extent of the provincial infestation. Unfortunately, the area was inaccessible to ground checks for positive identification of the casual agent.

After four years of sustaining the highest level of attack in the NIFR, damage in the Nadina Forest District increased but not as dramatically as in Mackenzie and Peace Forest Districts. Area affected rose 44% since last year to 1,351,012 ha (133,841 ha in parks and protected areas), but this is partially an artefact of surveyor methodology. Last year, the eastern half of the district was mapped primarily with small, relatively high severity disturbances while this year polygons were much larger but also of much lower intensity. The percentage of light intensity mortality remained the same, but trace rose from 34% to 68% with a corresponding drop in moderate and higher classifications. Mapping of larger, lighter intensity disturbances was also a result of what ground observations show to be a second wave of mountain pine beetle mortality that is killing the remaining scattered pine in the old attack areas.

Area attacked by mountain pine beetle in the Skeena Stikine Forest District continued to increase to more than quadruple last year with 299,416 ha affected. The outbreak is still relatively new in this district and the beetle populations are still expanding from the east to the west with most of the Bulkley TSA (Timber Supply Area) now infested. It was anticipated that infestations would expand further west this year than they did, but that prevailing winds from the west may have hampered beetle movement. Much of the new attack is at trace intensity, which accounts for a large increase in this category (a total of 92%). A few small polygon and spot infestations were recorded in the western Kispiox TSA, and in the southern tip of the Cassiar TSA.

Southern Interior Forest Region Damage

Area affected by mountain pine beetle in the SIFR peaked in 2007, corresponding to the provincial peak. Damage was down slightly in 2008 at 4,812,915 ha and dropped by half this year to 2,343,711 ha affected. The extent of this reduction varied from district to district but all SIFR districts had reduced area of attack.

Although infestations in the Cariboo area of the region were down substantially, they still represented two-thirds of the attack in the SIFR (Figure 6). Chilcotin Forest District continued to have the highest area of damage with 992,163 ha affected. This reduction by a third since last year primarily occurred in the northeast quarter of the district, where the infestation first started. Intensity of attack continued to decline as well (94% rated trace to light) though not as dramatically as last year. Changes in intensity levels over time in this district as mountain pine beetle populations have declined are illustrated in figure 7.

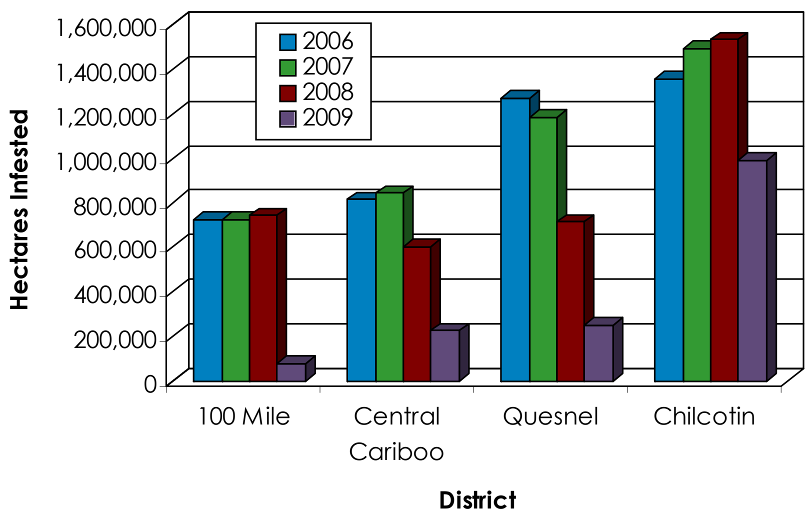


Figure 6. Hectares infested (all severity classes) by mountain pine beetle from 2006 – 2009 in the Southern Interior Forest Region (districts with more than 500,000 ha affected in 2008).

Infestations in the Quesnel Forest District dropped by a third to 251, 595 ha of mortality: most of the reductions occurred in mixed species stands in the eastern half of the district. Attack in the Central Cariboo Forest District decreased by a similar amount to 225,039 ha affected with the majority of infestations remaining in the western most portion of the district. Recorded intensity levels in both these districts

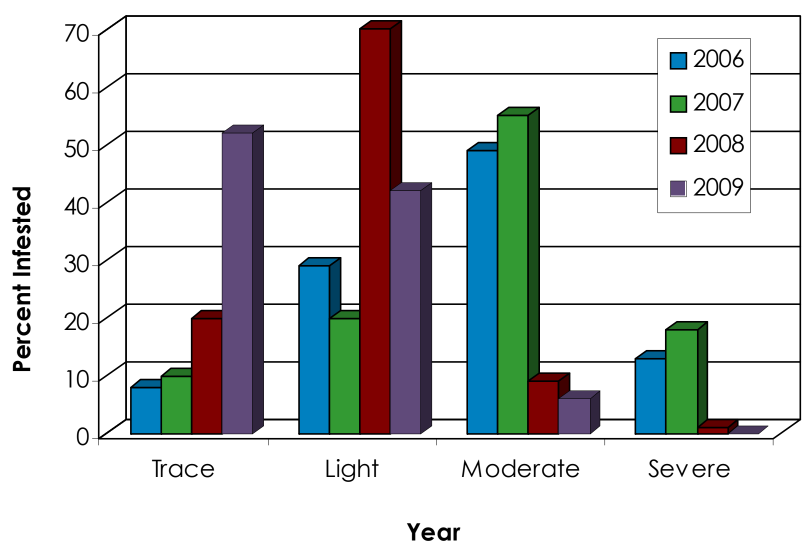


Figure 7. Percent change in severity of hectares infested by mountain pine beetle in the Chilcotin Forest District from 2006 – 2009 (very severe less than 1% all years).

dropped for a fourth year in a row with more than three-quarters noted as trace to light. Areas in the Central Cariboo Forest District that still had severe mortality were mapped south of the Marble Range and around Pavilion and Red Mountains.

After remaining relatively steady over the past three years, infestations in the 100 Mile House Forest District decreased almost tenfold over last year to 76,848 ha of attack. This was the largest drop reported for all districts provincially. Last year, infestations virtually covered the entire district. This year, residual disturbances are small and scattered, with some concentrations along the southern boundary. Intensity levels also fell for a third year in a row, with 81% of the attack rated as trace.

The smallest decrease in area attacked since last year (14%) occurred in the Cascades Forest District, where 320,751 ha were delineated. Infestations were generally in the same areas (scattered throughout the district but heaviest in the Merritt TSA), though expansions continued in low elevation ponderosa pine stands. Infestations in the Okanagan Shuswap Forest District continued to be heaviest mid district and along the Cascades Forest District boundary, though area affected was down 21% to 136,033 ha.

Headwaters Forest District experienced a second consecutive year of mountain pine beetle damage reductions, down 32% to 112,461 ha affected. Infestations were smaller than last year but in the same general areas along the southern district boundary and along the Fraser River in the Robson Valley. Mountain pine beetle attack in Kamloops Forest District also dropped for the second year in a row with a sharp decline of 61% to 90,254 ha mapped. Decreases were greatest in the north-western portion of the district.

After infestations approximately doubled from 2007 to 2008 in the Arrow Boundary and Rocky Mountain Forest Districts, area affected fell by half in both districts this year. A total of 43,172 ha and 51,645 ha were recorded per district, respectively. Mortality in the Kootenay Lake Forest District had a similar pattern, with a 55% decrease this year to 25,000 ha delineated. Not all pure pine types are infested in this district; for example, attack in the Hawkins Creek drainage is very low. Infestations in all three districts were relatively small and scattered in the same general areas as last year but reduced in size.

The remaining attack in the SIFR occurred in the Columbia Forest District where 18,738 ha were affected, down 54% since last year. Most of the attack continued to occur in the southeast tip of the district.

Coast Forest Region Damage

Mountain pine beetle infestations in the CFR declined for the fourth year in a row to 70,961 ha of attack. The majority of the disturbances continued to be mapped in the North Island – Central Coast Forest District. As was the case from 2007 to 2008, damage declined to almost half the level noted last year to 46,194 ha affected. Virtually all (99%) of this attack was located in Tweedsmuir Provincial Park. Infestations shrunk in both size and intensity again, with the remaining mortality located along the north-eastern border of the district.

Attack declined for the second consecutive year in the Chilliwack Forest District to 22,545 ha. Intensity of mortality also decreased with the majority (96%) rated as trace to light. Infestations were smaller but in similar areas as last year, with the majority of the disturbances located in the north-east tip of the district. The portion of attack noted within Manning Park rose substantially to 17,978 ha.

Logepole pine killed by mountain pine beetle in the Birkenhead Lake area of the CFR

Squamish Forest District also experienced a drop in infestations for the second year in a row to 2,222 ha. Disturbances continued to occur primarily in scattered areas across the eastern portion of the province, but in smaller polygons than previously noted.

Mountain pine beetle populations are not known to be established in the Haida Gwaii Forest District, but some pitched out attacks containing the beetle were identified in some shore pine. It is thought these mountain pine beetles may have been brought in via firewood from the mainland.

Beetle Flights / Larval Development

In almost all areas of the province, the summer weather was hot and dry. Overall, this resulted in good, concentrated beetle flights.

In the eastern districts of the NIFR, mountain pine beetle flights started near the end of the 1st week of July with a peak in mid July, though beetles were still flying through August. In the Peace Forest District it was noted that strong prevailing winds from the west continued to bring in large numbers of beetles from the Mackenzie Forest District. In the western districts of the NIFR, two main flights occurred with the first one near the end of July and a larger one occurring in late August through early September. Larval development was slow from the late flight, with ground surveys noting first and second instar development in November. The Kalum Forest District however reported a normal, very concentrated flight with regular larval development.

In the SIFR, mountain pine beetle flights were quite concentrated with the main flight about mid to late July; though beetles were flying through August. Flights were definitely more concentrated than the last two years, when cool wet weather resulted in several small flights that lasted later into the fall. Anecdotally, despite concentrated flights the number of beetles flying appeared to be down. This resulted in lower density of attack per tree, which results in better brood development compared to an overcrowded tree. Even though the weather in the southeast portion of the SIFR was cooler and wetter than the rest of the province, most of the rain did not fall until mid August, when the main flights were finished. Development was considered normal for most of the SIFR, with the exception of some areas in the Arrow Boundary and Kootenay Lake Forest Districts. During surveys of suppression areas in the Arrow Boundary Forest District, only adults and first and second instar larvae were often found at a time when larvae should be developed to the third and fourth instar stage. In the Kootenay Forest District, poor flight synchrony over the past couple of years has resulted in similar delayed development, to the point where some beetles are in a two year life cycle.

Western pine beetle (*Dendroctonus brevicomis*) in ponderosa pine areas was noted to have had very successful flights as well. A local land owner in the Merritt area had funnel traps out to catch both beetles and documented large western pine beetle flights starting in early June with another peak in August, and flights continued until hard frosts occurred around Thanksgiving.

Tree Response to Attack

Throughout the NIFR, tree colour change was reported to be a bit earlier than normal. This was probably due to drought conditions combined with the attack. The Peace Forest District was the exception, where colour change was observed to be normal. Pitch tube development was more variable and seemed to be driven by beetle population, rather than weather. In the Peace and the south half of the Skeena Stikine Forest Districts, high populations resulted in overwhelmed trees with no pitch tube response. For other areas, pitch tubes were fairly normal though somewhat small, possibly due to drought.

Pitch tubes and boring dust signify a successful mass attack by mountain pine beetle

In the SIFR, lodgepole pine colour change overall was normal. The occurrence of pitch tubes was also fairly normal. Dry weather combined with high attack densities did result in a lack of pitch tubes in a few scattered areas though. Colour change in ponderosa pine was much more variable, due primarily to the attack being caused by a combination of mountain pine beetle, western pine beetle and pine engraver bark beetle. Trees were turning colour in waves from the spring through the summer then again by late fall.

Population Fluctuations

Brood samples were collected from currently attacked trees in the early spring of 2009 to estimate overwinter mortality and vigour of progeny. Data collected included percent mortality of beetles (all life stages) which was used to calculate the "r" value for indicating whether a population is decreasing (<2.6), static (2.6 – 4.0) or increasing (>4.0).

Most of the samples were taken from mature stands in SIFR districts. Where attack was present in high enough numbers in young stands, samples were collected there as well. A total of 1,544 mature trees were examined across 152 sites in ten districts in 2009 (Table 4). Only beetle populations in Mt. Robson Park area of the Headwaters Forest District were predicted to be increasing on average (7 of 10 sites). In the adjacent Robson Valley TSA and farther south in the Arrow Boundary Forest District, populations were predicted to be static on average though one site in Robson Valley and a quarter of the Arrow Boundary sites had increases expected. The highest r-value for the SIFR (8.2) occurred at the one Robson Valley TSA site. It should be noted however that woodpecker activity was highest in this area and tree selected for samples had the lowest woodpecker disturbance, therefore the average mortality would have been higher if woodpecker caused mortality was factored in. All other r-values indicated decreasing populations. The only exception was one site in the Okanagan Shuswap Forest District. These figures suggest a continuation of the downward population trend noted last year, as opposed to 2007 when beetles were predicted to increase in mature stands in all districts.

Table 4. 2008/2009 mountain pine beetle overwinter mortality estimates in mature pine for the Southern Interior Forest Region.

District (TSA)	# of Sites Sampled	# of Trees Sampled	Average % Mortality	Average r -Value
100 Mile House	8	80	92.5	0.48
Arrow Boundary	15	134	88.8	2.81
Cascades (Lillooet)	12	119	99.0	0.46
Cascades (Merritt)	10	98	97.2	0.62
Central Cariboo	5	50	95.2	0.70
Chilcotin	5	50	97.3	0.61
Columbia (Golden)	14	135	92.8	1.4
Headwaters (Clearwater)	9	79	95.2	1.19
Headwaters (Mt. Robson Park)	10	200	71.3	4.80
Headwaters (Robson)	10	100	87.3	3.73
Kootenay Lake	9	89	89.3	1.78
Okanagan Shuswap	15	134	94.4	1.38
Rocky Mountain	30	276	91.1	1.93
Totals/Averages	152	1544	91.6	1.68

Fewer stands were available for immature pine sampling this year than in 2008, with 217 trees from 22 sites across three districts examined in the SIFR (Table 5). Average r-values for these sites were similar to 2008, but down to 0.63 from 2.4 in 2007. These averages indicate a decreasing population, with the exception of one site in the Lillooet TSA of the Cascades Forest District. Overall, these results concur that in most areas of the SIFR, mountain pine beetle populations peaked in 2007 and are now on the decline.

Table 5. 2008/2009 mountain pine beetle overwinter mortality estimates in immature pine for the Southern Interior Forest Region.

District (TSA)	# of Sites Sampled	# of Trees Sampled	Average % Mortality	Average r- Value
100 Mile House	5	50	99.7	0.01
Cascades (Lillooet)	5	49	96.0	1.71
Cascades (Merritt)	7	68	99.2	0.77
Kamloops	5	50	99.9	0.03
Totals/Averages	22	217	98.7	0.63

The only NIFR district to conduct overwinter mortality sampling was the Peace Forest District, where 1,247 trees over 58 sites were examined. The results were highly variable with r-values ranging from 0 to 16.85. The average was 4.5 which indicated an overall increasing population but the estimate has a low confidence due to a high variance. Generally, r-values were very high near Chetwynd and south of Dawson Creek. Increasing populations are indicated by sampling from Tumbler Ridge north past Fort St. John. Areas with low (decreasing) populations predicted were south of Tumbler Ridge and in the far north.

In areas where suppression efforts are still underway, data collected during ground surveys from late fall to now include green attack to red attack (G:R) ratio information (Table 6). This statistic is another tool for predicting changes in mountain pine beetle populations. A G:R ratio >1 indicates rising populations, while G:R <1 usually means declining populations. These ratios must be interpreted carefully; ratios higher than 5:1 probably indicate the sample area was inundated by beetles from other sources than the local populations.

Table 6. Green to red mountain pine beetle attack ratios observed in 2009.

Region / District	High	Average	Low
NIFR – Kalum	55:2	2.65:1	0:1
Skeena Stikine	15:1	3.5:1	0:1
SIFR – Arrow Boundary	2.7:1	1.2:1	1.4:1
Columbia (Golden TSA)	26:1	2.7:1	0:1
Okanagan Shuswap	6:1	2:1	0.5:1
Rocky Mountain	4.2:1	2.2:1	0.5:1
Kootenay Lake		4:1	

G:R data was available from far fewer districts this year, as most are no longer involved in suppression activities. Ground surveys are ongoing throughout the winter, so G:R data is still preliminary. For the noted suppression areas where beetle infestations are still relatively new, all averages indicate increasing populations but at a generally lower level than in past years. In the Arrow Boundary Forest District it was observed that the G:R ratios in areas treated in previous years were half that seen in non-treated areas.

Ponderosa, Whitebark and Western White Pine Mortality

Ponderosa pine continued to be the second most affected pine species in the province with a total of 89,803 ha of damage, down from last year's peak of 132,929 ha. Intensity increased somewhat, to 7,632 ha (9%) trace, 37,347 ha (42%) light, 26,416 ha (29%) moderate, 14,551 ha (16%) severe and 3,857 ha (4%) very severe. Mortality of ponderosa pine was not only attributed to mountain pine beetle, but also western pine beetle and this year substantial numbers of pine engraver bark beetle. Many trees were attacked by a complex of these beetles, particularly at the lower elevations. Capturing all the attack with the single aerial overview survey pass was difficult, as trees were changing colour throughout the summer.

Almost all the attack was located in the SIFR, encompassing the range of ponderosa pine. Infestations continued to be most prevalent in the Cascades Forest District, where 69,047 ha of attack were recorded. Mortality was particularly high along the Thompson River, down through Merritt, and south past Aspen Grove. Attack in the Kamloops Forest District declined substantially to 7,232 ha with the largest concentration remaining along the Thompson River heading toward the Cascades Forest District. Mortality in 100 Mile House Forest District was down to 2,314 ha, situated primarily around Kelly Lake and along the Bonaparte River at low intensity levels. The majority of the mature ponderosa pine in these three districts is now dead.

Attack in the Okanagan Shuswap Forest District remained relatively steady with 10,803 ha mapped. The largest concentration of disturbances was observed along Okanagan Lake and Salmon River. Small spot infestations were scattered throughout the Rocky Mountain, Arrow Boundary and Kootenay Lake Forest Districts each totalling 206 ha, 55 ha and 46 ha affected, respectively. Three spot infestations were also identified in the Columbia Forest District. The remaining 100 ha of attack occurred in the northeast corner of the Squamish Forest District in the CFR near Devine.

Where ponderosa pine has been under attack for at least two years, various observations have been made regarding the unusual instability of the dead trees. Due to the dry ecosystems where ponderosa pine occurs it had been expected that these trees, particularly the large ones, would remain standing dead for many years. Instead, a large percentage of the stems, both large and small, are breaking off or uprooting within two years. Many of the trees that are falling more rapidly have evidence of heart rot. This combined with the large crowns of open grown trees which effectively catch the wind present blowdown opportunities. A serious public safety problem is being created by this situation as ponderosa pine tends to grow in populated interface areas.

Severe ponderosa pine mortality adjacent to a populated area

Infestations in whitebark pine increased to a total of 18,803 ha provincially. Severity of mortality declined however for the second year in a row to 11,786 ha (63%) trace, 4,446 ha (23%) light, 2,223 ha (12%) moderate and 348 ha (2%) severe. Headwaters Forest District, where no damage was recorded last year, sustained the most attack with 11,409 ha affected, primarily in the Robson Valley TSA. Most of the attack (91%) was rated at only trace intensity. Damage in the Cascades Forest District was almost the same as last year with 4,729 ha delineated. The majority of this attack was scattered throughout the Lillooet TSA.

Whitebark pine mortality in the Kootenay Forest District dropped substantially to only 663 ha but rose in the Rocky Mountain Forest District to 781 ha. The remaining SIFR damage was located in the Arrow Boundary and Columbia Forest Districts, with 418 ha and 228 ha attacked, respectively. Infestations in these districts were small and widely scattered at high elevations. The only other attack in whitebark pine was recorded over 614 ha in the southeast corner of the NIFR's Prince George Forest District.

Western white pine mortality dropped from a peak of 3,777 ha last year to only 838 ha. All the infestations continued to be located in the SIFR, with the majority of them occurring in the southern portion of Headwaters Forest District (829 ha). Intensity levels were very low, with 98% denoted in the trace category. All of the trace disturbances were in the Headwaters Forest District. The remaining attack consisted primarily of spot infestations in the Arrow Boundary, Columbia, Kootenay Lake, Okanagan Shuswap and Rocky Mountain Forest Districts.

Young Pine Mortality

A total of 97,308 ha of young pine mortality was recorded provincially in 2009, down to less than a third of what was mapped last year. Since young stands are at the highest risk when beetle populations are very high in nearby stands and/or mature pine stands have been depleted, this drop is another indication that the outbreak is declining in most areas of BC. Various types of secondary bark beetles have also been observed killing some trees in immature stands.

Although infestations were down five fold in the SIFR since last year, the majority of attack was still located in this region with 52,427 ha affected. Precisely when this attack occurred was difficult to discern as colour change and colour retention was highly variable over the past two years. Levels of intensity decreased as well, with 67% trace, 25% light, 6% moderate and 1% severe. A large portion of the infestations were scattered throughout the 100 Mile House and Central Cariboo Forest Districts with 15,416 ha and 14,730 ha of attack, respectively. However, most (more than 91%) of these infestations were rated as trace intensity. Attack in the Kamloops Forest District totalled 8,437 ha and was scattered throughout the district, with the exception of one large concentration south of Lac le Jeune. Infestations in the Quesnel Forest District were primarily situated mid district, and covered 5,526 ha. Okanagan Shuswap Forest District contained 3,052 ha of attack, mostly scattered northwest of Okanagan Lake. A total of 2,266 ha of young pine mortality was mapped in the Headwaters Forest District, mainly east of McBride and south of Mahood Lake. All of the Chilcotin Forest District attack (1,577 ha) was of trace intensity and located at the eastern edge of the district. Almost all the 984 ha affected in the Cascades Forest District was situated in the northern portion of the Merritt TSA. Minor infestations (under 250 ha per district) were mapped in the Arrow Boundary, Columbia, Rocky Mountain and Kootenay Lake Forest Districts of the SIFR.

Infestations in the NIFR fell by almost half from 2008 to 44,881 ha of attack in young pine. Severity levels were much higher than in the SIFR, at 18% trace, 32% light, 27% moderate, 18% severe and 4% very severe. Prince George Forest District continued to have the most attack, but at one-fifth the level recorded last year. Small scattered infestations, primarily along the western border, totalled 11,708 ha. Attack in the Vanderhoof and Nadina Forest Districts was scattered across the northern two-thirds of the districts with 8,538 ha and 8,516 ha affected, respectively. Young pine mortality in the Fort St. James Forest District was mapped only in the southern tip of the district and covered 8,329 ha. Mackenzie Forest District infestations affected 6,334 ha, primarily along Williston Lake. Infestations totalling 981 ha were scattered around the Pine River area in the Peace Forest District. In the Skeena Stikine Forest District, 327 ha of attack were concentrated along the Telkwa River and the remaining 148 ha were delineated mid district in the Kalum Forest District.

Young lodgepole pine mortality

Part of the reason for the drop in infested young pine stand area recorded this year was due to a revised procedure that separated out what is now referred to as understory attack. This attack was showing through the grey canopy of old attacked mature pine stands, and it is uncertain if they are truly “young” trees or just very short suppressed trees. They are now recorded separately from young pine that is growing in clear cut harvested areas. A total of 6,176 ha of understory mortality was delineated in 2009, all at the trace intensity level. Most (5,600 ha) of the attack was detected in the Central Cariboo Forest District. The remaining 576 ha were observed in the 100 Mile House Forest District.

Dothistroma needle blight, *Dothistroma septospora*

Damage caused by Dothistroma needle blight in the NIFR was mapped across a total of 27,255 ha, down to half the record level reported last year (Figure 8). Disturbance severity was up slightly however, with 13,325 ha (49%) light, 10,632 ha (39%) moderate and 3,299 ha (12%) severe recorded.

Needle damage continued to be highest in the Skeena Stikine Forest District with 20,182 ha affected. Disturbances were concentrated at the confluence of the Cranberry and Kispiox Rivers, south of Kinaskan Lake and south of Hazleton. The Kalum Forest District sustained 6,817 ha of damage mid district, particularly along the Nass River. The remaining 256 ha were recorded in small areas near Babine Lake in the Nadina Forest District. With the relatively dry summer experienced over most of the NIFR this year, it is anticipated that damage levels should be lower next year.

The eastern portion of the Prince George Forest District was flown in the spring of 2009 using low level rotary wing. Dothistroma damage was noted to be particularly heavy in the usual high risk sites within the Sub- Boreal Spruce (SBS) vk biogeoclimatic subzone. These sites are typically close to a river and always occupy low-lying topographic positions. The highest risk sites are characterized by defoliation approaching 80 to 90%. Recovery on these sites appears to be unlikely given the slow but steady decline. For the first time a ground check identified what appears to be a significant level of foliar resistance in a few individual lodgepole pine trees. Further ground checks will be required to identify the frequency of these trees and the feasibility of collecting genetic material for screening.

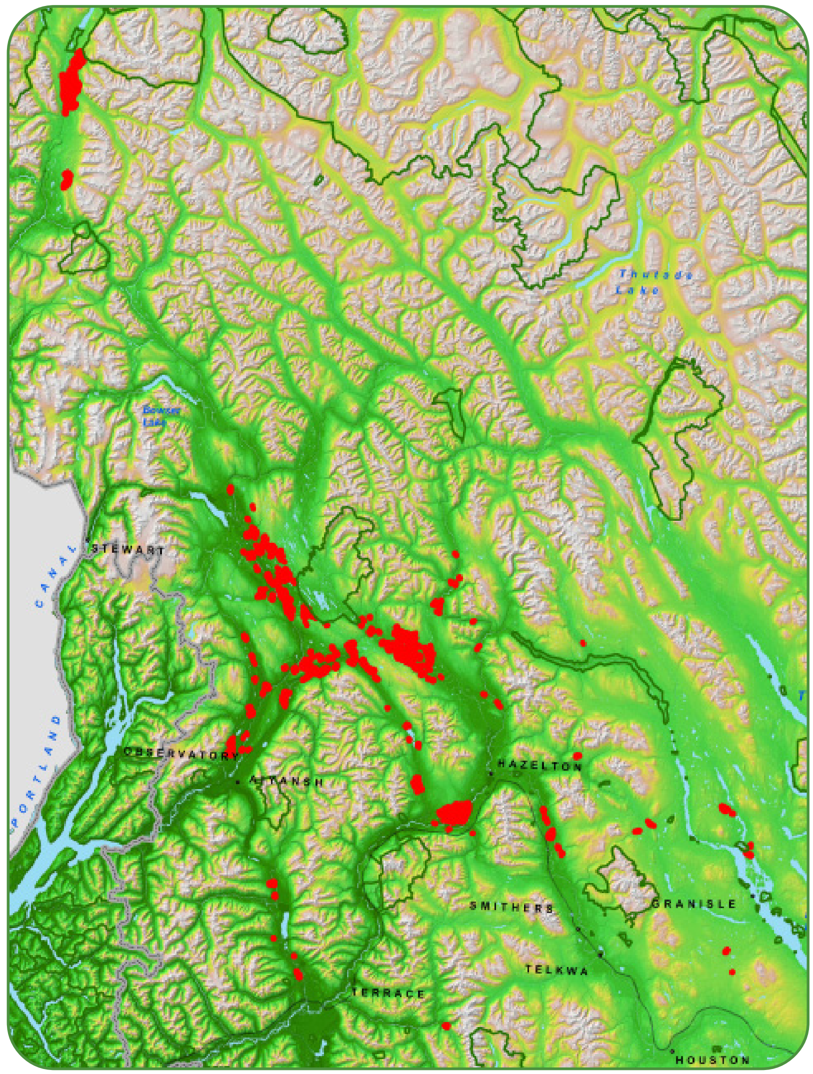


Figure 8. Dothistroma needle blight damage recorded during the 2009 aerial overview surveys in Northwest BC.

Dothistroma needle blight damage was not obvious enough to be observed during the overview flight in the SIFR, though it is known to be present, particularly in the Headwaters Forest District. In low lying areas of this district, infections have resulted in defoliation of the lower crown of planted western white pine. Although this is probably detrimental to tree growth, it may be beneficial to tree survival by preventing new white pine blister rust infections in a manner similar to pruning treatments.

Pine needle cast, *Lophodermella concolor*

Observable pine needle cast damage recorded during the overview survey was down 59% from last year to 7,022 ha affected in 2009. Levels of disturbances were noted as 6,875 ha (98%) light, 62 ha (1%) moderate and 85 ha (1%) severe. This is distinctly lower severity than 2008 when 77% was rated as moderate and 5% as severe.

Almost all (6,680 ha) of the pine needle cast damage was observed in the NIFR, of which 4,692 ha were mapped in the Skeena Stikine Forest District. These infection centers were located along the Dease River and also west of Babine Lake. The rest of the NIFR damage occurred in the Nadina Forest District. Defoliation was present in various small sites scattered around the district, but the largest concentration occurred between Morrison and Natowite Lakes.

The only damage in the CFR was delineated in the north tip of the North Island – Central Coast Forest District near Nahlousa Lake, where 323 ha were lightly affected. Minor light occurrences were mapped in the SIFR in the Arrow Boundary and Rocky Mountain Forest Districts with 4 ha and 15 ha damaged, respectively.

Although pine needle cast was identified as the primary damaging agent other needle diseases such as *Leptomelanconium pinicola* and *Phaeoseptoria contortae* were also present, particularly in the Nadina Forest District.

Pine engraver bark beetle, *Ips pini*

Pine engraver bark beetle populations have historically increased in the later stages of mountain pine beetle outbreaks to the point where they have caused notable mortality. To date, this has not been documented to a large extent. It is suspected (but not ground confirmed) that some of the understory and young pine under attack in areas where mountain pine beetle has been active for a while is associated with secondary bark beetles.

In 2009, 453 ha of attack were recorded in BC, but the majority was not in conjunction with mountain pine beetle attack. In the Cassiar TSA of the Skeena Stikine Forest District, 410 ha of trace intensity mortality (including a few small spot infestations) were noted. These areas were small and scattered and were not ground checked due to access issues. Pine engraver bark beetle was chosen as the damaging agent since affected trees appeared to be weakened by flood damage or they were growing on very rocky sites, hence they were more susceptible to attack by this secondary bark beetle (i.e., they attack weakened and very rarely healthy trees). In Vanderhoof Forest District, 10 ha of severe attack were identified in two small polygons. A few small areas totalling 33 ha of light attack were also recorded in the Rocky Mountain Forest District. In these cases, ground observations aided in identifying the damage agent. This was also true for 12 ha of light twig beetle (*Pityogenes* spp.) mortality (another secondary bark beetle) identified in the Arrow Boundary Forest District.

Anecdotal observations in beetle killed ponderosa pine stands around Merritt indicated that pine engraver bark beetles were playing an active role in killing trees weakened partially by mountain pine beetle and/or western pine beetle attacks. Most of the pine engraver bark beetle attack in these cases occurred on branches as opposed to the main stem. In some cases, they were sole cause of mortality.

Damaging Agents of Douglas-fir

Western spruce budworm, *Choristoneura occidentalis*

Recorded Defoliation

Damage caused by the western spruce budworm was down slightly (2%) from 2008 to 766,125 ha affected (Figure 9). Infestation severity however increased substantially to 619,351 ha (81%) light, 140,318 ha (18%) moderate and 6,457 ha (1%) severe.

The present outbreak is predominantly within the SIFR with 759,591 ha (99%) of the damage recorded in 2009. After slight decreases for two years, defoliation in the Central Cariboo Forest District rebounded to 250,037 ha affected (Figure 10). Levels of intensity, primarily along the Fraser River and around Williams Lake, also increased with moderate defoliation more than double and severe more than quadruple that of last year at 20,027 ha and 2,030 ha respectively. The majority (231,602 ha) continued to be classified as light damage however and occurred throughout the range of Douglas-fir stands in the district.

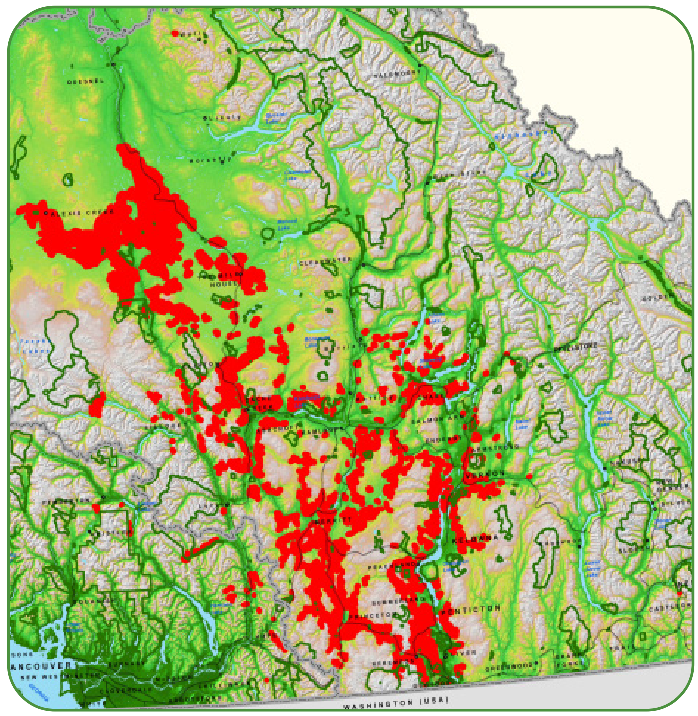


Figure 9. Areas defoliated by western spruce budworm in BC in 2009.

Infestations in the Cascades Forest District also increased to 154,751 ha of damage after a two year drop. A corresponding increase in severity was observed with 38% of the defoliation rated as moderate to severe compared to only 2% last year. Most of the heaviest defoliation occurred from Brookmere south to the Tulameen area in the Merritt TSA. Defoliation in the Lillooet TSA was mainly light and concentrated around the Fraser River, Fountain Lake and Gun Lake areas.

Defoliation in the Okanagan Shuswap Forest District continued a steady upward trend to 121,383 ha of damage recorded. Damage at the moderate intensity level also increased from 3% last year to 16% in 2009. The main area of mapped expansion was on the east side of Okanagan Lake from Coldstream east of Vernon down to the Hwy 33 corridor towards Big White and around Penticton. Populations also continued to increase along the Coquihalla Highway Connector and areas around Falkland. Areas with the highest levels of damage occurred west of Okanagan Falls.

The largest decrease in damage after four years of growth occurred in the 100 Mile House Forest District with a drop to 99,891 ha affected. Observed intensity levels remained the same as last year, with 93% light and the remaining 7% moderate. Pockets of moderate defoliation occurred adjacent to light defoliation in Loon Lake through to Clinton areas. Most of the remaining light defoliation was mapped from Lac La Hache to Horse Lake and north of Meadow Lake.

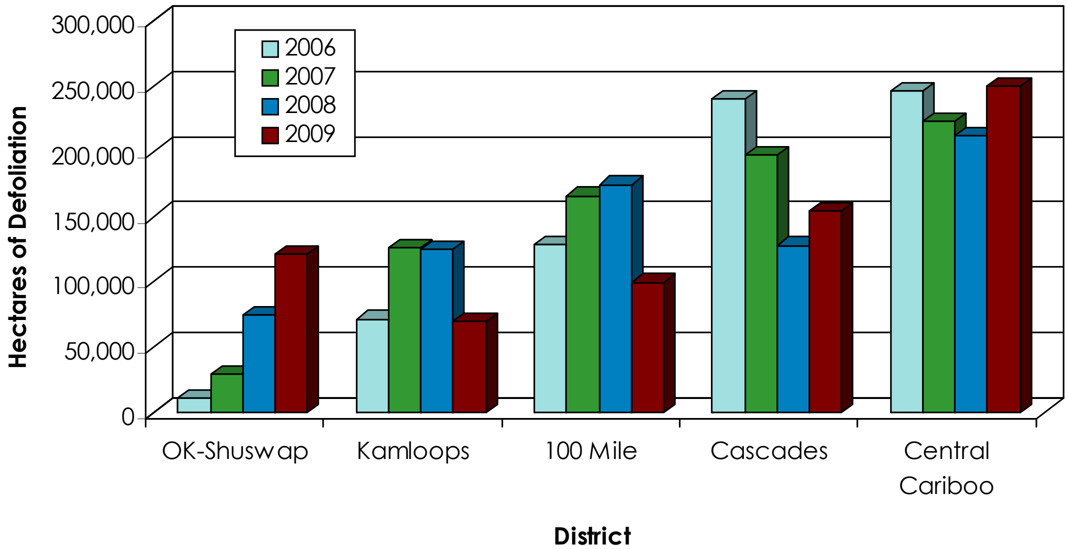


Figure 10. Hectares of western spruce budworm defoliation from 2006 – 2009, for districts with over 70,000 ha damaged in 2009.

Defoliation recorded in the Kamloops Forest District was also down substantially from 124,616 ha last year to 70,091 ha in 2009. Over 75,000 ha have been sprayed with *Btk* since 2007 and this has contributed to an obvious decline in damage. Damage severity increased from mostly (99%) light in 2008 to 11% moderate and 1% severe on untreated areas in 2009. Small scattered infestations occurred throughout the district, with main areas of damage around Scuitto Lake, Stump Lake and North of Kamloops Lake to Cache Creek.

Infestations in the Chilcotin Forest District rebounded by a third since last year to 2007 levels with 60,750 ha affected. Severity of damage also grew with moderate defoliation increasing fourfold to 20,027 ha and severe damage almost doubling to 2,030 ha. Damage continued to be mapped in the same general areas from the district's eastern boundary along the Chilko River to just past Alexis Creek.

Damage caused by three years of severe western spruce budworm defoliation in the Chilcotin Forest District

After a large expansion of 9,434 ha for the first time into the Quesnel Forest District last year, infestations shrank back to only 2,558 ha along the Fraser River near the district's southern boundary. Levels of damage continued to be recorded as light. Small light infestations near Adams Lake at the south tip of the Headwaters Forest District totalled 99 ha. In the Kootenay Lake Forest District, 36 ha of moderate defoliation occurred in a grand fir stand just south of Nelson.

The remaining 6,534 ha of western spruce budworm defoliation occurred in the CFR. This is down from a peak of 43,040 ha recorded in 2007. Intensity of damage was also lower with 5,782 ha (88%) light and 752 ha (12%) moderate. Most of the defoliation (5,927 ha) was mapped in the Chilliwack Forest District. The majority of the infestations were recorded around Spuzzum and Sawaqua Creek and north of Nahatlatch River. Squamish Forest District had the remaining 607 ha of light damage south of Pemberton and around Lillooet Lake.

Treatment Program

High value stands were treated with the biological control agent *Bacillus thuringiensis* var. *kurstaki* (Btk) to reduce western spruce budworm populations. Foray 48B® was applied aerially in a single application at a rate of 2.4 litres/ha. Treatment of 72,990 ha occurred from June 13th to June 28th on five SIFR districts and one CFR district. Block sizes ranged from 173 ha to 7,388 ha. This was the largest *Btk* treatment program to date in BC.

Aerial application was conducted in the southern portion of the SIFR and the CFR with two Lama 315B and two Hiller UH12ET helicopters. Treatment totalled 34,134 ha in the Kamloops Forest District, 993 ha in the Okanagan Shuswap Forest District and 1,474 ha in the Chilliwack Forest District.

For the northern portion of the SIFR program, treatment was conducted with two fixed wing AT 802 Air Tractors. Application occurred on 14,703 ha in Central Cariboo Forest District, 12,628 ha in Chilcotin Forest District and 7,106 ha in the 100 Mile House Forest District.

Btk treatment with an AT 802 Air Tractor

For treatment to be successful, bud flush and larval growth must be carefully monitored to determine the optimal application timing. Much of the development is weather dependent and 2009 was particularly problematic due to a cold, late spring followed immediately by very hot weather in many proposed spray areas. This resulted in retarded development followed by rapid change and a resulting short treatment window. However, pre- and post-treatment egg mass sampling conducted in several of the treated areas indicated that significant population reductions were achieved.

Egg Mass Results

Egg mass surveys were conducted at 733 sites in seven forest districts in the fall of 2009 (Table 7). The results predict potential defoliation for the spring of the following year based upon the density of egg masses found on a given surface area of foliage ($10m^2$). This prediction assists with prioritizing areas for possible treatments. Stands with predicted moderate to severe defoliation are considered for treatment, depending on various criteria such as previous silvicultural investments, stand recovery capability, values at risk and previous defoliation.

Table 7. Summary of western spruce budworm defoliation predictions for 2010 based on 2009 egg mass survey results.

Forest District	Number of Sites by Defoliation Category				Total Sites
	Nil	Light	Moderate	Severe	
100 Mile House	11	83	3	0	97
Cascades	23	115	13	0	151
Central Cariboo	7	62	3	2	74
Chilcotin	10	10	1	0	21
Chilliwack	1	10	1	0	12
Kamloops	16	85	8	0	109
Okanagan Shuswap	11	161	93	4	269
Total	79	526	122	6	733

A similar number of sites were surveyed as last year, though some locations were moved depending on the risk of defoliation for a given area. Sites with severe defoliation predicted for 2010 remained low, with only 6 sites identified compared to 28 as a result of the 2007 egg mass surveys. Of these, four were located in the Okanagan Shuswap Forest District, which also had three quarters of the sites where moderate defoliation was predicted. Areas of interest include Pinaus Lake, Ingram Lake, Monte Lake, Peachland and Summerland. Central Cariboo Forest District contained the other two sites with severe damage predicted, but only had three sites with moderate defoliation expected. Areas of concern are around Williams Lake in the Buckskin, Yorston, Drummond and Mayfield Lakes areas.

Cascades Forest District reported the next most significant level of defoliation anticipated with 13 moderate sites. Areas of interest include Nicola Lake, Comstock, Sunshine Valley and Fountain Valley. Kamloops Forest District had 8 sites with moderate damage predicted around Cache Creek, Deadman Creek, Red Lake and adjacent to Okanagan Shuswap Forest District sites at Monte Lake. 100 Mile House Forest District recorded 3 sites with moderate defoliation predicted in areas around Alkali Lake and Wohlleben near Clinton. Although one site with moderate levels of defoliation was predicted in both Chilcotin and Chilliwack Forest Districts, populations in general are low in these districts and are not expected to seriously impact stand productivity.

Western spruce budworm larva

Overall, the number of sites with light defoliation predicted has remained similar to last year but the number of moderate sites has decreased substantially while sites with nil defoliation predicted have correspondingly risen. However, high value stands are still at risk of significant defoliation in some areas so an aerial treatment program is planned for the spring of 2010.

Douglas-fir beetle, *Dendroctonus pseudotsugae*

Douglas-fir beetle infestations rose in BC for the seventh consecutive year to 100,726 ha affected, up slightly (4%) from last year (Figure 11). Severity levels were similar to 2008 with 58,962 ha (59%) trace, 34,632 ha (34%) light, 5,649 ha (6%) moderate, 1,469 ha (1%) severe and 15 ha (<1%) very severe. This reflects the typical nature of Douglas-fir beetle mortality that tends to occur in small scattered patches, which are either recorded as small spots of severe attack or polygons containing low severity attack. Wildfire, drought and western spruce budworm damage are suspected to be exacerbating the Douglas-fir beetle problem in some areas.

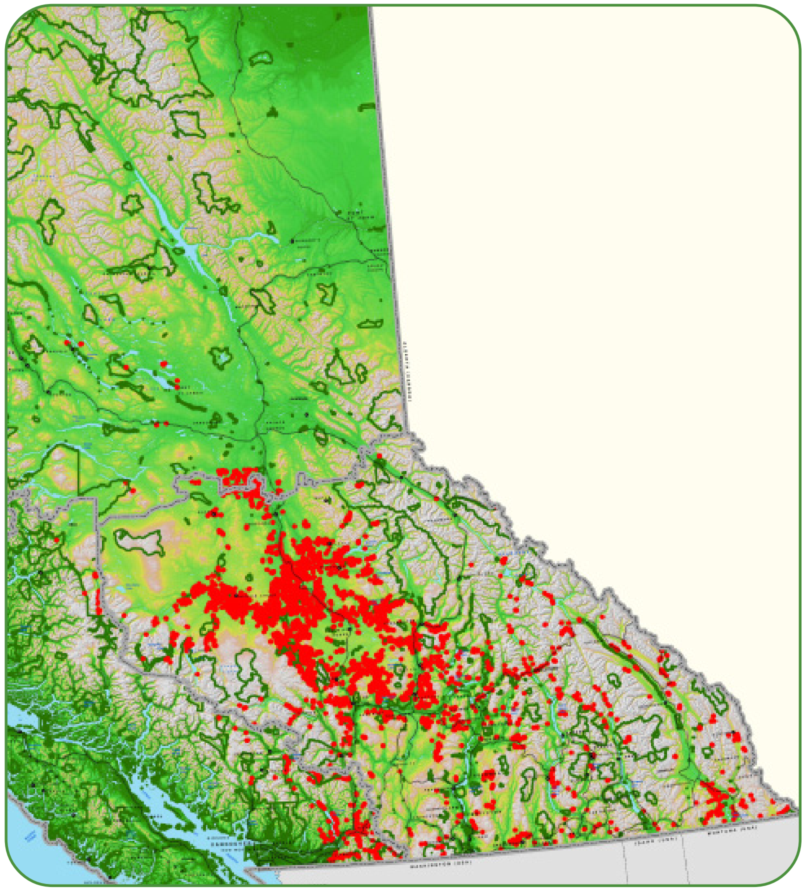


Figure 11. Douglas-fir beetle mortality recorded in BC in 2009.

The majority of the stands affected by Douglas-fir beetle (93%) continued to be detected in four districts in the Cariboo area of the SIFR (Figure 12). Infestations in the Central Cariboo Forest District continued to cover the largest area, with 51,248 ha affected. However, intensity of attack was lowest of all the districts with 75% recorded as trace. Mortality was scattered throughout the Douglas-fir types in the district, but the areas most affected were along the Fraser River, around Riske Creek and along Meldrum Creek. Attack recorded in 100 Mile House Forest District continued to steadily increase for the fourth year with 22,684 ha observed in 2009, though intensity levels were also low (71%) in this district. The largest infestations were located around Big Bar

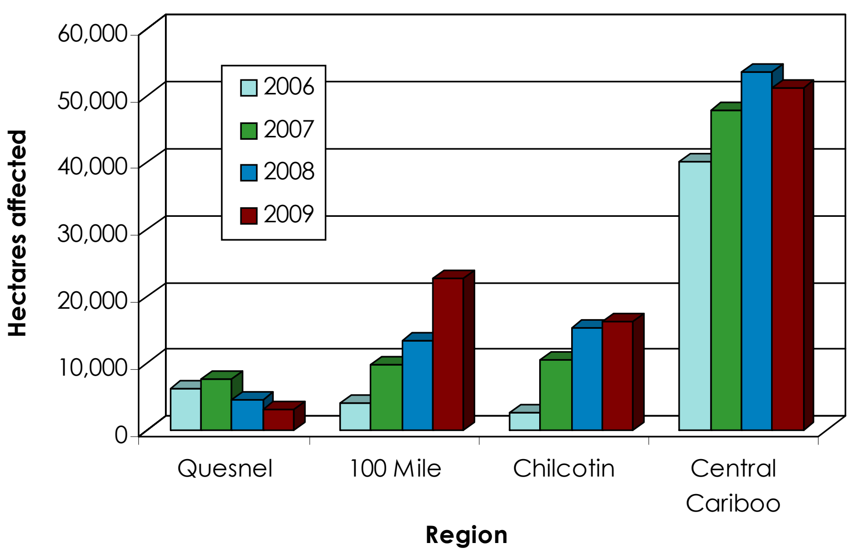


Figure 12. Hectares of Douglas-fir beetle damage from 2006 – 2009, for districts with over 3,000 ha damaged in 2009.

Mountain, but other areas of concern were around Bonaparte River, Bradley Creek, Lac La Hache, Lac Des Roche and Loon, Young and Canim Lakes. Infestations mapped in the Chilcotin Forest District have levelled off at 16,212 ha affected. Most of the damage continued to be along the Chilko and Chilcotin River drainages with some infestations along the Taseko River. Mortality in the Quesnel Forest District declined for the second year, with 3,139 ha of attack recorded. The majority of the infestations occurred along the boundary of the Prince George Forest District along the Blackwater and Fraser Rivers.

Overwintering brood mortality assessments were conducted for the affected Cariboo Forest Districts again this year. An r-value was produced from the results (Table 8), which indicated if the population was decreasing (<0.7), static (0.7 to 1.3) or increasing (>1.3). For the Central Cariboo and Chilcotin Forest Districts, both winter mortality and r-values indicated healthy beetle populations with expected increasing infestations. However, finding current attack in the Central Cariboo was a difficult task which suggested that the overall population was dropping and that only where active infestations centres were located was there indications of a viable population. In the 100 Mile House Forest District the r-value dropped to a level that indicates a static population. Sites were also sampled in Quesnel Forest District this year and the r-value is even lower at 0.7. Therefore, only the Chilcotin Forest District is projected as continuing to have a vigorous increasing population.

Table 8. Douglas-fir beetle overwinter mortality results for the three most affected Cariboo districts 2006 to 2009.

Forest District		**r Value**		
	2006	**2007**	**2008**	**2009**
100 Mile House	3.3	2.5	2.1	1.0
Central Cariboo	4.6	3.4	3.9	3.8
Chilcotin	4.5	2.3	3.1	3.4

For the rest of the SIFR, both the largest increase and the highest level of infestations occurred in the Kamloops Forest District, with 1,649 ha affected. Small pockets of mortality were observed throughout the district. A trap tree program in concert with an aggressive small scale salvage program is underway to address the problem. Conversely, infestations dropped substantially in the Rocky Mountain, Arrow Boundary and Columbia Forest Districts to 466 ha, 393 ha and 178 ha, respectively. Observed Douglas-fir beetle mortality remained relatively constant and at low levels (<550 ha) in each of the Cascades, Okanagan Shuswap, Headwaters and Kootenay Lake Forest Districts. Most of these infestations occurred in spots (1 – 50 trees per site) scattered throughout the districts, though the majority of the Headwaters Forest District attack was at the southern tip. Ground observations confirmed static populations with the exception of the Kootenay Lake Forest District, where a large expansion was noted (both on the ground and through detailed rotary wing flights) between Kalso and Coffee Creek.

Mortality caused by Douglas-fir beetle

In the NIFR observed attack increased by more than half over last year to 1,802 ha, but this was in part due to better visibility of attack without the masking effect of fresh mountain pine beetle mortality. Traditionally, Lindgren funnel traps have been used primarily to monitor beetle populations but with the relatively low levels of infestations occurring in the NIFR, a control program was successfully initiated in 2008 using three funnel trap clusters per site. Results were promising and trap sites were expanded this year to 32 in Fort St. James Forest District, 29 in Prince George Forest District and five in Vanderhoof Forest District. Traps were serviced regularly but a few areas had chronic problems with bear vandalism. A scare technique was successfully tested to address the problem this year (Project 4).

Servicing Lindgren funnel traps

Most of the mortality in the NIFR continued to occur in the Prince George Forest District, where 1,725 ha were infested. The majority of the attack was situated along the Blackwater River on the Quesnel Forest District border and around Punchaw and Barton Lakes. Smaller infestations were scattered throughout the southern portion of the district. Detailed aerial surveys conducted using helicopters were done to more accurately map infestations and reported 102 new sites. Ground surveys have reported increasing populations with an average 2:1 G:R attack ratio. In addition to the funnel trap program, interest by the small scale salvage program is increasing and is expected to address a large portion of the attack. A few small areas of attack resulted in 75 ha of infested trees in Vanderhoof Forest District. A storm in November 2008 in the southwest corner of Vanderhoof caused Douglas-fir blowdown on single-tree retention blocks. These trees were infested in 2009 and will be harvested soon to prevent an increased Douglas-fir beetle population in the area. Six scattered spot infestations (total 1.5 ha) were also mapped in Fort St. James Forest District.

The CFR reported 1,518 ha of primarily light intensity Douglas-fir beetle mortality. Most of this damage was from a substantial increase since last year in the Chilliwack Forest District where 1,249 ha were affected. The majority were scattered spot infestations, but the heaviest attack was around Nahatlatch Lake and Mehatl Creek in the north end of the district. Ground observations indicated a growing population in the Chilliwack River valley area as well. Attack in the North Island – Central Coast Forest District was down to only 193 ha, primarily along the eastern edge of the district north and south of Lonesome Lake. These infestations were the result of populations building in wildfire damaged Douglas-fir. The remaining 76 ha of attack were scattered around the Squamish Forest District. No Douglas-fir beetle mortality was observed during the overview survey in the Sunshine Coast Forest District, though the beetle is active in the Roberts Creek area.

Douglas-fir tussock moth, *Orgyia pseudotsugata*

A Douglas-fir tussock moth outbreak is presently underway in the SIFR. In 2009 a total of 17,512 ha of damage were mapped, up from only 2,249 ha last year. Intensity levels were higher in 2009 as well, with 3,839 ha (22%) light, 6,333 ha (36%) moderate and 7,340 ha (42%) severe.

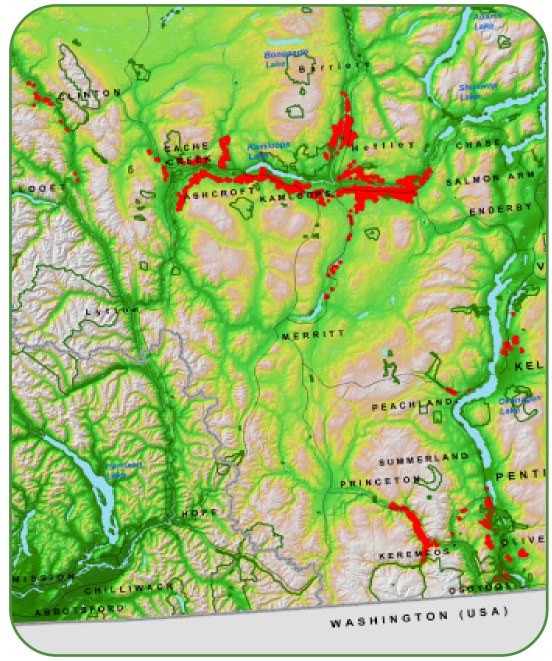


Figure 13. Douglas-fir tussock moth defoliation mapped in 2009.

The majority of the defoliation continued to occur in the Kamloops Forest District, where 13,546 ha were delineated (Figure 13). Infestation spread was considerable over last year, running east along the South Thompson River to Niskonlith Lake, west along the Thompson River and several side drainages almost to Spatsum, south along Hwy 5a to Stump Lake, and north along the North Thompson River to McLure. Ground observations of individual trees noted defoliation as far north as Barriere. Damage in the Okanagan Shuswap Forest District expanded to 2,990 ha in the areas of Trepanier Creek, Kelowna, Okanagan Falls south to Osoyoos and along the Similkameen River, which continued into the Cascades Forest District. Total defoliation in the Cascades Forest District was 976 ha occurring in stands north of Nicola Lake and the west side of the Fraser River near Fountain Valley, Watson Bar Creek and Big Bar Creek. No defoliation was mapped during the overview surveys in the Arrow Boundary Forest District, but ground observations noted small outbreaks around Rock Creek, Cascades, east of Midway and along Highway 3.

Douglas-fir tussock moth is monitored annually with pheromone traps at specific sites in Cascades, Kamloops, Okanagan Shuswap and 100 Mile House Forest Districts. As outbreaks develop quickly, this system provides an early warning of rising populations so treatments can be initiated before significant defoliation occurs (Table 9). The general overall rise in trap catches from 2006 through 2008 mirrored the developing outbreak quite well. In 2009 average trap catches decreased as populations peaked and/or were controlled in many areas, with the exception of 100 Mile House Forest District where a modest increase occurred. Since outbreaks tend to be quite localized, averages per district do not give an accurate picture: many individual sites continue to have outbreak level trap catches.

Table 9. Average number of Douglas-fir tussock male moths caught per trap, 2002 – 2009.

Year	District			
	Kamloops (90 traps)	Okanagan Shuswap (135 traps)	Cascades (57 traps)	100 Mile House (144 traps)
2002	11.5	6.5	8.2	1.2
2003	31.5	9.5	6.8	2.3
2004	13.6	7.2	2.8	1.3
2005	8.5	8.5	3.8	0.6
2006	12.7	2.2	1.4	0.5
2007	23.6	1.2[a]	5.0	0.6
2008	46.7	25.0[a]	11.8	2.2
2009	11.4	9.2[a]	10.5	3.9[b]

[a] 26 traps in 2007, 96 traps in 2008
[b] 180 traps in 2009

It should be noted that once an outbreak is underway in a given area the trap numbers are less meaningful. During incipient and outbreak stages of an outbreak, egg mass surveys in the fall are more reliable to predict populations and damage in the coming year. Since outbreaks build and collapse so rapidly it is also important to monitor natural levels of virus in local populations.

Based on 2008 trap catches and egg mass surveys, the MFR conducted aerial treatment with nucleopolyhedrosis virus (NPV) in late May to early June with two Hiller UH12ET helicopters from Western Aerial Applications Ltd. A total of 4,341 ha were treated, with some areas receiving alternate swath or reduced dosages (see SIFR Overview Report 2009 for details). Most of the treatments were in the Kamloops Forest District in outlying areas near the City of Kamloops. A small block was also treated at Stemwinder in the Cascades Forest District.

Although NPV is very effective at collapsing tussock moth populations, it is relatively slow acting and does not provide good foliage protection once the outbreak is underway and larval density is high. Hence, the City of Kamloops and private business pursued a label expansion to use Foray 48B® on Douglas-fir tussock moth infestations. The use was approved in time for spring treatments, and a total of 1,035 ha of city and private land were treated around the City of Kamloops and Heffley Creek in conjunction with the MFR program. Two aerial applications at a rate of 4 litres/ha were applied.

Another possible tool to protect trees from Douglas-fir tussock moth damage is Mimic* 240 LV (not currently registered for tussock moth in BC). This is an insecticide that "mimics" a juvenile hormone that induces premature moulting, resulting in larval mortality. This product was used on a trial basis by private companies on 10 ha of private land near Heffley with promising results.

Egg mass surveys were conducted again in the fall of 2009. Indications are that treatments around Kamloops were successful and that 2010 defoliation will be minimal in treated areas. The outbreak is now farther to the west and southeast of Kamloops, particularly in the Savona to Ashcroft area and south into the Spences Bridge area in the Cascades Forest District. Populations in the Okanagan Shuswap Forest District are variable and it is suspected that naturally occurring virus and parasitism are increasing and starting to impact the population in some sites. This includes areas around Kelowna and Osoyoos. The Trepanier and Postill Lake areas however still have robust populations.

Douglas-fir tussock moth larvae

Treatments for the spring of 2010 will involve a combination of NPV and Foray 48B®, depending on population density, stage of the outbreak, land status and location. Treatment priorities for the MFR are high value crown forest lands, while cities and regional districts will be encouraged to be involved in treatment of urban areas. Treatment in urban areas is important not only to save trees but to reduce health risks. Tussockosis is a toxic and allergic reaction which can affect the skin (welt-like rashes) and the respiratory system of humans. This condition can occur from contact with the larval hairs, cocoons or egg masses of the Douglas-fir tussock moth. People can be seriously affected, even those with no previous record of allergies or similar problems (approximately 1 in 5 people). Livestock, including horses can also be severely affected.

Laminated root disease, *Phellinus weirii*

A total of 192 ha of small infection centers of laminated root disease were identified in the CFR this year, down from 626 ha last year. Intensity of damage was 62% light, 33% moderate and 9% severe. Most of the damage was observed in the Squamish Forest District with 187 ha affected in the northeast corner of the district, mainly around the D'arcy/ Lillooet Lake area. The remaining 5 ha was noted in the Chilliwack Forest District near Agassiz. Normally, laminated root disease is very difficult to distinguish from older Douglas-fir beetle damage from the air. The surveyors were only able to identify these root disease centers because of their local knowledge.

Uprooted Douglas-fir with advanced laminated root disease decay

Damaging Agents of Spruce

Spruce beetle, *Dendroctonus rufipennis*

Hectares affected by spruce beetle rose a quarter over last year to 30,791 ha provincially after five years of decreasing from the peak of 315,953 ha in 2003. Attack intensity also increased to 7,393 ha (24%) trace, 7,751 ha (25%) light, 11,438 ha (37%) moderate 4,148 ha (14%) severe and 62 ha (<1%) very severe.

Only 25 ha (<1%) of the total spruce beetle attack mapped during the aerial surveys was in the commercial forest: the remaining infestations were located in provincial parks. Some specific spruce beetle infestations have been noted outside of parks that weren't observed aerially. This is expected, as capturing current spruce beetle attack from the air is very difficult due to the subtle, quick colour change infested trees experience before going completely grey.

Most of the mortality continued to occur in the SIFR, with 25,517 ha infested. The Central Cariboo Forest District continued to sustain the highest levels of attack, with 9,574 ha affected. Infestations were concentrated in the eastern portion of the district, particularly from Quesnel Lake south to Crooked Lake. 100 Mile House Forest District sustained 2,984 ha of spruce beetle damage concentrated just south of the Central Cariboo Forest District infestations, from Hendrix Lake to Deception Creek.

Spruce beetle attack increased to 2007 levels in the Okanagan Shuswap Forest District, with 5,218 ha delineated. Most of these infestations continued to be in Cathedral Provincial Park and the Snowy protected area. Current attack in the commercial forest around Apex and Nickel Plate Lake are being addressed through harvesting. Infestations have spread into the Similkameen River area of the Cascades Forest District, where plans are underway to harvest 2 million m^3 of infested wood this winter. In total, 2,961 ha were mapped as affected in the Cascades Forest District including small scattered infestations throughout the Lillooet TSA.

Infestations mapped in the Kamloops Forest District increased substantially this year to 3,048 ha. Two main infestations were identified: the Sun Peaks area continued to sustain mortality and a large area of attack was delineated around Silwhoiakun Mountain. Disturbances in the Headwaters Forest District remained similar to last year with 1,445 ha affected, primarily in the Serpentine and Dawson Creek areas. All other SIFR districts had infestations of less than 150 ha.

Spruce beetle damage in the NIFR continued on a downward trend, with 5,218 ha affected compared to 7,023 ha last year. The majority (3,428 ha) of attack occurred in the Skeena Stikine Forest District in small scattered pockets. The two largest areas were noted west of Glenora near Telegraph Creek and north of Buckley Lake. The Peace Forest District had 1,158 ha mapped in scattered groups between the Sikanni Chief and Beatton Rivers. In Fort Nelson Forest District, 413 ha of mortality were denoted around Beaver and Borrett Creeks. The remaining NIFR districts combined contained infestations totalling less than 100 ha.

Spruce beetle infestation in the Skeena Stikine Forest District

Spruce beetle populations continued to be low in the CFR, with only 56 ha of attack contained in the Squamish, Chilliwack and North Island – Central Coast Forest Districts.

Eastern spruce budworm, *Choristoneura fumiferana*

An eastern spruce budworm outbreak in the Fort Nelson Forest District peaked in 2001 at 1.6 million hectares of defoliation. Size and severity of infestations then decreased to the point where no defoliation was noted in 2006, followed by 1,137 ha of primarily light damage in 2007, and nothing was observed in 2008. This year, 99 ha of light defoliation mainly on spruce in the Coal Creek area at the north end of the Peace Forest District were observed.

Damaging Agents of True Fir

Western balsam bark beetle, *Dryocoetes confusus*

Western balsam bark beetle mortality more than tripled from last year to 1,727,719 ha across the province. Intensity levels remained similar with 1,625,368 ha of trace (94%), 98,011 ha light (6%), 3,721 ha moderate (<1%) and 618 ha severe (<1%).

The same stands tend to be attacked year after year with chronic, low levels of mortality. This is reflected in the high amount of trace intensity recorded. Unfortunately, this can result in large changes in hectares affected depending on whether the disturbances are mapped as small scattered spots or large trace polygons. The large increase this year over last is also in part a factor of the majority of the northern mountain pine beetle infestations (where most of the western balsam bark beetle is located) turning grey and hence no longer masking the red subalpine fir trees. Additionally, more of the Peace, Prince George, Skeena Stikine and Mackenzie Forest Districts (where the largest increases occurred) were surveyed in 2009 *vs*. 2008 (Figure 14).

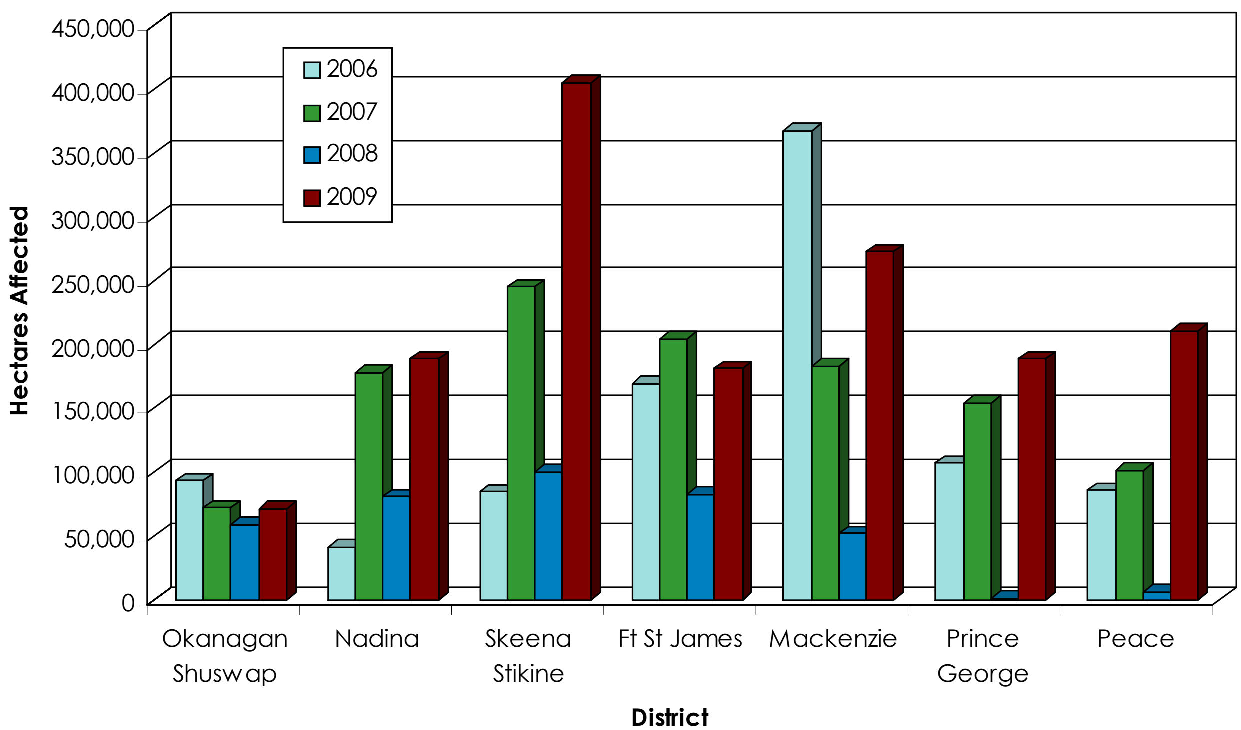


Figure 14. Hectares affected (all severity classes) by western balsam bark beetle in BC from 2006 – 2009, for districts with over 70,000 ha of damage in 2009.

Most of the attack (1,485,092 ha) continued to occur in the NIFR. As in the past two years, the Skeena Stikine Forest District was most affected with 404,836 ha infested. Large polygons were delineated throughout the range of balsam in the Kispiox and Bulkley TSA's plus scattered areas near the Yukon border in the Cassiar TSA. A total of 272,347 ha were infested in the Mackenzie Forest District. The northern third of this district was not flown, so total attack is most likely higher than noted. Infestations in the Peace rose dramatically from only 6,125 ha last year to 210,432 ha in 2009. The majority of this attack was concentrated along the western border with Mackenzie and Prince George Forest Districts. Recorded mortality rose to similar levels in the Prince George, Nadina and Fort St. James Forest Districts, with 188,754 ha, 188,420 ha and 181,105 ha noted, respectively. Infestations also rose in the remaining three NIFR districts but to a lesser extent: 18,675 ha in the Kalum Forest District, 17,825 ha in the Vanderhoof Forest District and 2,698 ha in the Fort Nelson Forest District.

Subalpine fir killed by western balsam bark beetle

Although western balsam bark beetle infestations in the SIFR increased by almost a quarter over last year to 234,683 ha, the increases did not occur consistently across the region. The Okanagan Shuswap Forest District continued to be the most affected and had a modest increase to 71,462 ha affected. The largest increase occurred in the Headwaters Forest District where infestations almost tripled to 60,002 ha of attack. Chilcotin Forest District mortality increased slightly to 22,338 ha while substantial increases occurred in the Kamloops and Quesnel Forest Districts with 17,490 ha and 16,361 ha recorded, respectively. The only other SIFR to experience an increase was the Columbia Forest District, where 6,865 ha of attack were delineated. Western balsam bark beetle mortality in the Cascades Forest District remained relatively static at 8,384 ha. Infestations in the Central Cariboo Forest District dropped by almost half of last year's total to 12,844 ha. Arrow Boundary Forest District experienced a 40% drop to 7,394 ha affected. Attack in all the remaining SIFR districts dropped by almost half to under 5,500 ha of scattered mortality each.

Western balsam bark beetle attack in the CFR dropped to almost a third of 2008 levels with only 7,944 ha affected. This may in part be due to less of the region being surveyed this year. North Island – Central Coast Forest District continued to have the majority of the attack, with 5,233 ha recorded. The remaining infestations were in the Chilliwack and Squamish Forest Districts with 2,485 ha and 226 ha mapped, respectively.

Two-year-cycle budworm, *Choristoneura biennis*

A total of 396,855 ha were defoliated by two-year-cycle budworm across BC in 2009. This is by far the largest area of damage recorded for this insect since the MFR has taken over the aerial detection program: the peak prior to this year was 160,231 ha mapped in 2002. A detailed helicopter flight in the Nadina Forest District this year noted patches of severe defoliation were resulting in up to 20% overstory mortality and/or topkill, and high percentages of understory mortality were occurring in the subalpine fir.

Since this budworm is on the odd year cycle in the NIFR, 392,316 ha (99%) of the damage occurred in this region in 2009 (Figure 15). Defoliation was classified as 35% light, 52% moderate and 13% severe; these high levels of defoliation are uncommon for this insect. Fort St. James Forest District sustained the highest amount of damage, with 262,020 ha affected, primarily mid district. A total of 107,591 ha of defoliation were recorded in the Nadina Forest District at the north tip adjacent to the infested stands in the Fort St. James Forest District, and from Morice Lake to the Sibola Range. The remaining 22,705 ha were mapped in the Skeena Stikine Forest District along the eastern boundary from Babine River to Smithers Landing. Interestingly, no defoliation was observed in the Prince George Forest District where damage is usually noted even in light years.

Two-year-cycle spruce budworm defoliation in the Skeena Stikine Forest District

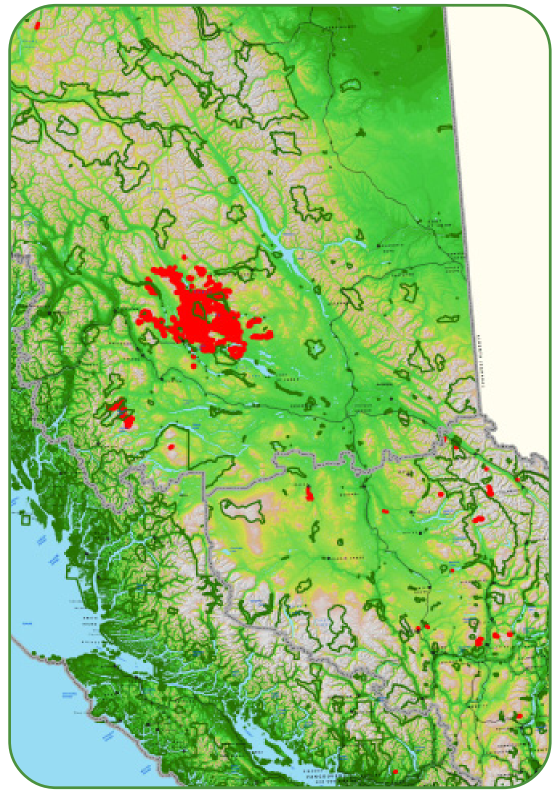


Figure 15. Two-year-cycle budworm defoliation mapped in 2009.

The SIFR experienced only 4,509 ha of two-year-cycle budworm damage this year as it is on the even year cycle. The majority (85%) of this defoliation was light, with the remaining 15% denoted as moderate intensity. Most affected were Headwaters Forest District with 2,161 ha and Kamloops Forest District with 1,659 ha. The Okanagan Shuswap and Central Cariboo Forest Districts had similar amounts of defoliation with 283 ha and 272 ha, respectively. A total of 114 ha were mapped in Quesnel Forest District and the remaining 20 ha in 100 Mile House Forest District. Light defoliation over 30 ha was also recorded in the Chilliwack Forest District of the CFR.

Delphinella needle cast, *Delphinella* spp.

Delphinella needle cast damage is rarely visible from the air, and has not been recorded since the MFR has been conducting the overview surveys. This year however it was seen as a chlorotic tinge to the affected stands. Samples were collected and the damage was confirmed by the regional pathologist to be caused by Delphinella needle cast infections. A total of 3,334 ha in the Kalum Forest District were affected at an intensity of 98% light and 2% moderate. Infected subalpine fir and Amabilis fir stands were located from Sand Lake south past Terrace almost to Kitimat River in a band running north to south.

Annosus root disease, *Heterobasidion annosum*

In the Kalum Forest District, extensive mortality of intermediate age (approx. 60 years old) amabilis fir was noted this year directly adjacent to the BC Hydro power line right of way from the Zymachord River northward through the Kalum valley to Lava Lake. Other tree species were not affected. On further investigation, it was found to be caused by Annosus root disease. In creating the right of way twenty to thirty years ago, woody debris including roots from trees and dirt were pushed to the sides into large berms. One possible explanation for this unusual level of infection is that the Annosus root disease may have thrived in these conditions and recently the adjacent Amabilis fir tree roots grew into the medium. The reason that it became so noticeable this year may have been in part due to the additional stress of a very dry growing season.

Damaging Agents of Hemlock

Western hemlock looper, *Lambdina fiscellaria lugubrosa*

Western hemlock looper infestations grew to 3,990 ha affected from 537 ha in 2008. Intensity of attack also increased, to 2,123 ha (53%) light, 1,844 ha (46%) moderate and 23 ha (1%) severe.

The majority of the mapped defoliation occurred on 3,014 ha around Meziadin Lake in the Kalum Forest District of the NIFR. Interestingly, the primary tree species attacked in this specific case was spruce rather than the more common host western hemlock. Rusty tussock moth (*Orgyia antiqua*) was also contributing to the damage in this area.

A total of 892 ha of damage were observed in the SIFR. In the Okanagan Shuswap Forest District, 642 ha of defoliation occurred east of Shuswap and Mabel Lakes. A further 250 ha of scattered light infestations were mapped along Revelstoke Lake in the Columbia Forest District. The remaining 84 ha were observed in small scattered areas along the eastern edge of the North Island – Central Coast Forest District in the CFR.

Pheromone traps have been used for several years in chronic areas of the SIFR to monitor western hemlock looper populations. Outbreaks are cyclical in nature and after peak moth catches in 2003, low trap numbers indicated an endemic population through 2007. Last year however trap catches increased substantially and this steep upward trend continued in 2009 in all three districts where monitoring was conducted (Table 10). Areas with the highest trap catches (over 700 moths per trap average) were around Serpentine, Mud Lake Road, Murtle Lake Road and Thunder Road in the Headwaters Forest District and Yard Creek Road and Upper Perry River in the Okanagan Shuswap Forest District. Large increases in trap catches also occurred around Scotch Creek, Lower Perry River and Greenbush Lake in the Okanagan Shuswap Forest District. Some areas saw reductions in average catches, but even at those sites numbers remained high relative to 2004 through 2007.

Table 10. Average number of western hemlock looper male moths caught per trap at various MFR sites (6-trap clusters per site), 2004 - 2009.

Forest District	Year					
(# sites)	2004	2005	2006	2007	2008	2009
Headwaters (5)	7.5	9.2	5.0	19.9	552.7	873.1
Okanagan Shuswap (11)	45.3	8.0	3.7	7.7	202.9	548.4
Columbia (11)	4.8	1.2	4.1	2.9	25.0	69.5

It is unclear if these trap catches predict any specific population trend as the trapping program began during the last outbreak so trap calibration is not complete. However, the large increases over the last two years suggest an outbreak is developing.

Western hemlock looper larva

Western blackheaded budworm, *Acleris gloverana*

Defoliation caused by western blackheaded budworm was recorded on 24,656 ha in BC this year, after no damage occurred in 2008. Although western blackheaded budworm can cause damage to several different conifer species, almost all the attack observed this year occurred on western hemlock trees. Intensity of defoliation was recorded as 9,929 ha (40%) light, 6,074 ha (25%) moderate and 8,653 ha (35%) severe.

Western blackheaded budworm defoliation on Haida Gwaii

The largest outbreak is occurring in the Haida Gwaii Forest District, where outbreaks are fairly cyclical, with about 7 to 9 years between approximately 5 years of noticeable defoliation. The last outbreak occurred from 1996 to 2001. Last year, defoliation was observed on the ground but it was not visible for aerial overview mapping. Infestations in 2009 were recorded on the southern islands, in particular on Moresby Island. Historical observations show that defoliation damage starts at the southern end of the islands and moved northward over time. Usually trees are heavily defoliated but recovery is good with very little mortality. Anecdotal observations have noted that spaced stands are more heavily damaged than unspaced stands and that south to southwest aspects are more defoliated than north aspects. A trapping study has shown pheromones are highly effective at attracting these moths.

For the first time since the MFR has conducted the aerial overview surveys, defoliation was also recorded in the NIFR. Most of the damage (9,227 ha) occurred in the Kalum Forest District north of the Zymoetz River, with the remaining 1,492 ha located in the Skeena Stikine Forest District mainly around Kitwancool Lake.

Hemlock sawfly, *Neodiprion tsugae*

Among the varied conifer defoliators found in the NIFR this year, the hemlock sawfly caused a total of 10,646 ha of defoliation. Intensity of damage was rated as 6,522 ha (61%) light, 688 ha (6%) moderate, and 3,455 ha (33%) severe. This defoliation was unusual because of its large area affected and the high severity of damage that occurred after only a single year of defoliation. This is the first hemlock sawfly outbreak to be recorded in the NIFR since 1979.

The majority of the damage occurred in the Kalum Forest District with 9,190 ha affected. Most of the defoliation occurred in one large infestation with varying degrees of intensity east of Terrace on the Zymoetz River. The remainder of the damage (1,456 ha) was mapped in the Skeena Stikine Forest District in a few moderate sized polygons on the Skeena River and around Kitwancool Lake. It is possible that some of the hemlock defoliation rated as unknown defoliation was also hemlock sawfly damage, but it could not be confirmed with ground checks.

Damaging Agents of Larch

Larch needle blight, *Hypodermella laricis*

After a peak of 68,228 ha of damage in 2006, area affected by larch needle blight continued to decline this year to 1,886 ha. Intensity levels were also down substantially, with 1,172 ha (62%) light, 697 ha (37%) moderate and 17 ha (1%) severe.

The majority of the defoliation continued to occur in the SIFR, with Rocky Mountain Forest District stands most affected at 862 ha of damage. Disturbances were small and scattered throughout the southern half of the district, with some infestations concentrated around Skookumchuck Creek. Arrow Boundary Forest District sustained 413 ha of damage, primarily around South Fosthall Creek. All 283 ha noted in the Columbia Forest District were around the Blackwater Creek area. In Okanagan Shuswap Forest District, 265 ha were affected, primarily east of Penticton and Osoyoos. The remaining 17 ha in the SIFR were recorded in the Kootenay Lake Forest District.

In the NIFR, only one polygon of 46 ha was delineated near Kahntah River in the northern portion of the Peace Forest District. The cause of this damage was thought to most likely be larch needle blight, though lack of ground access did not allow for confirmation.

Damaging Agents of Cedar

Yellow-cedar decline

Stands showing yellow-cedar decline totalled 8,009 ha this year, only 17% of the amount delineated in 2008 when 47,130 ha were mapped as affected. This is not a true reduction but rather a factor of less of the CFR being surveyed or surveyed less intensively this year, as well as less of the Kalum Forest District in the NIFR, where this damage has been found previously. Yellow-cedar decline is an ongoing process, where only portions of a tree may die at a time yet new mortality is sometimes difficult to differentiate from old mortality; hence, this may also account for a portion of the drop in hectares affected. Intensity of damage was assessed as 2,463 ha (31%) trace, 3,618 ha (45%) light, 1,149 ha (14%) moderate and 779 ha (10%) severe.

The majority of the decline was noted in the CFR with 7,378 ha recorded. North Coast Forest District sustained the most damage with 4,296 ha affected, primarily on Porcher Island, near Ecstall Lake and around Observatory Inlet. North – Island Central Coast Forest District disturbances were chiefly around South Bentinck Arm south to Owikeno Lake area, and totalled 2,961 ha. Haida Gwaii Forest District contained the remaining 121 ha of damage.

In the NIFR, the Kalum Forest District continued to have the majority of the damage with 544 ha of the 631 ha mapped for the Region, situated near the Dala River. The remaining 87 ha were observed in the Skeena Stikine Forest District.

Damaging Agents of Deciduous Trees

Bruce spanworm, *Operophtera bruceata*

In 2009, the second year of a Bruce spanworm outbreak was underway in the NIFR (Figure 16). A total of 637,347 ha of defoliation were mapped, up from 97,804 ha last year. Severity levels were similar to 2008, with 497,164 ha (78%) light, 134,833 ha (21%) moderate and 5,350 ha (1%) severe.

Most of the damage (634,186 ha) occurred in the Peace Forest District, where all of the disturbances were located last year. The primary infestation continued to grow outward north and south from the Peace River area. Ground observations indicated that the outbreak was even more widespread than mapped, but some foliage recovery before the overview flight was conducted resulted in less area being detected than was defoliated. The remaining 3,161 ha of severe defoliation were located in the Prince George Forest District. This infestation was contained in one large polygon on McLeod Lake.

Ground checks confirmed that the primary defoliating agent was Bruce spanworm, though minor populations of large aspen tortrix and forest tent caterpillar were also present. Bruce spanworm moths emerge in the late fall. The moths were observed in high numbers in the infested stands this fall, so one more year of what is usually a two to three year outbreak is anticipated. To date, no tree mortality has been noted.

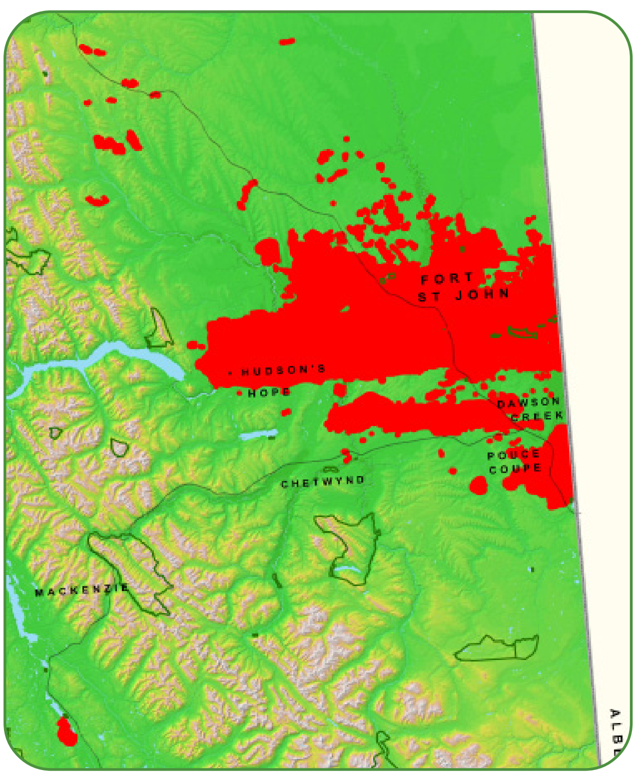


Figure 16. Bruce spanworm defoliation mapped in 2009.

Bruce spanworm damage

Gypsy moth, *Lymantria dispar*

The North American strain of the European gypsy moth has been periodically found in BC but aggressive detection and prompt eradication measures have successfully prevented establishment of moth populations.

Monitoring pheromone traps in 2008 caught sixteen moths in the Harrison Hot Springs area. In response to these catches, an aerial spray project was conducted in 2009 over 329 ha of primarily agricultural land to eradicate the population before becoming established and moving further into forests, farms and orchards. The treatment area encompassed part of Hot Springs Road with the northern most tip about 2.5 km away from Harrison Lake. The village was not sprayed. The organic *Btk* formulation Foray 48B® was applied three times between May 10^{th} to 31^{st}.

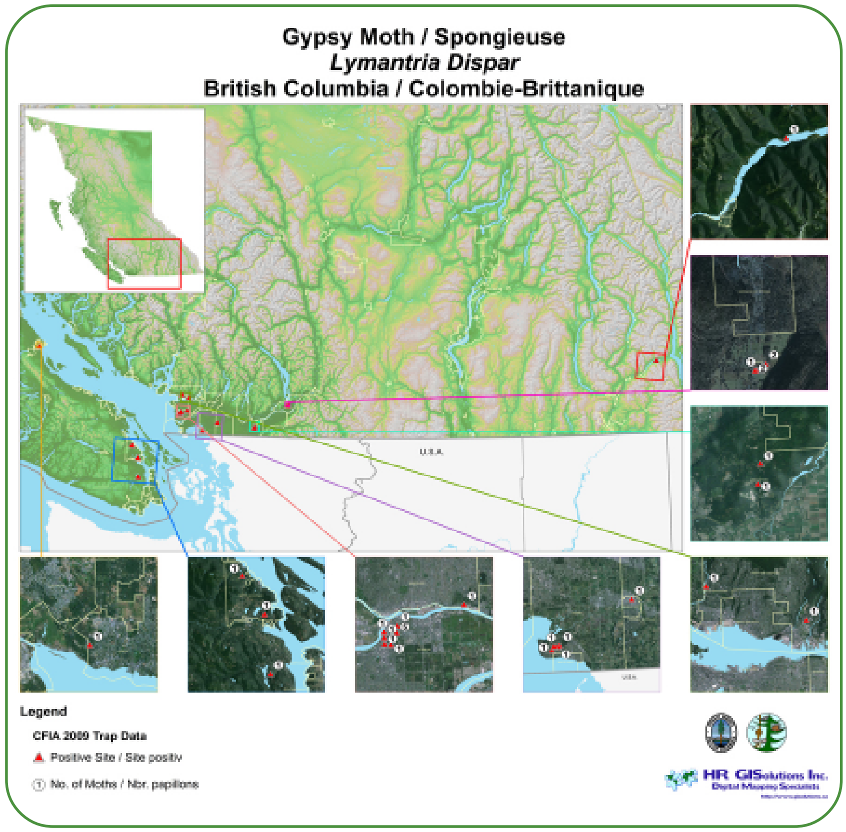


Figure 17. Gypsy moth trap locations with positive catches in 2009.

Monitoring pheromone traps deployed in 2009 resulted in a total of 30 male moth catches in the Lower Mainland and Vancouver Island area (Figure 17). Most positive trap catches were only one or two male moths per location with a few exceptions: Richmond (eleven moths), White Rock (five moths) and Harrison Hot Springs (five moths). The Harrison moths were all caught at the epicentre of last year`s treatment area, namely a hazelnut orchard where over 100 egg masses were discovered in the fall of 2008. Only one moth was found in the southeastern part of the province in Kokanee Creek Provincial Park. For the first time since participation in the gypsy moth monitoring program with the CFIA, traps set by the MFR caught two moths, one near Chemainus and the other in Kokanee Creek. The moth from Chemainus was identified as an Asian gypsy moth, which has alerted CFIA to intensify trapping in the Chemainus area this summer.

As a result of this year's trap catches (and the discovery of egg masses in Richmond), two areas have been identified for treatment in the spring of 2010. Up to four aerial applications are planned for 766 ha in Richmond in an area from the North Arm of the Fraser River to Westminister Highway and Gilbert Road to Shell Road. Also, up to four ground applications will be carried out on 25 ha near Macpherson Rd located just south of Harrison Hot Springs, to eradicate the remnant population after last year's larger treatment of that area. Foray 48B® will be used for both treatment areas. All other sites with positive trap catches in 2009 will be trapped at a higher density in 2010 to determine if these introductions survived and to attempt to locate the epicentre of these infestations.

Further information regarding the gypsy moth program and historical records can be accessed at the MFR's gypsy moth website at http://www.for.gov.bc.ca/hfp/gypsymoth/index.htm.

Forest tent caterpillar, *Malacosoma disstria*

Defoliation by forest tent caterpillar rose for the third consecutive year to 29,821 ha affected provincially. However, intensity of the damage was lower with 20,313 ha (68%) light, 5,088 ha (17%) moderate and 4,421 ha (15%) severe.

Most of the infestations continued to occur in the SIFR, with 28,321 ha detected in the Quesnel Forest District. Defoliation expanded from the Cottonwood River area last year to the west side of the Fraser River in 2009. Small scattered infestations totalled 216 ha of damage in the Arrow Boundary Forest District. Columbia and Kootenay Lake Forest Districts sustained the remainder of the defoliation in the SIFR with 76 ha and 29 ha affected, respectively.

All defoliation by the forest tent caterpillar in the NIFR occurred in the Prince George Forest District, where 1,180 ha were damaged east of the Fraser River at the south tip of the district. Forest tent caterpillar defoliation was not mapped this year around the Dunkley Lumber mill near Hixon, but ground observations and helicopter reconnaissance in August reported discoloured aspen stands. These stands have been attacked by a combination of forest tent caterpillar and satin moth over multiple years, including this spring. After attack this year they re-flushed, but it is suspected that the stress of defoliation combined with the stress of severe drought in the area caused the foliage discolouration.

Foliage discolouration of aspen suspected to be caused by previous defoliation and drought stress

Serpentine leaf miner, *Phyllocristis populiella*

Serpentine leaf miner damage increased six fold in 2009 over last year to 102,609 ha mapped across the province (Figure 18). Intensity of defoliation was evenly divided between all defoliation severity categories: 34,923 ha light, 35,056 ha moderate and 32,631 ha severe. This was a much higher level of damage than last year, when 99% of the disturbances were rated as light.

Damage in the SIFR was marginally higher than in the NIFR, with 51,762 ha affected. The majority of the defoliation continued to occur in Headwaters Forest District, where 20,087 ha of damage were delineated. Most of the disturbances were in the southern portion of the district, particularly along the Clearwater River. Infestations in the Quesnel Forest District totalled 9,750 ha, with the majority recorded in the Swift River area. Okanagan Shuswap Forest District sustained 4,921 ha of defoliation in infestations scattered throughout the northern portion of the district. Most of the damage in the Columbia Forest District (3,517 ha) was located along Revelstoke and Upper Arrow Lakes. Chilcotin Forest District infestations affected 3,482 ha, primarily around Choelquoit, Horn and Klinaklini Lakes. In the Central Cariboo Forest District, 3,313 ha of defoliation were mapped around Quesnel and Horsefly Lakes. A total of 2,893 ha were affected in the northern portion of

Figure 18. Serpentine leafminer defoliation mapped in 2009.

the Kamloops Forest District, particularly west of Chu Chua. Minor infestations were also recorded in the Arrow Boundary, Kootenay, 100 Mile House and Cascades Forest Districts.

In the NIFR, serpentine leaf miner attacked 50,473 ha of aspen. As in the previous year, Skeena Stikine Forest District contained the majority of the damage with 33,646 ha affected. Infestations included scattered defoliation up to the Yukon border in the north, but most of the large disturbances were around the Babine River area in the south, as was the case last year. Damage in the Prince George Forest District rose substantially, with 8,098 ha delineated. Defoliation was primarily located near the Parsnip and Fraser Rivers. Disturbances in the Fort Nelson Forest District rose to 4,556 ha, scattered throughout the eastern portion of the district. Peace Forest District had only a few polygons of defoliation at the northern tip of the district that totalled 1,474 ha. The remaining NIFR districts, each had minor infestations of less than 1,000 ha per district.

The only CFR district to be affected by serpentine leaf miner was the North Island – Central Coast Forest District, where 374 ha were delineated in the north-east corner around Qualcho Lake.

Aspen leaves damaged by serpentine leaf miner

Aspen and poplar leaf and twig blight, *Venturia spp.*

After several years of only minor damage due to aspen and poplar leaf and twig blight infections, damage increased seven fold over last year to 8,584 ha affected in the NIFR. Intensity levels decreased however with 5,837 ha (68%) rated as light, 2,430 ha (28%) moderate and 318 ha (4%) severe.

Disturbances increased in the Fort Nelson Forest District to 8,574 ha affected. Infection centers were scattered throughout the eastern half of the district, particularly along the Liard, Fort Nelson and Petitot Rivers. A small area of damage (10 ha) was also recorded north of Tachick Lake in the Vanderhoof Forest District. No damage was recorded in the Skeena Stikine Forest District, where the majority was mapped last year.

Satin moth, *Leucoma salicis*

After four years of very low satin moth populations, mapped defoliation rose from 127 ha in 2008 to 1,608 ha this year. Severity levels were very similar to last year, with 1,304 ha (81%) denoted as light and 303 ha (19%) moderate. The largest infestation occurred on 1,494 ha between Mt. Mobley and Shuswap Lake in the Okanagan Shuswap Forest District. The remaining 114 ha were concentrated in a few small polygons east of Adams Lake near Pisma Mountain in the Kamloops Forest District.

Satin moth cocoon rolled in a birch leaf

Although no other satin moth disturbances were mapped during the aerial overview survey, evidence of this moth was found in areas of predominantly forest tent caterpillar damage in the Quesnel Forest District. Also, a localized satin moth infestation was identified for the second year in a row in a different residential area of Prince George.

Birch leaf miner, *Fenusa pusilla*

A complex of defoliating insects, in which birch leaf miner was predominant, has been active in the southeast portion of the SIFR for several years with a peak of 22,500 ha affected in 2003. Since then, hectares affected has fluctuated between a high of 4,635 ha (2006) to a low of 14 ha (2007). Defoliation remained virtually the same this year as last, with 735 ha mapped. Three quarters of the damage was recorded as light (547 ha), with the remaining quarter at severe (187 ha) intensity. Most of the damage occurred around Sugar Lake in the Okanagan Shuswap Forest District, where 499 ha were affected. One infestation north of Rossland in the Arrow Boundary Forest District accounted for 187 ha, and the remaining 48 ha were detected in the Kamloops Forest District.

Birch decline

Birch decline near Nelson

The aforementioned birch defoliators in association with pathogens and unsuitable climate conditions create damage that is referred to as birch decline. This is much more difficult to observe during the aerial overview surveys than simply current defoliation, as dead tops (one of the signs) are not as easily seen as damaged leaves. For the first time, a total of 245 ha of birch decline damage was observed in small, scattered patches. Almost all the damage (200 ha) occurred in the Arrow Boundary Forest District, with an additional 40 ha and 5 ha noted in the Columbia and Kootenay Lake Forest Districts, respectively. A little more than half this damage was at the moderate intensity level, with the remainder split between light and severe. Ground observations show evidence of birch decline throughout the southern interior.

Damaging Agents of Multiple Host Species

Abiotic injury and associated forest health factors

Wildfire damage increased almost tenfold over last year due to the hot, dry summer that most of the province experienced. A total of 283,992 ha were burnt at primarily a severe level of intensity. The SIFR had the majority (70%) of the wildfire activity. The Chilcotin Forest District had the most hectares burnt, with 78,012 ha damaged. Of this, the largest fire in the province covered 66,571 ha in the Brittany Triangle area. Cascades Forest District wildfires totalled 40,332 ha with several large fires located chiefly in the Lillooet TSA. Several of these occurred in wildland/urban interface areas where wildfires are capable of spreading to structures. Wildfires where homes were threatened and evacuations were carried out included the large Tyaughton Lake fire (8,052 ha), three fires around Lillooet (Mt. McLean, Seton and Intlepam) and one south of Brookmere. 100 Mile House Forest District had 23,826 ha burnt, most of which (20,943 ha) occurred within the Kelly Creek interface fire. Quesnel Forest District (23,483 ha) had a total area burned similar to 100 Mile Forest District but the fires in the Quesnel Forest Districts were generally smaller and were mainly located in relatively isolated areas west of the city of Quesnel. The Okanagan Shuswap Forest District sustained 14,029 ha of wildfire damage. The largest was the 9,227 ha Terrace Mountain interface fire. Two relatively small but important interface fires occurred early in the season (Glen Rosa and Rose Valley fires) in Westbank. The Pritchard (2,100 ha) and Notch Hill (2,896 ha) fires were also interface wildfires.

The remaining wildfires in the SIFR were comparatively small and scattered, with less than 6,000 ha per district burnt. Many of the SIFR fires involved Douglas-fir trees that were damaged but not totally burnt. These trees are highly susceptible to Douglas-fir beetle and present the opportunity for building populations that can attack healthy trees.

In the NIFR, wildfires damaged a total of 72,349 ha. Fires in the Fort Nelson Forest District covered 36,408 ha, with the largest (23,764 ha) occurring at the junction of the Smith and Liard Rivers. Skeena Stikine and Mackenzie Forest Districts had 15,745 ha and 9,220 ha burnt, respectively. The remaining NIFR districts experienced less than 4,000 ha each of damage. In total 12,950 ha were damaged in the CFR. Wildfires affected 8,424 ha in the North Island – Central Coast Forest District, with less than 5,000 ha burnt in each of the remaining districts.

Drought effects, like wildfire damage, were primarily the result of the unusually hot, dry summer weather. Of the 65,817 ha mapped, intensity levels were noted as 52% severe, 36% moderate and 12% light levels. Most of the disturbances occurred in the Prince George Forest District (52,862 ha) around the Fraser River northwest of Mt. Rider. The next most affected was the Kalum Forest District (9,689 ha), with polygons mapped chiefly between Lakelse Lake and Mt. Davies. Almost all the damage in the CFR occurred in the North Island - Central Coast Forest District with 1,303 ha delineated. Similarly, the majority of the SIFR damage was noted in the Headwaters Forest District (1,303 ha).

Suspected drought damage in 100 Mile House Forest District

The tree species most often affected by drought was western redcedar. In the drier interior cedar-hemlock (ICH) biogeoclimatic subzones, western redcedar was frequently observed to have flagging which is the most common symptom of drought stress. Although drought stressed western redcedar was not mapped in the Kootenay Forest District this year, cumulative decline of this species in their drier ICH areas has been observed over the past several years. This general redcedar decline was also noted during ground surveys in the Okanagan Shuswap and Squamish Forest Districts. Other more drought tolerant species tend to show damage the year after the drought event, not within the same year. However, some young to intermediate age class Douglas-fir in the dry south-western portion of the 100 Mile House Forest District were noted during ground surveys to be experiencing tip dieback this fall.

Notable **hail** damage caused by one storm was widespread across one area between Punchaw Lake and the Fraser River on the border between Prince George and Quesnel Forest Districts. A total of 4,230 ha of multiple tree species, both deciduous and coniferous, were lightly affected. Of this, 3,260 ha were in the Prince George Forest District and 970 ha were in the Quesnel Forest District. Damage pits were caused by the hail on the west side of tree stems and many tops were completely stripped. Lodgepole pine trees, particularly young ones, were most affected. Six small cutblocks within the main area were almost in the moderate range of damage intensity.

Young lodgepole pine with hail damage

Flooding mortality occurred across 3,913 ha province wide, with 94% of the damage located in the NIFR. Of this, 1,285 ha and 1,235 ha were delineated in the Peace and Fort Nelson Forest Districts, respectively. An additional 515 ha were mapped in the Skeena Stikine Forest District and 387 ha in the Kalum Forest District. All other flooding disturbances amounted to less than 100 ha per district. In total, flooding caused double the damage that occurred in 2008. The tree species affected were primarily spruce, followed by some aspen, lodgepole pine, and then a minor amount of other species. All occurrences were small and scattered, mainly along rivers.

Windthrow damage affected 3,425 ha across BC in 2009, down substantially from 5,798 ha recorded last year. Severity of damage was chiefly recorded at severe (68%) and moderate (26%) levels. The general locations of windthrow disturbances moved from the SIFR last year to the NIFR, where 2,499 ha were delineated this year. Of this the most affected was the Peace Forest District with 1,061 ha recorded, primarily in aspen stands located between the Peace and Halfway Rivers. Remaining damage affected small, scattered stands of mainly aspen and spruce throughout the province.

Usually, windthrow as recorded during the overview survey refers to uprooting or breaking of trees by wind, snow or ice. However, in 2009 **windthrow damage due to snow/ice** was specifically defined in the 100 Mile House Forest District, where a heavy snowfall followed by freezing rain caused the damage in December 2008. A total of 917 ha of light intensity damage was recorded for this district primarily in Douglas-fir and aspen. Ground observations indicate the damage is more widely spread throughout the northern portion of the district and into the southern portion of the

Central Cariboo Forest District, though the majority is not visible from the height the overview survey is flown. The stems damaged were mostly of small diameter, so they should not contribute to Douglas-fir bark beetle population increases.

Red belt damage in the Rocky Mountain Forest District

Red belt damage occurred on a total of 1,185 ha this year, up from none the past two years but still well short of a peak of 26,639 ha affected in 2006. Damage occurred on Vowell Creek (477 ha) in the Rocky Mountain Forest District, at the north tip of Duncan Lake (202 ha) in the Kootenay Lake Forest District and the Prophet/Muskwa Rivers (506 ha) in the Fort Nelson Forest District. Intensity of damage was noted as 45% light and 55% moderate.

Slides occurred on 833 ha province wide, down one-third from last year to similar levels noted in 2007. Most of the damage (89%) was rated severe, with the remainder divided between the other intensity levels. Areas of damage were small and scattered, with 419 ha in the SIFR, 209 ha in the CFR and 205 ha in the NIFR. Districts sustained less than 70 ha of slide disturbances with the exception of the Arrow Boundary Forest District where 258 ha were affected. The majority of the slide damage in the southeast portion of the province that was recorded this year was caused by avalanches last winter. It was noted by backcountry experts that 2009 was one of the worst years for avalanches for that area in recent history. Spruce/balsam stands were most affected and downed spruce may contribute to a building spruce beetle population.

Animal damage

Although the masking effect of mountain pine beetle mortality was decreasing in most areas, animal damage observed during the aerial overview surveys remained low in 2009. Most animal damage is very scattered and does not always affect the whole tree, hence it is difficult to detect at the height flown for the survey and it is usually underestimated.

Bear damage in the Hurley River area

Porcupine (*Erethizon dorsatum*) damage was the only animal damage picked up during the 2009 aerial overview surveys. Small spots of severe damage were noted in the North Coast and Kalum Forest Districts, and three small polygons of trace to light damage were recorded in the Kootenay Lake Forest District in the southeast corner near the USA border. In total, only 11 ha of damage were observed though it is known to occur in dispersed locations throughout most of the province.

Black bear (*Ursus americanus*) damage was picked up in small polygons totalling 22 ha in 2008, but none was noted this year.

It is known however to be a continuing problem in young to intermediate age class stands, particularly in fertilized stands. Douglas-fir, lodgepole pine and spruce of about 10 to 15 cm diameter at breast height appear to be particularly susceptible.

Bear damage in the Headwaters Forest District

During aerial helicopter surveys for Armillaria in the Headwaters Forest District this year, unexpected occurrences of bear damage primarily in pine plantations was noted. Since the survey wasn't focused on pine plantations, estimates of the number of plantations affected were not recorded. However, it was observed by air and ground checks, and photos, that numerous young stands within the Clearwater unit were affected by significant bear damage. Much of the damage appeared be fairly recent based on the high ratio of red and yellow stems to greys. The spatial pattern of the damage ranged from slightly patchy to somewhat uniform and as high as an estimated 10 to 20% of stems affected. From the air, it appeared quite distinct from mountain pine beetle damage, which occurs in slightly older/ larger diameter young stands (typically > 15 cm dbh), and at a much higher incidence and distinctive patchiness. The occurrence of bear damage may merit additional attention to determine general occurrence patterns at a landscape level, impact and stand selection preferences. Ground checks and ground survey observations determined that the damage consisted of stripping of very long narrow strips of bark leaving smooth exposed cambium. The damage likely occurred in the spring when other food supplies are low.

Damage also continued from Bute to Toba inlets in the Sunshine Coast Forest District, though it appears to be moving further up the Quatam River than has previously been noted.

Snowshoe hare (*Lepus americanus*) populations are fairly cyclical, and are due to peak in about 2010 in the NIFR. Anecdotal observations around the Prince George area did not note a large increase in hare activity in 2009 though. However, hare browse of planted trees in stands that were underplanted following mountain pine beetle mortality and/or in brushy areas continued to be a problem. Significant damage reductions have been realized by planting primarily spruce that has spent one year in a nursery then one year outplanted in a field. This reduced the nitrogen content that attracts the hares and also produced hardier, woodier trees that are vigorous enough to withstand browsing (laterals easily take over for nipped terminals).

Red squirrel (*Tamiasciurus hudsonicus*) continued to cause more damage in lodgepole pine stands than has normally been seen for at least five years. It is still uncertain whether squirrel populations are up or whether increased damage is at least partly due to the large reduction in live lodgepole pine stands.

Woody bush rats (*Neotoma cinerea*) are still the suspected cause of browse damage on leaders of immature (3-7m tall) Douglas-fir trees, though this has not been confirmed to date. Browse damage is occurring around Sechelt and on Tree Farm License number 39 in the Tinhat Junction area of the Sunshine Coast Forest District. Timing of the damage has been narrowed to winter (primarily January), and imprints in the snow around the trees appear to be consistent with the woody bush rat theory.

Vole (*Microtus* spp.) populations continued to be very low in 2009. Since they have fairly cyclical populations and the numbers have been low for several years now, an upswing is expected soon. During a peak year, vole feeding can cause considerable damage to new seedlings.

Miscellaneous Damaging Agents

Conifer sawfly *(Neodiprion spp.)* was identified to be lightly defoliating 85 ha near the Lakelse River south of Terrace in the Kalum Forest District. One spot infestation was also noted in the Columbia Forest District.

Large aspen tortrix (*Choristoneura conflictana*) damage in the NIFR peaked in 2004 with 794,303 ha affected and has steadily declined since. This trend continued this year, with only one polygon of 45 ha of severe defoliation of aspen noted near Gutah Creek in the Peace Forest District.

Red turpentine beetle *(Dendroctonus valens)* has been attacking high value grafted trees in a seed orchard near Armstrong to an unusual extent this year. Mature trees have been attacked which is expected. However, trees as small as 4cm in girth and only seven years old have also been infested which is very unusual. Girdling due to larval feeding caused mortality in a significant number of infested trees that otherwise appeared to be healthy and vigorous. This is also unusual, as trees that are killed by red turpentine beetle normally have been weakened first by some other factor. Small stems were particularly vulnerable as it took very few larvae to girdle a tree, often resulting from a single parental entrance gallery.

Small seed orchard tree attacked by red turpentine beetle

A total of 125 lodgepole pine trees were noted to be infested in one orchard in 2009 and there appeared to be a clonal influence on the pattern of attack. Proposed control measures for future growing seasons include removal and disposal of all infested dead trees by spring, removal of duff and weeds around the bases of trees to increase effectiveness of spray treatments and establishment of a Lindgren funnel pheromone trapping program.

Weevils in young stands were observed to be causing notable damage. Both the white pine weevil (*Pissodes strobi*) in spruce and lodgepole pine terminal weevil (*Pissodes terminalis*) in lodgepole pine have been observed to be on the increase in the SIFR. Of particular note was lodgepole pine terminal weevil attack in the Chilcotin and western portions of the Central Cariboo and 100 Mile House Forest Districts. In some stands, attack was severe enough to give the appearance of frost damage to leaders, as it was so widespread. Even small thin leaders were attacked and killed but survival of the weevil, particularly in these cases, was very low. In transitional ecosystems, fatal attack of young lodgepole pine trees girdled by Warren root collar weevil (*Hylobius warreni*) larvae was also observed to be on the increase.

Pine terminal weevil attack in young lodgepole pine stand in the Chilcotin Forest District

Unknown defoliation was higher than has ever been recorded since the MFR became responsible for the aerial overview surveys with 20,454 ha affected across the province. Intensity was assessed as 12,397 ha (60%) light, 3,420 ha (17%) moderate and 4,637 ha (23%) severe. The majority of this damage occurred in mixed conifer stands in the Kalum and Skeena Stikine Forest Districts with 15,486 ha and 1,886 ha affected, respectively. These districts experienced a highly diverse variety of conifer defoliator damaging agents in 2009 including blackheaded budworm, two-year-cycle budworm, hemlock sawfly, hemlock looper and conifer sawflies. Hence, it was not possible to simply attribute defoliation to a given agent without ground checks. Due to funding constraints and accessibility issues, many disturbances did not get ground confirmation and were therefore labelled as unknown. Fort Nelson Forest District also observed 1,578 ha of unknown defoliation in aspen stands that were not accessible for agent identification. The remaining disturbances were small and scattered throughout the province, with no more than 320 ha per district.

Willow leaf blotch miner damage

Willow leaf blotch miner (*Micurapteryx salicifoliella*), which was observed to be severely affecting willow clumps in Fort Nelson last year, continued to cause damage in 2009. As native willow is considered to be a shrub, not a tree species, defoliation was not mapped during the aerial overview surveys. It was detected however in Fort Nelson District and in the Cassiar TSA of the Skeena Stikine Forest District, particularly east of the Cassiar Mountains. Reports of damage by the willow leaf blotch miner have also been noted in 2009 in the Yukon, Alaska, and northern Alberta.

Forest Health Projects

1. Are free-growing stands meeting timber productivity expectations in the Okanagan TSA?

Alex Woods, Forest Pathologist, NIFR
Wendy Bergerud, Senior Biometrician, Research Branch, Victoria

An intensive re-examination of 60 randomly selected free-growing stands was conducted in the Okanagan TSA in 2006, using the same methods as those of Forest and Range Evaluation Program (FREP) Report #13. For the past few years we have been analyzing the data and asking more and more questions of the data set. We hope to complete the FREP report on this TSA early in 2010. Stands in the ESSF zone within this TSA have increased in free-growing density since declaration much as expected in TASS/TIPSY. Density trends in the more prevalent ICH and MS zones have gone in the opposite direction. We have been surprised at the extent of the decrease in healthy free-growing stems in the 10 year period since these stands were originally designated as free-growing. Part of the reasons for the decline in healthy stocking is probably due to our focus on forest health agent detection in our survey. Part of the explanation also lies, however, in real changes in the health of stands over the years since these stands were last surveyed. The bottom line conclusion is that there are less healthy stems in managed stands of the Okanagan TSA than has been assumed in our inventory. Armillaria root disease and mountain pine beetle are two of the principle causes for this decline. The decrease in density of some individual species and ingress of others has also lead to changes in the leading inventory species in some stands. The FREP SDM protocol which has been designed using the lessons learned in both the Okanagan and Lakes TSA Intensive FREP studies will provide a means to monitor managed stands, updating our inventory and informing TSRs.

2. FREP Stand Development Monitoring (SDM)

Alex Woods, Forest Pathologist, NIFR

Stand Development Monitoring was piloted under District FREP programs in eight Forest Districts throughout the BC Interior in 2009. These pilots followed the basic methods developed in the intensive FREP studies as documented in FREP Report #13 "Are Free-growing stands meeting timber productivity expectations in the Lakes TSA?" (http://www.for.gov.bc.ca/hfp/frep/site_files/reports/FREP_Report_13.pdf). District staff was provided with a list of 60 randomly selected openings that were surveyed for free-growing in the period 1995-2001 as reported in RESULTS. A minimum of 30 stands from this list are to be surveyed over a 3-year period before formal reporting out.

In each selected opening, ten 3.99m radius silviculture survey plots were established following basic silviculture survey methods (i.e. Well spaced/Free-growing trees determined using a minimum inter-tree distance of 2m, trees assessed using current free-growing damage standards, total trees tallied and an inventory label determined). In addition to the standard silviculture methods, trees were tallied by species, by layer and by health status. Selected stands had to have a single homogeneous strata > 10ha in size, be managed as even aged and have a harvest data later than 1960. As a minimum the selected stands also needed to have sufficient documentation of stand condition at the time of free-growing declaration including inventory label, free-growing and total density and a map so that staff could be sure they were assessing the same opening that was originally declared.

District support for SDM has been outstanding. The eight districts that piloted SDM in 2009 surveyed over 80 stands in all. Two districts surveyed 15 or more stands. All of this work was done in-house by staff who are very keen to re-visit managed stands to see how they are doing. The pilots have led to the creation of specific SDM damage standards that are based on Free-growing damage stands but are tailored for stands later in their rotation when we have a better idea of future survival. SDM has also been well received at Forest Analysis and Inventory Branch where interest has been expressed to include the results of SDM surveys as part of the Timber Supply Review process.

3. Armillaria aerial sketch mapping

<u>Richard Reich</u>, *Regional Pathologist, NIFR*

One of the single most important risk factors to young stands in BC is Armillaria root disease. This method of aerial sketch mapping is an approach that was used in the Robson Valley to determine the incidence of visible Armillaria disease centres. In the late summer of 2009, the survey was expanded to include several thousand young silviculture openings within the entire Clearwater unit of the Headwaters Forest District were aerially (rotary wing aircraft) sketch mapped In addition, 3500 oblique digital aerial photographs were taken of representative conditions within 100's of these young stands. These photos were GPS synchronized to GPS flight tracks to enable an independent verification using photo interpretation. Finally, in the fall of 2009 over 20 silviculture openings were intensively ground surveyed, using a transect method, which provided the ground 'truthing' of the visible above-ground symptoms attributed to the presence of Armillaria. The results will be compiled over this coming winter.

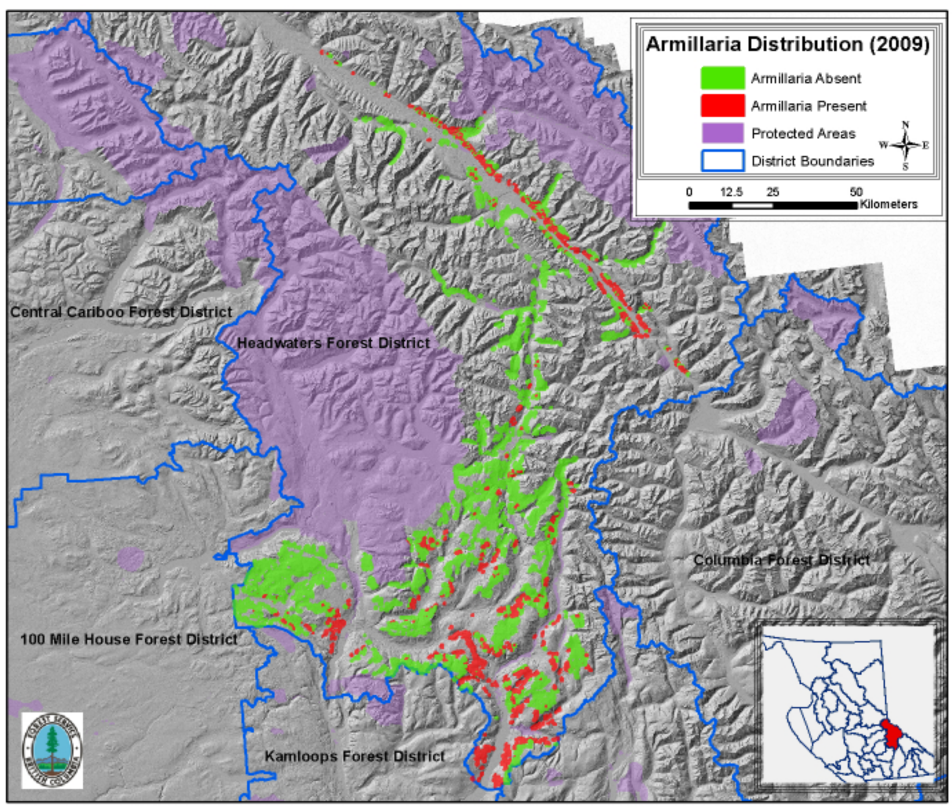


Figure 19. Preliminary results of Armillaria distribution as mapped during the aerial survey.

The map in figure 19 shows the areas surveyed and the preliminary results that describe the openings with and without visible evidence of Armillaria disease centres.

The deliverable will be an Armillaria overview GIS layer showing estimated incidence within each silviculture opening or delineated disease polygon. This layer will contain GPS flight lines and individual digital photographs for some of the openings can be viewed. This product will be an invaluable tool to aid incremental silviculture planning and prescription development in the Clearwater unit of the Headwaters Forest District. Planned future deliverables include an ecosystem based hazard and risk rating, and a climate change impact assessment.

4. Bear deterrents tested in Prince George Forest District

Robert Hodgkinson, Forest Entomologist, NIFR

When deploying pheromone baited Lindgren funnel traps against Douglas-fir beetle, black bears occasionally vandalize traps repeatedly at certain sites. In an attempt to deter damage at a site that had been repeatedly disturbed in the Prince George District in 2009, portable animal alarms or *Critter Gitters** were purchased and tested. Alarms are passive infrared detectors with loud audio wailers and flashing lights powered by 9 volt batteries. Once armed, the devices "memorize" a 90 degree wide infrared spectrum facing outwards to approximately 12 m. Any substantial movement into this zone activates the alarm which wails for 30 seconds and then re-sets. We attached 1 on each of 2 funnel trap poles in a 3-trap cluster at a site 6 km west of Punchaw Lake. For the next two weeks there was no bear damage. At week 3, a third pole without the alarm had been disrupted, and a second pole with an alarm had been moved slightly before the alarm had undoubtedly activated and scared the bear off. We re-set the alarms and there was no more bear damage at this site for the balance of the summer. Further tests of these alarms are planned for 2010.

"Critter Gitter" bear alarm installed on Douglas-fir beetle funnel trap pole in Prince George Forest District in June 2009.

* Margo Supplies, Edmonton, Alberta

5. Comandra resistance trial

Richard Reich, Regional Pathologist, NIFR

The Bulkley comandra resistance screening trial was established in 2004 under the guidance of Dr. Sally John, a consulting research geneticist, to field test putative resistance to comandra blister rust. She previously identified the putative resistance during a progeny trial assessment of the Chowsunket Lake site and pursued the establishment of this unique trial. Approximately 130 families are represented on the 3 fully replicated trial sites. The trial sites were selected in high risk areas based on high infection rates on each site by comandra blister rust within the surrounding plantation, and substantial cover of the alternate host, *Geocaulon lividum*. All 3 sites of the Bulkley comandra resistance trial were reassessed in the summer of 2009, by Deanna Danskin, NIFR Forest Health Technician, for incidence of infection and survival status. Incidence of new infection by pine stem rusts was fairly low in 2009 and has declined sharply from previous years. Overall cumulative infection is approximately 80% on 2 of the 3 sites, but less than 20% on the 3rd site. Mortality was high for the 2nd year in a row as comandra stem infections are causing rapid girdling on these young trees. The weather station data was also collected for each site at the end of the growing season which will provide the ability to monitor environmental conditions suitable for infection on an annual basis. Preliminary results indicate the presence of a few relatively low infection families, indicating that this form of resistance is not likely a result of major gene resistance, which would likely confer higher protection. Also of significance is the strong proximity relationship between infection of the lodgepole pine seedlings and the distance to the alternate host plants. The risk of infection drops off considerably over a distance of only a few meters. This finding emphasizes the importance of hazard rating sites for cover by *Geocaulon lividum* during the prescription stage of the stand establishment planning cycle.

6. Determining the effect of pre-commercial thinning on root disease incidence

Michelle Cleary, Regional Pathologist, SIFR
Duncan Morrison, Pathologist (retired), CFS

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

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

For the last two years, re-measurement of these pathology-silviculture trials have taken place. To date, 6 of the 11 installations have been re-measured and clearly show some interesting effects on disease development and growth of stands now at mid-rotation. Growth measurements and periodic mortality data collected now 15-18 years post-treatment will determine the patterns of mortality and their consequences which will help navigate potential benefits of different silviculture treatments.

7. FSP-FIA Project: Distribution and impact of Phellinus root disease in the Southern Interior

Michelle Cleary, Regional Pathologist, SIFR
Rona Sturrock, Research Scientist, CFS

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

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

8. Is stump removal reducing Armillaria root disease? The Wetask Lake Stumping Trial

Michael Murray, Forest Pathologist, SIFR
Adrian Leslie, Royal Roads University

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

Wetask Lake Armillaria treatment site near Revelstoke

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

Graduate student, Adrian Leslie (Royal Roads University, Victoria) has been recruited to undertake this assessment of the post-treatment stands. Our objective is to assess tree health, height and diameter growth and compare values between the two treatments. A total of 180 (3.99m radius) plots were inventoried in September-October. Preliminary findings indicate much natural regeneration has occurred. Furthermore, although the site was found to have a high incidence of Armillaria in 1993, the current evidence is not pronounced (Table 11). In fact, neither treatment is showing much infestation and correspondingly the difference between them is not significant. Next, we will be looking at potential differences between regenerating species. Thus, the study is ongoing and expected to yield final results and interpretations by summer 2010.

Table 11. Comparison of regenerating tree conditions for Wetask Lake stump removal

	No. Trees	Avg. ht. (cm)	Avg. DBH (cm)	No. w/ Armillaria
Stumps Present	1,071	475	4.18	12
Stumps Removed	1,174	421	3.83	8

9. Low dose and unique strain virus trial 2009

Lorraine Maclauchlan, Forest Entomologist, SIFR
Iral Ragenivich, Entomologist, USDA Forest Service
Imre Otvos, Senior Research Scientist, Pacific Forestry Centre, CFS

A trial was conducted on the Douglas-fir tussock moth looking at low dose treatments of NPV (see SIFR Overview Report 2009 for details at http://www.for.gov.bc.ca/rsi/ForestHealth/Overview.htm.

10. Monitoring whitebark pine in the Nelson area

Michael Murray, Forest Pathologist, SIFR

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

The previous sites, established by Stefan Zeglen, Forest Pathologist, CFR, consist of .25ha plots with all size classes of trees measured every five years. These inventories provide useful information on forest health trends and tree regeneration. The three new Nelson sites support lower densities of whitebark pine trees which would only yield low numbers within any .25ha plot. Thus, the monitoring is not plot-based, but site-based. Specifically, between 10 and 50 cone-bearing trees were selected across each site. Each tree was assessed for health, diameter, and number of cones.

At least 10 trees per site were sampled with increment boring for subsequent tree ring analysis (age, stress, etc.). The overall objective is to track each tree annually to determine health trends and cone production. The three sites being monitored are Mount Nelson, Red Mountain, and Gray Creek Pass – all within the Kootenay Lake Forest District. Several more sites may be added in the future. Preliminary findings based on 75 sampled trees indicate 9% died in 2008 from mountain pine beetle and 5% are currently under attack. Dead tops, a good indicator of blister rust, occur on 11% of trees and an additional 3% are showing active cankers. Another finding: a population of tall whitebark pine (approaching 30m) on Mount Nelson which overlooks the city.

Whitebark pine above the streets of Nelson

11. Septoria musiva update

Harry Kope, *Provincial Forest Pathologist, FPB*
Stefan Zeglen, *Forest Pathologist, CFR*

Septoria musiva (anamorph; *Mycosphaerella populorum*) causes leaf spots and cankers on *Populus* species (aspen and poplar) across almost all of North America. All North American *Populus* species are at least somewhat susceptible to *S. musiva*. Hybrids and Eurasian species sustain the most damage due to repeated defoliation and stem breakage.

Septoria musiva canker

The disease in British Columbia – Since the pathogen was first identified in the Fraser Valley in 2006 the MFR has worked in conjunction with the commercial nursery to have susceptible clones removed and destroyed. Where susceptible clones have not been immediately removed the nursery has chosen to control the disease on their stock using a fungicide. The nursery's long term goal is to replace all of the susceptible clones with clones that are more resistant to *S. musiva*.

The immediate concern with this exotic disease is: 1) what is the distribution of *S. musiva* in the Fraser Valley (and beyond), 2) has *S. musiva* infected native *P. trichocarpa*, and 3) can *S. musiva* be eradicated from the Fraser Valley?

As reported last year, a preliminary foliar survey was conducted in the Upper Fraser Valley to try and locate *S. musiva* outside the nursery area in native poplar trees. Foliage from over 400 trees was collected and examined for leaf spotting (a sign and symptom of the disease) by Dr. Richard Hamelin's lab at UBC. Results indicated that the native *P. trichocarpa* was almost exclusively infected by the native disease *S. populicola,* while hybrid poplars were infected by the non-native *S. musiva*.

During 2009, two more comprehensive surveys of native *Populus* species were carried out, again to determine whether the disease has become established on these hosts. The first survey was conducted on over 150 trees in June to ensure that leaves that may have become infected earlier in the year would be collected before a premature leaf drop occurred. A second collection of more than 250 trees was done in late September when spotting of leaves was easily detected. For all surveys, the collection area covered both sides of, and within 5 kilometres of the Fraser River, from Dewdney and Greendale in the west to Hope and approximately 25 kilometres east on Highways #1, #3 and #5 (see Figure 20).

Figure 20. The sampling area in the Fraser Valley for putative Septoria musiva infections of Populus trichocarpa.

Results from the 2009 collections are not available yet. At the moment, it appears that *S. musiva* is mostly restricted to planted hybrid poplars and does not display a propensity to spread to native *P. trichocarpa*.

12. Spruce weevil hazard rating in southern British Columbia

Art Stock, Forest Entomologist, SIFR

Pissodes strobi, commonly known as the spruce weevil in BC, is a major pest to spruces throughout the province. An analysis of provincial inventory data determined the number and distribution of spruce leading stands in susceptible size classes and ecosystems that would define the target population to be sampled. The analysis revealed the distribution and number of susceptible plantations. The total area of susceptible spruce plantations was >700,000 ha. An aerial survey method was tested and ground truthed on 161 polygons that were sub-sampled with two types of ground surveys and the costs, productivity and accuracy of the methods was assessed in a study conducted in susceptible spruce plantations in the Revelstoke and Robson Valley TSAs in the interior of BC in 2008 (Figure 21). Aerial surveys were conducted by having two observers tally the number of infested and uninfested spruce leaders of at least 500 stems per opening. A 10% sample of these aerially surveyed openings was ground sampled using two methods of plots:

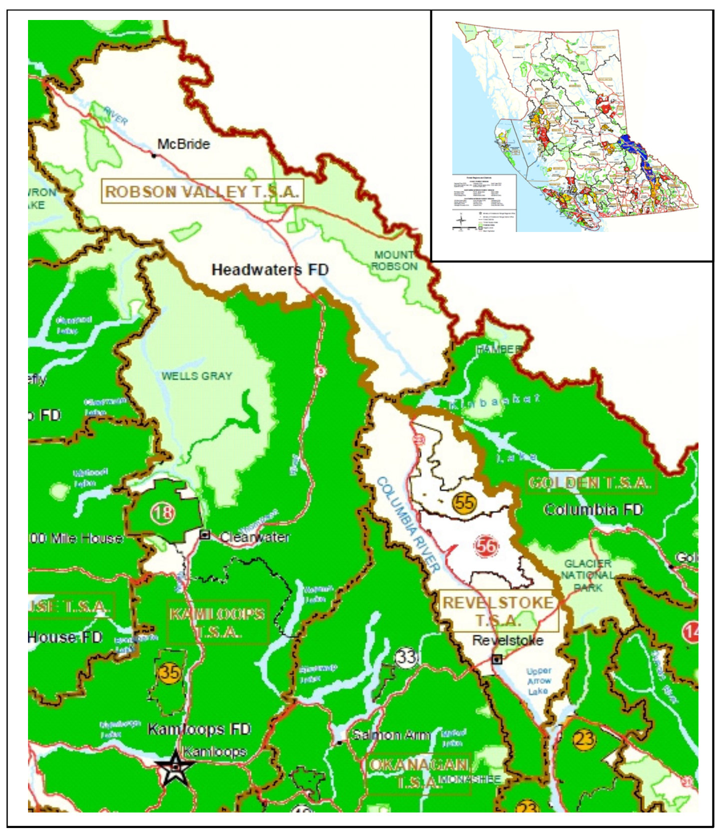


Figure 21. Location of the Revelstoke and Robson Valley Timber Supply Areas where the aerial and ground sampling was conducted.

1) conduct 8 5 x 100 m strip transects where each spruce was assessed for damage and then each strip was accompanied by a fixed radius plot to collect weevil and mensurational data; and 2) sample 40 plots on a grid where at each plot 5 of the closest spruce were assessed for weevil damage and then for every 8th plot, a fixed radius plot was sampled to get mensurational data from at least 12 trees/plot. The results of the survey comparison showed that the aerial (helicopter) survey was clearly the most efficient at about $220 per polygon (stand) followed by the ground surveys that averaged about $1000/ polygon. Due to budget constraints, an adequate comparison between the two ground survey methods was not possible but it appeared that the grid system was the most efficient.

A GIS exercise was also included in this study to project the impacts of different climate change scenarios would have on the potential hazard to spruce weevil damage based on the degree-day based stand susceptibility rating system designed by McMullen et al. (1976) where it was determined that a minimum of 785 degree-days above a threshold of 7.2 degrees C. would be required for weevils growing in the interior of BC to successfully develop and reproduce while coastal weevils required 888 degree days. Three climate change scenarios were modeled ranging from the most pessimistic rate of carbon emissions to the most optimistic. In even the most optimistic scenario, the area of high weevil hazard expands tremendously by the year 2050 (Figures 22 & 23). The analysis showed that the changes will happen relatively quickly and will be widespread. However, the current hazard rating system does not adequately explain the known distribution of the weevil so there must be some missing factors that need to be considered to refine this rating system.

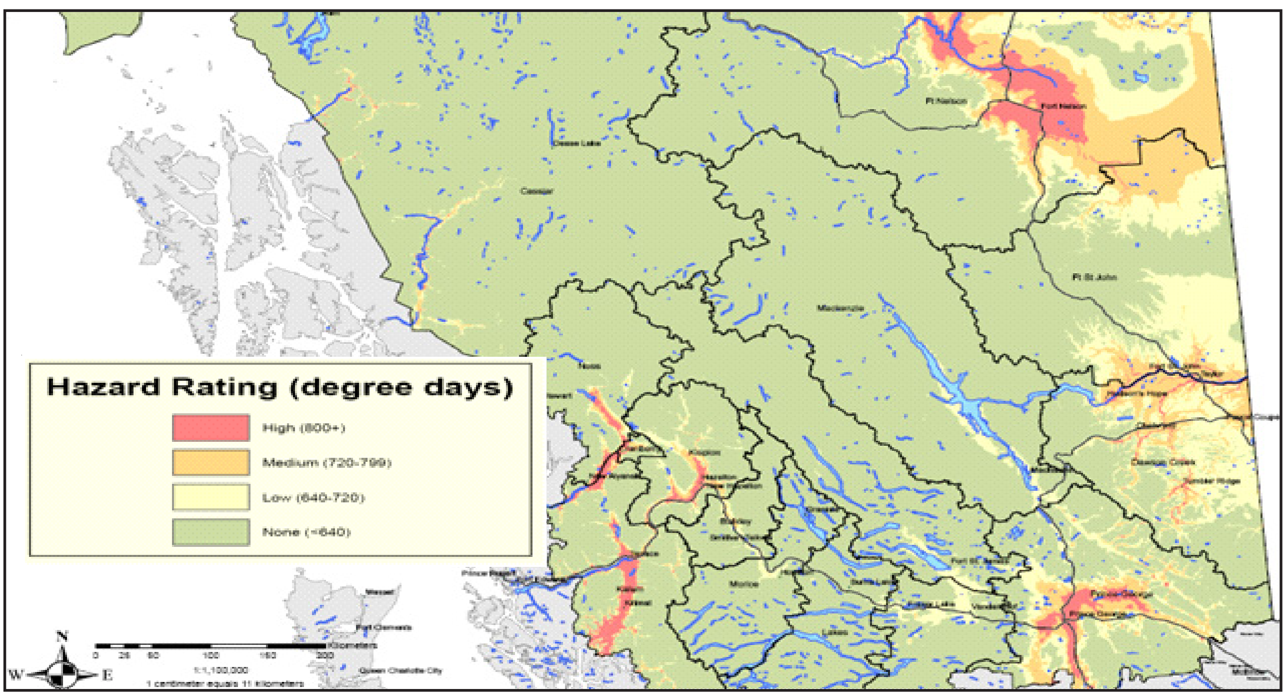


Figure 22. Current (2008) climate-based spruce weevil hazard rating for the Northern Interior Forest Region of British Columbia.

Other aspects of this study were to look at the potential impact of weevil damage on volume available over time in selected Timbers Supply Areas that are reliant on spruce. Further work is required to expand the aerial survey to other TSAs and to further refine the hazard rating system. For more information about this project, please contact Dr. Art Stock, Regional Forest Entomologist, Nelson, BC.

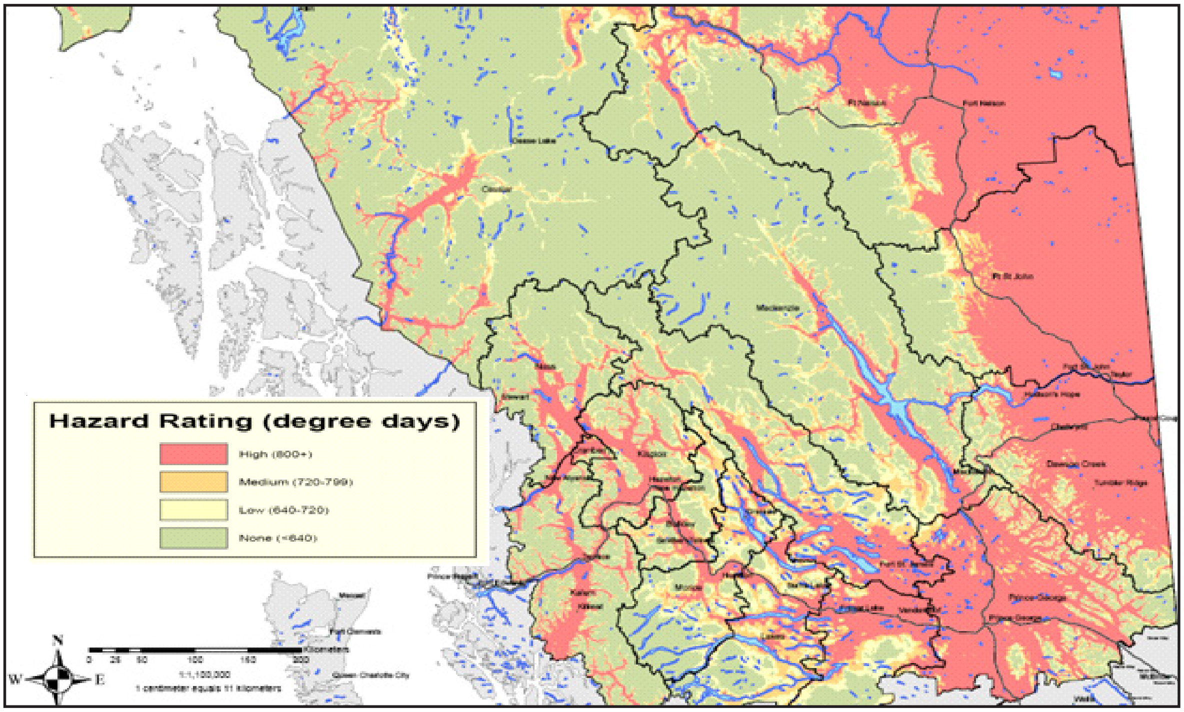


Figure 23. 2020 scenario B2 (most optimistic) and the resulting climate-based spruce weevil hazard rating for the Northern Interior Forest Region of British Columbia

13. Tree mortality events in Southeast BC. Is climate killing our forests?

Michael Murray, Forest Pathologist, SIFR

During the past several years, a number of tree species have suffered with pronounced death or injury with multiple agents evident. Paper birch has been denuded in the Kootenays with bronze birch borer and Armillaria root disease most obvious. Western red cedar is the most recent victim and agents have not been identified yet. Whitebark pine is dying from mountain pine beetles, blister rust, and fire. Although these mortality agents are native, except blister rust, trees may be more prone to death owing to underlying environmental stress.

Forest declines are typified by three elements: a complex-causal relationship; environmental stress; and two or more mortality agents. A milieu of factors can be challenging to analyze and eventually boil-down to any single cause of tree death. As trees begin to rot, the evidence becomes degraded and the die-off fades into memory. Since we expect a variety of offending agents, possibly in addition to those already mentioned, the question arises – why are one or more pests successfully killing trees in such large numbers in a short period of time? This die-off may be linked to climate perturbations inducing stress on trees.

Tree stress is evident in growth rings. During 2009, a collection of increment cores and cross-sections began. To date we have almost 200 samples from 16 sites between Revelstoke and Yahk. Two-thirds of samples are from birch. Preliminary examination of rings indicates many trees have suffered stress during the past 5—20 years. Looking at recent weather station date we see four consecutive years (2000-2003) of comparatively warm and dry summers (Figure 24). Weather records extending back 100 years are also being examined. Field sampling will continue in 2010.

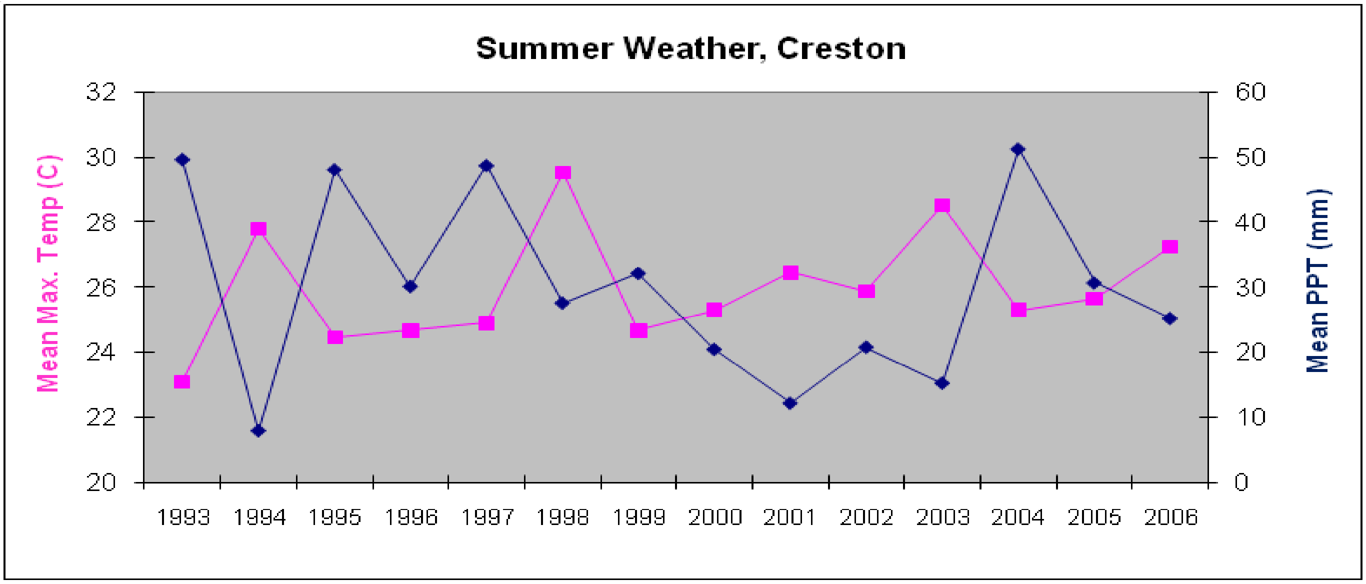


Figure 24. Creston experienced four consecutive years of unusually warm and dry summers (average monthly temperatures for July – September).

14. Western gall rust resistance trial establishment

Richard Reich, Regional Pathologist, NIFR

Two western gall rust resistance trial installations were established in June 2009. One is just west of the Mackenzie Junction in the Mackenzie rust belt and the other is near Crystal Lake, north of Prince George. The purpose of this trial is to verify the durable natural resistance to western gall rust through a controlled cross experiment. The resistant material has been identified in progeny trial installations occurring in very high risk locations and is crossed with susceptible families. The progeny trial installations yielded highly reliable results for assessments of incidence and severity of infection. The high risk was confirmed by the number and frequency of waves of gall rust infection which occurred during the approximately 20 years since establishment. The new trial sites were selected in high risk areas for western gall rust based on proximity to high risk young stands.

Western gall rust infection on young lodgepole pine

15. White pine family resistance trials

Michelle Cleary, Regional Pathologist, SIFR
Stefan Zeglen, Regional Pathologist, CFR

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

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

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

Forest Health Meetings

Western International Forest Disease Conference

Venue:
Valemount, October 4-8, 2010

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

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

A pre-WIFDWC field trip will also be arranged into the alpine at McBride Peak to examine the status of whitebark pine threatened by blister rust and mountain pine beetle in the northern Rocky Mountain trench. Besides the spectacular vistas in the alpine, we will visit a unique sand dune complex in the valley bottom with important and unique lichen and plant communities. This area is home to some of the most incredible lodgepole pine mistletoe (*Arceuthobium americanum*) in the southern interior of BC and we will hear about an ongoing yield loss simulation project for lodgepole pine mistletoe. In addition, we will view areas heavily impacted by Dothistroma needle blight and other foliage diseases and discuss the impact of forest pests on young managed plantations post-free growing.

Forest Health/Stewardship District staffs are encouraged to participate and take advantage of this unique opportunity which comes around to the southern interior of BC about once every 20 years. This will be a unique opportunity to hear from a diverse group of pathology experts; learn about pest-complex interactions, showcase pathology research in BC, and discuss approaches to help improve management of our forest resources.
For more information, refer to the official WIFDWC website: http://www.fs.fed.us/foresthealth/technology/wif/

Whitebark pine workshop

Michael Murray, Forest Pathologist, SIFR

Venue:
Hume Hotel, Nelson, BC. September 10-11, 2009

Summary:
Once very widespread at high elevations in BC, whitebark pine has declined from decades of non-native blister rust disease and the exclusion of natural fires. Most recently, the eruption of mountain pine beetle has killed-off thousands of hectares of already denuded whitebark pine. In many BC locations, only 25-50% has survived. Whitebark pine appears to be under further stress from climate change. Although not classified as a commercial species, whitebark pine has historically played a critical role for wildlife habitat, watershed dynamics, and timberline scenery. In 2008, the provinces of Alberta and BC placed this species on their endangered and blue-list, respectively. The US federal government is considering formal protection as threatened or endangered.

In September, about 50 people travelled to Nelson to hear updated science, policy, and management news on whitebark pine. This event was sponsored by MFR, Forest Genetics Council, and the Whitebark Pine Ecosystem Foundation. Attendees came from three provinces, six states, and Yukon Territory.

The first day of the workshop focused on expert presentations on a variety of topics:

Introduction & Legal Status Update for Whitebark in Canada and USA, by Cyndi Smith (Parks Canada) and Diana Tomback (Univ. of Colorado)
Introducing the Provincial Conservation Framework for BC, by Donna Thornton (Ministry of Environment)
Whitebark pine, Eurasian stone pines, the relative impact of blister rust and a plan for how we might proceed to protect this species in British Columbia by John King (MFR)
Cache site selection by Clark's nutcracker, by Teresa Lorenz (US Forest Service)
Darkwoods (a Nature Conservancy area) History and Future Management: Your help is needed, by Pat Field (Nature Conservancy of Canada)
Death by mountain pine beetle and rust: interactions and aftermath in whitebark pine forests in Waterton Lakes National Park, by Carmen Wong (Parks Canada)

Masting Synchrony in Whitebark Pine: what does it mean to be a "masting year"? by Eliot McIntire (Laval University)
Resource costs of masting in whitebark pine: four years of data after a high masting year, by Eliot McIntire (Laval University)
Trend in Health Status of Limber and Whitebark Pine in the Canadian Rockies, by Cyndi Smith (Parks Canada)
Mountain pine beetle phenology, condition, survival in whitebark pines, by Evan Esch (University of Alberta)
West Kootenay whitebark pine: resources, conservation, and education, by Brendan Wilson (Selkirk College)
All aboard: a genetic conservation strategy for B.C.'s whitebark pine, by Jodie Krakowski (MFR)
Conservation of whitebark and limber pine in Alberta Parks and Protected Areas, by Joyce Gould (Alberta Tourism, Parks and Recreation)
US Forest Service National Whitebark Pine Restoration Program - History and Progress, by John Schwandt (US Forest Service)
Enabling Grassroots Restoration of Whitebark Pine, by Randy Moody (Keefer Ecological Services Ltd)

The second day of the workshop consisted of a field trip to Gray Creek Pass which is located above Crawford Bay on Kootenay Lake. Amidst spectacular late-summer weather, participants paused at a cut block surrounded by whitebark pine to discuss current timber management practices. Julie Castonguay (Stewardship Forester, DKL) and Kevin Lavelle (Stewardship Officer, DCO) explained the BC tenures system – which was appreciated by the non-BC MFR attendees. At the top off the Pass, Deb MacKillop (Research Ecologist, SIFR) and Art Stock (Entomologist, SIFR) discussed the Biogeoclimatic Classification System plus mountain pine beetles. Michael Murray (Forest Pathologist, SIFR) demonstrated a 'tree-tong' for caging and collecting pine cones required for blister rust screenings. The final stop occurred at Oliver Lake with Stephen Arno (retired, US Forest Service) emphasizing alpine larch in his talk about conifer dynamics of the Selkirks.

Presentations (PowerPoint format) and further information are available at www.whitebarkfound.org

Attendees at the Whitebark Pine Workshop, Nelson BC September 10-11

Forest Health Presentations

Change and opportunity in the Canadian Boreal Forest and beyond

Lorraine Maclauchlan, Forest Entomologist, SIFR

Venue:
2009 GAA Environmental Workshop: Sustainable Forest Products, Toronto, Ontario, June 16th – 18th, 2009

Abstract:
Healthy forest landscapes contain age and species mosaics, diverse topography, dead trees, scattered new forests and evidence of past fires. Canada is a vast country predominated by deciduous and coniferous forests and associated with these forests are numerous insects and diseases that can impact growth or kill.

Landscapes offer physical barriers to many organisms including insects: climatic limitations, wind that scatters or limits spread and inhospitable ecosystems where there is no host or suitable resources. Landscapes also can offer the opposite: monotonous landscapes with few or no physical barriers, favourable climates and winds patterns that promote widespread movement and dispersal of insects.

Mountain pine beetle infestation Kootenay Lake Forest District

This talk wove a story of how insect reproductive biology, population dynamics, climate, aging forests and human intervention have accelerated forest succession. I described a native insect that has reached unprecedented outbreak levels due to a myriad of factors including climate change, human intervention and the tremendous plasticity of the insect itself. The mountain pine beetle, *Dendroctonus ponderosae*, and other native and introduced insects, are tremendously adaptable and fluid.

The mountain pine beetle outbreak is affecting over 13 million hectares and it is estimated that by 2014 77% of pine will be killed. This is most extensive and severe outbreak in recorded history with the insect invading areas historically considered climatically unsuitable, including higher elevation forests and the boreal forests of north-eastern British Columbia and Alberta.

Climate, weather, host species ranges and insect outbreak dynamics will stretch our ability to manage and maintain healthy forests. Our jobs will be to define and re-build healthy forests. The challenge will be what will we define as a "healthy" forest – it may be quite different from the current norm.

Cross-Country Checkup – British Columbia report

Tim Ebata, Forest Health Initiatives Officer, *Forest Practices Branch*

Venue:
National Pest Forum, Gatineau, Quebec, Dec 1st, 2009

Abstract:
A summary of BC forest health conditions for 2009. Highlights included: mountain pine beetle and Douglas-fir beetle infestations; several deciduous and coniferous defoliators; Septoria musiva update; tree declines; unusual hail damage and the Forest and Range Evaluation Program's Stand Development Monitoring project.

Forest insect risks for fertilization of lodgepole pine in BC

Robert Hodgkinson, *Forest Entomologist, NIFR*

Venue:
BCMFR Provincial Fertilization Meeting, Prince George, BC, February 11th, 2009

Abstract:
The presentation addressed potential insect threats to age class 1 & 2 lodgepole pine stands being considered for fertilization. These included mountain pine beetle, the engraver beetle *Ips pini*, secondary bark beetles, and Warren root collar weevil. It was recommended that fertilization resume in stands not unduly threatened by any of these insects.

Insect challenges in a changing climate

Lorraine Maclauchlan, *Forest Entomologist, SIFR*

Venue:
Pacific Northwest International Society of Arboriculture, Kelowna, BC, October 6th, 2009

Abstract:
The current, historically unprecedented outbreaks of mountain pine beetle and *Dothistroma* needle blight in British Columbia are strong indicators that relationships between pests, hosts and climate are being altered as climate changes. Numerous recent pest epidemics elsewhere in North America provide further strong evidence of the impact of changing climate on forest ecosystems.

The interactions between pests, hosts and climate are complex, have co-evolved over centuries, and in many instances, are not well understood. This, together with the uncertainty associated with how regional climates will change, makes it difficult to predict the responses of specific pests to climate change. Changes in thermal and moisture environments, combined with changes to host plant conditions, will interact synergistically facilitating the development of insect and pathogen outbreaks.

Large scale, pest-caused forest decline and mortality will have long-term ecological, social and economic consequences. Timber supplies, water resources as well as other forest resources will be

impacted. We anticipate increasing levels of mortality in the standing inventory in many Timber Supply Areas in the province as a result of forest pest activity. Much of the immature growing stock will also be affected by increasing levels of pest-caused mortality, growth losses and regeneration delays. Although the mountain pine beetle epidemic represents a current extreme, in many Timber Supply Areas it is possible that the combined impacts of multiple pests under the influence of climate change could approach a similar magnitude of impact on the remaining timber resource.

The management of forest lands has clearly become more challenging as a result of climate change. Forest management needs to respond and adapt to accommodate the diverse and innovative practices we will require to manage our forests into the future.

Mountain pine beetle colonization, reproduction and new generation emergence in live interior hybrid spruce in BC

Robert Hodgkinson, Forest Entomologist, NIFR

Venue:
National Pest Forum, Gatineau, Quebec, Dec 1st, 2009

Abstract:
We observed successful reproduction of mountain pine beetle (MPB) and emergence of new generation adults from interior hybrid spruce *Picea engelmannii* × *glauca* and compared a number of parameters related to colonization and reproductive success in spruce with nearby lodgepole pine *Pinus contorta* infested by MPB. The results indicated that reduced competition in spruce allowed MPB parents that survived the colonization process to produce more offspring per pair than in more heavily-infested nearby pine. We also conducted an experiment in which 20 spruce and 20 lodgepole pine were baited with the aggregation pheromone of MPB. Nineteen pines (95%) and eight spruce (40%) were attacked by MPB, with eight (40%) and three (15%) mass-attacked, respectively. Successful attacks on non-host trees during extreme epidemics may be one mechanism by which host shifts and subsequent speciation events have occurred in *Dendroctonus* spp. bark beetles.

Monitoring young stands in British Columbia

Alex Woods, Forest Pathologist, NIFR (prepared report)
Harry Kope, Forest Pathologist, Forest Practices Branch (presented report)

Venue:
National Pest Forum, Gatineau, Quebec, Dec 1st, 2009

Abstract:
The current silvicultural milestone for ensuring effective reforestation is the free-growing declaration. This licensee obligation to create a free-growing stand is one of the few measurable results in the *Forest and Range Practices Act* (FRPA). Once a stand is declared free-growing the Crown takes over responsibility for the stand and assumes that it will remain healthy and productive until

harvest. Timber supply reviews throughout the province base predictions of managed stand productivity, in large part, on the assumptions associated with free-growing designations. The free-growing declaration is the last mandatory entry of stand attributes used in the forest inventory system for stands between that early stage of development and possible harvest decades in the future. Under the Ministry's stewardship mandate, it is essential that the assumptions inherent in the free-growing declaration be tested to ensure validity of the systems that rely on it. A Forest and Range Evaluation Program (FREP) protocol entitled Stand Development Monitoring (SDM) has been developed for monitoring managed stands of age class 2 and 3, (i.e., age 20-60 years), 10-15 years post-free-growing declaration. Specific SDM damage criteria have been developed that are tailored to stands at this stage of development which are generally more lenient than free-growing damage standards. This protocol is designed to assess if free-growing stands are meeting timber productivity expectations and to update inventory labels to reflect current stand conditions. There are over 2.5 million ha provincially of free-growing openings in the Reporting Silviculture Updates and Landstatus Tracking System (RESULTS) database. Over time a considerable basis for comparisons will be developed between the condition of stands at the time of declaration and the current stand condition. These comparisons will form a central component of managed stand productivity estimates in Timber Supply Reviews. This protocol will provide a powerful tool for monitoring stand development and checking management assumptions. Specifically the following questions are addressed through this monitoring process:

- Is there a significant change in the number of well-spaced and free-growing (preferred and acceptable) species from the time of the free-growing declaration to the present?
- Is there a significant change in total stand stocking from the time of free-growing declaration to the present and, if so, is that change within the range that would be expected for stands at this stage of stand development?
- Is there a significant change in forest pest incidence from the time of the free-growing declaration to the present?
- Is there a significant change in the composition of leading species from the time of the free-growing declaration to the present?

Overview of hard pine stem rust research in the NIFR

Richard Reich, *Forest Pathologist, NIFR*

Venue:
BC Timber Sales general meeting, Prince George, Dec 3rd, 2009


Comandra blister rust infection

Abstract:
The presentation provided an overview of the key findings of several different research projects focusing on hazard rating, direct treatment, density management, and tree improvement site assessments. Resistance to stem rusts and foliar diseases is particularly apparent at the Prince George Tree Improvement Station due to high risk to certain pathogens and the clonal nature of the orchards which allows reliable separation of environmental effects from hereditary traits. Open pollinated family trials including progeny test sites and a

comandra blister rust field screening trial are providing insight into the range of resistance to pine stem rusts as well as the coinheritance of resistance to other pathogens. The hazard rating work in Mackenzie will guide the implementation of the rust strategy which identifies options for high risk sites. Density management on dry pine sites will continue to be promoted in the absence of effective species diversification.

Riding the roller coaster of forest health

Lorraine Maclauchlan, Forest Entomologist, SIFR

Venue:
SISCO spring conference, Naramata, BC, April 9th, 2009

Abstract:
This presentation was an update on current forest health conditions in the southern interior of BC.

Spruce weevil hazard rating in southern British Columbia

Art Sock, Forest Entomologist, NIFR (prepared report)
Tim Ebata, Forest Health Initiatives Officer, Forest Practices Branch (presented report)

Venue:
National Pest Forum, Gatineau, Quebec, Dec 1st, 2009

Abstract:
To develop a hazard rating for spruce weevil in southern BC, an analysis of provincial inventory data was undertaken to define the target population for sampling. An aerial survey method was then tested and ground truthed to determine the most effective method of sampling. A GIS exercise was also undertaken to project the impacts that different climate change scenarios would have on potential spruce weevil hazard. See project 13 for further details.

Stand development monitoring in the Strathcona TSA

Stefan Zeglen, Forest Pathologist, CFR

Venue:
Coast Silviculture Committee, Vancouver Island University, Nanaimo, BC, February 12th, 2009

Abstract:
The Forest Resources Evaluation Program (FREP) has been developing various protocols to facilitate the monitoring of forest resource values. As part of the Timber value, forest health has been developing a stand-level monitoring protocol over the last three years that examines post-free growing stands. The intent is to revisit stands at mid-rotation and provide a quantitative check that stand attributes and assumptions used in model projections remain valid. The Strathcona TSA was one of four TSAs across the province used to pilot the protocol. An overview of the development of the protocol, some results, and likely future steps were outlined.

The mountain pine beetle story: the path of the outbreak and future opportunities

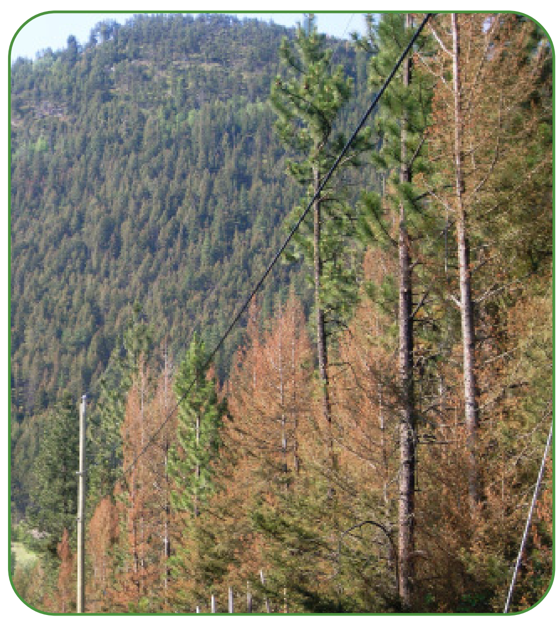
Lorraine Maclauchlan, *Forest Entomologist, SIFR*

Venue:
Mountain Pine Beetle and Water Management – Implicaitons for Water Users, Co-sponsored by the Southern Interior Beetle Action Coalition (SIBAC), Kelowna BC, June 2nd, 2009

Abstract:
Landscape, host condition and abundance, climate, fire and insect population dynamics have all played an equal and vital role in the extent and severity of the current mountain pine beetle, *Dendroctonus ponderosae*, outbreak in British Columbia. These factors, and many others, all coalesced in a unique spatial and temporal array to allow this insect to reach a critical mass on the B.C. landscape that exceeded all other recorded MPB outbreaks. This MPB outbreak is so extensive that only the severe depletion of the host resource will cause the collapse of the population and that collapse is now being witnessed. The most concentrated and extensive sources of high susceptibility host has now been depleted, primarily in the central interior, to a level where the landscape is very disjointed from the beetle's perspective. The outbreak is now in the "decline phase" in the all but the periphery of the outbreak area such as the far north, eastern and southern portions of B.C. In these last refugia of pine the beetle will once again display more typical outbreak dynamics and mortality factors will again start to govern the population (e.g. dispersal, predators and parasites, climate).

Conditions that predisposed our forests to this historic outbreak are also affecting other insects. There are currently outbreaks of Douglas-fir beetle, spruce beetle and numerous defoliator species such as western spruce budworm, Douglas-fir tussock moth and forest tent caterpillar. We must take this opportunity to learn from these insect outbreaks to look more critically at our forests, our management and factors that may leave the remaining resource in a vulnerable state.

Mountain pine beetle infestation on Williston Lake in the Peace Forest District



Douglas-fir tussock moth defoliation in the foreground with western spruce budworm damage on the hillside

Forest Health Publications

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