

2007 SUMMARY OF FOREST HEALTH CONDITIONS IN BRITISH COLUMBIA



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SUMMARY

The 2007 *Summary of Forest Health Conditions in British Columbia* (BC) is based on the provincial overview forest health survey data in conjunction with insect population surveys, ground observations and special projects undertaken by the Ministry of Forests and Range (MFR) and their associates.

Mountain pine beetle continued to be the leading cause of tree mortality across the range of pine in the province. A record 10.1 million hectares were affected in 2007, though the rate of infestation expansion has slowed considerably over the past four years. The Southern Interior Forest Region (SIFR) sustained over half the attack, with 5.4 million hectares of damage. For the third consecutive year, infestations were highest in the Chilcotin Forest District with 1.5 million hectares of attack. Quesnel Forest District was second with 1.2 million hectares of damage. The other two districts with more than half a million hectares of attack were Central Cariboo and 100 Mile House Forest Districts with 843,691 ha and 725,137 ha, respectively.

In the Northern Interior Forest Region (NIFR), mountain pine beetle infestations totalled almost 4.5 million hectares, of which 95% was situated in the five most southerly districts. For the third consecutive year Nadina Forest District damage was the highest at 1.1 million hectares. Fort St. James and Vanderhoof Forest District were close behind, with 879,858 ha and 830,626 ha of attack, respectively. Infestations in the Peace Forest District jumped dramatically from 50,312 ha last year to 736,499 ha in 2007. Although damage was down in the Prince George Forest District, it still accounted for most of the remaining attack with 650,154 ha of recorded mortality. The Coast Forest Region (CFR) contained the remaining 199,522 ha of mountain pine beetle disturbances.

Western balsam bark beetle accounted for primarily trace to light mortality over 1.56 million hectares across BC in 2007. The majority of the attack occurred in the NIFR (71%) with the Skeena Stikine, Fort St. James and Mackenzie Forest Districts most affected. For the fifth consecutive year Douglas-fir beetle infestations rose, with 80,776 ha of attack delineated provincially. The Central Cariboo, Chilcotin, 100 Mile House and Quesnel Forest Districts of the SIFR contained 94% of the attack. Recorded spruce beetle damage dropped by more than half since last year to 38,775 ha affected. Most of the mortality occurred in the Central Cariboo, 100 Mile House, and Okanagan Shuswap Forest Districts.

The primary defoliator in 2007 continued to be the western spruce budworm, which damaged 847,344 ha across the southern half of BC. Most (97%) of the defoliation occurred in the Central Cariboo, Cascades, 100 Mile House and Kamloops Forest Districts of the SIFR. Infestations also occurred in the Chilliwack and Squamish Forest Districts of the CFR. To reduce damage caused by this outbreak, a record 57,000 ha of high value stands in the SIFR were treated aerially with the biological control agent *Bacillus thuringiensis* var. *kurstaki* (Btk). The two-year-cycle budworm was also active across 39,854 ha this year, primarily in the Fort St. James, Nadina, Quesnel and Headwaters Forest Districts. Other defoliating insects that caused damage in 2007 included the large aspen tortrix in the NIFR. Infestations declined for the fourth consecutive year, with 61,910 ha affected.

Monitoring traps caught 153 male gypsy moths (North American strain of European gypsy moth) in 2006, resulting in ground spraying of *Btk* in the spring of 2007 in Victoria/Saanich, Colwood and Saltspring Island, plus treatment from the air on 210 ha in Courtenay. These treatments were followed up with high density mass trapping. Monitoring traps caught only 29 moths in 2007.

Of the abiotic damage agents, wildfire continued to affect the largest area, with 33,756 ha of damage occurring primarily in the southeast corner of the province. This is almost one-fifth the area burnt last year however, due to extensive rain that occurred in most areas during the fire season. Yellow-cedar decline was identified this year on 23,930 ha along the coast of BC. Windthrow damage occurred on 6,803 ha, of which 41% of the disturbances (caused by a large snowfall and wind events fall 2006) were located in the Peace Forest District.

Most diseases are not easily mapped during this overview survey. However, some foliar diseases like larch needle blight can be mapped. In 2007, 13,540 ha of larch were still damaged by needle blight in southeastern BC, an 80% reduction from the previous year. Dothistroma needle blight affected 2,597 ha in 2007, primarily in the NIFR. This was a similar amount to that noted last year but severity was much lighter, reflecting the dry 2006 growing season.

Other forest health factors such as forest tent caterpillar, aspen leaf miner, eastern spruce budworm, flooding and cedar leaf blight caused local damage.

2007 SUMMARY OF FOREST HEALTH CONDITIONS IN BRITISH COLUMBIA

INTRODUCTION

The diverse range of climate, soils and topography in British Columbia (BC) supports a wide variety of tree species in the forests. Many different damaging agents including insects, diseases, animals and abiotic factors can affect these varied forest types. Intensity of damage and size of disturbances caused by these agents can change dramatically from year to year. One of the primary monitoring tools for recording damage to the forests of BC on an annual basis is the aerial overview survey. This survey is currently (1997 to present) the responsibility of the BC Ministry of Forests and Range (MFR). Prior to 1997, monitoring surveys that included aerial overview surveys were conducted since 1912 in BC by the Canadian Forest Service's Forest Insect and Disease Survey.

The aerial overview survey is designed to capture forest disturbance information quickly and cost effectively over large areas. Collected information is recorded for individual forest health factors by severity of damage and is summarized by forest districts (Figure 1). Each forest region is responsible for surveying their area. The data is collated by Forest Practices Branch for inclusion in the provincial Land and Resource Data Warehouse.

Information from this survey is used for a variety of important purposes, including: monitoring changes in forest health conditions over time, providing input to Timber Supply Analysis, setting Government strategic objectives, providing supporting data for research projects and contributing to national indicators for sustainable forest management.

This report summarizes the 2007 aerial overview survey results. Disturbances that are visible during the surveys are included, such as tree mortality and most defoliation damage. Other forest health concerns, in particular diseases such as rusts, cankers and dwarf mistletoes, are not usually discernable. Information collected by methods other than the aerial overview survey on these agents was included in this report if it arose as a concern and/or damage conditions changed since last year. To ensure consistency, this additional information was not added to the overview data.

Additional insect population predictions, damage agent observations, forest health presentations, projects and publications have been provided by MFR staff and their associates. The intent of this report is to summarize forest health conditions from a MFR perspective: this does not necessarily include research and management of forest health in BC by other agencies such as universities and other levels of government.

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

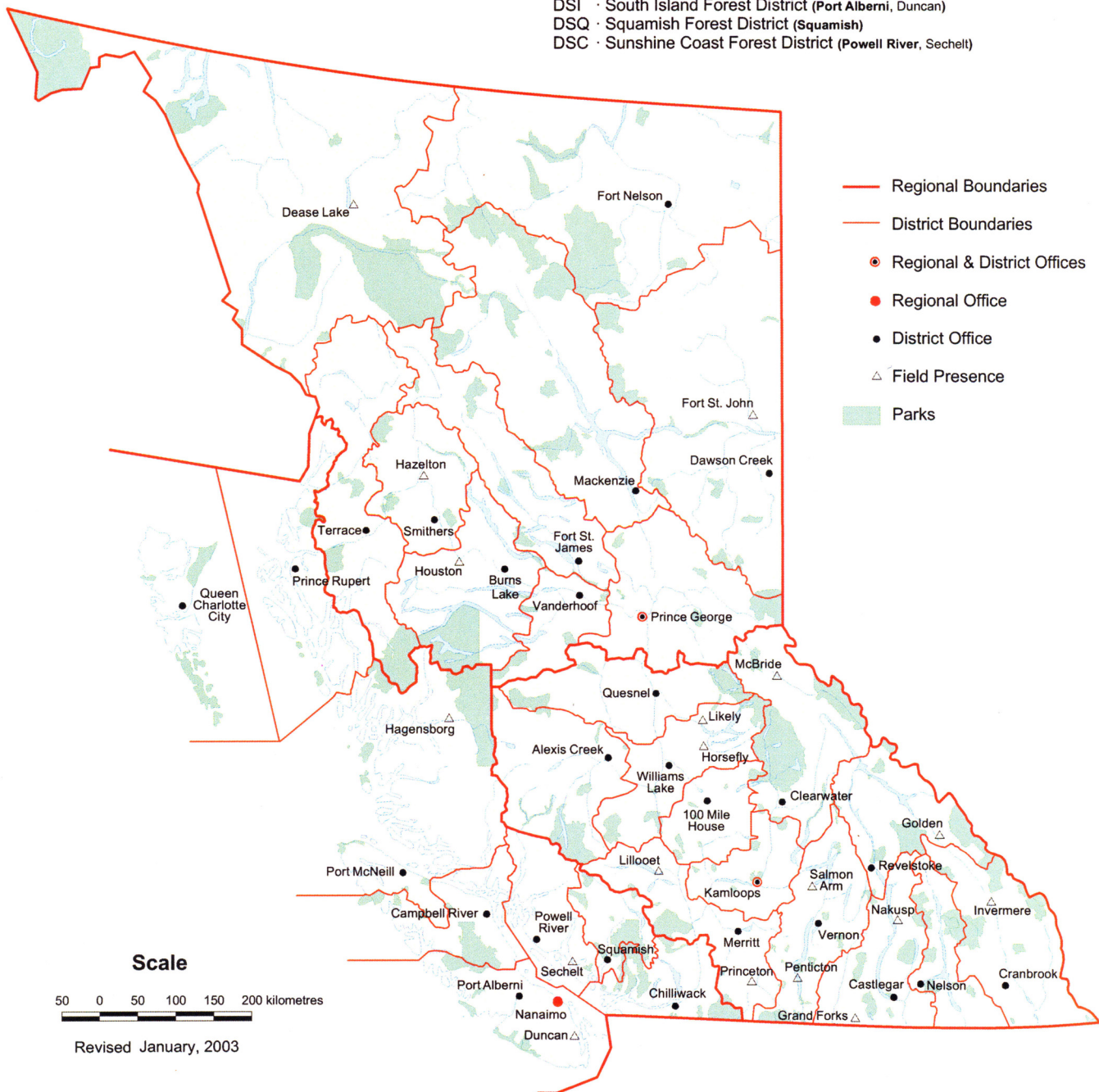


Figure 1. Map of British Columbia outlining regional and district forest boundaries as of April 1, 2003

METHODS

Fixed wing aircraft are utilized to conduct the aerial overview surveys. Experienced personnel use 1:100,000 scale maps to sketch the forest health disturbances on. Colour Landsat 5 satellite images are utilized for the base maps, with some features digitally enhanced to improve spatial orientation. Details of survey methodology are available online at the Integrated Land Management Bureau website: <http://ilmbwww.gov.bc.ca/risc/pubs/teveg/foresthealth/index.htm>.

Survey flights are conducted, conditions permitting, when damage from the primary forest health factors are most visible. This survey “window” varies by damage agent and general location. Flights across the province were carried out from July 5th to Sept 26th in 2007 (Table 1). In the southern portion of the province weather conditions were reasonable. Intermittent rain resulted in some breaks in the surveys, but this same rain kept visibility good by reducing haze and wild-fire hazards. Wildfires were an issue in the latter part of the summer for the Nelson zone, but most of the surveys there were completed before then. Weather in the Northern Interior Forest Region (NIFR) however was generally poor, with very frequent rain events. A total of 884 hours were flown during the 2007 survey period. Flight hours in the NIFR were higher than previous years, due to higher intensity flight lines.

Table 1. Flying hours and survey dates by region undertaken for the 2007 provincial aerial overview survey.

Region	Zone	Flight hours	Survey Dates
Southern Interior Forest Region	Cariboo	182.9	July 18 th – Aug 23 rd
	Kamloops	54.8	July 24 th – Aug 2 nd
	Nelson	105.9	July 15 th – Aug 9 th
Northern Interior Forest Region		468	July 5 th – Sept 26 th
Coast Forest Region		72.4	July 25 th – Sept 12 th
Total		884	July 5th – Sept 26th

Flight lines were recorded with hand-held Global Positioning Satellite (GPS) receiver units, with the exception of the Queen Charlotte Islands. The resulting digital files were used to monitor survey progress and ensure adequate coverage (Figure 2). Flights were conducted between 450 m – 1000 m above the ground in a grid pattern where topography was relatively flat and by drainages in mountainous terrain. Flying height and intensity of coverage depended on visibility and the extent of damage.

The goal was to survey all forested land in the province. The northwest portion of the NIFR has historically had low forest health factor issues and was therefore of lower priority to survey. It was usually left to the later part of the survey window but poor weather over the past two years near the end of the survey window has resulted in no data collection from this area. To address this issue, in 2007 the first area surveyed in the NIFR was the northwest. Unfortunately, poor weather then resulted in coverage gaps in the Mackenzie and Fort St. James Forest Districts.

Operational aerial survey data collected from fixed and rotary wing aircraft was incorporated into the survey summary to partially fill the data gaps. Not all forest health factors may have been recorded during these surveys. In total, 78% of the province was flown in 2007, compared to 82% last year (Figure 2).

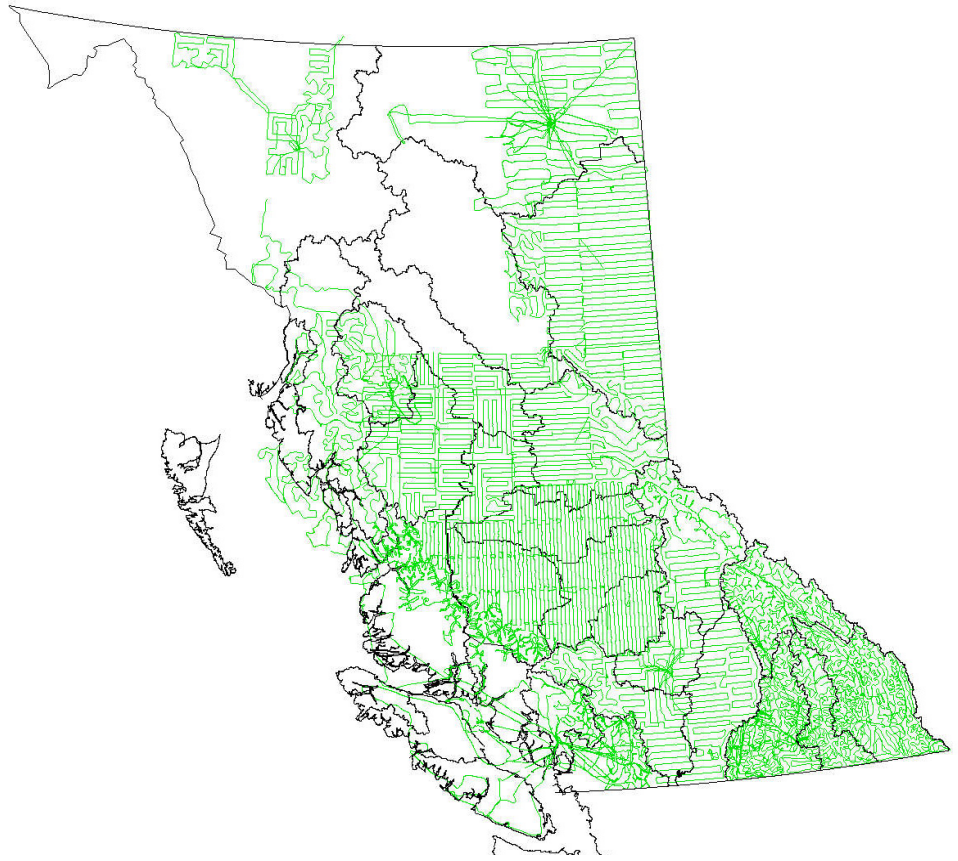


Figure 2. Flight paths flown while conducting the 2007 aerial overview surveys.

Only new damage is mapped each year for all damaging agents. Disturbances with causal agents that are not discernable from the air are ground checked, if access is possible. It is important to note that hectares of damage from past years cannot be added cumulatively, as new defoliation or mortality can appear in the same stands

that were damaged by the same forest health factor previously. The responsible agent is noted for each disturbance, and new in 2007 was the recording of primary host tree species. In some cases only one tree species is affected so this information is easily discernable to users of the data. Where multiple tree species can be affected however, this additional information can be valuable. For example, bark beetle populations can increase in spruce and Douglas-fir windthrow. Due to the significant number of young lodgepole pine stands dying from mountain pine beetle infestations, delineation was also made in 2007 between mature and immature stands for this specific case.

Trees killed by agents such as bark beetles were identified by observing foliage colour. Generally, dying tree foliage turns yellow to bright red, then over time colour intensity fades and foliage is shed. Large areas of mortality were mapped as polygons by five intensity classes (Table 2). Smaller areas of up to 50 trees were recorded as spots. To include these spots in total hectares affected, 1 – 30 trees were given a size of 0.25 ha and 31 – 50 trees 0.5 ha (intensity rating severe).

Tree defoliation (caused by insect feeding, foliage diseases or abiotic factors) is the other disturbance that is often visible from the air. This type of damage tends to be fairly widespread and is therefore mapped only as polygons. Three intensity classes are recorded, and they are assessed as a percentage of the foliage damaged over the entire polygon (Table 2).

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.

Hand mapped forest health disturbances were digitized using MFR Forest Practices Branch standards, available at: <http://www.for.gov.bc.ca/hfp/health/overview/arcinfo.htm>.

Fairly broad intensity classes, known errors of omission (i.e. missed trees) and other limitations of the aerial overview survey are recognized and limit the use of the data for certain applications. For example, accurate mortality volume estimations are not an expected outcome since actual number of trees killed (and consequently, volume) is not precise.



Aerial observer preparing to record forest health damage

GENERAL CONDITIONS

A total of 12,784,194 ha of damage to BC forests were observed during the 2007 aerial overview surveys (Table 3). Mortality caused by mountain pine beetle continued to be the leading cause, with a record 10.1 million hectares infested. The rate of increase in affected hectares has declined substantially over the last four years, which reflects the decline of infestations in areas where most of the host pine has been killed. However, the infestations on the leading edge of the mountain pine beetle outbreak increased substantially in 2007. Primarily trace levels of western balsam bark beetle mortality occurred across 1.5 million hectares of mature subalpine fir. Other bark beetles recorded as causing mortality were the Douglas-fir beetle and spruce beetle.



Mountain pine beetle was the leading cause of mortality in 2007



Western spruce budworm was the most damaging defoliator in 2007

Defoliating insects were the second leading group that caused damage in 2007. Western spruce budworm was by far the most damaging defoliator, with almost 850,000 ha affected. Large aspen tortrix and two-year-cycle budworm were the other primary defoliators. Injuries caused by abiotic factors remained the third largest grouping, with wildfire and yellow cedar decline being the main factors (Table 3). Damage caused by both defoliating insects and abiotic factors can fluctuate greatly from year to year.

The most damage attributable to a foliar disease was caused by larch needle blight. The overall amount of foliar disease damage recorded in 2007 was lower than in 2006. Incidences of identified animal damage remained very low. Both of these damage agent categories tend to be underestimated during aerial overview surveys because of the height flown and the abundance of mountain pine beetle mortality, which masks other more subtle damage. 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 2007 aerial overview surveys in British Columbia.

Damaging Agent	Hectares Affected
<i>Bark Beetles:</i>	
Mountain pine beetle ^a	10,051,919
Western balsam bark beetle	1,564,664
Spruce beetle	36,775
Douglas-fir beetle	80,776
Misc. beetle	1
<i>Total Bark Beetles:</i>	<i>11,734,134</i>
<i>Defoliators:</i>	
Western spruce budworm	847,344
Large aspen tortrix	61,910
Two-year-cycle budworm	39,854
Unidentified defoliators	4,672
Forest tent caterpillar	2,829
Aspen leaf miner	1,185
Eastern spruce budworm	1,137
Balsam woolly adelgid	860
Western hemlock looper	820
Green spruce aphid	604
Western blackheaded budworm	588
Alder sawfly	466
Douglas-fir tussock moth	88
Satin moth	34
Birch leaf miner	14
<i>Total Defoliators:</i>	<i>962,405</i>
<i>Abiotics:</i>	
Fire	33,756
Yellow cedar decline	24,283
Windthrow	6,803
Flooding	1,328
Slide	818
Frost Kill	173
Redbelt	86
Snow/Ice	24
Drought	14
<i>Total Abiotics:</i>	<i>67,284</i>
<i>Diseases:</i>	
Larch needle cast	13,540
Dothistroma	2,597
Cedar Leaf Blight	1,528
Aspen/poplar leaf/twig blight	1,313
Miscellaneous diseases	536
White pine blister rust	448
Laminated root disease	404
<i>Total Diseases:</i>	<i>20,366</i>
<i>Animals:</i>	
Porcupine	5
<i>Total Animals:</i>	<i>5</i>
Provincial Total	12,784,194

^aIncludes infestations in parks totalling 860,973 ha.



Western spruce budworm larva



Mountain pine beetle pitched out by tree response to attack

DAMAGING AGENTS OF PINES

Mountain pine beetle, *Dendroctonus ponderosae*

Provincial Situation

The mountain pine beetle continued to cause extensive mortality throughout the range of pine in BC (Figure 3). A record 10,051,919 ha were recorded as infested during the 2007 aerial overview surveys, with 860,973 ha of this located in provincial parks and protected areas.

Recorded hectares of infested timber rose sharply from 165,567 ha provincially in 1999 to 784,000 ha in 2001 (Figure 4). These dramatic increases continued through 2004, and then total affected hectares started to level off. For the past two years increases have been minor in comparison to the early stages of the outbreak, with a 6% rise from 2005 to 2006, and a further 8% from 2006 to 2007. This reflects the diminishing amount of unattacked pine that is left in the province.

Severity levels within attacked stands this year were 2,923,837 ha (29%) trace, 2,447,148 ha (25%) light, 2,933,172 ha (29%) moderate, 1,230,869 ha (12%) severe, and 516,894 ha (5%) very severe. Severe and very severe were the same levels as in 2006, but both the moderate and light intensity categories dropped, resulting in the trace category doubling.

Most of the infestations mapped at the trace level (with the exception of the Peace Forest District) represented scattered red attack that occurred within stands predominantly composed of old attack snags. In areas such as Quesnel and Vanderhoof Forest Districts, most of the beetle attack occurred several years ago in a “wave”

that killed most of the dominant, mature lodgepole pine. Within the last year or two however, these areas that had early attack have been experiencing a “backwash” effect, where the beetle is now damaging young stands and suppressed understory trees in the stands with dead pine overstory. These suppressed trees would not have even been visible aerially when the original estimates of percent stand attacked were made. Conversely, in areas such as the Kamloops Forest District where the leading edge of the infestation recently came through, the beetle pressure was so intense that many young stands and suppressed understory trees were killed along with the preferred mature stems.



Mortality due to 2004 mountain pine beetle attack west of Tagai Lake
in Prince George Forest District

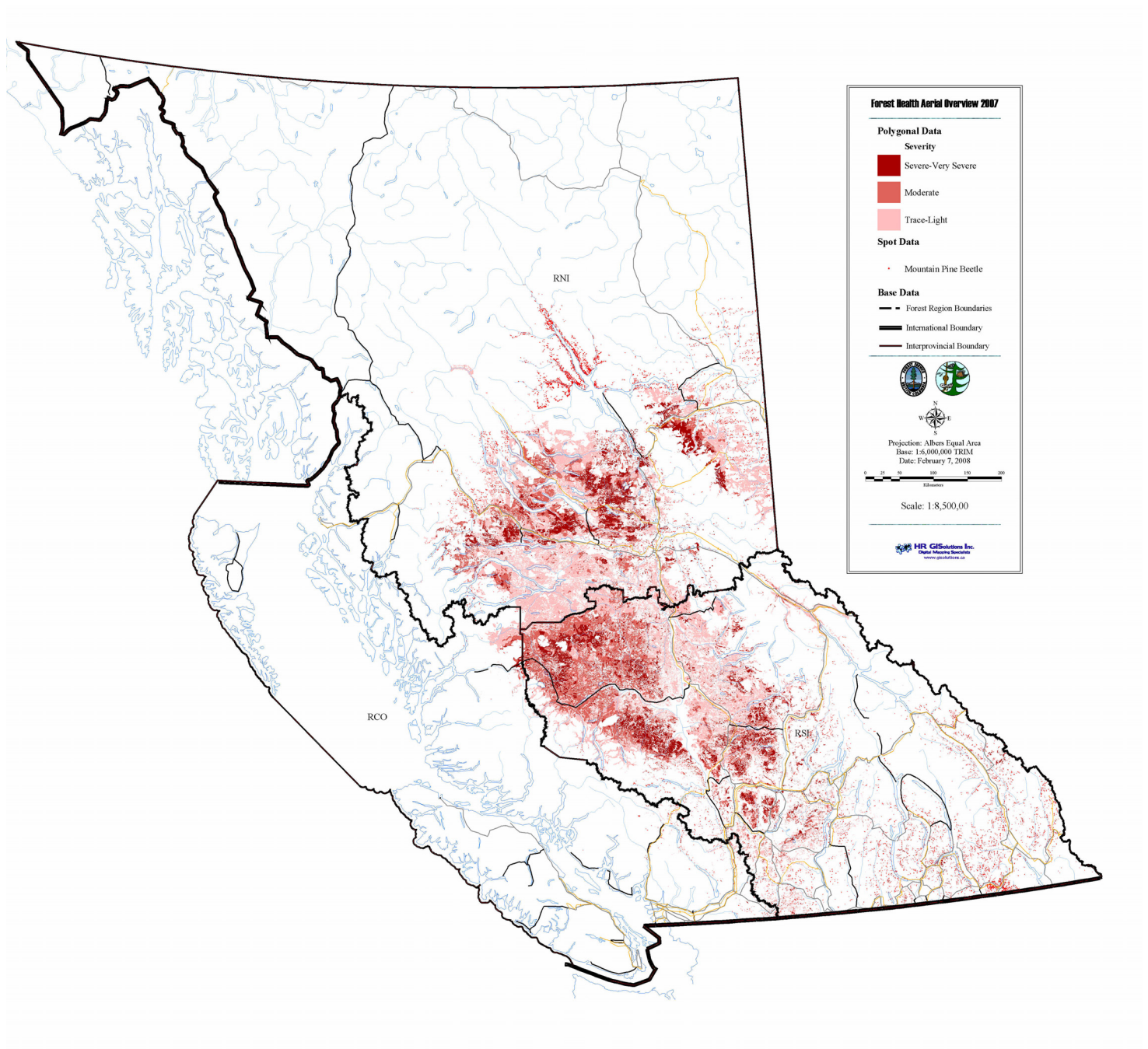


Figure 3. Mountain pine beetle infestations recorded in British Columbia in 2007.

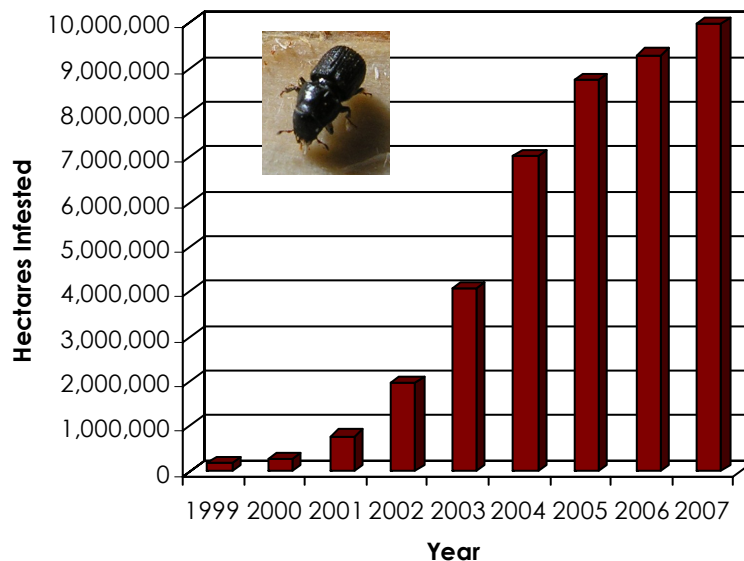


Figure 4. Hectares infested by mountain pine beetle from 1999 – 2007 in British Columbia.

Southern Interior Forest Region

Over half (5,380,729 ha) of the mountain pine beetle attack recorded in BC continued to be located in the Southern Interior Forest Region (SIFR). Of this, the majority (79%) of infestations were situated in the Cariboo area of the region (Figure 5).

For the third consecutive year, Chilcotin Forest District sustained the highest level of infestation with 1,491,475 ha affected. This level is 9% greater than in 2006, when 1,356,091 ha were observed to contain attack. Mortality within stands increased as well for the fourth year in a row, with 74% in the moderate to very severe range. Newly infested stands were located along mountain drainages in the south and west reaches of the district, particularly along Charlotte, Chilko and Tseko Lakes.

Infestations in the Quesnel Forest District declined slightly for the third year in a row, but the district still maintained the second highest level of attack in the SIFR, with 1,183,307 ha affected. The mountain pine beetle outbreak has been active in this district for several years, and the changes in attack intensity reflect this (Figure 6). Severe and very severe mortality levels have decreased substantially over the past two years, while trace has more than doubled since last year. The scattered trace mortality is all in old attack areas.

The Central Cariboo Forest District damage levels remained fairly constant, with a 4% increase over last year to 843,691 ha infested. Based on comments from aerial surveyors, attack continued to move into the younger age classes, where generally the intensity of damage appeared to increase from trace last year to moderate to very severe levels this year. Conversely, high severity levels in the mature stands have now moved to trace or light in old attack areas. When averaged for the district, trace severity jumped from 28% to 47% over last year, with a corresponding drop in light to 11%. Moderate, severe and very severe intensity levels remained constant at 19%, 11% and 12%, respectively.

Attack levels in the 100 Mile House Forest District were almost unchanged over 2006 with 725,137 ha infested. Severity of attack however dropped substantially over last year to less than half in the very severe category (11% from 27%) and was down to 9% from 15% for severe mortality. At the

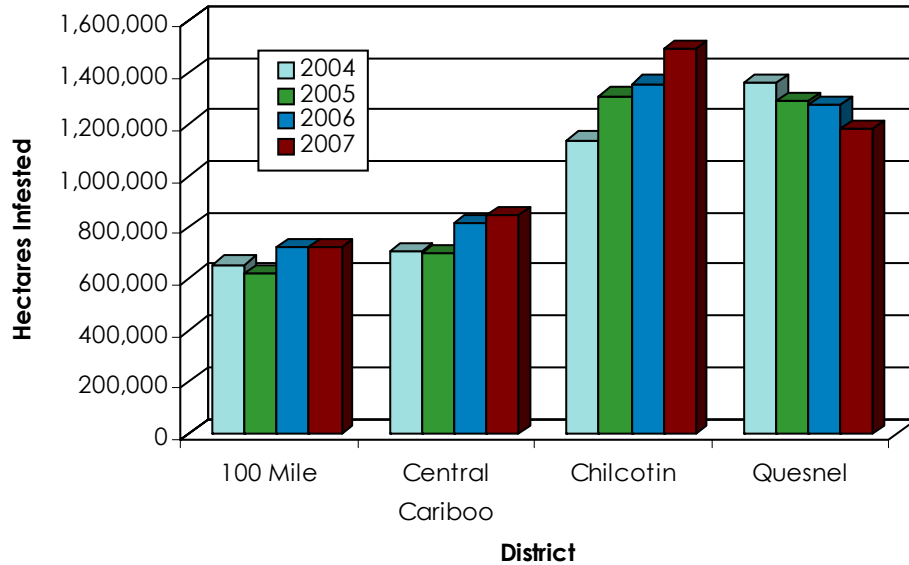


Figure 5. Hectares infested by mountain pine beetle from 2004 – 2007 in the Southern Interior Forest Region (districts with more than 500,000 ha affected in 2007).

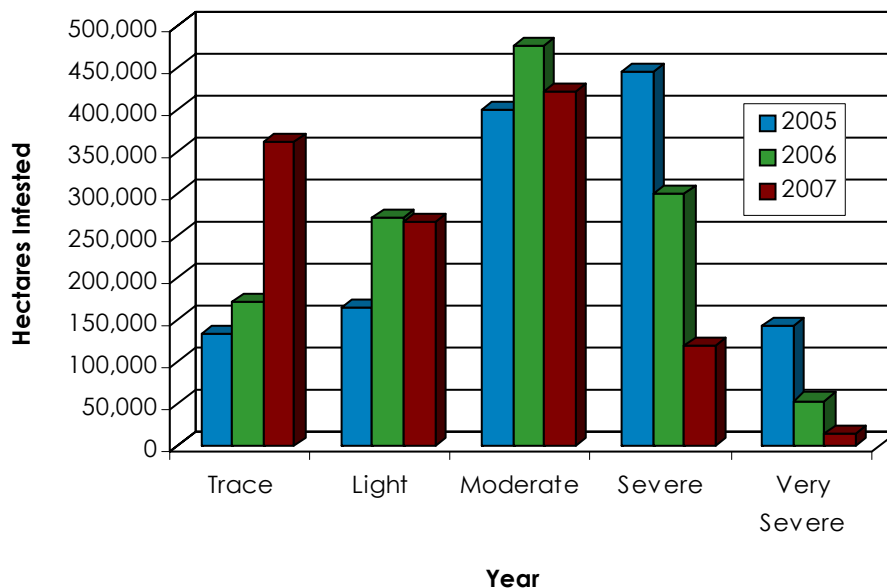


Figure 6. Change in severity of hectares infested by mountain pine beetle in the Quesnel Forest District from 2005 – 2007.

lower end, the area with trace intensity damage tripled to 33% from 13%. The most active infestations were located in the eastern portion of the district, from Canim Lake south to Loon Lake.

The mountain pine beetle attack in the Cascades Forest District increased sharply to 320,173 ha from only 195,176 ha last year. The majority of the mortality was in the light to moderate intensity range, at 46% and 34%, respectively. In the Merritt Timber Supply Area (TSA) portion of the district, infestations were concentrated in the north half but are moving southward. Young trees were being attacked in conjunction with mature trees, with approximately 50% of the stands affected. The expansion of the 100 Mile House and Central Cariboo Forest District's infestations into the Lillooet TSA was slower than anticipated. The Lillooet TSA also had less attack in the young stands than in the Merritt TSA.

Infestations recorded in the Kamloops Forest District dropped slightly to 303,230 ha from 320,759 ha in 2006. Intensity levels overall remained very similar to last year, though area and intensity of attack observed in young stands increased substantially. Attack was scattered throughout the pine

types in the district, with the heaviest infestations located along the 100 Mile House District border and south of Kamloops Lake.

Area affected doubled in the Headwaters Forest District, from 119,138 ha in 2006 to 233,269 ha. Infestations expanded and intensified along the southern district boundary and along the Fraser River in the Robson Valley. In areas along the Alberta border such as the Hugh Allen River, Renshaw Creek Morkill River and Holmes River drainages increases were lower, which may reflect the control efforts presently underway to inhibit expansion into Alberta.

Attack levels in the Okanagan Shuswap Forest District in 2007 remained similar to 2006 with 157,730 ha affected. The heaviest concentration continued to be on the west side of Okanagan Lake, with some movement south towards Peachland.

Observed infestations in the Rocky Mountain and Arrow Boundary Forest Districts dropped to 45,566 ha and 41,421 ha affected, respectively, compared to attack levels in 2006. The remaining attack in the SIFR was located in the Kootenay Lake Forest District (22,385 ha) and the Columbia Forest District (17,576 ha).



Young Lodgepole pine killed by mountain pine beetle in the Quesnel Forest District

Northern Interior Forest Region

Infestations delineated in the NIFR accounted for 44% of the attack recorded in the province this year. Almost all of these disturbances (95%) were contained in the five most southern districts (Figure 7). Total area damaged by the mountain pine beetle continued to increase to 4,471,668 ha compared with 3,899,040 ha last year.

Ground surveys in the NIFR have been complicated in many areas with attack starting unusually high up the tree (5m and up). This makes detection of current attack very difficult. It is theorized that this unusual attack pattern is wind driven.

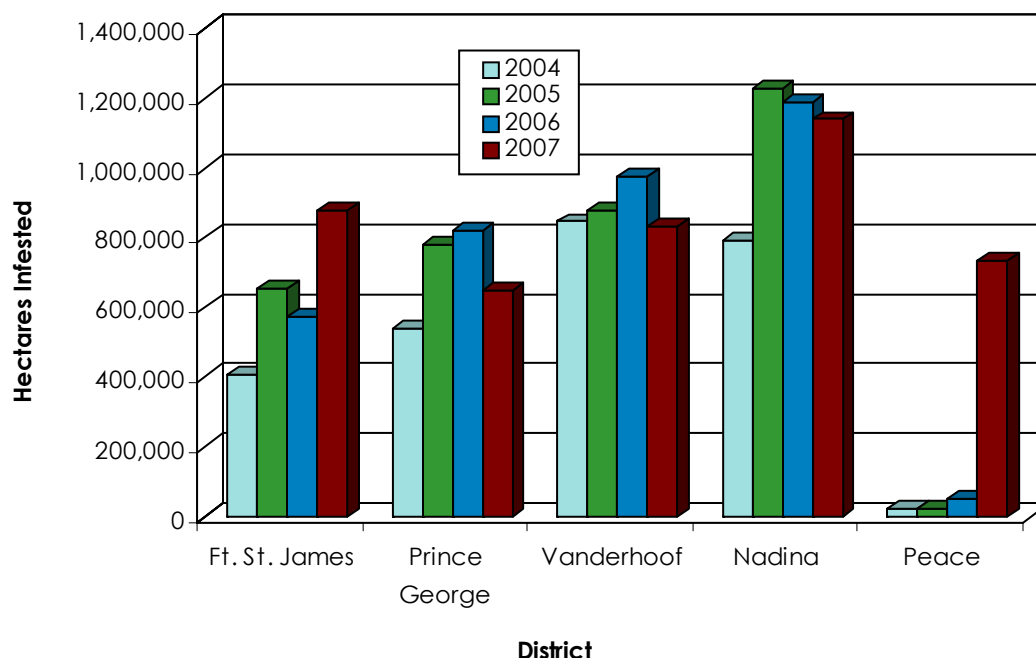


Figure 7. Hectares infested by mountain pine beetle from 2004 – 2007 in the Northern Interior Forest Region (districts with more than 500,000 ha affected in 2007).

For the third consecutive year Nadina Forest District sustained the highest levels of attack although total area continued to drop slightly, down to 1,140,002 ha from 1,186,684 ha last year. Despite the predominance of stands with high proportions of old, grey attacked trees, 162,048 ha of infestations in the Tweedsmuir Provincial Park and Entiako Protected Area were recorded and were mostly (70%) in the trace to light intensity levels. District-wide severity levels decreased, with trace at 30%, light 28%, moderate 29%, severe 12% and very severe 1%. Beetle infestations were still expanding into the Morice Lake (north-west) portion of the district, though not as quickly as anticipated.

Attack mapped in the Fort St. James Forest District increased substantially (35%) to become the second highest in the NIFR with 879,858 ha infested. Although poor weather prevented overview aerial surveying on the northern half of the district this year, the district staff was able to provide sketch mapping data for this area that was collected for a salvage harvest planning project. In the southern third of the district, pine stands are fully engulfed and are starting to turn grey. The beetle has been moving north, and the leading edge of the outbreak is now at the top end of the Nation Lakes. For the first time, attack in young stands was commonly observed. The general trend in mature stands is that infestations are growing in intensity, with severe increasing to 12% from 3% last year, and very severe to 9% from zero. The remaining area of attack is split between the trace, light and moderate groupings.

Although declining by 15% from last year's total area attacked, Vanderhoof Forest District contained the third highest level of attack in the NIFR with 830,626 ha affected. Infestations in the Entiako Protected Area dropped again this year to 63,700 ha affected. Intensity of attack continued to drop dramatically since most of the trees (except in immature stands) are grey. Trace mortality more than doubled since last year to 48% with a corresponding drop in the other categories.

Despite concentrated control efforts, infestations recorded in the Peace Forest District skyrocketed from 50,312 ha in 2006 to 736,499 ha in 2007 due to an unexpected mass migration of beetles in 2006 originating from the outbreaks in the central interior. Intensities of infestations were still relatively low, as would be expected in new areas of attack. Trace mortality was 45%, light 20%, moderate 13%, severe 14% and very severe 8%. Attack began in the southern portion of the district, and is now at high enough levels that suppression efforts have been abandoned. Beetle populations are now expanding north, with active areas in the north arm of Williston Lake, Arrow Creek and Osborne River. Suppression efforts continue north of Peace River where more whole tree mechanical fall and burn may be utilized this winter. The cost of this treatment method, where it can be utilized, is approximately one-tenth that of conventional fall and burn.

Prince George Forest District sustained the fifth highest level of attack in the NIFR, though delineated infestations dropped by 21% since the peak last year to 650,154 ha. The majority of the mapped mortality was in the western portion of the district, which corresponds to where the leading pine stands are located. Trace intensity was at 39%, contained primarily in the areas dominated by grey attack. Severe to very severe intensity classes were 11% and 13% respectively, and were mostly representative of attack in the younger age classes. Infestations were most active in the eastern Robson Valley and the Rocky Mountains.



Whole tree mechanical fall and burn treatment

Attack in the Mackenzie Forest District rose from only 969 ha in 2003 to 285,187 ha last year. Infestations mapped this year were down to 215,326 ha but this drop was due to weather interfering with a complete aerial survey of this district. Only the south tip was flown during the overview survey, and part of the north during a detailed survey (this information was rolled up into the overview data because of the incomplete survey). This still left a significant portion of the southern part of the district unsurveyed, where mountain pine beetle attack was known to be heavy. If population growth trends are similar to neighbouring districts, Mackenzie's total was probably well over 300,000 ha in 2007. Infestations intensified, with 14% in the severe and 13% in the very severe categories, compared to <1% severe last year. Mountain pine beetle infestations moved north up the Finlay River to just past Fort Ware in 2007 and eastward as well, most notably into the Ospika River drainage.

The Skeena Stikine Forest District sustained 18,430 ha of mountain pine beetle damage in 2007, up four-fold from last year. Intensity increased at the moderate level from 8% to 23%, though severe

mortality remained minimal at 1%. Infestations originated along the east and south boundary with Nadina Forest District, and were most active around Deep Creek, south of Chapman Lake, west of Babine Lake and up the Bulkley Valley to Telkwa. Current attack was reported for the first time within the town of Smithers.

Kalum Forest District contained the remaining 772 ha of recorded mountain pine beetle attack in the NIFR this year, up from only 58 ha last year. Mortality levels were still delineated as trace. A few spot infestations were located on the Kemano and Zymoetz Rivers, though the main observed attack was mapped on the Nadina Forest District boundary near Dogs Ear Peak. Current infestations reported in the Copper River drainage last year were intensively treated with fall and burn, but surveys to date have reported substantial new green attack. Thousands of additional new attacks occurred when beetles were blown in from the Nadina Forest District during a windstorm in the third week of August. Ground surveys have found infestations in and around Terrace wherever mature pines are located. Most of the attack is on private land thereby complicating management of these infestations.

Coast Forest Region

Infestations in the Coast Forest Region (CFR) declined slightly for the second year in a row to 199,522 ha of attack. The majority of the mortality (three-quarters in 2007) continued to occur in the North Island – Central Coast Forest District. Mountain pine beetle infestations were down almost 20% in this district since last year, to 150,597 ha. This was reflected in a similar downward trend in Tweedsmuir Provincial Park, with 137,380 ha of attack reported. Most of the mortality in the park is now grey (not recorded) or at trace levels. Average severity levels for the district were 42% trace, 27% light, 24% moderate and 7% severe.

The Chilliwack Forest District saw a sharp increase in area of attack, up to 31,922 ha from 19,257 ha last year. This was despite a 70% decrease in the infestations contained in Manning Park to 7,902 ha. Active areas included the northern half of Harrison Lake, the west side of the Fraser River north of Spuzzum Creek and the east side of the Fraser River north of Silverhope River. The highest intensity polygons were located near Boston Bar (94% of district severity remained at moderate or lower mortality levels).

Most of the remaining attack in the CFR was located in the Squamish Forest District with 16,848 ha affected, up 30% over last year. Intensity levels remained relatively low in this district as well. Infestations were located primarily in the western half of the district along the Lillooet River and adjoining side drainages.



*Mortality caused by mountain pine beetle in the
Squamish Forest District*

Small infestations totalling 155 ha of mainly trace attack was noted in the Sunshine Coast Forest District, primarily around Cortes Island and a small spot at the north end of Homathko River.

The small patch of mortality recorded last year about 10 km from Sayward on Vancouver Island in the Campbell River Forest District did not result in any new attack.

Beetle Flights / Larval Development

Beetle flights in the SIFR varied according to summer weather patterns. Kootenay Lake, Rocky Mountain and Arrow Boundary Forest Districts in the southeast generally had hot, dry July and August weather. This resulted in a concentrated normal flight peaking about mid July, with corresponding healthy late instar larvae overwintering. Minor flights occurred as late as early October, but the late brood that may develop from them will likely not affect the overall population.

For the remainder of the SIFR, frequent rain events resulted in interrupted, extended flight patterns with three general peaks: late June to early July, late August and mid to late September. The late flight beetle progeny are overwintering as early instar larvae which could be killed by a cold winter event. To date however, this event has not occurred.

Frequent rain in the NIFR also caused dispersed, non-synchronized beetle flights that in general began later than usual. In the western portion, the largest flight was in early August, with minor flights at the end of August and into mid September. In the east, the flight started the first week of July as is normal for this area, but was then interrupted by frequent rain storms that extended the flight period into early September. The Peace Forest District reported two primary flights in mid July and again late August to early September. In Fort St. James, flights were reported to be occurring as late as the end of September. The expected outcome of these late flights will be a high proportion of beetle progeny entering winter as first instar and even eggs thereby reducing overwinter survival and resulting in a higher proportion of brood undergoing 2-yr life cycles.

Tree Response to Attack

Unlike in previous years where drought was common, in 2007 plentiful rain and uncoordinated beetle flights in most parts of the province allowed for attacked trees to produce more resin (and consequently, larger pitch tubes) in response to beetle attack. There were some exceptions, particularly where high beetle populations occurred on the leading edge of infestations. Immature pine also continued to be poor at producing pitch tubes in response to mass attack.

Most currently attacked trees entered the winter without the early colour change (fading) that has been noticed to varying extents over the past few years. The most prevalent exceptions to this were the ponderosa pine and young lodgepole pine. The new infestation in Terrace also faded in the fall.

Population Fluctuations

Samples were collected from attacked trees in the early spring of 2007 in some areas to estimate overwinter mortality and vigour of progeny. Data collected included percent mortality of beetles and the number of gallery starts within the samples. This was used to calculate the "r" value for an area, which indicates whether a population is decreasing (<2.6), static (2.6-4.0) or increasing (>4.0).

In the SIFR, r-value samples were taken at a number of sites in mature and immature stands. A total of 1,305 mature trees were sampled across 131 sites in 2007 (Table 4). The r-values were averaged by district and predicted increasing populations for all districts. In the immature stands, 286 trees across 28 sites were sampled for districts where young pine were being attacked (Table 5). The r-values indicated that populations in young stands were increasing in the Okanagan Shuswap Forest District and the Lillooet TSA of Cascades Forest District. Populations remained static in the Merritt TSA of Cascades Forest District, and in all other districts populations appeared to be decreasing. This data concurs with other findings that on the whole, attack in young pine

does not usually contribute to an increasing beetle population.

Table 4. 2006/2007 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	10	100	52.5	6.1
Arrow Boundary	7	66	65.5	7.5
Cascades (Lillooet)	14	140	55.4	10.2
Cascades (Merritt)	14	140	27.2	13.8
Central Cariboo	5	50	57.3	5.2
Chilcotin	9	90	77.0	4.7
Columbia (Golden)	10	81	50.3	11.5
Headwaters (Robson)	9	90	59.7	6.5
Headwaters (Clearwater)	14	140	41.4	9.1
Kamloops	11	110	43.7	8.1
Kootenay Lake	5	51	62.3	9.8
Okanagan Shuswap	13	153	49	4.6
Rocky Mountain	10	94	60.9	8.9
Totals/Averages	131	1,305	54.0	8.2

Overwinter mortality sampling was also conducted in the suppression zones of the Peace Forest District in late May, 2007. The results were encouraging, with 73 to 100% mortality observed. The



Collecting overwinter mortality samples

Table 5. 2006/2007 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	77.8	1.7
Cascades (Lillooet)	1	10	48.7	6.3
Cascades (Merritt)	1	10	56.7	3.2
Central Cariboo	4	50	72.8	1.2
Chilcotin	3	30	97.9	0.3
Headwaters (Robson)	1	10	78.5	1.2
Headwaters (Clearwater)	1	10	100.0	0.1
Kamloops	4	40	64.3	2.3
Okanagan Shuswap	2	26	52.5	5.8
Quesnel	5	50	86.7	1.7
Totals/Averages	28	286	73.6	2.4

high mortality was likely due to several cold weather events in late November 2006, early April and May 2007. Similar results were

noted in sampling conducted across the border in northern Alberta. This result highlights the importance of late spring cold events in this district that would not normally be accounted for if r-value samples were taken in the more typical period of late March.

Forest districts with areas where efforts are being made to suppress mountain pine beetle populations conducted ground surveys. Green attack to red attack (G:R) ratio data was collected during these surveys. This statistic is another tool for projecting mountain pine beetle population growth in a given area. A >1 G:R ratio indicates an increasing population, while <1 G:R generally shows a declining population. These ratios must be interpreted carefully, as ratios higher than 5:1 may indicate the sample area was inundated by beetles from other sources.

For districts that are reporting this statistic, ground surveys are ongoing throughout the winter so data is still preliminary. Many factors can affect the ratios, including elevation, aspect and control measures. Where differences were very distinct, district divisions were noted (Table 6). On average, G:R ratio data indicates continued growth in beetle populations for the surveyed areas. Only the Morkill River area of the Headwaters Forest District showed a decreasing population. This information generally concurs with the results of the overwinter mortality data from the spring with the exception of the Peace Forest District. Despite high overwinter mortality in that district, it is suspected the high beetle numbers alone are still capable of driving populations upwards.

Table 6. Green to red mountain pine beetle attack ratios observed in 2007.

Region / District	High	Average	Low
NIFR – Mackenzie (North)	47:1	5.8:1	<1:1
Peace	31:1	7.5:1	0.1:1
Skeena Stikine			
South	10:1	5:1	1:1
Bulkley		<2:1	
SIFR – Arrow Boundary	2:1	1:1	<1:1
Headwaters (Morkill)	0.9:1	0.7:1	0.4:1
Headwaters (Holmes)	12:1	8:1	6:1
Columbia	5:1	2:1	1:1
Okanagan Shuswap	4:1		1:1
Rocky Mountain	4.2:1	1.3:1	0.4:1
Kootenay Lake	3:1		<1:1



Ponderosa pine killed by mountain pine beetle near Clinton

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 83,420 ha attacked. This total was up substantially over last year's when the host species was first recorded separately in the data with 46,775 ha of infested timber. Severity was classified as 8% trace, 48% light, 31% moderate, 12% severe and 1% very severe.

A small area (27 ha) of ponderosa pine mortality was recorded in the CFR. The remainder of the attack was located in the SIFR, throughout the range of ponderosa pine down to the US border and up to Chasm in 100 Mile House Forest District. Most affected were stands in the Kamloops Forest District, where 50,424 ha of attack were observed. Mortality in ponderosa is due in part to western pine beetle (*Dendroctonus brevicornis*), but it is suspected that the high mountain pine beetle populations are primarily responsible for the present attack. The beetle was still favouring the large trees, but adjacent young trees were also being killed.

At higher elevations near the treeline, whitebark pine mortality continued to rise as well, from 8,812 ha in 2006 to 14,238 ha in 2007. Severity levels were lower than for ponderosa pine, at 33% trace, 46% light, 18% moderate and 3% severe. All of this attack was located in the SIFR, scattered throughout nine of the twelve forest districts.

Young Pine Mortality

For the first time, young pine mortality was delineated separately from mature pine mortality during the aerial overview surveys. Over the past three years, immature pine mortality has become more and more noticeable. A total of 157,360 ha of attack were noted provincially in 2007. Severity levels were 16,446 (11%) trace, 33,367 ha (21%) light, 48,481 ha (31%) moderate, 39,580 ha (25%) severe and 19,486 ha (12%) very severe. Anecdotally, attack within young stands was observed to be very clumpy and concentrated: for example, it was common to have half a cutblock severely damaged, while the other half was unattacked.

The SIFR contained the majority of the attack, with 117,067 ha affected. Most of the infestations were contained in four districts: 40,119 ha in Quesnel, 38,121 ha in Central Cariboo, 16,758 ha in 100 Mile House and 12,758 ha in Kamloops Forest Districts. The remaining mortality was located in the Okanagan Shuswap, Headwaters, Chilcotin and Cascades Forest Districts.

A total of 40,293 ha of immature pine were affected in the NIFR in four districts. Prince George had 83% (33,422 ha) of the attack. Operational underplanting of 650 ha of immature pine mortality was undertaken this year with a mix of spruce (50%), Douglas-fir (25%) and lodgepole pine (25%). Snowshoe hare damage was a concern in underplanting, but larger stock in less susceptible sites (dry areas with less brush cover) were chosen for this method of regeneration. The large spruce beetle infestation from the 1980's in the Bowron River area east of Prince George that was replanted with a spruce/pine mix is now showing significant mountain pine beetle mortality. In some areas, attack density on individual young pine exceeded normal levels, with parent galleries less than 1 cm apart.

In Nadina Forest District 3,939 ha of attack were delineated, followed by 2,333 ha in the Vanderhoof Forest District. The rest (599 ha) of infested stands were located in the Fort St. James Forest District.

Aerial surveys do not record current year's attack as it is rarely visible. Ground observations in districts with young pine mortality suggest that current attack is on the decline, compared to levels detected over the past two years for most areas. Another interesting anecdotal ground observation is that beetle development appeared to be best on the south side of young pine in the NIFR, *vs.* the north side in the SIFR. It is suspected that this is a factor of temperature differences.



Aftermath of spruce beetle outbreak and escaped fire at
84.8km on Bowron Forest Service Road, 1986



Same location 2007 (21 years later) with regenerated
lodgepole pine stand attacked by mountain pine beetle

Young pine mortality during this outbreak has been primarily due to mountain pine beetle: however, a variety of other bark beetle species have also been found to be killing young pine. Hylurgops beetle (*Hylurgops rugipennis*) has been observed infesting the base of trees in conjunction with the mountain pine beetle in moist ecosystems, particularly in the Vanderhoof and Nadina Forest Districts. Lodgepole pine beetle (*Dendroctonus murryanae*) is another beetle that tends to mine at the base of the tree, and has been found to be predisposing pines to attack by mountain pine beetle in various areas. Ips beetles (*Ips* spp.) and twig beetles (*Pityogenes* spp.) tend to occupy the mid to upper bole of young trees above the portions colonized by mountain pine beetle but they have also overrun previously unsuccessful mountain pine beetle galleries.

A project has been undertaken to study and quantify mountain pine beetle attack in immature stands (Project 1, Pg. 52).

Related Forest Issues

Pine engraver bark beetle (*Ips pini*) populations have historically built up in the later stages of a mountain pine beetle outbreak to the point where they have caused significant mortality. To date, this has not been observed to a large extent with the exception of some affected young stands.

Warren root collar weevil (*Hylobius warreni*) has been recorded as migrating from beetle attacked mature stands into nearby immature pine stands. Studies are underway to determine how young stands are being impacted and how spatial patterns of salvage harvesting may affect weevil pressure.

Scattered interior spruce in mixed spruce/pine stands were killed by mountain pine beetle for the third year, due to intense beetle pressure in some areas. This did not usually result in successful tree colonization although it was documented in a few trees in the NIFR again in 2007. Two studies of this phenomenon were undertaken in 2007 in the Prince George area and have been submitted for publication. Some black spruce were also attacked by mountain pine beetle in the NIFR this year, but no successful colonization was found.

Another example of unusual mountain pine beetle attack was observed in Kootenay Lake Forest District where a severely scorched pine tree was mass attacked shortly after the fire and had well developed galleries. The outer bark was completely burned with very dry cambium and no needles, which would not normally be considered palatable for mountain pine beetle.

Protecting High Value Pine

At a smaller scale, varying degrees of success were reported for treatments designed to protect individual high value pine trees. The tree injection system tried in 100 Mile House Forest District last year did not have very encouraging results (Project 2, Pg. 55).

To try and protect young lodgepole pine stands, a trial was undertaken using plastic Hercon® flakes impregnated with the pheromone repellent verbenone and applied aerially. The trial took place in the SIFR on TFL 49. Five 20 ha treatment blocks were laid out in 20 – 25 year old stands of 80+% lodgepole pine, as well as five 20 ha control blocks. Application took place with a Hiller 12E helicopter on June 28, 2007. An assessment was conducted in the fall and preliminary results were encouraging (Project 3, Pg. 56).

Various pine species continued to be preventatively treated on private land, in seed orchards and in some city/university urban forests. Use of the verbenone pouches was common, by itself or in conjunction with the insecticide Sevin®. These measures continued to produce variable results, depending on how high beetle populations were in conjunction with the direction of the prevailing winds.

The City of Kelowna continued to experiment with wrapping boles of susceptible trees with fibreglass screen. Scots pine in a lakeside park were wrapped, however the screening from two trees was vandalized. The beetles mass attacked these two trees, but only lightly attacked the remaining trees through a few holes in the screening. These trees are expected to live. A further screening experiment was conducted by the city near the Kelowna landfill this year. Twenty pine were wrapped and verbenone was placed at the top of the trees above where the wrap could not be used. Twenty control pine were also chosen and all forty were baited with aggregation pheromones, to ensure beetle pressure. As soon as the control trees began to get attacked, the aggregation pheromones were removed from all the trees. All control trees were mass attacked. The beetles were observed running up and down the screened trees looking for an entrance, and finally a few burrowed slightly under the ground to get past the screen at the base and a few found entrances just above the screen at the top. This behaviour resulted in two light rings of attack at the base and tops of the trees. Attack is very light and the prognosis for the trees' survival is good. A detailed assessment will be conducted next spring.



Verbenone for sale in Creston

Dothistroma needle blight, *Dothistroma septospora*

Dothistroma (redband) needle blight damage was recorded on 2,597 ha of immature lodgepole pine during the 2007 overview surveys. This is a similar area of defoliation as was mapped in 2006, but severity levels were down substantially with only 6% severe, 33% moderate and 61% light intensity delineated. It is suspected that this is a reflection of the relatively dry 2006 growing season, which was not conducive to Dothistroma infection.

Most of the damage occurred in the Skeena Stikine and Kalum Forest Districts, with 1,557 ha and 1,031 ha affected, respectively. Defoliation from infections in the Skeena Stikine Forest District was noted in the Cranberry River corridor, along the Stikine River and near Mount Weber. Kalum Forest District damage was identified northwest of Swan Lake, near Dragon Lake and small but new sites near Kleanza Creek. A small plantation of 8 ha of damage south of Blue River was also identified in the Headwaters Forest District.

Identification of older dying needles underneath the flush of current foliage is difficult using the overview survey methodology. Frequent rain during the survey period also washed off dead needles, which reduced damage visibility. Therefore, actual stand damage was most likely higher than recorded. Detailed aerial surveys using helicopters and lower flight elevations were not conducted in the NIFR in 2007, though they are planned for 2008.

Detailed aerial surveys were performed in the northern portion of Headwaters Forest District in 2007. The most severely affected areas were identified around Castle Creek and the Upper Holmes River drainage southeast of McBride. In stands of lodgepole pine along the north end of Kinbasket Lake, 70-80% of trees were severely blighted with about one year of foliage retention. On the east and west side of the North Thompson River north of Blue River, about 20% of trees in stands of lodgepole pine were severely blighted.

Observations of planted western white pine from a variety of sites in the Okanagan Shuswap, Arrow Boundary, Columbia, and Kootenay Lake Forest Districts revealed unique host reactions on trees infected with Dothistroma needle blight. Symptoms included small (5-10 mm) resinous lesions in the bark at the base of needles that showed characteristic banding and fruiting bodies of *D. septospora*. Necrosis in bark stopped after the formation of a secondary periderm. Frequently, several circular lesions on the main stem amalgamated to form what appeared to be a larger stem canker. No fruiting bodies were observed on any circular depressions in the bark. A first report summarizing observations of Dothistroma on western white pine is currently being written for the publication *Pacific Northwest Fungi*.



Bark lesion caused by Dothistroma needle blight on western white pine

Two unusual areas of damage were noted from ground observations in the NIFR. Some light defoliation was identified north of Morrison Lake in the Sub Boreal Spruce Biogeoclimatic (BEC) zone. Interior Cedar Hemlock is the more common BEC zone where *Dothistroma* needle blight infections are found. Infected pine trees were also detected north of Dease River crossing in the Sub-Boreal White and Black Spruce BEC zone, which is the furthest north that *Dothistroma* has been recorded.

Planting to rehabilitate significantly damaged stands is planned for the spring of 2008. This will include a silviculture trial to be undertaken in the Kalum and Skeena Stikine Forest Districts. This trial is designed to test a variety of silvicultural treatments for their effectiveness in withstanding or eliminating browsing damage (in particular snowshoe hare) to seedlings planted under *Dothistroma* damaged trees within the first five years after planting. The trial variables will include: seedling protectors, tree species, seedling sizes, seedling origin, planting density and a range of site conditions. Results from this trial will also be useful for addressing the challenges faced with underplanting young pine stands damaged by mountain pine beetle.

The *Free Growing Damage Criteria* have also been adjusted this year for foliage retention after *Dothistroma* needle blight damage. The threshold for an acceptable healthy tree after defoliation was 20% foliage retention, but recent experience in the NIFR has shown that this is too low in regards to *Dothistroma*. Based on current observations of *Dothistroma* dynamics, a foliar retention threshold of 50% has been recommended.

On the research front, Alex Woods, NIFR regional pathologist, has been collaborating with Dr. Kathy Lewis of UNBC and three graduate students to investigate the history and genetics of *Dothistroma* needle blight and the relationship between weather and *Dothistroma* epidemiology.

Unlike the dry growing season of 2006, 2007 was very wet (the fourth wettest on record in Smithers), which provided ideal conditions for *Dothistroma* needle blight infection. Damaged needles turn colour during the next growing season so this year's rain is expected to result in increased *Dothistroma* damage showing up in 2008. Future monitoring for this needle blight will be essential, particularly for areas like the Robson Valley in Headwaters Forest District, which may experience increases in summer precipitation indirectly associated with global climate change.



Extensive Dothistroma needle blight damage to young lodgepole pine stands

White pine blister rust, *Cronartium ribicola*

White pine blister rust is an important damaging agent whose impact is apparent throughout its host's range but is rarely identified in aerial overview surveys. This year a total of 448 ha were mapped in the CFR at mostly the trace severity level. Sunshine Coast Forest District sustained 413 ha of damage primarily northeast of Campbell River on several small islands. Campbell River Forest District had 33 ha of mortality, mainly on Thurlow Island, and 1 ha of spot damage was delineated on the east side of Vancouver Island in the South Island Forest District.

Permanent sample plots have been established to study white pine blister rust infections and mortality rates on whitebark pine (Project 4, Pg. 57).



Canker on whitebark pine caused by white pine blister rust

Atropellis canker, *Atropellis piniphila*

Field observations from young (>25 year-old) stands in the Columbia, Okanagan Shuswap and Kamloops Forest Districts suggest that Atropellis canker is having an impact on lodgepole pine after it is declared free growing. Such observations are supported by preliminary data obtained from the Okanagan TSA Effectiveness Evaluation project investigating whether stands are currently meeting timber productivity expectations. Atropellis canker is rarely observed on pine before about the age of 20 and is not usually detected in a free-growing survey. Stem deformation, resinosus and black stain reduces the quality of the wood and lumber recovery. More surveys are needed to quantify the incidence and severity of Atropellis canker in pine and its associated impact on timber supply.



Atropellis canker on lodgepole pine

DAMAGING AGENTS OF DOUGLAS-FIR

Western spruce budworm, *Choristoneura occidentalis*

Recorded Defoliation

Defoliation by western spruce budworm continued on an upward trend in 2007 with 847,344 ha affected provincially (Figure 8). Severity of infestations dropped however, with 729,513 ha (86%) light, 112,927 ha (13%) moderate and 4,905 ha (1%) severe recorded.

The majority of the damage continued to occur in the SIFR with 804,305 ha (97% of total) affected. This is the highest recorded defoliation since 1987, when over 820,000 ha of infested stands were delineated.

Central Cariboo Forest District continued to sustain the most defoliation, with 223,145 ha of damage recorded (Figure 9). This was a minor drop in total area from 246,053 ha last year, but severity decreased significantly to 89% light from 63% light in 2006. Infestations occurred throughout Douglas-fir stands from McLeese Lake in the north through to the boundaries with Chilcotin and 100 Mile House Forest Districts.

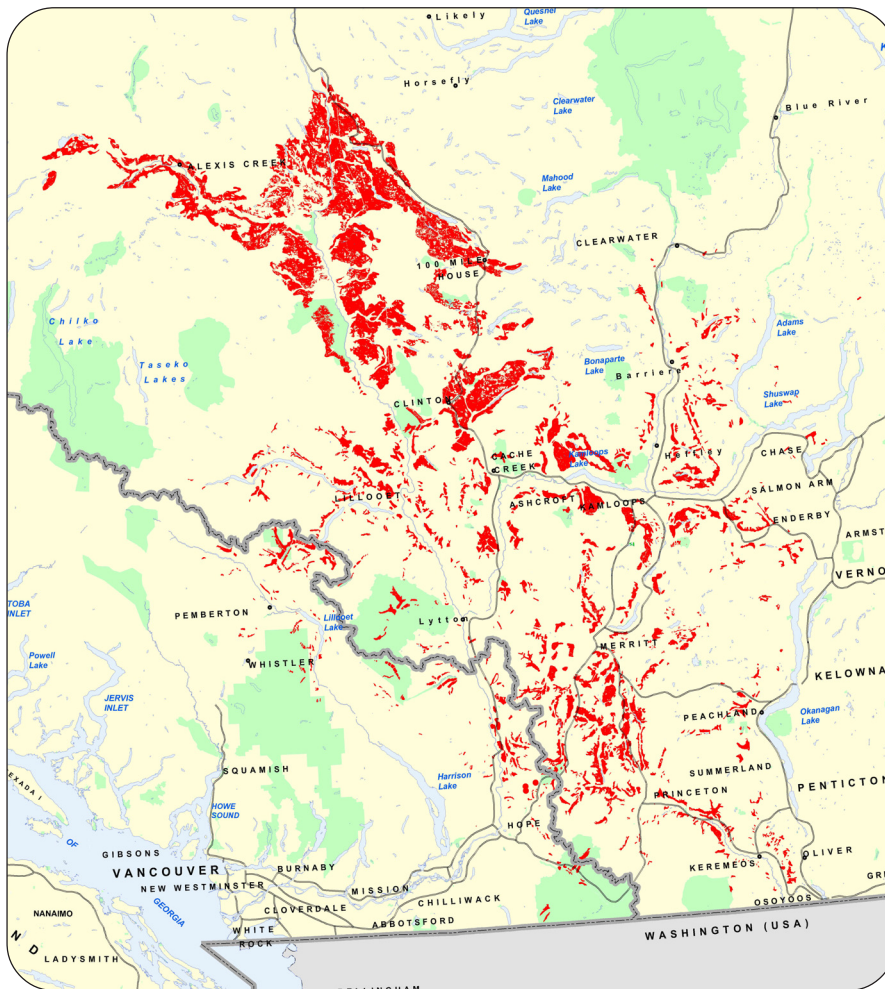


Figure 8. Areas defoliated by western spruce budworm in BC in 2007.

Cascades Forest District sustained the second highest level of defoliation, with 196,890 ha affected. This represented a 12% drop since last year, but was still more than double the hectares mapped in 2005. A quarter of the defoliation was rated at moderate to severe intensity. Infestation locations in the Merritt TSA were similar to the locations in 2006; near Coldwater River, north and south of Merritt, around Tullameen, Allison Lake and Princeton. Lower elevations though, in particular around Princeton, sustained lighter than expected defoliation. It was thought to be due to a combination of severe previous defoliation (lack of current food source) and an early warm spring which resulted in larvae emerging before buds were ready, causing significant

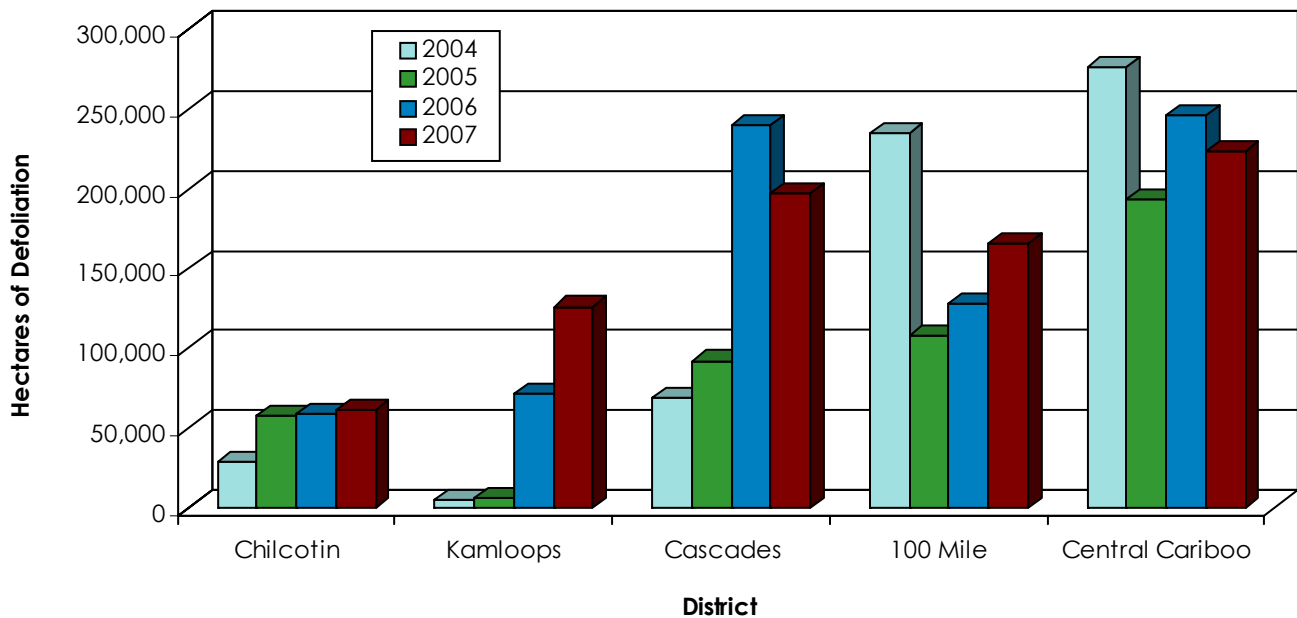


Figure 9. Hectares of western spruce budworm defoliation from 2004 – 2007, for districts with over 50,000 ha damaged in 2007.

mortality. Higher elevation infestations continued to thrive though, and defoliation continued to be mapped in subalpine fir stands along the Coquihalla highway (continuing into the Chilliwack Forest District) as well as in traditional Douglas-fir host stands. Infestations in the Lillooet TSA occurred west of the Kamloops Forest District border around Lillooet and Anderson, Pavilion and Carpenter Lakes.

Infestations in 100 Mile House Forest District steadily increased for the third year in a row to 165,994 ha affected, though this was still well below 2004 levels. The main areas were noted south of Lac La Hache to Horse Lake, around China Gulch, near Eighty-three Mile (defoliation is rapidly increasing in this area) and around Clinton as far east as Young Lake. This is the first time since the MFR took on the aerial overview surveys in 1999 that defoliation has been recorded as far east as Young Lake.

Defoliation in the Kamloops Forest District took the largest jump, increasing by three-quarters from 71,600 ha to 126,162 ha of damage. Infestations were scattered throughout the district, most notably north and south of Kamloops Lake, Scuitto Lake to Duck Range and Paul Lake to McLure. Damage was primarily recorded as light (94%) in 2007.

Damage observed in the Chilcotin Forest District has remained relatively static for the past three years, after doubling in 2004. A total of 61,861 ha of defoliation was mapped this year, from the western border with Central Cariboo Forest District south-west along the Chilko River and past Puntzi Lake to Pyper Lake. Although noted occurrence has spread slightly westward since 2006, intensity of damage is down dramatically: 77% of the stands were rated moderate – severe last year, but only 11% are higher than light in 2007, due at least in part to an aggressive treatment program.

Recorded damage was up almost three fold since 2006 in the Okanagan Shuswap Forest District to a total of 29,630 ha of predominantly light defoliation. The only other western spruce budworm damage recorded in the SIFR in 2007 was 623 ha of light defoliation in Headwaters Forest District along the North Thompson River.

Infestations in the CFR have increased for the past two years, and have more than doubled in the last year to 43,040 ha of observed defoliation. Damage intensity also continued to increase, with the moderate category doubling since 2005 to account for 33% of the area (1% reached severe, and the remainder was delineated as light). The Chilliwack Forest District sustained the highest attack with 24,338 ha recorded, primarily near the Fraser River north of Silverhope River Valley, north of Spuzzum Creek and in the Anderson River area. Squamish Forest District contained the remaining 18,702 ha, located mainly around Birkenhead River and the D'arcy area in the northeast quarter of the district. Most of the infestations in the CFR have moved out of the valley bottoms and into mature stands at higher elevations. Of greatest concern are young plantations that are being affected in the Anderson River area.

Treatment Program

In priority areas of concern, direct control measures were undertaken utilizing the biological agent *Bacillus thuringiensis* var. *kurstaki* (*Btk*). One aerial application of the *Btk* product Foray 48B® was applied to stands at a rate of 2.4 l/ha. Treatment of 57,000 ha occurred from June 15th – 23rd over five forest districts in the SIFR. This was the largest *Btk* program ever undertaken in BC.

The Cariboo portion of the program was conducted with two fixed wing AT 802 Air Tractors operating from the Williams Lake and 100 Mile House airports. A total of 21 areas ranging from 191 ha to 7,255 ha in size were treated, consisting of eight blocks in the Central Cariboo Forest District, seven in 100 Mile House Forest District (10,915 ha) and six in the Chilcotin Forest District (9,730 ha).

Treatment in the southern part of the SIFR was completed with one Lama AS315B Lama and one UH12ET Hiller helicopter. Ten blocks ranging from 173 ha to 6,015 ha in size were sprayed. Eight of the areas were located in the Kamloops Forest District and totalled 17,925 ha with the remaining 2,806 ha located in three blocks in the Merritt TSA of the Cascades Forest District.

Pre- and post- treatment egg mass sampling, though not a direct indicator of treatment success, suggested that significant population reductions were achieved in the 2007 treatment areas.



Aerial application of Btk by AT 802 Air Tractor

Egg Mass Survey Results

A total of 480 egg mass sites were surveyed throughout susceptible types in eight forest districts in the fall of 2006 (Table 7). The results were used to predict 2008 defoliation and to assist in prioritizing areas for spring treatment. Sites with moderate to severe defoliation were considered for treatment, depending on other criteria such as ecosystem (stand recovery capability), values at risk, and previous defoliation.

Table 7. Summary of 2007 western spruce budworm egg mass survey results.

Forest District	Number of Sites by Defoliation Category				Total Sites
	Nil	Light	Moderate	Severe	
100 Mile House	4	54	41	2	101
Cascades	2	50	59	7	118
Central Cariboo	2	51	15	0	68
Chilcotin	2	11	9	0	22
Chilliwack	0	1	6	1	8
Kamloops	0	36	65	16	117
Okanagan Shuswap	1	22	20	2	45
Squamish	0	1	0	0	1



Western spruce budworm egg mass

In the SIFR, Kamloops Forest District had the highest number of sites with moderate to severe defoliation predicted (a four-fold increase over last year), primarily reflecting increasing spread and severity of the infestations mapped in 2007.

Cascades Forest District (particularly in the Lillooet TSA) experienced a five-fold increase in sites with moderate to severe defoliation expected (59 and 7 sites, respectively).

In the 100 Mile House Forest District, sites with moderate defoliation expected almost doubled over last year to 41, though sites with severe predictions dropped somewhat. The primary areas of concern are around 83 Mile House, around Young Lake, and north of Jesmond in the Copper Johnny Creek area.

Okanagan Shuswap Forest District had twenty sites with moderate defoliation anticipated, and two at the severe level. This is a large jump from last year when no sites registered over the light defoliation level. The main areas of concern for this district are in the Westwold/Falkland area, Trout Creek near Summerland and south in the Similkameen River drainage.

Sites with moderate defoliation predicted dropped slightly in the Central Cariboo Forest District, but severe defoliation predictions dropped to nil from thirteen sites last year. Only a few areas around Hawks and Frost Creek, Farwell Canyon and North Gaspard are of interest.

The reduction in defoliation intensity as mapped this year in the Chilcotin Forest District was reflected in the site predictions: moderate sites remained the same at nine, but severe sites dropped from eight to nil. Only Bull Canyon and South Gaspard areas are being considered for possible

treatment. In total, 60,000 ha are targeted for treatment in the SIFR next spring, depending on funding.

The increase in mapped damage in 2007 for the CFR was mirrored in expected defoliation levels for 2008. Of the eight sites surveyed in the Chilliwack Forest District, six are predicted to have moderate defoliation and one to have severe, compared to none last year. Only one site was surveyed in the Squamish Forest District, and the prediction is for light defoliation.



Douglas-fir stand defoliated by western spruce budworm

Treatment of approximately 3,100 ha is planned for young high value plantations in the Anderson River area of the Chilliwack Forest District. This will be the first *Btk* treatment ever conducted for western spruce budworm control in this region.

Douglas-fir beetle, *Dendroctonus pseudotsugae*

Recorded Douglas-fir beetle attack rose provincially for the fifth year in a row to 80,776 ha of damage, up a quarter over 2006 (Figure 10). Severity of mortality in stands continued to be low with 56,617 ha (70%) trace, 14,868 ha (18%) light, 7,683 ha (10%) moderate and 1,608 ha (2%) severe. This is indicative of the small scattered patches that Douglas-fir beetle mortality often exhibits.

The majority of the infestations (94%) continued to occur in the Cariboo area of the SIFR (Figure 11). Overall damage was greatest in old growth management areas and mule deer winter ranges, where harvesting has been restricted to protect biodiversity and wildlife values. Tree stress from the extensive western spruce budworm defoliation in the Cariboo, particularly in the Chilcotin Forest District, likely contributed to increased Douglas-fir beetle mortality.

Overwinter brood assessments were conducted again in the spring of 2007 within three Cariboo forest districts. The results were used to produce an *r* value number for each district, which indicates if the population is decreasing (<0.7), static (0.7 to 1.3) or increasing (>1.3). The *r*-value in 2007 suggests that the population is still increasing, but at a lower rate overall than last year (Table 8). G:R ratios observed from fall surveys were highly variable, but they are generally indicating a decreasing population, particularly in the 100 Mile House Forest District. This may in part be attributable to extensive trap tree programs and sanitation harvesting.

Central Cariboo Forest District continued to sustain the majority of attack with a 16% increase over 2006 to 47,916 ha affected. This was less of a rise than the previous year, but still reflects a

steady four-year increase. Infestations are concentrated mid district along the Fraser River corridor, Gaspard Creek, Dog Creek and the Farwell Canyon area. Widespread blowdown (at least 200,000m³ of wood) occurred throughout Douglas-fir stands in the fall of 2007 in this district, and is cause for concern regarding further increases in Douglas-fir beetle populations.

Attack noted in the Chilcotin Forest District rose four-fold over last year to 10,532 ha. Damage expanded and intensified from the eastern boundary with Central Cariboo Forest District along the Chilko and Chilcotin River drainages to the Puntzi Lake area. Stands sustaining moderate mortality constituted 20% of the attack, which is double the provincial amount recorded at this level.

Infestations in the 100 Mile House Forest District more than doubled over 2006 levels to 9,733 ha affected. Mortality was observed primarily near the north district boundary around Eagle Lake, and the western district boundary near Canoe and Big Bar Creeks. Smaller infestations were located at Young Lake, Bonaparte River, and south-east of Clinton. An active current infestation at Canim Lake is presently being harvested by helicopter. Quesnel Forest District experienced a 20% increase in infestations since last year, with 7,586 ha of attack recorded. Most of the damage was noted in the Fraser River corridor, particularly in the Charleston area.

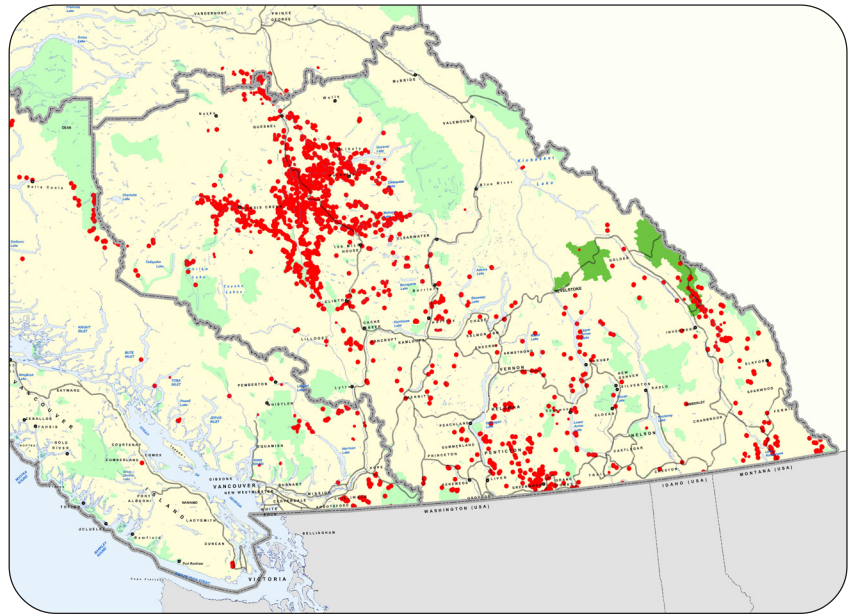


Figure 10. Douglas-fir beetle mortality recorded in BC in 2007

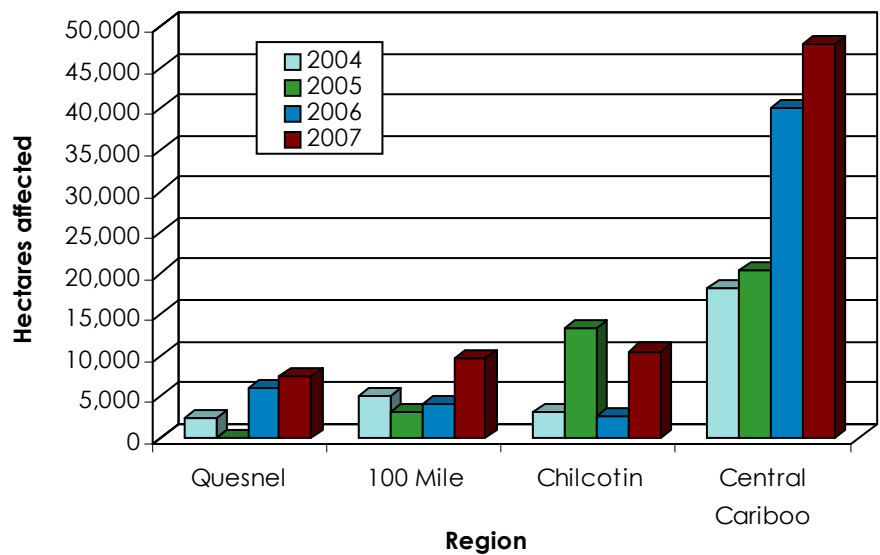


Figure 11. Hectares of Douglas-fir beetle damage from 2004 – 2007, for districts with over 5,000 ha damaged in 2007.

Table 8. Douglas-fir beetle overwinter mortality results for three Cariboo districts in 2006 & 2007.

Forest District	r Value	
	2006	2007
100 Mile House	3.34	2.49
Central Cariboo	4.58	3.43
Chilcotin	4.46	2.34

For the rest of the SIFR, Rocky Mountain Forest District sustained the highest levels of attack with 1,943 ha observed. Most of the attack was located in the south in the Elk Valley and on TFL 14, as well as along the Kootenay River at the north boundary. A total of 425 ha of mortality were recorded in the Arrow Boundary Forest District, primarily in the southwest along the Kettle, West Kettle and Granby Rivers. In the southeast section of the SIFR, Douglas-fir beetle was concentrated on ridges and steep slopes, particularly southwest slopes, at high endemic levels. Windstorm events such as the one that occurred in Rocky Mountain and Kootenay Lake Forest Districts in July could result in increased beetle habitat and hence increased populations.

Infestations in the Kamloops Forest District were scattered around Paul Lake, Heffley Lake, Louis Creek and Hat Creek. Only 257 ha were observed from the overview surveys, but the detailed flights picked up significantly more infestations. Small infestations were scattered throughout the remaining SIFR districts (200 ha or less per district).

In the CFR a total of 1,172 ha of attack were delineated, down 16% from last year. Ground surveys and observations suggest that the current population reflects this downward trend. There is concern however that widespread windthrow that occurred with several storms last winter may result in a Douglas-fir beetle population resurgence.

The majority of the CFR attack continued to occur in the Chilliwack Forest District, where 797 ha were affected, particularly in the Fraser Canyon, Nahatlatch River and Cowhead Pass areas. Surveys of major windthrow areas found patches of current attack of concern at Alexander Creek, Foley Creek and Tamihi Creek. An operational trial using the repellent pheromone MCH was also conducted in the spring of 2007. Initial results look good but assessments in the spring of 2008 will be needed to confirm this. Small areas of attack were also mapped in the Squamish (208 ha), North Island – Central Coast (133 ha) and Sunshine Coast (34 ha) Forest Districts.



*Mortality caused by
Douglas-fir beetle*

Recorded Douglas-fir beetle mortality in the NIFR dropped almost five-fold since last year to only 677 ha recorded, all in the Prince George Forest District. Intensity increased however, from primarily light to 38% moderate and 3% severe. These infestations occurred in the southern most portion of the district, near Punchaw Lake and in particular along the Blackwater River. Detailed surveys identified 112 sites, and initial ground surveys indicate large population increases with G:R ratios at 20:1 (range 1:1 to 69:1).

The aerial overview surveys did not pick up any attack in the Fort St. James Forest District, but small infestations reported last year have grown. Detailed aerial surveys identified 272 sites, and ground surveys report G:R ratios of 3:2. Fall and burn treatments of currently infected trees are underway. Douglas-fir blowdown and breakage occurred in the heavy fall snowfall of 2006, and is anticipated to exacerbate the Douglas-fir beetle condition in the NIFR.

Douglas-fir tussock moth, *Orgyia pseudotsugata*

Douglas-fir tussock moth populations are monitored on an annual basis with pheromone traps at established sites within known high hazard areas in Cascades, Kamloops, Okanagan Shuswap and 100 Mile House Forest Districts. The purpose of this system is to provide early warning of a rising population before significant defoliation occurs and to be able to initiate treatments for damage reduction.

Average numbers of moths caught per trap in each district have fluctuated considerably over the past six years, particularly in the Kamloops Forest District (Table 9). The threshold where an outbreak is likely (25 moths/trap for two to three years) has not been reached at the district level although numbers have been higher in specific areas, which reflects the localized nature of Douglas-fir tussock moth outbreaks.

Table 9. Average number of Douglas-fir tussock male moths caught per trap, 2002 – 2007.

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

^a 26 traps in 2007



Douglas-fir tussock moth larva
defoliating a blue spruce

Trap catches in the Kamloops Forest District continued to be the highest in the province, with the average number of moths almost doubling since last year. On a site specific basis, several areas just east of Kamloops had average catches substantially over the threshold level with the highest at 80 moths/trap on Robbins Range Road. This was substantiated with a small amount (87.8 ha) of defoliation recorded in 2007 in this general area (north of Campbell Lake). Intensity was noted as 12% light, 55% moderate and 33% severe. Moth catches also identified an area of concern near Heffley Creek north of Kamloops. Egg mass surveys are presently being conducted to refine infestation boundaries. A treatment program utilizing an aerial application of nucleopolyhedrosis virus (NPV) is planned for next spring in these anticipated outbreak areas.

Moth catches in the Cascades Forest District increased to an average of 5 per trap from only 1.4 in 2006, but this number is still well below outbreak levels. Trap catches remained very low in the Okanagan Shuswap and 100 Mile House Forest Districts. No Douglas-fir tussock moth damage was observed in these districts during the aerial overview surveys this year.

Laminated root disease, *Phellinus weirii*

Laminated root disease is a significant damaging agent of Douglas-fir, but infection centers are very hard to identify during the aerial overview surveys and are rarely mapped. In 2007, 404 ha of damage were delineated in the CFR, mostly at the trace to light severity level. Squamish Forest District had 277 ha affected, primarily north west of Pemberton along the Lillooet River and Lillooet Lake. A total of 126 ha of damage was noted in the Chilliwack Forest District, predominantly east of Hope and along the Skagit River.



Laminated decay of Douglas-fir caused by Phellinus weirii

A project is presently underway to study the distribution and incidence of laminated root disease in the SIFR (Project 5, Pg. 58).

DAMAGING AGENTS OF SPRUCE

Spruce beetle, *Dendroctonus rufipennis*

Spruce beetle caused mortality in 38,775 ha of mature spruce stands across BC in 2007. This is less than half the 83,660 ha recorded as infested last year, and well below the last peak of 315,953 ha in 2003. This recent dip in observed damage levels may in part be due to the two-year life cycle of the spruce beetle. Attack intensity however was higher than 2006, with 14,457 ha (39%) trace, 9,013 ha (25%) light, 7,740 ha (15%) moderate and 5,564 ha (15%) severe to very severe.

Spruce beetle infestations are difficult to map even under normal conditions due to the subtle, quickly fading colour change that occurs with attack. This situation is presently compounded in stands containing pine, as heavy mountain pine beetle mortality is tending to mask the spruce beetle damage. In some cases, particularly in the Central Cariboo and Quesnel Forest Districts, it is likely that the aerial overview surveys were significantly underestimating infested area.

Most of the damage (92%) was mapped in the SIFR. Infestations remained highest in the Central Cariboo Forest District although they were half of last year, with 14,412 ha affected. All infestations were in the east portion of the district, concentrated north and west of Quesnel Lake, south of Horsefly Lake and east of Crooked Lake. 100 Mile House Forest District attack dropped from 15,279 ha of mortality last year to 8,643 ha in 2007. Infestations were all in the northeast corner of the district around Hendrix Mountain, Boss Creek and west of Bosk Lake. For several years now the other district with significant spruce beetle damage was Quesnel Forest District, where infestations dropped dramatically from 28,483 ha last year to only 1,601 ha in 2007. Recorded mortality was primarily mid district in the Swift River valley area.

Unlike the large drops experienced in the northern districts of the SIFR, some of the southern districts had increases in spruce beetle damage. The Okanagan Shuswap Forest District saw

recorded mortality rise more than five-fold over last year to 5,874 ha. The majority of the mapped outbreaks were in the southern portion of the district in Cathedral Provincial Park and the Snowy protected area. A new outbreak was discovered west of Penticton near Nickel Plate Lake this year, with 234 green attack and 50 red attack identified in ground surveys. This infestation has been dealt with by a licensee.

Most of the remaining SIFR attack occurred in the Kamloops, Cascades, Rocky Mountain and Headwaters Forest Districts with 1,721 ha, 1,656 ha, 1,094 ha and 558 ha affected, respectively. The infestation of most concern from these districts continued to be at Sun Peaks near Kamloops.

Spruce beetle attack in the NIFR affected 515 ha, with 228 ha in the Peace and 178 ha in the Prince George Forest Districts. Infestations in the CFR totalled 483 ha in 2007, of which 350 ha were situated in the North Island – Central Coast Forest District, primarily in the northeast corner.

Stressed or damaged trees often provide conditions conducive to building spruce beetle populations. In the NIFR a very heavy snowfall event in the fall of 2006 resulted in widespread tree breakage in a variety of tree species including spruce. This situation is being watched closely by forest health staff so any outbreaks can be quickly acted upon. Another abiotic factor, fire, has the Kootenay Lake Forest District watching for spruce beetle attack. The 2007 Sitkum Creek fire in early August resulted in late summer attack of scorched spruce trees on the edge of the fire.

Rhizosphaera needle cast, *Rhizosphaera kalkhoffii*

Spruce can be infected with a needle cast disease caused by the fungus *Rhizosphaera kalkhoffii*. A severely infected tree may hold only the current year's needles. *Rhizosphaera* needlecast infects needles on the lower branches first and gradually progresses up the tree. As with many other needle diseases, new growth becomes infected during wet weather in the spring but symptoms are not visible until late fall or the following spring.

In the Morice TSA north of Houston, *Rhizosphaera* needle cast was identified about four years ago in a young interior spruce plantation. At the time, trees showed typical symptoms with very few healthy needles on the lower third of the crowns. It was anticipated at the time that the trees would recover from this disease. The stand was revisited in 2007 and as expected, most of the trees had recovered. However, almost 10% had not recovered and were either dead or very close to death. This level of severity is highly unusual, and it appears possible that the environmental conditions that have favoured the development of the current *Dothistroma* outbreak in the NIFR are also favouring other foliar diseases. How widespread infections by *Rhizosphaera* needle cast might be are unknown at this time.

Green spruce aphid, *Elatobium abietinum*

For the first time since the late 1990's, green spruce aphid damage was observed in BC last year. At that time, 195 ha of light defoliation were recorded at a number of bays on the west side of South Moresby Island in the Queen Charlotte Islands Forest District. In 2007, these infestations expanded and a few new ones were also mapped at the south tip of Moresby Island. A total of 604 ha were noted this year, and intensity increased dramatically from all light to all severe damage.

DAMAGING AGENTS OF TRUE FIR

Western balsam bark beetle, *Dryocoetes confusus*

Western balsam bark beetle attack was mapped on over 1.56 million hectares across BC in 2007, up from 1.19 million hectares in 2006. Increased size of infestations was offset however by a corresponding drop in intensity: 1,388,092 ha (89%) trace, 166,576 ha (10%) light and 9,995 ha (1%) moderate to severe mortality was recorded.

Subalpine fir (the primary host species) is most abundant in the NIFR of BC; hence, most of the mortality caused by this beetle occurs in the northerly forest districts (Figure 12). In 2007, recorded infestations tripled over last year in the Skeena Stikine Forest District to 245,307 ha affected. This was due largely to the northwest portion of the district being surveyed for the first time in several years. Mortality was particularly extensive around the Atlin Lake area and intensity was unusually high (primarily at the moderate level). Western balsam bark beetle mortality is usually in the trace to light range within a stand.

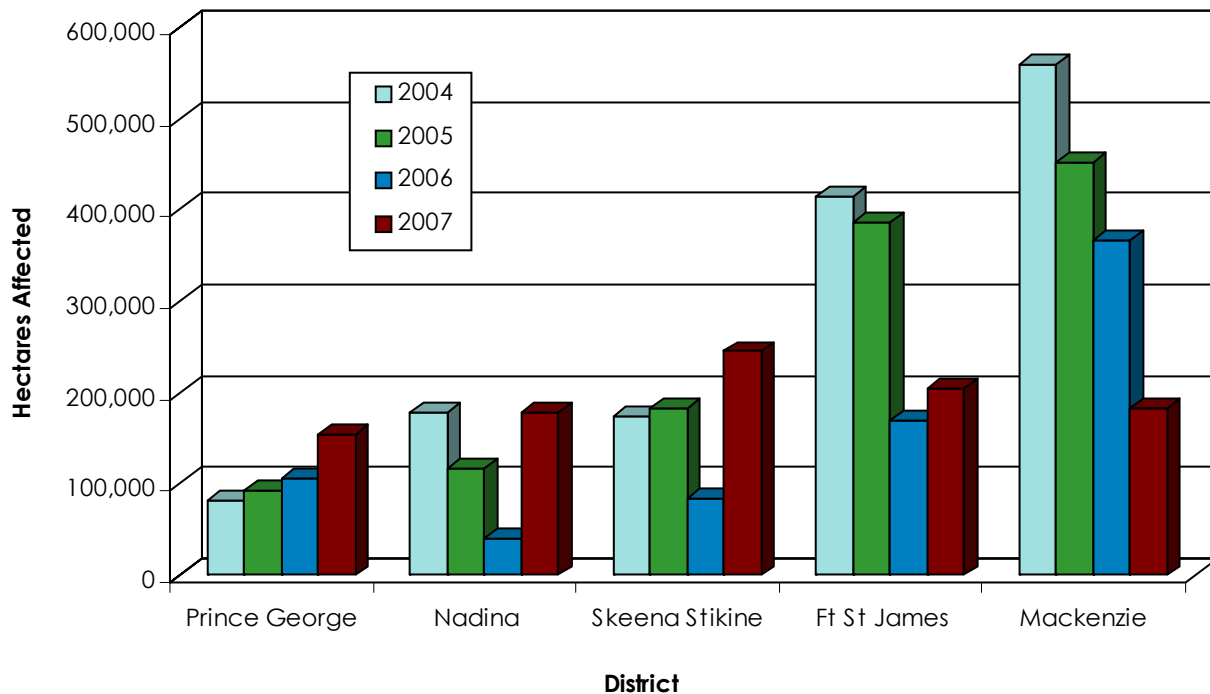


Figure 12. Hectares affected by western balsam bark beetle in BC from 2004 – 2007, for districts with over 150,000 ha of damage in 2007. Note that the Mackenzie Forest District was only partially surveyed in 2007.

Fort St. James Forest District had the second highest attack levels in the province this year, with 204,566 ha of damage. This was a slight increase over last year, but was still well below the peak of 414,531 ha recorded in 2004. Defoliation by two-year-cycle budworm in conjunction with consecutive years of western balsam bark beetle mortality has resulted in up to 50% mortality for some stands in this district.

Recorded infestations in the Mackenzie Forest District have been steadily declining over the past three years with levels at 183,086 ha this year, which is half of the attack that was noted in 2006. This is due at least in part to the northern portion of the district not being flown this year. Conversely, infestations in the Nadina Forest District increased to 178,155 ha of damage, which is almost four-fold the level recorded last year. Hectares of damage have been slowly increasing in the Prince George District over the past three years, with an increase of 44% since last year to 154,409 ha infested. Disturbances noted in the Peace Forest District rose 14% to 101,713 ha.

Area of attack remained relatively low in the remaining NIFR districts, at 31,060 ha in Vanderhoof Forest District, 7,929 ha in Kalum Forest District and 1,121 ha in the Fort Nelson Forest District.

In the SIFR, observed western balsam bark beetle damage more than doubled since 2006 in the Quesnel and Central Cariboo Forest Districts with 104,481 ha and 68,891 ha affected, respectively. Infestations mapped in the Headwaters Forest District almost doubled to 90,242 ha of attack. After a large jump last year, area of mortality in the Okanagan Shuswap Forest District decreased by a third to 71,993 ha. Infested area increased by 54% in the 100 Mile House Forest District to 19,233



Subalpine fir mortality caused by western balsam bark beetle

ha. Cascades and Chilcotin Forest Districts experienced similar levels of attack at 16,316 ha and 15,870 ha, respectively. Noted infestation levels all increased in the southwest part of the province, with 13,087 ha in Rocky Mountain, 12,567 ha in Arrow Boundary, 9,832 ha in Columbia and 6,376 ha in Kootenay Lake Forest Districts. The remainder of the SIFR western balsam bark beetle mortality occurred in the Kamloops Forest District, where 5,293 ha of damage were detected.

In the CFR, hectares of damage remained highest in the North Island – Central Coast Forest District, rising by half over last year to 11,733 ha affected. Recorded infestations doubled in the Chilliwack Forest District to 6,817 ha and rose sharply in the Squamish Forest District to 4,545 ha affected.

Two-year-cycle budworm, *Choristoneura biennis*

Two-year-cycle budworm defoliated a total of 39,854 ha provincially in 2007. Corresponding to the odd-year cycle that this budworm is on north of Prince George Forest District, 81% of the disturbances and all of the moderate to severe intensity damage was recorded in the NIFR.

Fort St. James Forest District sustained the most damage, with 24,178 ha of primarily moderate intensity defoliation delineated. Large infestations were mapped south of Trembleur Lake and south of the north arm of Stuart Lake. Some of these infested areas, in conjunction with western balsam bark beetle, have sustained up to 50% mortality. One small area of defoliation was also noted west of Cunningham Lake.



Two year cycle budworm defoliation of subalpine fir

Defoliation in the Nadina Forest District was primarily classified as severe, with 7,469 ha mapped. Damage was concentrated in two areas, south of Tochcha Lake and around Dome Mountain. The Dome Mountain infestation continued into the Skeena Stikine Forest District, resulting in 519 ha of severe defoliation being mapped in this district.

In the SIFR two-year-cycle budworm was in the off year and correspondingly all defoliation recorded was of light intensity. In the Quesnel Forest District, damage totalling 4,594 ha was delineated west of the Bowron Lakes in the Willow River and Little Swift River drainages. Headwaters Forest District was the only other SIFR district to sustain damage, with 3,094 ha recorded. Infestations were small and scattered, primarily west of the North Thompson River to Murtle Lake.

Eastern spruce budworm, *Choristoneura fumiferana*

Eastern spruce budworm was the primary forest health factor of concern in the Fort Nelson Forest District for many years. The peak of the outbreak was in 2001 when 1.6 million hectares of defoliation was recorded. Size and severity of infestations then decreased annually to low endemic levels in 2005, and no defoliation noticeable from the air in 2006. In 2007, a total of 1,137 ha of primarily light damage was recorded. Two small infestations were observed at Shekilie River near the Alberta border and near Ellen Creek east of Elson River. Most of the defoliation (870 ha) was mapped along Chipesia Creek near Mount Yakatchie.

Defoliation predictions for the coming year have been obtained through overwintering early instar larvae sampling on an annual basis until last year. Due to administrative difficulties, this sampling has not been undertaken for two years. Larval sampling to that point concurred with a decreasing population (no larvae at all were found in 2004 and 2005). Based on sampling history, current low levels of defoliation, and larval sampling results from chronic budworm areas across the border in Alberta, defoliation is anticipated to remain low in 2008.

Balsam woolly adelgid, *Adelges piceae*

Balsam woolly adelgid infestations were observed during this year's overview survey flight. Infestations by this introduced pest have previously been identified from ground and detailed surveys in the Campbell River, Chilliwack, South Island, Squamish and Sunshine Coast Forest Districts of the CFR. They have not however been detected during the aerial overview surveys, at least since the MFR has been conducting them.

In 2007, 860 ha of damage were mapped in the CFR at severity levels of 571 ha light, 245 ha moderate and 43 ha severe. Infestations in the Campbell River Forest District totalled 586 ha, and were located along the Loughborough Inlet and on East and West Thurlow Island. Damage was also observed in the Sunshine Coast Forest District, with 274 ha affected on Cortez Island and east of Toba Inlet.

DAMAGING AGENTS OF HEMLOCK

Western hemlock looper, *Lambdina fiscellaria lugubrosa*

Defoliation by western hemlock looper was recorded on 820 ha provincially in 2007. It should be noted that although the tree species under attack was identified as hemlock, all infestations were inaccessible so ground confirmation of the defoliating agent could not be made.

Almost all of the damage was reported in the CFR, and most of that was located in the Campbell River Forest District (768 ha). Infestations were scattered up Loughborough Inlet off the Johnstone Strait, and 82% were rated as moderate to severe in intensity. The remaining CFR damage occurred in the North Island – Central Coast Forest District, with 35 ha of primarily severe damage south of Broughton Strait.

The only other western hemlock looper damage noted in 2007 was in the NIFR's Kalum Forest District, where 16 ha of severe defoliation was mapped northwest of Terrace at Kitsumkalum River.

Due to the cyclical nature of western hemlock looper infestations, populations have been monitored in the SIFR for several years in chronic areas (Table 10). The number of male moths caught in the pheromone traps in 2007 continued to reflect an endemic population, after the peak in 2003.

Table 10. Average number of western hemlock looper male moths caught per trap at various MFR sites (6-trap clusters per site), 2003 - 2007.

Forest District (# sites)	Year				
	2003	2004	2005	2006	2007
Headwaters (5)	79.2	7.5	9.2	5.0	19.9
Okanagan	878.9	45.3	8.0	3.7	7.7
Shuswap (11)					
Columbia (11)	No traps	4.8	1.2	4.1	1.9

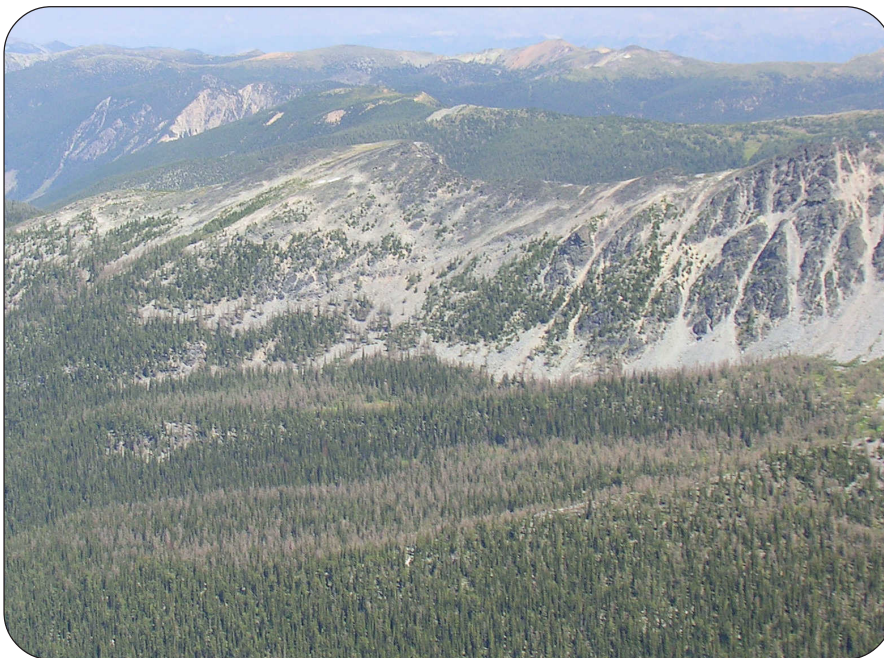
Western blackheaded budworm, *Acleris gloverana*

Defoliation by western blackheaded budworm dropped to less than half that recorded in 2006. Western hemlock was the affected tree species, and infestations occurred on 588 ha at primarily (93%) moderate intensity. Damage was mapped in Arrow Boundary Forest District east of Lower Arrow Creek near Mt. Freya. Infestations noted in the Kootenay Lake Forest District last year were not visible in 2007.

DAMAGING AGENTS OF LARCH

Larch needle blight, *Hypodermella laricis*

Larch needle blight damage dropped sharply to 13,540 ha from 68,228 ha affected last year in the southeast corner of BC. Severity of defoliation also rapidly decreased, with only 11% recorded as severe, compared to 68% in 2006. This corresponded to the expected drop in larch needle blight infection after the dry spring of 2006.



Alpine larch mortality due to severe larch needle blight infection

Last year, larch needle blight was landscape wide, with damage observed in most areas where larch was predominant. Most (92%) of the defoliation occurred in western larch stands, but the remaining damage was recorded on alpine larch. In 2007, defoliation was confined to valley bottoms and scattered pockets, and only western larch was observed to be infected. Previously affected stands of western larch that did not show current damage appeared healthy and are expected to have minimal long

term impact from the one year of defoliation. Unfortunately, many of the alpine larch stands that were severely defoliated in 2006 appear to have sustained high levels of mortality. Most heavily impacted were high elevation stands in the St. Mary's and Buhl River areas.

In 2007, Rocky Mountain Forest District continued to be the most impacted with 8,032 ha of damage (less than one-third of last year). Approximately one-third of the defoliation was classified as moderate to severe. Small pockets of defoliation were scattered throughout the eastern half of the district, but most of the damage was situated in the southwest portion in the St. Mary's and Yahk River areas.

Kootenay Lake Forest District had the second highest level of damage, with 3,706 ha of primarily light defoliation recorded. This was a large drop from the 21,249 ha noted last year. Most of the disturbances were at the southern end of the district, in the Kitchener Creek and Moyie River areas.

Arrow Boundary Forest District was the only other district in the SIFR to sustain damage in 2007, with 1,801 ha delineated (one-tenth the defoliation recorded last year). Small polygons were scattered in the west portion of the district west of Arrow Lake.

Unlike most of the province in 2007, these districts mainly had a dry spring, so 2008 damage from larch needle blight is expected to remain low.

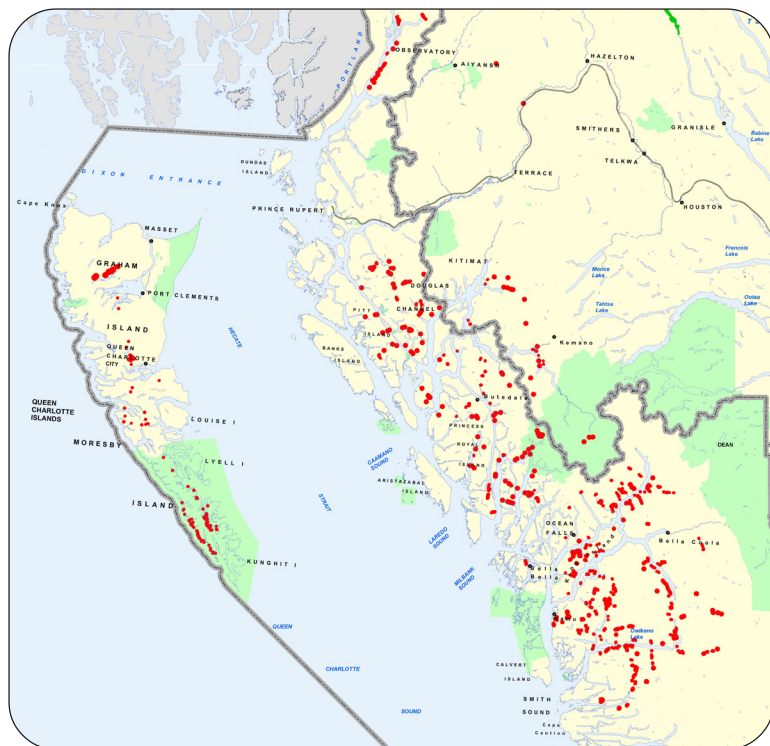
DAMAGING AGENTS OF CEDAR

Yellow-cedar decline

The occurrence of yellow-cedar decline was first extensively investigated in BC with detailed aerial flights of the coast in 2004 and 2006. This year was the first time that this disturbance was documented to any extent during the aerial overview survey. Several projects are underway to study yellow-cedar decline (Project 6, Pg. 58)

Damage observed totalled 24,282 ha situated along the coast of BC (Figure 13). This was almost six times the level recorded in the 2006 detailed survey, but the overview survey covered more area and polygons tended to be larger, encompassing smaller, scattered areas. Severity was recorded as 3,889 ha (16%) trace, 10,307 ha (42%) light, 1,546 ha (6%) moderate and 8,539 ha (36%) severe. Portions of the mid coast were not surveyed due to constant heavy marine fog.

In the CFR, 23,929 ha of yellow-cedar decline damage was delineated, with most of the decline (17,178 ha) located in the North Island – Central Coast Forest District. Decline was most prevalent on King Island and south of Burke Channel to Smith Inlet. A total of 4,769 ha were noted in the Queen Charlotte Islands Forest District, concentrated on the south tip of Moresby Island and around Masset Inlet on Graham Island. The remaining 1,982 ha were mapped in North Coast Forest District, most notably around Observatory Inlet and east of Grenville Channel.



Yellow-cedar decline damage

Figure 13. Yellow-cedar decline damage recorded in BC in 2007.

The NIFR sustained 353 ha of primarily light damage in the Kalum Forest District. Disturbances were mapped in scattered pockets near Kingcolith and were noted to be quite banded along elevation lines.

Cedar leaf blight, *Didymascella thujina*

Cedar leaf blight damage was identified for the second year in a row in a few locations along the coast. In total, 1,528 ha of damage occurred in two forest districts. The North Island - Central Coast Forest District of the CFR had 807 ha delineated in the upper Kimsquit River area. Severity was rated at 248 ha (31%) light, 493 ha (61%) moderate and 66 ha (8%) severe. The remaining cedar leaf blight disturbances were mapped in the Skeena Stikine Forest District of the NIFR. Damage was observed over 720 ha at light intensity along the Unuk River.

As with many other foliage diseases, wet spring and summer conditions in 2007 most likely resulted in further infections, which will become visible next year.



Cedar leaf blight damage

DAMAGING AGENTS OF DECIDUOUS TREES

Large aspen tortrix, *Choristoneura conflictana*

An outbreak by large aspen tortrix in the NIFR peaked in 2004 with trembling aspen and balsam poplar stands sustaining 794,303 ha of damage. Since then, infestations have steadily declined. Area affected in 2007 dropped again to half of last year, with 61,910 ha mapped at a similar level of severity.

Defoliation in the Peace Forest District remained relatively steady with 59,458 ha noted. Intensity of damage was 64% light, 33% moderate and 3% severe. Most of the infestations were located along Pine River, Halfway River, Swan Lake and in the agriculture belt near Dawson Creek. Damage in the Fort Nelson Forest District dropped dramatically from 50,898 ha in 2006 to only 58 ha of moderate to severe defoliation at the south edge of the district near Mt. Yakatchie. Infestations remained small in the Mackenzie Forest District, where 781 ha of primarily light defoliation were noted on the Peace Reach of Williston Lake.

Ground surveyors continued to have difficulty finding much definitive evidence of the insect, which supports the downturn in observed defoliation.

Gypsy moth, *Lymantria dispar*

Gypsy moths (North American strain of European gypsy moth) have been periodically found in BC since 1978 but aggressive detection and prompt eradication measures have been successful in preventing establishment.

Various treatment programs were employed in 2007 in response to 153 male moths caught in monitoring pheromone traps in the summer of 2006. Ground spray treatments with *Btk* were conducted in Victoria, Belmont Park in Colwood, and along Fulford-Ganges Rd on Saltspring Island. Three treatments per area were conducted using two different *Btk* formulations in the following manner: Dipel 2XDF® only on Salt Spring, Dipel 2XDF® with Foray 48B® in Victoria and Foray 48B® only in Colwood. An aerial spray of 210 ha using three applications of Foray 48B® was also undertaken near Courtenay. Applications were between May 7th to June 8th.

High density mass trapping was used as a follow-up treatment in the summer for all ground spray areas. Pheromone traps were also used in the Courtenay aerial treatment area to monitor effectiveness of the spray. Treatments at all sites except Saltspring Island were highly successful with no moths being captured. On Saltspring Island, treatment (the spray and/or mass trapping) resulted in a significant reduction of moths caught in the mass trapping grid. There were 35 male moths caught in 2006 and only 10 caught in 2007. These 10 moths were located in the epicentre of two previous treatments blocks. Mass trapping was employed as the only treatment in Sidney for the second consecutive year and it appeared to successfully eradicate this infestation. Mass trapping was also utilized in one area at Saltair near Ladysmith, where six moths were collected.

Monitoring pheromone traps deployed by the Canadian Food Inspection Agency caught fourteen moths around Vancouver Island: five at Lake Cowichan, four at Saltair, three at Saltspring (outside

of the MFR mass trapping area), one at Shawnigan Lake and one at Prospect Lake (Figure 14). More moths were caught in the Lower Mainland: six at Harrison Hot Springs, five at Langley, two in Delta, one in Burnaby and one at White Rock.



Figure 14. Gypsy moth trap locations with positive catches in 2007.

Treatment recommendations for 2008 will include a repeat of the ground spray on Saltspring Island with follow up mass trapping and a ground spray in Saltair. Both treatments are expected to cover less than 20 ha each. Mass trapping in Cowichan Lake is also anticipated. Other locations where moths were trapped in 2007 will be monitored next summer with sampling grids using various trap densities.

Further information regarding the current status as well as the historical record of the gypsy moth population monitoring and eradication programs in BC can be found at the MFR's gypsy moth website at <http://www.for.gov.bc.ca/hfp/gypsymoth/index.htm>.

Serpentine leaf miner, *Phyllocnistis populiella*

Recorded defoliation by the serpentine leaf miner dropped dramatically in 2007. Last year, 12,878 ha of aspen damage were noted in four south-eastern districts in the SIFR. This year no damage was observed aerially in these districts. However, extensive infestations were detected for the sixth consecutive year in the Cariboo area of the SIFR. Severe defoliation was present in virtually all aspen stands east of Highway 97 in the 100 Mile House and Central Cariboo Forest Districts. Light defoliation was noted south of Quesnel to Churn/Gaspard Creek and west of Highway 97 in the Quesnel and Central Cariboo Forest Districts. Mapping of extensive bark beetle infestations precluded delineation of the widespread, scattered serpentine leaf miner damage in these districts.

The only serpentine leaf miner damage actually mapped in the province was in the Fort Nelson Forest District in the NIFR. A total of 1,185 ha (severity levels of 65% light and 35% moderate) of defoliation were noted around Fort Nelson itself. After ground checks, personnel felt that damage by this defoliator was underestimated in the aerial survey this year.



Serpentine leaf miner damage

Satin moth, *Leucoma salicis*

Satin moth populations remained low for the third consecutive year across the province. Light defoliation noted in the CFR North Island – Central Coast Forest District last year was not observed this year. All noted 2007 damage was located in the SIFR. One moderate severity infestation of 29 ha was mapped at the south end of Tatlayoko Lake in the Chilcotin Forest District. Another light intensity polygon of 5 ha was delineated east of Lytton in the Cascades Forest District.

Of historical interest, this defoliator was introduced from Europe in 1920 and since then has spread throughout the southern and central interior. This summer, reports of satin moth defoliating aspen around Terrace were confirmed. This is the furthest north that satin moth populations have ever been documented in BC.



Satin moth found in Terrace in 2007

Forest tent caterpillar, *Malacosoma disstria*

Small infestations of forest tent caterpillar defoliation noted in the SIFR in 2006 were not detected this year. In 2007 2,829 ha of damage was mapped but all occurred in the NIFR. Intensity was delineated at 162 ha (6%) light, 2,435 ha (86%) moderate and 233 ha (8%) severe.

Most of the defoliation was observed in small, scattered patches throughout the Fort Nelson Forest District, with one concentrated area near Kiwingana River. A total of 1,753 ha of damage were noted. Infestations in the Kalum Forest District were noted north of Kitimat, with 977 ha affected.

In the CFR, 3 ha of light defoliation were observed in the Chilliwack Forest District.

Birch leafminer, *Fenusa pusilla*

Birch leafminer has been active in the southeast portion of the SIFR for the past several years. Damage peaked in 2003 with 22,507 ha affected, followed by a sharp decline then a steady expansion of defoliation for the past two years. In 2006, 4,635 ha were infested across the Arrow Boundary, Columbia, Kamloops, Kootenay Lake, Okanagan Shuswap and Rocky Mountain Forest Districts.

This year, the birch leafminer population appears to have returned to endemic levels, with only 14 ha of moderate defoliation detected in the Columbia Forest District. Birch leafminer is one of several damaging factors that may be leading to substantial birch decline in the southeast portion of the province (Project 7, Pg. 59).

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

Aspen and poplar leaf and twig blight infections have caused varying levels of damage across the NIFR in the past few years, with a peak of 82,376 ha affected in 2002. Infections for the past two years have been endemic (as noted from the ground) but damage was too low to be observed during the overview surveys.

In 2007, defoliation by the aspen and poplar leaf and twig blight was detected on 1,313 ha in the NIFR. Severities were recorded as 599 ha (46%) light, 172 ha (13%) moderate and 542 ha (41%) severe. Fort Nelson Forest District had 554 ha affected around Fort Nelson and Patry Lake at varying intensities. Ground observations found damage was much more widespread than was visible from the air. Prince George Forest District had 475 ha of severe damage concentrated south of the Fraser River near Sugar Bowl Mountain. Mostly light levels of disturbance were identified on 245 ha in the Peace Forest District, near the Alberta border east of Chincaga Lakes. The remaining 40 ha of primarily light intensity damage were situated on the east side of Atlin Lake in the Skeena Stikine Forest District.



Damage to aspen caused by
Venturia infection

It is anticipated that infections rates rose during the wet spring of 2007, and that corresponding visible damage will increase next year.

Septoria musiva canker, *Mycosphaerella populorum*



Septoria musiva cankers on
hybrid poplar whips

Septoria musiva is a common fungus that attacks native and hybrid poplars of central and eastern North America. Moderate defoliation can result from brown leaf lesions that kill leaf tissue. Of more concern are infections that penetrate current-year shoots and branches and eventually create sunken cankers. These cankers can become sites of physical tree weakness. Infected trees are prone to breakage, particularly in areas where snow loading is prevalent. Managed plantations of hybrid poplars have been extensively damaged by this canker.

Septoria musiva canker infections have now been positively identified on hybrid poplar in a forest nursery at Harrison Mills and at several clonal plantations along the Fraser River in the Chilliwack Forest District. Ten to fifteen year old trees were exhibiting cankers caused by old infections. An incidence survey was conducted in the nursery and tested samples confirmed the presence of *S. musiva*. The MFR is working with the nursery to limit the spread of the disease. Future work will include surveys of reforested sites and to determine whether the native black cottonwood (*Populus trichocarpa*) has become infected by the fungus.

DAMAGING AGENTS OF MULTIPLE HOST SPECIES

Abiotic injury and associated forest health factors

In general, biological injuries caused by insects and pathogens show up during the growing season, and are most visible annually when the aerial overview surveys are conducted. Abiotic injuries however, in particular wildfire and wind damage, sometimes occur after the flight and are recorded during the next survey period.

Wildfire continued to be the primary abiotic damaging agent in 2007, with a total of 33,756 ha of mostly severe intensity noted as burnt across the province. This is almost one-fifth the level of damage recorded last year, primarily as a result of extensive rain across much of the province during the wildfire season.

The SIFR had the highest wildfire activity, with an observed 22,803 ha of damage. Of this, four southeast districts contained the majority of the affected hectares: Arrow Boundary Forest District had 6,247 ha, Kootenay Lake Forest District 5,308 ha, Rocky Mountain Forest District 4,204 ha and Columbia Forest District 3,218 ha. This reflected the dry, hot summer conditions in the southeast portion of BC, as opposed to the rest of the province. The largest of these fires was the Pend O’Oreille River fire at 3,970 ha in the Arrow Boundary Forest District. The remaining fire damage in the SIFR remained below 1,600 ha affected per district.

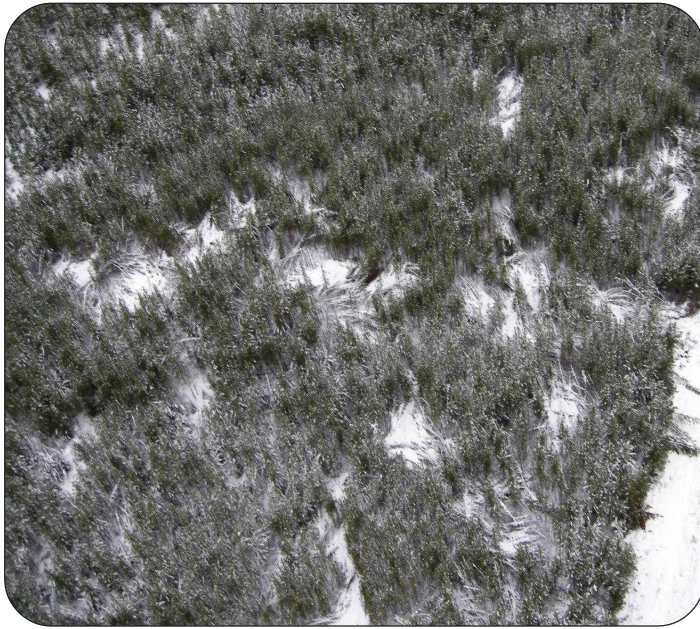
Fires damaged a total of 10,979 ha in the NIFR. Almost all of this damage was observed in the Fort Nelson Forest District, with 9,600 ha affected. Most of this occurred in the Turnagain Ck fire on the western boundary of the district. The Peace Forest District sustained 987 ha of wildfire damage, and the rest of the districts had less than 210 ha burnt per district.

As usual, wet conditions in the CFR resulted in the lowest wildfire occurrence with only 74 ha affected. Most of the damage was split between Chilliwack and Squamish Forest Districts.

Windthrow generically refers to the uprooting or breaking of trees, whether due to wind, snow or ice since it is not usually possible to differentiate the casual agent during the aerial overview survey. In 2007, 6,803 ha of windthrow damage was identified provincially. This is up 56% over the 4,346 ha recorded last year. Severity was delineated as 1% trace, 6% light, 27% moderate, 58% severe and 7% very severe. Normally, only higher intensity damage is recorded during this survey, as scattered understory windthrow cannot usually be detected.



Logepole pine stand damaged by wind and snow



Damage due to heavy snowfall

The NIFR sustained 3,337 ha of damage, with most of it (2,812 ha) continuing to be recorded in the Peace Forest District. Primarily pine, aspen and cottonwood were damaged, and the majority of the windthrow was situated along the Pine River and by Windy Creek. The Skeena Stikine, Prince George and Fort Nelson Forest Districts contained the remaining damage with 222 ha, 202 ha and 100 ha affected, respectively. A very large snowfall and several wind events occurred across the NIFR last fall. This caused widespread windthrow of which only a small percentage was visible aerially. Intermediate stands of lodgepole pine and aspen were the most affected, with most of the damage being broken stems. Snow press was also common along the edge of openings.

A total of 2,319 ha were affected in the CFR. South Island Forest District contained 1,642 ha of this damage, of which most was located along the west coast of Vancouver Island. Small scattered patches were observed throughout the rest of the CFR, totalling no more than 250 ha per district. Damage noted aerially most often was associated with exposed cutblock edges or in leave strips. Blowdown in this region was associated with widespread winter windstorms. In the North Island – Central Coast Forest District, it was observed that spindly second growth hemlock and amabilis fir were particularly susceptible.

Windthrow damage in the SIFR resulted in 1,147 ha of recorded damage scattered throughout seven districts, primarily in small scattered areas. In mid July a severe wind event occurred in the southeast portion of the SIFR. Resulting windthrow damage was noted around Creston, Goat River and Kid Creek north to Cranbrook, with 224 ha in the Kootenay Lake Forest District and 303 ha in the Rocky Mountain Forest District. This windstorm knocked down Douglas-fir, spruce and ponderosa pine, which may result in increased Douglas-fir beetle, spruce beetle and western pine beetle populations, respectively. A series of fall wind events in the Quesnel and Central Cariboo Forest Districts occurred after the surveys were complete, resulting in substantial amounts of scattered blowdown. Many leave strips were severely damaged, and plans are in progress for detailed surveys to identify the most significant patches.

Flooding caused 1,328 ha of damage, with approximately one-third moderate and two-thirds severe intensity mortality. Most of this (1,026 ha) continued to be located in the NIFR. Peace, Fort Nelson and Skeena Stikine Forest Districts sustained 468 ha, 253 ha and 193 ha of damage, respectively. Minor mortality was also noted in three other districts. Low levels of scattered damage also occurred in the CFR and SIFR with 283 ha and 15 ha affected, respectively.

Slide damage across the province totalled 818 ha compared to only 166 ha recorded last year. Most of the slides were classified as severe to very severe in intensity. Almost all were located in

the coastal mountains and the NIFR and were primarily a result of avalanche activity associated with heavy snowfall. From the aerial overview survey, it is difficult to pick up small slides or to determine if the activity is current.

Most of the slides occurred in the NIFR (476 ha). A total of 232 ha was recorded in the Skeena Stikine Forest District, with the largest (70 ha) near Eagle Mountain. In the Kalum Forest District, 177 ha were affected, with one large slide at Legate Creek on Highway 16 which killed two motorists. There were also several small scattered slides in the Kateen River valley. Damage from slides covered 319 ha in the CFR, primarily in the North Coast (146 ha) and North Island – Central Coast (112 ha) Forest Districts. Observed SIFR slide disturbances were minimal, with only 23 ha delineated.

Drought damage was recorded on 14 ha in the CFR during the overview survey this year. Although drought damage was not detected aurally in the SIFR, stressed cedars are appearing in large numbers in the southern part of the ICH BEC Zone in the Kootenay Lake and Arrow Boundary Forest Districts. Normal “winter flagging” has been occasionally severe, and dead tops or tree mortality are common.



Slide damage



Drought-afflicted cedars

Animal damage

A variety of animals cause damage to a wide range of tree species throughout the province, particularly at the seedling to sapling stages. Some animal populations are cyclical with corresponding peaks in damage, while other species are relatively stable and cause ongoing chronic tree injuries. Animal damage is often underestimated in the aerial overview surveys because most damage is not conspicuous enough to be visible at the survey height and/or because it is masked by the current mountain pine beetle outbreak.

Black bear (*Ursus americanus*) and **porcupine** (*Erethizon dorsatum*) feeding can cause tree girdling, which results in dead tops or mortality. In the North Island – Central Coast Forest District, areas around Smith and Kingcome Inlets were known to have had bear damage identified previously, but fog prevented surveying of this area in 2007. Bear damage continued in the Sunshine Coast Forest District, particularly at the mouth of Toba inlet where approximately 75% cumulative mortality has occurred in a plantation. Damage in a Ramsey Arm plantation has resulted in about 30% mortality from bear damage as well. New damage was observed this year on Elizabeth Island.

Damage in the CFR is primarily to juvenile spaced Douglas-fir, though cedar has been injured as well. Only 5 ha of porcupine damage was identified during the overview surveys, located in the Skeena Stikine Forest District. Ground observers reported significant porcupine damage in the Kalum Forest District.

Elk (*Cervus elaphus roosevelti*) and **black-tailed deer** (*Odocoileus hemionus columbianus*) browsing continued to be a serious problem in the Sunshine Coast Forest District, particularly around Sechelt, in the Deserted River area and on Texada Island. Douglas-fir sustained the highest damage. The elk and deer have learned to pull off the protective tubing and eat the trees. Reforestation costs can be prohibitive due to this problem, with costs reaching \$5,000/ha.

Snowshoe hare (*Lepus americanus*) feeding damage continues to be a problem, particularly in the NIFR. Young lodgepole pine stands with high mortality resulting from *Dothistroma* needle blight or mountain pine beetle often require replanting. To remove damaged stems is often not practical and/or very expensive, so underplanting is being conducted. Unfortunately, the dead overstory provides the hares with protection from predators and the seedlings are sustaining significant hare damage. This is particularly a problem in moist ecosystems, where understory brush also contributes to protective cover for the hare population. A blood derivative designed to deter browsing was tried in an underplanting trial this year but results were disappointing (Project 8, Pg. 60).

High levels of **vole** (*Microtus* and *Clethrionomys* spp.) damage occurred on seedlings and various species of juniper shrubs in the interior of BC over the winter of 2005/2006. This damage became visible in the spring and summer of 2006. Vole populations are usually very cyclical and outbreaks typically last only one year. The peak year (with the exception of large wildfire areas) was the winter of 2006 for the BC interior. Live trap monitoring in the summer of 2006 indicated a dramatic decline in vole populations, as expected. Damage observed in 2007 was subsequently very low.

Woody bush rats (*Neotoma cinerea*) are thought to be the cause of browse damage on Douglas-fir in some areas of the Sunshine Coast Forest District. Leaders and laterals have been nipped off cleanly at a sharp angle from two to six meters up immature trees. Consecutive years of attack have left some trees with multiple stems. The browse is too high and cleanly cut for ungulates, birds or other animals. Samples have been sent to the Canadian Forest Service for confirmation. Occurrences have been noted in the late winter/early spring around Haslam, Horseshoe and Goat Lakes. To date over 3,000 trees have been observed to have significant damage, with the worst browse detected in a young stand near Goat Lake where 93% of the trees were affected.



Suspected woody bush rat browse

MISCELLANEOUS DAMAGING AGENTS

Chlorotic western larch stands were observed and photographed aerially in the Kootenay Lake Forest District by forest health staff. Damage occurred primarily in plantations but also in some nearby mature stands in the Little Moyie drainage. Trees were chlorotic in colour throughout the crowns and damage did not appear similar to defoliation or to a commonly known needle disease. Ground surveys were not possible before needle drop, but will be conducted if this situation is noted again next year.



Chlorotic western larch stand

Fir engraver beetle (*Scolytus ventralis*) is currently active in the CFR in grand fir. It is especially evident along the east coast of Vancouver Island from Victoria northward to Sayward. However, because of the scattered distribution of grand fir it does not show up in the overview survey. Most of the attack is occurring on private land. It is believed that summer drought over the past decade is the underlying cause. This beetle seems to be slowly removing grand fir from the east coast of Vancouver Island.

Poplar and willow borer (*Cryptorhynchus lapathi*) is continuing to cause significant damage in the Skeena Stikine and Kalum Forest Districts. The areas most impacted are along major transportation corridors and transmission lines, particularly between Smithers and Hazelton. Willow continues to be attacked (in swamps as well as along corridors) but aspen and cottonwood infestations are becoming more common as well. Trees of all ages have been attacked, though mortality in the mature trees (particularly in willow groves) is of most concern. Infested trees are physically weakened, and tend to break. This was prevalent after the heavy snowfall last fall.



Poplar and willow borer damage

Rocky Mountain juniper was noticeably damaged this year in the Sub-boreal Spruce BEC zone in the Bulkley Valley of the Skeena Stikine Forest District. Foliage of affected trees turned brown and resulted in either dieback or tree death. No definitive sign of insect feeding or disease infection could be found on examined trees.

Striped alder sawfly (*Hemichroa crocea*) defoliated an identified 466 ha in the CFR in 2007. The majority of the infestations were on Gambier Island in Howe Sound in the Sunshine Coast Forest District. Most of the alder stands on the island were infested. Two small patches were also observed on the two islands just north of Gambier. The mapped polygons totalled 450 ha and were moderate (43%) and severe (57%) in intensity. The remaining 16 ha of moderate defoliation occurred in two small spots on Bowen Island adjacent to the Sunshine Coast Forest District infestations, in the Chilliwack Forest District.



Severe striped alder sawfly defoliation

Unidentified conifer damage, particularly to western hemlock and amabilis fir, was observed this year around the Port McNeil area. Damaged needles were falling off from the bottom up and the interior to the exterior of the trees, resulting in dieback or mortality. Hemlock of all ages was defoliated, but immature trees were most notably damaged. Damage occurred in small pockets of trees. No definitive symptoms were detected to identify the cause of this damage.

Unknown defoliation was more prevalent than usual with 2,121 ha mapped this year provincially. Intensity was identified as 60% light, 31% moderate and 9% severe. The majority of the damage was to coniferous trees, in particular western hemlock and cedar. All of the disturbances were in inaccessible areas; hence ground checks to confirm causal agents were not possible. In the NIFR, 2,550 ha were affected in the Skeena Stikine Forest District south of Gunanoot Lake on the Babine River. The remaining defoliation occurred in the CFR. North Island – Central Coast Forest District had 1,266 ha of damage around Dean Channel, along the Sheewahant River and south of Bella Coola River. A total of 838 ha were affected in the Sunshine Coast Forest District, primarily around Toba Inlet and on Marina Island. The remaining 17 ha of unknown defoliation were noted in the Chilliwack Forest District.



*Unidentified conifer damage in
Port McNeil*

FOREST HEALTH PROJECTS

1. Mountain pine beetle attack in immature stands – 2007 project summary

Lorraine Maclauchlan, Forest Entomologist, SIFR

The assessment of mountain pine beetle (MPB) impacts to young pine continued in 2007. As predicted, the extent and severity of attack was more rapid in the south as host resources became increasingly scarce. In 2007 the following surveys, assessments and trials were conducted: approximately 2,219 polygons aerially surveyed; 264 polygons (in 7 districts) ground surveyed; re-assessment of 24 permanent sample plots; 100 ha treated with verbenone flakes; plus other collaborative research investigations. Since the initiation of this project in 2005, over 5,228 young pine stands have been aerially surveyed one or more times. Approximately 4,230 stands have been surveyed at least once and 815 have been assessed two or all years (86 stands surveyed in all 3 years) (Figure 15).



Figure 15. Photographs of young stands placed chronologically top to bottom to show progress of MPB attack from 2005-2006 (left) and 2006-2007 (right).

In the 2007 aerial assessment over 83% of stands (11% coverage of target population by area) had some level of MPB attack, up from 49% in 2005. In 2005, 4.3% of stands had >50% red attack whereas in 2007, 16.8% had $\geq 50\%$ red attack and 25.2% of stands had $\geq 50\%$ total attack (red and grey attack). The highest in-stand attack and percent stands affected occurred in the Kamloops, 100 Mile House and

Quesnel Forest Districts with an average of 47%, 42 % and 39% total MPB attack, respectively. In Kamloops Forest District, 39% of candidate stands were surveyed, by area (7,125 ha surveyed of a potential 18,500 ha) and 45% of these had >45% MPB attack (Figure 16).

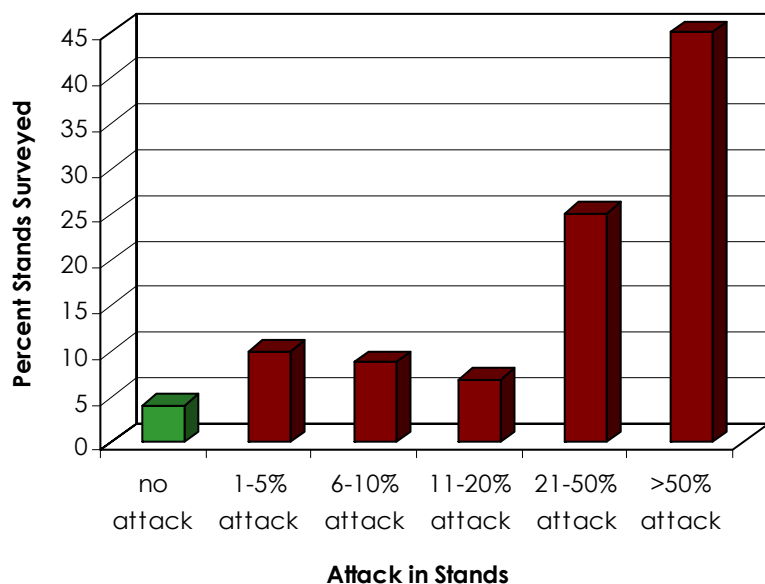


Figure 16. Results of 2007 aerial surveys in Kamloops Forest District showing total attack levels (grey + red) in stands by attack increments.

The 2006 beetle movement from surrounding infestations was very large and as a result very severe MPB mortality resulted in all age groups of stands assessed. There was now significant difference in percent attack in stands age 20 years through 55 years with all sustaining levels of 90% attack or higher on average (Table 11). Kamloops ground surveys in 40 stands showed a range of MPB attack from no attack to 92.9% green attack with an average of 11.9% green attack. In comparison, 2007 ground surveys in 100 Mile House Forest District showed a range of no attack to 100% green attack with an average of 34.4% green attack. Levels of attack in these young stands, particularly in more southern Districts are predicted to continue at least for another 2 years until the surrounding populations decline significantly.

Table 11. Stands aerially surveyed in Kamloops in 2007 showing number stands with and without MPB attack and average within stand attack.

Age	No MPB	No. stands w MPB attack	Percent stands w MPB	Ave. % attack in attacked stands
20-25	11	143	92.9%	37.9
26-30	1	77	98.7%	58.2
31-40	1	38	97.4%	63.6
41-50	0	12	100.0%	46.8
51-55	0	24	100.0%	53.4
unknown	0	3	100.0%	44.3

Twenty-four permanent sample plots (0.25 ha) established throughout the core mountain pine beetle outbreak area in 2005-2006 in young lodgepole pine stands were re-assessed in 2007. These plots were established to study mountain pine beetle attack behaviour, brood development, emergence success and incidence of other mortality factors in these young stands.

As with the 2006 assessment, location rather than any of the above attributes was most important, with respect to mountain pine beetle attack in these young stands. The total percent attack (green, red and grey) ranged from 0-91.9%. The southern portion of the SIFR had the highest level of current (2007) attack in the permanent sample plots (Table 12). Overall, attack levels have declined in 2007, from 2006 incidence.

Table 12. Average percent total MPB attack in plots located in five districts (2005-2007).

Location	No. Plots	Average % attack		
		2007	2006	2005
Vanderhoof-Nadina	4	1.4	44.1	0
Prince George-Quesnel	6	1.1	13.7	15.5
Central Cariboo	5	1.6	6.5	26.7
100 Mile	5	4.2	37.0	12.7
Kamloops-Okanagan	4	10.5	50.4	2.8

The older plots (41-55 years) had the highest level of cumulative attack; on average, 85% of the plot trees were attacked (green, red, grey) (Table 13). The younger age classes were less affected; however, between 40-53% of the plot trees were attacked.

Table 13. Average percent total MPB attack in plots, by age, in five districts (2005-2007).

Age	No. Plots	Average % attack			
		2007	2006	2005	Cumulative (2003-2007)
20-25	6	0.2	19.1	21.3	40.6
26-30	10	4.9	40.9	4.2	50.0
31-40	5	4.0	19.6	27.3	52.8
41-55	3	4.2	18.5	28.3	85.0

In 2007, as in 2006, attack densities were very high, ranging from 178-289 galleries/ m². Such high densities should not be conducive to successful

mountain pine beetle development and emergence. Larger diameter trees had greater emergence success than the smaller trees. Plots which had very high levels of green attack in 2006, did not have much current attack this year. This result is similar to that seen in 2006, where those stands which had significant levels of attack in 2005, did not have much in 2006. The beetles that successfully emerged from the plot trees did not remain in the stand.

In half the permanent sample plots assessed in 2007, over 45% of plot trees had some woodpecker activity. Sloughing and checking in dead trees due to mountain pine beetle has been visually assessed since 2006. Affected trees are degrading more rapidly in the wetter ecosystems than the drier sites.

Other bark beetles were also present in the plots and have contributed to tree mortality. *Ips pini*, *Hylurgops rugipennis*, and various twig beetles have been very active in 2007. In many cases, especially in the smaller trees, *Ips* and twig beetles have been more successful than the mountain pine beetle in causing mortality.



Young pine attacked by *Ips pini*

2. Single tree systemic injection trial using emamectin benzoate and fipronil for protection of lodgepole pine from mountain pine beetle

Leo Rankin, Forest Entomologist, SIFR

During the fall of 2005 and the spring of 2006, trials were established to test the efficacy of emamectin benzoate (EB) and fipronil (Fip) to protect lodgepole pine trees from successful attack by mountain pine beetle. Trees were selected and injected at the base with an Arborjet Tree IV injection pump system. The experimental site was located approximately 25 km east of 100 Mile House in the 100 Mile House Forest District. The site was located around 2050 metres elevation in the SBSdw1 BEC zone. Trees between 18.2 and 39.1 cm DBH were injected at the base. The average tree diameter injected was 26.6 cm DBH. Three tree groupings were selected at 25 meter spacing including a non-treated control tree, an EB injection tree and a Fip injection tree. The average uptake of the injected chemical was approximately sixty minutes during a tree injection. The trees were assessed for beetle attack in early August and it was determined that no aggregation baiting was required to initiate attack as most trees were mass attacked.

The injected systemic insecticides were assessed for post mountain pine beetle attack survival in October 2007. Virtually all trees in the trial including controls were attacked heavily and suffered high mortality. The assessments indicated that neither EB or Fip provided adequate protection to prevent tree mortality from mountain pine beetle. Both the fall and spring injections exhibited high mortality. For EB, mortality was 93% and 95.4% mortality for fall and spring injections respectively. In the Fip treatments, mortality was 93% and 100% mortality for fall and spring injections while controls had 96% and 100% mortality. Surviving or non-attacked trees were always in the small diameter classes which are least attractive to mountain pine beetle, generally more vigorous, resistant and capable of surviving beetle attack.

It appears there was some treatment effect demonstrated by the fall injection although the trees were almost all killed. The success under the bark did not appear to be as high in the EB injections and there was far less woodpecker activity on the EB trees. The control trees had immense amounts of woodpecker bark removal and the Fip trials were intermediate in woodpecker activity. It is hypothesized that EB injections (and to a lesser extent Fip) inhibited brood development and beetle survival but the beetle attack still resulted in enough fungal inoculation to kill the trees. At this time we are considering the establishment of another trial to test a new EB-fungicide formulation which may limit blue stain fungi while controlling the beetle.



*Blue stain fungi in mountain pine beetle
attacked stump*

3. Verbenone flake trial

Lorraine Maclauchlan, Forest Entomologist, SIFR

Verbenone flakes were aerially applied to 100 ha of 25 year old lodgepole pine 28 June 2007 to protect them from MPB attack. Five treatment blocks, each 20 ha, and 5 control blocks were selected on the basis of having less than 8% 2006 attack and with moderate adjacent MPB pressure. Each of the 10 blocks contained a baited Lingren funnel trap that was monitored weekly for beetle flight. The verbenone embedded in Hercon® flakes was applied at 6.7 kg/ha (15% *a.i.* by weight; 1,000 gm *a.i.* per ha) using a Hiller 12E equipped with a spreader.

Table 14. Strip surveys results of verbenone flake trial showing number pine and categories of MPB attack in each control and treatment block (average of 5 control blocks and 5 treatment blocks).

	No. trees	
	Control blocks	Treatment blocks
Healthy PI	1390	1601
MPB mass atk	118	15
Unsuccessful MPB	12	16
Old MPB & other	52	7
Other species	176	172
Average % successful 2007 MPB attack	7.8%	0.9%

Assessments consisted of the following:

- Weekly trap collection
- 10 strip plots 3 m x 10 m per block
- 5 variable radius plots per block to assess attack status & tree statistics (dbh)
- Star-probe at each trap: 3 m width in each of the cardinal directions to determine trap influence

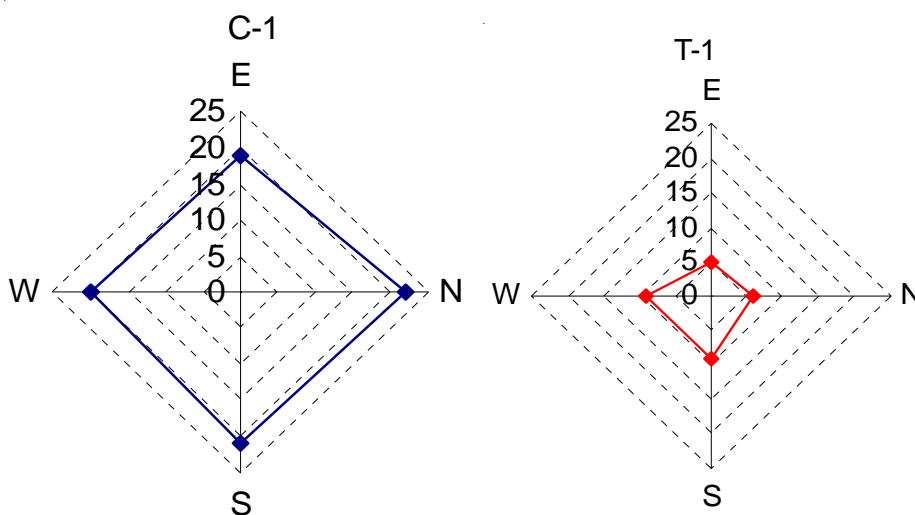


Figure 17. Area of MPB attack around Lindgren funnel traps in Control block 1 and Treatment block 1.

Tree size was not significantly different between blocks with average pine dbh in the control *vs.* treatment blocks 13.1 cm and 12.9 cm, respectively. All assessments showed significantly fewer successful mass attacks by MPB in treated blocks (Table 14). Attack was highest around funnel traps (Fig. 17) but was more contained in treatment blocks. In summary, the verbenone flake treatment was successful but overall the MPB pressure was much less than experienced in 2006.

4. Whitebark pine project update

Stefan Zeglen, Forest Pathologist, CFR

Starting in 2000, the Ministry of Forests and Range established a set of 10 permanent sample plots across part of the range of whitebark pine in BC (Figure 18). The primary purpose of these plots is to track the infection and mortality rate of whitebark pine due to white pine blister rust (WPBR) and other agents. Each plot is 0.25 ha in area and contains from 37 to 84 whitebark pine of various ages (above dbh). Data are collected on a number of tree and site attributes. Subplots are used to sample regeneration below dbh. Reassessment of these plots is intended to occur on a five-year interval starting in 2005. To date, five sites have been reassessed.

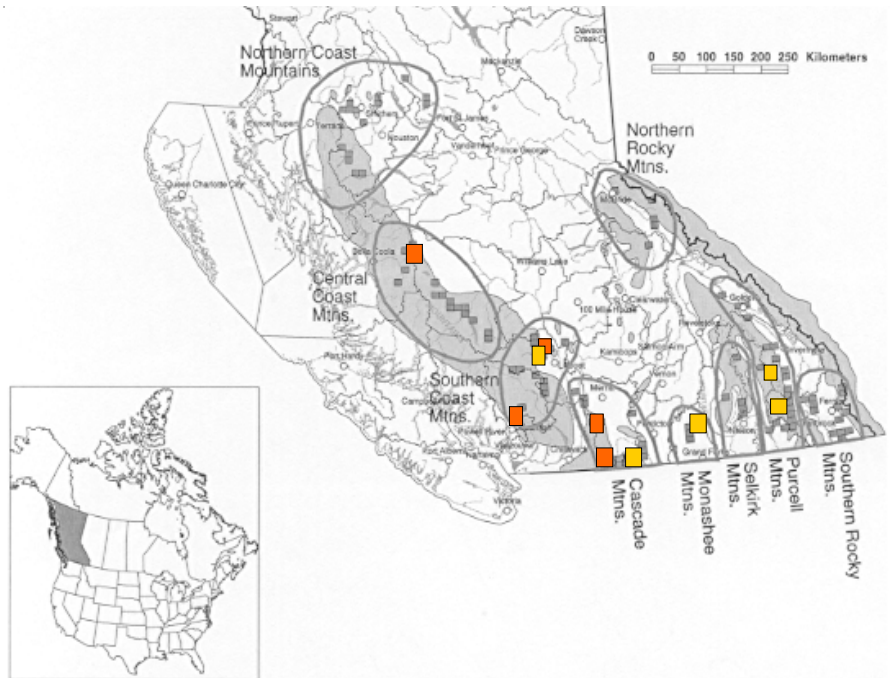


Figure 18. Whitebark pine permanent sample plot locations.

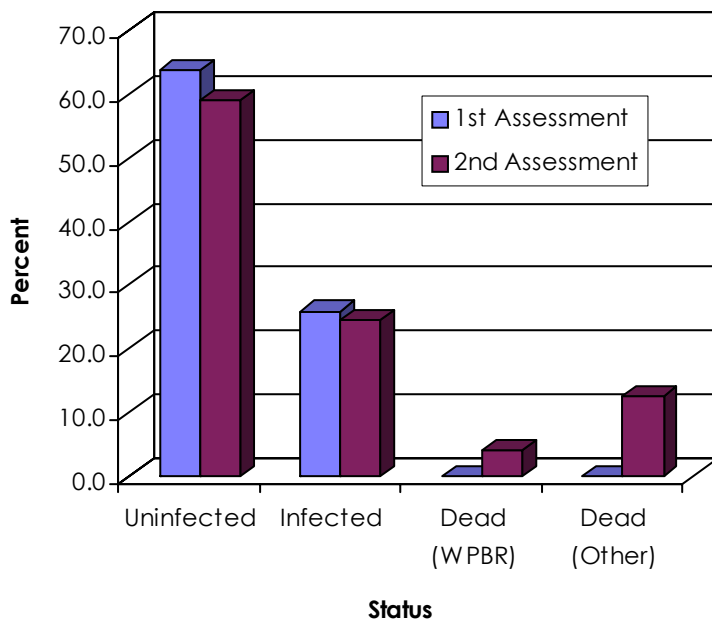


Figure 19. Assessment of whitebark pine permanent sample plots.

Results comparing the first assessment period (2000-2002) to the second assessment period (2005-2007) indicate that while the number of trees infected by WPBR is down slightly (-1.5%), mortality is up 6.3% overall (Figure 19). Much of that increase (3.7%) can be attributed directly to WPBR. Other mortality agents include *Armillaria* root disease but, somewhat strangely given the current ongoing epidemic outbreak, not mountain pine beetle. Also, since the first assessment the amount of uninfected trees has decreased by almost 5% to just under 60%.

5. Distribution and incidence of Phellinus root disease in the Southern Interior Forest Region (FSP-FIA Y081130)

Michelle Cleary, Forest Pathologist, SIFR

Phellinus sulphurascens (syn. *P. weirii*), the cause of Laminated root disease, is known to occur across a variety of BEC zones in the SIFR causing mortality and growth loss in natural and planted stands of Douglas-fir and predisposing trees to windthrow or attack by other pests and pathogens. Its distribution appears to be quite patchy and it frequently occurs in stands together with *Armillaria ostoyae* and Douglas-fir bark beetle (*Dendroctonus pseudotsugae*).

Specific work objectives aim to establish a root disease inventory (occurrence and incidence) according to a sampling matrix of Inventory Type Group, BEC and age class obtained from a network of growth and yield permanent sample plots in the Okanagan and Kamloops TSA. Preliminary results for the Okanagan TSA suggest that *Phellinus* is more frequently found in Douglas-fir leading timber types in the ICH (61%) compared to the IDF (15%). Incidence data for the Kamloops TSA is still being compiled. Future work will concentrate on building upon the existing incidence database and determining stand-level losses and a first approximation Operational Adjustment Factor (OAF) for *Phellinus* to be used in TSR.

6. Yellow-cedar decline projects

Stefan Zeglen, Forest Pathologist, CFR

Following a successful 2006, aerial surveys to establish the extent of yellow-cedar decline were continued this year. Overview flights of the Sunshine Coast, the North Shore mountains between Lion's Bay and Harrison Lake, and Vancouver Island north of Woss revealed no similar pattern of decline to that evident in areas of the north and mid-coasts. The most southerly, easily observed extent of the decline appears to occur at roughly Homathko Inlet. This concluded our initial gross overview and to date over 30,000 cumulative ha of decline has been identified, with the actual total likely much higher. The next step will be to begin interpretation of new aerial photos of the north and mid-coasts taken over the last two years to get a more precise estimate of the total amount of area subject to decline.

To get a better understanding of when the decline may have started, and how rapidly it is killing trees in affected areas, we partnered with the UBC Dendrochronology Lab to conduct a pilot study. Amanda Stan, a graduate student of Dr Lori Daniels, designed a sampling plan that used tree cores to build a dendrochronological record of tree growth on four sites in the North Coast Forest District. Over two weeks, crews collected over 500 cores from asymptomatic, declining and dead yellow cedar. These cores are being processed at UBC and the results of the pilot should be available by mid-2008. Special thanks go to the North Coast FD staff for all their help this summer.



Yellow-cedar decline damage

7. Birch dieback investigation

Michelle Cleary, Forest Pathologist, SIFR

Birch decline is widespread throughout the interior wetbelt in the SIFR. However, the condition has not been extensively investigated in BC, as it is yet to be perceived as a major issue in our managed commercial forests.

The decline appears to be a result of several factors, some of which are listed below, that appear to be working together or in sequence. Over time, these factors prevent normal tree growth and defensive processes, speed up the aging process, and hasten tree death.

- Birch is a shallow rooted species and stresses that damage roots can also contribute to decline. Such stresses can include abnormally warm winters when an insulating blanket of snow is temporarily absent, fires, or root exposure resulting in abnormal freezing and drying injury that may induce xylem cavitation.
- Root diseases (*Armillaria ostoyae* and *A. sinapina*) can occur on trees older than 40 years of age, especially in situations where they are mixed with conifers and are overtopped.
- An insect complex of bronze birch borer and birch leaf miner species are currently common and causing damage to birch in south-eastern BC and may be an important part of the decline complex. Birch leaf miner populations have been increasing steadily in the region over the last 4-7 years. Moisture stress such as the ongoing “drought” over the last decade has likely had some impact particularly in terms of the incidence of bronze birch borer.

A simple explanation of why decline occurs does not seem likely. There are usually a number of predisposing factors (climate or site factors, age, changed microclimate due to logging or other habitat changes), inciting factors (fungal pathogens and insects, period of drought frost, freeze/thaw, mechanical damage), and contributing factors (canker fungi, root disease, wood and bark boring insects), all of which cause a reduction in tree vigor and induce a state of decline from which it is difficult for trees to recover.

Dr. Suzanne Simard (Associate Professor) and Ameer Manceur (Ph.D. Candidate) from the University of British Columbia will be working with Michelle Cleary and Art Stock to help answer some of these questions surrounding incidence and severity of birch decline including identifying the pests and pathogens and consortium of environmental stresses affecting birch physiology and dieback.



Birch dieback

8. Plantskydd® application in underplanted mountain pine beetle damaged stands

Gord Dow, Regional Silviculture Specialist, NIFR and
Deanna Danskin, Forest Health and Silviculture Technician, NIFR

A trial was undertaken in the Prince George Forest District to determine the potential efficacy of the product Plantskydd® (a blood derivative designed to deter browsing) for prevention of small mammal damage on seedlings underplanted in mountain pine beetle damaged stands.

In July 2007, six 1 ha areas in the vicinity of the Pelican Forest Service Road were underplanted: two in one cutblock were planted with lodgepole pine, and four in another cutblock were planted with Douglas-fir and spruce. Within three days, three of the planted areas (containing each of the different tree species) were sprayed with the Plantskydd® product, and three were left as controls.

Initial assessments were conducted in late September. The spruce areas sustained the highest damage, with 90% browsing in the treatment block and 65% in the untreated. In the treated Douglas-fir area, 25% of the trees were browsed *vs.* 33% in the control. The lodgepole pine seedlings fared the best, with 0% feeding in the treated area and 3% in the untreated. Ungulate browse was responsible for the damage to the lodgepole pine, but all of the browse on the other species was due to snowshoe hare.

While statistical analysis has yet to be conducted, it is apparent that the application of Plantskydd® does little or nothing to deter browse, particularly on spruce seedlings.

9. Predicting risk of infection by comandra blister rust on lodgepole pine in the Sub-Boreal Spruce (SBS) dry cool biogeoclimatic subzone

Richard Reich, Forest Pathologist, NIFR
Sally John, Forest Geneticist, Isabella Point Forestry

The objective of this project was to model the influence of multiple factors in predicting risk of infection on a comandra blister rust resistance trial. Factors included: site, climate, ecology, host resistance, and alternate host abundance and susceptibility. The trial layout involved 50 trees of each of 130 families planted on a 1.5m square grid on each of three different sites in the SBSdk. Counts of the number of rust infections of comandra blister rust (CBR), stalactiform blister rust, and western gall rust were made in 2006 and also in 2007. Counts of the number of stems of the alternate hosts for the respective blister rusts were conducted on a 1.5 meter grid in 2007. Additional data collected included a decimetre accuracy differential GPS survey for terrain, and a standard ecoclassification for each site.

A preliminary spatial analysis of the percent incidence and the intensity of CBR infection based on the distance from the alternate host *Geocaulon lividum* was conducted. The preliminary spatial analysis showed that risk of infection is very high (50 – 60%) when lodgepole pine seedlings are in close proximity to *Geocaulon*, drops dramatically over the first several meters to ~ 20%, and gradually decreases to close to zero by 25 to 35 meters away. Future work will focus on modelling the influence of major variables. We hope to involve a graduate student in statistics in planning and implementing analyses.

10. Are free-growing stands meeting timber productivity expectations in the Lakes TSA?

Alex Woods, Forest Pathologist, NIFR

Wendy Bergerud, Senior Biometrician, Research Branch, Victoria

The current administrative milestone for ensuring effective reforestation is the free-growing declaration. When the free-growing milestone is achieved, it is assumed that the young managed stand is on a trajectory that will result in a productive mature stand. There are no monitoring procedures in place to determine if free-growing stands are meeting these expectations. The purpose of this study was to examine whether the reliance that has been placed on this policy is supported by stand performance from a timber yield perspective.

Sixty randomly sampled free-growing stands were evaluated in the Lakes TSA in central B.C. Sample stands were grouped into two classes based on the number of years since free-growing declaration: half were declared 1987-1994 (early), and the other half declared 1995-2001 (late). We used the silvicultural planning program Table Interpolation Program for Stand Yield (TIPSY) to estimate projected volume at a rotation age of 80 years.

We found that the mean projected volumes at rotation based on free-growing declaration values were not significantly different from volume projections based on 2005 stand attributes for either the early or late groups. Based on declaration attributes the mean projected volumes for the early and late groups were 327 and 316 m³/ha, respectively. Using 2005 stand attributes, projected volume for the early and late groups were 324 and 314 m³/ha, respectively. These projected values closely match the projected values from the most recent Timber Supply data package for the Lakes TSA. The mean density of both well-spaced and free-growing stems has remained relatively stable since declaration with both the early and late groups at or close to 1000 well-spaced stems per hectare.

The most significant difference between observation times (free-growing and 2005) for all stands was the marked increase in forest pest incidence. Over 27% of all declared free-growing pine leading stands had >20% hard pine rust incidence, with pine leading stands representing 90% of the sampled managed stands. The increase in pest incidence is probably due to a combination of increased recognition, as well as real increases in forest pests. The vast majority (84%) of pest affected trees in stands that no longer pass the minimum stocking level of 700 free growing stems/ha based on the Lower Confidence Limit (LCL) test are in the 4m+ height class. In 2005 one of the stands in the early group was identified as being attacked by mountain pine beetle, with 70-75% of the trees infested. As of November 2007 an additional ten stands in the early group have been attacked by the insects, though the incidence of attack in these stands is much less.



*Stalactiform blister rust infection
on young lodgepole pine*

11. Armillaria map verification project

Richard Reich, Forest Pathologist, NIFR

This is the 2nd year of a project initially described in the 2006 Forest Health Annual Report. The purpose of this project is to assess the accuracy of the Armillaria map of the northern portion of the Headwaters Forest District. The map was assembled over a period of several years starting in 1991 using detection methods ranging from specialized low-level aerial sketch mapping using rotary wing aircraft, to detailed ground surveys. In 2006 a verification project was initiated in collaboration with Michelle Cleary of the SIFR to determine the reliability of the Armillaria map by surveying a number of representative young stands.

Approximately 28 stands were surveyed in the fall of 2006, and an additional 23 stands were surveyed in 2007 for a cumulative total of 51 stands. Of these 51 stands, 46 have been 100% sketch mapped using GPS to track the delineation of the Armillaria root disease centers. A total of 2,428 ha were surveyed, of which 345 ha (14.2%) were infested with Armillaria.

The delineated Armillaria polygons will be transferred to the BCMFR forest inventory forest health layer to be used as an on-line planning tool. These polygons also form the basis for a population genetics study using DNA characterization of disease centers (into unique genets) in order to interpret landscape level infection patterns as they relate to operational surveys. Finally, these ground survey results are being compared with the free growing declarations recorded in the BCMFR RESULTS database.

12. Armillaria root disease projects

Michelle Cleary, Forest Pathologist, SIFR

Armillaria root disease (*Armillaria ostoyae*) causes considerable losses in immature and mature stands throughout much of the SIFR by killing natural and planted coniferous trees and causing progressive reduction in stem growth on older trees that sustain chronic (non-lethal) infections.

It is questionable as to whether stands established on sites infected with Armillaria will continue to remain free-growing after declaration. Tree mortality in new plantations starts as early as 4-5 years following planting. Mortality usually peaks around age 12-15 and will continue for several years thereafter. Since the disease is not fully expressed at the time most free growing declarations are made, large openings and understocked stands can be expected post-free growing.

Management strategies aimed at inoculum removal and/or regeneration of species that have low susceptibility to killing by Armillaria is encouraged on infested sites. A revised table of susceptibility ratings for conifers can be found in the FORREX Stand Establishment Decision Aid (SEDA) for Armillaria root disease for the SIFR. Linkages to SIFR Forest Health SEDAs can be found on the SIFR Forest Health website.

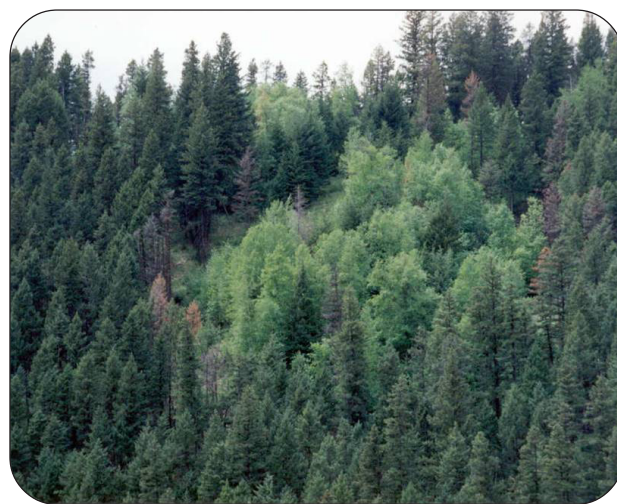
Armillaria root disease population genetics study in the Robson Valley:

In 2007, Simren Brar, a 4th year undergraduate forest science student at UBC with a special interest in molecular forest pathology and working for Michelle Cleary, spent several months collecting mycelial samples from trees killed by *Armillaria* from a selected number of stands previously surveyed as part of the larger *Armillaria* Map Verification Project in the Robson Valley led by Richard Reich. The objective of this study, which currently comprises Simren's undergraduate thesis project, is to examine the population structure of *Armillaria* isolates via DNA characterization of disease centres (e.g. number, size, age of individual genets). UBC researchers Dr. Yousry El-Kassaby and Dr. Richard Hamelin are collaborators on this thesis project. Results will facilitate interpretation of spatial patterns of disease centres as they relate to operational surveys at the landscape level.

Armillaria root disease – Mixed Species

Operational Trial:

Results pertaining to effective root disease resistance operating in western red cedar against *Armillaria ostoyae* led to the establishment of an operational trial near Nakusp in collaboration with Pope and Talbot Inc. This trial will measure the effectiveness of stumping versus mixed conifer plantations including western red cedar on sites heavily infested with *Armillaria* root disease. A similar trial was implemented in 2005 near Enderby. Mortality and growth responses in Douglas-fir and western red cedar will be measured on a 3-year cycle.



Typical root disease centre

13. Distribution and incidence of Phellinus root disease in the Southern Interior Forest Region (FSP-FIA Y081130)

Michelle Cleary, Forest Pathologist, SIFR

Phellinus sulphurascens (syn. *P. weirii*), the cause of Laminated root disease, is known to occur across a variety of BEC zones in the SIFR causing mortality and growth loss in natural and planted stands of Douglas-fir and predisposing trees to windthrow or attack by other pests and pathogens. Its distribution appears to be quite patchy and it frequently occurs in stands together with *Armillaria ostoyae* and Douglas-fir bark beetle (*Dendroctonus pseudotsugae*).

Specific work objectives aim to establish a root disease inventory (occurrence and incidence) according to a sampling matrix of Inventory Type Group, BEC and age class obtained from a network of growth and yield permanent sample plots in the Okanagan and Kamloops TSA. Preliminary results for the Okanagan TSA suggest that *Phellinus* is more frequently found in Douglas-fir leading timber types in the ICH (61%) compared to the IDF (15%). Incidence data for the Kamloops TSA is still being compiled. Future work will concentrate on building upon the existing incidence database and determining stand-level losses and a first approximation Operational Adjustment Factor (OAF) for *Phellinus* to be used in TSR.

14. Rust and foliar pathogen resistance in pine seedlots at the Prince George Tree Improvement Station

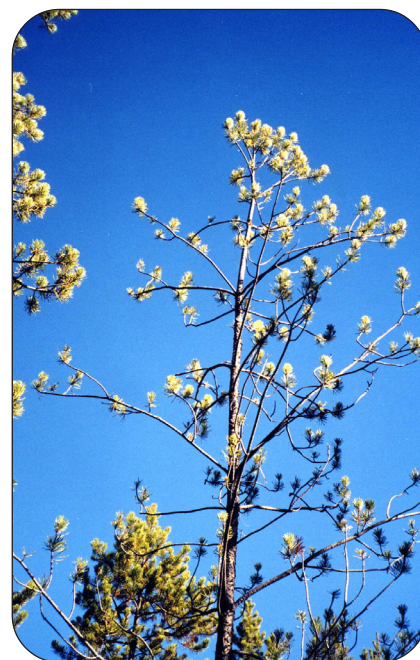
Richard Reich, Forest Pathologist, NIFR

An assessment of resistance to the major pathogens affecting the three remaining lodgepole pine seed orchards at the Prince George Tree Improvement Station (PGTIS) was initiated in 2006, with additional assessments conducted in 2007. Western gall rust and three foliar diseases were found to be the most prevalent diseases. The foliar diseases are *Dothistroma pini*, *Lophodermella concolor* and *Elytroderma deformans*. Incidence and severity of these pathogens as well as foliar retention were assessed in detail.

With this information we can now shed light on the level of resistance by disease for multiple diseases. We can also examine the likelihood that resistance to one organism will be correlated to resistance to one or more other pathogen(s). This will also help us to quantify the risk of selecting for resistance to a particular organism.

Given that several of the clones occur in more than one orchard at the PGTIS, we can also learn about the influence on environment for disease expression. Learning how environment influences the occurrence of a particular pest or group of pests will also help us understand the effect of changing climate.

Finally, given that the seed source for these orchards comes from a wide geographic origin, we can look at the limitations or challenges that will likely arise when seed is transferred to new geographic locations. What are the forest health risks associated with moving seed a considerable distance? How long do we need to wait before we see the effects of moving seed too far?



Needle loss due to several years of *Lophodermella* infection

15. East Kootenay FIDS permanent sample plot results for defoliators

Janice Hodge, JCH Forest Pest Management

Art Stock, Forest Entomologist, SIFR

Thirteen permanent sample sites were established in the east Kootenays using original locations of the Forest Insect and Disease Survey (FIDS) Unit of the Canadian Forest Service, which established a network of permanent sample plots (PSP) in the early 1960's. These re-established plots are primarily to monitor the incidence of western false hemlock looper, *Nepytia freemani*, which has historically caused severe defoliation, and western spruce budworm, *Choristoneura occidentalis*. The East Kootenays do not have history of visible defoliation by western spruce budworm. It is possible however, given climate change and Douglas-fir encroachment throughout the Rocky Mountain Trench, that conditions may become favourable for increasing western spruce budworm populations. Three-tree beating collections were conducted between June 17-19, 2007. Five of 13

plots were positive for western spruce budworm (3rd-4th instar), while 4 were positive for false hemlock looper (2nd- 3rd instar). Three of these were in PSP's with western spruce budworm. The most common defoliator, found in 8 PSP's, was the greenstriped forest looper, *Melanolophia imitata*, a solitary defoliator of several conifer species. The number of larvae at any one PSP was not significant, nor was any defoliation noted.

Also, moderate to severe birch leaf miner defoliation was visible in the Arrow-Boundary Forest District, along Hwy 6 eastward from the District boundary, and in the Kootenay Lake Forest District.

16. Mountain Caribou recovery

Art Stock, Forest Entomologist, SIFR

Ken White, Forest Entomologist, NIFR

Art Stock and Ken White were invited by the Provincial Mountain Caribou Recovery Team to act as forest health specialists in order to have input into developing criteria for forest health activities within the Mountain Caribou Recovery (MCR) area. This work involves collecting information on the presence of forest health agents within the MCR area, and developing best management practices to allow for forest health activities to occur, while maintaining attributes of the landscape that are needed to preserve mountain caribou habitat. A report will be written early in 2008, and this will form the basis for forest health treatments throughout mountain caribou habitat around BC.

FOREST HEALTH MEETINGS

Forest health field training sessions

A number of Forest Health field training sessions were held this year in the Arrow Boundary, Campbell River, Cariboo, Headwaters, Kootenay Lake, Queen Charlotte Islands and Sunshine Coast Forest Districts. Participants included district staff, licensees, and private woodlot owners. Topics covered a wide range of forest health issues with emphasis on field diagnostics, current research of important forest pests, and challenges surrounding forest health and management of young stands particularly as it relates to free growing.

Upcoming western white pine management workshop

June 17-18, 2008. Vernon.

Western white pine has been decimated throughout its natural range since the introduction of white pine blister rust (*Cronartium ribicola*) to western North America. For several decades now, the selection and breeding of white pines resistant to blister rust has remained a high priority for pathologists, geneticists, and forest practitioners.

Despite its high ecological and commercial value there has been a reluctance to include western white pine in reforestation plans. However, high survival rates of genetically-improved, blister rust-resistant stock and impressive growth yields have been demonstrated which now warrants us to 'rethink' our desire to manage this species.

This workshop will provide foresters opportunities to learn about a wide range of topics including: the autoecology of western white pine, its wood properties and uses; the biology of the fungus and the history of rust in North America; recent advances in genetic resistance of western white pine and the status of the resistance breeding programs in the U.S. and Canada; growth and yield results from operational research trials; and management strategies for western white pine, now and in the future. For further information, please email Michelle.Cleary@gov.bc.ca.

FOREST HEALTH PRESENTATIONS

BC conditions report

Tim Ebata, Forest Health Project Specialist, Forest Practices Branch

Venue:

National Pest Forum, Ottawa, Dec 4-6, 2007

Abstract:

The provincial summary of forest health conditions was reported to a national audience at the annual National Pest Forum. This meeting is attended by forest health representatives from all provinces and territories, and by forest health researchers, program administrators and regulators from various federal agencies (i.e., CFS, CFIA, PMRA, etc.). Preliminary totals and trends were presented together with highlights from the year's survey. Provincial forest health program highlights that included publishing of the Provincial Forest Health Strategy and Program Description and the current recruitment opportunities were also presented. The provincial reports are considered to be an important component of the National Forest Pest Strategy's objective to communicate and exchange forest health information on a national level.

BC's changing landscape: an insect's view on forest succession and management

Lorraine Maclauchlan, Forest Entomologist, SIFR

Venue:

ExpoFor 2007 ABCFP Annual Meeting, Harrison Hotsprings, Feb. 21, 2007.

Abstract:

Insects are our continual and closest neighbours, so much a part of day-to-day life that most of us hardly take notice unless they are particularly loud, obnoxious or bothersome. Human beings form a tiny 2-legged minority in an overwhelmingly 6-legged world. Insects may not have read about global warming - but they certainly know about climate change! The most influencing factor in an insect's ecology is weather (temperature, moisture) as it affects their reproductive success, dispersal, host resistance and mortality rates. As such, almost imperceptible changes in climate can have huge impacts on insects. Examples were given of how insects have, and could, respond to change. Insects will not respond smoothly and at steady rates but explosively or in an insidious fashion. Past, current and potential future outbreaks and which insects will become major players, and why, were discussed.

Entomological & other observations from the Northern Interior Forest Region

Robert Hodgkinson, Forest Entomologist, NIFR

Venue:

Forest Health Committee of BC meeting, Pacific Forestry Center, Victoria, Jan. 30, 2007 and Alberta-BC Intermountain Forest Health Meeting, Best Western Inn, Hinton, Alberta, April 17, 2007.

Abstract:

The following forest pests and their impacts were outlined: mountain pine beetle and *Ips pini* in young lodgepole pine stands, snowshoe hares, Douglas-fir beetle, spruce beetle, western balsam bark beetle, 2-year budworm, and mountain pine beetle attacking interior and black spruce.

Host response to infection by *Armillaria ostoyae* in the roots of Douglas-fir and western red cedar in the southern interior of BC

Michelle Cleary, Forest Pathologist, SIFR

Venue:

12th IUFRO International Conference on Root and Butt Rots of Forest Trees, Berkeley California – Medford, Oregon, USA. August 12-19, 2007.

Abstract:

Armillaria root disease is a significant forest health concern in southern interior forests of BC. *Armillaria ostoyae* is most predominant and damaging in the Interior Cedar-Hemlock (ICH) BEC zone. Within this zone, aboveground symptoms of *Armillaria* can be detected in only one-quarter of the trees with belowground infection. Cumulative mortality can be as much as 20% by age 20 years resulting in undesirable stocking in juvenile stands. Moreover, growth loss will occur in trees sustaining non-lethal infections and the probability of infection increases with increasing tree size. Ultimately, these losses can become considerable over time and create serious challenges for managing sustainable timber production on infested sites. Few options are available to mitigate potential losses due to *Armillaria* root disease. Removal of stumps is a very effective means of reducing the amount of woody inoculum that would otherwise be available to the fungus. Another less intrusive option is to plant conifer species that have a low susceptibility to killing by *A. ostoyae*.

In this study, microscopic examination of infected root tissue revealed unique resistant mechanisms operating in western redcedar that are effective at containing infections and halting further spread of *A. ostoyae* in host tissue. Inoculations on 20-30 year old trees showed that the frequency at which resistant reactions, including necrophylactic periderm formation and compartmentalization of infected woody tissue, were induced following invasion by the fungus was significantly higher in western red cedar trees than in Douglas-fir and western hemlock trees.

In a survey of twenty juvenile mixed conifer plantations throughout the ICH zone in the southern Interior of BC, cumulative mortality in Douglas-fir trees was significantly higher than in western red

cedar trees. The probability of mortality among trees infected with *A. ostoyae* depended on both species and tree size. The incidence of mortality was significantly greater in the smaller diameter size classes than in the larger size classes for both species and cedar mortality was consistently lower than Douglas-fir. Although the risk of mortality decreased with increasing tree size in both species, the rate of decrease was noticeably greater among cedar compared to Douglas-fir trees. There was an increasing trend in the proportion of infected trees showing compartmentalization and callusing with tree size for both western red cedar and Douglas-fir, but the increase was markedly greater for cedar than Douglas-fir trees and occurred much earlier even when the trees were relatively small. Results of this study suggest that the higher degree of resistance against *A. ostoyae* in western red cedar may help alleviate long-term impacts of root disease when regenerated on sites infested with *Armillaria*.

Is an unprecedented Dothistroma needle blight epidemic related to climate change?

Alex Woods, Forest Pathologist, NIFR, Smithers RSC.,
Dave Coates Research Silviculturalist, NIFR, Smithers RSC and
Andreas Hamann, University of Alberta

Venue:

“Climate Change Impacts on Boreal Forest Disturbance Regimes” VI International Conference on Disturbance Dynamics in Boreal Forests, University of Alaska, Fairbanks, Fairbanks Alaska, USA May 30 - June 2 2007.

Abstract:

Dothistroma needle blight caused by the fungus *Dothistroma septospora* is a major pest of pine plantations in the southern hemisphere, where both the host and the pathogen have been introduced. In northern temperate forests where the pest and host trees are native, damage levels have historically been low; however, *Dothistroma* is currently causing extensive defoliation and mortality in plantations of lodgepole pine in northwest BC. The severity of the disease is such that mature lodgepole pine trees in the area are succumbing, which is an unprecedented occurrence. This raises the question whether climate change might be responsible by surpassing an environmental threshold that has previously restricted the development of a pathogen in temperate regions. Establishing a causal relationship between climate change and local biological trends is usually difficult, but we found a clear mechanistic relationship between an observed climate trend and the host: pathogen interaction. A local increase in summer precipitation, not climate warming, appears to be responsible. We examined whether the recently observed climate change trend exceeds natural fluctuations of local climate.



*Mature lodgepole pine succumbing to
Dothistroma infection*

Oh No - mountain pine beetle in spruce! and murder and attempted murder: mountain pine beetle attacks 2 species of spruce in Interior of BC

Robert Hodgkinson, Forest Entomologist, NIFR

Venue:

Regional Forest Stewardship Meeting, Smithers, April 24, 2007, and Integrated Pest Management Forum, Edmonton, Alberta, Northern Forestry Centre, November 6, 2007.

Abstract:

Historical observations of mountain pine beetle attacking spruce were reviewed up to the spring of 2006. An account of the 2 spruce successfully attacked at Miworth, B.C. was given along with the objectives, methods, observations, and preliminary results of the emergence trap trial. The results of trials in 2006 and 2007 have been submitted for publication. A brief summary of the observations on black spruce being attacked was given.

Our Future Forests – pest management versus forest succession. Do we have a choice?

Lorraine MacLauchlan, Forest Entomologist, SIFR

Venue:

Pest Management Association of B.C. Feb.2, 2007.

Abstract:

In the past two decades British Columbia has experienced unprecedented outbreaks of bark beetles and defoliators. Currently BC is experiencing concurrent outbreaks of mountain pine beetle, western pine beetle, spruce beetle, Douglas-fir beetle and the western spruce budworm. Past forest management, including fire suppression, harvesting and other activities in our forests could in part be factors in these events. Coupled with man's activities in the forest, BC has a vast inventory of aging forests spread across the landscape. These aging forests and changing climate patterns are conducive to the building and expansion of many forest insect pests. This talk focused on the current mountain pine beetle and western pine beetle situation in BC, the influence of climate in outbreak dynamics and the status of our young pine stands.

Received the 2007 "PheroTech Award of Excellence" in the field of integrated pest management in forestry and teaching, at the PPMA conference.



*Ponderosa pine mortality caused by western
and mountain pine beetle*

Red-band needle blight of pines in British Columbia, Canada: What does the future hold?

Alex Woods, Forest Pathologist, NIFR, Smithers RSC.,

Venue:

Society of American Foresters, Annual General Meeting, Portland Oregon, USA, October 24-26, 2007, as a member of a panel of speakers covering forest disease issues in western North America.

Panel Abstract:

Managing Forest Disease on the West Coast presented information and examples of the major forest diseases that are having an impact on forests and forestry in British Columbia, Washington, Oregon and California. Each speaker provided a short background piece on the disease, discussed how the disease influences forest growth, mortality and composition, and then related specific examples of management programs that are dealing with the disease.

Moderated by David Shaw, Extension Forest Health Specialist, Oregon State University Extension Service.

1. Swiss Needle Cast of Douglas-fir in Oregon. David Shaw, Oregon State University, Director, Swiss Needle Cast Cooperative.
2. Red Band Needle Blight of Pine in British Columbia. **Alex Woods, British Columbia Forest Service.**
3. White Pine Blister Rust Along the Pacific Coast. Ellen Goheen, USDA Forest Service.
4. Sudden Oak Death in California. Susan Frankel, USDA Forest Service.
5. Sudden Oak Death in Oregon. Alan Kanaskie, Oregon Department of Forestry.
6. Port Orford Cedar Root Disease in Oregon and California. Everett Hansen, Oregon State University.

These examples from the west coast of North America and their influence on forests and forestry can be used to elucidate the threats and opportunities that are present throughout the country in the face of changing climates, management regimes, and social attitudes. Some of these diseases are caused by native fungi gone bad, while others are caused by introduced fungi and fungus-like organisms. The stories and examples of specific management responses to each of these diseases represents some epic fights to continue forest management and protect forests in the face of overwhelming odds. These battles continue as we speak.

The changing landscape: tracking the footprint of the mountain pine beetle

Lorraine Maclauchlan, *Forest Entomologist, SIFR*

Venue:

Mountain pine beetle and Hydrology Conference, Kelowna, BC. July 9, 2007.

Abstract:

Mountain pine beetle is the most destructive agent of mature pine forests in western North America. This insect has evolved with its host, all native pine species, and normally is innocuous in a forest setting, killing only scattered, suppressed trees. However, periodically populations erupt into large scale outbreaks and the beetle acts as the natural succession agent of our pine dominated forests. This current outbreak is larger, more extensive and more locally severe than historically recorded. The outbreak started in numerous geographically distinct areas in British Columbia in the late 1990's. The vast expanses of aging pine forests coupled with successive years of mild winters and warm summers have fuelled the mountain pine beetle expansion. Over 9.2 million hectares of various levels of red attack were mapped in 2006 in BC. The mountain pine beetle flight of 2006 was one of the most synchronized and concentrated yet observed in the south so the area of infestation is expected to grow significantly in the southern portions of BC. The dynamics of the outbreak have changed in the past three years due to the exponential rise in beetle numbers and depletion of the host. The momentum of the outbreak is now being driven by massive aerial movements of the beetle that can often consume a stand in a single year. The pressure is so extreme in many areas throughout the core of the outbreak that non-traditional hosts and younger age classes are at risk. The presentation focussed on the trends of this outbreak, projections for our young stands and how and when the outbreak will collapse.

Update on the impact and projections of mountain pine beetle in immature pine stands in BC

Lorraine Maclauchlan, *Forest Entomologist, SIFR*

Venue:

Alberta/British Columbia Intermountain Forest Health Workshop, Hinton Alberta, April 2007, and: Forestry Expo, Grande Prairie, Alberta, May 11, 2007.

Abstract:

The mountain pine beetle has been moving into young lodgepole pine stands throughout the range of the outbreak area in BC. Although historically this behaviour foreshadows the collapse of the MPB, the current outbreak is more extensive and severe than any in our past experience. As a result, we need to estimate the full impact of the MPB to our mid-term timber supply by quantifying and projecting losses in these young pine stands. In 2005 and 2006, 1,206 stands and 2,528 stands, respectively, in seven Districts were aerially surveyed. The proportion of stands having some level of mountain pine beetle attack increased from 49% in 2005 to 74% in 2006. The greatest increases in both percent stands affected and severity of in-stand attack was seen in the Central Cariboo and areas south. *Ips pini* was also active in these stands, with 60% or more of stands affected to some level in Quesnel, Central Cariboo and 100 Mile House Districts. It is projected that the proportion of mortality will be higher in the far south as the beetle is forced into less favourable host resources and habitats.

Workshop on forest silviculture & bark beetles: A sensitive ecosystem: ideas on management of western balsam bark beetle

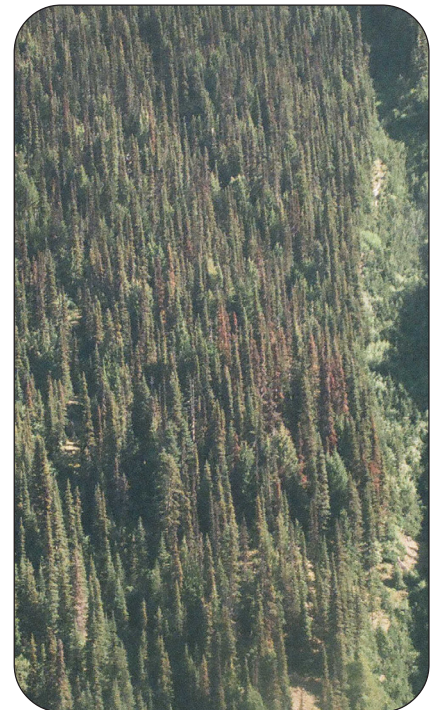
Lorraine Maclauchlan, Forest Entomologist, SIFR

Venue:

2007 Western Forest Insect Work Conference, March 8, 2007.

Abstract:

Subalpine fir-spruce forests experience low level, constant mortality caused by *D. confusus*, and other mortality agents, creating small to medium sized gaps. The mortality pattern caused by *D. confusus* is spatially aggregated with small gaps regenerated by subalpine fir and medium gaps mirroring the size and pattern of spruce found within these ecosystems. Small diameter trees die first in these stands, often killed by secondary insects, disease or suppression. These trees cumulatively occupy up to a quarter of the dead tree basal area in a stand. Initially, *D. confusus* attack in a stand is spatially random. Over time, attacked trees are spatially aggregated, displaying a shift of position to new clusters of susceptible trees, as clusters of susceptible trees are “used up”. Blowdown is spatially random and has minor influence over the dynamics of *D. confusus* except when these events are of a larger scale. *D. confusus* does not fully utilize fresh blowdown but often selects susceptible, slow growing, live standing subalpine firs. Management could “mimic” these natural spatial patterns through various harvesting options such as small or medium patch harvesting. Baiting in multiple bait-centres prior to harvest can create small patches of attack that could be then be removed. Larger cutblocks are also effective in managing *D. confusus* given site specific requirements for regeneration. Cut block edges incur more blowdown and *D. confusus* attack in the first ten years following harvest but equilibrate over time. Seedling regeneration and recruitment is comparable among these harvesting regimes and is largely a function of micro-site and aspect.



Subalpine fir attacked by western balsam bark beetle

FOREST HEALTH PUBLICATIONS

Aukema, B., Hodgkinson, R., Huber, D. and Lindgren, S. 2007. Eating themselves out of house and home: mountain pine beetle attack spruce! Can. Silv. 4: 12.



Ministry of Forests and Range, Forest Practices Branch

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