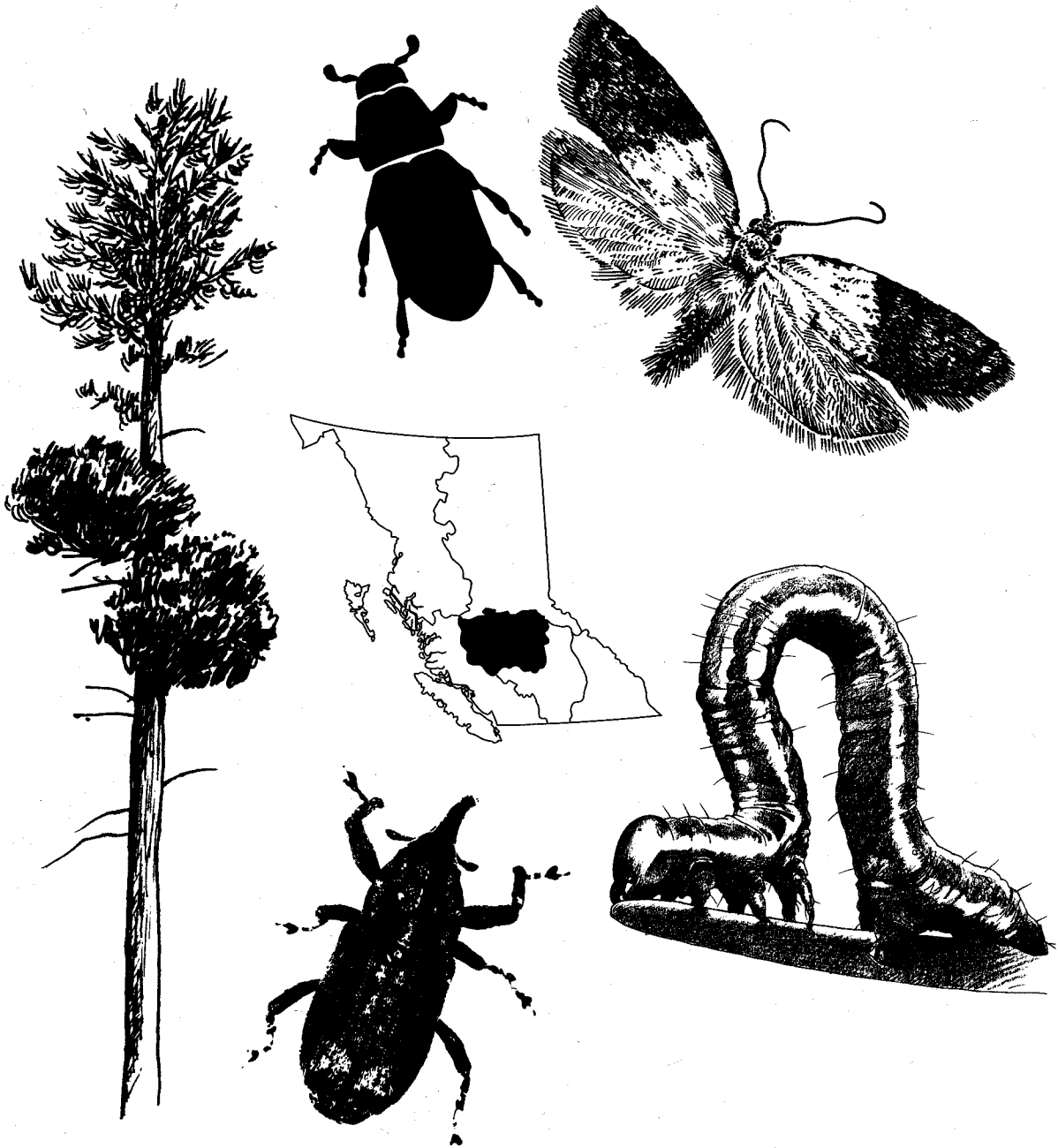




Forest Insect and Disease Conditions Cariboo Forest Region - 1994

R. Erickson and R. Ferris
Canadian Forest Service - Pacific and Yukon Region



Natural Resources
Canada

Ressources naturelles
Canada

Canadian Forest
Service

Service canadien
des forêts

Pacific and Yukon
Region

Région du Pacifique
et Yukon

Canada

Contents

Introduction	2
Summary	4
Douglas-fir Pests	5
Douglas-fir beetle, <i>Dendroctonus pseudotsugae</i>	5
Western spruce budworm, <i>Choristoneura occidentalis</i>	11
Climatic damage	12
Pine Pests	12
Mountain pine beetle, <i>D. ponderosae</i>	12
Pine needle cast, <i>Lophodermella concolor</i>	17
Pinewood nematode, <i>Bursaphelenchus xylophilus</i>	18
Spruce Pests	18
Two-year-cycle spruce budworm, <i>C. biennis</i>	18
Spruce beetle, <i>D. rufipennis</i>	21
Alpine Fir Pest	22
Western balsam bark beetle, <i>Dryocoetes confusus</i>	22
Western Hemlock Pest	23
Western hemlock looper, <i>Lambdina f. lugubrosa</i>	23
Pests of Young Stands	25
Multiple Host Pests	27
Black army cutworm, <i>Actebia fennica</i>	27
Biomonitoring/Acid rain	27
Deciduous Tree Pests	28
Forest tent caterpillar, <i>Malacosma disstria</i>	28
Gypsy moth, <i>Lymantria dispar</i>	32
Satin moth, <i>Leucoma salicis</i>	33
Poplar-and-willow borer, <i>Cryptorhynchus lapathi</i>	33
Other Noteworthy Pests	34

Introduction

Forest Insect and Disease Survey (FIDS) is a national program in the Canadian Forest Service, Natural Resources Canada. FIDS is responsible for an annual, overview survey of forest pest conditions in Canada; to support the Plant Health Directorate of Agriculture Canada in quarantine related matters; to conduct research and develop survey techniques, and conduct related biological studies. The co-operation of provincial, industrial and municipal agencies is valuable to meet these mandates and is gratefully acknowledged.

This regional report outlines the status and impact of forest pests in British Columbia in the Cariboo Forest Region in 1994, and attempts to forecast some of their trends. Pests are discussed by host, in order of importance. It is compiled from information obtained mainly from field observations and collections by FIDS during the 1994 field season, which extended from May 30 to September 30. There were 260 insect and disease samples and other pest data collected and pest damage was mapped and photographed during 32 hours of fixed-wing and 5 hours rotary-wing aerial survey, supplied by the British Columbia Forest Service (Fig. 1). Additional information was obtained from an aerial survey contracted by the B.C. Forest Service.

Throughout this report, subjective terms "light", "moderate", and "severe" are used; when referring to insect and disease defoliators these are defined as follows:

- Light : discolored foliage barely visible from the air, some branch tip and upper crown defoliation
- Moderate : pronounced discoloration, 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

When referring to bark beetle infestations throughout this report, the following criteria are used:

- Light : 1-10% of stems killed
- Moderate : 11-29% of stems killed
- Severe : 30%+ of stems killed

The Forest Insect and Disease Survey has conducted an annual pest survey in the Cariboo Forest Region since the late 1930s and from an established field headquarters at Williams Lake since 1954. Inquiries can be directed to FIDS in the Cariboo Forest Region at the following address from May to September:

Canadian Forest Service
Forest Insect and Disease Survey
Sidcum Sub., Comp. 33,
Williams Lake, B.C.
V2G 2V4, Ph. 392-6067

FIDS staff including the ranger, Insectary, and Herbarium may be reached at the address below:

Canadian Forest Service	Ph. 363-0600/363-0716
Pacific Forestry Centre	FAX 363-6005
506 West Burnside Rd.	Internet: BERICKSON@A1.PFC.FORESTRY.CA
Victoria, BC V8Z 1M5	

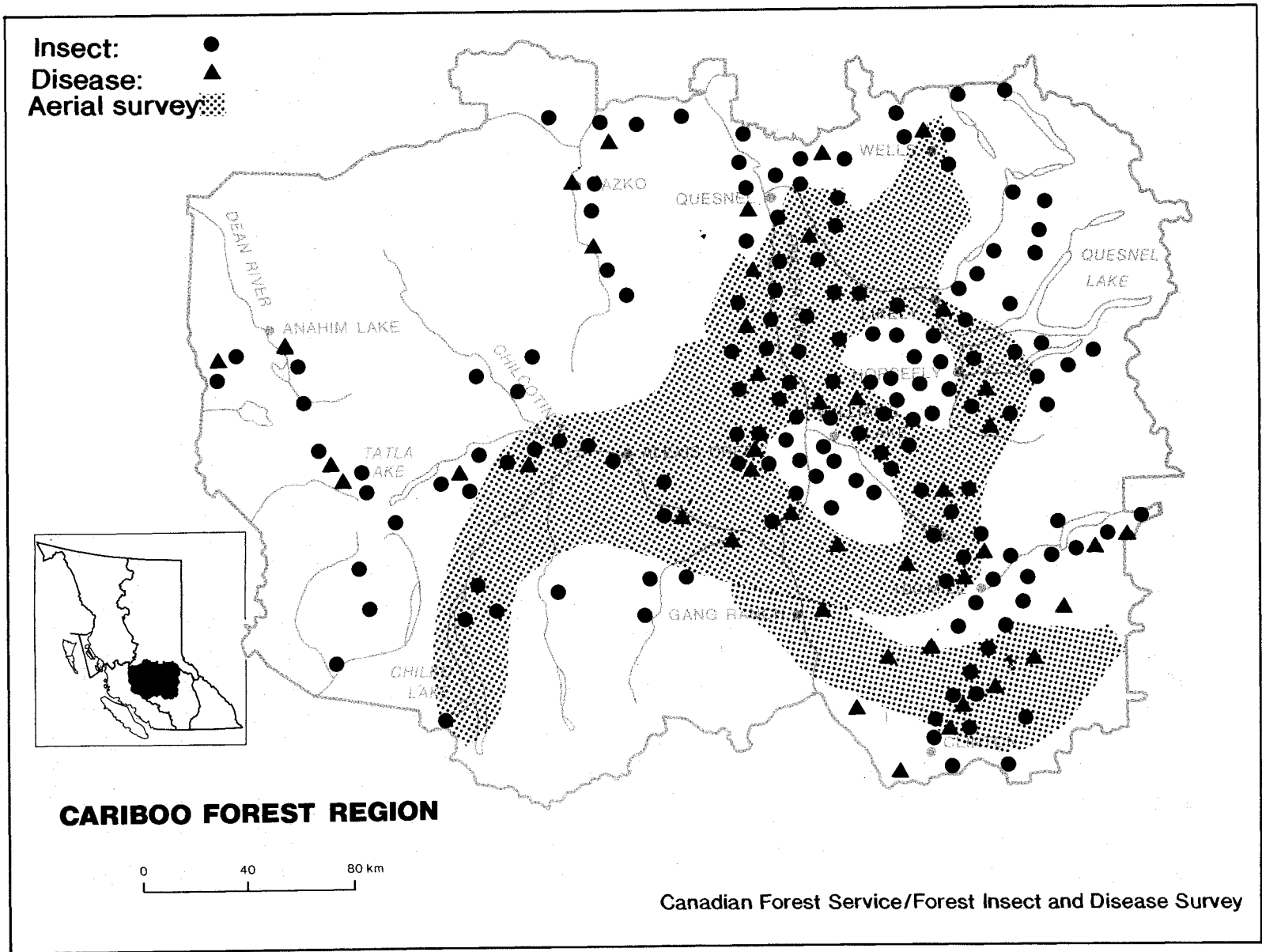


Figure 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator damage in 1994.

Summary

The following report summarizes the forest pest conditions in the Cariboo Forest Region, based on the survey conducted by FIDS in 1994. The pests are grouped by host and land tenure including Timber Supply Area (TSA).

The Cariboo Forest Region is located centrally in British Columbia on the interior plateau and ranked third¹ in the province in forest area harvested in 1992-93. There are three TSA's in the Cariboo Forest Region; Quesnel, Williams Lake and 100 Mile House. Not included in the TSAs are one Tree Farm License (TFL), the National Defense Department Training area near Riske Creek and one major provincial park. More detailed reporting for specific pests is available on request from FIDS, Pacific Forestry Centre, Victoria.

For the sixth consecutive year the most damaging pest was **Douglas-fir beetle**, which killed mature Douglas-fir over 5230 ha, down by 25% from 6920 ha last year. Most of the decrease occurred in the Chilcotin Military Block and in Williams Lake TSA.

Western spruce budworm infestations continued at low levels in the Clinton area. Larval numbers were up in beating collections, however only trace defoliation was noted near Clinton along Big Bar Lake Road and on Hart Ridge.

Increases in recent tree mortality to 1660 ha from 780 ha last year occurred in **mountain pine beetle** infestations from the Quesnel area to 100 Mile House, especially from Mackin Creek to Big Lake. Lodgepole pine were recently killed from northwest of Quesnel south to Clinton including the Narcosli, Horsely and 100 Mile House areas.

Pine needle cast on lodgepole pine increased fivefold, discoloring the one-year old needles over nearly 500 000 ha mainly in the Chilcotin from Tatla Lake to Riske Creek and in the 100 Mile House area. Similar widespread infection and defoliation occurred in the Chilcotin from 1981-85, and was suspected to have caused growth reduction especially in the younger trees.

Defoliation of Engelmann spruce and alpine fir by **two-year-cycle spruce budworm** was not as severe as predicted. Mainly light defoliation was mapped over 110 520 ha in the eastern portion of the region from Willow River to Mahood Lake including Swift and Little Swift rivers and Quesnel Lake.

The most common pests recorded in surveys of 23 **young stands**, 15-years-old or younger, treated under FRDA 1 and II, were spruce and pine **terminal weevils**, **pine needle cast**, and **rusts** and **mammals**.

Studies at **biomonitoring** and **acid rain plots** east of Quesnel, west of Williams Lake and east of Chasm indicated no effects on vegetation from acid rain.

The area and intensity of defoliation of trembling aspen by **forest tent caterpillar** increased to over 53 000 ha of light to severe from Horsely to Quesnel, up from 47 000 ha last year. The most severe damage occurred in the Quesnel area where large numbers of larvae had completely stripped aspen by the middle of June. Some stands partially refoliated in July.

¹ Annual Report 1992/93, BC Ministry of Forests

Douglas-fir Pests

Douglas-fir beetle *Dendroctonus pseudotsugae*

The area of mature Douglas-fir recently killed by Douglas-fir beetle in Cariboo Forest Region was 5230 ha in 1730 patches of 2-300 trees, down from 6920 ha in 2540 patches last year, following two consecutive years of increases (Figure 2, Table 1). Nearly 80% of the total infested area was mapped in the Chilcotin Military Block near Riske Creek in 10% of the patches, similar to 1993. Elsewhere beetle-killed trees were recorded from the Blackwater River near Quesnel, south along the Fraser to the Clinton area, east of Williams Lake to Horsely, and west in the Chilcotin to the Homathko River. Where undertaken and completed properly, salvage and control logging were effective in reducing the number of infestations and the population potential of this important bark beetle. Control efforts were impeded in parts of the Williams Lake TSA by aboriginal lands claims issues.

Table 1. Douglas-fir beetle infestations and trends, Cariboo Forest Region, 1994.

Land tenure and location	Biogeoclimatic zones ¹	1994		1993	
		Area (ha)	Number of patches	Area (ha)	Number of patches
<u>QUESNEL TSA</u> Fraser R.- Narcosli Cr.	SBSk1,SBSk2	220	150	300	350
<u>WILLIAMS LAKE TSA</u> Williams Lake, Horsely, Chilcotin	IDF, SBS	780	1170	1120	1622
<u>NATIONAL DEFENSE</u> DND, Riske Cr.	IDF	4110	190	5320	248
<u>100 MILE HOUSE TSA</u> Bonaparte R.,	IDF, SBS	120	220	180	320
Total		5230	1730	6920	2540

¹ SBSk1,k2: sub-boreal spruce, dry, warm.
SBS : undifferentiated sub-boreal spruce.
IDF : interior Douglas-fir.

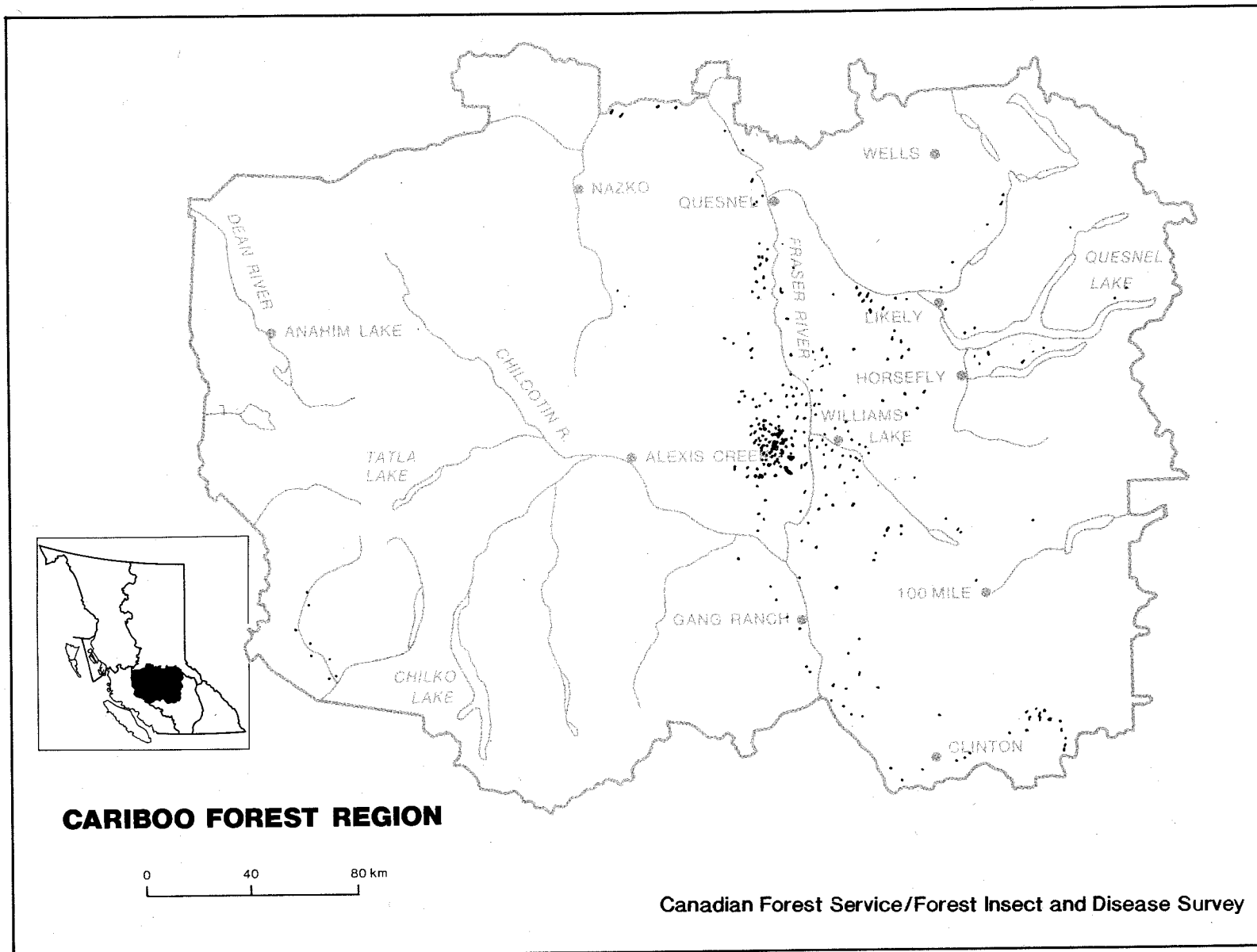


Figure 2. Areas of recent Douglas-fir mortality caused by Douglas-fir beetle, detected during aerial and ground surveys, 1994.

Quesnel TSA

Infestations of Douglas-fir beetle in **Quesnel TSA** decreased in 1994 to 220 ha in 150 patches, down from 350 patches over 300 ha last year due to salvage logging and depletion of the host. The total in Quesnel TSA represents only 4% of the total infested area in the Cariboo region. The infestations were again most severe in the chronic areas along the Fraser River from Quesnel south to near Marguerite. The Douglas-fir stands in that area and much of the Cariboo Forest Region are highly susceptible to Douglas-fir beetle attack because of their age, the possible moisture deficit condition caused in part by the steepness of the slopes and the fact that the trees are growing on the northern limits of their range. Elsewhere small patches of 2-10 recently killed trees were mapped along the Blackwater, Nazko and Quesnel rivers.

Williams Lake TSA, Chilcotin Military Block

The outbreak decreased in the **Williams Lake TSA** where 780 ha (15%) of the area and 1170 (67%) of the patches in the region were located, down from 1622 patches over 1120 ha in 1993. There also was a decrease in the **Chilcotin Military Block** near Riske Creek to 4110 ha in 190 separate patches from 5320 ha in 248 patches last year. Infestations occurred mainly in stands of mature Douglas-fir in the IDF and the dry southern subzone of the SBS biogeoclimatic zones.

The most severe infestations again occurred in the Chilcotin Military Block (DND) at Riske Creek, where the area of tree mortality decreased for the first time since 1988, following a fourfold increase in 1993. Last year may have been a turning point in the size of the Douglas-fir beetle infestations, and may never be repeated since the Chilcotin Military Block is rapidly being depleted of susceptible mature and overmature Douglas-fir.

FIDS historical files indicate that the largest infestations reported in the last 50 years were: 1958, 13 000 dead trees from Lac La Hache to Williams Lake; 1961, 14 000 recently killed trees in the Williams Lake-Lac La Hache areas; and 37 000 trees recorded in 1963 in the Chilcotin. Extrapolating from the 1994 infested area and the average number of recently killed trees per hectare from the cruise data, there were **139 120** trees mapped in 1994 in the Cariboo Forest Region, down from 207 600 in 1993.

Infestations declined from Sheep Creek to Macalister along the Fraser River, west of the Fraser to Riske Creek, south of Williams Lake to Alkali Lake including Chimney Lake and from Riske Creek south to the Chilcotin River. Infestations also decreased along Homathko River and Mosley Creek, likely a result of host depletion after four consecutive year of infestation. The decrease continued to 83 patches from 138 last year from 150 Mile House to Big Lake and to 11 patches over 3 ha from 18 patches over 9 ha last year in the Alexis Creek area and west along the Chilko River.

100 Mile House TSA

Following an increase last year in 100 Mile House TSA, infestations declined slightly to 120 ha in 220 patches from 180 ha in 320 patches last year. Only 11 patches over 3 ha were mapped in the Young Lake-Bonaparte River area, down from 50 patches over 30 ha last year. Tree mortality continued at a much reduced rate in scattered patches in the Canim Lake area. Near Green, Loon and Big Bar lakes and Bonaparte River, 97 patches totalling 50 ha were mapped, down from 130 patches over 56 ha in 1993.

Decreases have, in part, been due to prompt and effective control action, comprised of selective logging and/or single tree disposal, by the BCFS and the Forest Industry.

1994 Survey

Fixed-radius plots, 0.24 ha in size located throughout the outbreak, were used to assess tree size, attack category and severity of attack (Table 2, 3, Figure 3). The plots showed **10%** (range 1-33%) of stems per hectare over 20 cms dbh were **currently attacked** at the 15 locations examined, down from an average 24% (range 4-62%) last year. The number of **recently killed red trees**, averaged **7%** (range 1-20%), down from an average 14% (range 0-33%) last year. The average percent current attack and recently killed were twice the regional average in the DND Block. The location of these plots was directed to active infestations, marked by a number of red trees.

Table 2. Status of Douglas-fir beetle populations in cruise plots in the Cariboo Forest Region, 1994.

Land tenure and location	Percent of stems/ha				
	Current ¹	Red	Grey	Partial	Healthy
<u>NATIONAL DEFENSE</u>					
Drummond L.(W)	20	6	16	4	54
Drummond L.(NW)	21	7	5	5	62
Drummond L.(N)	19	19	18	4	39
Moose Rd. #1	26	19	7	0	48
Moose Rd. #2	33	5	0	0	62
Moose Rd. #3	28	13	2	2	55
Badger Rd.	11	20	15	3	51
Stack Valley #1	7	19	14	5	55
Stack Valley #2	12	18	16	8	46
Wolf Cr.	23	11	2	4	60
<u>WILLIAMS LAKE TSA</u>					
Bald Mtn.(E)	7	15	10	3	65
Meldrum Cr.	31	6	0	6	57
Fraser R. #1	4	12	10	4	70
Fraser R. #2	6	3	0	0	91
Mackin Cr.	1	1	2	1	95
<hr/>					
Average (DND)	20	14	9	3	54
Average (without DND)	10	7	8	3	72

Table 3. Status of Douglas-fir beetle based on volume of Douglas-fir in cruise plots in the Cariboo Forest Region, 1994.

Land tenure and Location	Percent of volume per hectare (m ³)				
	Current ¹	Red	Grey	Partial	Healthy
<u>NATIONAL DEFENSE</u>					
Drummond L.(W)	34	8	28	5	25
Drummond L.(NW)	49	13	8	4	26
Drummond L.(N)	25	26	35	2	12
Moose Rd. #1	26	38	14	0	22
Moose Rd. #2	57	6	0	0	37
Moose Rd. #3	30	26	2	2	40
Badger Rd.	12	36	21	3	28
Stack Valley #1	6	28	30	3	33
Stack Valley #2	9	26	24	6	35
Wolf Cr.	35	25	9	3	28
<u>WILLIAMS LAKE TSA</u>					
Bald Mtn.(E)	11	20	17	3	49
Meldrum Cr.	50	12	0	5	33
Mackin Cr.	17	9	11	10	53
Fraser R. #1	5	17	19	4	55
Fraser R. #2	10	5	0	0	85
Average (DND)	28	23	17	3	29
Average (without DND)	19	13	9	4	55

¹ Current = trees attacked in 1994; red = trees attacked in 1993; grey = trees killed prior to 1993. Only trees 20 cm DBH and greater were recorded.

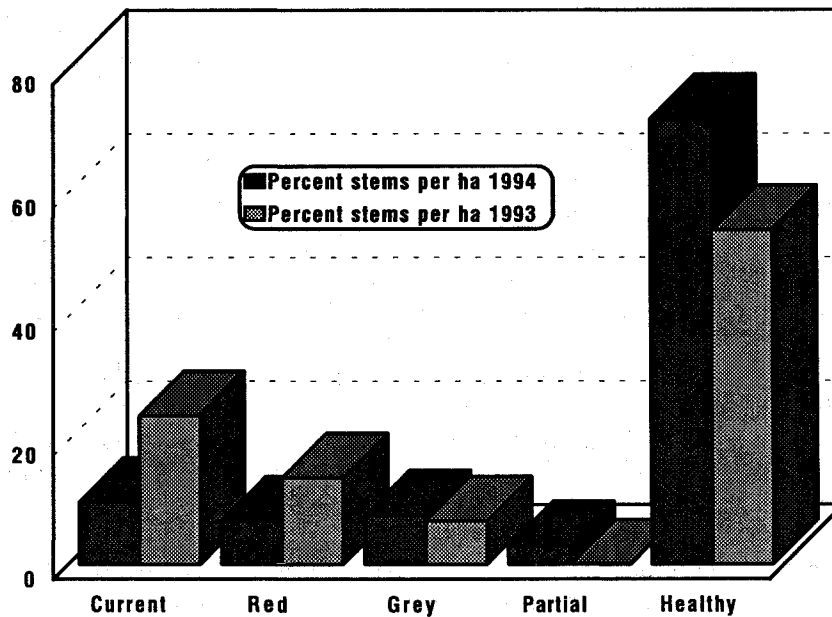


Figure 3. Douglas-fir beetle population status in 1993 and 1994, Cariboo Forest Region.

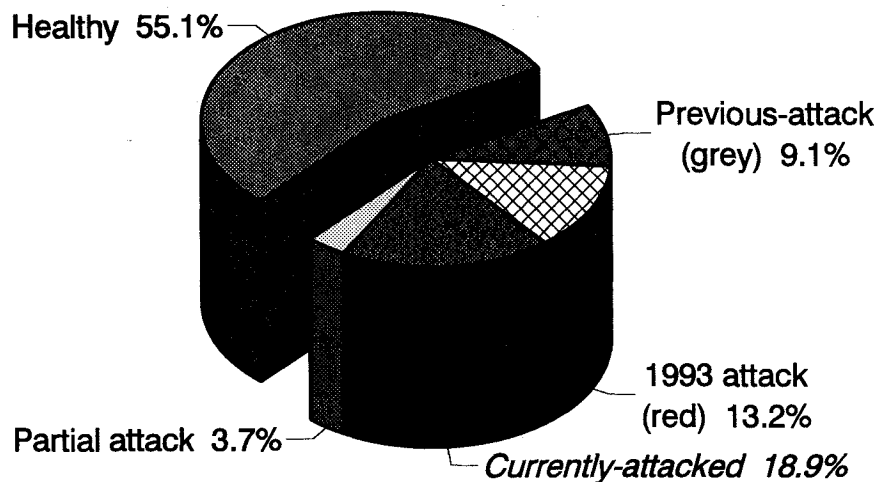


Figure 4. Depletion of stand volume by Douglas-fir beetle, Cariboo Forest Region, 1994.

Douglas-fir beetle prefers mature, high-volume trees, making calculating the results of surveys by **volume** the most accurate method of interpreting the effect of the beetle on the stand. By this method, nearly 19% of the wood was currently-attacked at the 15 locations surveyed throughout the epidemic area (Figure 4), down from 30% last year. When Douglas-fir beetle infestations have subsided, most of the harvestable wood volume in a typical stand has been removed and the only remaining trees are small (20-35 cm dbh) trees not susceptible to beetle attack.

There were an average 15 healthy Douglas-fir beetle larvae, pupae and adults per 900 cm² of bark surface, at the locations surveyed in 1994, less than the previous five years. Overwintering mortality studies by BCFS found an average 15% mortality of progeny and a low proportion of adults to larvae, indicating the possibility of reduced attack in 1995.

The highest beetle populations were recorded in the Chilcotin Military Block where an average 20% (range 7-33%) of stems per ha were infested, down slightly from 31% (range 4-62%) last year.

Forecast

As predicted in 1993, the outbreak continued this year, however some reductions occurred in number of patches mapped and the rate of current attack. The reductions may have resulted from the good growth and vigor of the host, especially in the spring and early summer, reducing the ability of the beetle to overcome the trees natural defenses.

Weather records from the Atmospheric Environment Service at Williams Lake Airport showed monthly mean temperature in the winter months 1991-92 were 4.4°C above normal. In 1992-93 they averaged 1.5°C below the 1961-90, 30-year average. Last winters monthly mean was exactly normal, -5.8°C. Warmer than average and normal winters contribute to high percentages of overwintering brood survival.

Control action, including trap trees and salvage logging, has been successful in most of the region, however some new attack will occur in 1995. The amount depends on the winter temperatures, the susceptibility of the host in 1995 and the amount of control action undertaken by forest managers.

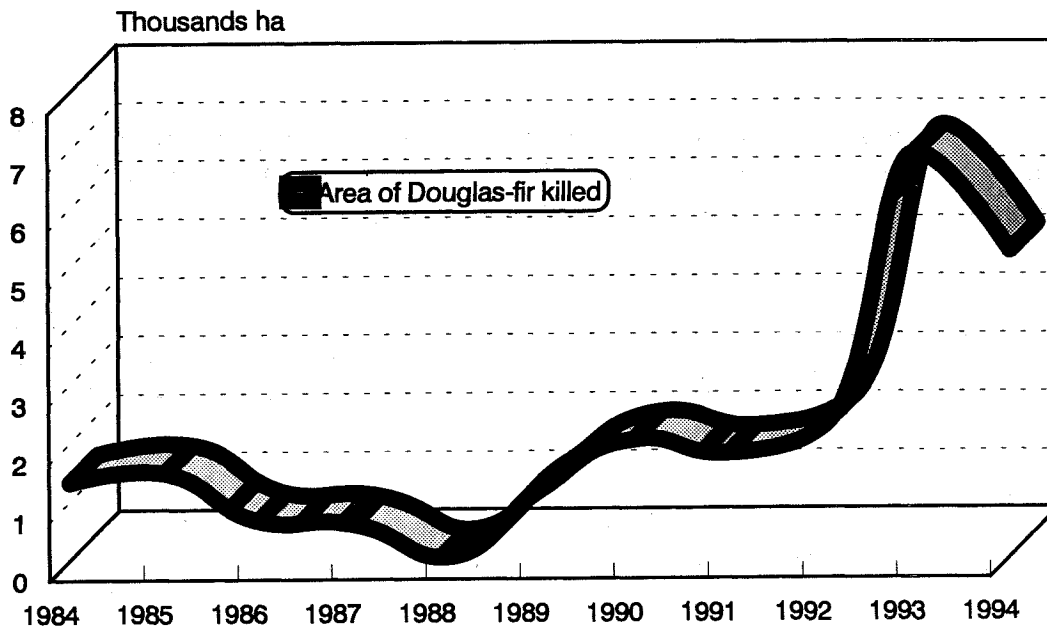


Figure 5. Douglas-fir beetle infestations, Cariboo Forest Region, 1984-94

Douglas-fir beetle will continue to be a major pest of mature and overmature Douglas-fir in the Cariboo Forest Region, with fluctuations from year to year (Figure 5). Elimination of the pest is not possible; however, losses can be reduced using sound management techniques such as trap trees and single tree disposal. Infestations in the DND block especially and elsewhere throughout the region, will continue until the susceptible old growth Douglas-fir is depleted. In only the infestations recorded this year, approximately 880 190 m³ or an average 63% of the volume of Douglas-fir (including current, red and grey attack categories) has been killed. This is not a cumulative figure but the effects of beetle infection as demonstrated by the infestations mapped in 1994. Simple sale of the timber affected would have realized approximately \$70 500 000.

Western spruce budworm *Choristoneura occidentalis*

There was no defoliation of Douglas-fir by western spruce budworm mapped during aerial surveys this year in the Cariboo Forest Region, down from 360 ha of light near Cavanaugh Creek last year. However, in ground assessments, localized populations were recorded resulting in trace defoliation at several locations, including Big Bar Lake road, Hart Ridge and Kelly Lake. Standard beating samples throughout the region averaged 42 larvae (range 1-95) per sample, similar to an average 47 last year.

Survey

The number of male moths caught in five pheromone-baited Multiplier® traps at three locations averaged 215, (range 17-570). As part of a province-wide study to improve the forecasting of rising budworm populations, two study sites were added in the Cariboo Forest Region at Viewland Mountain east of Horsely and Km 2 Big Bar Lake road near Clinton. The largest population was found at Big Bar Lake road where an average 423 moths per trap and 195 larvae per beating sample were collected. At Viewland Mountain 219 moths per trap were caught and two larvae collected per beating sample. There were 34 moths per trap and one larva per sample at Bridge Lake, up from one moth and one larva last year.

Forecast

Egg counts at three locations near Clinton averaged 130 egg masses/10 m² of foliage indicating² moderate defoliation overall in 1995. Moderate defoliation is predicted at Cavanaugh Creek and Kelly Lake and severe at Big Bar Lake road, similar to last year. Parasitism, disease and abnormally cool, wet, weather (if severe enough) would reduce the population.

Budworm populations are dependent on climate, as are other defoliators. Warm, dry weather in the spring of 1995 would contribute to an increase in area defoliated and intensity of defoliation, given the number of overwintering budworm larvae.

Climatic damage

Over 25 ha of mature Douglas-fir were severely affected by abnormal weather conditions causing foliage discoloration and premature needle drop near Bluff Lake southwest of Tatla Lake. Three large patches were mapped southeast of the Lake at 1620 m elevation on north facing slopes. Only the Douglas-fir component of the stand was damaged, Englemann spruce and lodgepole pine were not. It was estimated that 5% of the 50 cm dbh, 30 m high Douglas-fir trees were dead and the remainder of the stand declining. Secondary insects such as Douglas-fir beetle, *Dendroctonus pseudotsugae*, and *Scolytus* spp. could cause further tree mortality.

This coastal transition IDF biogeoclimatic zone commonly sustains drastic changes in temperature which combined with the high elevation of the site could have caused the damage. Further damage could occur if similar, extremely rapid changes in temperature happen again in the area.

Approximately three dominant Douglas-fir per ha were damaged by severe winds over a large area from Mackin Creek to Meldrum Creek along the west side of the Fraser River. Tree tops 10-15 m long were broken by strong winds in early 1994. The remaining small snags were infested with Douglas-fir beetle. Infestations may develop in patches near the damaged trees.

Pine Pests

Mountain pine beetle *Dendroctonus ponderosae*

The area of lodgepole pine killed by mountain pine beetle more than doubled to 1660 ha from 780 ha last year; however, the number of infestations decreased to 1170 from 1540 (Figure 6, Table 4). The new infestations contained 5-50 recently killed trees and larger existing infestations 50-100 trees. Moderate and severe tree mortality was widespread in patches from Quesnel west to the Nazko River, south along both sides of the Fraser River to Clinton; west of Williams Lake; in and north of the Chilcotin Military Block and in the Horsefly and 100 Mile House areas.

² 1-50 egg masses/10 m² of foliage = light defoliation
51-150 egg masses/10 m² of foliage = moderate defoliation
151+ egg masses/10 m² of foliage = severe defoliation

Table 4. Mountain pine beetle infestations, Cariboo Forest Region, 1993-94

Land tenure and location	1994		1993	
	Area (ha)	Number of Infestations	Area (ha)	Number of Infestations
<u>QUESNEL TSA</u> Narcosli Cr.- Quesnel R.-Nazko R.	570	370	140	265
<u>WILLIAMS LAKE</u> Chilko L.-Taseko L. Chilcotin-Horsefly	10 830	5 545	95 180	85 805
<u>100 MILE HOUSE TSA</u> 100 Mile House area	125	215	220	320
<u>PROVINCIAL PARK</u> T'Silos Park	25	10		
<u>NATIONAL DEFENSE</u> Chilcotin Military Block	100	35	80	50
Total	1660	1180	715	1525

Quesnel TSA

The number of infestations increased by 40% in **Quesnel TSA** mainly south and west of Quesnel, to 370 over 570 ha in 0.5-80 ha patches, up from 265 totalling 140 ha in 1993. Near Twan Creek, west of Macalister new spots were recorded and existing ones expanded to 57 infestations over 300 ha, up from 40 patches over 30 ha last year. From the headwaters of Narcosli Creek north to Baker Creek near Quesnel, 215 patches were mapped over 310 ha up from 200 infestations covering 190 ha last year. East of there at Beedy Creek, 42 new infestations were recorded over 60 ha. Fewer infestations were mapped from Quesnel northwest to Charleson Creek where 35 patches totalling 50 ha were located, from 80 infestations over 60 ha last year. Infestations were also reduced from Pantage Creek west to Pelican Lake and in the Nazko River area, where 47 patches were mapped over 76 ha, down from 150 infestations over 50 ha last year.

Williams Lake TSA

Mountain pine beetle infestations in **Williams Lake TSA** more than doubled in area to 840 ha from 355 ha but declined in number of patches to 550 from 890 last year, 50% of the regional total.

Infestations continued east of Williams Lake mainly in the Horsefly area and north to Big Lake where 225 patches were mapped over 145 ha up in area from 90 ha last year. Recently dead patches were also mapped west of the Fraser River in the Mackin Creek area and near Gaspard Creek.

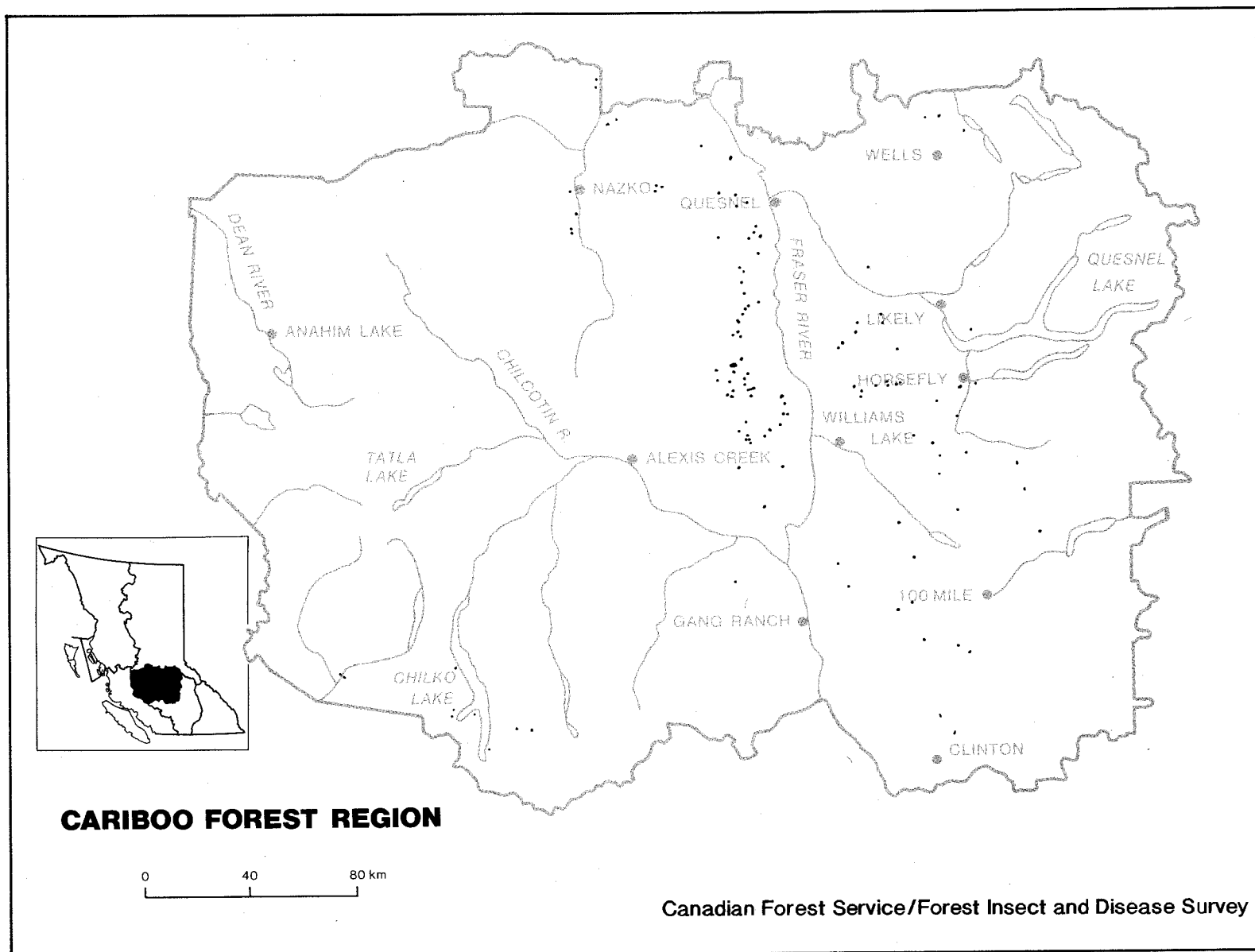


Figure 6. Areas of recent lodgepole pine mortality caused by mountain pine beetle, detected during aerial and ground surveys, 1994.

100 Mile House TSA

Infestations continued over 125 ha in 215 patches, 0.5-35 ha in size in **100 Mile House TSA**, down slightly from 220 ha in 320 infestations last year.

Small patches combined, resulting in fewer patches of larger area from Clinton north to 100 Mile House and northwest to Canoe Creek where 49 patches covered 43 ha from 135 separate infestations over 35 ha last year. Infestations increased to 165 patches over 92 ha from 100 Mile House west to Pigeon Creek and east of Lac La Hache, up from 128 patches over 38 ha last year.

Provincial Park

Infestations in the Chilko Lake area declined further to total 10 ha at 5 locations, from 95 ha last year due to host depletion. There were 10 separate patches mapped totalling 25 ha in the new T'Silos Provincial Park near Yohetta and Upper Taseko lakes.

National Defense

Infestations increased in the DND block to 100 ha from 80 ha last year, mainly in the northwest near Deer and Coyote trails and Horse Road. There has been no pest management actions to date to reduce the mountain pine beetle populations.

1994 Survey

The average number of stems per ha currently attacked averaged 15% (range 8-27%) at ten locations examined throughout the infestation (Table 5, Figure 7), up from an average 10% last year. To assess attack category, severity and tree size, prism cruises were carried out at representative infestations. The number of recently-killed (red) averaged 10% of stems per ha and old dead (grey) 2%, little changed from 16% and 3% last year.

Over 3000 pheromone baits were used in or near small infestations to contain the beetle flight for single tree disposal in the Quesnel, Chilcotin, Williams Lake, Horsefly, and 100 Mile House B.C. Forest Service districts. These methods are sometimes effective to control expansion of infestations especially when used along with control/salvage logging.

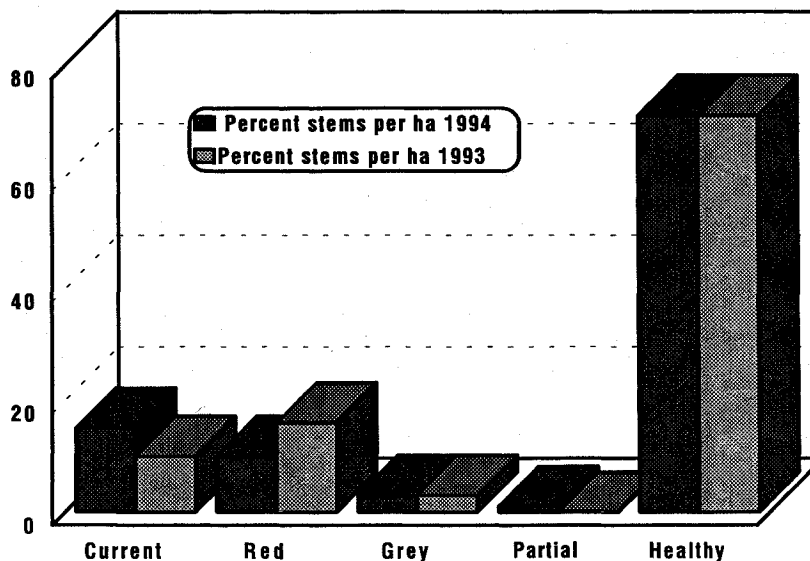


Figure 7. Mountain pine beetle population status in 1993 and 1994, Cariboo Forest Region.

Table 5. Status of mountain pine beetle populations in cruise plots in the Cariboo Forest Region, 1994.

Land tenure and location	Percent of stems/ha				
	Current ¹ Healthy	Red	Grey	Partial	
QUESNEL TSA					
Twan Cr.	17	18	1	0	64
100 MILE HOUSE TSA					
Snag L.	13	10	11	7	59
NATIONAL DEFENSE					
DND/Deer Trail	10	3	5	3	79
/Deer Trail	11	4	1	2	82
/Coyote Trail	8	8	0	0	84
/Horse Road	13	2	1	4	80
WILLIAMS LAKE TSA					
Big Lake	12	20	1	0	67
Mackin Cr.	27	8	0	1	64
S. Mackin Cr.	24	12	3	0	61
Meldrum Cr.	10	9	0	0	81
Average	15	10	2	1	72

¹ Current = trees attacked in 1994; red = trees attacked in 1993; grey = trees killed prior to 1993.

The mountain pine beetle flight resulted in 40+ larvae per 900 cm² of bark surface at most of the infestations examined. Overwintering survival of the mountain pine beetle brood should be good under normal winter temperatures.

Forecast

Similar to last year, the infestation can be expected to continue in the Cariboo Forest Region in 1995, with existing infestations expanding and new ones beginning near the old and at other locations. Other areas of mature lodgepole pine in the large expanses of pine forest approaching susceptible age classes throughout the region should be considered high hazard. Mountain pine beetle populations can be temporarily reduced by predators, disease and inclement weather; however, overall the beetle will persist in mature pine stands until the mature pine stand component is depleted.

Mountain pine beetle populations have been increasing for three years throughout the region except in the Chilko Lake area. There, after seven continuous years, infestations have subsided to the endemic point. Tree mortality is expected to continue in small manageable patches.

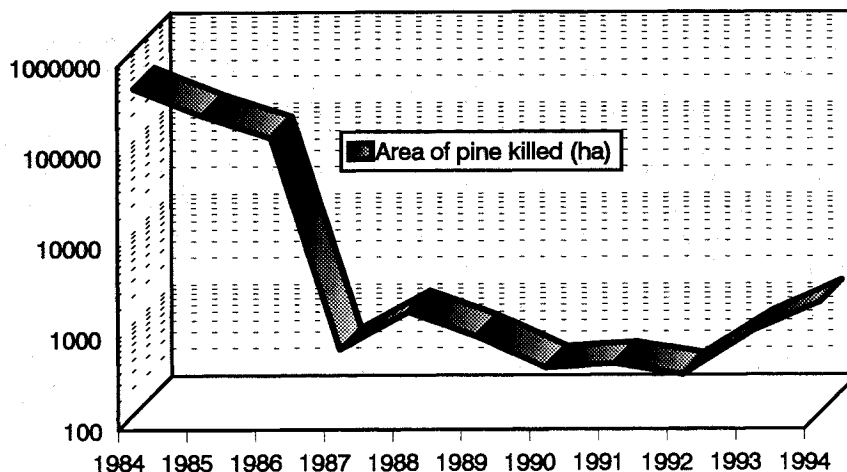


Figure 8. Mountain pine beetle infestations, Cariboo Forest Region, 1984-94.

In the remainder of the region annual increases have occurred simultaneously over widespread areas. This is probably a normal situation for this bark beetle and has occurred in the past. Prompted by certain weather and stand conditions, populations can increase rapidly resulting in catastrophic infestations such as those seen through the 1980's (Figure 8). In the past, forest pests were not as closely monitored, and slight changes in pest populations often went unnoticed. Timely modern forest management practices hinging on annual detection surveys, should be effective in reducing the rate of population increase and the resulting damage.

Pine needle cast *Lophodermella concolor*

The area of lodgepole pine infection by the pine needle cast fungus, *L. concolor*, increased fivefold to 495 300 ha (light to severe) from 116 220 ha (moderate and severe) last year, mainly in the 100 Mile House TSA and in the Chilcotin in the fifth consecutive year of infection in the region. Over 130 large patches were mapped covering 4280 ha light, 400 000 ha moderate and 91 020 ha severe, the largest area of pine needle infection ever recorded in the Cariboo Forest Region (Figure 9). Up to 90% of the one-year-old foliage of 1-to 8-m-high trees was discolored in patches 34 to 67 400 ha.

Infection of pine in **100 Mile House TSA** was light and moderate in four large patches along both sides of Loon Lake over 40 000 ha, up from 24 000 in 1993. Light to moderate infection was also mapped northwest of Clinton to Big Bar Lake in twelve patches over 29 400 ha, similar to last year, and in about four patches over 37 500 ha west of Highway #97 from 70 Mile House to 100 Mile House. East of Highway #97, pine was infected near Green Lake over 27 000 ha, near Sulphurous Lake over 23 000 ha in seven patches, and south of Bridge Lake to Deadman River in four polygons totalling 104 600 ha, up from 25 800 ha last year. New infection was mapped west of 100 Mile House to Pigeon Creek in 24 patches totalling 40 500 ha light to moderate infection.

In **Williams Lake TSA** in the Chilcotin, mainly young pine were lightly to severely infected by the fungus causing pine needle cast in 54 widespread large patches over 212 300 ha from Riske Creek to Tatla Lake. The most severe infection in the TSA occurred in the Alexis Creek area.

The damage to young lodgepole pine is probably more severe than mature trees, since the susceptible young needles constitute a larger percentage of the total foliage. Loss of these needles means a loss of growth potential for the year. Chronically infected trees appear tufted since only the current foliage remains. Infection of needles occurs the summer before the discoloration is visible. Damage will continue if moist weather conditions suitable for the spread of the fungus occur next summer. Infection in Cariboo Forest Region could be reduced in 1995, based on 10% less precipitation than normal at Williams Lake from April to September 1994 (Environment Canada).

Pinewood nematode
Bursaphelenchus xylophilus

Pinewood nematode studies were curtailed in the Cariboo Forest Region and British Columbia in 1994. None of the samples collected in the 1993 study from 23 locations along the coast contained either the pinewood nematode or the principal vector, the woodborers *Monchamus* spp.

Woodborer-attacked western hemlock and lodgepole pine bolts set out at Horsefly Peninsula in 1993 were collected and placed in rearing cages at Pacific Forestry Centre. These bolts will be examined and emergence of woodborers recorded until spring 1995 to work toward the relief of the European Community (EC) ban on export of untreated green lumber. Negotiations between the EC and Canadian representatives of government and industry including FIDS personnel from BC, will continue in 1995.

Pinewood nematode occurs rarely in Canada, Washington and Oregon but is endemic in the eastern half of the United States. The nematode is introduced into living trees by the maturation feeding of woodborers that have emerged from an infected, recently killed tree. The main hosts are pines, balsam fir and some larches. Douglas-fir, some eastern pines and Colorado blue spruce seem to be resistant. Pinewood nematode can complete its life cycle in 4-12 days, depending on temperature. In warm climates, several generations in a short time can produce huge numbers of larvae in infected trees, which often die rapidly with no visible symptoms until needles wilt and discolor. Woodborers attack the weakened tree injecting the nematodes and the cycle continues. **This has not happened to date in British Columbia.** The nematode can also be transported long distances in wood chips or logs from mill site to mill site.

Spruce Pests

Two-year-cycle spruce budworm
Choristoneura biennis

High populations of two-year-cycle spruce budworm continued throughout the eastern part of the Cariboo Forest Region and lightly and moderately defoliated spruce and alpine fir over 110 520 ha in 260 separate infestations (Table 6, Figure 9). The previous year spruce budworm completed its two-year life cycle was 1992 when 160 600 ha were defoliated in the same areas.

Table 6. Location and area of spruce and alpine fir defoliated by two-year-cycle spruce budworm, as determined from aerial and ground surveys, Cariboo Forest Region, 1994.

Land tenure and location	Area of defoliation (ha)		
	Light	Moderate	Total
<u>QUESNEL TSA</u>			
Towkuh Cr.	160	0	160
Barkerville	8 700	0	8 700
Lightning Cr.	3 900	4 900	8 800
Willow R.- Big Valley Cr.	24 660	0	24 660
Cunningham Cr.	1 550	0	1 550
Swift R.-Little Swift R.	4 820	0	4 820
Matthew R.	800	0	800
TSA Subtotal	44 590	4 900	49 490
<u>PROVINCIAL PARKS</u>			
Bowron Provincial Park	16 700	0	16 700
Provincial park Subtotal	16 700	0	16 700
<u>WILLIAMS LAKE TSA</u>			
Little R.	480	0	480
Mitchell R.	960	0	960
Penfold Cr.	3 000	0	3 000
Niagra Cr.	410	0	410
Quesnel L., North Arm	5 800	2 500	8 300
Roaring R.	2 320	100	2 420
Bill Miner Cr.	2 500	0	2 500
Lynx Cr.	460	0	460
Cariboo R., Cariboo L.	13 800	0	13 800
Seller Cr.	3 200	0	3 200
MacKay R.	830	0	830
Horsefly R.	2 950	0	2 950
TSA Subtotal	36 710	2 600	39 310
<u>100 MILE HOUSE TSA</u>			
Hendrix L.	2 890	0	2 890
Spanish Cr.	330	0	330
Deception Cr.	1 800	0	1 800
TSA subtotal	5 020	0	5 020
TOTAL	103 020	7 500	110 520

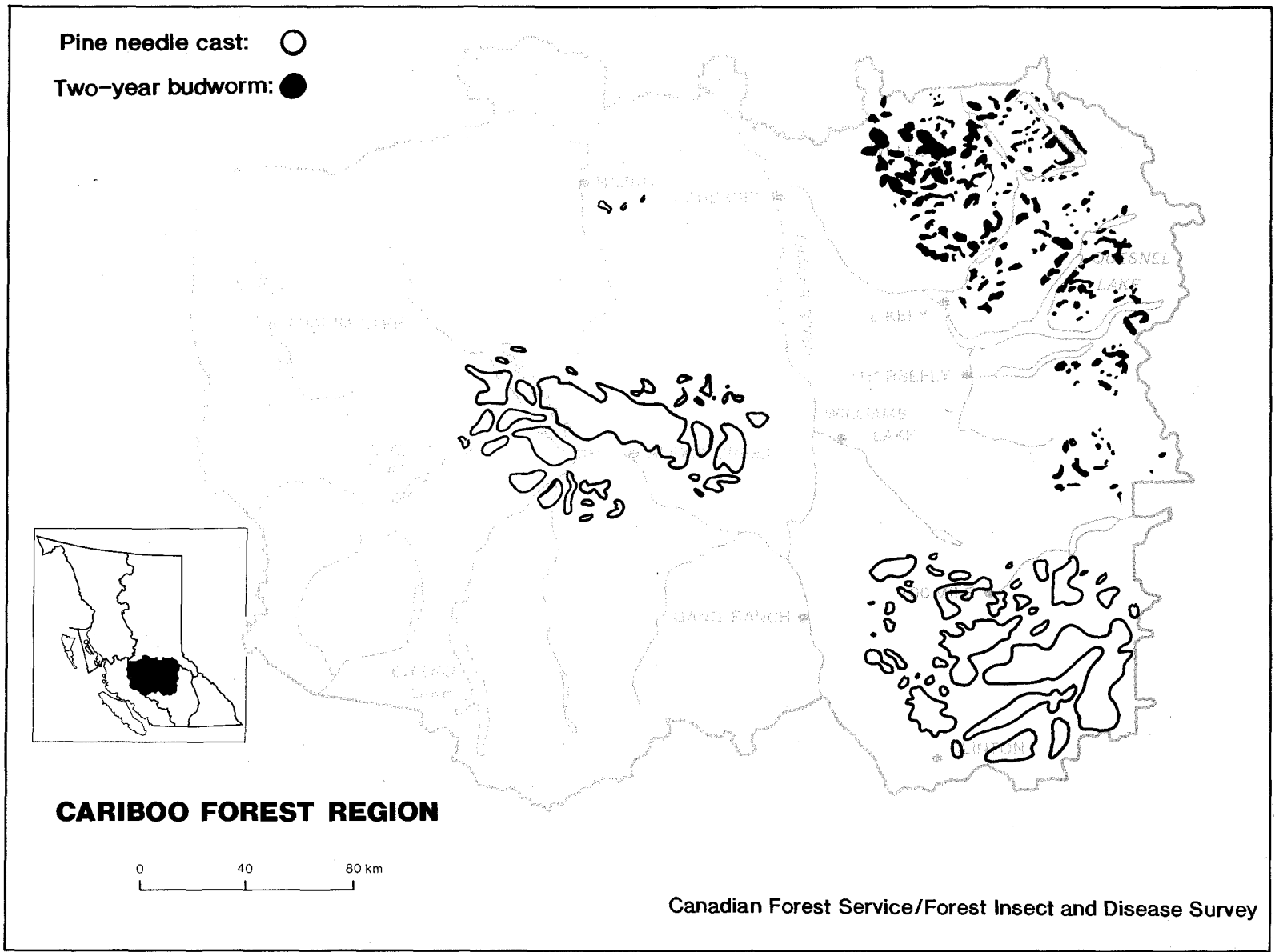


Figure 9. Areas of defoliation and discoloration detected during aerial and ground surveys, 1994.

Quesnel TSA, Provincial Parks

Similar to 1992, most (60%) of the outbreak occurred in the Quesnel TSA and Bowron Provincial Park covering 66 190 ha down from 109 090 ha. The mainly light defoliation extended from Big Valley Creek south to Barkerville Provincial Park and Cunningham Pass including Willow River and many of its tributaries. The most severe defoliation occurred along highway #26 to Barkerville near Lightning Creek. Understory trees were severely defoliated resulting in top, branch and even tree mortality. More than 40% of the undergrowing regeneration 2 to 4 m high were killed from repeated defoliation by spruce budworm at several locations along the Swift and Little Swift rivers east of Quesnel. Similar damage could be found in other stands moderately defoliated in 1992 and 1994.

Light defoliation was mapped over 16 700 ha in Bowron Provincial Park around the chain of lakes including Bowron, Indianpoint, Issac, Lanezi, Sandy and Spectacle lakes, up from only 7 500 ha in 1992. The defoliation was widespread and will result in some damage; however tree mortality will be minimal and restricted to smaller suppressed stems.

Williams Lake TSA

Light and moderate defoliation of spruce and alpine fir extended over 39 310 ha in the Williams Lake TSA from Cariboo River south to Hendrix Lake, identical to 39 050 ha in 1992, over 35% of the regional total. Defoliation occurred along Cariboo Lake and Cariboo River, from there to the North Arm of Quesnel Lake including Little River and Seller Creek, east in creeks draining into Quesnel Lake, along the upper Horsefly River and south to the southern boundary of the TSA. The most severe defoliation was mapped along the North Arm of Quesnel Lake and along Roaring River.

100 Mile House TSA

Mainly light defoliation was recorded over 5 020 ha northeast of 100 Mile House including Deception Creek, Spanish Creek and near Hendrix Lake. This was less than half of the area defoliated in 1992, however permanent damage can be expected from the repeated defoliation of the spruce-alpine fir stands.

Two-year-cycle spruce budworm can cause significant damage to spruce and alpine fir stands every two years on the **even** years when the larvae **mature**. Damage, such as top-kill, branch dieback, and loss of annual increment. Severe defoliation for several successive years, could also help predispose large-diameter spruce to attack by spruce beetle.

Two-year-cycle spruce budworm populations are little affected by parasitism and disease in the larval stage, however dramatic changes in climate remain the single largest factor affecting increases or decreases. The next year budworm larvae reach ultimate instars will be 1996. Widespread defoliation will occur again, based on infestation history, unless severe climatic events take place to reduce budworm numbers.

Spruce beetle *Dendroctonus rufipennis*

The number of small , 0.5-3 ha patches of recently-killed mature Engelmann spruce increased 40 over 60 ha in the northern part of Cariboo Region from Bowron Park to Nazko River, up from 52 infestations over 13 ha last year. There was no widespread blowdown in the region to contribute to rising populations, only the usual localized single trees widely scattered through spruce stands.

Single, recently killed trees were mapped during aerial surveys at six locations around Bowron Lake Provincial Park, similar to last year. There has been no population build-up since the large area of spruce-subalpine fir forest was blown down in 1990. However, stands in the mature SBS biogeoclimatic zone are very susceptible to spruce beetle attack and must be closely monitored.

West of the park, infestations were mapped totalling 5 ha near Willow River and Towkuh and Kruger creeks in leave blocks at the edges of the stands. Infestations continued at Alice Creek north of Cottonwood over 10 ha in two patches, reduced from 14 ha in four patches last year. Small infestations continued in the Nazko-Blackwater River area west of Quesnel where six patches over 34 ha were mapped, slightly increased from 10 new patches over 3 ha recorded last year.

Records of Forest Insect and Disease Survey show that three major spruce beetle epidemics have occurred in the Cariboo Forest Region since 1962: from 1962-65 near Big Valley Creek and Cottonwood River; from 1969-70 near Cottonwood River and Cariboo Lake; and 1980-86, in Bowron Provincial Park and at other scattered locations near the park. The largest infestation, from 1969-70, peaked at 26 260 ha in 1970. All these infestations began with large-scale blowdown and usually followed the same pattern of population increase in the windfall, concentrating the number of emerging beetles, resulting in more successful attack in standing green trees. Weather conditions at the same time contributed to widespread moisture stress in mature trees enhancing the success of beetle attack.

Forecast

There were no ground surveys completed for spruce beetle; however, populations will probably continue throughout the region. Forest managers must continue to place high priority on the salvage of spruce blowdown to control spruce beetle populations in any mature spruce stand.

Alpine Fir Pest

Western balsam bark beetle *Dryocoetes confusus*

Western balsam bark beetle infestations continued in high elevation spruce-alpine fir stands throughout the region over 2500 ha in 65 separate patches, up slightly from 2200 ha in 223 patches in 1993.

The most severe damage continued in the western Chilcotin where 1100 ha were mapped in 27 patches from the south end of Chilko Lake north to Tatlayoko Lake, including Franklyn Arm, Nine Mile, Farrow, Tredcroft and Girdwood creeks. Infestations also continued near Dorothy and Yohetta lakes.

Alpine fir were killed over 660 ha in 11 patches west of Quesnel near Snaking River and south of Kluskoil and Batnuni lakes. In the eastern portion of the region 18 infestations totalling 600 ha were located near Canim Lake and 10 patches over 190 ha were mapped east of Bowron Provincial Park in Betty Wendle Creek.

All of the alpine fir component of a mixed stand near Jacques Lake east of Horsefly were killed by western balsam bark beetle. The mortality occurred over five ha during the past four years in trees 10 - 60 cm dbh and 25 m high. This high rate of attack is not normal for the Cariboo region and could be related to the low elevation of the stand.

The number of trees killed fluctuates slightly from year to year, generally continuing until the mature fir component of the stand is depleted. Western balsam bark beetle is a chronic pest of spruce-true fir stands throughout the region and, based on historical trends, tree mortality is expected to continue next year.

Western Hemlock Pest

Western hemlock looper *Lambdina f. lugubrosa*

Western hemlock looper populations collapsed in mature western hemlock and western red cedar stands in the eastern portion of the region in late 1993. There was no defoliation or larval population recorded in the region this year.

Damage appraisal

In cooperation with BC Forest Service, four mortality plots were established near Quesnel Lake in 1992 to monitor damage caused to western hemlock and western red cedar by western hemlock looper.

The mortality averaged 35% of stems (range 8-51%) at the four plots, up from an average 6% in 1993 and less than one percent in 1992 (Table 7). The trees affected had an average 1.7 m top kill, slightly higher than 1.4 m recorded last year.

Table 7. Condition of trees in western hemlock looper appraisal plots, Cariboo Forest Region, 1994.

Location	Average tree defoliation (percent) ¹			Total no. of dead trees			Average top-kill (m)		
	1994	1993	1992	1994	1993	1992	1994	1993	1992
Bouldery Cr.	35	50	96	51	12	0	1.5	1.3	0.4
Summit Cr.	25	70	78	37	4	0	2.5	2.0	0.3
Killdog Cr.	31	80	84	43	6	0	1.1	0.8	0
Lynx Peninsula	29	51	74	8	3	1	1.8	1.7	0
Average	30	63	83	35	6	<1	1.7	1.4	<1

¹ There was no new defoliation in 1994.

Stands defoliated for at least two years were cruised and 100 western hemlock, western red cedar and alpine fir over 10-cm dbh were selected and marked for later examination at each of Bouldery, Summit, and Killdog creeks and Lynx Peninsula. These plots will be re-examined for several years to get an accurate estimate of the tree mortality caused by successive years of moderate and severe defoliation. FIDS records of previous infestations show that most tree mortality occurs in the **second** and **third** year **after** the collapse. Tree mortality in previous infestations averaged from 30-50% of stems per hectare. Insects such as hemlock bark beetle, *Pseudohylesinus tsugae*, in the upper bole, and western larch borer, *Tetropium velutinum*, in the mid bole were abundant in the dead trees.

Tree mortality occurred throughout the diameter distribution of the stands, average 51.2 cm (range 14.7 - 175 cm); however most trees killed were slightly smaller than the plot average. At Bouldery Creek the average dbh of plot trees was 45.0 cm and the average diameter of dead trees 34.6 cm; at Summit Creek, average dbh of plot trees was 87.1 cm, and that of dead trees was 77.3 cm; at Killdog Creek the average dbh for plot trees was 65.2 cm, and that of dead trees was 56.7 cm; and on the Lynx Peninsula, the average dbh for plot trees was 36.0 cm, and that of dead trees was 36.1 cm. The presence of the heart rot, caused by *Echinodontium tinctorium*, was noted but not assessed. Secondary insects were not an obvious factor in the mortality of the trees.

The highest rate of mortality was recorded at plot 1, Bouldery Creek 51%, possibly magnified by the steep slope and resulting moisture stress for the stand. The Summit Creek plot #2, contains the largest trees and 37% mortality; Killdog Creek, plot 3, had 43% and Lynx Peninsula only 7%. Plot 4 at Lynx Peninsula had a higher percentage of cedar and less severe defoliation for the three years recorded. All plots except plot 4 contained trees nearly dead with only two or three remaining green branches. These were recorded as questionable and are likely to die in the future. There were 10 declining trees at Bouldery Creek, 12 at Summit Creek, 7 at Killdog Creek and none at Lynx Peninsula. If these trees are figured into the mortality calculations the average mortality at all plots would be 41%.

Nearly 60% of the advanced western hemlock regeneration 1-4 m high in the plots were dead. These trees were severely defoliated by concentrations of larvae dropping off the overstory to feed on whatever was available.

Forecast

Egg collections at two locations from each of 5 trees averaged less than 1 healthy egg per 100 grams of air-dried lichen, similar to last year, indicating no defoliation in 1995. Egg sampling was carried out to complete a study by an SFU graduate student, Mya Evenden, to equate moth trapping data to population level. One Multipher and three Universal, baited-plastic traps were placed at Km 6109 and Km 6117, Bouldery Creek Road east of Horsefly (Table 8).

Table 8. Western hemlock looper moth trapping results by pheromone concentration, Bouldery Creek, Cariboo Forest Region, 1994.

Location	Number of male moths caught			
	Universal (100 mg)	Universal (10 mg)		Multipher (10 mg)
		Trap 1	Trap 2	
Km 6109	11	2	0	4
Km 6117	26	1	3	0

There will be no population of western hemlock looper and no defoliation is forecast for 1995. Appraisal plots will be re-examined in 1995. Tree mortality is expected to be slightly higher than that recorded this year, by up to the 6% recorded as declining this year.

Pests of Young Stands

Young stands managed under the Forest Resource Development Agreement, FRDA were surveyed at 23 locations to assess pest incidence and severity. None of the stands examined was completely pest free. The treatments included spacing, chemical application and fill planting in stands needing release or rehabilitation.

The young stands examined were scattered throughout nine biogeoclimatic zones in all three TSAs. Lodgepole pine, Douglas-fir, Engelmann spruce, and alpine fir were the main host components. Natural and planted regeneration up to 25 years old were sampled using fixed radius plots, (radius range 3.26 - 5.64 m) on transects through the plantations, recording a minimum of 10 plots and 100 trees per stand (Table 9).

Table 9. Pests of young stands surveys, Cariboo Forest Region, 1994.

Host and pest	Severity index ¹	No. of stands affected	Percent of trees affected
Lodgepole pine - 1213 trees in 11 stands, 2 stands pest free, major² tree species in 9.			
Warrens' root collar weevil	6	3	3
Western gall rust	5	4	3
Lodgepole terminal weevil	4	2	<1
Pine needle cast	3	8	60
Douglas-fir - 294 trees in 4 stands, 2 pest free, major species in 1.			
Conifer-poplar rust	3	1	10
Engelmann spruce - 2463 trees in 15 stands, 3 pest free, major species in 11.			
Spruce weevil	4	13	21
Alpine fir - 233 trees in 2 stands, 1 pest free, major species in none.			
Abiotic	3	1	1
Total: 4208 trees in 23 stands, 2917 trees were pest free however no stands were pest free.			

¹ Severity index: 1. Pest free
 2. Negligible damage
 3. Loss of current growth potential
 4. Loss of long term growth potential and volume
 5. Life threatening
 6. Mortality

² Major is more than 50%.

Overall, 70% of the trees examined in the 23 plots were pest free, up from an average 48% last year. Pine needle cast, *Lophodermella concolor*, infection increased again and was widespread throughout the region this year. It was the most common pest in 8 of the 11 plots containing pine. Spruce weevil was found in one of 10 stands that were **not** selected for special weevil study. The fungus discolored an average 66% of the lodgepole pine foliage.

Over half of the stands surveyed were selected because they were infested with spruce weevil, *Pissodes strobi* in a program to monitor weevil attack by biogeoclimatic zone (Table 10). An average 12% (range 3-46%) of the trees were currently attacked, 14% (range 2-61%) had only old attack and 3% (range 0-19%) contained both.

Elsewhere in the region the percent of currently attacked spruce leaders averaged 24%. This weevil is a common and important pest of Engelmann spruce causing loss of dominance of the most preferred crop trees in the stand.

Young stands are an integral part of forest management and will continue to demand more management resources. Surveys of young stands will continue next year in the Cariboo Forest Region.

Table 10. Results of young stand surveys for spruce weevil, Cariboo Forest Region, 1994.

TSA and location	Biogeoclimatic zone	Percent trees attacked		
		Current	Old	Current and old
<u>QUESNEL TSA</u>				
Towkuh Cr.	SBS WKI	11	9	1
Kruger Cr.	ESS FWK1	6	2	2
Fifteen Mile L.	SBS MW	3	2	0
Sovereign Cr.	SBS WK1	15	7	2
<u>WILLIAMS LAKE TSA</u>				
Cariboo L.	SBS WK1	7	11	2
Mt. Warren	SBS MW	14	6	4
Cedar Cr.	ICH WK2	5	6	1
Hazeltine Cr.	ICH WK2	46	33	19
Gavin L.	ICH MK3	4	2	0
Mitchell Bay	ICH WK2	15	61	6
Horsefly R.	ESSF WC3	8	17	3
MacKay R.	ESSF WK1	15	8	2
Average		12	14	3

Multiple Host Pests

Black army cutworm *Actebia fennica*

A single small 3 ha infestation was recorded east of Horsefly near Jacques Lake where 1-5 larvae per 900 cm² of duff caused 90 % defoliation of herbaceous growth and 60% defoliation to scattered Engelmann spruce seedlings over 1/5 ha. The mainly sandy soil in this recently burned clear-cut was disturbed by ravens feeding on the larvae and pupae. The amount of predation was significant, reducing the possibility of defoliation next year. Whatever population continues in 1995 will have more herbaceous growth to feed on as the block greens, protecting the planted spruce from further damage.

Cutworm infestations have historically occurred in the wetter parts of the region in spruce-alpine fir forest types particularly in the Cariboo-Horsefly lakes area where significant infestations occurred in 1985.

Biomonitoring/Acid rain

There was no mortality or damage associated with acid rain in the three biomonitoring/Acid Rain National Early Warning System, **ARNEWS**, plots located in the Cariboo Forest Region near the Cottonwood River east of Quesnel, west of Williams Lake near Felker Lake and east of Chasm along the Bonaparte River. The Cottonwood plot has been established and monitored for nine consecutive years with no evidence of change in the condition of plant or lichen growth.

The ARNEWS plot network was initiated in 1984 when the Canadian Forestry Service decided to establish a national program to detect early signs of air pollution damage to Canada's forests. Since that time more than 150 ARNEWS plots have been established across Canada; more than 10 000 trees are annually monitored in the plot network.

Annual examinations of the plots includes assessment of tree condition and damage, re-examination of the ground cover in the four vegetation subplots, and photography and foliar evaluation of other tagged trees and chemical evaluation of foliage from trees near the plot. Soils were also analyzed at the time of plot establishment and will be re-examined periodically.

To date at plot #915 at Cottonwood, five trees have been removed, three felled by firewood cutters and two killed by root rot caused by *Inonotus tomentosus*. There was trace to light infection of year-old needles of lodgepole pine in the plot by the fungus causing pine needle cast, *Lophodermella concolor*. The plot at Bonaparte River, #921, had five dead standing ponderosa pine when the plot was first surveyed and no more recent mortality. There was no recent or old mortality at the Felker Lake plot #922; however, there was trace to light infection of the foliage of all plot and off-plot trees by pine needle cast fungi.

The Canadian Forest Service is concerned about the potential effects of acid rain on Canada's forests. Monitoring of the plots will continue in 1995.

Deciduous Tree Pests

Forest tent caterpillar *Malacosoma disstria*

Mainly trembling aspen were lightly to severely defoliated over 52 000 ha in 470 separate patches from Quesnel to Horsefly, up from 47 000 ha in 238 infestations last year (Figure 10, Table 11). In the seventh consecutive year of high populations in the Cariboo Forest Region, the current infestation is the largest recorded since 1973 when 70 000 ha of aspen were defoliated in the Quesnel area. The most severe infestations this year were mapped in Quesnel TSA along the Quesnel River. Infestations declined in the Horsefly area in Williams Lake TSA, for the first time since they began in 1990.

Table 11. Area of aspen defoliated by forest tent caterpillar, Cariboo Forest Region, 1994.

TSA and Location	Area of defoliation (ha)							
	Light		Moderate		Severe		Total	
	1994	1993	1994	1993	1994	1993	1994	1993
QUESNEL								
Quesnel	720	100	0	0	7200	0	7920	100
Quesnel R.	1010	0	5500	3960	14 100	5720	20 610	9680
N.W. Quesnel	0	0	4200	0	1500	0	5700	0
WILLIAMS LAKE								
Horsefly	1950	540	6200	660	1940	30 480	10 040	31 680
Likely	980	0	4350	270	500	4600	5830	4870
McKinley	0	0	0	620	0	0	0	620
Tyhee L.	1900	0	0	0	0	0	1900	0
100 MILE HOUSE								
Bridge L.	0	50	0	0	0	0	0	50
Totals	6560	690	20 250	5510	25 240	40 800	52 000	47 000

Quesnel TSA

As predicted, infestations expanded again in Quesnel TSA, resulting in 8020 ha light to severe defoliation in the northern part of the city of Quesnel; 20 710 ha light to severe south along the Quesnel River from the city to Beaver Creek and over 5700 ha moderate and severe northwest of Quesnel to Blackwater River. Shade and ornamental tree defoliation and the large number of larvae were major problems for homeowners in the city of Quesnel and surrounding area.

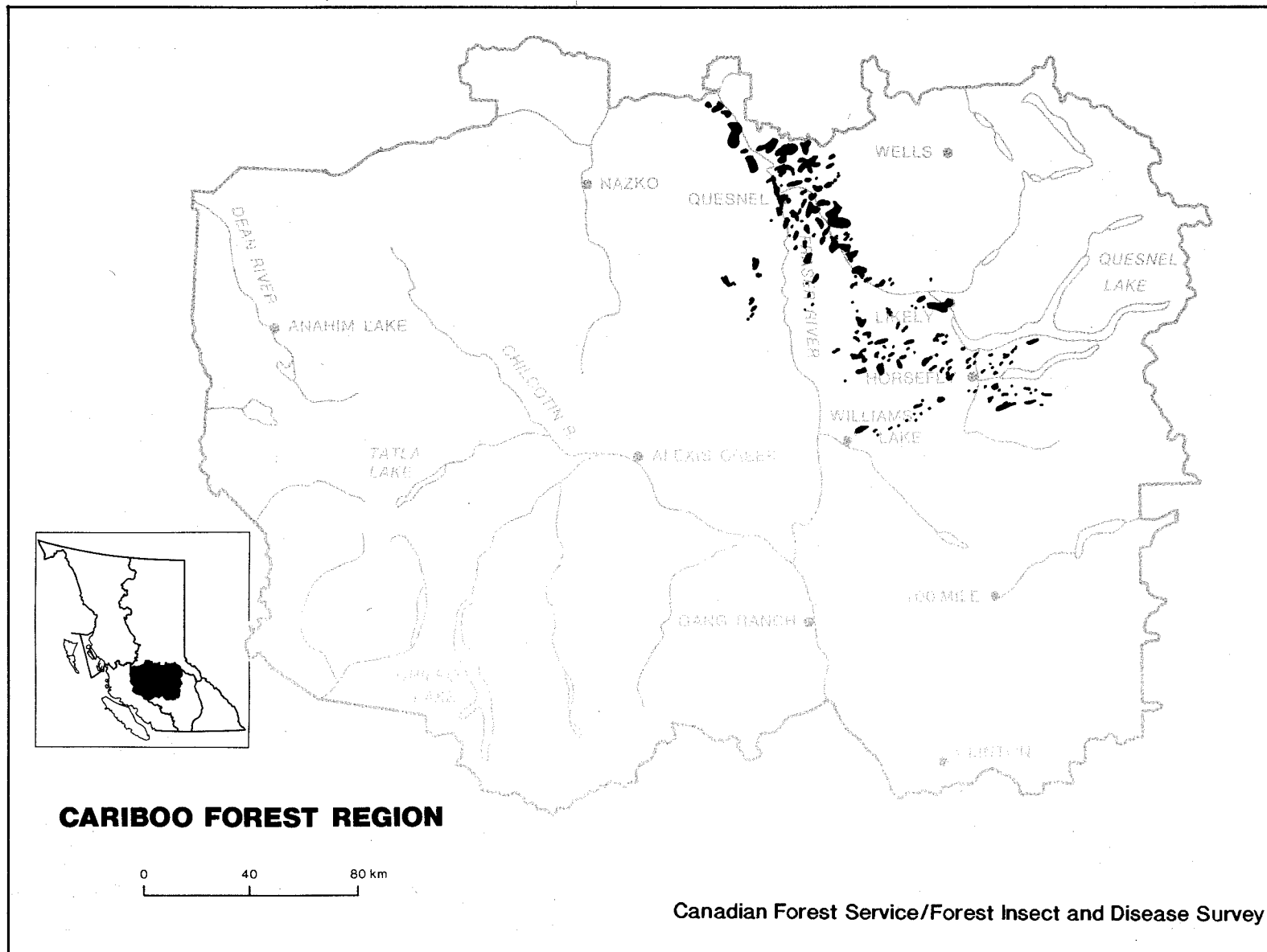


Figure 10. Areas of trembling aspen defoliated by forest tent caterpillar, detected during aerial and ground surveys, 1994.

Williams Lake TSA

The outbreak decreased to 10 190 ha light to severe defoliation in the Horsefly area following four years of consecutive increases, down from 31 680 ha last year. This represents only 30% of the regional total, down from 65% last year, switching places in the ranking with Quesnel TSA. Light to severe defoliation was mapped over 10 190 ha from Black Creek to Big Lake, 5930 ha light to severe west of Likely and 1450 ha new light defoliation in the Tyhee Lake area.

100 Mile House TSA

As predicted, infestations in the 100 Mile House TSA near Bridge Lake collapsed where high populations had been recorded for six consecutive years. There were over 800 ha defoliated in 1992 from Bridge Lake to Canim Lake. Larval virus infection was determined as the main cause of the collapse.

Damage

The most common adverse effects of forest tent caterpillar infestations are growth reduction, branch and top dieback, and a great nuisance to the public from the presence of thousands of hairy larvae since many of the stands affected are on private and recreational property. Successive years of severe defoliation by forest tent caterpillar has also been shown to cause tree mortality of trembling aspen.

Parasites/Disease/Predators

Insect parasites, particularly dipterans, such as *Arachnidomyia aldrichi*, appear early in an infestation and can reduce populations by 80%. Cool temperatures at the time of egg hatch causes mortality of early instar larvae making early spring temperatures critical for larval survival. Birds can play an important role as predators and nucleopolyhedrosis virus (NPV) and fungi as pathogens, to further reduce the population.

An average 14% of the larvae were healthy down from 29% last year at some of the same locations. This is based on collections of 100 late instar larvae at each of seven locations throughout the outbreak (Table 12).

Table 12. Percent parasitism and disease levels of forest tent caterpillar larvae/pupae, Cariboo Forest Region, 1994,1993.

Location	Percent killed by disease		Percent killed by parasites				Percent healthy 1994
	1994	1993	Hymenopterans		Dipterans ¹		
	1994	1993	1994	1993	1994	1993	
Robert L.	68	0	0	0	30	79	2
Likely	70	42	2	0	22	30	6
Big L.	30	6	1	0	54	89	15
Miocene	40	1	3	2	36	8	21
Dragon L.	44	0	0	0	32	57	24
10 Mile L.	38	-	0	-	43	-	19
Quesnel R.	82	-	0	-	6	-	12
Average	53		<1		32		14

¹ Unidentified at the time of writing, however, probably *Arachnidomyia aldrichi*.

Parasitism of larvae at seven representative locations averaged 32% (range 6-54%) by dipteran parasites, down from an average 49% (range 8-89%) last year. The locations with a low rate of parasitism usually had higher rates of infection by virus, pathogens, microsporidia, etc. The average infection rate by these agents was 53% of larvae collected (range 30-82%) up from an average 22% (range 0-65%) last year. There was less variation in the infection rate between collection points this year indicating the entire outbreak may be declining.

Forecast

Egg masses were assessed on each of three trees at ten representative locations throughout the outbreak. The surveys indicated that six of the locations will be severely defoliated, three moderately and one not at all in 1995 (Table 13).

Table 13. Predicted defoliation of trembling aspen by forest tent caterpillar in 1995, based on egg mass surveys, Cariboo Forest Region, 1994.

Location and TSA	Average number of egg masses/tree		Avg. dbh (cm)	Predicted ¹ defol. 1995	Defoliation 1994
	New	Old			
<u>WILLIAMS LAKE TSA</u>					
Beaver Valley	21	22	13	severe	moderate
Horsefly Lake	0	5	10	none	moderate
Big Lake	3	5	12	moderate	severe
Robert Lake	3	7	9	moderate	severe
Jacques Lake	2	3	16	moderate	severe
150 Mile House	15	20	12	severe	moderate
<u>QUESNEL TSA</u>					
Quesnel North	85	15	11	severe	severe
Quesnel West	47	10	8	severe	severe
Quesnel East	59	35	12	severe	severe
Quesnel South	30	24	10	severe	moderate
Average	26	15	11		

¹ A 10-cm dbh tree would be 100% defoliated with 11+ egg masses.

Forest tent caterpillar infestations in the region have typically remained one to three years per location and then have shifted to other nearby uninfested aspen. There should be no defoliation in the Horsefly-Likely area. In the Big Lake - Likely area small patches of light to moderate defoliation may again be visible but the large patches will not reoccur. Populations will be much reduced along the Quesnel River and south of Quesnel; however, defoliation may be mapped again north of Quesnel in the 10 Mile Lake area and north along the Fraser River. The severity of the damage should be reduced to light to moderate with small patches of severe. Major weather changes, as we have experienced periodically in the past, could affect larval survival and alter projected infestation trends.

Gypsy moth
Lymantria dispar

There were no adult moths caught in pheromone-baited sticky traps placed in forest recreation areas, parks, other crown land and highway rest areas in the region this year (Table 14), in the 17th consecutive year of monitoring the populations of this pest.

Table 14. Gypsy moth trapping sites and results, Cariboo Forest Region, 1994

TSA and location	Number of sticky traps per location	Number of male moths caught
<u>QUESNEL TSA</u>		
Australian Cr. Rest area	1	0
Barkerville Provincial Park	3	0
Bowron Lake Provincial Park	1	0
Cottonwood Provincial Park	1	0
Ten Mile Lake Provincial Park	1	0
<u>WILLIAMS LAKE TSA</u>		
Bull Canyon Provincial Park	1	0
McLeese Lake Rest Area	1	0
Chilcotin Training Area (DND)	2	0
Horsefly Lake Provincial Park	1	0
<u>100 MILE HOUSE TSA</u>		
Bridge Lake Provincial Park	1	0
Canim Lake Provincial Park	1	0
Chasm Provincial Park	1	0
Downing Provincial Park	1	0
Green Lake Provincial Park	3	0
Kokanee Bay Private Park	1	0
108 Mile Municipal Park	1	0
Lac La Hache Provincial Park	3	0
Loon Lake Provincial Park	1	0
Mahood Lake Provincial Park	1	0
Ruth Lake Provincial Park	1	0
<u>BELLA COOLA</u>		
Hagensborg Municipal Airport	1	0
Stuie Provincial Park	2	0
Total	30	0

The continuing gypsy moth survey is a co-operative project with Agriculture Canada (Plant Health), Canadian Forest Service, and the British Columbia Forest Service, to monitor the spread of this important defoliator of deciduous trees. The survey will continue in 1995 in the Cariboo Forest Region.

Satin moth
Leucoma salicis

Over 160 ha of mainly aspen was severely defoliated for the first time near Bluff Lake southwest of Tatla Lake. Satin moth is a pest introduced from Europe 75 years ago. It has been a periodic pest of ornamental trees in Williams Lake for 3-4 years. Patches of moderate and severe defoliation were mapped near Bluff Lake and down Mosley Creek to Twist Lake. Mass collections reared to determine parasitism revealed no parasites and only 20% infection of larvae by the fungus *Paecilomyces* sp., not considered to be an effective controlling agent.

This insect has been a pest of forest-growing poplar and deciduous ornamentals for many years in the Kamloops, Vancouver and Nelson regions. Infestations are closely followed by increases in the native and introduced parasites and collapse of the infestations. Populations will probably continue next year at Bluff Lake, based on the above rearing results.

Poplar-and-willow borer
Cryptorhynchus lapathi

Mortality of willow caused by the poplar-and-willow borer continued throughout the region, predominately in the eastern portion of Cariboo Forest Region. This weevil, an introduced pest from Europe, has developed into a chronic pest of willow throughout the region.

The most severe damage recorded occurred this year from Quesnel west to Puntchesakut Lake where all the willow were attacked and 40 - 100% of the shoots were killed on each shrub. Many 2-10 ha patches of willow were also attacked from Horsefly to the Quesnel River. Weevil populations were high throughout the range of willow in the region, mainly in the warmer, damper biogeoclimatic zones. These zones and subzones are often the ones where competition from brush is a seriously limiting factor in the establishment of new stands after harvesting.

Continued mild winters have contributed to the increases in populations and damage. Mortality of willow is not seen by forest managers as a situation that needs changing, and it may be an important bio-control tool. Damage will continue in 1995; however, the severity will depend on winter temperatures that affect adult weevil survival.

Other Noteworthy Pests

Collections and observations of other potentially damaging pests, currently of minor significance, are listed by host and importance in Table 15.

Table 15. Pests of minor significance in the Cariboo Forest Region, 1994.

Host/pest	Location	Damage	Status ¹
Coniferous Hosts			
Douglas-fir			
.....			
Douglas-fir needle cast <i>Rhabdocline pseudotsugae</i>	Empire Valley Meason Cr. Riske Cr.	From 30 to 60% of small, 1-4 m high trees were 30% infected in small 1-2 ha patches.	S
Armillaria root rot <i>Armillaria ostoyae</i>	Pear L. Mahood L.	A small 1/4 ha patch contained five recently dead trees. There was an average 10 recently trees per ha on the south side of the lake.	I
Conifer-poplar rust <i>Melampsora occidentalis</i>	Loon L. Cedar Cr. Horsefly R.	From 40 to 80% of the younger trees were 25-80% infected in small 1/4 to 1 ha patches.	S
Alpine fir			
.....			
A true fir tip blight <i>Delphinella abietis</i>	Horsefly Bay Viewland Mtn.	From 50 to 80% of the trees were infected and 25 to 40% of the current shoots killed, in 1/2 to 1 ha patches.	I
Fir-fireweed rust <i>Pucciniastrum epilobii</i>	Keithly Cr.	All trees 1-5 m high were infected over a widespread area resulting in 30% defoliation.	S
Pacific Yew			
.....			
Needle and shoot blight <i>Dothiora taxicola</i>	Killdog Cr.	Dieback of 5% of new shoots on all shrubs over 2 ha at the east end of Quesnel Lake, similar to that collected at Abbott Cr. in 1992.	S

Table 15. (Cont'd)

Host/pest	Location	Damage	Status ¹
Rocky Mountain Juniper			
Kabatina blight <i>Kabatina juniperi</i>	Pear L. Loon L.	Over 25% of the shoot killed on 30% shrubs in 1/4 patches over widespread areas.	S
Ponderosa pine			
Elytroderma disease	Loon L. Clinton	Brooming and premature needle loss of ponderosa pine remained low in 1994, in chronically infected areas near Loon Lake, Clinton, and west to Kelly Lake. Over 30% of the trees were 20% infected, similar to the light infection on half of the trees last year. The infection was mainly confined to brooms in the lower crown.	S
Whitebark Pine			
Pine needle cast <i>Lophodermella arcutata</i>	Jesmond	Over 30% of the year-old needles were infected on 70% of the trees 1-10 m high over 2 ha, at 1900 m elevation.	I
Deciduous Hosts			
Poplar			
Cytospora canker <i>Valsa sordida</i>	Black Cr. Meiss Cr.	Aspen about 10 m high, were infected resulting in mortality of 5-50% of stems per ha in 1/2 ha patches. Last year the fungus was recorded as the cause of a branch canker.	I
Aspen heart rot <i>Phellinus tremulae</i>	Black Cr.	More than 20% of the stems over 1/2 ha were recently killed by this very common and widespread heart rot.	I
Armillaria root disease <i>Armillaria sinapina</i>	Redstone	More than 10 mature aspen were killed over 1/4 ha near Redstone in the Chilcotin.	I

Table 15. (Cont'd)

Host/pest	Location	Damage	Status ¹
Willow			
Conifer-willow rust <i>Melampsora epitea</i>	Beaver Valley Bouldery Cr.	All the foliage on willow shrubs was 80% infected over widespread areas at the two locations for the first time in recent years.	I
Pacific willow leaf beetle <i>Pyrrhalta carbo</i>	Beaver Valley Cariboo L. Willow R.	Willow shrubs 1-4 m high had an average 60% of their foliage skeletonized from Beaver Valley east Likely and Cariboo Lake, and north Willow River. All the willow in this large area were infested with defoliation ranging from 30-90%. This was the most severe infestation by this leaf beetle ever recorded in this area.	I
Birch			
Amber-marked leafminer <i>Profenusa thomsoni</i>	Quesnel R.	For the first time since 1992, birch trees of all ages were mined so that by the middle of August they were an an average 50% defoliated from Horsefly north to Likely and along the Quesnel River to Quesnel. The infestation followed the distribution of birch in the region.	I
Multiple Hosts			
Salt damage	Highway #97	No significant damage reported.	D
Rhizina root disease <i>Rhizina undulata</i>	Jacques L.	More than 15% of recently planted Engelmann spruce seedling and 70% of the Douglas-fir seedlings were killed by this fungus last year over 1 ha. The area was well burned and moist, typical of rhizina infected areas. Parts of the clear-cut will need replanting.	I

¹ I = Increasing; D = Decreasing; S = Static