

# **Forest Insect and Disease Conditions**

**Kamloops Forest Region  
1987**

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Government  
of Canada

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## INTRODUCTION

This report outlines the status of forest pest conditions in the Kamloops Forest Region in 1987. Emphasis is placed on pests which are capable of sudden, damaging outbreaks and some population trends are forecast.

The Forest Insect and Disease Survey (FIDS) is a nation-wide network, within the Canadian Forestry Service (CFS). FIDS has the responsibility of producing an overview of forest pest conditions and their implications; maintaining records and surveys to support quarantines; supporting forestry research; providing advice on forest pest conditions and developing and testing survey techniques by conducting related biological studies. The cooperation of provincial, industrial and municipal agencies is essential for the effective fulfillment of those mandates and is gratefully acknowledged.

There were 350 insect and disease collections submitted to Pacific Forestry Centre by FIDS personnel on field assignments in Kamloops and Summerland from May 12 to September 30 (Map 1).

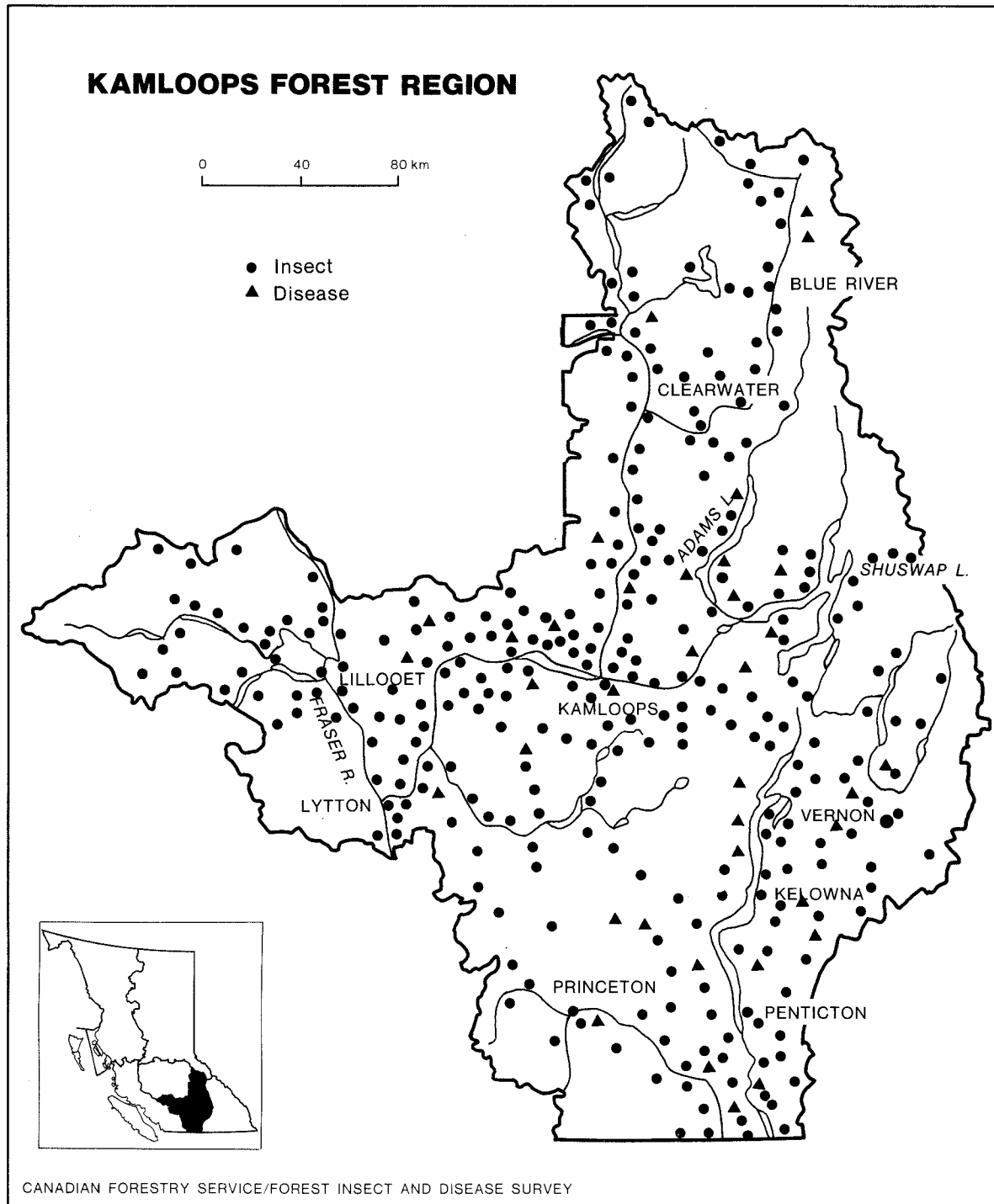
Damaging defoliating insects were collected in 80% of standard three-tree beating collections, compared to 92% in 1986.

A more extensive aerial survey in 1987 used a total of 76.3 hours (Map 2) to map forest pest damage, mainly the western spruce budworm outbreak. The survey was a cooperative project with the British Columbia Forest Service (BCFS) who provided 64.8 hours flying time, and Canadian Forestry Service, Forest Insect and Disease Survey provided the remainder.

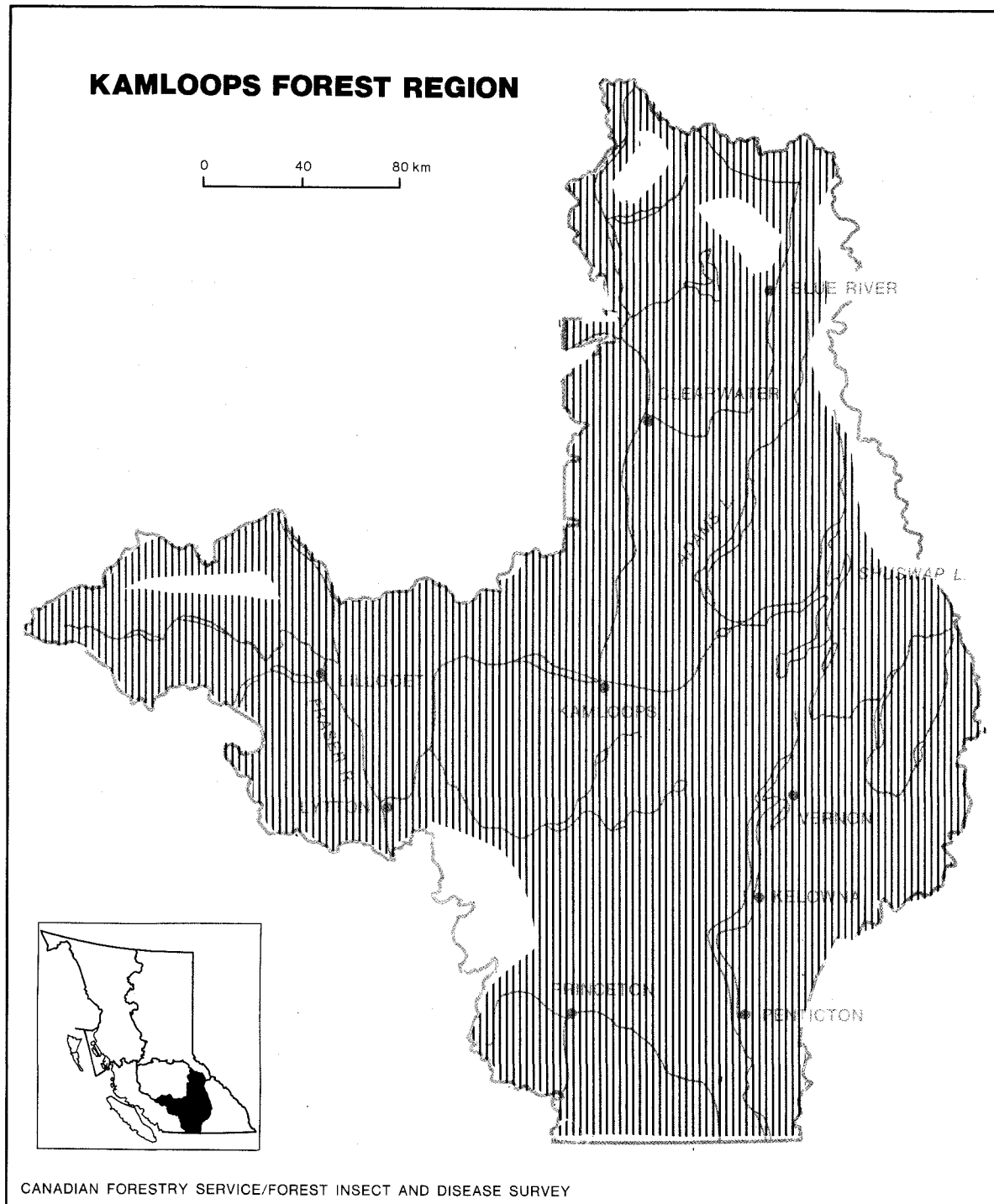
Approximately 320 aerial, oblique 70-mm color prints were taken of western spruce budworm, mountain pine beetle and spruce beetle damage from Lillooet to Kamloops.

Services and technical information were supplied approximately 120 times to the general public, government agencies and the forest industry in Kamloops Forest Region.

Large scale copies of maps included in this report are available on request from FIDS, Pacific Forestry Centre, 506 W. Burnside Rd., Victoria, B.C. V8Z 1M5.



Map 1. Locations where one or more forest insect and disease samples were collected in 1987



Map 2. Areas covered by aerial surveys to map bark beetle and defoliator infestations in 1987

## SUMMARY

Mountain pine beetle continued as the most important forest pest, killing 1 849 900 pine trees over 19 030 ha throughout the region, down from 4 790 000 trees on 46 750 ha last year. Chronic infection of ponderosa pine by Elytroderma needle disease continued through the southern two-thirds of the host range. There was less infection and discoloration of lodgepole pine this year by Lophodermella needle casts. Light to severe defoliation of pine by pine needle sheathminer continued in 1-10-ha patches from Salmon Arm to Clearwater.

The western spruce budworm outbreak more than doubled for the third consecutive year to 821 360 ha throughout the region. Populations of Douglas-fir tussock moth remained low; however, there was an increase in the number of moths caught in pheromone-baited traps. There were more Douglas-fir cone moth larvae collected than last year in beating samples along with western spruce budworm.

Spruce beetle killed mature Engelmann spruce in Lillooet and Merritt TSA's over 2 930 ha, up from 2 100 ha last year.

The area and intensity of Engelmann spruce and alpine fir defoliation by two-year-cycle spruce budworm decreased slightly to 16 950 ha, from 22 680 ha last year and extended from the upper North Thompson River to Hobson Lake in Wells Gray Park.

Fewer alpine fir were killed this year by western balsam bark beetle; 500 trees over 1750 ha were killed in 1987, down from 4570 trees over 2290 ha.

There was no visible defoliation of western larch by larch casebearer, similar to 1986; however, overwintering larval counts were high in samples from southeast of Vernon. Larch needle blight infections discolored 1550 ha of western larch, up from none last year.

Following a collapse of infestations in 1986, western blackheaded budworm caused light defoliation over 1100 ha of western hemlock in Wells Gray Park.

Special surveys were carried out for pests of young stands, pinewood nematode, European pine shoot moth, western spruce budworm and for pest damage in provincial parks throughout the region. Pheromone-baited sticky, universal and multipher traps were set out to assess populations of western spruce budworm, Douglas-fir tussock moth, black army cutworm, larch casebearer, gypsy moth, and pine budmoth. The ARNEWS plot southwest of Penticton was reassessed.

The Environment Canada weather office at Kamloops Airport recorded only 160.5 mm precipitation in 1987. The driest full year since they began keeping records in 1895 was 1979 when 153 mm was measured. These drought conditions have a great effect on forests and generally contribute to more pest damage.

## PINE PESTS

**Mountain pine beetle**  
**Dendroctonus ponderosae**

An estimated 1 849 900 lodgepole, ponderosa and white pine were killed by mountain pine beetle over 19 000 ha this year, less than half the number recorded in 1986 (Table 1, Map 3). The reduction was caused partly by cold temperatures in November two years ago and depletion of susceptible host from continuing infestations. The greatest reduction in recent tree mortality occurred in the Lillooet TSA which accounted for only 28% of the total number of red trees in the region as compared to 66% last year. There was a corresponding increase to 60% from a 28% share last year in Okanagan TSA, a change predicted by the cruise results from 1986.

Table 1. Recent pine mortality (red) caused by mountain pine beetle, Kamloops Forest Region, 1987.<sup>1</sup>

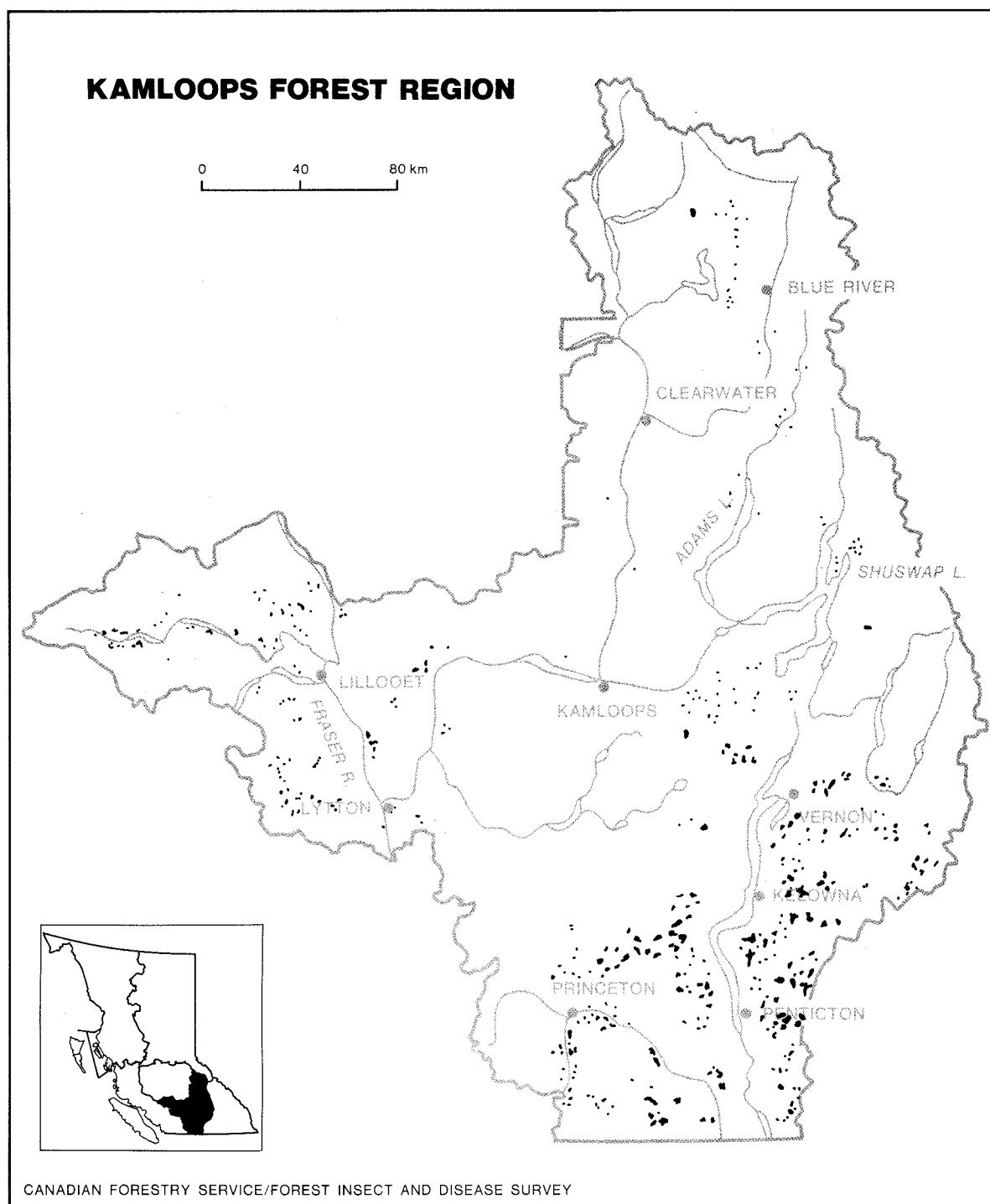
TSA	Area (ha)	No. of trees killed	Volume of trees killed (m <sup>3</sup> )
Kamloops	150	16 000	8 000
Lillooet	5 300	541 600	265 400
Okanagan	11 300	1 053 700	483 650
Merritt	2 250	238 600	95 200
Total	19 000	1 849 900	852 250

<sup>1</sup>Determined from aerial and ground surveys.

Stands in which 80% or more of the pine component were killed, in or prior to 1986, were mapped as "grey" (Table 2). Most of this area, 88%, was along Downton and Carpenter lakes in Lillooet TSA. The largest infestations have occurred along these lakes, many of them in inaccessible locations making salvage logging difficult. The remaining areas of old, dead standing trees were mapped along Mission and Belgo creeks in Okanagan TSA and in the Chain Lake area in Merritt TSA, 8% and 4% of the total, respectively.

In Lillooet TSA there were only 5300 ha of ponderosa, white and lodgepole pine recently killed, down substantially from 30 630 ha mapped last year (Table 1). Scattered infestations have occurred in some parts of Lillooet TSA for the last 25 years. Much of the susceptible host has been depleted by beetle and logging, thereby reducing the potential for infestations.

Small populations are continuing on the fringes of old infestations from Downton Lake to the Bridge Glacier, along the upper Yalakom River; in the Stein River Valley and its tributaries, and along Relay and Mud creeks north of Carpenter Lake.



Map 3. Areas of lodgepole pine recently killed by mountain pine beetle determined by aerial and ground surveys, 1987



Table 2. TSA, area, number and volume of pine trees killed by mountain pine beetle before 1986 (grey), Kamloops Forest Region, 1987.<sup>1</sup>

TSA	Area (ha)	No. of trees killed	Volume of trees killed (m <sup>3</sup> )
Kamloops	290	2 900	11 600
Lillooet	65 890	6 589 000	3 294 500
Okanagan	5 930	593 000	237 200
Merritt	2 760	276 000	110 400
Total	74 870	7 460 900	3 653 700

<sup>1</sup>Determined from aerial and ground surveys and digitized at Pacific Forestry Centre.

The area of old dead pine (grey) in Lillooet TSA increased to 65 080 ha, nearly 90% more than was mapped last year. These were located throughout the TSA, in all the major infestations of the past 10 years.

In Merritt TSA the area of recently killed pine was down 50% to 2230 ha (Table 1). Northeast of Princeton at Hayes, Trout and Summers creeks, the amount of susceptible pine was reduced by beetles and logging to the point where infestations were sufficiently restricted and spread has slowed. The BCFS lethal trap tree program and single tree disposal has also reduced the number of new small infestations, hence the potential for large infestations.

The area of recently killed pine decreased the least in Okanagan TSA where 11 330 ha (Table 1) were mapped compared to 11 770 ha in 1986. Infestations continued, as predicted from surveys last year: in the Hydraulic Lake-Dale Creek area; in Okanagan Mountain Park; north of Trout Creek; from Bruer Creek to Mohr Creek along the upper Kettle River; and from Vernon south to Belgo Lake.

Expansion and contraction of the area of mature lodgepole pine infested by mountain pine beetle occurs annually throughout the region. In 1987, the area of all pine mortality (recent and old) increased by 7 580 ha (Table 3).

Table 3. **Major** mountain pine beetle infestations, Kamloops Forest Region, 1987  
(change from 1986 in brackets).

TSA and Location	Area of pine mortality (ha)		
	Red <sup>1</sup>	Grey <sup>2</sup>	Change 1986-87
<u>Lillooet TSA</u>			
Downton L.-Bridge Glacier	1 640 (- 3 290)	7 270 (+ 10)	-3 280
Downton-Tyaughton lakes	90 (- 1 680)	12 930 (+ 1 560)	- 120
Gold Bridge	0 (- 730)	5 590 (+ 1 340)	+ 610
Relay-Mud creeks	400 (- 1 930)	3 880 (+ 3 880)	+1 950
Lower Marshall Cr.-Tyaughton Cr.	0 (- 1 050)	10 110 (+ 2 540)	+1 490
Stein River and tributaries	1 240 (- 4 300)	8 660 (+ 5 610)	+1 310
Lillooet-French Bar Cr.	540 (-11 140)	12 690 (+12 690)	+1 550
Anderson L., Cayoosh Cr., Yalakom R.	760 (- 490)	3 950 (+ 3 950)	+3 460
Subtotal	4 670 (-24 610)	65 080 (+31 580)	+6 970
<u>Merritt TSA</u>			
Hayes-Trout creeks	1 110 (- 2 650)	2 030 (+ 280)	-2 370
Summers Cr.	300 (- 270)	360 (+ 360)	+ 90
Princeton-Eastgate-Manning Park	320 (- 440)	0	- 440
Wolfe Cr.	300 (- 20)	100 (+ 100)	+ 80
Ashnola R.	60 (- 120)	260 (- 10)	- 130
Subtotal	2 090 (- 3 500)	2 750 (+ 730)	-2 770
<u>Okanagan TSA</u>			
Yard Cr.	230 (+ 50)	0	+ 50
Naswhito Cr.-Pinaus L.	380 (- 160)	0	- 160
Shorts-Whiteman-Beak creeks	310 (- 190)	410 (+ 410)	+ 220
Coldstream	130 (- 280)	0	- 280
Lumby	680 (- 230)	0	- 230
Mission-Belgo-Daves creeks	1 270 (- 870)	2 330 (+ 1 460)	+ 590
Belgo L.-Vernon	710 (- 280)	0	- 280
Dale Creek	2 050 (+ 920)	350 (+ 350)	+1 270
Hydraulic L.-Lebanon L.	1 850 (- 1 380)	640 (+ 640)	- 740
Bruer Cr.-Mohr Cr.	320 (+ 160)	0	+ 160
Okanagan Mtn. Park	320 (- 90)	820 (+ 640)	+ 550
Trout Cr.-Summerland	1 380 (+ 70)	1 270 (+ 1 130)	+1 200
Vaseux Cr.-Saunier Cr.	1 160 (+ 1 030)	0	+1 030
Subtotal	10 790 (- 1 250)	5 820 (+ 4 630)	+3 380
TOTAL <sup>3</sup>	17 550 (-29 360)	73 650 (+36 940)	+7 580

<sup>1</sup>Red : pine trees recently killed

<sup>2</sup>Grey: pine trees killed before 1986

<sup>3</sup>Not a complete total for region or TSAs, see Tables 1 & 2

### Forecasts

Based on current attack recorded on 11 variable plot cruises in Okanagan TSA, infestations should continue in most areas surveyed (Table 4). Current attack averaged 6% of the stems/ha (range 0-22%), up slightly from 4% last year. The volume of trees currently attacked averaged 22 m<sup>3</sup>/ha (range 0-81) up slightly from an average of 13 m<sup>3</sup>/ha (range 0-52) in 1986. There were a total of 151 plots examined, an average of 14 plots per location.

Table 4. Mountain pine beetle cruise data, Okanagan TSA, Kamloops Forest Region, 1987.

TSA and Location	Healthy	Current attack	Partial attack	Red	Grey	Dead other causes	Total
<u>Lily Pad Eco. Res.</u>							
stems/ha	1172	42	0	22	43	87	1366
volume/ha (m <sup>3</sup> )	299	14	0	13	17	14	357
% of stems	86	3	0	2	3	6	100
% of volume	83	4	0	4	5	4	100
<u>Vernon Creek</u>							
stems/ha	293	33	0	0	44	38	408
volume/ha (m <sup>3</sup> )	117	14	0	0	10	5	146
% of stems	71	9	0	0	11	9	100
% of volume	81	10	0	0	7	2	100
<u>Bonneau Creek</u>							
stems/ha	323	26	21	31	25	19	445
volume/ha (m <sup>3</sup> )	165	21	7	23	18	4	238
% of stems	73	6	5	7	6	3	100
% of volume	68	9	3	10	8	2	100
<u>McGregor Creek</u>							
stems/ha	335	0	23	9	11	11	389
volume/ha (m <sup>3</sup> )	174	0	11	6	6	2	199
% of stems	86	0	6	2	3	3	100
% of volume	87	0	6	3	3	1	100
<u>Daves Creek</u>							
stems/ha	1014	11	0	75	54	0	1154
volume/ha (m <sup>3</sup> )	137	4	0	25	18	0	184
% of stems	88	1	0	6	5	0	100
% of volume	74	2	0	14	10	0	100

TSA and Location	Healthy	Current attack	Partial attack	Red	Grey	Dead other causes	Total
<u>Gillard Main</u>							
stems/ha	543	63	80	115	7	0	808
volume/ha (m <sup>3</sup> )	141	32	26	50	4	0	253
% of stems	67	8	10	14	1	0	100
% of volume	55	13	11	19	2	0	100
<u>Nipple Mountain</u>							
stems/ha	720	299	0	181	111	38	1349
volume/ha (m <sup>3</sup> )	86	81	0	57	25	2	251
% of stems	53	22	0	13	9	3	100
% of volume	34	32	0	23	10	1	100
<u>Dale Creek</u>							
stems/ha	722	55	36	147	178	0	1138
volume/ha (m <sup>3</sup> )	97	15	10	36	62	0	220
% of stems	63	5	3	13	16	0	100
% of volume	45	7	4	16	28	0	100
<u>Kathleen Main</u>							
stems/ha	1227	39	0	55	61	0	1382
volume/ha (m <sup>3</sup> )	267	19	0	18	12	0	316
% of stems	89	3	0	4	4	0	100
% of volume	84	6	0	6	4	0	100
<u>Trout Creek</u>							
stems/ha	618	78	0	41	113	33	883
volume/ha (m <sup>3</sup> )	116	42	0	21	57	4	240
% of stems	69	9	0	5	13	4	100
% of volume	48	18	0	9	23	2	100
<u>Jellicoe</u>							
stems/ha	536	18	10	220	87	0	871
volume/ha (m <sup>3</sup> )	126	2	2	88	54	0	272
% of stems	62	2	1	25	10	0	100
% of volume	46	1	1	32	20	0	100

Increased infestations will likely occur in 1988 east of Kelowna from Dale Creek to Saunier Creek, based on surveys at Nipple Mountain near Dale Creek where 22% current attack was recorded.

High populations will continue from Belgo Lake to Vernon, based on cruise data from Vernon Creek where 9% current attack was recorded.

Infestations at Mission-Belgo creeks have continued for 16 years, eliminating 70-100% of the susceptible mature pine. The effect of this reduction of available host was illustrated at nearby Daves Creek where only 1% current attack was recorded. The infestations at Mission-Belgo-Daves creeks will decline further in 1988.

In the Trout Creek area west of Summerland, current attack averaged 5%. The lower valleys have been depleted of mature pine by repeated attacks of mountain pine beetle since 1976 when infestations first began. The infestations have spread up the valley sides and toward the headwaters of tributary creeks. Similar expansion is expected next year north of the Chain Lake-Osprey Lake valley into the remaining mature susceptible pine.

Further decreases in numbers of recently killed trees are expected in 1988 in Lillooet TSA, based on aerial surveys and overwintering larval studies.

In Merritt TSA declines will also likely continue except north of Hayes Creek to Siwash Creek where infestations could expand into available susceptible hosts. Use of lethal trap trees and single tree disposal in many parts of Merritt TSA will help keep populations in check.

Small infestations at several scattered locations in Kamloops TSA will continue at low levels. Salvage logging and lethal trap tree projects should control the largest infestations at Tranquille River and near Jim Black Lake in the Highland Valley.

#### **Forecast summary**

Populations should increase greatly from Dale Creek to Saunier and Vaseux creeks in Okanagan TSA, based on high numbers of currently attacked trees recorded on cruise strips at Nipple Mountain and overwintering brood studies at Dale Creek and Hydraulic Lake. Infestations will remain static or increase slightly from Vernon to Belgo Lake and from Bruer Creek to Mohr Creek along the Upper Kettle River. Elsewhere in the region, populations should remain static or decline.

#### **Elytroderma needle disease** **Elytroderma deformans**

Chronic infection of ponderosa pine by Elytroderma needle disease continued at the same level as 1986 throughout the host range in the region. Light to severe needle discoloration and variable amounts of brooming occurred in many areas in the spring and early summer. Infection intensity varied with 10-60% of the needles discolored on 30-80% of trees over scattered areas of 1 to 250 ha. Some of the most severe damage occurred along the Knouff Lake Road where 80% of the 2-m high pine were 30-60% discolored over 250 ha. All trees in 50 to 200-ha patches were 30-60% discolored near Separating Lakes, in the Venables Valley and along Tranquille River.

Similar damage of 20-50% discoloration occurred on 60% of the multi-age trees in 1 to 50-ha patches, along Green Mountain and Naramata roads and on Anarchist Mountain.

Severe infections will probably continue throughout the southern portion

of the range of ponderosa pine next year, based on the present high infection level and the history of Elytroderma needle disease in the region.

**Lophodermella needle cast**  
**Lophodermella concolor**

There was less infection and discoloration of lodgepole pine by this disease in 1987, even in the areas such as Tranquille River, previously infected for four consecutive years.

The most severely damaged areas were Montigny Creek near Little Fort where all multi-age lodgepole pine had 60% of the foliage discolored. Approximately 80% of the trees were 20-50% discolored over 50 ha at Greenstone Creek west of Kamloops and Roche Lake south of Kamloops.

Successive years of severe infection likely results in increment loss, reduced height growth, and poor form characterized by a "bottle brush" appearance since the infected needles fall the following summer, leaving only current growth.

**Pine needle sheathminer**  
**Zelleria haimbachi**

Severe defoliation of current growth of lodgepole pine continued in the same areas infested in 1986 from Salmon Arm to Clearwater.

The most severe defoliation occurred from Salmon Arm to Clearwater for the third consecutive year and in 3 to 4-m high lodgepole pine west of Salmon Arm in the Fly Hills. The current growth was 100% defoliated on all the trees over 295 ha, down from 410 ha last year. Branch dieback and mortality of severely defoliated trees could occur if populations persist in 1988.

Multi-age lodgepole pine stands were lightly to severely infested at several other locations. Along Chase Creek, all pine had 30-50% of current growth defoliated from Pillar Lake to Charcoal Creek. Defoliation of current growth ranged from 15 to 100% on scattered individuals in the Gold Bridge and Barriere areas, and from Clearwater to Vavenby along the North Thompson River Valley.

Pine needle sheathminer overwinters as an early-instar larva and in the spring, migrates to needle bases to feed. Based on past infestation history, similar damage will probably occur next year.

**Pinewood nematode**  
**Bursaphelenchus xylophilus**

Pinewood nematodes were identified for the first time in Kamloops Forest Region in lodgepole pine wood samples from Tranquille River near Kamloops. The wood sample was taken from a mature, 20-m high pine tree recently killed by mountain pine beetle. A total of 28 collections of wood and adult woodborers were made throughout the region. Wood samples were collected from the stem of recently dead trees at 16 locations and live adult woodborers, a possible vector of pinewood nematodes, at 12 locations (Table 5).

The woodborers were all netted alive at mid-day from log decks at mills and in the forest. The most common species found was Monochamus scutellatus, one of the principal insect vectors for pinewood nematodes in the north-central United States. Flatheaded woodborers were as common as roundheaded woodborers but were discarded in the field.

Table 5. Adult woodborers identified in collections for pinewood nematode, Kamloops Forest Region, 1987.

Woodborer	Number
<u>Cerambycidae</u>	
<u>Monochamus scutellatus</u>	53
<u>M. maculosus</u>	3
<u>M. notatus</u>	4
<u>Neacanthocinus obliquus</u>	1
<u>Tetropium velutinum</u>	1
<u>Dicerca tenebrosa</u>	9
<u>Xylotrechus undulatus</u>	2
<u>Buprestidae</u>	
<u>Buprestis rusticorum</u>	8
<u>B. langi</u>	1
<u>B. nuttalli</u>	1
<u>Siricidae</u>	
<u>Urocerus gigas flavicornis</u>	3
<u>Xeris spectrum</u>	1
<u>Sirex cyaneus</u>	1
TOTAL	88

Pinewood nematode, while having been collected occasionally from dead trees (killed by other causes) in British Columbia, cannot yet be considered a tree killer as in Japan and parts of the United States. In the USA, Scots pine is the preferred host, particularly in ornamental plantings, where they could easily be off-site and stressed and thereby more susceptible.

Since some countries place quarantine restrictions on wood products suspected to be infected by nematodes, careful monitoring of British Columbia nematode infections is important. Monitoring will continue in 1988 for the sixth consecutive year in Kamloops Forest Region.

## DOUGLAS-FIR PESTS

Western spruce budworm  
*Choristoneura occidentalis*

The area of the budworm outbreak in Kamloops Region more than doubled to 821 360 ha from 407 980 ha last year (Map 4). This was the third consecutive year of 100% or greater annual increases and the twenty-first year of continuous budworm infestations in some part of the region. Severe defoliation<sup>1</sup> occurred over 22 000 ha, moderate over 177 000 ha and light over 622 000 ha (Table 6) extending throughout the region. There were also 540 ha of grey mapped for the first time near Ashcroft where many undergrowing regeneration and some mature Douglas-fir were killed after several successive years of severe defoliation.

Table 6. Location and area of Douglas-fir defoliated by western spruce budworm as determined from aerial and ground surveys, Kamloops Forest Region, 1987 and change from 1986.

Location	Area of defoliation (ha)				1986-87
	Light	Moderate	Severe	Total	
<u>Kamloops TSA</u>					
Veasey L.-Hat Cr.	7 270	0	0	7 270	-6 390
Cache Cr.	9 260	0	0	9 260	+2 010
Scottie Cr.	810	0	0	810	-2 800
Barnes L.-Highland Valley	5 490	710	0	6 200	-320
Pass Valley-Deadman R.	11 930	1 200	0	13 130	-10 110
Separating L.-Durand Cr.	4 560	440	210	5 210	-7 110
Durand Cr.-Lac Le Jeune Rd.	6 310	6 000	2 470	14 780	+3 590
Sabiston-Carabine-Criss creeks	11 860	3 210	2 200	17 270	-3 630
Tranquille R.	6 360	3 290	1 430	11 080	+3 080
Campbell Cr.	5 700	1 100	0	6 800	+3 200
Ducks Meadow-Monte L.	10 550	2 150	0	12 700	+7 800
Mt. Martin	1 210	0	0	1 210	+1 210
Little Shuswap L.-Pemberton Hill	13 620	6 070	0	19 690	+12 200
Paul L.	8 610	1 490	1 050	11 150	+250
Lac du Bois-Jamieson Cr.	4 830	7 420	2 600	14 670	+900
Heffley L.-Heffley Cr.	6 590	4 530	700	11 820	+1 860
Louis Cr.	11 190	6 740	130	18 060	+6 080
Barriere	11 610	5 120	140	16 870	+4 230
Orchard L.	7 920	3 770	750	12 440	+4 300
Barriere R.	7 120	2 020	0	9 140	+2 040
Dixon Ridge	8 000	3 040	2 380	13 420	+920

<sup>1</sup>Light : discolored foliage barely visible from the air, some branch tip and upper crown defoliation

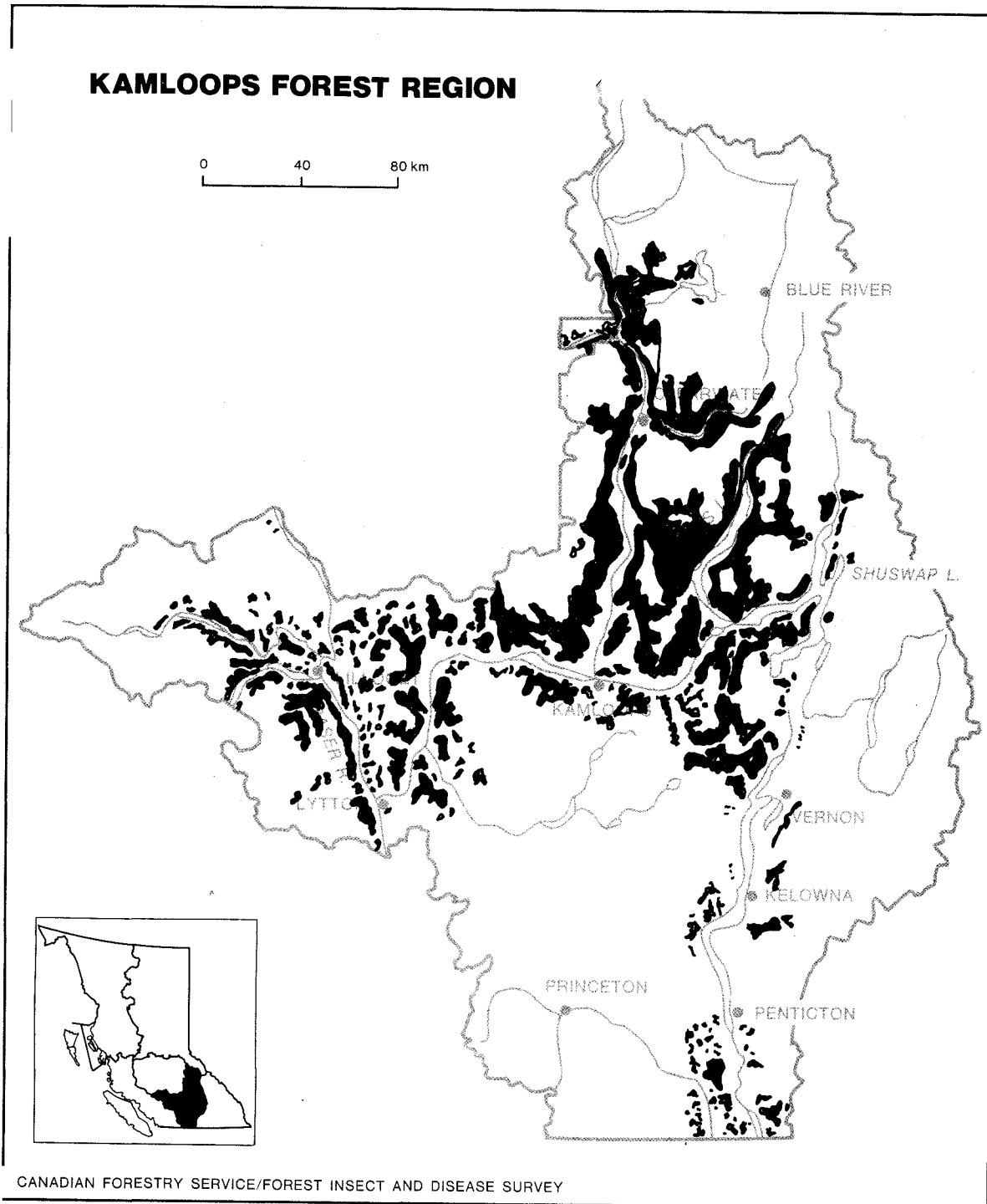
Moderate: pronounced discoloration, noticeably thin foliage, top third of many trees severely defoliated, some completely stripped

Severe : bare branch tips and completely defoliated tops, most trees sustained more than 50% total defoliation



Location	Area of defoliation (ha)				1986-87
	Light	Moderate	Severe	Total	
<u>Kamloops TSA....</u>					
Sinmax Cr.-Skwaam Bay	18 220	5 050	0	23 260	+3 630
E. Barriere L.	15 950	6 380	680	23 010	+2 480
Adams L.-Adams R.	57 440	7 940	1 080	66 460	+31 300
Darfield-Barriere	10 200	4 360	0	14 560	+6 090
Little Fort	14 000	8 480	830	23 310	+11 290
Clearwater-Lemieux L.	12 460	8 890	2 380	23 730	+12 430
Clearwater-Mahood L.-Wells	78 640	11 820	150	90 610	+89 440
Gray Park					
Vavenby	17 030	14 790	320	32 140	+24 140
Avola	26 420	730	0	27 150	+27 150
Subtotal	411 160	126 550	19 500	5 572	+231 260
<u>Okanagan TSA</u>					
S. of Chase	16 960	1 050	0	18 010	+9 010
Adams L.-Scotch Cr.	17 680	6 070	0	23 750	+19 000
Seymour Arm	21 700	1 090	0	22 790	+22 790
Skimikin-White L.	4 070	1 850	0	5 920	+2 040
Tappen-Sicamous	8 180	1 300	0	9 480	+9 480
Salmon Arm-Enderby	2 410	0	0	2 410	+2 410
Falkland	10 840	1 400	0	12 240	+9 040
Equesis Cr.	9 120	550	0	9 670	+9 000
Armstrong	540	0	0	540	+540
Glenemma-Irish Cr.	4 560	1 930	0	6 490	+3 970
Shorts Cr.	810	0	0	810	+810
Vernon-Vernon Cr.	6 140	0	0	6 140	+6 140
Peachland	12 080	240	0	12 320	+12 320
SW of Kelowna	3 820			3 820	+3 820
Shuttleworth Cr.	1 040			1 040	+1 040
Keremeos Cr.-Kaleden	5 340	1 020	0	6 360	+6 360
Vaseux Cr.-Anarchist Mtn.	7 880	0	0	7 880	+4 250
Blue L.	630	0	0	630	-390
Mt. Kobau	1 730	890	0	2 620	+1 570
Shoudy Cr.	1 640	1 680	0	3 320	+2 390
Blind Cr.	10 210	900		11 110	+9 100
Subtotal	147 380	19 970	0	167 350	+134 690

Location	Area of defoliation (ha)				1986-87
	Light	Moderate	Severe	Total	
<u>Merritt TSA</u>					
Pimainus Ridge	2 000	0	0	2 000	+350
Soap L.-Agate Cr.	6 500	1 100	310	7 910	-2 000
Subtotal	8 500	1 100	310	9 910	-1 650
<u>Lillooet TSA</u>					
Botanie Cr.	2 000	0	0	2 000	+1 350
Twaal Cr.	10 360	3 130	0	13 490	+10 490
Lytton-Intlpam Cr.	4 460	2 650	0	7 110	+1 930
Stein R.	1 270	0	0	1 270	+1 270
Izman Cr.	3 490	300	0	3 790	+2 590
Lillooet-Fountain V.	8 030	3 160	0	11 190	+4 120
Pavilion	5 160	1 380	0	6 540	+4 120
Ward Cr.	1 090	0	0	1 090	+1 090
Cayoosh Cr.	3 560	1 670	0	5 230	+4 410
Anderson L.-Seton L.	1570	5 670	480	7 720	+2 070
D'Arcy	330	2 690	170	3 190	+1 460
Yalakom R.	6 210	1 490	0	7 700	+5 190
Mission Pass	1 240	3 070	690	5 000	+920
Carpenter L.	6 290	4 610	670	11 570	+11 000
Subtotal	55 060	29 820	2 010	86 890	52 010
<u>SUMMARY (1987 defoliation)</u>					
KAMLOOPS TSA	411 160	126 550	19 500	557 210	
OKANAGAN TSA	147 380	19 970	0	167 350	
MERRITT TSA	8 500	1 100	310	9 910	
LILLOOET TSA	55 060	29 820	2 010	86 890	
GRAND TOTAL	622 100	177 440	21 820	821 360	
<u>SUMMARY (Change from 1986)</u>					
KAMLOOPS TSA	+154 960	+61 640	+14 660	+231 260	
OKANAGAN TSA	+115 530	+19 160	0	+134 690	
MERRITT TSA	-1 000	-910	+260	-1 650	
LILLOOET TSA	+25 650	+24 350	+2 010	+52 010	
TOTAL	+295 140	+104 240	+16 930	+416 310	



Map 4. Areas of defoliation of Douglas-fir by western spruce budworm, determined by ground and aerial surveys, 1987

KAMLOOPS TSA

The majority of the western spruce budworm outbreak (557 210 ha) occurred in the Kamloops TSA from Cache Creek to Chase and north to Wells Gray Park and Avola. In areas infested last year, the defoliation intensified, resulting in 126 550 ha moderate, and 19 500 ha severe.

Mortality of undergrowing Douglas-fir regeneration and some 20-m high mature trees, mapped as "grey" areas over 540 ha, occurred mainly southeast of Ashcroft near Separating Lakes and along Sabiston Creek north of Kamloops Lake. In other areas of severe defoliation, top and branch dieback was common on all ages of trees. Some of these areas were near Red Lake and along the lower part of Tranquille River where defoliation has been severe annually for up to six consecutive years. Other areas most severely affected were from East Barriere Lake southwest to Dixon Ridge and on the west side of the North Thompson Valley from Little Fort to Clearwater, particularly along Lemieux Creek.

The largest expansion in the region occurred north and east of Clearwater into Wells Gray Park and just north of Avola. Defoliation was light to moderate over 149 900 ha, up from 9170 ha lightly defoliated in 1986. Large increases also occurred from Paul Lake to Little Shuswap Lake including the top end of Louis Creek where light to severe defoliation was up 80% to cover 38 050 ha.

The effect of repeated defoliation on Douglas-fir was surveyed at five locations in Kamloops TSA where infestations have been most severe (Table 7). The variable plot cruises assessed the status of Douglas-fir on 10 plots at each location.

Table 7. Status of Douglas-fir on cruise strips in stands infested by western spruce budworm, Kamloops Forest Region, 1987.

Location	Per cent stems / ha			
	Dead	Defoliation <sup>1</sup>		
		Light	Moderate	Severe
Separating Lakes	35	22	27	16
Indian Gardens	8	60	19	13
Tranquille R.	26	0	3	71
Mt. Harper	27	0	24	49
Orchard L.	0	0	84	16

<sup>1</sup>Light : 0-25% total tree defoliation  
 Moderate: 26-65% total tree defoliation  
 Severe : 66+% total tree defoliation

Mortality averaged 19% of stems/ha in trees less than 26-cm dbh. An average of 31% of stems/ha were moderately defoliated and 31% severely defoliated. Tree damage varies with site, stand age, and vigor of the trees. Changing climatic conditions affect the quality and quantity of food available for budworm populations, thereby controlling their numbers to some degree. However, the greatest effect on the stands results from a combination of severity and number of years of successive defoliation.

Although the outbreak area doubled overall in Kamloops TSA this year, light to severe defoliation was down by 9200 ha from Cache Creek to Scottie Creek and in the Veasey Lake-Hat Creek area. The area infested and defoliation intensity was also down by 9200 ha from Cache Creek through the Pass Valley to Deadman River. Additional reductions totalling 7 110 ha occurred from Separating Lakes to Durand Creek near Savona and on 3630 ha in the Sabiston-Carabine-Criss creeks area.

Fluctuations of populations in chronically infested areas have occurred before, south of Cache Creek. These periodic reductions probably occur because of starvation and the resulting increase in parasitism. Starvation occurs since much of the foliage has been removed by successive years of defoliation.

#### **OKANAGAN TSA**

The total area of light and moderate defoliation expanded fourfold to 167 350 ha and areas lightly defoliated in 1986 intensified to moderate in 1987. New areas of light defoliation were mapped from Seymour Arm on Shuswap Lake to Ratchford Creek, in the Vernon area east and west of Kelowna and in the Keremeos area. This is the second year of defoliation for some areas around Shuswap Lake, in the Vernon area and from Blue Lake to Anarchist Mountain south of Penticton.

#### **MERRITT TSA**

Light to severe defoliation of multi-age Douglas-fir by budworm continued in the Pimainus Ridge - Soap Lake area over 9 910 ha, down slightly from 11 560 ha in 1986. This was the third successive year of defoliation in parts of Pimainus Ridge where infestations have occurred intermittently since 1976. Top-kill and branch and tree mortality have occurred; however, no definitive measurements of the damage are available to date.

#### **LILLOOET TSA**

Defoliation in Lillooet TSA intensified in areas infested in 1986 and spread into new areas, lightly to severely defoliating 86 890 ha, up from 36 260 ha last year.

Forest Insect and Disease Survey records show that western spruce budworm infestations in the Lillooet TSA have occurred periodically since 1916, earlier than any other part of the region. Since 1967, defoliation of Douglas-fir has been mapped annually except from 1981-83. This year, the most severe defoliation was mapped over 27 480 ha in the Carpenter-Anderson-Seton lakes area.

Repeated defoliation at Marshall Creek near Carpenter Lake has caused an estimated 1-5 m of top-kill on 80% of trees and 5% tree mortality in all age classes over 300 ha.

New light defoliation over 20 060 ha was recorded, again along Carpenter Lake, north of Lillooet along the west side of the Fraser River, along the Yalakom River and north of Spences Bridge at Murray and Twaal creeks. These areas represent 40% of the increase in Douglas-fir defoliation for the entire TSA. The remainder of the increase occurred over 18 740 ha along Anderson-Seton

lakes; at Botanie and Cayoosh creeks; near Pavilion and from Lytton to Lillooet along the Fraser River and tributaries.

To predict defoliation of Douglas-fir by western spruce budworm for the current year, 100 buds were examined in May at 36 locations (Table 8). The number of infested buds were counted and expressed as a percentage to compare with the criterion in the Table 8 footnote. Results indicated severe defoliation at 61% of the locations sampled, moderate at 25% and light at 14%. Follow-up defoliation assessments showed predictions were correct at 54% of the stands sampled, less severe at 44% and more severe at only 2% of locations examined.

Table 8. Percent buds infested by western spruce budworm, predicted defoliation and actual defoliation, by TSA, Kamloops Forest Region, 1987.

TSA and Location	Percent of buds infested (May)	Defoliation	
		Predicted <sup>1</sup>	Actual (August)
<u>KAMLOOPS TSA</u>			
Scottie Creek	27	M	L
E. Bonaparte I.R.	23	M	M
Cache Creek	48	S	L
Oregon Jack Creek	13	L	L
Highland Valley	7	L	L
Sabiston Creek	29	M	M
Indian Gardens	21	M	L
Paul Lake #1	35	S	S
Paul Lake #2	30	M	S
Mt. Harper	59	S	S
Heffley Creek	20	M	M
Knouff Lake	40	S	S
Orchard Lake	73	S	M
Louis Creek	92	S	S
Fadear Creek	40	S	M
Barriere	70	S	M
Little Fort	60	S	S
Little Shuswap Lake	80	S	S
Ducks Meadow	29	M	M
Chase	41	S	M
Adams River	76	S	S
Skimikin	20	M	M
Sicamous	2	L	L
<u>Okanagan TSA</u>			
Falkland	47	S	M
Joyce Lake	45	S	M
Pinaus Lake Road	90	S	M
Blind Creek	46	S	M
Mt. Kobau #1	38	S	M
Mt. Kobau #2	5	L	L
Blue Lake	48	S	L
Anarchist Mountain	53	S	L

TSA and Location	Percent of buds infested (May)	Defoliation	
		Predicted <sup>1</sup>	Actual (August)
<u>Lillooet TSA</u>			
Marshall Creek	37	S	S
Mission Pass	34	S	M
Fountain Valley	19	M	M
Venables Valley	5	L	L
Botanie Creek	33	S	L

<sup>1</sup> 0% buds infested = no defoliation  
 1-15% " " = light "  
 16-30% " " = moderate "  
 31+% " " = severe "

The moth flight occurred during the last two weeks in June, earlier than previous years when flights occurred in the first two weeks in July. The early spring and dry weather probably contributed to this slight abnormality. A study to correlate the number of moths trapped in baited "Multiplier" traps with subsequent defoliation was carried out at six locations throughout Kamloops Region. There was an average of slightly more than one larva per 45-cm branch tip at trap locations, where trap catches averaged 680 (range 220-2400) moths each. More data collection is required before valid conclusions can be drawn.

At 50 locations sampled throughout the infestation, there was an average of 229 (range 8-649) egg masses (Table 9). This was 30% less than 1986 when the average was 385 (range 65-1330). Two 45-cm branch tips were collected from each of ten trees per location and the number of egg masses on each branch was counted and extrapolated to the number per ten square meters of foliage. This number was then compared to established criteria (Table 9 footnote) to predict the severity of defoliation next year. Severe defoliation was predicted in 1988 at 32 locations (64% of samples) moderate at 15 (30%) and light at three (6%). These results, although based on more samples, are nearly identical to those done in 1986.

Table 9. Number of western spruce budworm egg masses in 1986 and 1987 and predicted defoliation by TSA in Kamloops Forest Region for 1988.

Location and TSA	No. of egg masses per 10 m <sup>2</sup> foliage 1987	1986 <sup>1</sup>	Predicted defoliation 1988 <sup>2</sup>	Change in number of egg masses (%)
<u>Kamloops TSA</u>				
Scottie Creek	8	351	light	-98
E. Bonaparte I.R.	475	776	severe	-39
Cache Creek	212	500	"	-58
Highland Valley	232	260	"	-11
Oregon Jack Creek	427	112	"	+280
Sabiston Creek	178	766	"	-77
Indian Gardens	300	173	"	-73
Beaton Lake Road	247	-	"	-
Tranquille River	601	345	"	+74
Kamloops I.R. 1	474	-	"	-
" " " 2	182	-	"	-
Paul Lake	389	425	"	- 8
Heffley Lake	113	492	moderate	-77
Louis Creek	190	450	severe	-58
W. of Barriere	102	418	moderate	-76
E. Barriere Lake	112	166	"	-32
Lemieux Lake	237	274	severe	-13
Dixon Ridge	77	-	moderate	-
Burton Creek	233	597	severe	-61
Clearwater	129	-	moderate	-
Raft River	125	-	"	-
Birch Island	85	518	"	-84
Avola	249	-	severe	-
Clearwater Lake	38	-	light	-
Neskainlith I.R.	294	-	severe	-
Little Shuswap Lake	428	441	"	- 3
Adams River	121	255	moderate	-52
<u>Okanagan TSA</u>				
Falkland	295	256	severe	+15
White Lake	236	509	"	-54
Round Lake	363	65	"	+458
Monte Lake	119	-	moderate	-
Equesis Creek	35	-	light	-
Westbank	220	-	moderate	-
Irish Creek	65	-	moderate	-
Spanish Lake	266	-	severe	-
Peachland	98	-	moderate	-
Mt. Kobau	275	254	severe	+ 8
Keremeos Creek	315	-	"	-
Blind Creek	264	238	"	+11
Blue Lake	264	333	"	-21
Anarchist Mountain	649	300	"	+116



Location and TSA	No. of egg masses per 10 m <sup>2</sup> foliage		Predicted defoliation	Change in number of egg masses (%)
	1987	1986 <sup>1</sup>	1988 <sup>2</sup>	
<u>Merritt TSA</u>				
Pimainus Ridge	242	276	severe	-12
Soap Lake	314	-	"	-
<u>Lillooet TSA</u>				
Marshall Creek	114	83	moderate	+38
Mission Pass	155	880	severe	-82
Cayoosh Creek	98	258	moderate	-62
Black Hills Creek	269	-	severe	-
Fountain Valley	84	322	moderate	+74
Izman Creek	209	-	severe	
Murray Creek	229	-	"	-

<sup>1</sup>19 locations sampled in 1987 were not sampled in 1986.

<sup>2</sup> 1-50 egg masses/10 m<sup>2</sup> foliage - light defoliation  
 51-150 " " " - moderate "  
 151+ " " " - severe "

The number of egg masses decreased at 21 locations sampled in 1986 and increased at nine; however, because of the large range of number of egg masses in the prediction criterion in footnote 2, Table 9, defoliation predictions for 1988 were similar to those made for 1987. To refine the predictions, overwintering budworm larvae were sampled at 12 locations in February, 1987. The results were inconclusive and more studies will be carried out.

British Columbia Forest Service district personnel also sampled budworm egg masses (Table 10). Their collections predict severe defoliation at 21% of locations, moderate at 54%, light at 20% and nil at 5%.

Similar to last year, predictions made from B.C. Forest Service collections were less severe than those from the Canadian Forestry Service, Forest Insect and Disease Survey collections; however, none of the locations coincided.

Table 10. Average number of egg masses collected by the British Columbia Forest Service with predicted defoliation for 1988 by district, Kamloops Forest Region, 1987.

BCFS District	Range and average number of egg masses per 10 m <sup>2</sup> foliage	Predicted defoliation	No. of locations
Kamloops	0-663 avg. 160	nil	1
		light	7
		moderate	8
		severe	8
Vernon	49-260 avg. 101	nil	0
		light	2
		moderate	25
		severe	3
Salmon Arm	0-411 avg. 101	nil	3
		light	3
		moderate	7
		severe	3
Lillooet	11-226 avg. 89	nil	0
		light	3
		moderate	1
		severe	2
Penticton	0-195 avg. 96	nil	1
		light	2
		moderate	6
		severe	2

The percent parasitism of western budworm by hymenopteran and dipteran parasites increased to an average of 20% (range 3-79%) at 14 locations from an average of 9% (range 0-27%) at 23 locations in 1986 (Table 11). Collections of 150-400 early- and/or late-instar budworm larvae at each location were reared to assess parasitism.

Table 11. Percent parasitism in early- and late-instar<sup>1</sup> western spruce budworm larvae by TSA, Kamloops Forest Region, 1987 (1986 in brackets).

Location and TSA	Instar	Percent parasitism				Total
		Apanteles	Glypta	Tachinidae	Phytodietus	
<u>Kamloops TSA</u>						
Scottie Creek	early	-	-	-	-	-(2)
	late	0	2	11	2	15(14)
E. Bonaparte I.R.	early	0	3	0	0	3(8)
	late	0	18	23	0	41(-)
Oregon Jack Creek	early	7	11	0	0	18(3)
	late	0	15	18	0	33(-)
Barnard Creek	early	2	4	0	0	6(-)
	late	0	8	2	5	15(1)
Durand Creek	early	2	10	0	0	12(4)
	late	0	20	10	1	31(0)
Sabiston Creek	early	2	5	0	0	7(5)
	late	0	8	0	0	8(7)
Indian Gardens	early	8	0	0	0	8(0)
	late	4	19	14	0	37(6)
Beaton L. Rd.	early	3	9	0	0	12(2)
	late	0	15	4	0	19(-)
Tranquille R.	early	4	0	0	0	4(5)
	late	0	0	10	0	10(-)
Knouff L. Rd.	early	3	9	0	0	12(1)
	late	3	22	20	0	45(22)
Little Shuswap L.	early	8	23	11	0	42(18)
	late	-	-	-	-	-(13)
Adams R.	early	6	4	3	0	13(8)
	late	1	9	9	0	19(8)
Little Fort	early	3	0	76	0	79(-)
	late	-	-	-	-	-----
<u>Okanagan TSA</u>						
Anarchist Mtn.	early	2	5	2	1	10(-)
	late	-	-	-	-	-----

<sup>1</sup>Early collections (May 26-June 8) were mostly third instar. Late collections (June 10-22) were fifth and sixth instar.

Although percent larval parasitism increased from 1986 at every location resampled, researchers are not confident that this will result in a large reduction in populations. Insect parasites are most effective in reducing low populations of budworm and have little effect on high population levels ("Western spruce budworm", USDA Technical Bulletin No. 1694). Other budworm mortality factors such as predators and disease affect all stages of the budworm. Collections of 100 larvae each were made for disease assessment at 11 locations throughout the outbreak. The average infection rate of 15% by bacteria will not cause appreciable mortality.

The most important factors affecting populations are climate and stand condition relating to host stress. Abnormal weather can put stands under stress, making them favourable for budworm. Population build-up and spread can occur when Douglas-fir stands are stressed and sufficient quality and amount of foliage remain.

Since natural mortality factors probably will not have a large effect on budworm populations, the outbreak should continue next year throughout the area infected in 1987. The effect of repeated severe defoliation on the host, Douglas-fir, could be extensive top and branch dieback and tree mortality, if the present drought in Kamloops Forest Region continues into 1988.

The British Columbia Forest Service applied Bacillus thuringiensis (B.t., Futura) by aircraft on 11 experimental blocks north and east of Kamloops. The blocks ranged in size from 36-200 ha, totalling 898 ha. One of the blocks treated was Paul Lake Provincial Park, in cooperation with Lands, Parks and Recreation. Foliage protection was satisfactory in the same area treated similarly last year. Significant population reduction was achieved in six blocks; however, the amount of foliage protection varied. In half of the blocks, there was acceptable foliage protection; in the remaining plots, there was light to severe defoliation.

#### Douglas-fir tussock moth Orgyia pseudotsugata

No defoliation was recorded or larvae collected in beating collections this year in the region. However, there was an average of four moths per trap (range 0-24) caught in pheromone-baited sticky traps, up markedly from an average of <1, range 0-5, in 1986.

Six traps are set out annually at each of 16 locations where tussock moth infestations have occurred in the past (Table 12). They were baited with the pheromone (2)-6-heneicosen-11-one at .01% concentration by weight to monitor the male adult tussock moth populations.

Table 12. Number of male Douglas-fir tussock moths in pheromone-baited sticky traps by TSA, Kamloops Forest Region, 1987.

TSA and Location	Avg. no. moths/trap @ .01% pheromone conc.		Total no. moths	
	1987	1986	1987	1986
<u>Kamloops TSA</u>				
Heffley Creek	0	<1	0	2
Stump Lake	0	0	0	0
Kaneta	0	0	0	0
Monte Lake Provincial Park	0	0	0	0
Chase	0	0	0	0
Barnes Lake	<1	3	5	20
Pavilion	0	0	0	0
Battle Creek	<1	0	5	0
Carquile	0	0	0	0
Cherry Creek	24	0	143	-
<u>Okanagan TSA</u>				
Winfield (McKinley Rd.)	23	5	139	30
Summerland (McNulty Main)	0	0	0	0
Kaleden (St. Andrews G.C.)	5	2	32	12
Blue Lake	2	<1	11	4
Vernon (BX)	5	0	29	0
Armstrong (Mt. Swanson)	<1	0	2	0
<u>Merritt TSA</u>				
Stemwinder Provincial Park	2		9	5
TOTAL			375	73

The most recent defoliation occurred over 70 ha in 1985 at the Six Mile Lookout west of Kamloops. That was the tail end of the previous widespread infestation which began in 1981 with 1050 ha defoliation from Kamloops to Pritchard and near Falkland. In 1979, two years before, only 153 mm of precipitation was recorded at Kamloops airport. That was the driest year recorded there since they began keeping records in 1895.

Only 160.5 mm precipitation were recorded in 1987 at Kamloops, making it the second driest year in over 90 years. This fact and the rising number of moths caught in traps indicate a rising population and the potential for large-scale defoliation by 1989.

**A Douglas-fir coneworm**  
**Dioryctria pseudotsugella**

An average of 19 coneworm larvae per three-tree beating sample were collected along with western spruce budworm at all the parasite sampling locations (see budworm section), up slightly from an average of 10 last year. At Fountain Valley and Pavilion, this coneworm defoliated 100% of the current growth and destroyed all the seed in the moderate cone crop over 300 ha.

Normally this insect causes severe damage to Douglas-fir cone crops and flowers only; however, conditions that contribute to the rise of western spruce budworm populations also cause cone moth numbers to increase. If the current drought continues, defoliation and cone damage from Dioryctria sp. may increase slightly next year.

**SPRUCE PESTS**

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**Spruce beetle**  
**Dendroctonus rufipennis**

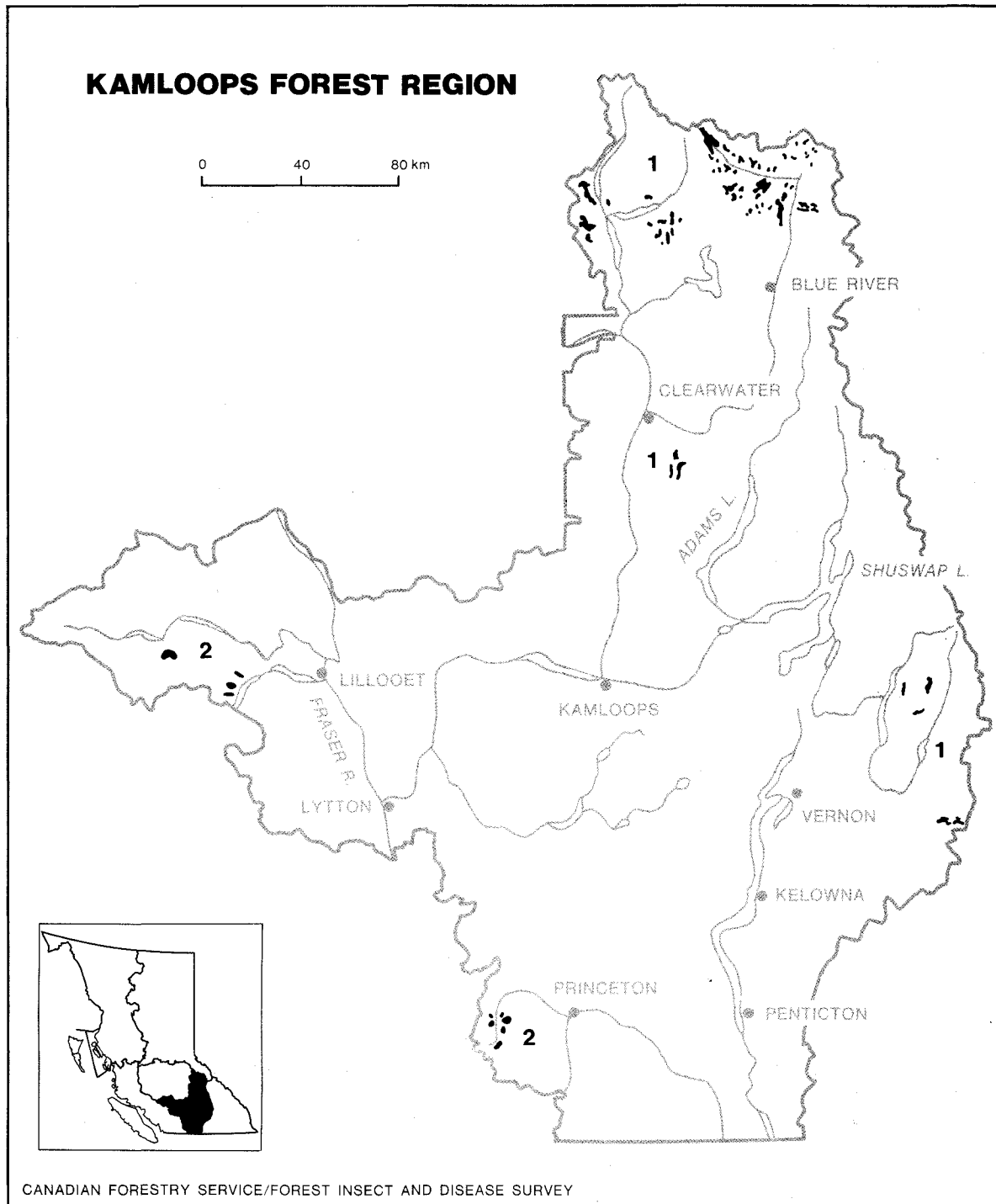
Mature Engelmann spruce were killed over 2930 ha, up from 2100 ha in 1986. Recently killed mature spruce were mapped over 1380 ha at Connel and McGillivray creeks on Anderson Lake in Lillooet TSA, up from 790 ha last year (Map 5). Infestations mapped in 1986 at Whitecap Creek, near Anderson Lake, were salvage logged; however, the Connel and McGillivray creeks infestations continued unchecked by any control efforts. The access to both creeks is very difficult, allowing spruce beetle to build up and kill approximately 75% of the mature spruce volume particularly in Connel Creek which has been infested since 1983. Despite salvage logging, the infestation of Noel Creek near Gold Bridge increased slightly to 670 ha from 570 in 1986.

In Merritt TSA, recently killed and many old dead Engelmann spruce were mapped over 830 ha, up from 710 ha in 1986 along the upper Tulameen River, including Arrastra, Packers and Champion creeks. A further 50 ha were recorded on Lawless Creek, a tributary of the Tulameen River near Princeton.

Spruce beetle infestations typically start as a result of population buildup in windthrow and slash. If weather and stand conditions are suitable, the beetle attack then turns to standing mature spruce until the populations are controlled by salvage logging, trap trees or host depletion.

Host depletion is a factor in the Tulameen infestations where a large reduction in area of recent mortality is expected next year.

It appears that much of the mature spruce is dead at McGillivray Creek, based on 70-mm aerial oblique photography taken in August, 1988. The infestations still harbour a large beetle population, judging by the large number of recently killed trees and should allow the infestation to continue next year at the same level.



Map 5. Areas where current defoliation by (1) two-year cycle spruce budworm and recent tree mortality by (2) spruce beetle were detected during aerial surveys, 1987

**Two-year-cycle spruce budworm**  
**Choristoneura biennis**

The area and intensity of defoliation of multi-aged Engelmann spruce-alpine fir stands by two-year budworm decreased in the upper North Thompson River and Wells Gray Park (Map 5) to 16 950 ha of light defoliation from 22 680 ha light and moderate last year. New infestations were mapped east of Vernon.

Light defoliation occurred over 9 780 ha in the upper North Thompson River valley, up from 8 150 ha light and moderate last year. The increase is mainly a reflection of better aerial survey coverage.

New infestations were recorded at Angus Horne Creek in Wells Gray Park where 870 ha light defoliation were mapped. There were 3440 ha light defoliation at Hobson Lake, also in Wells Gray Park, the same as was recorded last year. No visible defoliation was recorded in other areas in Wells Gray, infested in 1986. Light defoliation was mapped for the first time over 810 ha at Harper Creek southeast of Clearwater. In Okanagan TSA, new infestations were recorded: light defoliation over 1140 ha at Keefer Lake east of Vernon, and 900 ha from the upper Shuswap River to Tsuius Creek.

This year was the stage in the budworm life cycle when early-instar larvae feed only lightly before overwintering, then resume feeding to mature next spring. A small proportion of the larval population developed out of synchronization with the majority. They were probably responsible for the limited defoliation that was mapped in the "off" year of their life cycle.

Egg sampling was not carried out since there was no moth flight; however, based on historical trends of two-year-cycle budworm infestations in Kamloops Region, there should be more severe defoliation next year. All infestations mapped in 1987 should continue in 1988. New areas will likely be found adjacent to existing infestations.

#### ALPINE FIR PEST

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**Western balsam bark beetle**  
**Dryocoetes confusus**

Fewer recently dead high-elevation mature alpine fir were mapped this year; a total of 550 trees over 1750 ha were mapped, down from 4570 trees over 2 290 ha last year.

Many of the infestations mapped in 1986 were less visible in 1987; however, new areas of tree mortality were located nearby. In Lillooet TSA, 200 dead alpine fir were scattered over 940 ha on Mt. Lytton. In 1986, 500 trees were killed over 810 ha, 2 km away on Kanaka Mountain. The only infestation mapped in Kamloops TSA was north of Heffley Lake where 50 trees were killed over 80 ha. There were too few trees to map at Wentworth Creek where 600 trees were killed over 160 ha last year. In the Okanagan TSA, 100 trees were killed over 10 ha near Bolean Lake east of Falkland. Western balsam bark beetle infestations are chronic in this area and will continue to be, as long as susceptible, mature alpine fir remain. There were 200 dead trees over 720 ha at Frank Ward Creek west of Vernon, down from 500 trees over 260 ha last year.



This bark beetle and its associated fungus Ceratocystis dryocoatidis are a chronic problem of mature alpine fir throughout the region. Populations do not increase dramatically the way other bark beetles do; however, some years the recently dead trees are a brighter red than other years. Red foliage can stay on the trees for up to five years.

### **LARCH PESTS**

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#### **Larch casebearer Coleophora laricella**

Larch casebearer populations remained low and defoliation was recorded only along the King Edward Main east of Vernon, where very light defoliation was noted in the spring.

No male moths were caught in five pheromone-baited sticky traps at each of three locations: McKinney Creek Road, Salmon Arm, and King Edward Main near Vernon. There is some concern that the pheromone concentration was faulty, and resulted in the negative counts.

Overwintering larval counts, up dramatically from low levels in 1986, predict<sup>1</sup> severe defoliation in larch stands along the King Edward Main east of Vernon (143 larvae/100 spur shoots) and negligible defoliation at Shuttleworth Creek near Okanagan Falls (7 larvae/100 spur shoots).

#### **Larch needle blight Hypodermella laricis**

Infection levels increased, causing severe discoloration over 1550 ha up from less than 5 ha in three light scattered areas in 1986 and up markedly from the last major recorded damage of 110 ha in 1985.

The increases were due to the damp, warm, spring weather during spore release, conditions which are favourable for infection.

Discoloration of 30 to 100% occurred on all trees in 1- to 3-ha patches from Falkland to Glenema, west of Salmon Arm, south to Deep Creek and along the King Edward Main east of Vernon. East of Salmon Arm there was severe infection and discoloration from Mara Creek to Sicamous, along the northeast side of Mara Lake; Mabel Lake at Kingfisher Creek, and along the east side of the Shuswap River from Mara Park south to Reeves Lake. Scattered patches of 1-110 trees were 60% discolored along the Arawana Main on the east side of Okanagan Lake north of Penticton.

Infection will likely continue in 1988 if spring weather conditions are favourable.

<sup>1</sup> <u>Defoliation category</u>	<u>No. of overwintering larvae/100 spur shoots</u>
negligible :	0.6 - 11.5
light defoliation :	11.6 - 60.4
moderate defoliation :	60.5 - 136.5
severe defoliation :	136.6+

**Larch budmoth**  
**Zeiraphera improbana**

Larch budmoth populations remained at endemic levels with small numbers of larvae (0-3) collected in standard three-tree beating collections.

Pheromone-baited sticky traps were not set out since the population collapsed in 1986. Populations should remain low, based on historical trends, however, larval monitoring will continue throughout the range of larch in the region.

**WESTERN HEMLOCK PEST**

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**Western blackheaded budworm**  
**Acleris gloverana**

Following a collapse of infestations in 1986, there were 1100 ha of western hemlock lightly defoliated in interior wet belt stands this year. A small, 130-ha patch was lightly defoliated near Tumtum Lake as were 970 ha along Azure River and Lake in Wells Gray Park.

No egg samples were collected; however, if the dry weather conditions in 1987 continue in 1988, further defoliation can be expected.

**MULTIPLE HOST PESTS**

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**Black army cutworm**  
**Actebia fennica**

High numbers of cutworm larvae caused substantial defoliation of planted Douglas-fir seedlings near Vavenby in the Clearwater Forest District, and east of Salmon Arm in the Okanagan TSA. At the headwaters of Otter Creek, east of Vavenby, six areas .5- to 1-ha were infested on ridge tops in a 150-ha clearcut burned in 1984. There was an average of 20 larvae per 1000 cm<sup>2</sup> duff sample and Douglas-fir seedlings and herbaceous growth were 50 and 100% defoliated, respectively.

In a burned logged area near Salmon Arm, about 10% of spruce and Douglas-fir seedlings were 30-100% defoliated over 4 ha near ridge tops on west-facing slopes in the Larch Hills. The buds were damaged on 5% of the defoliated trees. The 80-ha clearcut was burned in the fall of 1985.

The history of cutworm infestations in the region show that the Fly Hills Wildfire west of Salmon Arm was infested in 1975, and recently logged and burned areas at Adolph Creek in the upper North Thompson River in 1983. Infestations could increase next year in the Clearwater District since more than 70 clearcuts were slashburned in 1986. These broadcast burns were very intense so many black areas, very attractive to black army cutworm, were available during their flight period last summer.

Five pheromone-baited<sup>1</sup> sticky and four "Multipher" traps caught an average of 17 moths per trap in the Larch Hills. The sticky traps were the standard FIDS milk carton type and the multipher traps were a dry, plastic trap. An average of 7 and 11 moths per trap, respectively, were caught in 57 sticky and 19 "Multipher" traps set out in the Clearwater District by the British Columbia Forest Service. All the trap locations were burned in 1986; however, verification of the identification of some of the adults caught is pending.

In another study, T. Maher collected an average of 112 (range 55-225) moths per multipher-type trap within the infestation at Otter Creek. This was part of a Canadian Forestry Service contract<sup>2</sup> to develop a seedling, damage index from the number of moths caught in pheromone-baited "Multipher" traps.

The moth trapping forecasts larger than normal numbers of moths in slash-burned areas in 1988. These factors would indicate possible infestations at several locations in the Clearwater District next year.

### Cone and seed pests

Douglas-fir cone crops were highly variable from light to heavy throughout the Kamloops Region. Approximately 30% of the cones were infested by Douglas-fir cone moth, Barbara colfaxiana, 16% by Douglas-fir coneworm, Dioryctria abietivorella, and 4% by both the Douglas-fir cone midge, Contarinia oregonensis, and Douglas-fir seed chalcid, Megastigmus spermotrophus. There was also external damage to cones and flowers by western spruce budworm, Choristoneura occidentalis, and a Douglas-fir coneworm, Dioryctria pseudotsugella. Combined, more than half of the Douglas-fir cone crop at 11 collection locations were infested. About 30% of the remaining uninfested cones had only an average of 5 seeds per cone, range 1-14. An average of around 10 seeds per cone is considered a good crop. There was a large disparity in the number of healthy seeds per cone between locations sampled.

A single collection of lodgepole pine cones was 20% infested by western pine shoot borer, Eucosma sonomana.

The cone crop was below average in volume for collecting and the yield of seed was poor, making 1987 less than average for Douglas-fir and Engelmann spruce seed production.

The British Columbia Forest Service seed orchard at Skimikin had only an average of 30% of current growth of Engelmann spruce seed trees defoliated, despite 22 to 269 western spruce budworm larvae per standard beating sample. Ground and aerial application of pesticide, including B.t., helped alleviate some of the damage. The Engelmann spruce seed trees of West Kootenay provenance at Skimikin also had an average 2.5 new Adelges spp. galls per branch. This level of infestation was similar to that in 1986 and has always been more severe than other provenances. That could be a result of genetic differences between the seed trees or the proximity to the alternate host in surrounding native stands.

<sup>1</sup>The pheromone used was: 1% cis-7-dodecenyl + cis-11-tetradecenyl.

<sup>2</sup>Vegetation damage appraisal and pheromone trapping calibration studies, contract No. F52-41-105.

Other seed orchards examined in the region had no significant pest damage.

### DECIDUOUS TREE PESTS

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#### Forest tent caterpillar, Malacosoma disstria Western tent caterpillar, M. californicum pluviale

Scattered poplar, birch, willow and alder were totally defoliated by forest tent caterpillar along Chase Creek from Falkland to Charcoal Creek. Approximately 5 ha of a similar stand type were 80-100% defoliated south of Monte Lake.

Western tent caterpillar severely defoliated poplar in .5- to 1-ha pockets along Silver Star Road, King Edward Main and at Km 46 on the Mission Creek-Belgo Creek road.

This was the first reappearance of high populations and defoliation by these deciduous pests in Kamloops Region since 1979 when 800 ha were severely defoliated in and near Wells Gray Park. Populations are expected to continue next year based on limited egg mass searches.

#### Gypsy moth Lymantria dispar

Sticky traps baited with pheromone to attract male gypsy moths were placed at 43 locations in forested provincial and municipal parks throughout the Kamloops Region; all were negative. This was the twelfth consecutive year of efforts to monitor the spread of gypsy moth throughout British Columbia.

The gypsy moth trapping program is a cooperative project with Agriculture Canada and the British Columbia Forest Service. Over 236 male and female moths, 27 live pupae, 15 old egg masses and 36 new egg masses were collected in the southeastern section of Kelowna. These discoveries resulted in a proposal to aerally apply the biological pesticide, Bacillus thuringiensis (B.t.), over 130 ha in the area where the different life stages of gypsy moth were found. In addition, about 2 ha will be treated with B.t. from the ground. Surveys will continue to monitor the further spread of this serious defoliator.

### PESTS OF YOUNG STANDS

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Young stands were surveyed at eight locations, using fixed-radius plots on transects, to assess the damage from pests (Table 13).

At 50% of the plots, western spruce budworm caused trace to light defoliation of Douglas-fir, Engelmann spruce, ponderosa and lodgepole pine.

Other pest problems recorded in the survey include frost damage, pine terminal weevil, and Warren's root collar weevil. The most significant of those was animal damage east of Kelowna, caused by a yet unknown rodent. Root and basal feeding caused 15% mortality of lodgepole pine seedlings.

Table 13. Pests of young stands by TSA in the Kamloops Forest Region, 1987.

TSA and Location	Pest	Ht(m)	Host	Damage
<u>Kamloops TSA</u>				
Charcoal Cr.	Frost damage	2	1P	30% of current growth killed
	Warren's root collar weevil, <u>Hylobius warreni</u>	2	1P	1% of pine regeneration killed
Falkland	Elytroderma needle disease, <u>Elytroderma deformans</u>	3	pP	10% of trees 40% discolored
	Western spruce budworm, <u>Choristoneura occidentalis</u>	3	pP	Current growth 50% defoliated on 5% of the trees
Badger L. Rd.	Western spruce budworm	3	eS, D-fir	Current growth 10% defoliated on 80% of the trees
Martin Meadows L.	Western spruce budworm	2.5	eS, D-fir	85% of trees averaged 20% total defoliation
<u>Okanagan TSA</u>				
Mission-Belgo crs.	Animal damage	.5	1P	15% of seedlings killed by feeding on roots and stems
Km 17 Railroad Cr.	Pine terminal weevil, <u>Pissodes terminalis</u>	2	1P	Recently attacked terminals on 6% of trees
Blue Lake	Western spruce budworm	1	D-fir	About 60% of current growth defoliated on 80% of trees
McDougall Cr. Rd.	Western spruce budworm	1.5	D-fir	About 80% of current growth defoliated on 80% of trees

11P - lodgepole pine; pP - ponderosa pine; D-fir - Douglas-fir; eS - Engelmann spruce

#### OTHER FOREST PESTS OF MINOR SIGNIFICANCE

Collections and observations of pests of minor importance were made throughout the region (Table 14). Pine sawfly, which is capable of severe defoliation on lodgepole pine, was collected in low numbers in three-tree beating samples at McNulty near Vavenby where it caused up to 14 170 ha severe defoliation from 1976-78.

Table 14. Currently active pests of minor significance in the Kamloops Forest Region, 1987.

TSA and pest	Host <sup>1</sup>	Location	Damage	Status
<u>Kamloops/Okanagan TSA</u>				
Cicadas, Cicadidae	D-fir	Scotch Cr.	Nearly 40% of branchlets killed on all trees over 50 ha	decreasing
Drought damage	D-fir	Mt. Lolo	Approximately 40% of the current growth was killed on all trees over 5 ha	new
European pine shoot moth, <u>Rhyacionia buoliana</u>	Mugho pine	Penticton	90% of trees examined had 0-6 infested shoots per tree, the remaining 10% were uninfested	static
Pine sawfly, <u>Neodiprion</u> sp.	lP	McNulty	Average 77 larvae per three-tree beating sample	decreasing
Satin moth, <u>Leucoma salicis</u>	bCo	Stump L. Mt. Lolo	Approximately 1 ha 110% defoliated at Stump L., 10 ha at Mt. Lolo	static

<sup>1</sup>lP - lodgepole pine; bCo - black cottonwood; D-fir - Douglas-fir

#### FOREST PESTS IN PROVINCIAL PARKS

Forest insects or diseases were found in 25 of the 47 parks sampled, in the seventh year of annual pest surveys in provincial parks in Kamloops Region. The most damaging pests were mountain pine beetle, Dendroctonus ponderosae, western spruce budworm, Choristoneura occidentalis, two-year-cycle spruce budworm, Choristoneura biennis, and western blackheaded budworm, Acleris gloverana.

Mountain pine beetle killed lodgepole pine trees in three parks. There were 80 ha red and 160 ha grey in scattered pockets along the Ashnola River and Ewart Creek on the west and east boundaries of Cathedral Park. At Eneas Lakes Park west of Okanagan Lake a 60-ha corner of the park was infested, part of a much larger adjacent infestation. In the continuing infestation in Okanagan Mountain Park, there were 329 ha red, recently killed and 870 ha grey mapped, up from 350 ha red and 110 ha grey last year.

Western spruce budworm expanded into 12 parks from 9 last year. The largest expansion occurred in Wells Gray Park where 62 760 ha light and 9 070 ha moderate defoliation were mapped, up from 1 020 ha light and 180 ha moderate last year. The infestation extended from Spahats Creek north to Clearwater and Myrtle lakes, including Mahood Lake. Significant damage also occurred in Paul

L. Park where 250 ha light and 40 ha severe defoliation were recorded, down from 380 ha moderate last year. The application of Bacillus thuringiensis (B.t.) for two consecutive years has controlled the infestation at Paul Lake.

Increased populations and light to moderate defoliation occurred at the following parks: Monte Lake, Marble Canyon, Seton Portage, Dutch Lake, Herald, Shuswap Lake, Darke Lake, Nickel Plate and North Thompson River. Similar populations and damage were observed at Apex Mountain and Niskonlith Lake recreation sites.

Two-year-cycle spruce budworm in the immature larval stage of its life cycle, lightly defoliated 4500 ha of alpine fir and Engelmann spruce near Hobson and Angus Horne lakes in Wells Gray Park, down from 9190 ha light and 2590 ha moderate in 1986. If climatic conditions favourable to budworm occur, in 1988 the defoliation could be severe when the larvae mature and feed.

Western hemlock was lightly defoliated over 960 ha for the first time near Azure Lake and River in Wells Gray Park. The last infestation occurred in 1985 when 3100 ha were defoliated.

The infestations reported are expected to continue if weather conditions are favourable for the pest and supply of the preferred host is sufficient.