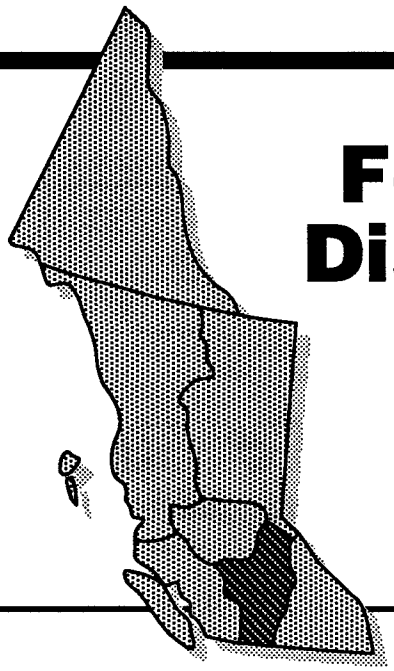
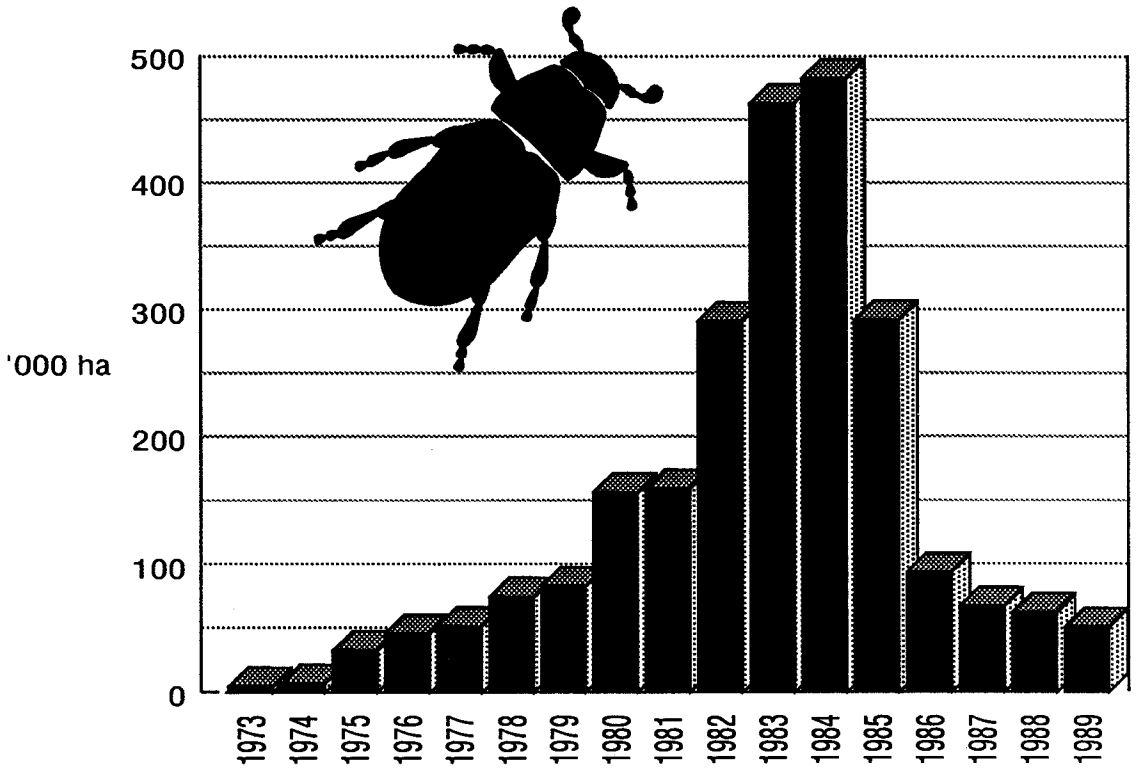


Forest Insect and Disease Conditions

Kamloops Forest Region
1989

H.P. Koot & J. Loranger



Mountain Pine Beetle in British Columbia

Forestry Canada Forêts Canada

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APPENDICES

The following appendices are available upon request from the Forest Insect and Disease Survey, Forestry Canada, 506 West Burnside Road, Victoria, B.C. V8Z 1M5.

I. Maps of major 1989 beetle and defoliator infestations in the Kamloops Forest Region.
II. Pest Report: Western budworm larval levels and predicted defoliation of Douglas-fir in the southern interior of British Columbia, June 1989. C. Wood.
III. Pest Report: Status of Douglas-fir tussock moth in Kamloops Forest Region, 1989, November 1989. Peter Koot.
IV. Pest Report: Defoliation of Douglas-fir by western spruce budworm in British Columbia in 1989 and forecast for 1990. November 1989. C. Wood.
V. Summary of 1989 pheromone trapping program, Kamloops Forest Region.
VI. Summaries of pest problems in young stands, Kamloops Forest Region, 1989.

INTRODUCTION

This annual report describes and summarizes the status of forest pests and the effects of environmental factors on forests in the Kamloops Forest Region in 1989, and attempts to forecast population trends and highlight pests that are capable of sudden damaging outbreaks with forest management implications. Pests are mentioned by host, in order of importance, and occasionally within the context of a management unit or Timber Supply Area (TSA).

The Forest Insect and Disease Survey (FIDS) group is the national network within Forestry Canada responsible for:

(1) producing an overview of forest pest conditions and their implications;

(2) maintaining records and surveys to support quarantines and facilitate predictions;

(3) supporting forestry research, and herbaria, insect collections and records;

(4) providing advice on forest insect and disease conditions; and,

(5) developing and testing survey techniques and conducting related biological studies.

This report was compiled mostly from information derived from field observations and records collected during the field season (Map 1), which extended from late May to early October. A total of 280 insect and disease collections were submitted for identification and verification to the Pacific Forestry Centre. Provincial agencies, industry, and private sources submitted additional insect and disease collections. More than 200 contacts and on-site pest examinations were made with personnel from British Columbia Forest Service (BCFS), other government agencies, forest industry and private individuals.

The cooperation of provincial, industrial and municipal agencies is essential for the effective fulfillment of those mandates and is gratefully acknowledged.

Major forest pest damage was mapped during 72 hours of fixed-wing aerial surveys provided by the BCFS. The area covered by aerial surveys is shown on Map 1.

Throughout this report, defoliation intensity is defined as follows:

light - discolored foliage barely visible from the air, some upper crown and branch tip defoliation;

moderate - pronounced discoloration and noticeably thin foliage; top third of many trees severely defoliated, some completely stripped;

severe - top, plus many branches completely defoliated, most trees more than 50% defoliated.

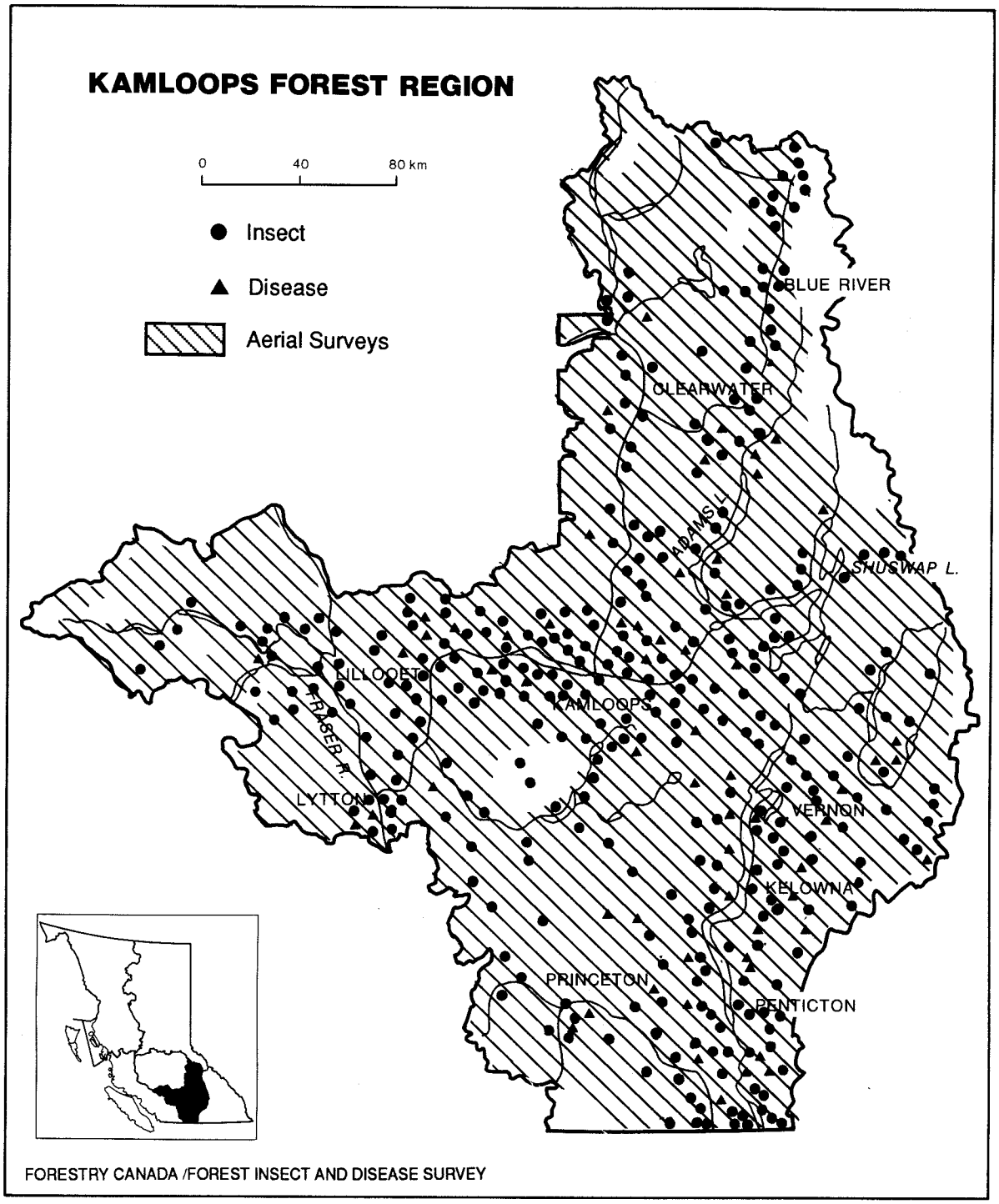
During the FIDS field season from May to October, correspondence can be directed to:

Forest Insect and Disease Survey
Forestry Canada
1379 Dominion Crescent
Kamloops, B.C.
V2C 2X2 Ph. 372-1241

Forest Insect and Disease Survey
Forestry Canada
P.O. Box 487
Summerland, B.C.
V0H 1Z0 Ph. 494-8742

or, throughout the year to:

Forest Insect and Disease Survey
Forestry Canada, Pacific Forestry Centre,
506 West Burnside Road
Victoria, B.C.
V8Z 1M5 Ph. 388-0600



Map 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 infestations in 1989.

SUMMARY

The most damaging pest in the region continues to be **mountain pine beetle**, killing an estimated 1.2 million lodgepole pine and white pine over 12 000 ha, down from 3.5 million pine over 17 600 ha in 1988. **Pine needle sheathminer** outbreaks expanded to 7500 ha in 33 separate areas in Adams, Shuswap and Barriere lakes areas, up from 574 ha in 7 areas in 1988. **European pine shoot moth** continues to be an urban forestry problem on ornamental pines in the Okanagan Valley at Penticton and Kelowna, where up to 30% of new shoots were damaged. **Pinewood nematode** was not found in any samples examined in the region. **Elytroderma needle disease** is chronic in parts of the North Thompson River and Okanagan valleys. **Lophodermella needle disease** caused up to 30% discoloration of lodgepole pine foliage between Penticton and Kelowna and areas east of Kelowna. Large numbers of **pine butterflies** were active in the crowns of ponderosa pine near Pritchard and near Vernon, but defoliation was not evident.

Defoliation of Douglas-fir by **western spruce budworm** declined in intensity and area for the second year to 143 000 ha from 345 000 ha in 1988. Following predisposition by drought over 2 - 3 years, more than 320 pockets of **Douglas-fir beetle** infestations were recorded during aerial surveys. **Douglas-fir tussock moth** larvae caused top-stripping of ornamental spruces and Douglas-fir in scattered areas in the City of Kamloops, but not in natural forest stands. Larval populations of **false hemlock looper** increased substantially for the first time since 1983 between Savona and Falkland, and north of Kamloops to Barriere, but defoliation was not apparent.

Infestations of **spruce beetle** in mature spruce stands declined for the third consecutive year to 940 ha from 1450 ha in 1988, mostly in Lillooet TSA. **Two-year-cycle spruce budworm** caused 4140 ha of light to moderate defoliation, down from 44 450 ha in 1988. More than 30% of spruce terminals were attacked in a plantation at Upper South Barriere Lake by **white pine weevil**, and about 5% were attacked in plantations at Fennell Creek and near Blue River.

Western balsam bark beetle remained active in stands of alpine fir throughout the region, infesting 310 ha, compared to only 46 ha the previous year. **Foliage diseases** of alpine fir were common at light to moderate intensity in the upper Jamieson Creek area and upper North Thompson River Valley.

Larch needle blight declined to only small, scattered pockets of infection in the North Okanagan area.

Populations of **black army cutworm** remained at low levels in the Clearwater and Salmon Arm districts. **Climatic injury** was widespread throughout the region. This resulted in dead buds, foliage discoloration, branch dieback, top-kill and occasional tree mortality. **Rhizina root disease** fruiting bodies were found scattered over 80 ha of a recently planted burn near Clearwater, but were not associated with seedling mortality.

The most common pests of seed orchards were **adelgids** and **aphids** at Skimikin and Heffley Creek seed orchards, affecting up to 42% of white spruce provenances. Other pests causing more minor damage included **western spruce budworm**, **Sclerophoma needle disease** and **winter injury**.

Pest and damage assessments of planted and naturally regenerated areas were completed at 11 locations. Significant levels of damage were found at 8 sites. Several of the more important pest problems included **armillaria root rot** on lodgepole pine and Douglas-fir; **spruce adelgids** on Engelmann spruce, **western gall rust** on lodgepole pine and **winter damage** to western red cedar and western hemlock.

Of the deciduous pests, **tent caterpillars** were the most damaging. Defoliation of predominantly trembling aspen extended over more than 1000 ha, from west of Ashcroft to Clearwater, from Kamloops to Chase and parts of the North Okanagan Valley. The **apple ermine moth**, an introduced insect, was found for the first time in the region as far north as Little Fort and eastward to Perry River. The **gypsy moth** trapping program continued for the fourteenth year in the region. Negative results were obtained from the 41 locations sampled.

PINE PESTS

Mountain pine beetle
Dendroctonus ponderosae

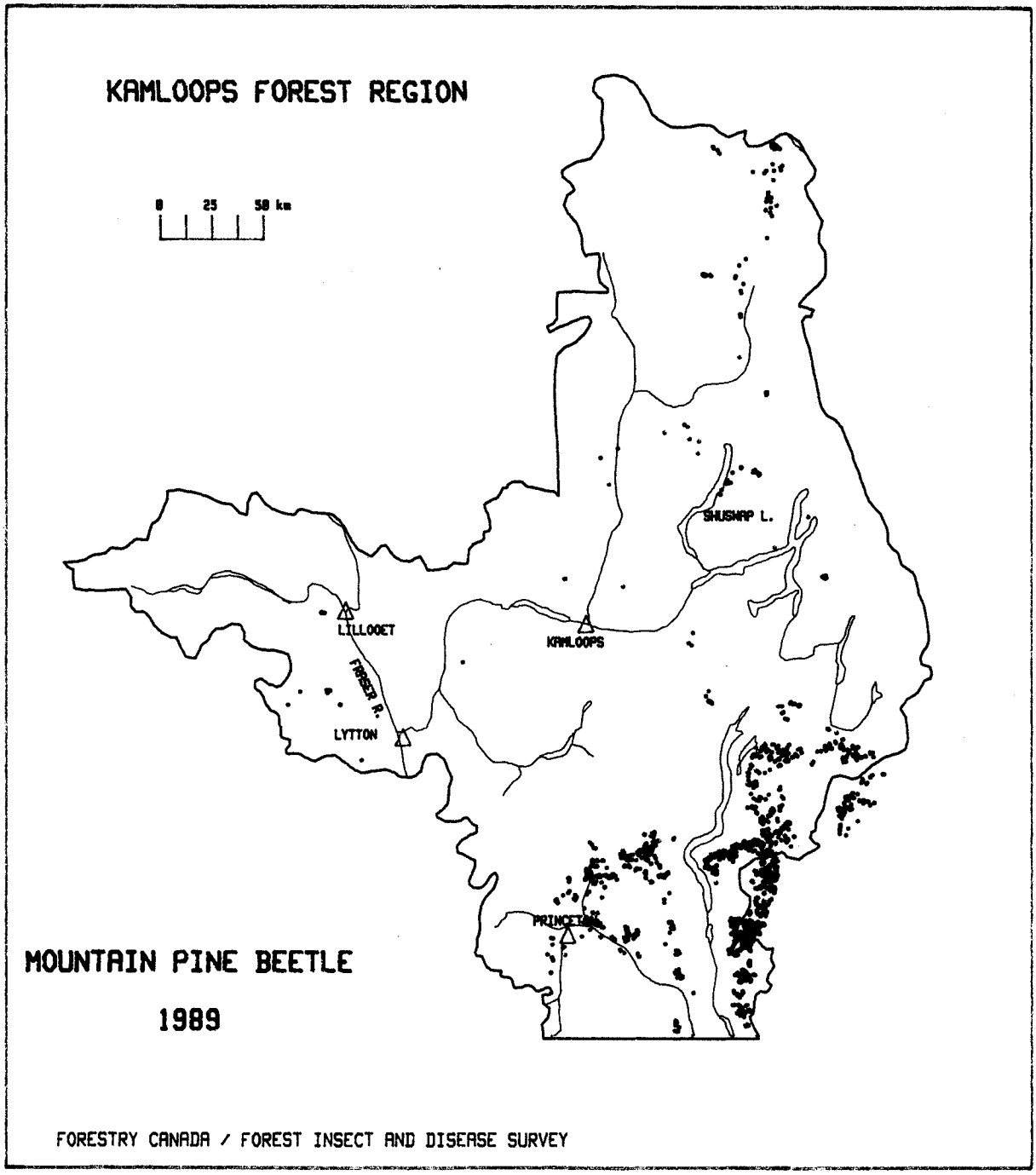
Mountain pine beetle continued to be the most damaging pest in the region, killing an estimated 1.2 million lodgepole and western white pine over 12 000 ha, a decrease from nearly 3.5 million pine over 17 600 ha in 1988. Volume losses amounted to 620 000 m^3, a decline from nearly 1.8 million m^3 in 1988. While beetle infestations in lodgepole pine stands continued at lower levels throughout the region, infestations in stands containing white pine increased. Most notable were those in the Kamloops TSA along the North Thompson River Valley from Vavenby to Albreda and in the Adams Lake-Barriere lakes area.

The largest and most widespread outbreaks continue in lodgepole pine stands in the Okanagan TSA along both sides of the Okanagan Valley, from Vernon south to the U.S.A. border. Infestations in other TSAs were generally smaller and scattered, ranging in size from 5 to 400 trees. Information in the following table was compiled from data obtained from a cooperative Forestry Canada-BCFS aerial survey.

Table 1. Recent pine mortality (red) caused by mountain pine beetle as determined from aerial and ground surveys, Kamloops Forest Region, 1989.

TSA	Tree species[1]	Number of infestations	Area (ha)	Number of trees killed	Volume of trees killed (m^3)
Kamloops	lP, wP	176	800	10 400	7 800
Lillooet	lP, wP	45	100	3 100	2 000
Okanagan	lP	1 031	9 600	1 079 000	539 600
Merritt	lP	214	1 500	141 100	70 600
Totals		1 466	12 000	1 233 600	620 000

[1] lP - lodgepole pine; wP - white pine



Map 2. Areas of lodgepole pine recently killed by mountain pine beetle as determined by aerial and ground surveys, 1989.

Table 2. Major mountain pine beetle infestations, Kamloops Forest Region, 1989.

TSA and location	Red 1989 (ha)	Red 1988 (ha)	Change 1988-89 (ha)
Okanagan TSA			
Yard Cr.	40	280	- 240
Naswhito Cr.-Pinaus L.	30	0	+ 30
Shorts-Whiteman-Beak creeks	0	150	- 150
Coldstream	60	275	- 215
Lumby-Ferry Cr.-Kettle R.	450	910	- 460
Mission-Belgo-Daves creeks	380	1 020	- 640
Ideal L.-Vernon	440	885	- 445
Dale Cr.-Campbell Cr.	1 300	2 140	- 840
Hydraulic L.-Lebanon L.	1 450	2 470	- 1 020
Bruer Cr.-Mohr Cr.	200	355	- 155
Okanagan Mtn. Park	210	375	- 165
Trout Cr.- Summerland	250	615	- 365
Vaseux Cr.-Saunier Cr.	3 400	2 175	+ 1 225
Trinity Valley-Michel L.	20	100	- 80
Glen L.-Trout Cr.	1 300	1 800	- 500
Chase Cr.	20	0	+ 20
Anglemont-Seymour Arm	50	0	+ 50
Subtotal	9 600	13 550	- 3 950
Lillooet TSA			
Downton L.-Bridge Glacier	0	650	- 650
Downton-Tyaughton lakes	0	250	- 250
Stein R. and tributaries	30	1	+ 29
Lillooet-French Bar Cr.	0	75	- 75
Anderson L., Cayoosh Cr.	15	34	- 19
Relay-Mud creeks	0	250	- 250
Seton L.	45	0	+ 45
Pavilion	10	0	+ 10
Subtotal	100	1 260	- 1 160
Kamloops TSA			
Barriere lakes-Fennell Cr.	60	5	+ 55
Vavenby-Albreda	700	165	+ 535
Tranquille R.-Jim Black L.	10	0	+ 10
Six Mile Cr.-Pritchard	20	0	+ 20
Darfield	10	0	+ 10
Subtotal	800	170	+ 630

TSA and location	Red 1989 (ha)	Red 1988 (ha)	Change 1988-89 (ha)
Merritt TSA			
Hayes-Trout creeks	810	1 830	- 1 020
Hedley-Princeton-Manning Park	660	630	+ 30
Summers Cr.	30	190	- 160
Subtotal	1 500	2 650	- 1 150
TOTAL	12 000	17 630	- 5 630

Kamloops TSA

The area of recently killed pine in Kamloops TSA expanded almost fivefold to 800 ha, from 170 ha in 1988. This is primarily the result of substantial increases in numbers of infested white pine in scattered small pockets along the North Thompson River Valley from Vavenby north to Albreda and in the Adams Lake-Barriere lakes area. More than 120 infestations, ranging in size from 5 to 150 trees each, were mapped in these areas in 1989 as compared to only 50 infestations in 1988. Most notable were expansions at Momich and Saskum lakes, Harper Creek, Mad River and along the North Thompson River from Avola to Albreda, including the south end of Monte Lake.

Beetle activity continued in small pockets of 5-20 trees each in lodgepole pine stands, mostly in the Kamloops District including areas in Watching Creek, Peterson Creek, southeast of Pritchard and north of Chase.

The small localized, scattered and frequently inaccessible nature of infested white pine stands can make management efforts difficult. Timely harvesting practices and complementary pheromone baiting are the current means of effectively controlling beetle populations.

Lillooet TSA

In Lillooet TSA the area of infestation was reduced to 100 ha from 1260 ha in 1988, continuing the trend which began in 1984. Small infestations in lodgepole pine still persist along Cayoosh Creek, Duffey Lake, Cottonwood Creek, near Pavilion and east of Shalalth, while declines occurred at Laluwissin Creek, Texas Creek, Rough Creek, and north of Pavilion. Decreases in recent years are the result of host depletion from previous infestations, salvage logging, and successive years of overwintering brood mortality. Combined, these have greatly reduced beetle populations and susceptible lodgepole pine stands.

Okanagan TSA

Infestations in the Okanagan TSA declined to 9600 ha from 13 550 ha in 1988, following an increase the previous year. Declines were greatest in the Penticton District east and south of Kelowna, including Okanagan Mountain Park, Daves Creek and the Campbell-Stirling-lower Saunier Creek drainages. Reductions were primarily due to host depletion, including harvesting, mostly in valley bottoms and mid-slopes, but increasingly in plateau areas. A notable exception to the general decline is the coalescing of smaller infestations between upper Shuttleworth and Saunier creeks.

The largest reduction in Vernon District occurred along Coldstream Creek where the number of infestations declined from 15 to 5 in 1989, due mostly to timely harvesting of susceptible and infested timber. Infestations continued at reduced levels in the Oyama-Swalwell-Aberdeen lakes area and over a larger area west of Peachland from Eneas Lakes Park to Mount Kathleen. Elsewhere in the TSA, beetle activity continued at levels similar to 1988, i.e. in areas of small scattered infestations.

Merritt TSA

The infested area in lodgepole pine stands in Merritt TSA declined to 1500 ha from 2650 ha in 1988. Most of this reduction has occurred in the Spukunne-Shinish creeks and Chain Lake area as a result of continued harvesting and host depletion. Other decreases were noted south of Princeton to Manning Park boundary where infestations, active since 1980, were reduced to small scattered pockets. The only major expansion occurred between Princeton and Hedley in high-elevation stands in the Hedley, McNulty, Steven and Jacob creeks drainages, along the north side of Similkameen River. In these areas tree mortality ranged from 10-50% of stems in outbreaks up to 70 ha.

Overwintering brood assessments ("R" values) were made at six locations in May 1989 in the Okanagan and Merritt TSAs. These values were used to estimate brood mortality and determine health and vigor of progeny. Analysis of this information revealed a general increase in populations (Table 3). For the most part, observations during fall cruising confirmed this trend, in spite of the overall decline observed from aerial surveys.

Table 3. Mountain pine beetle reproductive ratios, Okanagan TSA, Kamloops Forest Region, Spring 1989.

Location	"R" value[1] (range)	"R" value (average)	Population status[2]
Spukunne Cr.	1-12	7.3	increasing
Jellicoe	3-19	7.7	increasing
Darke Lake	1-7	4.0	static
Ellis Lake	3-20	11.6	increasing
Carmi Rd.	4-22	12.9	increasing
Wilkinson Cr.	1-19	8.2	increasing
Stump Rd.	1-14	8.0	increasing
Glen Lake	1-9	3.8	static

[1]"R" $\frac{a + b}{c}$ a = number of eggs and larvae
b = number of pupae and adults
c = number of galleries originating within sample area

[2]Interpretation of "R" values to determine population status:

$\leq$ 2.5 - decreasing population
2.6-4.0 - static population
$\geq$ 4.1 - increasing population

Four stands in the region were prism-cruised to determine the condition of the beetle brood, predict future trends and assess current and previous attack intensities in terms of volume and numbers of trees affected (Table 4).

Table 4. Mountain pine beetle cruise data, Kamloops Forest Region, 1989.

	Percent of pine attacked							
Location/TSA	Healthy	Current attack (1989)	Partial attack (1989)	Red (1988)	Grey (pre-1988)	Dead other causes	Total	Total volume (m^3/ha)
Okanagan TSA								
Wilkinson Cr.	56	9	2	6	25	2	100	237
Carmi	27	32	10	14	15	2	100	303
Merritt TSA								
Spukunne Cr.	44	1	13	5	37	0	100	239
McNulty Cr.	82	8	7	3	0	0	100	239
Average	52	13	8	7	19	1	100	255

Current attack averaged 13% in 4 areas in 1989, up marginally from 10% in 1988 and 6% in 1987. However, the population sample size was only half that of previous years, and should be considered when making comparisons. Based on the present level of current attack, the apparently healthy brood development and barring any adverse climatic impact, outbreaks in the Okanagan and Merritt TSAs are expected to continue at reduced levels in 1990. Infestation expansions are expected only in the Saunier-Vaseux-Inkaneep drainages of the Okanagan TSA, although the present rate of harvesting could ameliorate this trend. In the Merritt TSA, additional current attack between Hedley and Manning Park (Eastgate) should increase tree mortality in 1990. In the Kamloops TSA beetle activity is expected to continue in more than 120 spot infestations of white pine in mixed stands in the Barriere lakes area and North Thompson drainage from Vavenby to Albreda in 1990. Management options are limited due to the nature of these infestations, i.e. small, scattered and in difficult terrain.

Pine needle sheathminer
Zelleria haimbachi

Outbreaks of sheathminer in lodgepole pine stands expanded to 7500 ha in 33 separate areas in the Adams, Shuswap, and Barriere lakes areas. This is up from 574 ha over 7 areas and follows four consecutive years of moderate to severe defoliation in localized stands in the Adams Lake - Shuswap Lake - Salmon Arm area.

Discoloration was mostly moderate on immature pine in two locations covering 1200 ha on Mt. Boysse near Chase and along lower Scotch Creek. Elsewhere, light discoloration dominated 2500 ha in 8 areas east and west of Adams Lake including Barriere lakes and Adams Plateau. Lightly discolored pine occurred over 3800 ha in 23 scattered patches including lower Adams Lake, Little Shuswap Lake, Chase Creek, Pritchard, Monte Lake, Paxton Valley and Tappen.

There was no evidence of discoloration north of Kamloops or near Lytton, where new pine shoots were mined and discolored in 1988, the exception being two small areas of light defoliation near Tappen. Needleminer activity or previous branch dieback was not obvious along the Fly Hills, where most of the current foliage was mined in 1988. Spruce budworm feeding near Pritchard and Falkland frequently made initial aerial observations of sheathminer damage difficult to delineate. Both species feed in the same mixed stands of lodgepole pine and Douglas-fir.

Pine needle sheathminer is generally of limited economic importance. Tree mortality has not been observed in B.C., but minor branch dieback has been reported in areas of recurring severe damage, resulting in some growth reduction. Severe defoliation can be of particular concern in arboreta, ornamental plantings, and Christmas tree plantations where aesthetics and tree form are important.

European pine shoot moth
Rhyacionia buoliana

Shoot moths continued to be an urban forestry problem of Mugho, Scots and Austrian pines in at least two locations in the Okanagan Valley. The highest incidence of attack was recorded at Trinity Centre in Penticton where 30% of new shoots were damaged, up from an average of 20% in 1988. Ornamental pines at

Okanagan College in Kelowna sustained 5% shoot damage, similar to 1988 levels. While attacked trees can be deformed and their growth can be retarded, they are seldom killed.

Formal surveys of native and exotic pines were discontinued this year following testing of the efficacy of pheromone baits in sticky traps, and determination of the status of shoot moth in 1988 since provincial quarantine regulations lapsed in 1981. Establishment of shoot moth populations beyond known areas in the Okanagan Valley has not occurred, and there is no evidence of the moth in native pines.

A gouty pitch midge, Cecidomyia piniinopis, causing damage similar to shoot moths, was common in the shoots of open-growing ponderosa pine in the Lytton area.

Pinewood nematode
Bursaphelenchus xylophilus

Surveys for pinewood nematode were required to assist in the phytosanitary certification of wood products for export to several countries. In Japan it has caused a disease in pines (mostly) called pine wilt. More than 1200 samples from trees and potential vectors collected throughout British Columbia since 1982 have shown that the nematode is uncommon in the forest, with only individual predisposed trees affected at a few widely distributed locations.

In 1988 as part of a national FIDS survey, more than 200 potential vectors including woodborers, bark beetles, wood wasps and others were collected in the Pacific Region and submitted to Memorial University of Newfoundland for extraction of nematodes. Additional samples were obtained this year in Kamloops Region along Adams Lake, where numerous woodborers were found in association with recent harvesting in Douglas-fir stands. Nationally, more than 5000 insects were processed. While several other genera of nematodes commonly associated with insects were obtained, the pinewood nematode was not recovered from any of the insects. These results continue to support the statement that the pinewood nematode is not abundant in Canada, and that damage in the forest, if present, is below the level of detection.

Pine needle diseases
Elytroderma deformans
Lophodermella concolor
Hendersonia pinicola

Needle discoloration and brooming by Elytroderma needle disease is chronic in many multi-aged ponderosa pine stands of the Interior Douglas-fir (IDF) and Ponderosa Pine-Bunchgrass (PPBG) biogeoclimatic zones. In the North Thompson Valley up to 60% foliage discoloration of ponderosa pine occurred on more than 200 ha along Heffley Creek, up slightly from 1988. Infection intensity was similar in areas up to 100 ha each near Knouff Lake and Paul Lake. In the Okanagan Valley lighter infections (>30% foliage discoloration) were common throughout the host range in scattered areas from Vernon to Osoyoos.

Up to 30% of year-old lodgepole pine needles were infected by L. concolor in scattered patches between Penticton and Kelowna along Penticton Creek, Weyman

Creek, Greyback Road and at Chute Lake. H. pinicola, a secondary invader (hyperparasite) of needles infected by L. concolor, was found on 30% of needles in a 50-ha lodgepole pine plantation near Blue River.

Based on the present infection levels and the history of these pathogens, continued infection can be expected in these areas in 1990.

Pine butterfly
Neophasia menapia

Large numbers of pine butterflies were observed in flight in the upper crowns of ponderosa pine during mid-summer in stands east of Pritchard along the South Thompson River and along Monte Creek. Butterflies were also active on the west side of Okanagan Lake near Vernon.

Damage resulting from feeding by pine butterfly larvae has not been reported since 1973 when light defoliation occurred in scattered locations along Okanagan Lake from Summerland to Vernon. Some tree mortality resulted from an epidemic at Okanagan Landing in the early 1960s.

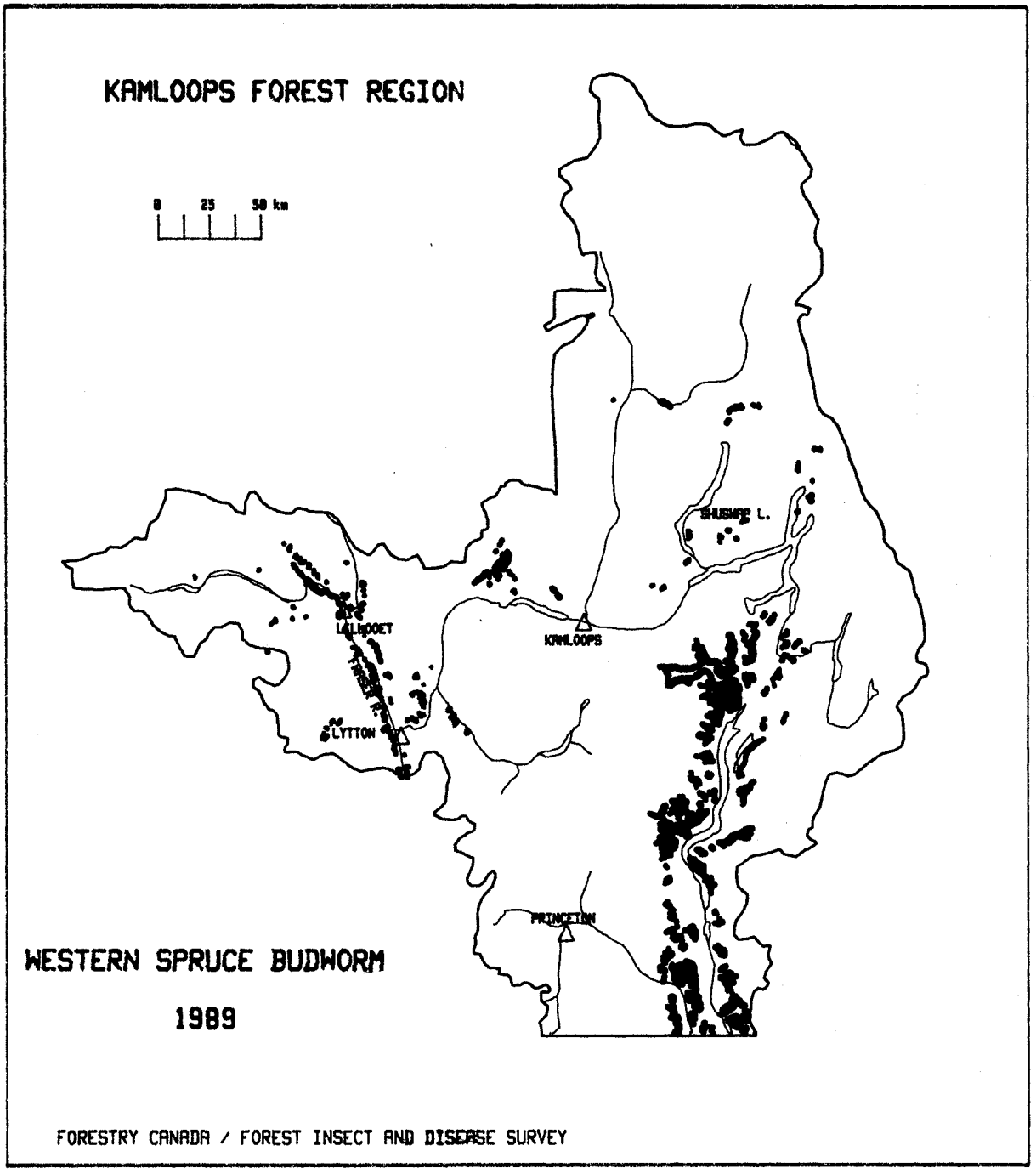
Considering the numerous adults observed, there is potential for defoliation of ponderosa pine in the aforementioned area in 1990.

DOUGLAS-FIR PESTS

Western spruce budworm
Choristoneura occidentalis

Defoliation of Douglas-fir by western spruce budworm declined in intensity and area for the second year to 143 300 ha from 345 000 ha in 1988 (Map 3 and Table 5). Nearly 400 infestations were aerially sketchmapped, of which 114 390 ha were lightly defoliated, 25 410 ha moderately and 3500 ha severely. This is the twenty-third consecutive year of significant defoliation in the Kamloops Forest Region.

The decline, as forecast by 1988 egg counts, was predominantly in the Kamloops TSA and included the Thompson River drainages from Cache Creek to Chase and Kamloops north to Avola. Major reductions also occurred at Shuswap Lake and surrounding areas in the Okanagan TSA. However, infestations expanded by almost 50% to 12 570 ha in Lillooet TSA mostly along Bridge River and the Fraser River south of Lillooet, the only areas of notable expansion in the region. Additional tree mortality has not been observed in the region since the 540 ha identified in 1987.



Map 3. Areas where Douglas-fir was defoliated by western spruce budworm as determined by ground and aerial surveys, 1989.

Table 5. Location and area of Douglas-fir defoliated by western spruce budworm as determined from aerial and ground surveys, Kamloops Forest Region, 1989.

Location	Area of defoliation (ha)			
	Light	Moderate	Severe	Total
Okanagan TSA				
Scotch Cr.	500			500
Seymour Arm-Ratchford Cr.	1 200			1 200
Reinecker Cr.	1 100			1 100
Salmon Arm-Enderby	4 500	2 300		6 800
Mara L.	260			260
Salmon R.	1 600	1 300	590	3 490
Monte L.-Falkland	13 700			13 700
Glenemma-Irish Cr.	6 400	2 500	1 600	10 500
Armstrong	350	300	180	830
Equesis Cr.-Naswhito Cr.	4 700	600		5 300
Vernon Hill-Coldstream Cr.	650			650
Bouleau Cr.-Lambly Cr.	4 550	250		4 800
Vernon-Vernon Cr.	5 400			5 400
S. Kelowna-Penticton	7 900	1 500		9 400
Westbank-Peachland	13 900	5 000	350	19 250
Summerland-Penticton-Keremeos	6 400	1 900		8 300
Ellis Cr.-Shuttleworth Cr.-Osoyoos	9 400	2 700		12 100
Okanagan Falls-Keremeos-Osoyoos	12 500	4 400	780	17 680
Subtotal	95 010	22 750	3 500	121 260
Lillooet TSA				
Stein R.	400			400
Lytton-S. of Kanaka Bar	1 200	70		1 270
Twaal Cr.-Botanie Cr.	1 400			1 400
Lytton-Della Cr.	1 200	700		1 900
Izman Cr.-Laluwissin Cr.	300			300
Lillooet-Texas Cr.	1 400			1 400
Fountain Valley	1 200			1 200
Pavilion	300			300
Bridge R.	1 800	1 000		2 800
Yalakom R.	1 200	150		1 350
Anderson L.-Seton L.	250			250
Subtotal	10 650	1 920		12 570

Location	Area of defoliation (ha) Light	Moderate	Severe	Total
Kamloops TSA				
Pass Valley-Deadman R.	600	240		840
Sabiston Cr.-Carabine Cr.-Criss Cr.	4 000	500		4 500
Tranquille R.	600			600
Little Shuswap L.	350			350
Kwikoit Cr.-Adams L.	700			700
Upper Adams R.	1 000			1 000
Birch I.-Vavenby	700			700
Subtotal	7 950	740		8 690
Merritt TSA				
Soap L.-Agate Cr.	780			780
Subtotal	780			780
REGIONAL TOTAL	**114 390**	**25 410**	**3 500**	**143 300**

Okanagan TSA

The total area of defoliation in Okanagan TSA declined by 46% to 121 260 ha in 1989. Infestations in the Okanagan Valley remained largely unchanged in area at 100 000 ha, but declined substantially at Shuswap Lake and surrounding area. Areas of moderate defoliation in the TSA were reduced more than 100% to 22 750 ha and light by 33% to 95 010 ha. Severe defoliation remained virtually unchanged at 3500 ha and occurred over limited areas near Silver Creek, Armstrong, Equesis Creek, Powers Creek, west of Oliver and Mt. Kobau.

Lillooet TSA

Of the 12 570 ha of infestation which represented an increase of 30% from 1988, 85% were in the light defoliation category; the remainder were moderate. Expansions occurred along the Fraser River between Lillooet and Kanaka Bar over 4500 ha as compared to 3000 in 1988 and along Bridge River on 3000 ha, up from 2150 ha in 1988. Elsewhere, defoliation was up slightly south of Pavilion and along Fountain Valley, while staying relatively unchanged between Lytton and Spences Bridge. Additional tree mortality and top-kill were not observed along Marshall Creek and at Mission Pass, areas of previously chronic infestation.

Kamloops TSA

By far the largest reduction in infestation occurred in the Kamloops TSA, from 152 540 ha of defoliation in 1988 to only 8960 ha in 1989, primarily in the Interior Douglas-fir (IDF) biogeoclimatic zone. Stands were not severely defoliated and only 740 ha sustained moderate defoliation. Little or no defoliation occurred in the Ashcroft-Cache Creek area to Chase, marking a major decline from the 1988 defoliation level. The same applies to the North Thompson River Valley and side drainages from Kamloops to Avola, including Wells Gray Park and west of Adams Lake. Moderate defoliation persisted in several localized areas along Deadman River at Criss and Clemes creeks. Light defoliation totalling 7950 ha was more widespread in these same areas, but also along Tranquille River, upper and lower Adams Lake and between Birch Island and Vavenby.

Merritt TSA

Only 780 ha of light defoliation occurred along the Nicola River Valley between Soap Lake and Pulpit Rock, down from more than 6000 ha recorded in 1988. This is the fifth consecutive year of defoliation in parts of the valley, with some scattered tree mortality evident from previous infestations.

Bud sampling

Surveys of infested buds were done in late May at 32 locations to assist in predicting defoliation for the current (1989) year (Table 6). At each location, a total of 100 buds were examined from five trees. Severe defoliation was predicted at 16% of sites, moderate at 13%, light at 59% and trace or no defoliation at 12%. Subsequent aerial surveys and ground assessments found predictions to be correct at 65% of the stands sampled, compared to 40% in 1988 and 54% in 1987. While attempts to accurately predict current defoliation from bud samples has had limited success historically, virtually all samples did reflect the general downward trend predicted by 1988 egg counts.

Table 6. Percent buds infested by western spruce budworm, predicted and actual defoliation, by TSA, Kamloops Forest Region, 1989.

TSA and Location	Percent of buds infested			Defoliation 1989	
	1989	1988	1987	Predicted[1]	Actual
Okanagan TSA					
Skimikin	**9**	44	20	L	Trace
Sicamous	**4**	9	2	L	nil
Falkland	**7**	25	47	L	L
Equesis Cr.	**40**	16	-	S	L
Joyce L.	**24**	44	45	M	L
Darke L.	**57**	35	-	S	M
Peachland Main	**46**	27	-	S	L
Glenrosa	**51**	32	-	S	M
Postill L.	**11**	-	-	L	Trace
Apex-Yellow L.	**17**	49	-	M	L
Twin Lakes	**18**	40	-	M	L
Blind Cr.	**11**	25	46	L	L
Blue L.	**9**	16	48	L	Trace
Anarchist Mtn.	**39**	6	53	S	L
Lillooet TSA					
Fountain Valley	**3**	26	19	L	L
Botany Cr.	**14**	51	33	L	Trace
Kamloops TSA					
Scottie Cr.	**1**	5	27	Trace	nil
Cache Cr.	**8**	10	48	L	Trace
Oregon Jack Cr.	**3**	4	13	L	Trace
Highland Valley	**1**	8	7	Trace	Trace
Sabiston Cr.	**19**	12	29	M	M
Indian Gardens	**4**	18	21	L	Trace
Cherry Cr.	**8**	27	-	L	L
Paul L.	**3**	30	35	L	L
Heffley Cr.	**6**	22	20	L	Trace
Louis Cr.	**5**	10	92	L	Trace
Fadear Cr.	**9**	18	40	L	Trace
W. Barriere	**11**	17	70	L	Trace
Niskonlith L.	**2**	21	-	Trace	nil
Duck Meadow	**4**	21	29	L	Trace
Adams R.	**3**	27	76	L	Trace
Orchard L.	**0**[2]	10	73	nil	nil

[1] 1-15% buds infested - trace to light defoliation
16-30% buds infested - moderate defoliation
31%+ buds infested - severe defoliation

[2]Area sprayed with *Bacillus thuringiensis* (*B.t.*), 1988

Larval and moth sampling

Larval populations in much of the Kamloops Forest Region were down from 1988 levels. More than 40 standard beating samples averaged 23 larvae per collection in 1989, compared to 45 in 1988, reflecting the overall reduction in intensity and incidence of defoliation.

For the third year, mid- to late-instar budworm larvae and adult males were monitored in areas with low populations but with a history of outbreaks. Moths were caught in baited Multipher® traps at three locations as part of a study to correlate trap catches with larval densities and defoliation in 1990. Beating samples from 25 Douglas-fir at each site averaged 1 larva per 45-cm branch, whereas trap captures averaged 237 (range 80-370) moths per trap. This compares to 0.7 larvae per branch and an average 311 moths per trap in 1988 for the same areas. Several more years of sampling and analysis are necessary before numbers can be correlated with population potential and damage.

Egg sampling

Based on egg mass counts completed at 20 locations in the region, an overall decline continued for the second year (Table 7). Two 45-cm branch tips were collected from each of ten trees per location. The number of egg masses per branch were counted and then extrapolated to 10 m^2 of foliage. These numbers were then used to determine defoliation severity for 1990.

Table 7. Average number of western spruce budworm egg masses from 1987-89 and predicted defoliation in Kamloops Forest Region in 1990.

TSA and Location	Predicted defoliation in 1990[1]	No. of egg masses per 10 m^2 foliage **1989**	1988	1987
Kamloops TSA				
Highland Valley	none	**0**	10	232
Oregon Jack Cr.	none	**0**	29	427
Sabiston Cr.	moderate	**123**	85	178
Criss Cr.	moderate	**145**	-	-
Cherry Cr.	moderate	**86**	43	247
Paul L.	severe	**162**	78	389
Louis Cr.	none	**0**	0	190
Adams R.	light	**37**	9	121
Okanagan TSA				
Falkland	light	**49**	37	295
Blind Cr.	light	**23**	10	264
Postill L.	light	**17**	20	-
Peachland Main	moderate	**51**	43	35
Equesis Cr.	moderate	**51**	43	35
Darke L.	moderate	**87**	76	-
Blue L.	light	**8**	98	264
Apex Mtn. Rd.	moderate	**57**	99	315
Glenrosa	moderate	**143**	231	220
Mt. Kobau	severe	**310**	661	275
Lillooet TSA				
Fountain Valley	moderate	**124**	70	84
Botanie Cr.	none	**0**	53	-
Regional average		74	86	227

[1] 1-50 Average number egg masses per 10 m^2 foliage - light defoliation
51-150 Average number egg masses per 10 m^2 foliage - moderate defoliation
151+ Average number egg masses per 10 m^2 foliage - severe defoliation

While the average number of egg masses declined by nearly 15% from 1988, generally small increases occurred in half the stands examined. These include 4 of 8 sites in the Kamloops TSA, 5 of 10 in the Okanagan TSA and in 1 of 2 sites in the Lillooet TSA. Of the locations sampled, severe defoliation is predicted in the Kamloops TSA north of Paul Lake Provincial Park. This is in the immediate vicinity of the area previously sprayed with B.t. in 1988. If this forecast prevails in 1990, the Park may again be at risk to defoliation, in which case it would be prudent to consider some advance planning and discussion of management options. In the Okanagan TSA, severe defoliation is again

predicted in the Mt. Kobau area where defoliation has persisted for the past five years, resulting in some top-kill and branch dieback, but negligible tree mortality. Elsewhere, defoliation is expected to continue at mostly reduced levels throughout stands defoliated in 1989.

Parasitism

Parasitism in mass rearings of late-instar larvae by hymenopteran and dipteran parasites averaged 15% (range 2-44%) at 12 locations, up from 13% in 1988. This is still too low to effectively reduce budworm populations. Prior studies have shown that insect parasites are most effective in controlling low populations of budworm, but have little influence on high populations.

The decline in budworm populations, particularly in the Kamloops TSA, can be partly attributed to foliage depletion leading to larval starvation and subsequent mortality. This occurred in chronically infested stands in areas such as Indian Gardens, Separating Lakes and parts of Sabiston Creek. Additional mortality may have occurred due to depletion of nutrient reserves of early-instar larvae following emergence during a prolonged dry fall in 1987.

Impact

Growth loss and tree mortality associated with budworm defoliation have been variable. Damage appraisal monitoring of long-term study plots in open-growing Douglas-fir stands near Cache Creek indicate that tree mortality averaged 30-40% in 1987, reflecting the 1986 collapse of the infestation in these stands. Diameter increment reduction in mature trees occurred one or two years after the first year of defoliation in 1979, with increment being almost negligible since 1982. Monitoring continues in 64 research plots established in 1986 in Douglas-fir stands in Kamloops TSA which had sustained 0 to 7 years of defoliation. As of 1988, tree mortality averaged 4.9%, but varied from 0 to 75%. A trend of increasing mortality with increasing number of years of defoliation is apparent.

A computer model was developed at PFC, by Dr. Alan Thomson, to calculate budworm impacts on uneven-aged interior Douglas-fir. This model permits the user to simulate the outcome of infestations of varying duration and severity. The program reads inventory plot data and makes two projections, one without budworms and the other assuming a budworm outbreak of a specified duration and severity. The time step in this model is 10 years, with cutting cycles of 10 years.

In a BCFS-Forestry Canada cooperative aerial spray trial, B.t. was applied to Douglas-fir at ultra low volume (ULV) over 150 ha west of Westbank. In Nelson Forest Region, a 500-ha block near Johnstone Creek was aerially sprayed for the third consecutive year by BCFS. Spray trials of previously treated blocks elsewhere in the Kamloops Forest Region by BCFS were discontinued due to low budworm populations in those areas.

Douglas-fir beetle
Dendroctonus pseudotsugae

More than 320 pockets of Douglas-fir beetle infestations were recorded during aerial detection surveys in mid-summer. Recent mortality of mature Douglas-fir was usually restricted to small groups comprised of 5 to 30 trees each. Predisposing factors such as several years of drought and localized severe defoliation by spruce budworm have contributed to the increase in Douglas-fir beetle infestations.

Most infestations were in the Cache Creek and surrounding areas, from Pavilion Lake east to Pass Valley and south to Venables Valley, including Barnes Lake. Three other areas of notable beetle concentration totalling nearly 50 pockets included Deadman River Valley, Louis Creek Valley and the Clearwater-Vavenby area. Small infestations of 3 to 15 trees were common along Seton Lake and at Lytton and Spences Bridge in the Lillooet District; near Red Lake, Fadear Creek, lower Adams Lake, Monte Lake-Paxton Valley, Niskonlith Lake and Barriere-Little Fort areas in the Kamloops District. Some increases in single and multiple attacks also occurred in the Okanagan Valley. Attacks in recent windfalls were common throughout the host range, particularly north of Pavilion and near Tunkwa Lake where infestations were building in scattered windthrown overmature Douglas-fir.

This is the first substantial increase in Douglas-fir beetle activity since the last recorded outbreak, from 1977-79, when trees severely defoliated by Douglas-fir tussock moth were also attacked by beetles.

While the judicious use of trap trees and timely harvesting of infested trees continues in most areas, additional mortality is expected in 1990 due to the beetle buildup, especially in susceptible stands adjacent to present outbreaks and in inaccessible areas where control measures were not possible.

Douglas-fir tussock moth
Orgyia pseudotsugata

Defoliation of single ornamental spruce and Douglas-fir occurred for the second consecutive year in the City of Kamloops, but encompassing a larger area than that previously recorded. Defoliation was not observed in Douglas-fir forests, however, larvae were collected (range 1-39 larvae per standard FIDS sample) for the first time since 1985 between Savona and Chase, Kamloops to Vinsulla, and near Kelowna. The largest collection of larvae was found at Jamieson Creek.

Male moth captures at 18 monitoring locations (Table 8) increased for the fourth consecutive year from an average of 14 in 1988 to 18 per site in 1989. Single sticky traps, to determine distribution, were located at 1- to 2-kilometer intervals from Deadman Creek to Pritchard for the second consecutive year, and for the first time in the Okanagan, from Vernon to Penticton. Moths were captured at 60 of 76 sites and averaged 30 per trap, up from an average of 19 moths at 25 of 33 sites in 1988. Research has shown that trap catches of 25 or more moths per location indicate a potential for visible defoliation within two summers.

Table 8. Number of male Douglas-fir tussock moths caught in pheromone-baited sticky traps at 18 permanent monitoring sites, Kamloops Forest Region, 1989.

TSA and Location	Avg. no. moths per trap 1989	1988	1987
Kamloops TSA			
Carquile	**<1**	<1	0
Battle Cr.	**7**	2	<1
Barnes L.	**<1**	0	<1
Six Mile Ranch	**66**	47	-
Cherry Cr.	**58**	64	24
Stump L.	**<1**	0	0
Heffley Cr.	**6**	<1	0
Monte L.	**17**	4	0
Chase	**4**	0	0
Whispering Pine (Kaneta)	**1**		-
Okanagan TSA			
Winfield	**56**	40	23
Summerland	**0**	2	0
Kaleden	**22**	20	5
Blue L.	**28**	19	2
Vernon	**52**	18	5
Armstrong	**1**	0	<1
Merritt TSA			
Stemwinder Prov. Park	**16**	2	<1
Lillooet TSA			
Pavilion	**0**	<1	0
Average	**18**	14	4

Pheromone traps were also distributed and monitored by BCFS personnel in three districts. Trap catches averaged 8.4, 6.4 and 6.4 moths per trap from Kamloops, Vernon and Merritt districts, respectively, a small increase from 1988.

Egg surveys were conducted in early October at locations where traps contained 25 or more moths each. Only 1 to 4 egg masses per site were found in up to one-hour searches in and adjacent to areas with high trap catches between Savona and Pritchard, at Jamieson Creek and in the Okanagan Valley near Winfield.

The data from 184 pheromone traps, and the low but rising egg mass densities, indicate a potential for limited defoliation occurring in Douglas-fir stands in the Kamloops Region in 1990. Most susceptible are forest stands near Kamloops and Winfield and ornamental or shade trees in urban and rural areas, particularly around Kamloops. Only 7% of larvae were infected by nuclear polyhedrosis virus (NPV) at both Cherry and Jamieson creeks, not enough to substantially reduce population levels next year.

False hemlock looper
Nepytia freemani

Larval populations in Douglas-fir stands increased substantially in parts of the region for the first time since the previous outbreak in 1981-83, but without apparent defoliation.

Larval numbers in standard FIDS samples ranged from 1 to 40, averaging nearly 12 larvae per positive collection. Notable areas of increase include Spences Bridge, Savona to Falkland including Cherry Creek and Pritchard, and north of Kamloops to Barriere, all historically active areas. However, the numbers of larvae and very low egg counts from these areas indicate that there is little chance of defoliation occurring in 1990.

SPRUCE PESTS

Spruce beetle
Dendroctonus rufipennis

Infestations of spruce beetle in mature spruce stands declined for the third consecutive year to 940 ha, from 1450 ha in 1988 and 2930 ha in 1987. Recent mortality was confined mostly to six previously infested stands at Connel, McGillivray and Noel creeks in the Lillooet TSA totalling 905 ha, similar to 1988. Attack densities averaged 20%, but ranged up to 60% towards lower Connel Creek. Older infestations in the Tulameen River drainage declined further to two areas totalling 24 ha, down from 425 ha in 1988. Other localized infestations included more than 100 infested spruce along East Barriere Lake and scattered single trees in upper Harper Creek adjacent to a recent patch of spruce blowdown. Reduction of spruce beetle hazard in this latter area would be contingent upon removal of downed host material. Elsewhere, several small pockets of infestation comprising 5-10 trees each persist along North Kwoiek and Cayoosh creeks in Lillooet TSA.

Spruce beetle infestations most frequently result from populations building in windthrow and slash. This is typically followed by attacks to standing mature spruce. Population control is usually achieved by one or a combination of management practices such as slash reduction, sanitation logging, use of trap trees and pheromone baiting. Natural population control can also occur as a result of host depletion.

Two-year-cycle spruce budworm
Choristoneura biennis

Aerial and ground surveys detected 4140 ha of defoliation in spruce-alpine fir stands, of which nearly 2700 ha were classified as light defoliation and 1440 ha as moderate. This reduction from 44 450 ha in 1988 reflects the predictable nature of the 'off-cycle' period, verified by the lower numbers of mature larvae feeding. The bulk of the larval population will mature in 1990.

Light defoliation by immature larvae totalled over 300 ha west of Barriere along Peterson, Fishtrap and Poison creeks. More than 3800 ha of spruce-fir forest suffered light to moderate defoliation by mature larvae east of Cherryville at Keefer Lake, where about 2000 ha were lightly defoliated in 1988.

Defoliation can be expected in parts of Wells Gray Provincial Park and the upper North Thompson River drainage in stands defoliated in 1988, as budworm larvae in these areas will reach maturity in 1990.

White pine weevil
Pissodes strobi

The distribution and incidence of the white pine weevil (also known as spruce weevil) in Engelmann spruce plantations and natural regeneration was investigated in several areas of the region. In a 30-ha plantation at Upper South Barriere Lake, current (1989) attack was evident on 15% of the terminals. Cumulative years of weevil attack has resulted in slightly more than one-third of the plantation having multiple leaders, cactus tops and occasional dead crowns. Examination of brood revealed a healthy weevil population, but also numerous *Lonchaea* sp. predators.

Elsewhere, 1989 weevil attack affected 5% of advanced regeneration extending several kilometers along Lempriere Creek north of Blue River. Light weevil attack also occurred in a spruce plantation along Fennell Creek and occasional scattered attacks were common in natural regeneration north of TFL 35 in the Beauregard-Allen lakes area.

Surveys of this pest will continue in 1990, with emphasis on locating small isolated stands with light attack, to test enhanced leader clipping techniques.

Enhanced clipping involves placing leaders into buckets or barrels covered with screens to prevent the release of weevils, but allow the escape of associated parasites and predators to enhance biological control in the area. Ongoing research will determine if this method becomes a viable pest management option.

ALPINE FIR PESTS

Western balsam bark beetle
Dryocoetes confusus

Additional aerial surveys into more remote areas of the region are mainly responsible for the increase in area of balsam bark beetle infestation to 310 ha from only 46 ha in 1988. The largest of these, at 250 ha, occurred near Twaal Lake west of Clearwater and consisted of one large infestation and 10 smaller ones. Given the number of dead stems (about 20% of the alpine fir component) the infestation appears to have been chronic in this area for at least 10 years. One other notable infestation occurred near Tranquille Lake where nearly 10% of alpine fir over 50 ha were recently killed. Elsewhere, spot infestations of 1 to 3 ha each were common throughout the region including the upper North Thompson River Valley, Hobson-Clearwater lakes, Perry, Cayoosh and Stein rivers and other smaller drainages of the Fraser River south of Lillooet.

While the area and intensity of attack do not fluctuate dramatically from year to year, consistent and accurate mapping is difficult due to the prolonged retention of red foliage by the trees and the infrequency of aerial surveys in remote subalpine drainages.

Foliage diseases
Pucciniastrum epilobii
Delphinella abietis

Several foliage diseases continued to infect mostly the new growth of true firs at scattered locations in the Kamloops Region. The fir-fireweed rust, *P. epilobii*, infected up to 80% of the 1989 alpine fir foliage throughout the upper Jamieson Creek-Bonaparte Lake area. Similar infection levels occurred on natural regenerated alpine fir growing in several plantations along Otter Creek.

Another needle disease, *D. abietis*, infected an average of 30% of the new growth of alpine fir in stands along the North Thompson River near Adolph Creek. Infections have been common in this area for several years without any apparent adverse effects.

LARCH PESTS

Larch needle blight
Hypodermella laricis

H. laricis infections declined to only small scattered pockets of foliage discoloration from 1200 ha in 1988. Light to moderate infections were sporadic from Deep Creek to Sicamous, Cherryville to Keefer Lake Road, and along Coldstream Road. Foliage browning was light between Yard Creek and Sicamous, Mabel Lake to Shuswap Falls, and at Chute Lake, Little White Mountain, McCulloch Lake, Dale Creek and Okanagan Falls roads, where infections were more extensive in 1988.

Infection severities depend substantially on weather conditions during spring sporulation, which coincides with bud break on the larch trees. If conditions are wet during this period in 1990, the existing inoculum may promote increased infections.

MULTIPLE HOST PESTS

Black army cutworm
Actebia fennica

There were no reports of larvae or damage anywhere in the region; however, moths were caught in pheromone-baited traps supplied by Forestry Canada and placed by the B.C.F.S. in the Clearwater Forest District. Although the results from sticky traps were inconclusive, an average of 60 male moths were caught in each of 15 Multipher® traps confirming a low population level.

Building on earlier studies by R. Shepherd in cooperation with FIDS, a contract to develop a predictive warning system linking moth catches in non-sticky pheromone traps with subsequent defoliation and a seedling and vegetation damage index, completed its third and final year of field studies. A report is being compiled.

Climatic injury

A combination of unusually cold temperatures and strong winds in late January and early February caused extensive winter damage throughout the Kamloops Region in 1989. The symptoms included dead buds on branches and leaders in the upper crowns of larger trees and severe bud-kill and discoloration of foliage in crowns above the snowline in younger trees in plantations. Another effect was foliage desiccation and occasional tree mortality, mostly on roadside Douglas-fir, lodgepole pine and ponderosa pine.

Most notable areas of winter injury include roadside damage along Highland Valley, parts of the Fraser Canyon near Lytton, Lillooet to Gold Bridge, Knutsford, and Monte Creek to Sicamous, including the north shore of Shuswap Lake. Severe discoloration was also prominent over extensive areas of cedar in the North Thompson River drainage, particularly in Wells Gray Provincial Park and near Vavenby. Western hemlock regeneration was also frequently discolored in these same areas.

While road salt was associated with roadside damage in some areas, the main factor was the rapid soil drainage in conjunction with cold dry winds depleting foliage moisture which could not be replaced. Premature needle drop of the inner crowns was also observed on many conifers in plantations and forest stands. The extent and severity of damage varied from place to place and between trees, indicating possible genetic differences in both natural and planted trees.

Except where occasional mortality occurred along roadsides, most trees are expected to recover although some may develop crooks, forks or multiple tops.

Rhizina root disease
Rhizina undulata

The fruiting bodies of *R. undulata* were found widely scattered over more than 80 ha in a recently burned and planted area of TFL 18, west of Clearwater. While sporophores were common, there was no evidence of infection on planted lodgepole pine seedlings that had died. The occurrence of substantial seedling mortality, which was restricted to a particular seed lot, may have been the result of planting shock or some other physiological condition. No other occurrences of Rhizina root disease were observed or reported in the region in 1989. However, in the Nelson and Prince Rupert forest regions, *R. undulata* infected and killed newly planted conifer seedlings in 37 of 72 burned sites. This was the second consecutive year of seedling mortality caused by Rhizina root disease since it was first recorded in B.C. 20 years ago.

The increase in the abundance of fruiting bodies observed in 1989 could produce additional inoculum capable of infecting more sites in 1990, but there is no reliable method of prediction.

Seed orchard pests

The most common pests found in seed orchards this year were adelgids and aphids at Skimikin and Heffley Creek (Balco-Canfor) seed orchards. At Heffley Creek, a spruce twig aphid, *Mindarus obliquus* moderately to severely infested 65% of the new growth of Central Interior Plateau and Smithers white spruce provenances. Trees were subsequently treated with an insecticidal soap. At Skimikin 42% of high- and low-elevation provenances of white spruce were severely galled by Cooley spruce gall adelgid, *Adelges cooleyi* and a spruce gall adelgid, *Pineus* sp., while 35% were moderately and 23% lightly infested. Another adelgid on white pine was common on severely reddened foliage infected with *Sclerophoma* sp. in the same seed orchard. This damage was associated with winter injury. Western spruce budworm, *Choristoneura occidentalis*, larval feeding on lodgepole pine rooted cuttings and seedlings, distorted lateral and terminal shoots on 5% of seedlings at Skimikin. The unusual occurrence of budworm larvae in these beds was attributed to their proximity to infested stands.

Assessments of cone and seed insects and diseases in natural stands was de-emphasized in the Pacific Region in 1989, partially due to the conclusion of a research study at Pacific Forestry Centre.

PESTS OF YOUNG STANDS

Surveys of 10- to 25-year-old stands were completed in mid-summer, comprising more than 1300 trees in 122 plots at 11 locations. This was part of a continuing evaluation of major pests and environmentally related problems and their impact on both naturally regenerated and planted areas. A minimum of 100 trees were assessed in 10 or more fixed-radius plots located at 50-m intervals along transect lines in each location.

Table 9. Summary of pests of young stands, Kamloops Forest Region, 1989.

Host/Pest	Number of stands examined	Number of stands affected	Percent of trees affected	Remarks
LODGEPOLE PINE	8			
Armillaria root rot, *Armillaria* sp.		4	3	Occasional small foci; minor impact at present.
Western gall rust, *Endocronartium harknessii*		2	25	Majority of galling was on branches. 43% and 8% of trees infected at Mayson Lake and Blue River, respectively.
Animal damage		3	25	Debarking injury by squirrels on lower stems of 44% of trees near Whitewood Lake; partial callousing. Minor breakage from cattle at Johnson Lake.
A secondary needle fungus, *Hendersonia pinicola*		1	12	A hyperparasite of *Lophodermella concolor* affecting 30% of foliage near Blue River.
Pine needle sheathminer, *Zelleria haimbachi*		1	25	Discoloration of 60% of new growth at Adams Lake.
DOUGLAS-FIR	8			
Armillaria root rot, *Armillaria* sp.		5	8	Occasional small foci. Heaviest infection of 21% near Km 51 - Adams Lake.
Rhabdocline needle cast, *Rhabdocline pseudotsugae*		2	30	Average 10% foliage infection on 30% of trees at Queest Creek.
Western spruce budworm, *Choristoneura occidentalis*		2	40	Light defoliation of current growth on 50% of stand.
Cooley spruce gall adelgid, *Adelges cooleyi*		1	20	Some minor needle mottling.

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Host/Pest	Number of stands examined	affected	Percent of trees affected	Remarks
ENGELMANN SPRUCE	10			
Spruce adelgids, Adelges cooleyi and Pineus sp.		8	75	Mostly moderate branch galling - average 2 galls/branch. Heaviest infestations of 92% incidence at Fennell and Otter creeks.
White pine terminal weevil, Pissodes strobi		2	30	Old and new attacks causing dead tops, multiple leaders and cactus tops at Upper South Barriere Lake and Fennell Creek.
Frost damage		1	35	50% desiccation of new growth at Blue River.
WHITE PINE	7			
White pine blister rust, Cronartium ribicola		2	13	Recent and advanced branch and stem infections. Some tree mortality.
WESTERN HEMLOCK, WESTERN RED CEDAR	8			
Winter damage		6	77	Average 40% foliage reddening. No permanent damage expected.

DECIDUOUS TREE PESTS

Tent caterpillars
Malacosoma spp.

Defoliation of trembling aspen occurred on more than 1000 ha in the Kamloops Region. The largest infestation occurred south of Clearwater where 750 ha of aspen were moderately defoliated. West of Ashcroft two stands totalling 60 ha were severely stripped along Cornwall Creek and upper Hat Creek Valley. One isolated pocket of moderate defoliation was observed on 30 ha along the upper Deadman River and in three areas east of Kamloops near Pritchard, Louis Creek and along Paxton Valley, a total of over 170 ha. In the north Okanagan Valley some light feeding damage occurred on deciduous roadside trees east of Salmon Arm, between Enderby and Vernon and from Vernon to Falkland.

Based on some cursory ground observations and historical data, populations are expected to be maintained in 1990.

Apple ermine moth
Yponomeuta malinella

Detection surveys identified apple ermine moth for the first time in Kamloops Region in 1989. This serious pest of apple trees, introduced to North America from Europe, was found for the first time in B.C. at Duncan in 1981. Since then it has spread eastward through the Fraser Valley and into Kamloops Region. Here it has been found as far north as Little Fort and as far east as Perry River, causing only minimal damage in old orchards and other unsprayed trees. No evidence of this pest has been found in the Okanagan to date, but surveys will continue in 1990 to help identify its distribution.

Gypsy moth
Lymantria dispar

In cooperation with Agriculture Canada (Plant Health) and the B.C.F.S., the gypsy moth trapping program continued for the fourteenth year in the Kamloops Region. Pheromone-baited sticky traps were located at 41 locations in provincial and municipal parks and on Department of National Defence property. All FIDS traps were negative, but one adult was captured by Agriculture Canada at Kelowna.

There were no aerial or ground applications of *Bacillus thuringiensis* (B.t.) in 1989, following successful applications in 1988 at Kelowna.

OTHER NOTEWORTHY PESTS
CURRENTLY ACTIVE IN THE KAMLOOPS FOREST REGION, 1989

Pest	Host[1]	Location	Remarks
European leaf roller, *Archips rosanus*	Apple	general	Common on roadside apple and occasional willow. Light defoliation.
Fall webworm, *Hyphantria cunea*	roadside trees and shrubs	general	Scattered light to moderate defoliation.
Western false hemlock looper, *Nepytia freemani*	D-fir	Kamloops	Increased larval populations; isolated light defoliation expected in 1990.
Fir-fireweed rust, *Pucciniastrum epilobii*	alF	N. Thompson River Valley	Scattered occurrence. Up to 100% incidence and 30% foliage infection.
Gouty pitch midge, *Cecidomyia piniinopis*	pP	Lytton, Kanaka Bar	Infested shoots common on regeneration.
Herbicide damage	D-fir pP, lP	Pat Lake, Dairy Creek, Duck Meadow, Clearwater	Distorted needles, stems, terminals and mortality of young growth. Over-spray from knapweed control.
Larch needle cast, *Meria laricis*	wL	Queest Creek	Average 30% foliage infection in young mixed stands.
Larch budmoth, *Zeiraphera improbana*	wL	McKinney Creek Road	Light defoliation over 10 ha.
A larch tip blight, *Lachnellula calyciformis*	wL	Harper Lake	New host record. Causing localized infections.
A needle disease, *Sclerophoma* sp.	wP	Skimikin	Causing needle blight in seed orchard following winter injury.
Poplar and willow borer, *Cryptorhynchus lapathi*	B, W	Pritchard	Common in young stands in area.
Poplar twig and shoot blight, *Venturia macularis*	tA	Pavilion Lake	Moderate to heavy browning on 20 trees; less severe than 1988.

Pest	Host[1]	Location	Remarks
Satin moth, *Leucoma salicis*	deciduous	Clearwater	No defoliation, but adults and egg masses found.
Tomentosus root disease, *Inonotus tomentosus*	eS	Barriere	Occasional small foci. Increased evidence of more widespread distribution.
Western hemlock looper, *Lambdina f. lugubrosa*	wH, wC	Blue River, Lempriere Sta.	Increase, but still low populations.

[1]alF - alpine fir; B - birch; D-fir - Douglas-fir; eS - Engelmann spruce; lP - lodgepole pine; pP - ponderosa pine; tA - trembling aspen; W - willow; wC - western red cedar; wH - western hemlock; wL - western larch; wP - white pine.

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