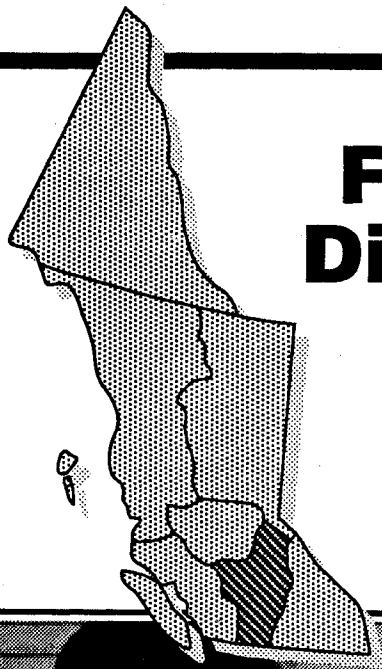
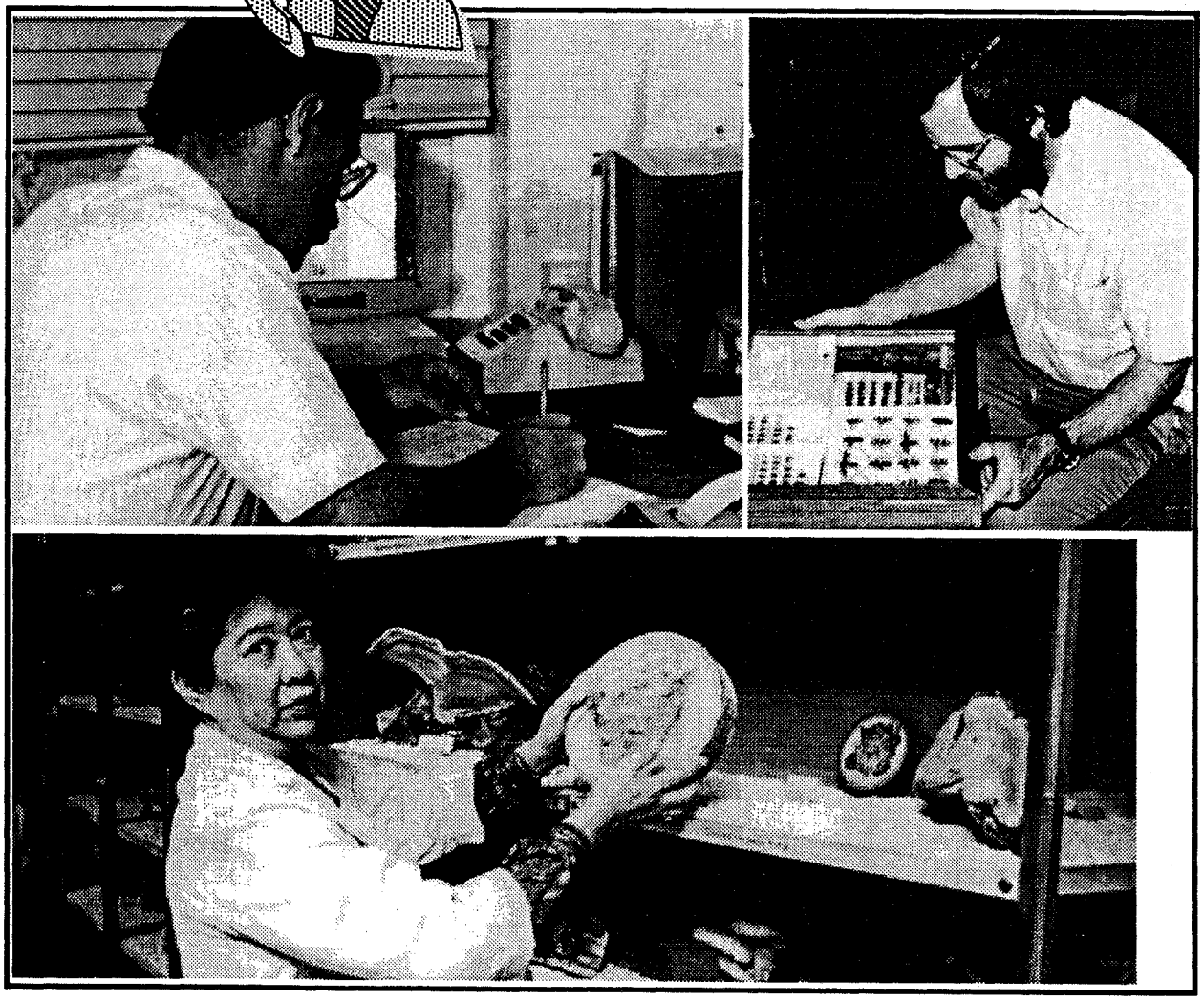


Forest Insect and Disease Conditions

Kamloops Forest Region
1991

H.P. Koot & J. Hodge



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APPENDICES

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

I. Maps of major 1991 beetle and defoliator infestations in the Kamloops Forest Region.

II. Pest Report: Western spruce budworm in the Kamloops, Nelson, and Vancouver Forest Regions, June 1991. J. Hodge, H.P. Koot, A. Stewart, R. Turnquist, C. Wood.

III. Pest Report: Western hemlock looper in the Clearwater Forest District, Kamloops Forest Region, August 1991. H.P. Koot.

IV. Pest Report: Summary of forest pest conditions, Kamloops Forest Region, September 1991. H.P. Koot and J. Hodge.

V. Pest Report: Western spruce budworm in British Columbia 1991 and forecast for 1992, November 1991. J. Hodge.

VI. Pest Report: Douglas-fir tussock moth in the Kamloops Forest Region, November 1991. H.P. Koot and J. Hodge.

VII. Pest Report: Western hemlock looper in British Columbia 1991 and forecast for 1992, December 1991. A. Stewart, H.P. Koot, R.D. Erickson.

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 1991, 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 November. A total of 386 insect and disease collections were submitted for identification and verification to the Pacific Forestry Centre. Provincial government agencies, industry, and private sources submitted additional insect and disease collections. Approximately 286 contacts and on-site pest examinations were made with personnel from the British Columbia Forest Service (BCFS), other government agencies, the forest industry, educational institutions and private individuals. Their cooperation is essential to effectively fulfill these responsibilities and is greatly appreciated. Special thanks are extended to the BCFS for the provision of 79 hours of fixed-wing aerial survey time and assistance in producing preliminary regional sketch maps. The area covered by the aerial survey 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 completed stripped;

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

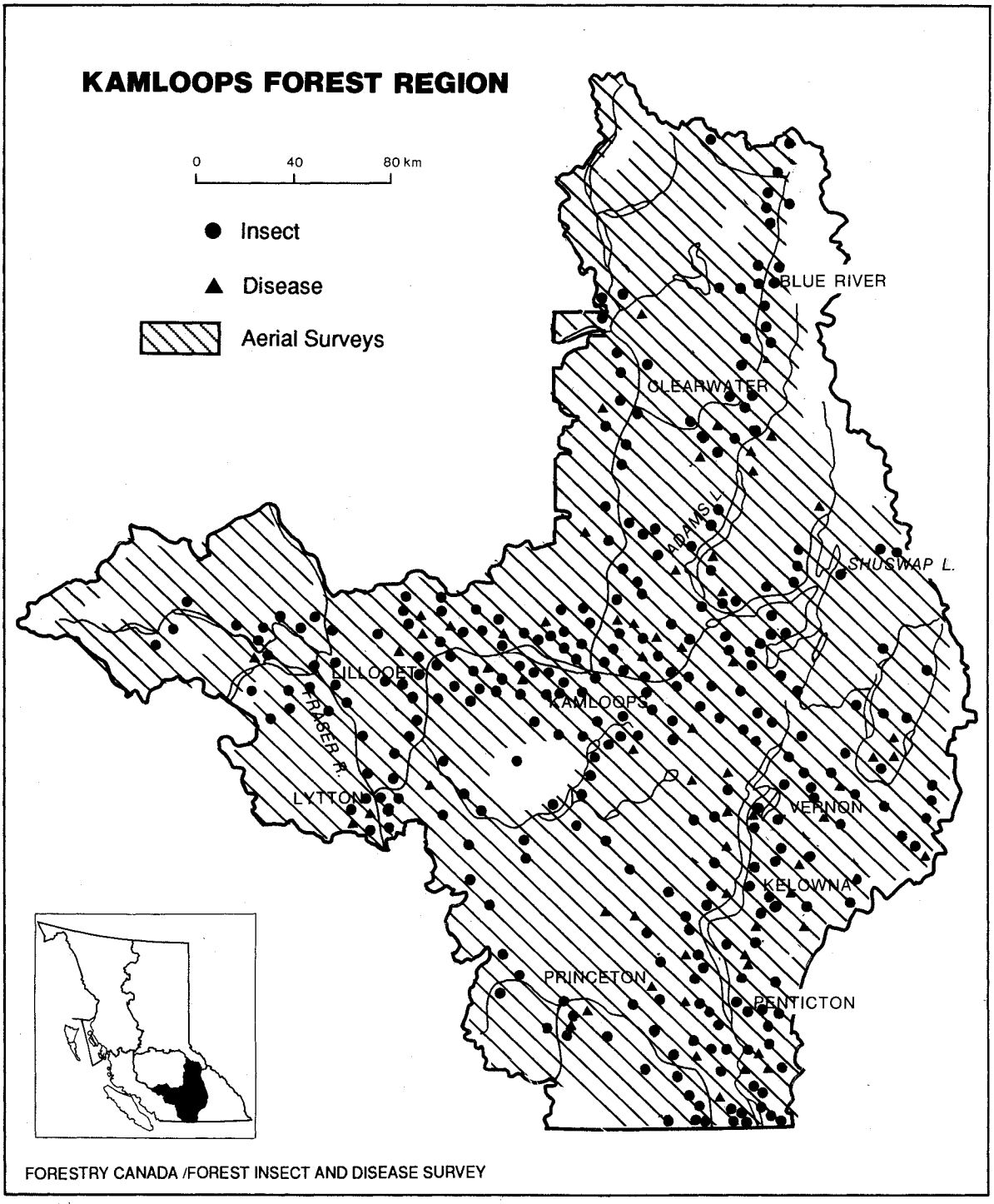
During the FIDS field season from May to October, correspondence can be directed to:

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
R.R. # 4 Site 92
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 Rd.
Victoria, B.C.
V8Z 1M5 Ph. 363-0717

Additional copies of this report or related publications such as provincial and national pest survey overviews, forest pest leaflets, and regional forest pest histories, can be obtained from FIDS at the above address.



Map 1. Location where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map pest damage in 1991.

SUMMARY

The most damaging pest in the region continued to be **mountain pine beetle,** which killed an estimated 3.5 million lodgepole pine and white pine over 19 000 ha, the majority of which occurred in the Okanagan TSA. This marks the first increase since 1984, when infestations extended over 58 000 ha. **Pine needle sheathminer** outbreaks declined to 11 700 ha in 52 separate areas, from 26 000 ha in 144 infestations in 1990. Extensive sampling for detection of **pinewood nematode** has shown it to be rare in British Columbia forests. Urban populations of **European pine shoot moth** in the Okanagan remained similar to 1990, causing damage to approximately 40% of the new shoots on Mugho and Scots pine. Pine needle diseases, including those caused by **Lophodermella concolor**, **Lophodermium pinastri**, and **winter flecking** continued over widespread areas.

Infestations of **western spruce budworm** in Douglas-fir stands, increased in both size and intensity, defoliating 386 000 ha, up from 193 000 ha in 1990. **Douglas-fir beetle** infestations increased two-fold to 700 pockets of 5 to 30 trees each, recorded during aerial surveys. Increased numbers of **Douglas-fir tussock moth** larvae, moths and egg masses were recorded in both forested stands and urban locations in the Thompson and Okanagan valleys. Eight small patches of severe defoliation totalled 135 ha between Kamloops and Savona. Larval populations of **western false hemlock looper** increased throughout the IDF and PP biogeoclimatic zones, and caused trace to light defoliation in several small areas near Savona in association with Douglas-fir tussock moth.

Infestations of **spruce beetle** declined to 335 ha from 1 000 ha in 1990, in the Lillooet, Kamloops and Merritt TSAs. Mature 'off-cycle' **two-year-cycle spruce budworm** larvae defoliated 6 775 ha of alpine fir and spruce in 11 areas between Keefer and Sugar lakes east of Lumby, twice the area defoliated in 1990 at the same location.

Alpine fir stands infested with **western balsam bark beetle** were detected during aerial surveys on 1710 ha, up from 1 000 ha in 1990. The largest outbreaks were at Taweel Lake, Blanc and Wentworth creeks.

Larch casebearer populations caused light to moderate defoliation of western larch in several previously infested areas in the Okanagan Valley and near Sicamous. **Larch needle blight** increased in incidence and intensity east of Vernon where 3 825 ha were discolored.

Root disease surveys emphasized increased distribution sampling for **blackstain** and **tomentosus root rots** north of Kamloops. Populations of **black army cutworm** remained at low levels with no larvae or damage reported. **Ground squirrels** were responsible for uprooting lodgepole pine seedlings near Coldscaur Lake and Barriere Mountain. No symptoms of damage from acid or toxic rain were found in the permanent **Acid Rain National Early Warning System (ARNEWS)** plot near Twin Lakes, only the effects of spruce budworm defoliation on Douglas-fir.

Pests of Young Stands surveys of 1989/90 FRDA-treatments, were completed in mid-summer, comprising 5 686 trees in 494 plots at 43 locations. Less than 5% of the trees sampled were in severity categories which indicated future tree mortality or long term growth loss. These losses were mostly attributed to **stem diseases** on pine, **abiotic factors** on multiple hosts, and to a lesser extent

weevils and **mammals** on pine. The most frequent pests encountered were **needle diseases**, particularly **Lophodermella concolor** on lodgepole pine, and **adelgids** on spruce and Douglas-fir. Sixty-three percent of trees were pest free.

Of the deciduous pests, **forest tent caterpillar** was the most damaging. Defoliation of trembling aspen, black cottonwood, birch and willow doubled to 6 500 ha, the third consecutive year of damage, mostly in the North Thompson Valley. No **Gypsy moth** adults were captured in any of 39 pheromone-baited traps distributed throughout the provincial park system in Kamloops Region.

PINE PESTS

Mountain Pine Beetle
Dendroctonus ponderosae

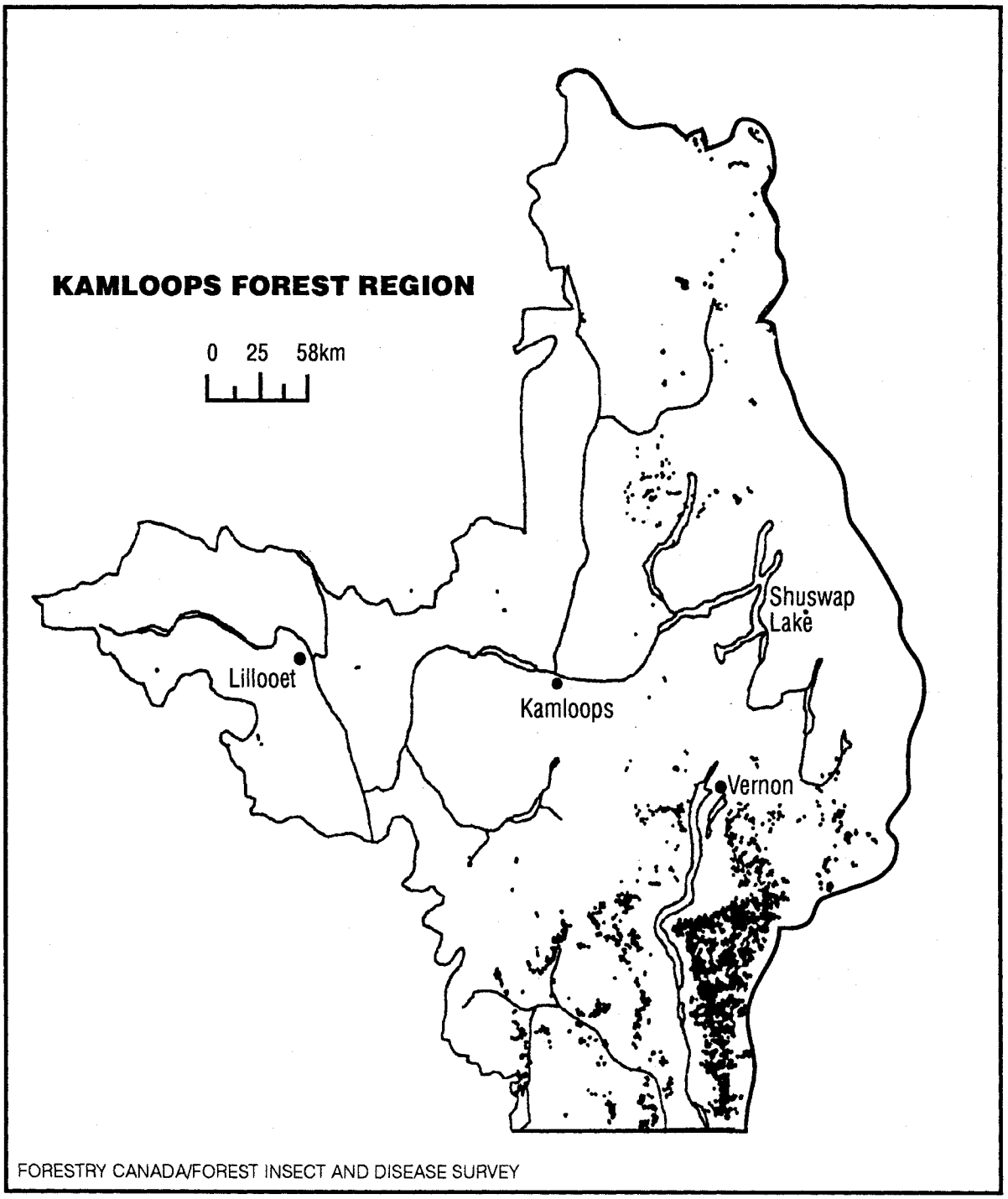
The area of mountain pine beetle infestations more than doubled to 18 975 ha, up from 7 900 ha in 1990, leading to mortality of an estimated 3 519 650 lodgepole pine and white pine representing volume losses of 1 368 200 m^3 (Map 2, Table 1). This marks the first increase since 1984 when populations reached a peak of 58 000 ha (Figure 1).

The majority of the outbreak remains in the Okanagan TSA, accounting for 86% of the total infested area, with the remainder in the Merritt, Kamloops and Lillooet TSA's (Table 2). Beetle activity in the Okanagan TSA was directly related to the management strategies and tactics within Beetle Management Units, with significant increases occurring in the Stirling Creek-Vaseux Creek and Anarchist Mountain area where only salvage strategies exist. Infestations in other TSA's were generally small and scattered with a few larger pockets.

Table 1. Recent pine mortality (red) caused by mountain pine beetle as determined from aerial and ground surveys, Kamloops Forest Region, 1991.

TSA	Tree species[1]	Number of infestations	Area (ha)	Number of trees killed	Volume of trees killed (m^3)
Kamloops	lP,wP	153	1 808	51 500	36 500
Lillooet	lP,wP	8	2	300	150
Okanagan	lP	2 118	16 453	3 360 300	1 277 800
Merritt	lP	406	712	107 550	53 750
Totals		2 685	18 975	3 519 650	1 368 200

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



Map 2. Areas of pine recently killed by mountain pine beetle as determined by aerial and ground surveys,1991.

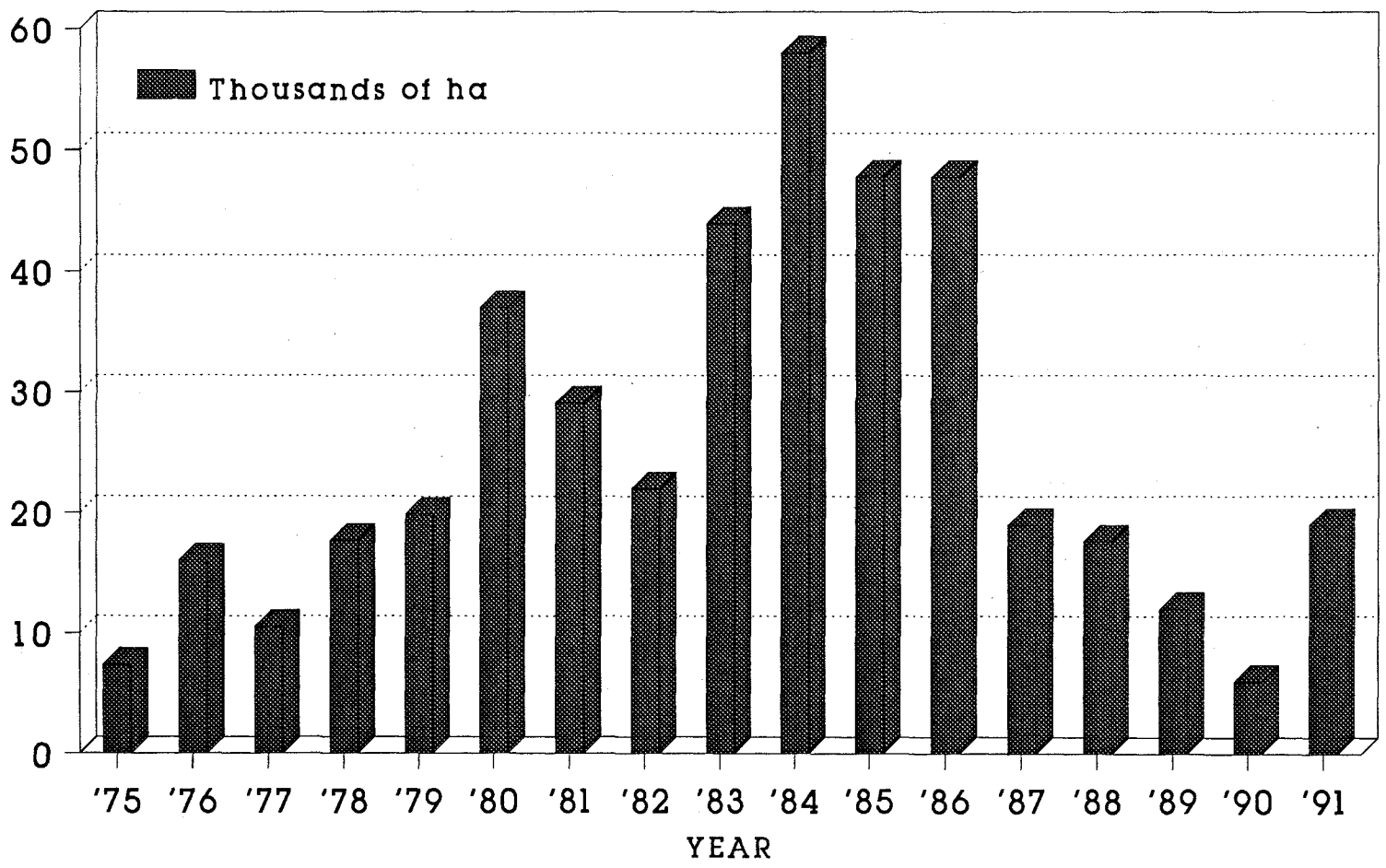

MOUNTAIN PINE BEETLE 1975-1991
KAMLOOPS REGION
Thousands of ha
60
50
40
30
20
10
0
'75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90 '91
YEAR
FORESTRY CANADA/FOREST INSECT AND DISEASE SURVEY

Figure 1.

Table 2. Major mountain pine beetle infestations, Kamloops Forest Region, 1991.

TSA and Location	Red 1991[1] (ha)	Red 1990 (ha)	Change 1990-91(ha)
Kamloops TSA			
Barriere Lakes-Fennel Creek	74	7	+ 67
Vavenby-Albreda	1 290	550	+ 740
Adams Lake-Adams River	440	20	+ 420
Kamloops	1	1	
Mahood Lake	1	1	-
Paxton Valley	2	0	+ 2
Subtotal	1 808	579	+1 229
Okanagan TSA			
Yard Creek	30	3	+ 27
Shorts Creek-Falkland	160	5	+ 155
Coldstream	4	2	- 2
Lumby-Ferry Cr-Sugar Lake	175	15	+ 160
Upper Kettle River	400	70	+ 330
Mission-Belgo-Daves Creek	110	70	+ 40
Ideal Lake-Vernon	135	80	+ 55
Dale Creek-Campbell Creek	1 980	1 430	+ 550
Penticton Creek-Chute Lake	1 960	570	+1 390
Hydraulic Lake-Lebanon Lake	2 490	1 220	+1 270
Lambly Lake-Brenda Lake Mine	17	40	- 23
Okanagan Mountain Park	460	275	+ 185
Trout Creek-Summerland	875	650	+ 225
Vaseux Creek-Saunier Creek	4 975	2 120	+2 855
Inkaneep Creek	1 100	180	+ 920
Shoudy Creek-Ollala	800	215	+ 585
Yellow Lake-Fairleigh Lake	350	90	+ 260
Cathedral Park-Ewart Creek	400	-	+ 400
Monte Lake-Adams Lake	30	1	+ 29
Humamilt Lake-Seymour Arm	4	1	+ 1
Subtotal	16 453	7 037	+9 412
Merritt TSA			
Hayes Creek-Trout Creek	243	150	+ 93
Bromley Rock-Manning Park	391	160	+ 231
Coquihalla-Kingsvale	1	0	+ 1
Tulameen-Aspen Grove	77	0	+ 77
Subtotal	712	310	+ 402

(Cont'd)

Table 2. (Cont'd)

TSA and Location	Red 1991[1] (ha)	Red 1990 (ha)	Change 1990-91(ha)
Lillooet TSA			
Duffey Lake - Cayoosh Creek	2	-	+ 2
Subtotal	2	-	+ 2
TOTAL	**18 975**	**7926**	**+11 450**

[1] Trees attacked in 1990, discolored in 1991

DAMAGE

Kamloops TSA

Populations of mountain pine beetle tripled to 1800 ha, killing an estimated 51 500 trees with 36 500 m^3 in volume losses. These increases occurred in lodgepole pine in the headwaters of the North Thompson River, near Pleasant Creek and on western white pine near Momich Lake where the infestation expanded to 800 trees. Spot infestations on white pine also increased in the Barriere Lakes area. Infestations near Albreda and in Wells Gray Park remained the same size, however the intensity levels decreased due to depletion of host material.

Okanagan TSA

The area of infestation increased causing mortality of approximately 3 360 000 trees over 16 400 ha, totalling 1 300 000 m3 in volume losses (Table 2). Beetle activity in the TSA seemed to be directly linked to the beetle management strategy for a given area.

Despite management tactics aimed at controlling beetle populations, infestations continued or increased, as indicated by the "R" values in the spring of 1991. As expected, the most significant increases occurred in those areas where salvage strategy for mountain pine beetle management was implemented. This type of management is undertaken in areas with extensive outbreaks, characterized by a high proportion of red and gray attack, where suppressive beetle management exceeds the available resources or where access is planned or possible within five years (Safranyik and Hall, 1990). The potential for population increases exists in these areas and was most apparent from Penticton Creek to Lebanon Lake and east to Hydraulic Lake (+2600 ha), and the Saunier-Vaseux-Inkaneep Creek drainages (+3800 ha). Increases were attributed to coalescing of previous and new spot and patch infestations.

Elsewhere, suppression and/or maintain low management strategies have reduced the beetle risk and increases have been minimal given the increasing beetle population in 1991. Tactics employed under these strategies include aggressive harvesting of all infested polygons, single tree treatments and extensive semio-chemical programs. These areas include all Beetle Management Units (B.M.U.'s) within Vernon District as well as the Ashnola, Nickel Plate, Trout Creek, Barton Hills, Mission Creek and Oliver (excluding Anarchist Mountain) B.M.U.'s in the Penticton District. The only decrease occurred in the Lambly Lake-Brenda Lake Mine area where suppression activities are being practiced.

Merritt TSA

The area infested by mountain pine beetle increased to 712 ha from 310 ha recorded in 1990, causing mortality of approximately 107 550 lodgepole pine and volume losses of 53 750 m^3. Large patches in the Hedley, Spukunne, Hayes and John Creek drainages combined with increased spot infestations of 5-30 trees in the Rampart, Paul, Willis and Pasayten creek drainages were responsible for the increase in area. Suppressive or maintain low management strategies throughout the TSA have effectively reduced the beetle risk.

Lillooet TSA

Infestations in Lillooet TSA comprised only a few hectares, similar to 1990. Spot infestations in lodgepole and white pine continued to persist near Duffey Lake and along Cayoosh Creek where control options are restricted by steep terrain.

FORECAST

In order to determine beetle population trends, two types of surveys are conducted annually in areas of infestation. Overwintering brood assessments ("R" value) surveys were conducted in the spring. They are used to estimate brood mortality and determine health and vigor of progeny. These results are supplemented with fall surveys which determine current attack and help estimate volume losses and infestation trends. Based on overwintering brood assessments, completed at 7 locations in the Okanagan and Merritt TSA's, and fall surveys conducted at 5 locations in the Okanagan TSA, populations appear to be static to declining (Table 3).

Average "R" value decreased to 2.1, indicating declining populations, from an average of 13.2 in 1990. An "R" value of 4.1 at Mosquito Lake, indicates populations will increase, however single tree treatment in this area could suppress beetle activity. Increasing populations are also expected at Lebanon Lake where an "R" value of 5.0 was determined in the fall. Holding action activities in this area could alleviate population growth somewhat, however the abandon strategy in the adjacent area (Okanagan Mountain Park) acts as a reservoir for beetles and could help maintain the existing population.

Table 3. Mountain pine beetle reproductive ratios and overwintering survival, Kamloops Forest Region, spring 1991.

Location	"R" value[1]	Population status[2]	Overwinter survival
Okanagan TSA			
Mosquito Lake	4.1	increasing	35%
King Edward Lake	0.2	decreasing	1%
Ellis Creek	0.5	decreasing	4%
Idleback Lake	0.6	decreasing	6%
Lebanon Lake	5.0	increasing	49%
Gregoire Creek	0.7	decreasing	7%
Merritt TSA			
Whistle Creek	3.9	static	54%

[1] "R" $= \frac{\text{sum of } (a+b/c)}{\text{no. of trees examined}}$

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

As expected poor overwintering survival (average 22%), due to small diameters of host material and low temperatures, led to reduced current attack rates. Of the 5 surveys completed this fall, only that at Chute Lake showed a greater than 1:1 ratio of current to red attack (Table 4). Reduced availability of large diameter pine may hinder beetle population growth. According to fall surveys the largest diameter trees within the stands examined have already been attacked.

In summary, reduction of beetle hazard accomplished through various management strategies combined with natural factors i.e. poor overwinter survival and depletion of desirable host material, should lead to decreasing beetle populations. These decreases should be most evident in those areas where management strategies have had the least affect on population dynamics i.e.salvage logging areas.

Table 4. Mountain pine beetle cruise data, Kamloops Forest Region, 1991.

Location/TSA	Percent of pine attacked						Total volume (m^3/ha)
	Healthy	Current attack (1991)	Partial attack (1991)	Red (1990)	Grey (pre-1989)	Total	
Okanagan TSA							
Shorts Creek	94	3	<1	<1	<1	100	371
Bull Creek	85	5	-	8	2	100	300
Chute Lake	68	14	1	12	5	100	330
Venner Meadows	83	3	-	13	1	100	285
Snehumption Creek	36	24	5	25	10	100	349

Pine needle sheathminer
Zelleria haimbachi

The outbreak of pine needle sheathminer in lodgepole pine stands declined to 11 680 ha in 52 separate infestations, from 26 625 ha in 144 areas in 1990 and follows five consecutive years of defoliation in localized areas. In addition, mixed stands of lodgepole pine and Douglas-fir were moderately to severely defoliated over 13 460 ha by both the sheathminer and western spruce budworm at 12 locations, mostly between Monte Lake and Salmon Arm and near Chase.

Moderate discoloration occurred on 5800 ha in 19 areas along the North Thompson River Valley near Barriere, Clearwater, Avola, Vavenby, the Adams Lake area, between Paxton Valley and Chase, the Salmon River Valley and north of Kelowna. Areas of lightly discolored pine covered nearly 5900 ha in 33 locations including, Vavenby to Avola, Raft and Adams rivers, and scattered areas between Monte Lake and Salmon Arm, where some of the most notable expansion occurred in mixed stands in association with spruce budworm. Ground observations noted moderate to severe defoliation of a young pine plantation along Lambly Creek near Kelowna. Elsewhere, mined shoots and discoloration, not visible aerially, were common in many parts of the host range, including the Barriere lakes area and along both sides of Adams Lake, where light to moderate defoliation was detected in 1990. Infestations also declined along the Raft River and along the Clearwater River in Wells Gray Park.

No overwintering population assessments were completed, but infested stands are expected to recover. Generally, pine needle sheathminer is of limited economic importance. Some minor branch dieback may occur in those areas having experienced several years of moderate and occasionally severe defoliation. Tree mortality has not been observed in B.C., but minor branch dieback has been reported in areas of recurring 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.

Pinewood nematode
Bursaphelenchus xylophilus

After examination of over 2000 samples of trees, logs, lumber, and potential insect vectors since 1980, more than 200 of which were in the Kamloops Region, this nematode has shown to be rare in British Columbia forests.

In 1991, special attention was directed to support pinewood nematode research at Pacific Forestry Centre. This involved a cooperative trial to control this nematode and the potential woodborer vector, Monochamus spp. by heat treatment, as an alternative to kiln drying. Potential sites with infested wood material were identified at Kamloops, Merritt and Salmon Arm mill sites, however, suitable logs were subsequently obtained at a site near Squamish. Results of the heat pasteurization trial conducted at this location were not yet available at the time of this writing.

European pine shoot moth
Rhyacionia buoliana

Shoot moth populations on Mugho and Scots pines remained at levels similar to 1990 at Trinity Centre in Penticton. About 40% of the shoots were infested in each of 25 trees examined. Attempted control by pruning of infested shoots several years ago, has not been very effective. At Okanagan College, populations declined slightly, with about 20% of shoots the infested.

Feeding by this moth leads to deformed and stunted trees, but rarely to tree mortality. At this time, many years after it's introduction into B.C., the insect continues to be a pest of urban ornamental plantings and has not been found in natural stands. Surveys in 1989 detected the shoot moth on Douglas-fir in a Christmas tree plantation at Richmond in the Vancouver Region. This is the first record on this host in North America. However, this is seen as an isolated case, and is probably due to the close proximity of numerous infested Scots pine.

Pine needle diseases
Lophodermella concolor
Lophodermium pinastri
Winter flecking

Infection of pine needles by native diseases continued over widespread areas throughout the range of primarily lodgepole pine in the Kamloops Region.

Similar to last year, infection of year-old foliage by Lophodermella concolor, was common throughout many lodgepole pine stands in the region. Foliage infection with intensities as high as 100% occurred on roadside regeneration and along the fringes of mature stands in the Okanagan Valley and adjacent areas east of Kelowna, west of Peachland and Summerland and south of Merritt. From samples obtained at 13 locations, incidence of infection varied from 100% over small patches of roadside trees and blocks of immature stands to 20% incidence over several hundred hectares. In the North Thompson Valley, nearly half the foliage was infected on 80% of lodgepole pine in several

plantations near Blue River, and similarly at two locations east of Lillooet near Marshall, Mud, and Hurley creeks. A secondary invader, Hendersonia pinicola, was frequently found in association with L. concolor. Some increment loss can be expected during epidemics.

The pine needle blight fungus, L. pinastri, caused severe mid-crown discoloration of western white pine along roadsides between Avola and Albreda. Reddening of the older foliage was most severe near Bone Creek where up to 70% of the foliage was affected in scattered patches. Epidemics of needle blights last 1-3 years and only small and weak trees succumb to the disease.

Winter flecking of foliage caused by the action of sunlight on frozen water droplets, was also common on white pine in the same area.

Other foliage diseases, such as red band and Elytroderma needle diseases reported on last year, were less noticeable in 1991 and not as widespread.

DOUGLAS-FIR PESTS

Western spruce budworm
Choristoneura occidentalis

Infestations of western spruce budworm increased in both size and intensity in the Kamloops Region, defoliating 386 000 ha (Map 3, Table 5), up from 193 000 ha in 1990, but less than the peak of over 800 000 ha in 1987 (Fig. 2). This includes, mixed stands of Douglas-fir and lodgepole pine over 13 500 ha defoliated by budworm in association with pine needle sheathminer. Severe defoliation in Kamloops Region accounted for 13% of the area infested as compared to only 2% in 1990.

Table 5. Location and area of Douglas-fir defoliated by western spruce budworm as determined from aerial and ground surveys, Kamloops Forest Region, 1990 and 1991.

Location	Area of defoliation (ha)						
	Light		Moderate		Severe		Total
	1990	1991	1990	1991	1990	1991	1991
Okanagan TSA							
Shuswap Lake-Salmon Arm-Enderby-Monte Lake	15 050	23 500	18 050	22 100	250	4 100	49 700
Falkland-Armstrong-Lumby-Vernon-Okanagan Lake (N.)	23 450	9 700	22 200	46 800	1 350	10 900	67 400
Kelowna-Penticton (E.and W. sides Okanagan Lake)	20 000	4 300	17 900	56 300	600	8 900	69 500

(Cont'd)

Table 5. (Cont'd)

Location	Area of defoliation (ha)						
	Light		Moderate		Severe		Total
	1990	1991	1990	1991	1990	1991	1991
Okanagan TSA							
Penticton-Keremeos-Oliver-Osoyoos	7 700	22 400	26 600	24 300	1 300	3 000	49 700
SUBTOTAL	66 200	59 900	84 750	149 500	3 500	26 900	236 300
Kamloops TSA							
Adams River-S. Thompson River-Monte Creek	3 200	4 700	2 150	7 150	550	6 250	18 100
North Thompson River-Kamloops-Deadman River	2 550	18 500	300	23 700	-	5 200	47 400
Pass Valley-Maiden Creek	100	700	-	-	-	-	700
Louis Creek-Barriere-McLure	-	1 200	-	100	-	-	1 300
Roche Lake-Stump Lake	-	1 250	-	700	-	100	2 050
SUBTOTAL	5 850	26 350	2 450	31 650	550	11 550	69 550
Lillooet TSA							
Pavilion-Fountain Valley-Lillooet-Texas Creek	5 100	2 500	1 000	10 400	-	4 800	17 700
Spences Bridge-Stein River-Laluwissin Creek	5 200	7 800	1 650	4 750	50	3 800	16 350
Anderson-Seton-Carpenter lakes-Yalakom River	8 250	12 400	1 200	26 500	-	2 500	41 400
Upper Stein River	1 700	1 850	400	900	-	-	2 750
SUBTOTAL	20 250	24 550	4 250	42 550	50	11 100	78 200

(Cont'd)

Table 5. (Cont'd)

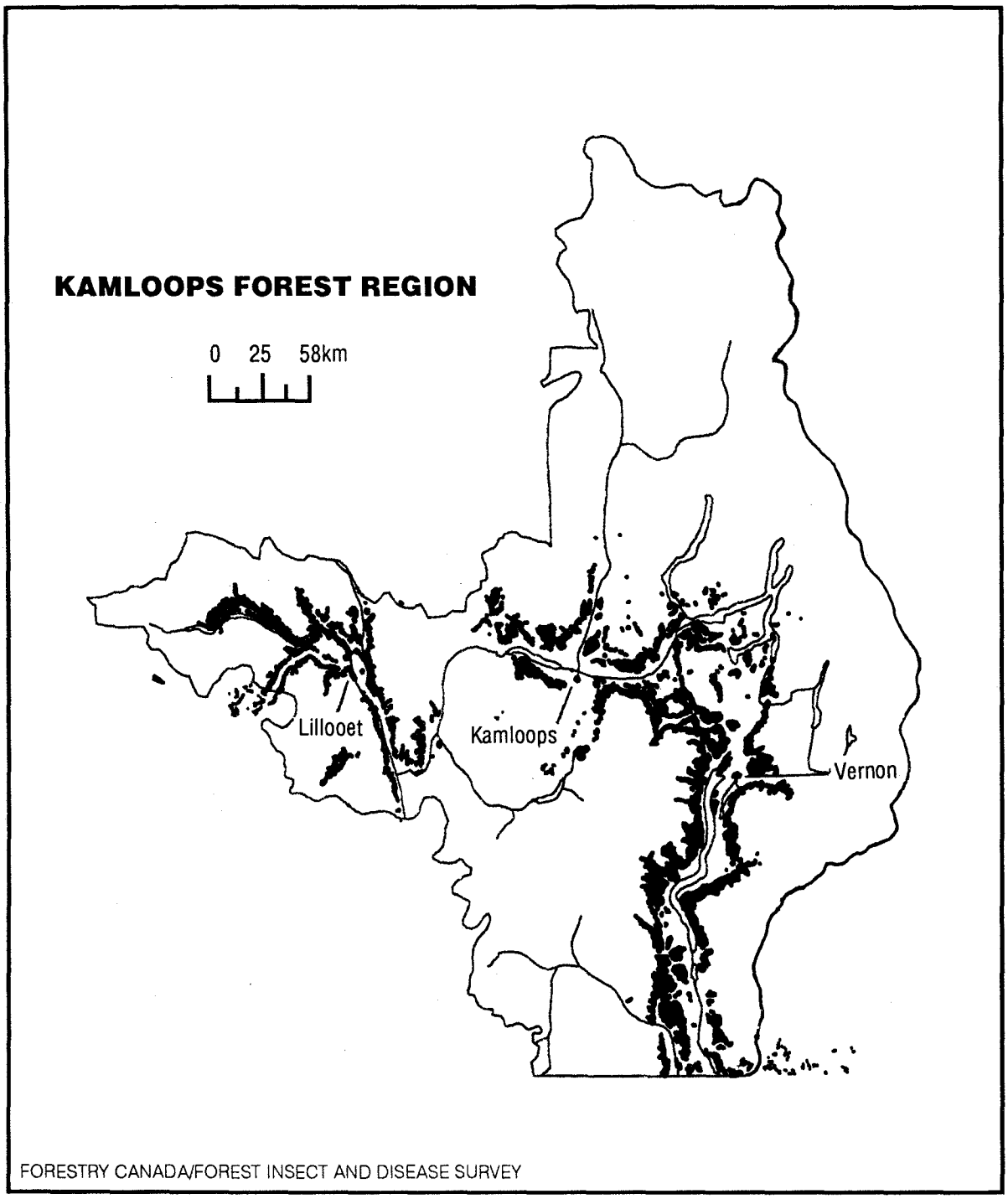
Location	Area of defoliation (ha)						
	Light		Moderate		Severe		Total
	1990	1991	1990	1991	1990	1991	1991
TSA							
Peter Hope Lake-Nicola Lake	-	1 500	-	200	-	-	1 700
Soap Lake-Nicola River	250	-	100	150	-	-	150
Hedley-Winters Creek	-	-	-	-	-	100	100
SUBTOTAL	250	1 500	100	350	-	100	1 950
TOTAL	92 550	112 300	91 550	224 050	4 100	49 650	386 000

DAMAGE

Okanagan TSA

Defoliation in the Okanagan TSA increased in area by 36% to 240 500 ha from 154 450 ha in 1990. Light defoliation declined 18% to 51 380 ha, moderate increased 40% to 155 500 ha and severe increased 88% to 33 100 ha, accounting for 21, 65 and 14% respectively of the total defoliation in the Okanagan TSA.

While defoliation intensity decreased in large infestations between Osoyoos and Penticton they were offset by increases in area due to the coalescence of smaller pockets. On the west side of Okanagan Lake, major expansions of previous infestations resulted in moderate defoliation between Penticton and Glenemma with large pockets (up to 1000 ha) of severe defoliation scattered throughout. Area of infestation increased slightly on the east side of Okanagan Lake extending north to Mara Lake with the most significant occurring between Mission Creek and Postill Lake and from Coldstream to Mara. Moderate defoliation dominated this area, however pockets of severe defoliation were noted, with the most significant occurring northeast of Swan Lake. In addition, new areas of light defoliation were mapped north of Beachcomber Bay, near Vernon. Elsewhere, in the North Okanagan-Shuswap, both size and severity of infestations increased, with 54% of the severe defoliation in the TSA recorded in this area. The most extensive severe defoliation occurred in the Salmon River Valley-Monte Hills area, Chase Creek, and Turtle Valley, where in addition to the many unmanaged natural stands, a number of mostly young managed stands are also at risk from budworm feeding.



Map 3. Areas where Douglas-fir was defoliated by western spruce budworm as detected by ground and aerial surveys, 1991.

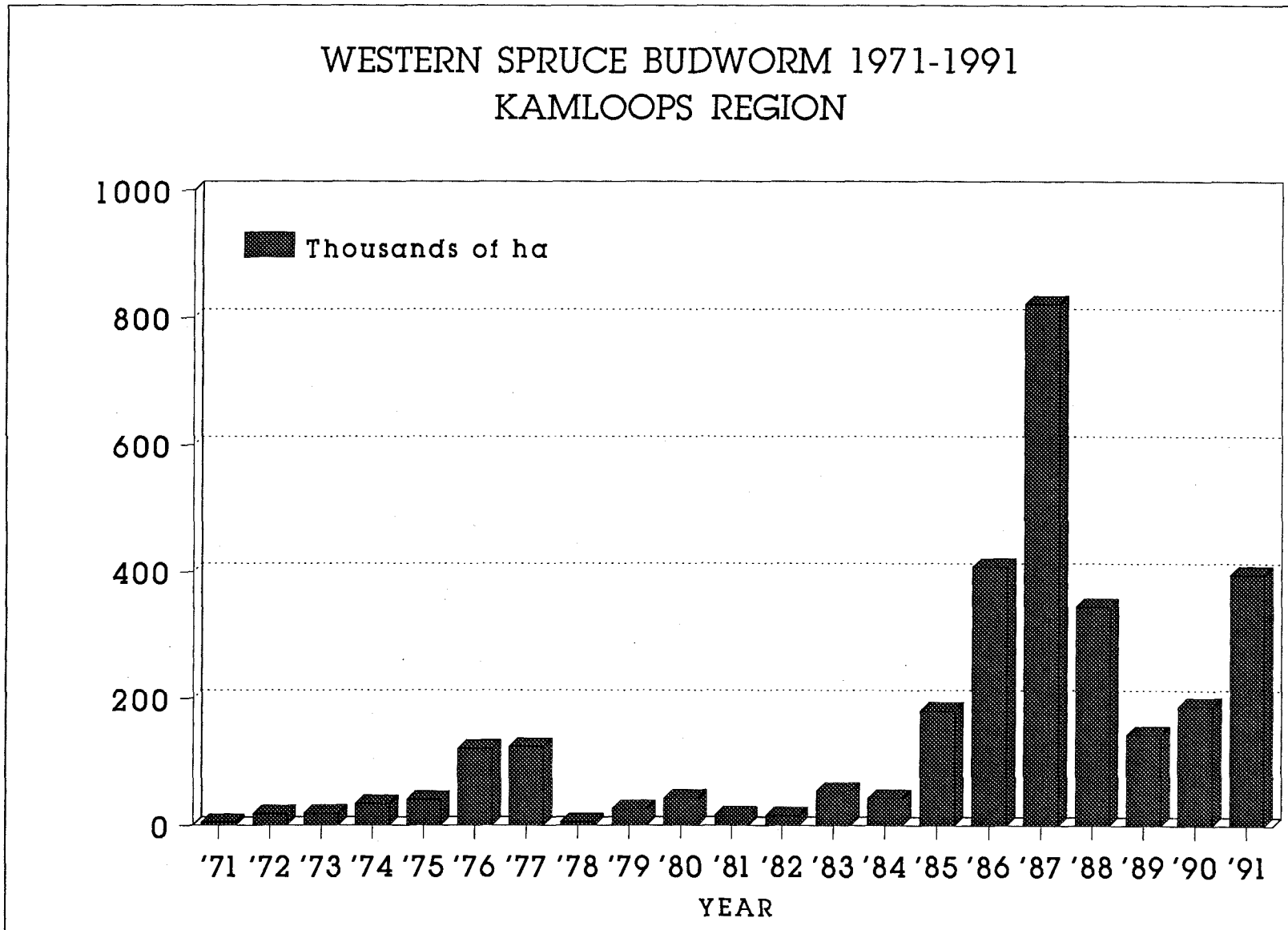

WESTERN SPRUCE BUDWORM 1971-1991
KAMLOOPS REGION
1000
800
600
400
200
0
Thousands of ha
'71 '72 '73 '74 '75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90 '91
YEAR
FORESTRY CANADA/FOREST INSECT AND DISEASE SURVEY

Figure 2.

Top-kill, and mortality of both immature and mature trees were recorded at several locations throughout the Okanagan TSA. Of the 24 egg sample areas surveyed, top-kill was noted at 9, ranging from 5% at Postill Lake to 25% at Apex-Yellow Lake; understorey mortality was recorded at 6 locations, ranging from 5% at Postill Lake to 60% at Lambly Creek; mortality of mature trees was <10% at each of 4 plots.

Kamloops TSA

The total area of defoliation in the TSA increased dramatically to 69 550 ha, from only 8 850 ha in 1990. Of this amount, 11 550 ha was defined as severe defoliation, 31 650 ha as moderate, and 26 350 ha as light.

Major expansions in area and defoliation intensity occurred along the upper slopes of the South Thompson Valley between Chase and Kamloops. Similar expansion occurred along the North Thompson River north to McLure, north and south of Kamloops Lake, including Tranquille River, Carabine Hills, Sabiston, Durand and Duffy creeks, and along Deadman River. Defoliation also increased south of Kamloops along Campbell Creek to Stump Lake. Areas already severely impacted and with the potential for significant damage, including tree mortality, are the Martin Mtn.-Monte Hills area, Pemberton Hill, Shumway Lake, Duffy and Beaton creeks area, Tranquille River and Sabiston Creek. Within these areas are intensively managed stands and plantations where tree mortality, deformity and growth loss will adversely affect the immediate and long term goals for these areas.

Lillooet TSA

The outbreak expanded more than threefold in the Lillooet TSA, to 78 250 ha, of which 11 150 ha were rated as severely defoliated, 42 550 ha as moderate, and 24 550 as light. Most of this expansion occurred in the Lillooet area, along Seton, Anderson, and Carpenter lakes, Cayuse Creek, and Fountain Valley. Elsewhere, defoliation intensity increased up to 50% in areas defoliated in 1990, including Bridge River, Yalakom River, the Fraser River south of Lillooet to Kwoiek Creek, Stein River, and along the Thompson River Valley between Lytton and Twaal Creek. Severe defoliation occurred in pockets throughout infested areas in the TSA, but was most severe in Fountain Valley, where branch die-back, top-kill and mortality of Douglas-fir is becoming more common. Additional tree mortality and top-kill can also be expected along Marshall Creek and at Mission Pass, both areas of previously chronic infestation.

Merritt TSA

The area of light to severe defoliation of Douglas-fir expanded to 1 950 ha from 350 ha in 1990. Populations declined in the Soap Lake area, where scattered tree mortality is still evident from previous infestations. New infestations near Peter Hope Lake and north of Nicola Lake covered 1 700 ha of moderate defoliation. Severe defoliation occurred over 100 ha in the Winters Creek drainage of the Similkameen Valley.

SAMPLING SURVEYS

Bud sampling

A bud sampling survey, repeated annually since 1987, continued in late May at 25 locations to assist in predicting defoliation for the current (1991) year (Table 6). At each location, a total of 100 buds were examined from five trees. Severe defoliation was predicted at 18 sites, moderate at 4, and light at 3 locations. Bud samples predicted an upward trend in defoliation severity in 85% of samples for the same areas assessed in 1990. Subsequent aerial surveys and ground assessments found predictions to be correct at 56% of the stands sampled, similar to accuracies obtained between 1987 and 1990 which ranged from 40-65%. For predictive purposes, bud sampling is a good tool, allowing enough time for decision-making during epidemic conditions where a control option may be valid. In areas where the predicted and actual defoliation were not the same, the difference was never more than one defoliation category.

Table 6. Percent buds infested by western spruce budworm, predicted and actual defoliation, by TSA, Kamloops Forest Region, 1991.

	Percent of buds infested					Defoliation 1991	
TSA and location	**1991**	1990	1989	1988	1987	Predicted[1]	Actual
Kamloops TSA							
Sabiston Creek	**24**	27	19	12	29	M	M
Cherry Creek	**47**	17	8	27	-	S	S
Paul Lake	**31**	24	3	30	35	S	M
Martin Mtn.	**73**	-	-	-	-	S	S
Pemberton Hill	**71**	-	-	-	-	S	S
Lillooet TSA							
Fountain Valley	**52**	19	3	26	19	M	M
Okanagan TSA							
Falkland	**33**	14	7	25	47	S	M
Skimikin	**28**	-	-	44	20	M	M
Equesis Creek	**54**	24	40	16	-	S	M
Crossman	**28**	-	-	-	-	M	M
Meighen	**81**	-	-	-	-	S	S
Postill Lake	**87**	44	11	-	-	S	M
Lambly Creek	**82**	-	-	-	-	S	S
Glenrosa	**51**	50	51	32	-	S	S
Darke Lake	**78**	66	57	35	-	S	M
Priest Creek	**13**	-	-	-	-	L	M
Peachland Main	**75**	25	46	27	-	S	S
Chute Creek	**58**	-	-	-	-	S	M
Apex-Yellow Lake	**57**	19	17	49	-	S	S
Taylor Lake	**6**	-	-	-	-	L	L

(Cont'd)

Table 6. (Cont'd)

TSA and location	Percent of buds infested					Defoliation 1991	
	1991	1990	1989	1988	1987	Predicted[1]	Actual
Okanagan TSA							
Blind Creek	**49**	24	11	25	46	S	M
Gregoire Creek	**13**	-	-	-	-	L	M
Mt. Kobau	**19**	21	-	14	38	M	M
Blue Lake	**39**	-	-	16	48	S	M
Anarchist Mtn.	**38**	11	39	6	53	S	M

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

Larval and moth sampling

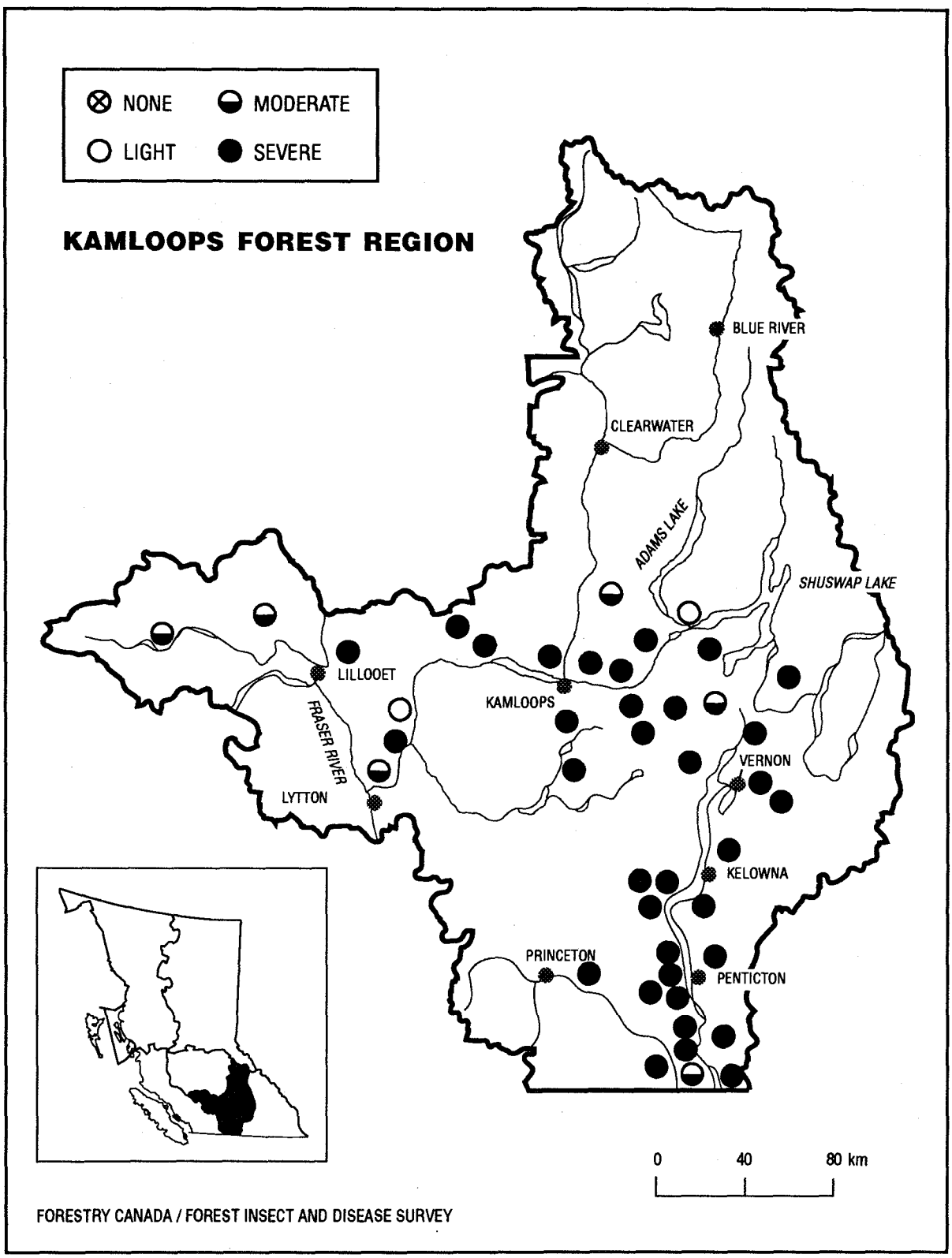
Larval populations in the region, throughout much of the Interior Douglas-fir (IDF) biogeoclimatic zone, were up for the second consecutive year. Standard beating samples at 54 locations averaged 48 larvae per collection, compared to 37 in 1990.

Mid- to late-instar budworm larvae and adult males were monitored for the fifth year in areas with low populations, but with a history of outbreaks. Moths were caught in baited "Multipher" traps at four locations as part of a study to correlate trap catches with larval densities and defoliation in the following year. Branch tip beating samples from 25 Douglas-fir at each site, averaged 2.1 larvae per 45-cm branch, and trap catches averaged 219 (range 12-605) moths. This is down slightly from an average 2.8 larvae per branch and 245 moths per trap in 1990. Sampling and analysis are expected to continue next year.

FORECASTS

The number of egg masses increased 40% from 1990 at 46 locations in the region (Table 7, Map 4). Based on these, defoliation in 1992 is predicted to be severe at 35 sites, moderate at 9, and light at 2 locations. This is a significant increase in defoliation intensity from 1991 levels, for which only half of egg sample areas were predicted to be severe. Additional egg sampling by the B.C. Forest Service at 201 sites in three districts, indicated severe defoliation at 10% of sites, mostly in the Vernon District, moderate at 27%, light at 54%, and no defoliation at 9% of sites.

Two 45-cm branch tips were collected from each of ten trees per location. The number of egg masses per branch were counted and extrapolated to 10 m^2 of foliage. These numbers were then used to determine defoliation severity for 1992. Predictions preclude adverse climatic conditions which could decrease overwintering larval survival rates.



Map 4. Defoliation by westerns pruce budworm forecast for 1992, based on 1991 egg surveys.

Table 7. Predicted defoliation for 1992 and average number of western spruce budworm egg masses on Douglas-fir from 1988-1991, including percent change, Kamloops Forest Region, 1991

TSA and location (90-91)	Predicted defoliation '92[1]	No. of egg masses per 10 m² foliage 1988	1989	1990	1991	% Change
Kamloops TSA						
Adams River	light	9	37	27	37	+37
Fadear Creek	moderate	-	-	-	72	-
Paul Lake	severe	78	162	150	302	+101
Pemberton Hill	severe	-	-	960	827	-14
Martin Mountain	severe		-	373	739	+98
Niskonlith Lake	severe				184	-
Shumway Lake	severe				818	-
McQueen Lake	severe	-	-	-	345	-
Sabiston Creek	severe	85	123	361	472	+30
Criss Creek	severe		145	111	185	+67
Oregon Jack Creek	light	-	-	-	14	-
Cherry Creek	severe	43	86	105	596	+467
Average		**54**	**110**	**298**	**382**	**+51**
Okanagan TSA						
Falkland	severe	37	49	101	528	+422
Monte Lake	severe	-			613	-
Glenemma	severe				416	-
Skimikin	severe				248	-
Hunter-Blurton	severe		-	-	168	-
Haines Creek	moderate		-	137	74	-46
Bardolph Lake	severe				401	-
Harris Creek	severe	-	-	-	199	-
Equesis Creek	severe	43	51	87	233	+167
Whiteman Creek	severe	-	-	-	172	-
Postill Lake	severe	20	17	43	447	+939
Lambly Creek	severe	-	-	364	152	-58
Glenrosa	severe	231	143	357	370	+4
Darke Lake	severe	76	87	74	218	+194
Priest Creek	moderate	-	-	236	87	-63
Peachland Main	severe	43	51	336	306	-9
Chute Creek	severe		-	264	447	+69
McNulty Main	severe		-	-	367	-
Riddle Creek	severe	-	-	-	326	-
Apex-Yellow Lake	severe	99	57	222	264	+19
Taylor Lake	severe	-	-	248	325	+31

(Cont'd)

Table 7. (Cont'd)

TSA and location (90-91)	Predicted defoliation '92[1]	No. of egg masses per 10 m² foliage 1988	1989	1990	1991	% Change
Okanagan TSA						
Blind Creek	severe	10	23	77	183	+137
Gregoire Creek	severe	-	-	214	238	+11
Mount Kobau	severe	661	310	521	454	-13
Roberts Creek	moderate	-	-	-	147	-
Anarchist Mountain	severe	99	-	-	256	-
Blue Lake	moderate	98	8	143	74	-48
Average		**128**	**80**	**188**	**285**	**+36**
Lillooet TSA						
Yalakom River	moderate	-	-	348	146	-58
Fountain Valley	severe	70	124	109	407	+273
Murray Creek	severe	-	-	-	200	-
Mission Pass	moderate		-	-	67	-
Gun Lake	moderate		-	-	98	-
Botanie Creek	moderate		-	0	74	+100
Average		**70**	**124**	**230**	**165**	**+38**
Merritt TSA						
Peter Hope Lake	severe	-	-	-	505	-
Average		-	-	-	**505**	-

[1] 1- 50 eggs/10m² - light defoliation
51-150 eggs/10m² - moderate defoliation
151+ eggs/10m² - severe defoliation

In **Kamloops TSA**, egg masses collected at 12 sites increased 51% from 1990 levels, with severe defoliation predicted at 9 of those sites. Stands at Monte Lake, Sabiston Creek, and Duffy and Beaton creeks already severely impacted by successive years of budworm feeding, will likely deteriorate further following additional severe defoliation.

Severe defoliation is predicted at 23 of 27 sites in the **Okanagan TSA**, where numbers of egg masses increased 36%. The most severe defoliation is forecast at Falkland, Equesis Creek, Postill Lake, Darke Lake, and Blind Creek, where the number of eggs more than doubled. Although larval mortality from starvation may occur at several locations due to population pressure and lack of

host material, populations generally will remain high enough throughout the TSA to cause extensive defoliation and result in some tree mortality, and top-kill.

In **Lillooet TSA**, severe defoliation is predicted in 2 of 6 areas sampled. This follows the trend elsewhere in the region, of continued expansion of infestations. Although some larval disease was found in portions of the Fountain Valley infestation, high populations are forecast to continue to cause additional tree mortality and growth loss of Douglas-fir stands in this area.

Due to limited defoliation in the **Merritt TSA**, only one site was sampled. Egg counts at Peter Hope Lake predict severe defoliation in 1992, with possible expansions of existing populations nearby, north of Nicola Lake.

BIOLOGICAL CONTROL

Parasitism in rearings of late-instar larvae and pupae by hymenopteran and dipteran parasites averaged 6% at 13 of 15 locations sampled, and ranged from 0% along Apex Mtn. Rd. to 18% at Anarchist Mtn. As in recent years these levels are too low to effectively reduce budworm populations. Previous studies have shown that insect parasites are most effective in controlling low populations of budworm, but have minimal influence at epidemic levels. However, disease which affected more than 50% of larvae in several locations in Fountain Valley near Lillooet, may help to ameliorate the severe defoliation expected there in 1992. More than 30% of larvae were also infected by an unidentified pathogen west of Kamloops near Cherry Creek, which may contribute to a reduction in severe defoliation forecast there.

IMPACT

Defoliation by spruce budworm can severely reduce tree growth. During infestation years, annual increment is progressively reduced with each additional year of defoliation, in a cause-effect relationship that usually has a 1-year lag (Thomson and Van Sickle, 1980; Alfaro et al., 1982). It takes several years to regain a full compliment of foliage after defoliation ceases; during this period radial growth slowly recovers. Height growth is also reduced or entirely eliminated during each year that defoliation occurs, because of the budworm's preference for the current year's buds and foliage. Additionally, severe defoliation sustained over several years can result in top-kill, which reduces tree height by one to several internodes. Following top-kill, height growth resumes by means of lateral branches gaining apical dominance or by branches originating from adventitious buds on the main stem (Van Sickle et al., 1983). This process may result in the formation of stem defects that can affect the tree's merchantability.

Losses caused by budworm feeding can be determined with growth and yield models. Recently a system was designed for projecting growth of uneven-aged stands of Douglas-fir in the Kamloops Region (Alfaro, and Maclauchlan, 1990). The system produces losses in total stand volume and harvestable volume, for every 10-year interval. Using a 20 year projection on 32 stands defoliated for 7 years, the system calculated that volume losses per hectare averaged 6.2, 23.3 and 32.8% of total stand volume, for light, moderate, and severe infestations, respectively.

Douglas-fir beetle
Dendroctonus pseudotsugae

Infestations of Douglas-fir beetle in mature Douglas-fir, increased more than two-fold to 700 pockets of 5 to 30 trees each, as recorded during aerial detection surveys in midsummer. Recent mortality of mature Douglas-fir was mostly comprised of small outbreaks of 5 to 30 trees each. This large increase was partially a reflection of the more intensive aerial surveys in Kamloops Forest District in which nearly every pocket of infestation was photographed and sketch-mapped.

The majority of infestations continue to be in the Cache Creek area from Pavilion Lake east to Kamloops Lake and from Scottie Creek south to Venables Valley. Some of the most concentrated areas of small infestation pockets include, Hat Creek Valley, Maiden and Allen creeks, Campbell Mountain, Pass Valley, Barnes Lake to Pennie Lake, upper Deadman River, Durand Creek and Carabine Creek. Other areas with fewer infestations but, some expansion, are those located south of Spences Bridge, along Stein River, south of Ashcroft, and at Louis Creek. The number of beetle-killed trees elsewhere in the region have not changed substantially. Single attacks and small pockets of infestation continued throughout the host range of Douglas-fir in the Okanagan and Similkameen valleys and south of Merritt.

The ongoing practice of timely harvesting of infestation pockets, and the judicious use of trap trees associated with pheromone baiting, should reduce the impact of expanding infestations and help keep them in check. However, two additional elements requiring extra vigilance in Douglas-fir stands are windthrow and the cumulative effects of severe western spruce budworm defoliation. Both can initiate increases in beetle populations. Mature Douglas-fir in stands which have endured several years of severe defoliation are particularly vulnerable to attack by beetles. Susceptible stands include those in the Okanagan TSA north of Falkland, in the Kamloops TSA near Monte Lake, Duffy and Beaton creeks area, Tranquille River Valley and Sabiston-Carabine creeks area, and in Lilloet TSA along Fountain Valley.

Douglas-fir tussock moth
Orgyia pseudotsugata

Douglas-fir tussock moth populations increased for the fourth consecutive year in Douglas-fir stands between Kamloops and Savona, where eight 10 to 40 ha patches of severe defoliation totalled 135 ha. The most serious defoliation occurred at Indian Gardens Ranch, near Pat Lake and at Brussels Lake, where small patches of trees were totally stripped. Elsewhere, defoliation was limited to single Douglas-fir and ornamental spruce in urban areas, including Kamloops, Vernon, Kelowna and Penticton. Virus infection and parasitism in some late instar larvae and cocoons may have contributed to a decline of populations between Keromeos and Hedley.

Male moth captures in pheromone-baited sticky traps increased for the sixth consecutive year in Douglas-fir stands selected for the greatest historical frequency of outbreaks. Counts at 18 **monitoring** sites in Kamloops Region, averaged 38 moths per trap (6 traps/location), up from 25 in 1990.

Single traps located at 1- to 2-kilometer intervals in the Thompson and Okanagan valleys, to determine population **distribution** and to help locate epidemic centers, averaged 59 moths per trap, up from 47 last year. Both types of trapping methods reflect increased egg laying potential and therefore additional defoliation in 1992. Additionally, an average of 38 moths per trap were caught by the British Columbia Forest Service at 186 separate locations in the Kamloops Region, up from 20 at 80 locations in 1990.

Egg mass surveys were conducted at 37 sites in the Thompson, Okanagan and Similkameen valleys where most traps contained 40 or more moths, or where there was previous defoliation (Map 5). These indicated severe defoliation for 1992 at 8 sites, moderate at 6, and light or trace at 18 sites (Table 8); no eggs were found at 5 locations. Egg mass density was determined using a sequential sampling method, which required the inspection of a minimum of 20 trees per site.

Table 8. Summary of sequential Douglas-fir tussock moth egg mass surveys, and pheromone trapping, 1991 and predicted defoliation for 1992, Kamloops Forest Region.

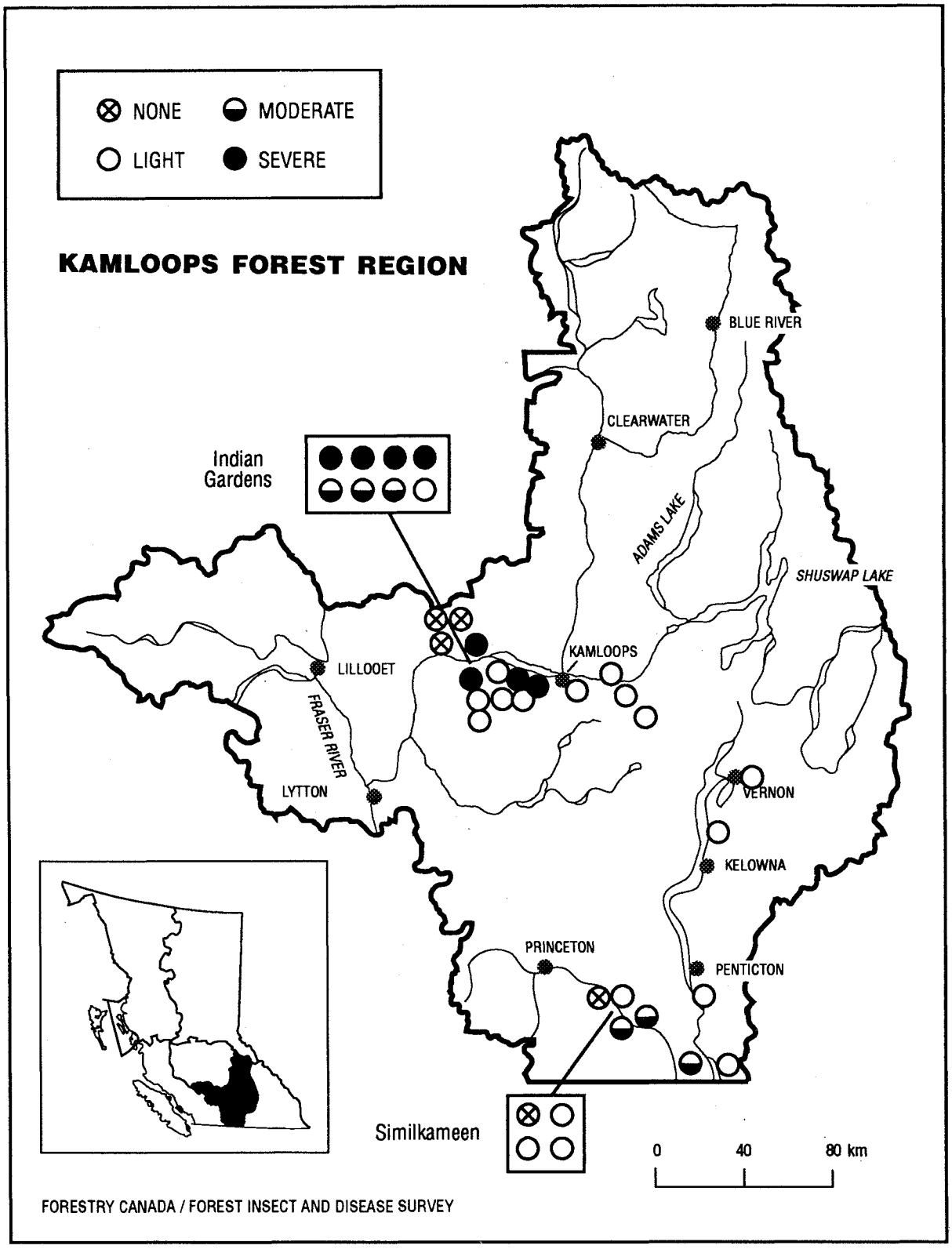
Trap type/ Location	Avg. No. moths/trap	Avg. No. egg masses/tree	1991 defoliation	Predicted 1992[1] defoliation
MONITORING TRAPS				
Battle Creek				
Km 3	59	0.0	Nil	Nil
Monte Creek				
Robbins Range	62	0.1	Nil	Trace
North Okanagan				
Vernon	46	0.2	Nil	Trace
Winfield	49	0.2	Nil	Trace
South Okanagan				
Anarchist Mtn.	37	0.2	Nil	Trace
Blue Lake	50	0.8	Nil	Moderate
Kaleden	59	0.2	Nil	Trace
Similkameen Valley				
Stemwinder Park	33	0.0	Nil	Nil
DISTRIBUTION TRAPS				
Deadman River				
Km 16	61	0.0	Nil	Nil
Criss Creek	-	0.0	Nil	Nil
Sabiston Creek	98	21.0	Light	Severe

(Cont'd)

Table 8. (Cont'd)

Trap type/ Location	Avg. No. moths/trap	Avg. No. egg masses/tree	1991 defoliation	Predicted 1992[1] defoliation
Indian Gardens				
E. of Guichon Rd.	79	1.8	Nil	Moderate
Guichon Rd. Junc.	42	0.4	Trace	Light
W. of Guichon Rd.	52	0.9	Nil	Moderate
Pipeline - W1			Severe	Severe
Pipeline - E1			Severe	Severe
Pipeline - E2, E3			Severe	Severe
NE Corner Lot 20			Trace	Moderate
N. of Ranch			Light	Severe
Six Mile Ranch				
Rifle Range	102	0.3	Nil	Light
Six Mile Ranch Rd.	101	0.4	Trace	Light
1.2 km E. of prev.	92	0.4	Trace	Light
1.3 km E. of prev.	114	0.1	Nil	Trace
Brussels Creek		6.1	Severe	Severe
Munro Creek		-	Severe	Severe
Dominic Lake Rd.				
Km 2	56	0.2	Nil	Trace
Beaton Rd.				
Beaton Lake		2.1	Light-	Severe Moderate
Kamloops				
Rose Hill		0.1	Nil	Trace
Duck Range Rd.				
Monte Creek		0.1	Nil	Trace
Pritchard				
5.1 km W. Pritchard	58	0.1	Nil	Trace
Similkameen Valley				
Shoemaker Creek 1	11	1.4	Nil	Moderate
Shoemaker Creek 2	6	0.6	Nil	Light
Winters Creek	106	0.2	Nil	Trace
Larkin 1	59	0.5	Trace	Light
Larkin 2	5	0.7	Trace	Moderate
Plot 20	95	0.0	Nil	Nil
Bradshaw Creek	64	0.2	Nil	Trace

[1] <0.7 egg masses/tree (3 branches) = trace to light defoliation
0.7 - 2.0 egg masses/tree (" ") = moderate defoliation
>2.0 egg masses/tree (" ") = severe defoliation



Map 5. Defoliation by Douglas-fir tussock moth forecast for 1992, based on 1991 egg surveys.

Two control programs were initiated jointly by Forestry Canada and the British Columbia Forest Service. One was an aerial operational spray program in June, using Douglas-fir tussock moth virus on 200 ha west of Kamloops, and the other, an experimental spray program in August on 8 ha, using Douglas-fir tussock moth pheromone in a male moth confusion trial near Hedley. The virus application was successful in reducing defoliation in the treated stands, although defoliation did occur in two plots sprayed with a stored virus (approx. 10 years old), which was one of three types used. Preliminary results from the confusion trial near Hedley, indicate that mating by moths was impeded by the presence of elevated amounts of pheromone during the mating period. Additional tests are planned for 1992.

Western false hemlock looper
Nepytia freemani

Larval populations increased for the third consecutive year throughout much of the IDF and PP biogeoclimatic zones in the region. In association with Douglas-fir tussock moth, the looper caused some light defoliation in several stands of Douglas-fir near Savona at Indian Gardens Ranch and Six Mile Point. There was also trace defoliation on 10 ha at Jamieson Creek.

Elsewhere, the highest populations were found along the North Thompson Valley between Kamloops and Barriere, along Deadman River and the Similkameen Valley between Keremeos and Hedley, but there was no defoliation. Up to 111 larvae were obtained in standard FIDS samples at permanent sample sites, up from 33 in 1990, and 20 in 1989. Larvae were also common in low numbers in the Okanagan Valley and along the Thompson River from Spences Bridge to Cache Creek.

Increased numbers of larvae in 1991 and predictions of trace to light defoliation from egg counts in the Jamieson Creek-Westsyde Rd. area, indicate that populations will likely continue to increase in 1992, despite evidence of some high egg parasitism. Some additional sampling will take place in 1992, especially in historically active areas between Chase and Salmon Arm, from Monte Lake to Falkland and near Barriere.

SPRUCE PESTS

Spruce beetle
Dendroctonus rufipennis

Infestations of spruce beetle declined to 335 ha from over 1000 ha in 1990, a trend which began in 1987. Much of this reduction can be attributed to timely detection and harvesting of infested stands.

As in the past few years, recent spruce mortality was generally confined to previously infested stands in seven separate patches in the Lillooet, Kamloops, and Merritt TSAs. In Lillooet TSA recent tree mortality ranged from 10 to 20% in three pockets along Noel and Cadwallader creeks, adjacent to areas of previous harvesting. Aerial surveys in Noel Creek detected one new spot

infestation near the headwaters of the valley. Long-standing outbreaks at McGillivray and Connel creeks along Anderson Lake have further declined in area and intensity, due to host depletion and harvesting. In Kamloops TSA the infestation at Nikwikwaia Creek near Adams Lake, which was first reported in 1990, is mostly restricted to stand fringes and up to 0.5 km beyond cut block boundaries. Present management action includes pheromone baiting and felling of 600+ spruce trap trees to reduce risk of further spread. Difficult terrain and crucial downstream fish habitat may preclude harvesting as a traditional means of beetle control for this area.

In the Mt. Thynne-Brook Lake area of the Merritt TSA, most of the beetle population in some of the more than 100 000 m^3 of winter (1989-91) spruce blowdown has been removed through salvage logging. No active infestations in standing trees were noted. However, beetle activity in any stumps should be closely monitored, as well as stand fringes.

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

Two-year-cycle spruce budworm
Choristoneura biennis

Mature 'off-cycle' budworm larvae defoliated 6775 ha of alpine fir and spruce in 11 areas east of Lumby, between Keefer and Sugar lakes. This is twice the area defoliated in 1990 within the same general location. Severe defoliation occurred on 280 ha at Holmes Lake. Stands moderately defoliated totalled 3820 ha, at Keefer and Holmes lakes, Monashee, Currie and Cherry creeks, and at Kate Lake. Light defoliation was evident on 2675 ha surrounding Keefer and Holmes lakes, and along Cherry Creek.

Areas of chronic infestations in the North Thompson Valley showed no signs of defoliation, as 1991 was not a "flight" year, when larval populations are immature. However, some defoliation may be expected in these areas in 1992.

Based on egg counts from alpine fir at Keefer Lake, severe defoliation is predicted for 1993, the year when larvae mature in this area. Some light defoliation may also be visible in 1992 from feeding by the immature stage.

ALPINE FIR PESTS

Western balsam bark beetle
Dryocoetes confusus

Recent tree mortality determined from aerial surveys, increased to 1710 ha from nearly 1000 ha in 1990.

The largest infestations continue to be in chronic areas near Taweel Lake west of Clearwater, at Blanc Creek east of Pritchard, and at Wentworth Creek near Kamloops. Infestations totalling more than 1000 ha in the Wentworth Creek-Tranquille Lake area and near Taweel Lake are longstanding epidemics in which an additional 5% of alpine fir may be attacked annually. The result is increased stand decadence over large areas. The accumulated mortality should level off when about two-thirds of trees over 20-cm are attacked. The more recent infestation of 350 ha at Blanc Creek has been partially harvested, but there is potential for further expansion of beetle kill.

Infestations up to 70 ha were located near Monashee Creek, Trout Creek, Munro Lake, Fly Hills and Anstey River in Okanagan TSA, McGillivray Creek in Kamloops TSA, and Hurley Creek in Lillooet TSA. Spot infestations of 1 to 3 ha were common throughout the host range in the region, especially along the upper West Kettle River and along the east side of Mabel Lake.

While the area and intensity of attack do not fluctuate dramatically from year to year, consistent and accurate mapping is difficult. This is due to the retention of red foliage for up to five years, the extensive mortality caused by other agents, including root rots, and the inconsistency of aerial surveys in remote subalpine drainages.

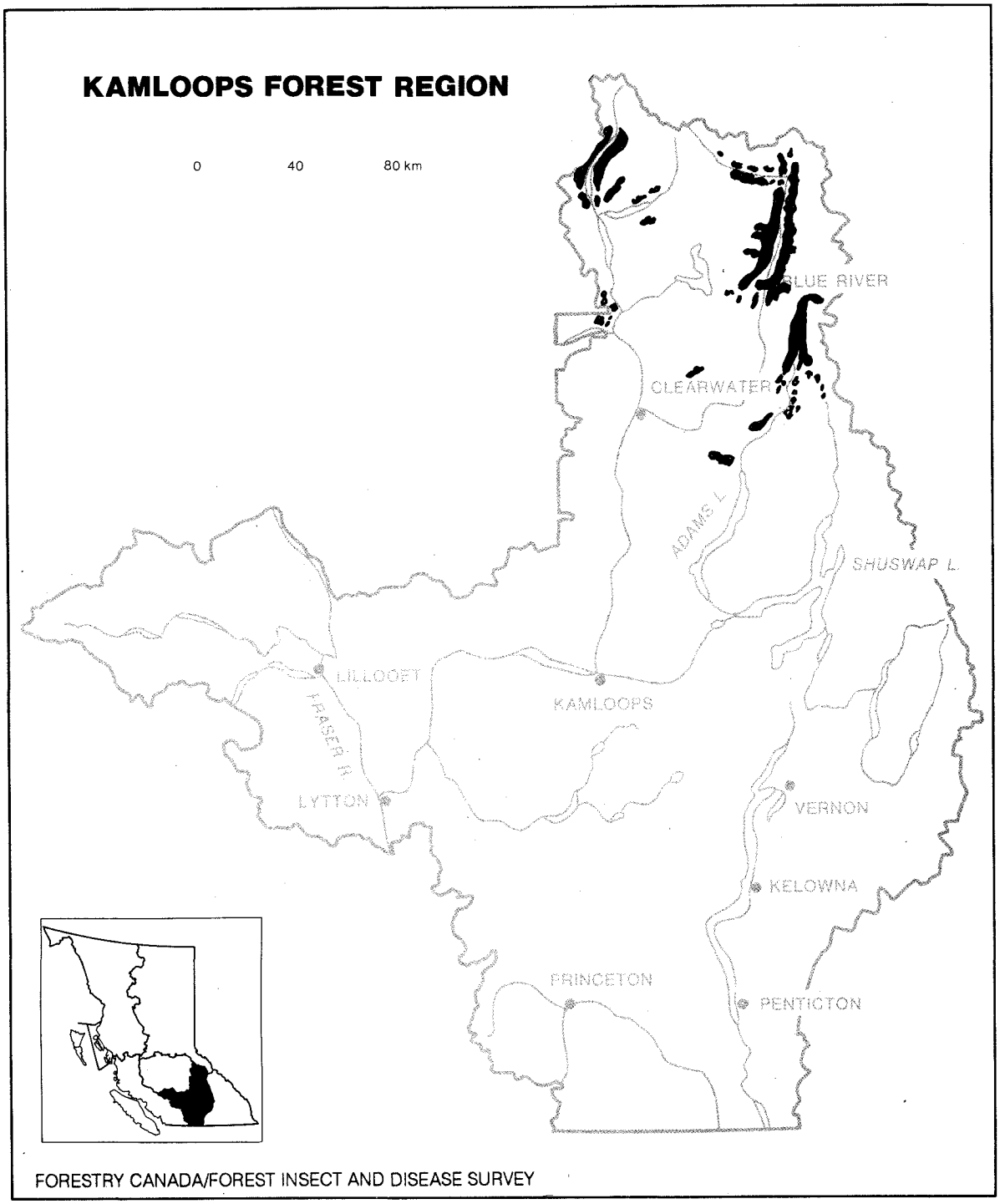
WESTERN HEMLOCK PESTS

Western hemlock looper
Lambdina fiscellaria lugubrosa

Western hemlock looper in the Clearwater Forest District, defoliated more than 36 000 ha of western hemlock and western red cedar in mature and overmature hemlock-cedar stands in the North Thompson and Adams river drainages and in Wells Gray Park along Hobson and Azure lakes (Map 6). This is the first outbreak in the Kamloops Region since 1984 when defoliation was spread over 8 000 ha, and followed increased larval populations in 1990.

Severe defoliation occurred on 4 200 ha from Blue River to the Albreda River, near Tumtum Lake in the Adams River drainage and along Hobson Lake in Wells Gray Park. Moderate defoliation occurred on 17 900 ha in these same areas and in the upper Adams and North Thompson river drainages and near Messiter Summit. There was light defoliation on 14 000 ha south of Tumtum Lake, along Oliver, Gold and Gollen creeks, Azure Lake in Wells Gray Park, and elsewhere near areas moderately or severely defoliated.

Samples of "old man's beard" lichen were obtained this fall from seven representative areas within the outbreak to determine the number and viability of overwintering eggs and help forecast damage trends in 1992 (Table 9).



Map 6. Defoliation by western hemlock looper as determined by aerial surveys in 1991.

Table 9. Location, average number and status of western hemlock looper eggs and predicted defoliation for 1992, Kamloops Forest Region 1991.

Location	Avg. no. eggs per 100 g lichen				Predicted 1992[1] defoliation
	Healthy	Parasitized	Infertile	Old	
Lempriere	145	50 (26%)	1	16	severe
Miledge Creek	113	112 (50%)	4	40	severe
Mud Lake	80	56 (41%)	2	24	severe
North Foam Creek	15	7 (32%)	0	6	light
Adams R.-Finn Cr.	96	20 (17%)	2	16	severe
Tumtum Lake	162	66 (29%)	7	40	severe
Gollen Creek	15	2 (12%)	1	4	light

[1] light - 5-26 eggs; moderate - 27-60 eggs; severe - 61+ eggs

While the number of overwintering eggs predict the potential for severe defoliation occurring at 5 of 7 sample locations, the high percentage of parasitism (avg. 30%) may ameliorate the damage. In previous outbreaks, when 30% egg parasitism or greater occurred, populations frequently collapsed the following year. Population reduction would be greatest at Miledge Creek and Mud Lake near Blue River, where parasitism was 50% and 41% respectively. With the exception of the most recent outbreak of 1983-1984, hemlock looper infestations since 1945 have collapsed after causing only one year of defoliation.

Some tree mortality and top-kill may occur in stands severely defoliated in 1991, even after only one year of defoliation. Generally, trees that are 100% defoliated are killed outright, while those 80% or more defoliated frequently die or succumb to secondary invaders, particularly in overmature stands.

LARCH PESTS

Larch casebearer
Coleophora laricella

Larch casebearer populations were variable, causing light to moderate defoliation in scattered locations where previous damage occurred on the east side of the Okanagan Valley, and east of Salmon Arm. Populations increased in the South Okanagan, resulting in light defoliation of immature larch along Shuttleworth Creek, where there was little damage in 1990. Light to moderate defoliation, up to 30%, also occurred at Gregoire Creek, Trinity Valley, and along both the King Edward and Harris Creek roads. The infestation between Sicamous and Canoe, representing the most northerly occurrence of larch casebearer, declined in intensity to 20% defoliation, from 50% in 1990.

Pupal parasitism was less than 2% in a sample reared from Enns Creek near Canoe, where the introduced parasite, Chrysocharis laricinellae was found. Parasitism was 6% and less than 1% in the Okanagan Valley at King Edward Main and Gregoire Creek respectively, where Agathis pumila and an unidentified chalcid were present. These levels were too low to effectively reduce populations. Similar population levels can be expected in 1992.

Larch needle diseases
Hypodermella laricis
Meria laricis

Larch needle blight, H. laricis, infections and incidence increased, especially in the Trinity Valley-Sugar Lake-Harris Creek area where 360 ha, 2 260 ha, and 1 205 ha of severe, moderate and light defoliation, respectively, were mapped during aerial surveys. Numbers of trees infected ranged from 40-100% with infection intensities of 40-80%. All areas sampled were confirmed as H. laricis. A larch needle cast, M. laricis, common in 1990, was not found in 1991.

MULTIPLE HOST PESTS

Root Diseases

While distribution of the two most well known root diseases, Armillaria root rot, Armillaria ostoyae and laminated root rot, Phellinus weirii is documented throughout most of Kamloops Region, there are two others, namely blackstain root disease, Leptographium wageneri, and tomentosus root rot, Inonotus tomentosus which are not. The incidence and distribution of these latter two diseases appears to be greater than first believed, and their importance has frequently been overlooked. Reasons for this are that the field identification can be difficult, especially with tomentosus root rot, where infection can be well advanced before visible symptoms are evident. Additionally, in both cases, the characteristics of infection are frequently masked by other agents such as root weevils, Ips spp. engraver beetles, and even secondary infections of Armillaria. Increased emphasis by FIDS will be placed on detection and assessment of blackstain and tomentosus root rots in 1992, particularly in the ESSF and SBS biogeoclimatic zones north of Kamloops.

The occurrence of root disease in the Kamloops Region is widespread, and results in growth loss and mortality in stands of varying age within a rotation. Recognition and management combined with an understanding of the biology of these diseases is a crucial component to reaching and maintaining desired stocking levels for a particular stand. There are several root disease fungi that cause similar symptoms and damage, however each disease has specific management prescriptions. Thus, examination of the roots and root collar area is always necessary to positively identify root diseases.

At present, site rehabilitation techniques such as stumping can be costly, but usually the benefits gained in terms of reduced volume losses can

exceed the initial cost. Other viable options include planting of a less susceptible species near the infected centres if the disease incidence is low and widely scattered, or throughout the area if the incidence is high. To be effective, identification of disease incidence and intensity prior to harvest is critical.

Black army cutworm
Actebia fennica

As in the previous three years, there were no reports or observations of cutworm larvae or damage anywhere in the region, although adults were caught in baited "Multipher" traps. Numbers of male moths trapped increased marginally to 29 per trap, from 26 in 1990. Low populations are predicted to continue for 1992 in areas where traps were deployed along the North Thompson Valley from Clearwater to Miledge Creek and along the north half of Adams Lake.

Some additional data is still required to verify that the threshold level of 600 or more moths per trap indicates a high risk of vegetation and seedling defoliation.

Ground squirrels

The Columbia ground squirrel, Spermophilus columbianus appeared to be associated with lodgepole pine seedling mortality of 30 and 50% in pockets in recent plantations at Coldscaur Lake and at Barriere Mountain respectively, near Clearwater. Typical damage appeared as uprooted seedlings severed at the root collar, root feeding and stem feeding (portions of roots or stems occasionally missing). Many of the seedlings were completely pulled up and could be found within a 1-2 m radius from their planting spot. Sightings and signs of ground squirrel were abundant in both areas, but this kind of behavior for them was atypical, and could reflect either a feeding or behavioral response.

Fill-in planting was recommended in late summer or fall to avoid this type of damage which occurred in these new spring plantings. However, since 1991 is the second year of seedling mortality at Barriere Mountain, this may not be totally successful, and some additional damage could occur in 1992. A follow-up survey is planned in 1992 and if this problem reoccurs, it should be an issue for some research in the future.

Acid rain monitoring

As part of the Acid Rain National Early Warning System (ARNEWS), a 10 X 40 m plot was established in 1985 in the Okanagan TSA, in the Twin Lakes area south of Penticton, to detect and monitor any impact of air and rain borne pollution on native trees and indicator plants. Visual assessments of plot vegetation and pest conditions are conducted annually. No symptoms of damage from acidic or toxic rain were found in 1991, only the effects of western spruce budworm defoliation which included partially chewed, discolored and missing foliage on up to 40% of the crowns of Douglas-fir.

PESTS OF YOUNG STANDS

Surveys of 2 to 60-year old stands, of which most were 1989/90 FRDA-treatments, were completed in mid to late summer, comprising 5686 trees in 494 plots at 43 locations (Table 10). This was part of a continuing evaluation of major pests and environmentally related problems and their impact on both naturally regenerated, planted and treated areas, i.e. brush control, spacing, fertilizing etc. Analyzing this data on an annual basis gives a broad overview of pests of young stands rather than quantifying the intensity and incidence of specific problems. Additional surveys in subsequent years will provide a larger data base from which these numbers can be obtained for particular pests.

The methodology consists of identifying and quantifying pests and assigning them a severity category according to their impact on stocking levels/volume losses. 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 10. Severity and occurrence of pest types, based on surveys of 43 young stands in the Kamloops Region, 1991.

Pest type[1]	Hosts[2]	Severity index[3]	Percent of total
Pest Free	alF,eS,lP,wH, wC,wP,D-fir,wL	1	63
Needle Diseases	alF,D-fir,lP,wL,wP	2,3,6	17
Sucking insects	alF,D-fir,eS,lP,	2,3,4	8
Defoliators	alF,wH,D-fir,eS,lP	2,3	5
Abiotic	alF,D-fir,eS,lP,mH, wL,wC	2,3,4,5	4
Stem Diseases	lP,alF,eS	2,3,4,5,6	2
Mammal Damage	alF,eS, wH,,lP,	3,4,5	1
Woody Tissue Feeders	eS,lP	2,4,5	1

[1] see text for breakdown of pest type.
[2] alF - alpine fir;D-fir - Douglas Fir;eS - Engelmann spruce;lP - lodgepole pine;wC - western red cedar; wH -western hemlock;wP - white pine; mH -mountain hemlock
[3] Severity Index (SI)
SI 1=Pest Free
SI 2=damage negligible or very short term
SI 3=Loss of current growth potential
SI 4=Some net loss of volume and/or significant long term loss of growth potential
SI 5=Life threatening
SI 6=Recently dead-grey or red standing.

Table 11. Summary of pest losses in 43 young stands according to Severity Index, Kamloops Region, 1991.

Severity Index	Percent of Total
1	63
2	18
3	15
4	3
5	<1
6	<1

In terms of impact on stocking levels, less than 5% of those trees sampled were in severity categories which indicate long term growth loss or death.

Table 12. Severity indexes expressed as a percentage of the total number of host trees sampled, Kamloops Region, 1991.

Host	% of total trees sampled	% according to Severity Index[1]					
		1	2	3	4	5	6
Pine species	61	57	21	17	4	<1	<1
Engelmann spruce	18	70	8	19	3	<1	-
Alpine fir	7	67	14	15	4	-	-
Western hemlock	5	94	4	1	-	-	1
Douglas-fir	4	47	44	2	4	-	3
Western red cedar	3	98	-	-	1	-	1
Western larch	1	32	68	-	-	-	-
White pine	1	83	13	2	2	-	-

[1] As defined in Table 10.

PINE PESTS

Lodgepole pine was recorded in 37 plantations, with a total of 3426 trees sampled, of which 57% were pest free.

Stem rusts on lodgepole pine accounted for 4% of the total number of pests on pine, with the majority being western gall rust, Endocronartium harknessii. Branch and stem galls of this rust were noted in 16 plots scattered throughout the Region. The greatest incidence occurred in stands located in the Big White area, where up to 32% of the pine sampled had branch or stem galls (SI

3 or SI 4). Stem infections by western gall rust and Commandra blister rust, Cronartium comandrae can cause significant volume losses or mortality by girdling or wind breakage at the cankers, whereas branch infections will lead to minimal volume losses.

Lodgepole pine dwarf mistletoe, Arceuthobium americanum, occurred at one site near Isintok Lake in the Penticton District. At present the incidence is low; however, the adjacent mature stand was severely infected, and will eventually lead to a higher incidence in the plantation. Stem infections will reduce wood quality and lead to volume losses (SI 4).

Needle discoloration by lodgepole pine needle disease caused by Lophodermella concolor, occurred at 15 of the 37 stands containing lodgepole pine, and accounted for 24% of the pests found on pine. Infection intensities varied from 10-30% of last year's foliage. Infections of lodgepole pine needle cast usually cause little growth loss, unless severe infections under suitable climatic conditions become repetitive. Light infections of Scirrhia pini on white pine were observed at a stand along Whitewater Road.

Light to moderate (SI 3) defoliation by pine needle sheathminer, Zelleria haimbachi occurred in 5 stands, located in the Vernon, Salmon Arm, Clearwater and Kamloops Districts, representing 5% of the lodgepole pine examined. The most severe infestation was found in a spaced stand near Haines Creek, Salmon Arm district, where 95% of the lodgepole pine were infested.

Pine terminal weevil, Pissodes terminalis, was recorded in 8 stands in the Penticton District and 1 stand in the Kamloops District, accounting for <1% of pests found on pine. Intensity within stands was low with the highest occurring in the Big White area, where 9% of the trees were attacked. Feeding by pine terminal weevil will result in terminal dieback causing significant growth losses and lowering of timber quality i.e. SI 4. Warren's root collar weevil, Hylobius warreni, was only noted at 2 sites and on a total of 3 trees. Complete girdling of the root collar area by this weevil will lead to tree mortality.

Other pests of minor significance were; western spruce budworm, Choristoneura occidentalis, Giant conifer aphids, Cinara sp., gall aphids, Pineus sp., Atropellis canker, Atropellis piniphila, Sequoia pitch moth, Synanthedon sequoiae, Northern pitch twig moth, Petrova albicapitana and gouty pitch midge, Cecidomyia piniinopis.

DOUGLAS-FIR PESTS

Douglas-fir was encountered in 8 of the stands surveyed, with a total of 223 trees sampled, of which 47% were pest free.

Infestations of western spruce budworm, Choristoneura occidentalis, occurred on 10% of the trees sampled, all of which were located in a single plantation near Haines Creek in the Salmon Arm District. Defoliation was light and therefore damage was rated as SI 2. Severe or repeated infestations of spruce budworm can lead to growth losses and tree mortality.

Cooley spruce gall adelgid, Adelges cooleyi, was recorded on 30% of the Douglas-fir sampled, with severity ratings of SI 2. Douglas-fir acts as the alternate host to this pest, and unless infestation intensity is severe, damage is minimal.

Moderate infections (SI 3) of conifer-cottonwood rust, Melampsora occidentalis, were recorded on 3% of the trees. Incidence and intensity of needle diseases are directly related to climatic conditions and under normal conditions minimal damage results.

SPRUCE PESTS

Engelmann spruce occurred in 31 of the stands surveyed, with a total of 1029 trees sampled, of which 70% were pest free.

Infestations of adelgids, A. cooleyi and/or Pineus sp. were found on 22% of the Engelmann spruce. Severity ratings ranged from SI 2 to SI 5, with the most severe infestation occurring near Bigg Creek in the Vernon District. Damage by both these pests is usually minor, however severe infestations or repeated attacks can result in stunted, deformed trees.

White pine weevil, Pissodes strobi, damage was recorded on 2% of the spruce sampled, with the majority occurring at Silence Lake, in the Clearwater District. Weevil damage is usually rated as SI 4, since net loss of volume and/or significant long-term growth loss will occur as a result of terminal dieback.

ALPINE FIR PESTS

Alpine fir was recorded in 29 of the stands surveyed, with a total of 402 trees sampled, of which 67% were pest free.

Light (SI 2) and moderate (SI 3) infections of the Fir-fireweed rust, Pucciniastrum epilobii, occurred on 18% of the alpine fir surveyed. Infection intensities ranged from 30%-80% of this year's foliage. As with other needle rusts, severe infections can lead to growth reduction and defoliation of the current growth.

Western spruce budworm, Choristoneura occidentalis and Balsam twig aphid, Mindarus abietinus were recorded, but numbers were too low to cause any damage.

WESTERN LARCH PESTS

Western larch was recorded in 5 of the stands surveyed, with a total of 62 trees sampled, of which 32% were pest free.

Larch needle blight caused by Hypodermella laricis, was found on 34% of the larch sampled. Damage is usually limited to minor growth reductions (SI 2), but tree mortality is possible after successive years of severe defoliations.

MULTIPLE HOST PESTS

Abiotic

The most common damage encountered was that caused by frost or snow, usually on lodgepole pine, alpine fir or engelmann spruce. This type of damage was most apparent at high elevation sites in the ESSF biogeoclimatic zones. Drought, which affected mainly western larch, flooding, mechanical damage, poor form, poor site and winter drying were also recorded. Combined incidence of these pests accounted for 4% of the trees surveyed throughout the Kamloops Region. Local topography, aspect and site conditions all influence the incidence and intensity of abiotic injuries and normally result in decreased wood quality and/or volume losses.

Mammals

Mammal damage caused by cows, deer, rabbits and squirrels accounted for 1% of all pests found on all species. Lodgepole pine trampled on by cattle exhibited mainly branch breakage. Deer browsing of mostly western red cedar and some alpine fir, causing multi-topped bushy trees, will result in growth losses (SI 3,4). Feeding by squirrels and to a lesser extent rabbits, on the stems of young lodgepole pine may eventually lead to tree mortality.

DECIDUOUS TREE PESTS

Forest tent caterpillar
Malacosoma disstria

Defoliation of trembling aspen, black cottonwood, birch and willow doubled to 6500 ha in the region in 1991, the third consecutive year of damage. Defoliation occurred in 38 separate patches along the North Thompson Valley between Barriere and Avola and north of Clearwater in Wells Gray Provincial Park. Small scattered infestations in the Salmon Arm area declined, following an increase in 1990.

The largest single infestation covered 1400 ha of moderate defoliation in Wells Gray Park near Hemp Creek, followed by 1000 ha of light and moderate defoliation near Blackpool, similar to 1990. Other large infestations up to 750 ha were found along the Mad and Clearwater rivers, and near Little Fort. Smaller infestations were common on river bottom land and islands in the North Thompson River between Barriere and Clearwater. Most defoliation was light or moderate, although individual or small clumps of 5 to 30 trees each were sometimes totally stripped.

While no overwintering population assessments were completed, observations of significant moth flights, historical data, and some cursory ground observations indicate a continuance of the outbreak for 1992. Outbreaks of tent caterpillar are eventually controlled by a variety of biotic factors, including parasites, predators and a nuclear polyhedrosis virus (NPV). To date there has been no evidence of tree mortality or significant branch dieback resulting from defoliation.

Gypsy moth
Lymantria dispar

No gypsy moth adults were caught in any pheromone-baited traps distributed throughout the Kamloops Region in cooperation with Agriculture Canada (Plant Health) and the B.C. Forest Service. FIDS deployed 39 traps at provincial parks.

Elsewhere, about 72 male gypsy moths were caught in 17 areas, from 8 000 traps monitored in British Columbia in 1991. Nine of the 72 adults were confirmed to be the Asian strain of gypsy moth, and another 13 are suspected. This is the first capture of this strain in North America. Most of the captures were from the lower mainland and southern Vancouver Island.

OTHER NOTEWORTHY PESTS
CURRENTLY ACTIVE IN THE KAMLOOPS FOREST REGION, 1991

Pest	Host(s)[1]	Location	Remarks
Douglas-fir needle midge, Contarinia pseudotsugata	D-fir	Dunn Lake	Light infestation, common on immature in area.
Turpentine beetle, Dendroctonus valens	pP	Barnhartvale	Scattered single attacks in urban area.
Warren's root collar weevil, Hylobius warreni	lP	Bonaparte Rd., Mayson Lake	Scattered light (1%) mortality in plantation.
Fall webworm, Hyphantria cunea	roadside trees and shrubs	widespread	Scattered light to moderate defoliation.
Webspinning sawflies, Pamphilidae	pP	S. of Peachland	Isolated gregarious colonies; trace defoliation
White pine weevil, Pissodes strobi	eS	W. of Darfield	5-30% of advanced regeneration infested in several pockets.
Fir mealy bug, Puto cupressi	alF	Debbie L. Rd.	Extensive gouting of semi-mature trees
Stalactiform blister rust, Cronartium coleosporioides	lP	Murtle L. Rd.	1% stem infection in plantation.

(Cont'd)

Pest	Host(s)[1]	Location	Remarks
Swiss needle cast. *Phaeocryptopus gaeumannii*	D-fir	Sugar Lake Rd.	60% of young growth 80% infected in plantation.
Phellinus root rot, *Phellinus tremulae*	tA	Halamore Lake	Common in area of mature tA.
Rhizina root rot *Rhizina undulata*	lP	Clearwater, TFL 18	Suspected cause of 25% seedling mortality in localized area.
Poplar twig and shoot blights *Venturia populina*, *V. macularis*	bCo, tA	Tyaughton Cr. Brookmere	90% infection on 10% of trees on 100 ha.
	tA	Peachland Main	50% foliage infection of roadside regen.
Fir needle rust, *Uredinopsis pteridis*	alF	Kingfisher Rd.	100% infection of new growth on one tree.
CLIMATIC DAMAGE Drought	wL	Upper Campbell Creek	50% foliage discoloration on half of 40 ha plantation.
Frost	D-fir	Brookmere	80% discoloration of new growth of single trees.
	wH	Laforge Rd.	20-100% discoloration over 30% of plantation.
	tA	Mosquito Main	10% of immature aspen 40% discolored.
Snow	D-fir	Whistle Creek	Extensive bending of immature trees for 6 km along road.
Deer browsing	lP	Bear Cr. Main	5% of tops clipped in 40 ha plantation. Common example for Region.

(Cont'd)

Pest	Host(s)[1]	Location	Remarks
Salt damage	D-fir pP	Fountain Valley, Westwold, Carquile, Anarchist Mtn.	Severe discoloration of roadside trees in localized areas.
	lP	Sunday Summit	

[1] alF - alpine fir; bCo - black cottonwood; D-fir - Douglas-fir; eS - Engelmann spruce; lP - lodgepole pine; pP - ponderosa pine; tA - trembling aspen; wH - western hemlock; wL - western larch

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