Forest Insect and Disease Conditions Kamloops Forest Region - 1994

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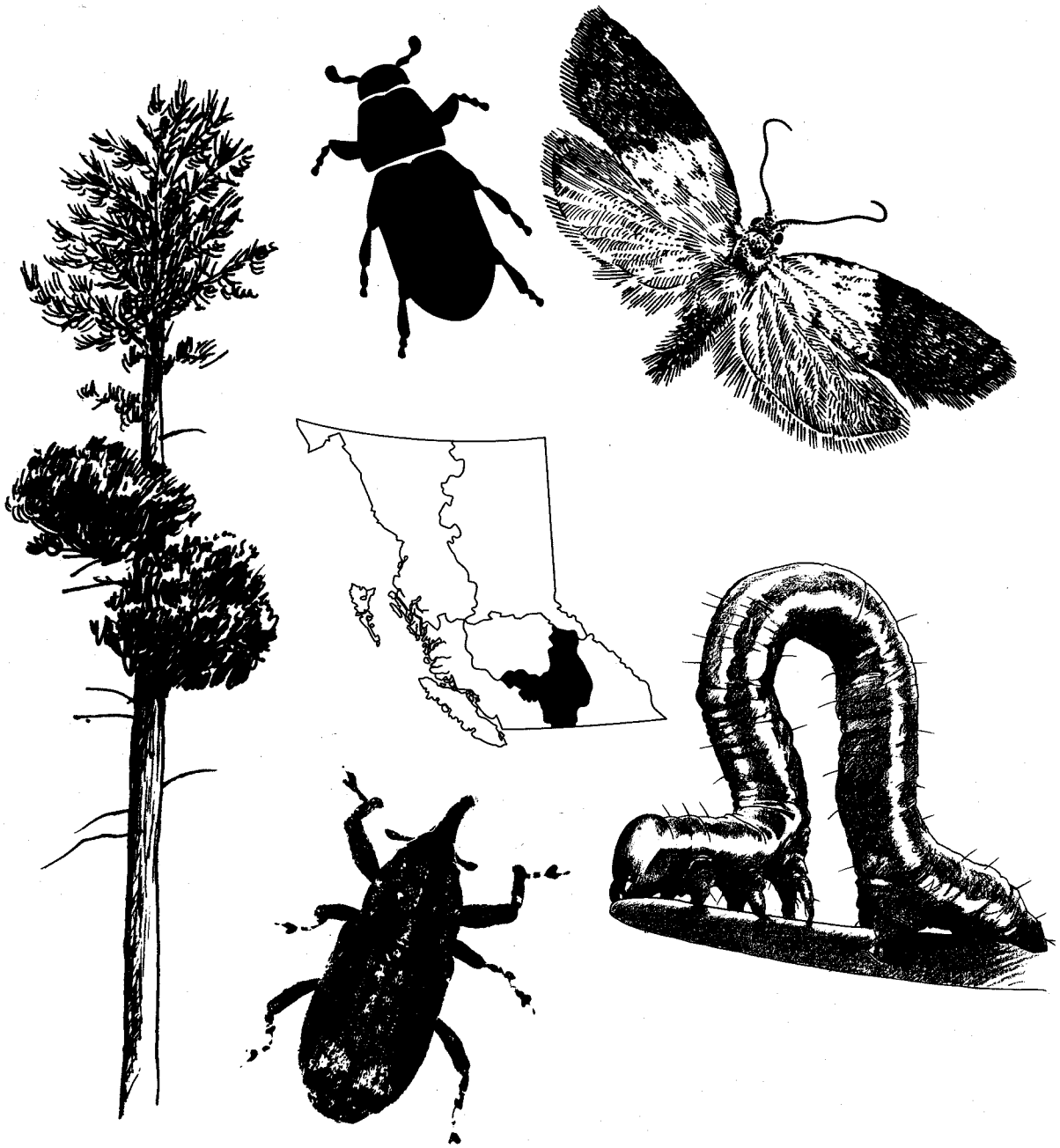
Canadian Forest Service - Pacific and Yukon Region



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Contents

Foreword

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 1994, 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 the Canadian Forest Service 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.

Introduction

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 215 insect and disease collections were submitted for identification and verification to the Pacific Forestry Centre (PFC). Some of these specimens were added to the extensive permanent collections in the PFC Insectary and Herbarium. Provincial government agencies, industry, and private sources submitted additional insect and disease collections. Approximately 400 contacts and on-site pest examinations were made personally and 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 their participation in a cooperative survey and for the provision of 86 hours of fixed-wing and 1 hour of helicopter aerial survey time and assistance in producing preliminary regional sketch maps. The area covered by the aerial survey is shown on Map 1.

Definitions:

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.

Incidences of trees killed by bark beetles are defined as:

light- 1-10% of the stand; **moderate**- 11-29%; **severe**- 30%+.

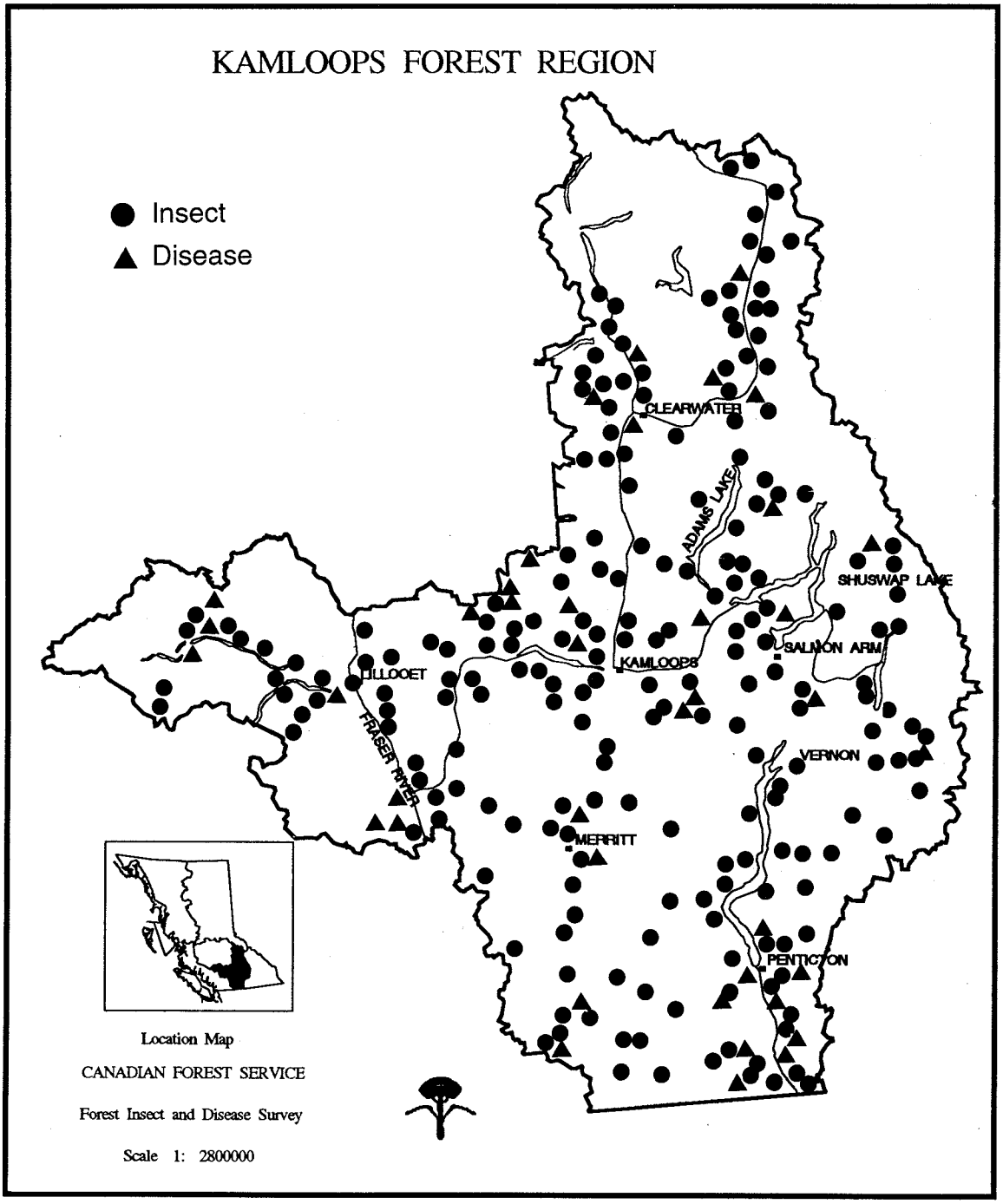

Figure 1. Location where one or more forest insect and disease samples were collected in 1994.

Summary

While infestations of the **mountain pine beetle** are much reduced from 1993, it continues as the most destructive forest insect in the Kamloops Forest Region, killing nearly 1.4 million lodgepole pine and white pine on 8865 ha.

The majority (69%) of the infestation remains in the Penticton Forest District. Areas of recent ponderosa pine mortality attributed to **western pine beetle**, declined to only 80 ha from 300 ha in 1993, most of which were in the Penticton Forest District. The **gouty pitch midge** was identified as the primary cause of ponderosa pine deformity and decline in the South Okanagan. Damage characteristics include faded yellow or red drooping needles, chlorosis, and branch dieback. The **pine needle diseases**, including **pine needle cast**, and **Elytroderma needle disease**, continued to be prominent throughout their respective host ranges. **Salt damage** to roadside trees is a continuing problem along Carpenter Lake.

The area and intensity of **western spruce budworm** defoliation declined for the third consecutive year to 14 250 ha. The majority of the infestations were in mixed age-class Douglas-fir stands in the Okanagan and Merritt TSA's. Egg samples indicate that budworm populations should rise slightly in 1995. After increasing in area in 1993, **Douglas-fir beetle** outbreaks declined by 50% to 775 patches covering 600 ha, mostly near Lillooet, Kamloops and Sicamous. Pockets of infestation generally contained from 5 to 30 trees each. Populations of **Douglas-fir tussock moth** collapsed in all areas of the region in 1994 and no defoliation was recorded. Continued endemic levels are expected in 1995.

Spruce beetle outbreaks increased to 2500 ha from 2040 ha in 1993, the third consecutive increase in area infested. While several new pockets were scattered in the Region, the majority occurred in previously infested stands in the Merritt and Lillooet TSA's. Light to moderate defoliation of spruce and alpine fir forest by **two-year cycle spruce budworm** extended over 18 200 ha in Clearwater Forest District including Wells Grey Provincial Park. "Off-cycle" budworm lightly defoliated an additional 400 ha in the Vernon Forest District.

Populations of **spruce weevil** and attacks to spruce leaders are increasing in the Region. Of 24 managed plantations aged 11 to 19 years old, 71% were attacked, affecting an average of 17% of spruce in each stand.

Recent infestations of **western balsam bark beetle** as determined from aerial surveys, numbered 100 and declined to 2870 ha from 5200 ha in 1993. The largest infestation is in the Taweel Lake area and covers 1100 ha. Surveys of 15 selected immature *Abies* spp stands for **balsam woolly adelgid** along the boundary with Vancouver Forest Region, found no evidence of the pest.

Following three successive years of defoliation by **western hemlock looper**, populations collapsed and there was no new damage. Tree mortality from previous defoliation was mapped over 15 500 ha in the North Thompson Valley, Wells Grey Provincial Park, and the upper Adams River drainage. **Western blackheaded budworm** populations increased, causing light to moderate defoliation on 1414 ha in the Salmon Arm and Vernon Forest districts.

Infections and discoloration of western larch by **larch needle diseases** declined for the third year to only 300 ha, from 420 in 1993. **Larch casebearer** populations increased, causing moderate defoliation on 300 ha near Vernon and light defoliation on immature roadside larch along Shuttleworth Creek.

Black army cutworm populations remained relatively low for the sixth consecutive year and there were no reports or observations of damage to seedlings. Low populations are again predicted in 1995 in areas where pheromone traps were deployed.

Pests of Young Stands surveys were completed in 46 young stands, mostly treated under the FRDA II agreement. Pest occurrence and damage was assessed on 6170 trees in 544 plots. Only 1% of trees of all species were killed or affected by life threatening agents. More than half of all trees examined were pest free. Two biomonitoring plots established in 1992 and a third **acid rain monitoring** plot established in 1986 were re-examined and showed no damage associated with acid rain. A biodiversity study at the Monte Creek site also included sampling of pitfall and flight interception traps, primarily for beetles.

Defoliation of trembling aspen and black cottonwood by **satin moth** totalled 168 ha in southern areas of the Region, down from 250 ha in 1993. No male **gypsy moths** were caught in any of 42 pheromone-baited traps distributed in provincial parks throughout the Kamloops Forest Region. A **birch leafminer** discolored birch over several thousand hectares in scattered areas on both sides of Adams Lake. For the first time in many years the **aspen leafminer** caused widespread damage in trembling aspen stands along the Adams River Valley.

Other noteworthy pests mentioned near the end of this report are those that have the potential for causing significant damage, but are presently at low levels or causing damage in localized areas.

Pine Pests

Mountain pine beetle
Dendroctonus ponderosae

While the area of mountain pine beetle infestation is much reduced from 1993, it remains the most damaging forest insect in the Kamloops Forest Region, having a major impact on harvesting schedules of lodgepole pine and on watershed, recreational, wildlife, and other resource values. The majority of the outbreak remains in the Penticton Forest District, 69% of the total infestation area, followed by the Merritt District at 22%.

Beetle infestations in 1994 declined in area to 8865 ha from 19 920 ha in 1993, killing an estimated 1 391 000 mature lodgepole pine and white pine (Table 1, Figures 2,3). Pine volume losses totalled more than 494 000 m^3 in 1994, a 70% reduction from 1993. This is the second consecutive annual decline, brought on by continued management action, lower attack densities and below average 1993 brood development, particularly in the Okanagan Valley. A continuation of the same management strategies and a general host depletion, will likely result in a further reduction in 1995.

Table 1. Recent pine[1] mortality (red attack) caused by mountain pine beetle as determined from aerial and ground surveys, Kamloops Forest Region, 1994.

TSA[2]/ District	Number of infestations	Area (ha)	Number of trees killed	Volume of trees killed(m^3)
Kamloops TSA				
Kamloops District	66	164	10 700	7 500
Clearwater District	85	165	6 500	6 000
Okanagan TSA				
Salmon Arm District	85	28	6 250	2 200
Vernon District	233	387	86 250	30 200
Penticton District	1 449	6 105	913 700	319 800
Merritt TSA				
Merritt District	981	1 977	359 000	125 700
Lillooet TSA				
Lillooet District	12	39	8 600	3 000
Totals	2 911	8 865	1 391 000	494 400

[1] - lodgepole pine, white pine, ponderosa pine.

[2] - includes TFL's, parks and non-tenure areas.

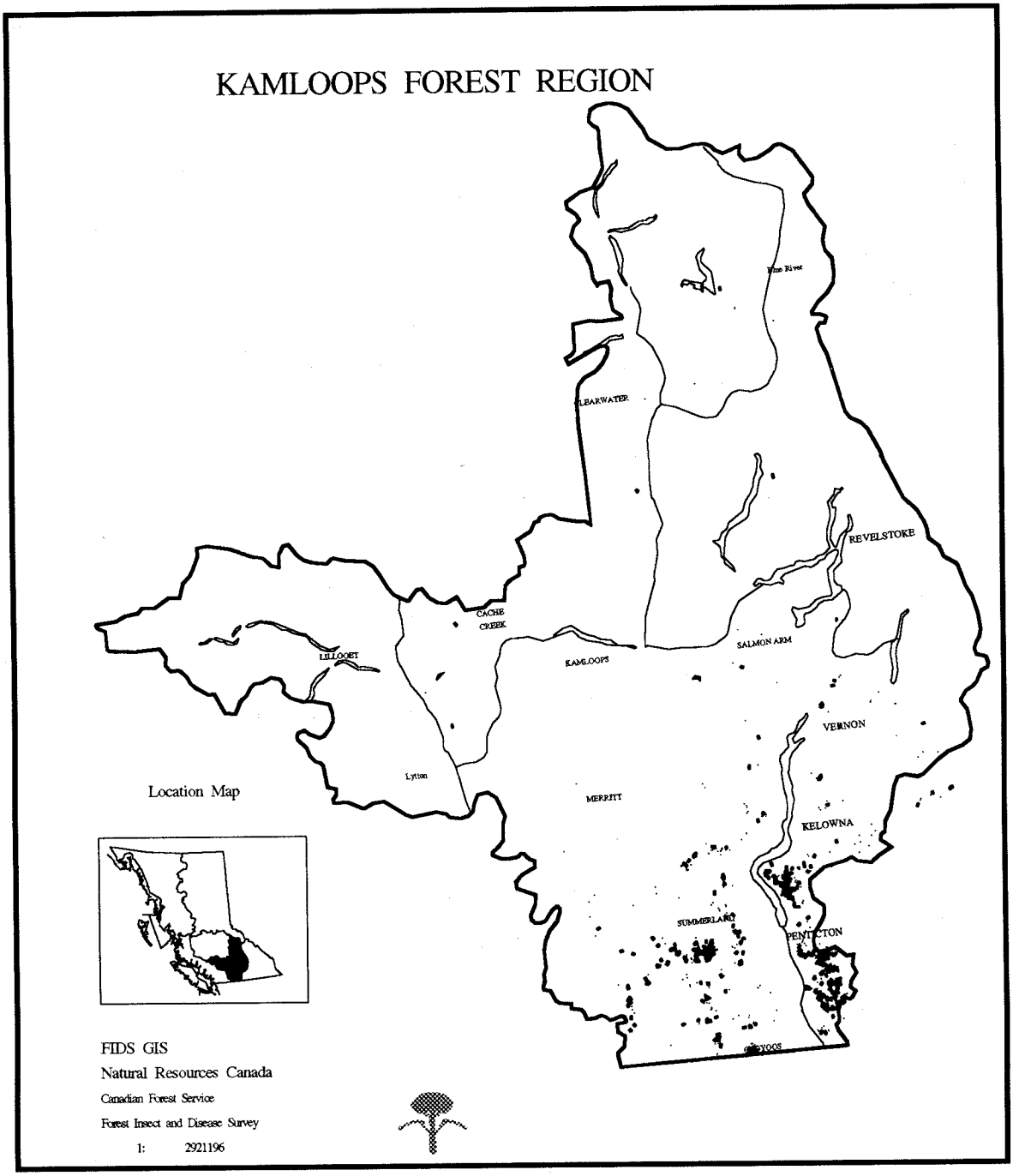

Figure 2. Areas of pine recently killed by mountain pine beetle as determined by aerial and ground surveys, 1994.

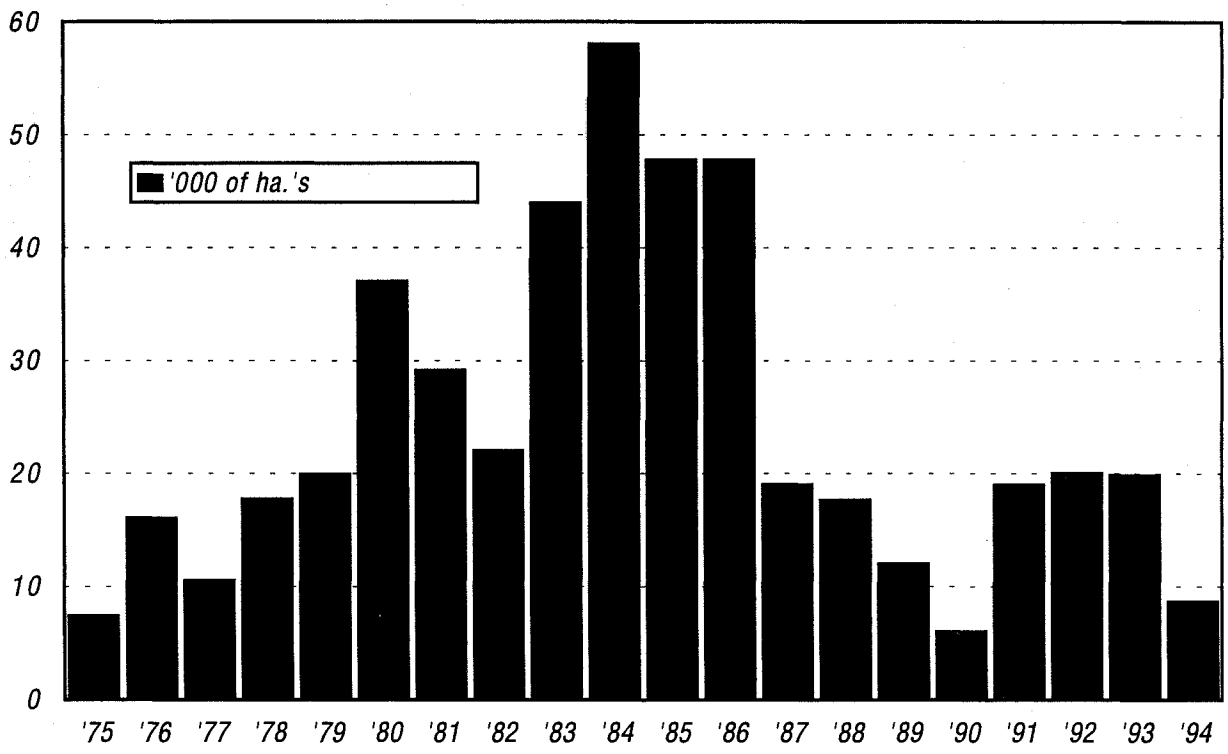

Figure 3. Area (ha) of mountain pine beetle infestation, 1975-1994, Kamloops Forest Region.

Kamloops TSA

Beetle activity in stands of lodgepole pine and white pine declined to 329 ha, from 555 ha in 1993 (Table 2). Beetles killed an estimated 17 200 trees, mostly white pine in the North Thompson and Adams rivers drainages. This reduction is primarily the result of a continuation in the decline of several of the larger infestations in stands at Murtle lake in Wells Gray Park, in the upper Adams Lake area near Momich Lake and in the Adams River drainage at Mica Creek and Dudgeon Lake. Both host depletion and control initiatives have had the most impact on this trend. However, there was some increase in spot infestations containing 5 to 20 trees each along the North Thompson Valley north of Avola and in the Mud Lake area. Small infestations did not change substantially from 1993 in most stands containing white pine between Blue River and Albreda and in the Barriere lakes area, or in lodgepole pine stands along Paxton Valley. Along Georges Creek near Monte Lake, there was some spread in small patches of lodgepole pine east of areas previously infested. Two small infestations were recorded in the Hat Creek Valley, near Popcock Creek and Blue Earth Lake, where none was detected previously.

Table 2. Major mountain pine beetle infestations, Kamloops Forest Region, 1994.

TSA and Location	Red 1994[1] (ha)	Red 1993 (ha)	Change 1993-94 (ha)
Kamloops TSA			
Barriere Lakes-Fennel Creek	4	70	-66
Vavenby-Albreda	125	120	+5
Adams Lake-Adams River	48	331	-283
Kamloops-Barriere	30	3	+27
Monte Hills-Chase	72	31	+41
Hat Creek-Cache Creek	50	-	+50
Subtotal	329	555	-226
Okanagan TSA			
Humamilt Lake-Seymour Arm	5	125	-120
Three Valley-Mabel Lake	5	35	-30
Sicamous-Yard Creek	5	12	-7
Monte Lake-Sorrento-Falkland	31		+31
Salmon Arm-Enderby	10	-	+10
Shorts Creek-Falkland	49	340	-291
Coldstream-Armstrong	93	113	-20
Lumby-Keefer Lake-Sugar Lake	82	328	-246
Upper Kettle River	172	78	+94
Mission-Belgo-Daves creeks	29	156	-127
Ideal Lake-Vernon	41	168	-127
Dale Creek-Campbell Creek	29	210	-181
Penticton Creek-Chute Lake	1 350	1 510	-160
Hydraulic Lake-Lebanon Lake	136	710	-574
Trepanier Creek-Lambly Lake	192	250	-58
Okanagan Mountain Park	229	1 788	-1 559
Trout Creek-Peachland	586	1 700	-1 114
Vaseux Creek-Saunier Creek	1 860	5 589	-3 729
Inkaneep Creek	607	1 019	-412
Shoudy Creek-Ollala	469	1 138	-669
Yellow Lake-Fairleigh Creek	325	694	-369
Cathedral Park-Ewart Creek	215	566	-351
Subtotal	6 520	16 529	-10 009

(Cont'd)

Table 2. (Cont'd)

TSA and Location	Red 1994[1] (ha)	Red 1993 (ha)	Change 1993-94 (ha)
Merritt TSA			
Merritt	5	30	-25
Douglas Lake-Sawmill Lake	2	148	-146
Spences Bridge	0	30	-30
Jellicoe-Princeton	148	189	-41
Princeton-Merritt	64	128	-64
Hedley-Princeton	1 423	1 549	-126
Coalmont-Manning Park	335	74	+261
Subtotal	1 977	2 148	-171
Lillooet TSA			
Duffey Lake-Cayoosh Creek	2	3	-1
Pasulko Lake-Murray Creek	37	0	+37
Subtotal	39	3	+36
Regional Total	**8 865**	**19 235**	**-10 370**

[1] Trees attacked in 1993, discolored in 1994

Okanagan TSA

Following a small decline in 1993, the area of active beetle infestation in lodgepole pine stands decreased by 60% to 6520 ha in 1994, with estimated losses of nearly 352 200 m^3. Aerial surveys detected 1767 separate infestations, the majority of which were small patches of 0.25 to 5 ha each. As in 1993, most of the decrease occurred on the east side of the Okanagan Valley, from Osoyoos north to Vernon, where beetles have been active for many years. This continuing decrease in infestation area is primarily the result of aggressive management strategies, in some cases combined with a lack of suitable host material and low brood survival due to overwintering mortality.

Due to prolonged beetle activity in the south Okanagan Valley, host depletions accounted for a 60% reduction in infested area, mostly on the east side of Okanagan Lake in the Penticton, Campbell, Dale, Stirling, Vaseux, Saunier, Inkaneep creek drainages and the Chute Lake-Okanagan Park area. Infestations were also smaller and less numerous on the west side of the valley between Trout Creek and Lambly Lake and reduced by up to 50% in area in the Similkameen Valley between Shoudy Creek and Ollala and in the Cathedral Park area.

In the central Okanagan Valley, small infestations in the Upper Kettle River drainage more than doubled in size to a total of 178 ha. Declines continued in the Mission-Belgo-Daves creeks area, between Ideal Lake and Vernon, east of Lumby, and on the west side of Okanagan Lake from Shorts Creek to Falkland.

Following slight increases in 1993, scattered pockets of attack in white pine declined in northern parts of the TSA near Humamilt Lake, Anstey Arm, and Yard Creek. Most of these outbreaks are in mixed stands where rate of spread is low.

Merritt TSA

After an increase in 1993, infestations declined by 8% to 1977 ha. Lodgepole pine volume losses involving 359 000 stems were estimated at 125 700 m^3. Approximately 70% of the infestation area occurred between Hedley and Princeton, where the outbreak, composed mostly of spot infestations, declined by 126 ha from 1993. Other areas of significant decreases in numbers of red trees include the Douglas Lake-Sawmill Creek area and scattered locations between Princeton and Merritt. Notable increases occurred in the number of spot infestations of 5 to 25 trees each, totalling 335 ha between Coalmont and Manning Park, where brood assessments have shown a static to increasing population trend. Aggressive tactics, involving extensive MSMA treatments, fell and burn and semio-chemical baiting continue to be an integral part of pest management in the Merritt Forest District, where underlying conditions such as stand age favor beetle development.

Lillooet TSA

Beetle activity in the Lillooet TSA continues to be limited to spot infestations, but their numbers have increased to 39 from only 2 in 1993. Some expansion was recorded at Pasulko Lake, Izman Creek and along Murray Creek, frequently in close proximity to stands of Douglas-fir infested with Douglas-fir beetle. A few small pockets of infested white pine and lodgepole pine remain infested near Duffey Lake and along Cayoosh Creek, similar to 1993, where steep terrain limits control options in these areas.

Forecast

Overwintering brood assessments and fall beetle cruises are the two types of annual surveys conducted to assist in estimating beetle population trends and determine tree condition. Brood assessments to determine "R" values are made in the spring to estimate infestation trend, and mortality of progeny (Table 3). Supplemented with fall cruises, this information helps to provide the levels of current attack, volume losses and outbreak trends. An overview survey conducted mostly by the B.C. Forest Service in the two most active districts of Merritt and Penticton, indicated with only two exceptions, a decreasing population trend for 1995. Of the 17 areas sampled, only Willis Creek and Pasayten River in the southern portion of the Merritt TSA showed populations to be continuing at static or increasing levels.

Table 3. Mountain pine beetle reproductive ratios and overwintering survival, Kamloops Forest Region, spring 1994

TSA/District	Location	"R" value[1]	Pop. status[2]	Overwinter mortality
Okanagan TSA				
Penticton Dist.	McDougall Creek	0.3	decreasing	39%
	West Kettle	0.1	decreasing	84%
	Headwaters	0.4	decreasing	23%
	Gillard	0.4	decreasing	31%
	Big Meadow	0.5	decreasing	45%
	Trout Creek	0.3	decreasing	37%
	Isintok	1.3	decreasing	61%
Merritt Dist.	Pasayten River	5.0	increasing	7%
	Willis Creek	3.1	static	19%
	Sunday Creek	1.0	decreasing	26%
	Whipsaw Creek	1.3	decreasing	0%
	Smith/Whistle creeks	1.9	decreasing	3%
	Stemwinder	1.8	decreasing	4%
	Stevens Creek	0.5	decreasing	18%
	Jura	0.1	decreasing	20%
	Tulameen	1.4	decreasing	1%
	Siwash	0.2	decreasing	0%
Overall average		**1.1**	**decreasing**	**33%**

[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 the population status:
- ≤ 2.5 - decreasing population
- 2.6-4.0 - static population
- ≥ 4.1 - increasing population

Elsewhere in the Kamloops Region, where cursory observations were made of brood development in both lodgepole and white pine, beetle production was generally low, indicating a continuing decline for 1995. While this prediction can be used as a general guide, deviations can be expected due to variations in slope, aspect, stand composition, management strategies etc., throughout the Region.

Local climate also strongly influences beetle populations. Unseasonably cool summers such as occurred in 1993 retarded brood development and reduced survival and subsequent green (current) attacks. As a result, beetle flights in 1994 were staggered, particularly in the southern half of the Region, where current attacks averaged only 5% in four representative areas (Table 4). These factors, plus continued management strategies aimed at reducing beetle infestation and further host depletion, point to a likely reduction in beetle populations over the next several years.

Table 4. Mountain pine beetle cruise data, Kamloops Forest Region, 1994.

Location/TSA	Percent pine attacked						Total pine volume (m^3/ha)
	Healthy	Current attack (1994)	Partial attack (1994)	Red (1993)	Grey (pre-1992)	Total	
Okanagan TSA							
Penticton Creek	95	2	-	2	1	100	310
Elinor Lake	50	11	1	19	19	100	149
Allendale Lake	76	5	5	5	9	100	467
Merritt TSA							
Stemwinder	91	3	1	5	0	100	325

Western pine beetle
Dendroctonus brevicomis

Areas of recent ponderosa pine mortality attributed to western pine beetle declined to only 80 ha from 300 ha in 1993. Only 40 small infestations were recorded during aerial surveys in the Penticton Forest District, although occasional small groups of 2 to 5 trees occurred elsewhere. The majority of infestations developed as small pockets of 5 to 20 trees each, mostly between Kaleden and Oliver. Smaller patches up to five trees each were common along Osoyoos and Skaha lakes, Ashnola River, Ellis Creek and in the Kamloops Forest District near Kamloops, Heffley Creek and Hat Creek Valley. Along the lower slopes, the western pine beetle was frequently associated with attacks by the red turpentine beetle and at higher elevations with both turpentine beetle and mountain pine beetle.

After the initial buildup of populations, precipitated by previous drought conditions, beetle attacks are expected to decline generally in 1995. However, overmaturity, root rot and fire will continue to play a significant role in population increase. Sanitation-salvage logging is the generally accepted method used to minimize losses.

Gouty pitch midge
Cecidomyia piniinopis

The gouty pitch midge has been identified as a significant contributor to ponderosa pine deformity and decline in vigor throughout many areas of the South Okanagan, particularly in the Bunchgrass Biogeoclimatic Zone. Occasional tree mortality, faded, yellow or red drooping needles, chlorosis, and branch dieback have been reported since 1991. Numerous other pests such as needle scales, pitch moths, sawflies, gall rust, pine moth and bark beetles were frequently found in association with the gouty pitch midge. The damage is first noticed in early summer when new shoots fade, droop and die. On some trees nearly every new shoot is affected. Typically attacks are most common on open growing pines and heaviest on trees with sticky twigs, and lighter on trees with drier twigs. Damage is difficult to predict as populations fluctuate widely from year to year due to natural control.

Pine needle diseases

Lophodermella concolor
Hendersonia pinicola
Elytroderma deformans

Foliage discoloration resulting from infections by native pathogens, continued over widespread areas throughout the host range of lodgepole pine and, to a lesser degree, ponderosa pine in the Kamloops Forest Region.

Discoloration and premature casting of year-old needles by *L. concolor*, frequently in association with the secondary blight fungus, *H. pinicola*, was mapped over more than 148 000 ha (Figure 4). Most of the stands were immature lodgepole pine, many of which were previously infected. The area estimation is likely low, as many of the infected needles were shed prior to aerial surveys, making area and severity assessments difficult. The largest areas of damage were found in the Merritt, Penticton and Vernon Forest districts.

In Merritt Forest District the most extensive areas of discoloration occurred along the Similkameen and Pasayten River valleys and upper Hayes and Siwash creek areas on nearly 50 000 ha. The most severely affected stands with up to 100% year-old needle discoloration were noted between Pasayten River and Copper Mountain, along Whipsaw Creek and at Aspen Grove. The occurrence of needle cast in Penticton Forest District was most severe in the Ashnola River Valley, north of Apex Mountain, and along Ellis, Peachland, Klo, and Sterling creeks. Lighter discoloration over widespread areas was recorded west of Okanagan Falls, west of Summerland and east of Kelowna. In Vernon Forest District light to moderate foliage browning was extensive south of Westwold in the Monte and Barton Hills areas, at Aberdeen lakes, and in scattered locations south of Mabel Lake. Elsewhere, more than 12 600 ha of light to moderate discoloration were mapped in Kamloops Forest District, mostly between Tunkwa Lake and Bonaparte Lake. Other smaller areas in the Region, include infected stands along Carpenter Lake, Yalakom River, Highland Valley, McLure, Mahood Lake, Vavenby and Anstey Arm. The extent and intensity is similar to the past two years and includes many managed stands that were spaced, thinned, pruned or fertilized.

The present epidemic in 1994 was perpetuated by moist conditions in late spring and early summer of 1993. These conditions conducive to infection spread were not as common in 1994 and should help to reduce inoculum spread and discoloration for 1995. Increment loss can be expected in stands with chronic foliage loss due to successive years of infection.

Elytroderma needle disease, caused by *Elytroderma deformans,* continued to be widespread on ponderosa pine, adversely affecting its growth throughout the Ponderosa Pine and Bunchgrass biogeoclimatic zones in the Region. Affected trees usually display prominent witches' brooms and needle browning and make little perceptible growth. Severely diseased pines are susceptible to attacks by the red turpentine beetle. Some notable areas of increased disease occurrence include stands along Green Mountain Road, southwest of Princeton, near Savona, Bridge River, Hat Creek, Paul Lake and Pritchard where up to 80% of the foliage was affected.

Salt damage

The cumulative impact of years of salt usage along Carpenter Lake (reported in previous years) has resulted in thinned crowns, dieback of tops, and tree mortality of ponderosa pine and Douglas-fir, mostly on the lower side of the road. This appears to be a chronic problem area and would be a good candidate for an alternate de-icing method. In addition to the aesthetics, slope stability is also being compromised in several areas where tree mortality is high.

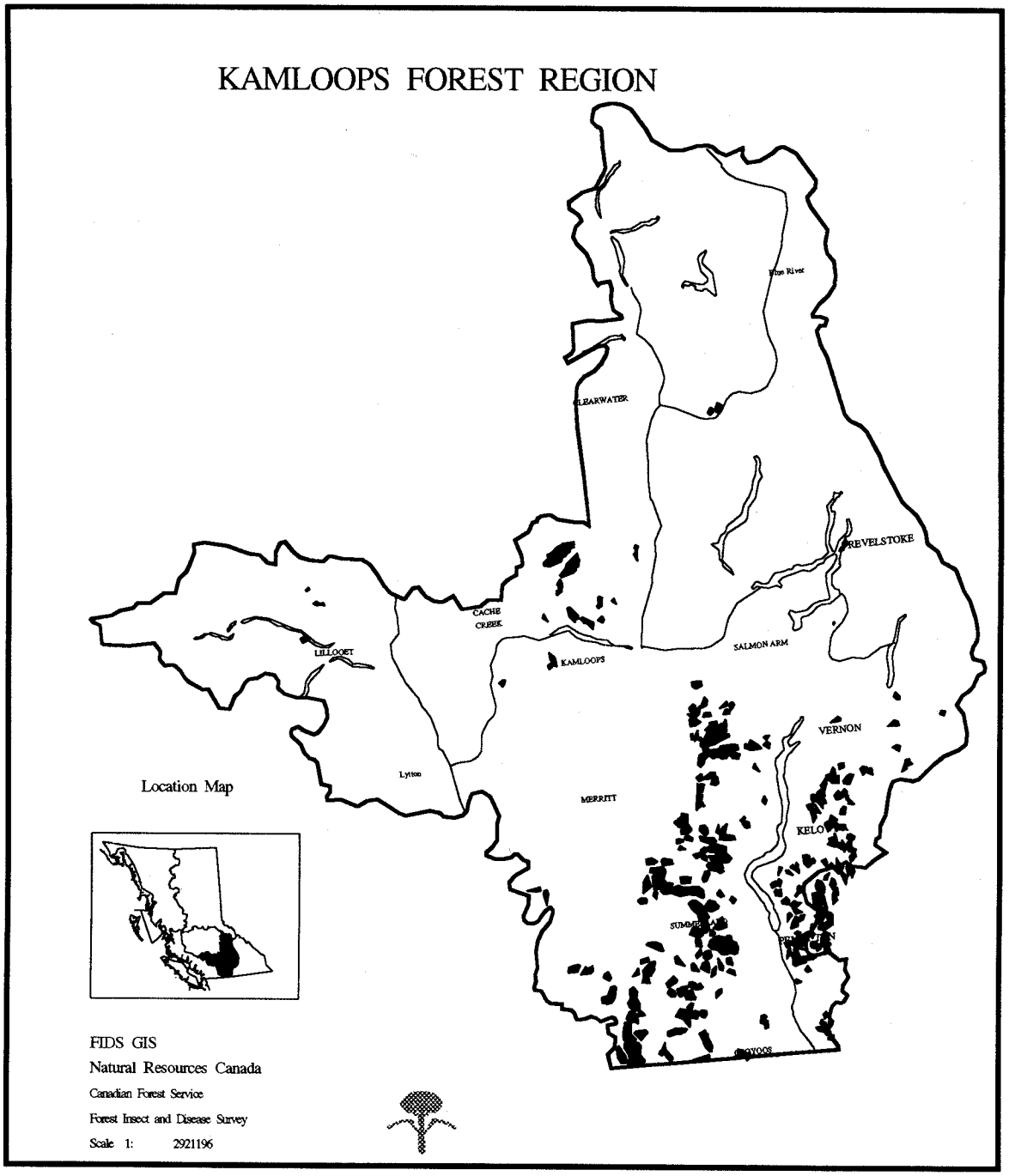

Figure 4. Areas of lodgepole pine infected by pine needle cast, *Lophodermella concolor,* as determined by ground and aerial surveys, 1994.

Douglas-fir Pests

Western spruce budworm
Choristoneura occidentalis

Aerial surveys of western spruce budworm defoliation indicated a decline in area of nearly 65% from 1993 to 14 250 ha, of which 6750 ha were lightly defoliated, 7350 moderate, and 150 severe (Figures 5 and 6). This is the third successive year of reduction in area and defoliation intensity. The majority of feeding was in mixed age-class Douglas-fir stands in the Okanagan and Merritt TSA's (Table 5). Trace levels of defoliation not visible during aerial surveys were observed in many stands previously infested.

Table 5. Area of Douglas-fir defoliated by western spruce budworm, by TSA, as determined from aerial and ground surveys, Kamloops Forest Region, 1993 and **1994.**

	Area of defoliation (ha)						
	Light		Moderate		Severe		Total
TSA	1993	**1994**	1993	**1994**	1993	**1994**	**1994**
Okanagan	16 100	2 500	50	2 500	0	150	5 150
Merritt	12 600	1 600	0	3 950	0	0	5 550
Lillooet	4 900	1 550	1 600	0	0	0	1 550
Kamloops	3 500	1 100	250	900	0	0	2 000
Totals	37 100	6 750	1 900	7 350	0	150	14 250

Damage

The area of infestation in the **Okanagan TSA** declined to 5150 ha from 16 150 ha in 1993. The majority of defoliation was light to moderate on 5000 ha. Most occurred in the Penticton Forest District in 12 patches between Westbank and Summerland and in five areas west of Kaleden at elevations from 700 to 1300m. The only area of severe defoliation was on 150 ha along Peachland Creek, where some scattered top-kill may occur. Elsewhere, there was light defoliation along Okanagan Lake near Vernon and south of Silver Star Mountain in Vernon District totalling 100 ha and east of Chase in Salmon Arm District on 50 ha. Successive years of defoliation have led to scattered tree mortality and top-kill in the Salmon River Valley-Monte Hills area, Postill Lake, Glenrosa, along Peachland Main, Darke Lake, Chute Lake Rd, Apex-Yellow Lake area, Mount Kobau and Anarchist Mountain.

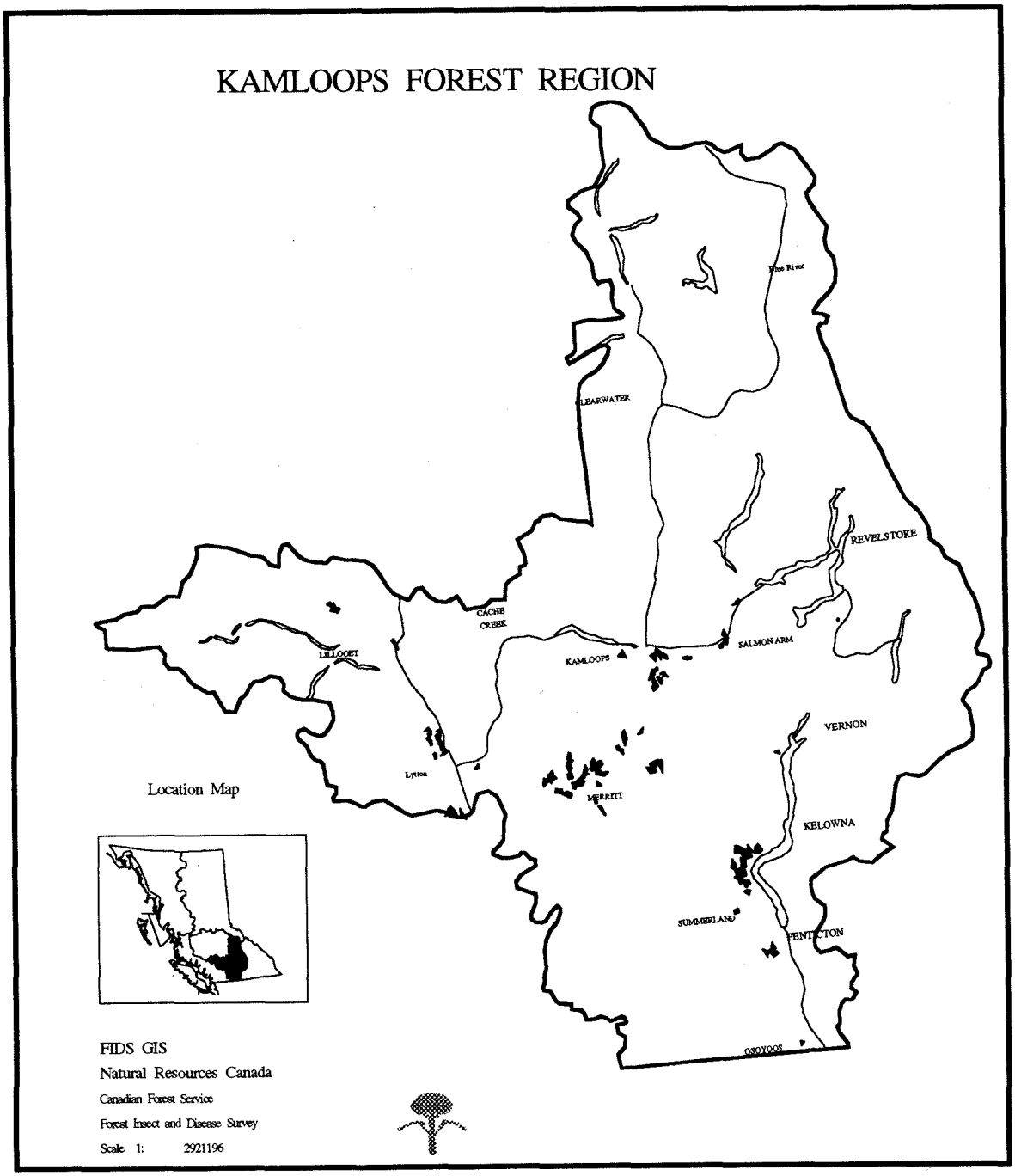

Figure 5. Areas where Douglas-fir was defoliated by western spruce budworm as detected by aerial and ground surveys, 1994.

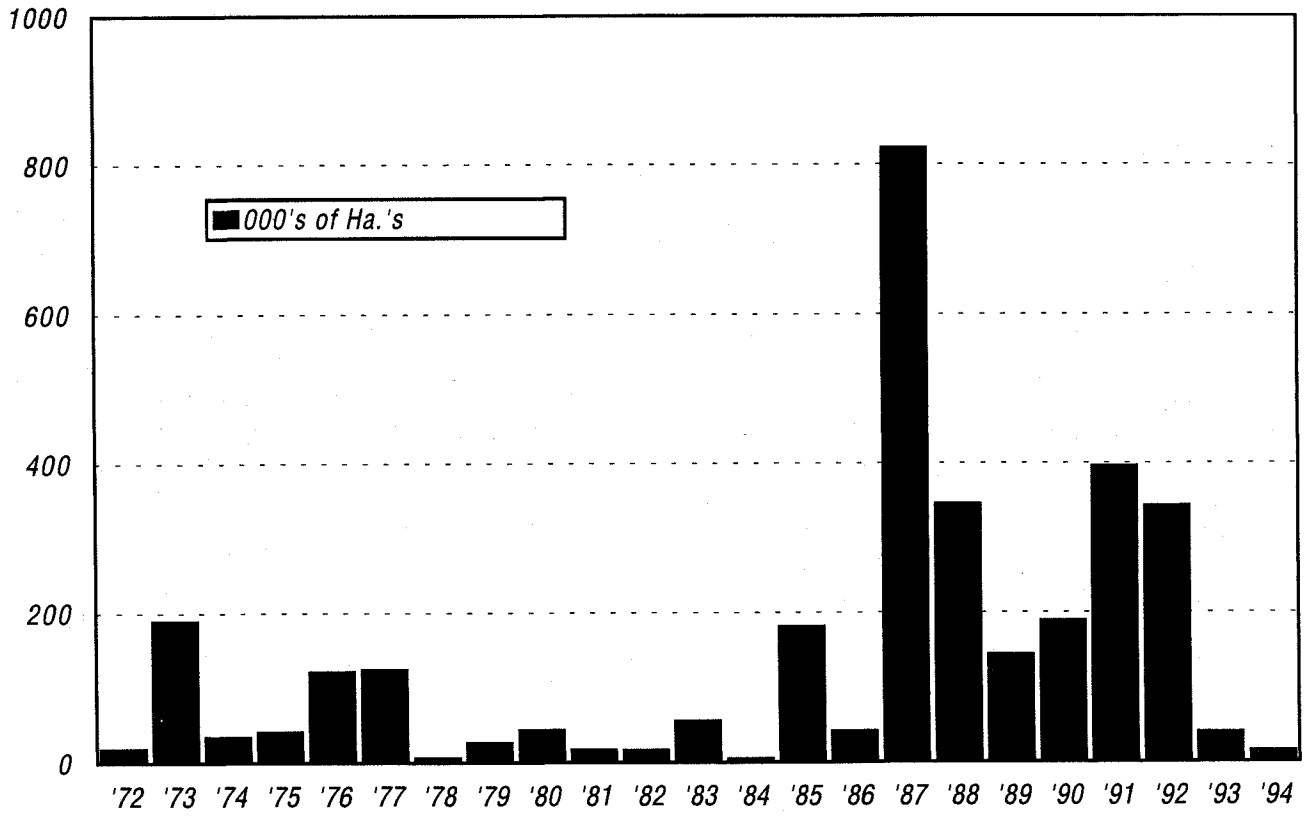

Figure 6. Area (ha) of western spruce budworm infestation, 1972-1994, Kamlops Forest Region.

In **Merritt TSA**, infestation area declined by 60% to 5550 ha in 1994. Moderately defoliated stands covered 3950 ha and those lightly defoliated extended over 1600 ha. Most defoliation occurred in stands previously defoliated surrounding Merritt, including areas between Nicola Lake and Stump Lake, and along Clapperton and Guichon creeks. While infestations generally subsided there was some expansion in Douglas-fir stands north of Douglas Lake. While the epidemic in most parts of Merritt District are relatively recent, signs of scattered top-kill are beginning to appear in the Merritt area in stands with successive years of moderate to severe defoliation.

The area of defoliation in **Lillooet TSA** dropped by 76% to 1550 ha, all of which was classified as light. The Yalakom River Valley was the only area west of Lillooet with recurring visible defoliation and occurred on 270 ha in five areas. Infestations south of Lillooet declined substantially to less than 1200 ha and with the exception of Izman Creek, none were recorded in side drainages of the Fraser River. There was some minor expansion in area south of Kwoiek Creek bordering Vancouver Forest Region. No defoliation was mapped in Fountain Valley where previously chronic infestations have resulted in extensive branch dieback, top-kill and some tree mortality, particularly in dense immature stands. Douglas-fir beetle attacks were common in some chronically defoliated stands along Fountain Valley and along the Fraser River between Lillooet and Lytton.

The infestation area in **Kamloops TSA** declined to 2000 ha from 3750 ha in 1993, the lowest level since 1978. The bulk of the infestation developed as light to moderate defoliation on more than 1500 ha in the Kamloops area between Iron Mask Hill, Barnhartvale

and Shumway Lake. A further 400 ha were lightly to moderately discolored south of Pritchard, where there was only trace defoliation the year before. Trace defoliation not discernible from the air was evident in several other areas, including the Little Shuswap Lake area, Pemberton Hill, Jamieson Creek, south of Kamloops Lake, Stump Lake and along Deadman River.

Sampling Surveys

Bud sampling

Bud sampling surveys repeated annually since 1987 to predict defoliation for the current (1994) year, were reduced to reflect the declining budworm population trend. Some additional emphasis however, was given to the more recent epidemic in the Merritt area. At 11 locations, severe defoliation was predicted at five, moderate at three, and light at three. A total of 100 buds were examined from five trees at each location. Subsequent aerial surveys determined a defoliation class at least one category lower than that predicted by the bud counts in seven areas. However, this was anticipated as all these locations were targeted with an aerial application of *Bacillus thuringiensis* (Bt), which reduced budworm populations and damage. Bud sampling provides a useful tool for predicting defoliation intensity, and allows time for decision making during epidemic conditions where a control option may be required. Over the years it has been determined that there is seldom a difference of more than one defoliation category between predicted and actual defoliation.

Larval and moth sampling

Consistent with the trend of decreasing defoliation intensity, larval populations were lower than 1993. Standard beating collections, mostly from the Interior Douglas-fir (IDF) biogeoclimatic zone averaged 24 larvae per sample, compared to 25 in 1993 and 31 in 1992. Bacteria, virus and disease of late-instar larvae was up 10% from last year in representative areas sampled.

For the eighth consecutive year adult males were monitored at four locations with low populations, and a history of outbreaks. This year an additional 10 locations were added as part of a study to correlate trap catches with subsequent defoliation. Counts only averaged 89 adults (range 0-262) per trap from the original four locations, compared to 358 moths per trap in 1993. Including the additional new locations, the average trap catch was further reduced to 50. Trap counts indicate the potential for light defoliation at Stump Lake and near Skimikin, but none in the other areas monitored.

Forecasts

Following three consecutive years of decline in most areas sampled (Table 6,Figure 7), budworm populations are predicted to rise slightly in 1995. The average number of egg masses obtained per 10 m^2 of foliage was 14% higher than 1993. Defoliation is forecast to continue in most previously defoliated areas. Of those areas sampled, severe defoliation is predicted in the Merritt Forest District at Steffens Creek, near Stump Lake, and in Penticton District along Trepanier Creek. Moderate defoliation is predicted south of Pritchard in Kamloops District, near Darke Lake in the Okanagan, and along Yalakom River, Fountain Valley and Botanie Creek in Lillooet District. Elsewhere, the data indicates lower populations with defoliation varying from trace to light. A more extensive survey by the B.C.Forest Service, designed to answer operational requirements, has found similar results.

Table 6. Average number of western spruce budworm egg masses on Douglas-fir from 1991-1994, and predicted defoliation in Kamloops Forest Region in 1995.

	Predicted Defoliation 1995	No. of Egg Masses Per $10m^2$ Foliage[1] 1994	1993	1992	1991	% Change 1993-94
Kamloops TSA						
Pemberton Hill	light	36	10	46	827	260
Niskonlith Lake	light	35	90	32	184	-61
McQueen Lake	trace	7	0	104	345	100
Pritchard	moderate	129	-			
Average		**52**	**30**			**73**
Okanagan TSA						
Skimikin	light	41	-	-	248	
Postill Lake	light	20	73	41	447	-73
Glenrosa	trace	7	7	8	370	0
Trepanier Creek	severe	183	-	-	-	
Darke Lake	moderate	56	29	74	218	93
Apex-Yellow Lakes	trace	8	7	50	264	14
Blind Creek	trace	7	0	20	183	100
Anarchist Mountain	trace	8	17	92	256	-53
Blue Lake	nil	0	8	12	74	-100
Average		**37**	**20**			**85**
Lillooet TSA						
Cayoosh Creek	light	14	30	32	-	-53
Yalakom River	moderate	114	60	135	146	90
Fountain Valley	moderate	104	20	37	407	420
Botanie Creek	moderate	74	30	54	74	147
Average		**77**	**35**			**120**
Merritt TSA						
Steffens Creek	severe	200	379	-	-	-47
Merritt	moderate	135	-	-	-	
Peter Hope Lake	severe	212	20	89	-	960
Average		**182**	**200**			**-9**

[1] 1 - 10 eggs/$10m^2$ - trace defoliation; 11 - 50 eggs/$10m^2$ - light defoliation; 51 - 150 eggs/$10m^2$ - moderate defoliation; 151+ eggs/$10m^2$ - severe defoliation

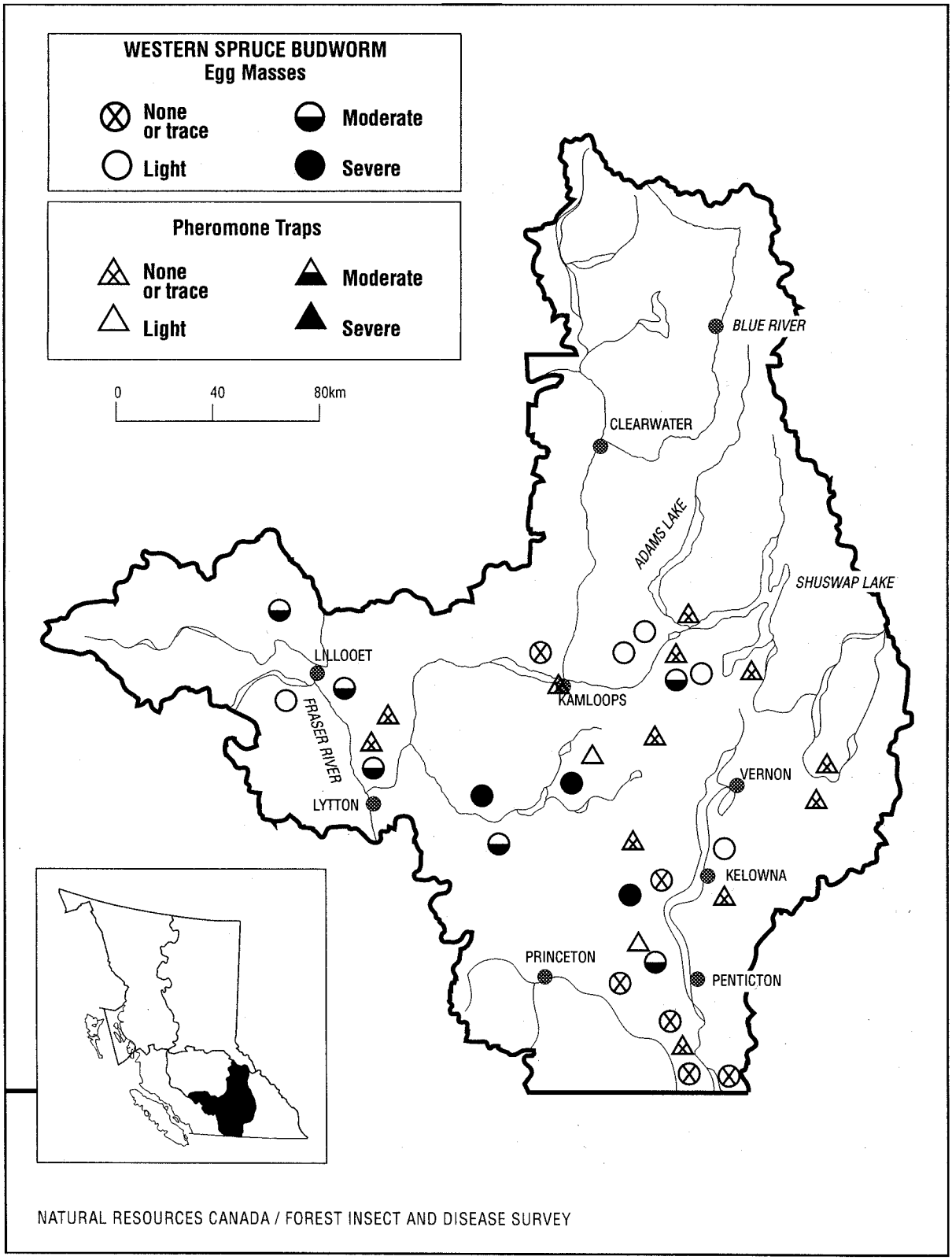

Figure 7. Defoliation by western spruce budworm forecast for 1995, based on egg mass surveys and pheromone trap counts in 1994.

The egg mass sampling method consisted of collecting two 45-cm branch tips from each of ten trees per location. The number of egg masses were counted on each branch and extrapolated to 10 m^2 of foliage. These figures were then used to determine defoliation severity for 1995. Predictions preclude adverse weather conditions, which would affect overwintering survival of larvae.

Biological Control

Parasitism and disease reduced late-instar larval populations by an average 45% in five representative areas sampled, 12% less than 1993. Most larval mortality was caused by Diptera and Hymenoptera parasites, and averaged 26%, up from 9% last year. Bacterial and viral diseases affected an additional 19% of larvae. A fungus, *Entomophthora* sp., was isolated in a collection where 20% of larvae were killed. The impact of fewer biological control factors is not expected to significantly alter the population trend in 1995. Studies have shown parasites to be effective at controlling low populations of budworm, but have minimal influence at epidemic levels, as is the case where the aforementioned samples were taken.

Aerial applications of the biological insecticide *Bacillus thuringiensis* (Bt) by the B.C. Ministry of Forests totalled 21 517 ha of budworm-infested stands at 36 locations. Sprays were applied between June 1 and June 17. This followed successful applications on 34 000 ha of managed stands in 1993. The objective was to reduce feeding damage in priority areas. Experimental spray treatments of two different products were also carried out by the Canadian Forest Service on 300 ha near Merritt, but the results were not yet available.

Impact

Successive years of severe defoliation have resulted in tree mortality, top-kill, increment loss, and tree deformity in many parts of the IDF zone, although amounts vary by site. The budworm impact is most severe in uneven-aged stands in the drier ecozones. Analysis of information gathered on an annual basis from 64 research plots in young stands of Douglas-fir in Kamloops District indicates an average annual increase in tree mortality of approximately 1%. Cumulative tree mortality since 1986 is now 13%.

Due to the exclusion of fire and the use of selective harvesting methods, many Douglas-fir stands are uneven-aged with a dense understory of Douglas-fir, which favors budworm feeding and population buildup. Even-aged stand management should be encouraged where it is an option in historically active budworm areas.

Douglas-fir beetle
Dendroctonus pseudotsugae

After substantial increases in 1993, beetle outbreaks declined by 50% to 775 patches covering 600 ha in 1994, mostly near Lillooet, Kamloops and Sicamous. Individual outbreaks were generally small, comprising 5 to 30 trees each, with occasional pockets up to 100 trees in size. Continuing a practice initiated several years ago in the Kamloops Forest District, virtually every pocket of infestation was again photographed and sketch mapped during aerial surveys to facilitate pest management operations.

In the **Lillooet Forest District** increases occurred as numerous spot infestations along Twaal and Murray creeks near Spences Bridge, from Lillooet to Kwoiek Creek, and along Fountain Valley, Cayoosh Creek and Tyaughton Creek. New pockets of red trees were also observed near Botanie Lake, the Mission Pass area, Marshall Creek, Carpenter Lake, and the Yalakom River-Bridge River area. Many of these infestations are associated with

successive years of moderate to severe spruce budworm feeding damage in mature Douglas-fir, particularly in Fountain Valley, Marshall Creek, and along the Fraser River south of Lillooet.

While some of the largest infestations comprising up to 300 trees occur in the **Kamloops Forest District** along Tranquille River and at nearby Copper Creek, new attacks declined substantially along Durand Creek, in the Deadman River-Criss Creek area, between Barnes Lake and Pukaist Creek, in the Maiden and Scottie creeks area and near Paul and Heffley lakes. The reduction in beetle activity in many of these areas is directly related to the control activities undertaken by the forest companies and the B.C. Ministry of Forests with the use of trap trees, pheromone baits and timely extraction. A large infestation on Adams Lake opposite Skwaam Bay is presently being addressed with the aid of helicopter logging and use of trap trees, after extensive surveys revealed increased beetle populations and attacks. Some expansion in small spots is also evident near Stump and Roche lakes and in upper Deadman Creek.

In **Salmon Arm Forest District** spot infestations expanded around Sicamous, Mara Lake, Humamilt Lake and to a lesser extent along Perry River, Salmon River Valley and east of the city of Salmon Arm where the number of recent outbreaks totalled 77. Elsewhere, there were small increases in spot infestations east of Vernon near Lavington, Lumby and Cherryville in **Vernon Forest District**, and along Pimainus Hills in **Merritt Forest District**. Beetles are also still active in some root diseased stands near Helmcken Falls in Wells Gray Provincial Park. Attacks to single trees and occasional small groups continued throughout the host range of Douglas-fir in the Okanagan and Similkameen valleys and south of Merritt.

The judicious use of trap trees and associated pheromone baiting combined with timely harvesting, should help reduce the impact of expanding infestations and keep them in check. Those stands with recent windthrow containing mature and overmature Douglas-fir and those repeatedly defoliated by the western spruce budworm, will require extra vigilance.

Douglas-fir tussock moth

Orgyia pseudotsugata

Populations of Douglas-fir tussock moth collapsed in all areas of the region in 1994 and no defoliation was recorded. This followed the predicted decline in 1993 as indicated by an overall reduction in trapped moths and egg masses. Increased incidence of the nucleopolyhedrosis virus (NPV), fungal infections, and pupal parasitism all contributed to the collapse in 1994. Populations also returned to endemic levels on ornamental Douglas-fir and spruce in urban settings, where only a few larvae were noted in localized areas of Kamloops and Vernon.

Male moth captures in pheromone-baited sticky traps at **monitoring** sites decreased for the second consecutive year in Douglas-fir stands selected for the greatest historical frequency of outbreaks. Counts at 17 sites averaged 18 moths per trap (6 traps per location), down from 27 in 1993. This indicates that no defoliation of Douglas-fir is likely in or near previously defoliated stands in 1995. Despite the high numbers of adults captured at Battle Creek east of Cache Creek and at Monte Creek, where counts averaged 95 and 74 adults per trap respectively, the absence of egg masses indicates that defoliation is not likely to occur in these areas in 1995. Counts in single traps located at 1-2 kilometer intervals in the Thompson and Okanagan Valleys were also down, averaging only 12 moths per site, compared to 43 previously. These traps were placed to determine population **distribution** and to help locate epidemic centers. Similar results were obtained by the B.C. Ministry of Forests with trap catches at 141 sites in three districts averaging 14 moths per trap.

Due to low populations, aerial applications of virus (Virtuss®) were discontinued this year by the B.C. Ministry of Forests. Approximately 610 ha were successfully treated in 1993. As an alternate means of control the Canadian Forest Service has been testing the feasibility of mating disruption in the Kamloops area. The 1994 pheromone confusion trial (by M. Hulme and T. Gray) found that mating was effectively blocked in two treatment trials at Wallachin where the average count was less than one moth per trap. Untreated areas at Wallachin and near Kamloops averaged 70 moths per trap.

Spruce Pests

Spruce beetle
Dendroctonus rufipennis

The area of mature spruce infested by spruce beetle increased to 2500 ha from 2040 ha in 1993. This is the third consecutive year of increase. The majority occurred primarily in previously infested stands in the Merritt and Lillooet TSA's with new pockets scattered throughout the Region.

In the **Merritt TSA** infestations increased three-fold to 1560 ha due to population increases in or near infestations in the Tulameen River drainage; along Lawless, Illal, Britton, Skwum, Holm, Pioneer, Granite, Arrastra creeks, and Lodestone and Granite mountains. The most notable spread in area occurred south of Mt. Thynne and the headwaters of Champion Creek. Three new pockets totalling 30 ha were mapped along upper Coldwater Creek on the west side of the Coquihalla Highway, and several new areas were also recorded on the east side of the valley near Coquihalla Lakes. Harvesting of infested stands near Brook and Andy's lakes has led to a reduction in affected area. Management strategies aimed at further reducing the beetle hazard are also being implemented, including the use of pheromones and conventional and lethal trap trees.

The area infested in the **Lillooet TSA** declined by nearly 60% to 630 ha as a result of harvesting and host depletion in the Noel, McGillivray, and Connel creeks drainages. However, new infestations were recorded along Whitecap Creek, Carl Creek and Hurley River. Elsewhere, smaller infestations of 0.5 to 20 ha were recorded along the Stein River and Cadwallader, Van Horlick, Casper, and North Kwoiek creeks. Several of the longstanding outbreaks in mature spruce in valley drainages of Anderson Lake may continue at varying levels until natural control factors prevail or the host is depleted.

In the **Okanagan TSA**, five pockets totalling 240 ha were mapped in stands along Torrent and Smythe creeks in the Vernon Forest District. Beetles were detected here in 1993 in blowdown. Beetle infestations were also detected in the Monte Hills, but ground checks were not completed. No new faders were found near Flat Top Mountain in the Penticton Forest District where partial harvesting and trap trees were utilized to reduce beetle numbers. Surveys revealed a rapidly declining spruce beetle population. Examination of several consecutive years of windthrow near Greyback Lake found evidence of beetle in windfalls, but none in standing spruce.

A new outbreak on 100 ha was recorded near Blue Earth Lake, southwest of Ashcroft in **Kamloops TSA**. Spot infestations of 1 to 10 ha were noted at Martin Mountain and Hustalen Creek in the Kamloops Forest District and along the Murtle River and near Clearwater Peak in the Clearwater Forest District.

Spruce beetle infestations most frequently result from populations building in windthrow and slash, including high stumps, followed by attacks to standing mature spruce. While the beetle's normal life cycle takes two years, a one year-cycle can be initiated by extended warm weather. This happened in several areas in 1994, thus accelerating the attack interval and limiting management options. Beetle control is usually achieved by one or a combination of management practices such as slash reduction, sanitation logging, the use of trap trees, or pheromone baiting. Natural population control can also occur as a result of host depletion and extended severe winter temperatures. Identification of infested trees and windfall and monitoring of cutblock boundaries for blowdown is key to keeping spruce beetle activity to a minimum.

Two-year cycle spruce budworm
Choristoneura biennis

Light to moderate defoliation of spruce and alpine fir forests by mature ("on-cycle") budworm larvae in the Clearwater Forest District covered 18 200 ha. In addition, 400 ha were lightly defoliated by immature ("off-cycle") budworm larvae in patches near Keefer and Holmes lakes in the Upper Kettle River drainage and near Sugar Lake in Vernon Forest District.

The majority of defoliation in the Clearwater Forest District occurred in Wells Grey Provincial Park along Clearwater and Hobson lakes on 9500 ha, down from 90 000 ha infested in this area during the last outbreak in 1992. South of Canim Lake in TFL 18, light to moderate defoliation totalled 4500 ha, a decline from more than 10 350 ha defoliated in 1992. Similarly, light defoliation in the upper North Thompson River Valley on 4200 ha is down from more than 47 000 ha defoliated previously. In Vernon Forest District the infestations in the upper Kettle drainage and Sugar Lake areas is the smallest since defoliation was first recorded there in 1987.

Based on historical trends, defoliation of alpine fir-spruce stands in 1995 is expected east of Lumby, where budworm larvae will mature to cause more extensive defoliation than in 1994. Egg samples from representative stands at Sock Lake and Maury Lake in TFL 18 forecast light defoliation to occur in these and probably similar areas in 1996 when larvae are again mature. Areas of chronic infestation in Wells Grey Provincial Park and in the upper North Thompson Valley are likely to sustain at least light defoliation in 1996.

While the impact of budworm defoliation in alpine fir-spruce stands has not been well researched, observations in areas of chronic infestation indicate the presence of bud mortality, occasional branch dieback, and some top-kill. Stress from chronic foliage loss may also be a factor in the incidence of Armillaria root disease and attacks by secondary pests in infested stands.

Spruce weevil
Pissodes strobi

Examination of managed spruce plantations aged 11 to 19 years old, indicates that populations of spruce weevil and attacks to leaders are increasing in the Kamloops Forest Region, where trees have reached susceptible age classes. The weevil was found in 71% (17) of stands with a significant component of spruce, where the average overall attack density (current and older) was 17%, but ranged from 2 to 54%. The highest attack densities of 54%, 46% and 38% occurred in Kamloops Forest District at Martin Mountain and Smith Lake and in Salmon Arm Forest District at Old Town Creek, respectively. The two worst occurrences of spruce weevil were in the Montane Spruce Zone, while most of the remainder were equally divided among the Interior Cedar Hemlock, and Engelmann Spruce Sub-alpine Fir zones.

With generally mild winters and warm summers spruce weevil attack can be expected to continue and even increase overall as more stands reach susceptible age classes in the Region. Repeated attacks by the weevil can reduce merchantable volume at rotation age due to crook, fork, stem decay, and other deformities. Research efforts at the Pacific Forestry Centre are presently focused on development of resistant trees, biological control, stand density and species mix, and the effect of deciduous overtopping.

Alpine Fir Pests

Western balsam bark beetle
Dryocoetes confusus

Recent infestations of western balsam bark beetles numbered 100 and declined to 2870 ha from 5200 ha in 1993. One of the largest and most chronic areas continues to be the outbreak near Taweel Lake in the Kamloops District, where 1100 ha of infestation were aerially mapped. There is little significant variation in area affected from year to year, with 1 to 5% annual tree mortality occurring over the past six years. Similar long standing infestations in the Wentworth Creek-Tranquille Lake area continue unchanged on 200 to 300 ha. Infestations on 200 ha at Blanc Creek in Salmon Arm Forest District, continue to decline due to host depletion and some harvesting. A more recent 400 ha outbreak east of Mara Lake was up to 5% infested, as were previously recorded infestations totalling 900 ha near Humamilt Lake and Ratchford Creek. In Vernon Forest District beetle-killed trees generally occurred in small pockets of 5 to 30 trees each, including upper Whiteman Creek and Salmon River areas, Outlet Creek, Harris Creek, Mabel Lake, and Winnifred Creek. Spot infestations were also common in scattered locations west of Summerland in Penticton Forest District and in the Lillooet Forest District along upper Kwoiek Creek, Texas Creek, Hurley River, and near Gun Lake.

While the area and intensity of attack does not fluctuate dramatically from year to year, consistent and accurate mapping is difficult due to retention of red foliage for up to five years. Once established, beetles continue to selectively attack small groups of trees, killing up to 5% annually.

Balsam woolly adelgid
Adelges piceae

Surveys to determine distribution of balsam woolly adelgid in mature and immature stands were initiated in the Kamloops Forest Region after infestations were recently found just outside the western boundary. Well established populations were discovered in the Vancouver Forest Region in the Birkenhead Lake area, with smaller populations west of Spuzzum and east of Lillooet Lake. These recent finds suggest that the adelgid may already be established in the Lillooet Forest District adjacent to positive identifications in the Vancouver Forest Region. However, surveys of 15 selected immature stands of *Abies* spp. in the Lillooet and Merritt Forest Districts found no evidence of the adelgid or damage. Additional emphasis will be placed on detection in these areas in 1995.

The balsam woolly adelgid was first detected in British Columbia in 1958, and has since been spreading slowly north along the coast and inland. Initially there was widespread mortality of mature trees which were probably the most susceptible. The rate of tree mortality appeared to decline in the ensuing years and so did the survey efforts. Recent finds in immature stands has again raised concern regarding its spread outside the quarantine zone, and the implications regarding movement of *Abies* spp. and its effect on natural regeneration.

Western Hemlock Pests

Western hemlock looper
Lambdina fiscellaria lugubrosa

Populations collapsed in 1993 following three successive years of defoliation in old-growth stands of western hemlock and western red cedar, and remained low in 1994. Tree mortality resulting from repeated severe defoliation since 1991 was mapped over 15 500 ha in the North Thompson Valley, Wells Gray Provincial Park, and the upper Adams River drainage.

Larval populations returned to low endemic levels throughout areas previously defoliated north of Clearwater. Higher numbers were found in beating samples along the Eagle River Valley, Wap Creek and south of Greenbush Lake, where there was some minor feeding on understory hemlock in association with western blackheaded budworm. Based on egg samples from nine areas in the Kamloops Region, defoliation is predicted at only one location (Table 7). However, even at this site defoliation may be minimal due to high parasitism levels. Most of the parasitism is attributed to the Hymenopterous parasites, *Telenomus* and *Trichogramma* spp.

Table 7. Location, average number, and status of western hemlock looper eggs and subsequent defoliation predicted for 1995, Kamloops Forest Region, 1994.

Location	Avg. no eggs (per 100 g lichen)				Predicted 1995[1] defoliation
	Healthy	Parasitized	Infertile	Old	
Vernon Forest District					
Sugar Lake -km 44	7	16	6	5	light
Salmon Arm Forest District					
Wap Creek	0	1	0	4	none
Clearwater Forest District					
Murtle Lake Road	2	2	0	22	none
Mud Lake	1	0	0	6	none
Peddie Mtn. Road	2	1	2	18	none
Finn Creek	0	0	1	2	none
Avola Mountain	0	1	0	4	none
Clearwater Lake	0	1	0	16	none
Helmcken Falls	0	0	0	15	none

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

A cooperative study with Simon Fraser University initiated in 1992 to develop a pheromone trapping and forecasting system, continued in 1994. Assessments were completed at eight locations in the Region with a history of looper activity. The trials helped with pheromone trap placement timing, indicated the 10 microgram lure as the lure of choice, and showed that the universal traps captured higher numbers of moths than the Multipher® traps. With those areas clarified, this technique becomes available as a monitoring and forecasting tool to be used beginning in 1995.

Damage appraisal plots were established in 1992 in three hemlock-cedar stands representing moderate to severe defoliation near Blue River to monitor tree growth and survival. After two years of assessment, tree mortality in the moderately defoliated stand was 34% and was greatest in the intermediate and suppressed crown classes. Tree mortality in two severely defoliated stands was 41% and 44% and equally distributed through all the crown classes. Heartrot by the Indian paint fungus, *Echinodontium tinctorium*, and attack by secondary insects also contributed to the mortality. Presently the impact on understory hemlock and cedar resulted in 40% and 8% tree mortality respectively. The total impact in terms of volume losses was assessed at 4.7 million m^3 of hemlock and cedar over an accumulated infestation area of 88 000 ha. Of this total, 3.6 million m^3 was in the moderate to severe defoliation impact category, and represented an average 28% volume loss over 15 500 ha. In lightly impacted stands, where 2% of trees were killed, tree mortality totalled 1.1 million m^3.

Western blackheaded budworm

Acleris gloverana

Blackheaded budworm populations increased, causing mostly light and some moderate defoliation of western hemlock, totalling 1414 ha in the Salmon Arm and Vernon Forest districts. In Salmon Arm Forest District light defoliation was recorded on 1250 ha in mature and overmature hemlock stands along the Eagle River Valley between Malakwa and Clanwilliam, including Craigellachie, Crazy Creek, Wap Creek, and Victor Lake. Two infestations were found in Vernon Forest District on 165 ha. Moderate defoliation occurred at Tsuius Creek and Kidney Lake near Mabel Lake, both areas of historic budworm activity. Defoliation of understory hemlock was common in all areas, but less intense than in the overstory.

While the majority of feeding was by the budworm, larvae of western hemlock looper and conifer sawflies also contributed to the defoliation. This is the first occurrence of damage in the Region by this budworm since the last outbreak which occurred from 1985 to 1988, primarily in Wells Gray Provincial Park. The last known recorded outbreak along the Eagle River Valley was active from 1965 to 1968.

Overwintering egg samples assessed at Wap Creek forecast light defoliation in the area for 1995. Based on historical trends, similar defoliation intensity is likely in other areas recently defoliated. A pheromone trapping trial along Wap Creek also pointed toward continued high populations for 1995.

Western Larch Pests

Larch needle diseases
Meria laricis
Hypodermella laricis

Discoloration of western larch by needle diseases declined for the third year to only 300 ha, from 420 ha in 1993. No discoloration of larch stands was detected during aerial surveys. Moderate foliar browning by *M. laricis* was observed following ground surveys in two large stands of larch between Lumby and Ashton Creek and along Trinity Valley, where discoloration was also recorded in 1992 by *H. laricis*. Foliage discoloration was very light along Mabel Lake, Hunters Creek, Hidden Lake and at Kingfisher, where there was moderate browning in 1993.

Larch casebearer
Coleophora laricella

Larch casebearer populations increased, causing moderate defoliation on 300 ha south of Vernon between Cosens Creek and Brewer Creek. This is the first substantial defoliation since 1984, when there was moderate defoliation on 1100 ha in this area. There was also some minor feeding by western spruce budworm and discoloration by a larch needle disease. Light to moderate defoliation was also evident on immature larch along Shuttleworth Creek, where defoliation has occurred previously. Overwintering larvae were common in both areas, suggesting continued defoliation in 1995.

Multiple Host Pests

Black army cutworm
Actebia fennica

There were no reports or observations of cutworm larvae or damage for the sixth consecutive year in the region. Numbers of male moths caught in pheromone-baited Multipher® traps declined for the first time in four years to 107 moths per trap from 147 in 1993. Low populations are predicted to continue in 1995 in areas where traps were deployed in 1993 broadcast burns in the Clearwater area and upper Adams River Valley. Some light feeding on herbaceous ground cover may be evident at one site near Cayenne Creek in 1995, where 320 moths were captured; no significant feeding is expected in other areas surveyed. No damaging outbreaks have developed where fewer than 600 moths per trap were caught the previous year.

Deciduous Pests

Gypsy moth
Lymantria dispar

No male gypsy moths were caught in 42 pheromone-baited traps distributed in provincial parks throughout the Kamloops Forest Region by FIDS staff, as part of a co-operative program to help detect the introduction of this pest in the region. Only 39 moths were recovered in nine municipalities in British Columbia in 1994, down from 141 in 1993. Most of the positive catches were from previously active areas in the Lower Mainland and on Vancouver Island. Aerial applications of *Bacillus thuringiensis* var. *kurstaki* (Btk.) in April and May were completed over 678 ha at five locations in an effort to eradicate populations.

Satin moth
Leucoma salicis

Light to moderate defoliation in four patches totalled 168 ha in the southern parts of the Region, down from 250 ha recorded in 1993. Defoliated stands were near Anarchist Mountain, Yankee Flats, and Shorts Creek. No defoliation was observed west of Lillooet where defoliation was light at Hurley River, Cayoosh Creek and along Carpenter Lake in 1993. Populations also declined east of Princeton and between Hedley and Keremeos, following two consecutive years of defoliation. Moth flights reported in the Clearwater area indicate the possibility of defoliation there in 1995.

A birch leafminer
Lyonetia speculella

This leafminer discolored birch over several thousand hectares in scattered areas on both sides of Adams Lake. Many of the severely affected trees refoliated by mid-summer, so that only 650 ha of discolored birch were mapped during aerial surveys. Still visible in early August were four patches, mostly in immature stands near Stukamapten Lake and near Bugcamp Creek.

Aspen leafminer
Phyllocnistis populiella

For the first time in many years aspen leafminers caused widespread damage in trembling aspen stands along the Adams River Valley north and east of Adams Lake. Extensive mining under both leaf surfaces gave the aspen foliage a "silvery" appearance in immature stands, particularly in the Harbour Lakes area. Infestations occur sporadically throughout the range of trembling aspen, but seldom cause notable damage other then reduced tree growth from repeated attacks.

Special Surveys

Pests of Young Stands

Forest health surveys were completed in 46 young stands, most of which were treated under the FRDA II agreement. Pest occurrence and damage was assessed on 6170 trees in 544 plots. Sites were selected from stand opening lists stratified by Forest District, biogeoclimatic zone, and type of treatment. The majority of stands examined occurred in the Montane Spruce (MS), Engelmann Spruce Sub-alpine Fir (ESSF), and Interior Cedar Hemlock (ICH) zones, with the most common treatment being juvenile spacing. The survey methodology consisted of identifying and quantifying pests by assigning them a field code based on the level and type of damage of each. A minimum of 100 trees were assessed in 10 or more fixed-radius plots located between fixed intervals along transect lines in each location. In stands greater than 10 years old, strip surveys (5M) were conducted between plots to quantify root diseases.

Similar to 1993, 53% of trees examined were pest free (Severity Index [SI]1), as compared to a five year average of 57% (Figure 8). Only 1% of trees of all species were either recently killed (SI 6) or affected by life threatening agents such as root diseases, white pine blister rust, western gall rust, and mechanical and mammal damage. Damage resulting in significant growth reduction or volume loss (SI 4) affected 4% of trees and was caused by spruce weevil, pine terminal weevil, mammals, pine dwarf mistletoe, and some abiotic conditions such as snow, ice or wind. Significant loss of current growth potential (SI 3) was found in 14% of trees and was due to such pests as needle diseases, Adelgids, the gouty pitch midge, and other problems such as poor tree form. Minor damage having negligible impact (SI 2) occurred on 28% of trees. Causal agents were Adelgids, needle scale, bud miners, needle diseases, mammals, and abiotic conditions.

The Cooley spruce gall adelgid was the most common pest encountered, affecting 1262 spruce and Douglas-fir, or 20% of all trees surveyed. The second most common group of pests were needle diseases, accounting for 8% of trees examined, followed by abiotic conditions at 7%, tree deformity 4%, spruce terminal weevil 3%, and mammal damage 3%. All other notable pests each affected less than 2% of trees surveyed. Trees killed by root disease represented only 0.2% of all trees surveyed. The figures should not be construed as a balanced representation of pest incidence in general, as many stands were selected for tree species to determine specific pest occurrence, i.e. spruce weevil and balsam woolly adelgid. Also, recent treatments reduced the incidence of many pests since the dead and dying trees were removed. Table 8 summarizes specific pests according to host and provides a minimum and maximum range of intensity levels recorded.

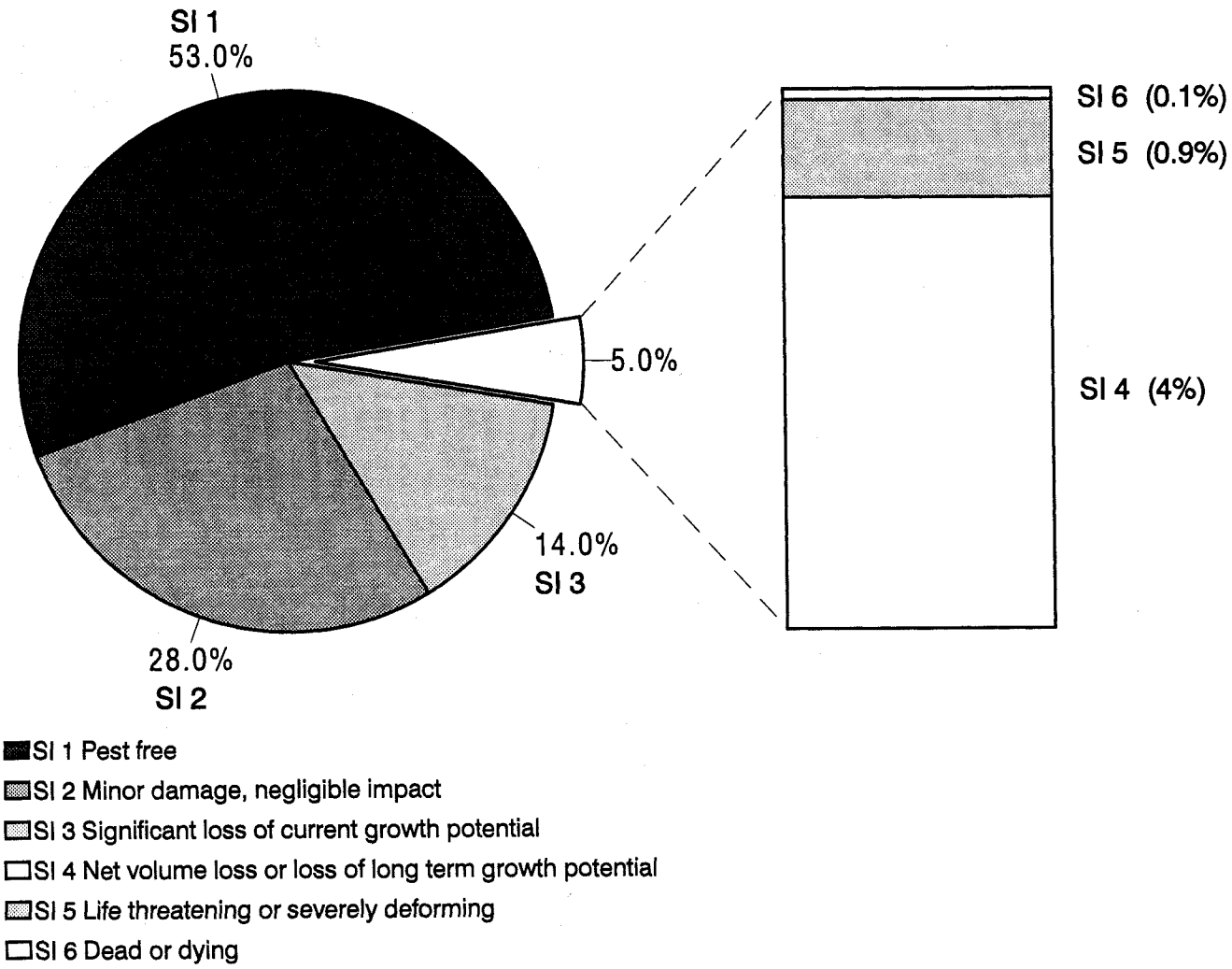

Figure 8. Summary of pests of young stands by severity index, Kamlops Forest Regin, 1994.

Table 8. Summary of surveys in recently treated young stands, by host, Kamloops Forest Region, 1994.

Host/Pest	No. stands affected	% of trees affected[1] Avg	Min	Max	Severity[2] Index
Spruce - 2534 trees in 45 stands, 1023 (40%) trees were pest free					
Armillaria root disease	2	2	2	2	6,5,2
Spruce weevil	19	8	1	37	4
Abiotic	14	7	1	37	4,3,2
Mammal damage	2	1	1	1	4,2
Adelgids	36	25	1	72	3,2
Giant conifer aphids	4	3	1	8	2
Needle scale	2	2	1	3	2
Bud miners	1	6	6	6	2
Lodgepole pine - 1342 trees in 41 stands, 754 (56%) trees were pest free					
Armillaria root disease	2	1	1	1	6,5
Mammal damage	4	17	2	63	6,5,3
Western gall rust	13	4	1	13	5,3
Poor form (fork, broken top, crook, sweep, multi-top)	25	2	0.5	10	4,3,2
Abiotic (snow, ice, wind)	3	2	0.5	4	4,3,2
Pine terminal weevil	5	5	0.5	18	4
Pine dwarf mistletoe	1	1	1	1	4
Pine needle cast	17	26	1	78	3,2
Gouty pitch midge	2	1	1	2	3
Giant conifer aphids	7	4	1	9	2
Alpine fir - 1159 trees in 44 stands, 843 (73%) trees were pest free					
Armillaria root disease	2	2	1	2	6
Poor form (fork, broken top, crook, sweep, multi-top)	23	3	0.5	20	4,3
Abiotic (snow, ice, wind)	10	4	1	9	4,3,2
Needle diseases	14	10	1	47	3,2
Douglas-fir - 133 trees in 17 stands, 78 (59%) trees were pest free					
Mammal damage	2	1.5	1	1	6,5,4,3,2
Armillaria root disease	1	1	1	1	5
Poor form (fork, broken top, crook, sweep, multi-top)	6	1	0.5	2	5,3
Douglas-fir needle midge	1	28	28	28	3,2
Cooley spruce gall adelgid	2	8	7	9	2
Western hemlock - 307 trees in 23 stands, 294 (96%) trees were pest free					
Armillaria root disease	1	1	1	1	5
Poor form (fork, broken top, crook, sweep, multi-top)	9	1	0.5	3	4,3

Table 8. (Cont'd)

Host/Pest	No. stands affected	% of trees affected[1] Avg	Min	Max	Severity[2] Index
Western white pine - 119 trees in 23 stands, 100 (84%) trees were pest free					
White pine blister rust	8	2	1	3	6,5,3
Poor form (fork, lean)	1	2	2	2	3
Pine leaf chermid	1	1	1	1	2
Western red cedar - 472 trees in 18 stands, 219 (46%) trees were pest free					
Mammal damage	1	1	1	1	4
Poor form (fork, crook, sweep)	3	16	1	47	3
Abiotic (frost)	2	1	1	1	2

[1] Percent of trees affected includes only trees from stands in which pest occurred.

[2] Severity index:
1 -pest free
2 -minor damage, minimal impact
3 -significant loss of current growth potential
4 -net volume loss or significant longterm loss of growth potential
5 -life threatening or severely deforming
6 -dead or dying

Acid rain monitoring

In order to identify changes in forest vegetation and tree vigor related to air pollutants or acid rain, 15 Acid Rain National Early Warning System (ARNEWS) plots were established by F.I.D.S. in British Columbia between 1984 and 1986 as part of a nation-wide network. Baseline data were obtained for analysis of a number of parameters including conifer foliar chemistry, soil types, ground cover species including lichens and mosses, natural regeneration and forest pests. In 1992 an additional 12 plots were established in the province to better represent the biodiversity of the various biogeoclimatic zones and some of the tree species under-represented in existing plots. In Kamloops Forest Region two new plots were established, one representing the driest forested zone (Ponderosa Pine) in B.C., located near Monte Creek. The other represented a deciduous forest and was located in a trembling aspen stand at Lambly Creek.

Visual assessments of plot trees and ground cover and foliage analysis were made at both newly established plots and the previously established Twin Lakes plot. No symptoms of acid or toxic rain or other air pollutants were found at any of the sites. Only some minor feeding by a needle miner was evident on ponderosa pine foliage at the Monte Creek site. Pests on trembling aspen at the Lambly Creek site included forest tent caterpillar causing some light defoliation on two trees, and a canker caused by *Valsa sordida* on four trees. The canker fungus is ususally associated with damage from the sun, wounds etc. No obvious pests were found at the earlier established Twin Lakes site. Monitoring at all three sites will continue in 1995.

Other Noteworthy Pests
Currently Active in the Kamloops Forest Region, 1994

Host and Pest	Location	Remarks
Douglas-fir		
A Douglas-fir needle midge *Contarinia pseudotsugae*	Little Fort - Clearwater, Monte Creek, Hunters Creek	Extensive discoloration and subsequent needle drop of roadside and undergrown regeneration.
A root collar weevil *Pissodes fasciatus*	Ashnola River	Associated with scattered root rot infected roadside trees.
Green-striped forest looper *Melanolophia imitata*	widespread	Common in collections; avg. 2 larvae/beating sample.
Laminated root rot *Phellinus weirii*	Bromley Rock	Pockets of 4-5 trees scattered throughout 80 year old stand.
Western false hemlock looper *Nepytia freemani*	widespread	Common in low numbers; no damage.
Lodgepole Pine		
An engraver beetle *Pityogenes p. knechteli*	Penticton Creek	Found in 2% of dying stems in a spaced stand.
Ground squirrels	Pearson Creek	Girdling and uprooting of 1% of planted pines.
Lodgepole pine terminal weevil *Pissodes terminalis*	Windy Lake	30% of 15 year-old stand with old and new attacks.
Needle cast *Lophodermella montivaga*	Martin Mtn.	Average 20% foliage infection on 60% of immature pines in area.
Pine needle sheathminer *Zelleria haimbachi*	widespread	Decline. Occasional light feeding in scattered stands.
Velvet top fungus *Phaeolus schweinitzii*	Pearson Creek	A red-brown butt rot common throughout mixed stands in area.
Winter damage	Highway 97C, Penask Lake	Extensive flagging and occasional stem breakage in high elevation stands.

Host and Pest	Location	Remarks
Ponderosa pine		
Fir coneworm *Dioryctria abietivorella*	Postill Lake, Trout Creek, Okanagan Falls	Infesting up to 40% of new shoots on open growing trees.
Whitebark pine		
White pine blister rust, *Cronartium ribicola*	Mt. Riordan	Branch and stem cankers on up to 60% of trees in scattered stands.
Spruce		
A wood decay fungus *Chondrostereum purpureum*	Greyback Lake	New host record (Engelmann spruce). Found on root segments of blowdown.
Spruce gall adelgid *Pineus similis*	Casper Creek	Occasional severe branch galling and stem attack in plantations.
Alpine fir		
Fir-fireweed rust *Pucciniastrum epilobii*	North Thompson Valley, Kwoiek Creek, Monashee Summit	Up to 50% foliage discoloration on 30-50% of regeneration in localized areas.
Western hemlock		
Conifer sawflies *Neodiprion* spp.	North Thompson Valley	Increase. Up to 50 larvae per beating in hemlock stands. No defoliation.
Western larch		
Larch-willow rust *Melampsora paradoxa*	Shuttleworth Creek	Up to 20% of needles infected on 10% of young larch.
Western larch woolly adelgid *Adelges oregonensis*	Shuttleworth Creek	Immature larch with 20% of shoots infested in localized area.
Poplars		
A tip blight *Valsa sordida*	Kwoiek Creek, Ashnola River, Penticton Creek, Lambly Creek	Common on immature aspen and cottonwood.

Host and Pest	Location	Remarks
Conifer-cottonwood rust *Melampsora occidentalis*	Hunters Creek	Lightly affecting 10% of black cottonwoods.
A leaf blight *Ciborinia whetzelii*	Okanagan Falls	Isolated pocket with 30% foliage infection on aspen.
Poplar shoot blight *Venturia* spp.	Vavenby-Birch Is. Ashnola River, McKay Creek	Widespread light infections on aspen and cottonwood.
Poplar borer *Saperda calcarata*	Shatford Creek Cayoosh Creek Lambly Creek	Up to 50% of trembling aspen attacked.
Other deciduous hosts		
Fall webworm *Hyphantria cunea*	widespread	Scattered light to moderate and occasional severe defoliation on deciduous roadside trees and shrubs.

Appendices

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

I. Maps of major 1994 beetle and defoliator infestations in Kamloops Forest Region.

II. Summary of pest problems in provincial parks within the Kamloops Forest Region, 1994.

III. Details of pheromone trap programs, Kamloops Forest Region, 1994.

IV. ARNEWS and biomonitoring surveys data, Kamloops Forest Region, 1994.

V. Pest Reports:

- Blackheaded budworm in the Kamloops Forest Region, August, 1994 J. Hodge and P. Koot
- Summary of forest pest conditions in the Kamloops Forest Region , 1994, August, 1994. J. Hodge and P. Koot
- Western spruce budworm in British Columbia, 1994, and forecast for 1995. P. Koot, J. Hodge, R. Turnquist and R. Erickson
- Tree mortality and defoliation caused by western hemlock looper in British Columbia in 1994 and forecast defoliation for 1995. R. Turnquist, A. Stewart, N. Humphreys, P. Koot, R. Erickson

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

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Natural Resources Canada
1379 Dominion Crescent
Kamloops, B.C.
V2C 2X2 Ph. 372-1241

Forest Insect and Disease Survey
Natural Resources Canada
R.R.#4, Site 92
Summerland, B.C.
V0H 1Z0 Ph. 494-8742

or, throughout the year to:

Forest Insect and Disease Survey
Natural Resources Canada,
Pacific Forestry Centre
506 West Burnside Rd.
Victoria, B.C.
V8Z 1M5 Ph.363-0600

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.