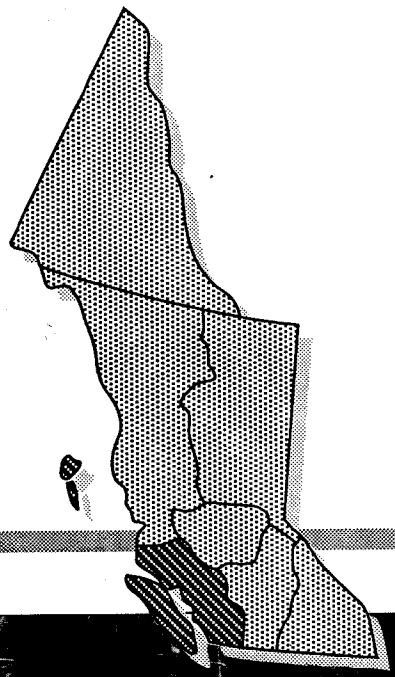
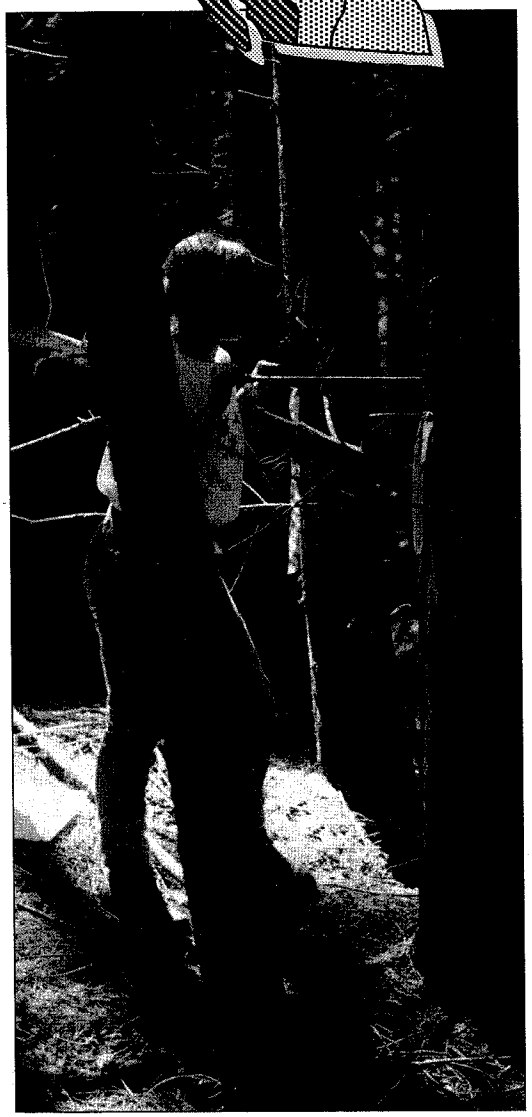
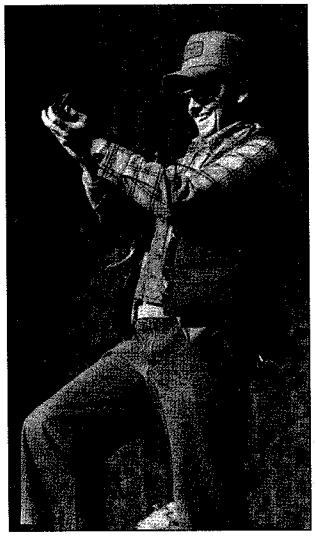


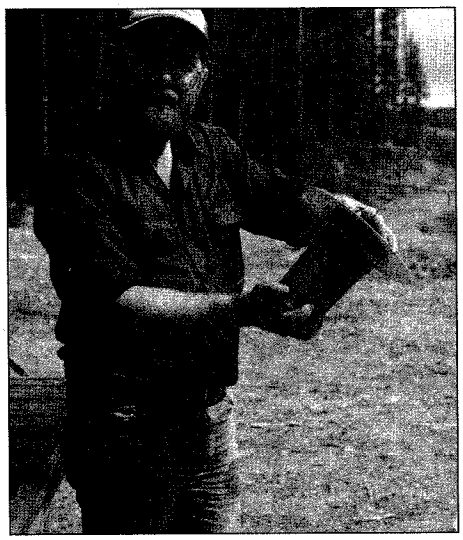
Forest Insect and Disease Conditions

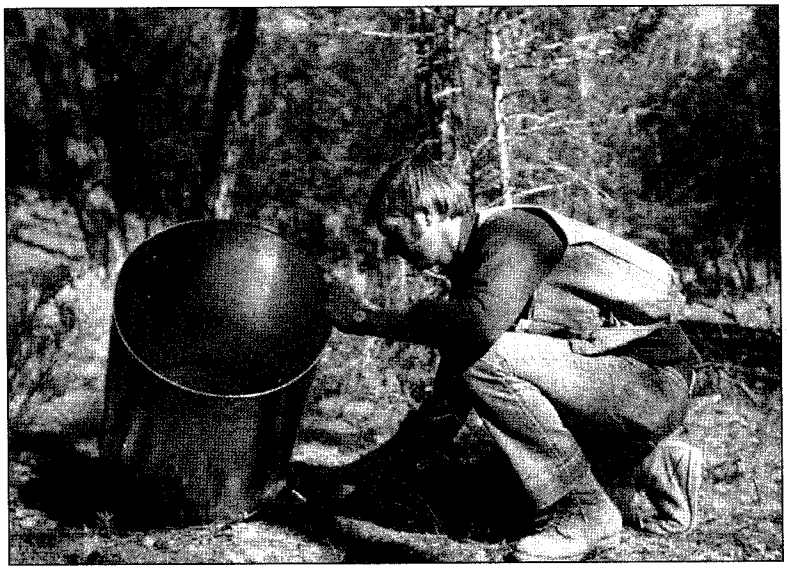
Vancouver Forest Region • 1993

Rod Turnquist and Colin Wood









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Foreword

Forest Insect and Disease Survey (FIDS) is a nation-wide network within the Canadian Forest Service (CFS) with the responsibility of: (1) producing an overview of forest pest conditions and their implications, including predictions where possible; (2) maintaining records and surveys to support quarantines; (3) supporting forestry research with field studies, records, Herbarium and Insectary collections; (4) providing advice and extension on forest insect and disease conditions; (5) developing and testing survey techniques; (6) and conducting related biological and impact studies.

Throughout the year, correspondence and inquiries regarding forest pest problems, and requests for publications can be directed to FIDS headquarters at:

Pacific Forestry Centre
Canadian Forest Service
506 West Burnside Road
Victoria, B.C.
V8Z-1M5 Ph. 363-0600

During the field season, May to October, inquiries can also be directed to the FIDS field stations.

For the Vancouver Mainland district:

Forest Insect and Disease Survey
Canadian Forest Service
P.O. Box 692
Agassiz, B.C.
V0M-1A0 Ph. 796-2042

For the Vancouver Island district:

Forest Insect and Disease Survey
Canadian Forest Service
Kye Bay, R.R.#1
Comox, B.C.
V9N-5N1 Ph. 339-4722

For the Queen Charlotte Islands:

Forest Insect and Disease Survey
Canadian forest Service
Box #23, Terrace,
B.C.
V8G-4A2 Ph. 635-7660

For the Bella Coola/Mid-Coast area:

Forest Insect and Disease Survey
Canadian Forest Service
Sidcum sub., Comp. 33, R.R. #3
Williams Lake, B.C.
V2G-1M3 Ph. 392-6067

Defoliation intensities in this report are defined as follows:

Trace - evidence of feeding barely detectable at close range
Light - some branch and/or upper crown defoliation, barely visible from the air
Moderate - pronounced discoloration and noticeably thin foliage, severe top defoliation
Severe - top and many branches completely defoliated, most trees more than 50% defoliated

Introduction

This report outlines the status of forest pest conditions in the Vancouver Forest Region for 1993 and forecasts trends of some potentially damaging pests. Pests are listed by host in order of importance with emphasis given to those capable of damaging outbreaks. Where possible, pest losses are quantified by Timber Supply Areas (TSAs) within Forest Districts. Most of the information was gathered through the monitoring of already known or recently reported insect or disease problems; through the detection of pest problems during travels through the region; annual aerial surveys during which major pest problems are mapped for area and severity, and several special surveys and collections.

Several special surveys were carried out during the field season. These included: pests in provincial parks, ecological reserves and seed orchards; changes in tree condition in Biomonitoring/Acid Rain National Early Warning System (ARNEWS) plots; pheromone trapping of defoliators including spruce budworm, western hemlock looper, and gypsy moth; surveys for the recently introduced pine shoot beetle and for European pine shoot moth; surveys for pinewood nematode in yellow cedar, western hemlock and lodgepole pine. Additionally, forest pest-related enquiries from the forest industry, government agencies, and the general public were investigated, causal agents identified, and management options suggested. Cooperation was provided to a Simon Fraser University graduate student researching pheromones for monitoring western hemlock looper populations.

During the 1993 field season, special collections were made which contributed to the current and continuing studies at the Pacific Forestry Centre, and other research institutes. The collections included woodborers and woodborer infested material, pinewood nematode samples, cottonwood sawfly larvae, winter moth larvae, western yew shoots and berries, mountain hemlock cones, balsam and hemlock woolly adelgids, foliar samples from ARNEWS plots, and earthworms.

The FIDS field season extended from early May to late September, during which samples collected for identification by CFS/FIDS and co-operators totaled 400. This included 179 insect and 130 disease collections, and 91 others such as pheromone-baited traps. The locations where samples were collected and the areas covered during 13.4 hours of fixed-wing aerial surveys are shown in Figure 1.

Forest pest conditions on the Queen Charlotte Islands in 1993 are detailed in this report. The survey, from July 13-24, and the report were completed by John Vallentgoed, FIDS Ranger based in Terrace in the Prince Rupert Region (West). Forest pest conditions in the Mid-Coast Forest District part of the Vancouver Region were assessed and reported by Bob Erickson, FIDS Ranger based in Williams Lake in the Cariboo Forest Region. The authors wish to acknowledge the support and assistance of the British Columbia Ministry of Forests with aerial surveys, and Scott Paper Ltd. with ground transportation and defoliator and disease sampling.

Summary

This summary of pest conditions in the Vancouver Forest Region in 1993 lists the most damaging pests, generally in order of importance by host affected.

January and February were **drier and colder than normal.** Desiccating winds during this period caused winter damage on several conifer species in the upper Fraser Valley. The cold weather also affected spruce aphid populations, which declined throughout the region this year. Growing season weather records (from April to September) from the Vancouver, Victoria and Port Hardy Airport Weather stations recorded **warmer than normal temperatures**, and except for Port Hardy, **wetter than normal conditions** prevailed. Mean temperatures at the Vancouver, Victoria, and Port Hardy Airports were warmer than the 30 year (1961-90) average by 6, 5, and 8% respectively. The rainfall for the same time period at Vancouver and Victoria was 16 and 44% more than the 30 year average, respectively. Port Hardy had 3% less rainfall than the 30 year average. This wet weather may have contributed to the decline in spruce budworm populations. As well, the mild, wet weather may also have contributed to the incidence of various needle and leaf casts, blights, spots, and rusts, which increased region-wide this year.

Western spruce budworm populations declined, light defoliation was recorded over 3715 ha of mostly Douglas-fir, an 84% decrease from 21 130 ha in 1992. Defoliation declined throughout all previously infested areas in the Soo TSA. Defoliation increased in the Fraser TSA, where the area defoliated near Boston Bar almost doubled. The area of **Douglas-fir beetle** attacks increased to 360 ha in 312 infestations from 170 ha in 210 infestations recorded in 1992. Part of this increase is due to new infestations in the Mid-Coast TSA. **Douglas-fir** and **rusty tussock moth** populations in the Fraser Valley remained endemic, no defoliation was seen or reported. **Root rots**, a common and ongoing widespread problem in both young and mature stands, were found in various locations region-wide.

Mountain pine beetle killed an estimated 11 000 trees over 525 ha in 144 infestations, down from 15 000 trees over 775 ha in 152 infestations in 1992. Most mortality continues to occur in the Soo TSA. **Pinewood nematode** surveys continued in attempts to gain an exemption for both yellow cedar and western hemlock from the European Community's ban on green lumber imports. Surveys for the **pine shoot beetle,** a European pest recently introduced to eastern North America, were negative. There was no recorded spread of **European pine shoot moth** populations in native trees at Richmond. Populations remain endemic in ornamental pines in the lower mainland and southeastern Vancouver Island. The incidence of **pine needle cast** increased throughout the region.

Spruce bark beetle populations remained low for the eighth consecutive year. No mortality was recorded in previously infested stands in the Mid-Coast Forest District. **Spruce weevil** populations continued to cause leader mortality throughout the host range. **Spruce aphid** populations declined, causing only light defoliation in coastal areas.

Balsam bark beetle killed mature alpine fir over 530 ha, down from 625 ha recorded in 1992. Most mortality occured in the Fraser TSA. Active **balsam woolly adelgid** populations were found both within and outside the new (1992) quarantine zone.

Western blackheaded budworm populations remained at endemic levels for the second consecutive year. **Hemlock woolly adelgid** populations increased at seed orchards on Vancouver Island and Sunshine Coast locations.

Cedar leaf blight was endemic throughout the host range.

A total of 35 **young stands** were surveyed for pest problems, which included **root rots, foliar diseases,** and **abiotic damage**. No evidence of acid rain damage was found at 11 **Biomonitering/ARNEWS** plots in the region. Eleven **seed orchards** were visited at least once for pest detection, some of which included **woolly adelgids** and **root rot**. **Climatic damage** was recorded on several different conifer species at various locations in southwestern B.C.

No adult male **gypsy moths** were caught in 88 traps placed by FIDS. However, about 141 were caught in traps placed by Agriculture Canada in various locations in southwestern B.C., including two of the Asian biotype, the first since 1991. **Winter moth** populations on the lower mainland and Vancouver Island lightly to moderately defoliated various deciduous species, similar to 1992. For the third consecutive year **cottonwood sawfly** populations increased, lightly to severely defoliating mainly black cottonwood on islands in the Fraser River near Chilliwack. Infections caused by a previously undetected species of **a poplar rust** were confirmed on hybrid poplars from the Fraser Valley and Vancouver Island. Severe scorching of Garry oak by the **jumping gall wasp** in the the Capital Region continued for the eighth consecutive year. Light damage continued near Duncan and Nanaimo, but there was no further reported spread. Discoloration and premature defoliation caused by the **oak leaf phylloxeran** was again common in the Greater Victoria area, and for the first time, mortality occured in some chronically infested trees. Populations were found, for the first time, on Garry oak at Sumas Mountain, near Chilliwack. **Northern tent caterpillar** populations increased, lightly to severely defoliating a variety of trees and shrubs at various Vancouver Island and some Gulf Island locations. **Dogwood leaf blight** continued at moderate to high levels throughout the host range. The incidence and intensity of **bigleaf maple scorch** and **leafspot** declined in lower mainland areas but was still common on south-eastern Vancouver Island. **Birch leafminer** populations infested most birch in lower mainland areas. **Fall webworm** populations although common, declined from the levels recorded in 1992. **Western winter moth** populations collapsed, no defoliation was seen or reported.

A summary of **new host and distribution records** in the region is included in this report, as well as a table summarizing **other noteworthy and minor pests**.

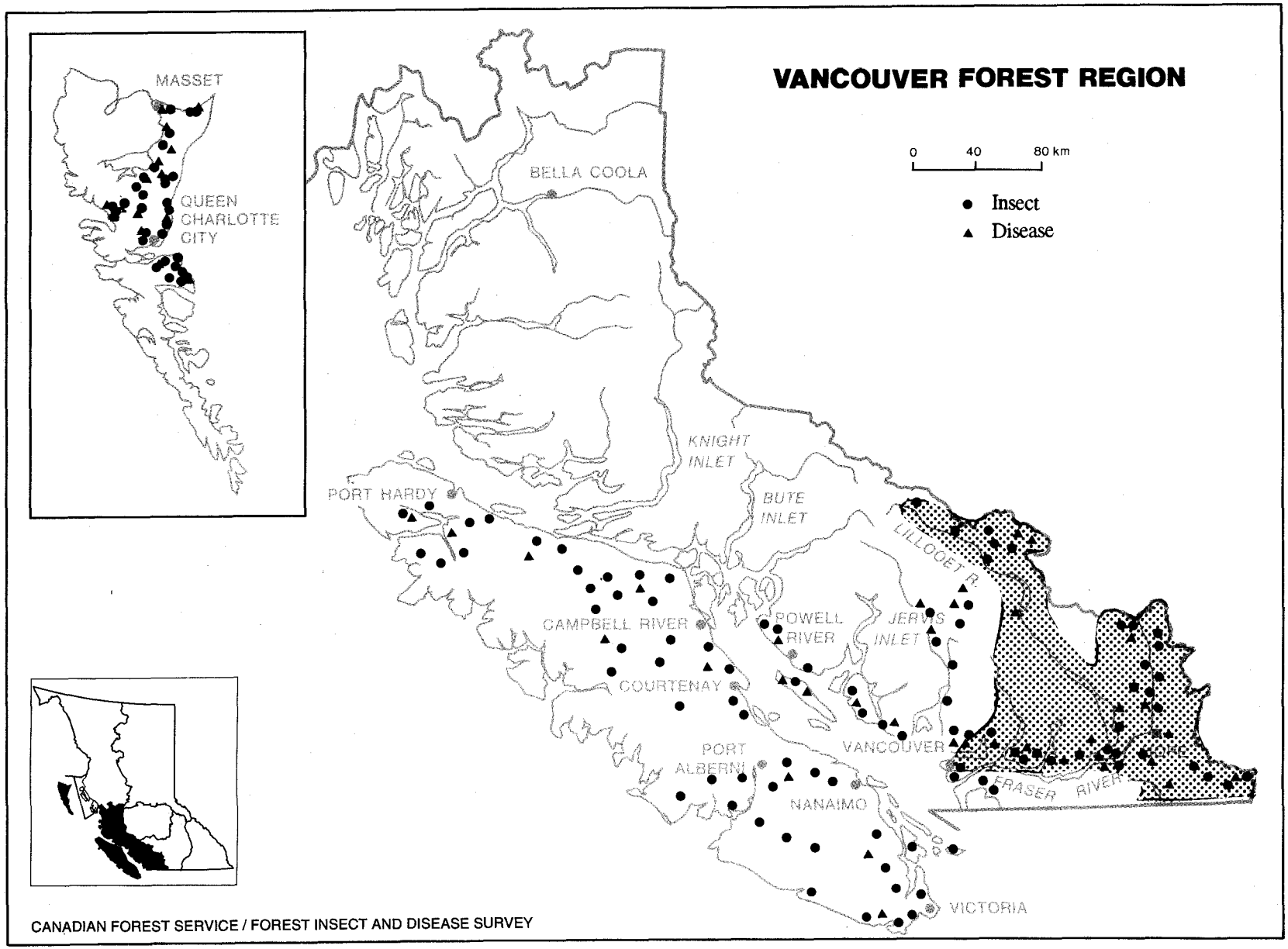

Figure 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1993.

Douglas-fir Pests

Western spruce budworm
Choristoneura occidentalis

The area of western spruce budworm-damaged Douglas-fir declined almost sixfold to 3715 ha in 40 pockets, from 21 130 ha in 47 pockets in 1992 (Figure 2). There were 3200 ha of light, and 515 ha of moderate defoliation. No severe defoliation was recored in 1993. This was the eighth consecutive year of defoliation caused by the budworm (Figure 3).

Defoliation

Budworm populations declined in most previously infested areas in the Soo TSA (Table 1). Only 85 ha of light defoliation was recorded in the Phelix Creek area, near Blackwater Creek. No defoliation was visible from the air in the Haylmore-Spruce-Eight Mile creeks area or the Birkenhead-Gates rivers area, where the infestation originated. Though not detectable during aerial surveys, some trace to very light defoliation was visible, from the ground, in the lower crowns of Douglas-fir in these areas. Defoliation continued in patches up the northeast side of the Lillooet River Valley, near Pemberton, from the Railroad-North-Pebble-Salal creeks area almost to Silt Lake at the head of the valley. The area and intensity of defoliation in these locations declined to 2885 ha of mostly light, with some moderate defoliation, from the 12 430 ha recorded in 1992. Defoliation in the upper lillooet River Valley areas near Pebble, Salal, and Manatee creeks was mostly on amabilis fir.

In the Fraser TSA, defoliation increased for the second consecutive year, to 745 ha from the 370 ha recorded in 1992. Infestations expanded near Hannah and Francis lakes as well as on southwest facing slopes above the Nahatlatch River in the Four-Barrel main area. Some defoliation was also recorded across the valley from this area. A small patch of light defoliation was again recorded near Hannah Creek.

Mass collections of budworm larvae from the Four-Barrel Main area in the Fraser TSA and from the Salal Creek area in the Soo TSA found varying levels of fungal disease as well as parasitism. At Salal Creek, 16% of the larvae died from an Entomophthoraceous fungus, *Erynia* sp., and 3% died from an unknown disease. About 3% of the larvae from the Four-Barrel Main area also died from an Entomophthoraceous fungal disease. Parasitism at Salal Creek was 19% and at Four-Barrel Main was 6%. The wet, cool late spring and early summer was conducive to the spread of fungal disease and may have contributed to the decline in budworm populations in the Pemberton area.

Damage

Although the infestation declined in most areas, cumulative top kill of up to a metre was evident on semi-mature trees at North, Blackwater and Fowl creeks in the Soo TSA. At Salal Creek, where the budworm is feeding almost exclusively on Amabilis fir and western and mountain hemlock hybrids, more than a metre of top stripping was evident.

Permanent plots were established in an approximately 30-year-old, naturally regenerated, spaced stand at Eight Mile Creek, north of Pemberton. Top-kill was noted in this stand, which was moderately defoliated in 1991 and '92. Although the infestation in this area declined, 3% of plot trees were 20%+ defoliated, and 68% were <20% defoliated. Twenty-nine percent of trees surveyed had top-kill and/or more than 5% bud and shoot mortality. The

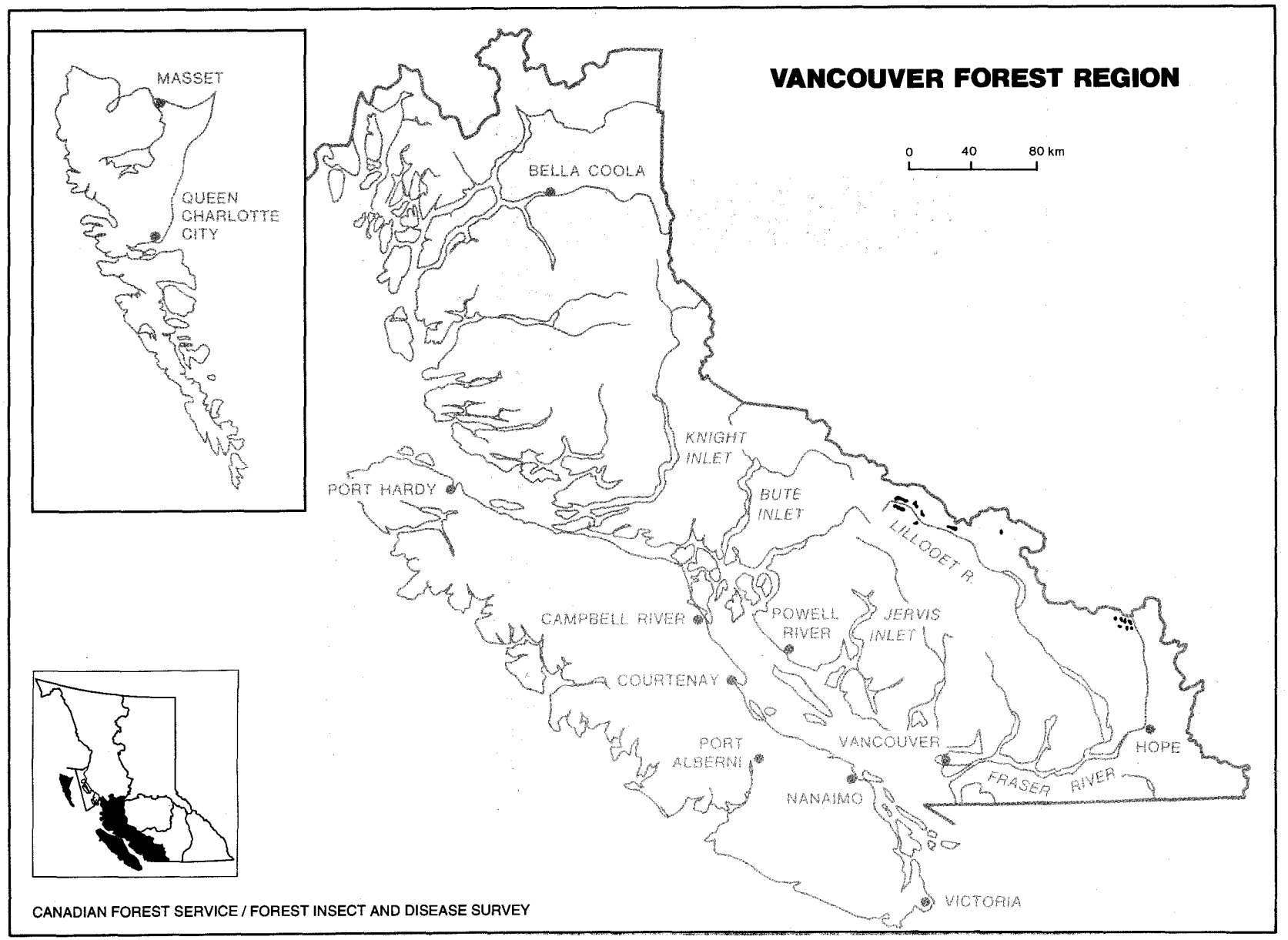

Figure 2. Areas where current defoliation by the Western spruce budworm was detected during ground and aerial surveys in 1993.

younger, smaller diameter trees exhibited the most defoliation, top-kill, and bud and shoot mortality. Surveys will continue in these plots to record the effects, over time, that budworm defoliation has on younger trees in a spaced stand.

No tree mortality has been recorded during this infestation. Some understory trees in areas with high budworm populations have been moderately to severely defoliated, and may not recover. Growth reduction, averaging 12%, was recorded in trees moderately defoliated in 1989 (FIDS file report, 90-6, 1989).

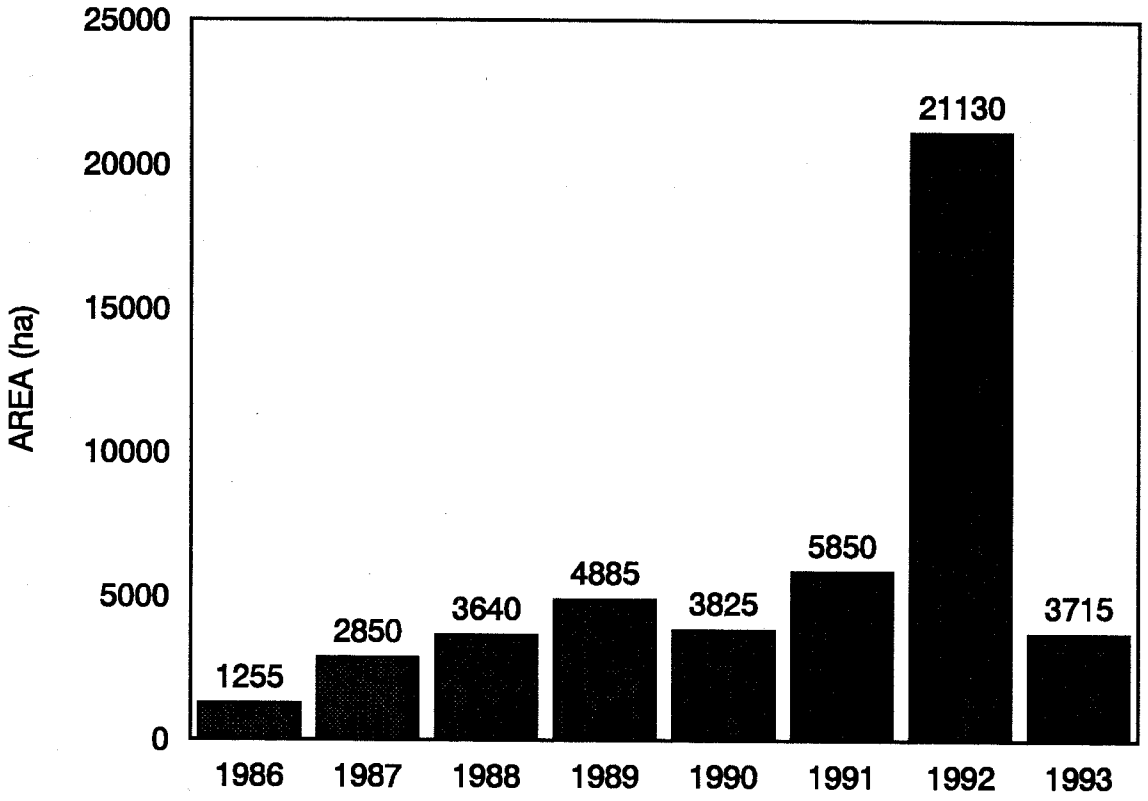

Figure 3. Area of Douglas-fir defoliated by the western spruce budworm, 1986-1993, Vancouver Forest Region, 1993.

Table 1. TSA, location and area of defoliation of Douglas-fir by western spruce budworm, from aerial surveys, Vancouver Forest Region, 1993 and 1992.

Tsa and location	Area of defoliation (ha)							
	Light		Moderate		Severe		Total	
	1993	1992	**1993**	1992	**1993**	1992	**1993**	1992
Soo TSA								
Birkenhead R.	-	1420	-	800	-	-	-	2220
Blackwater-Phelix creeks	**85**	860	-	-	-	-	**85**	860
Spruce-Haylmore-Eight Mile creeks	-	2200	-	420	-	-	-	2620
Birkenhead Lake-Sockeye Creek	-	540	-	1310	-	-	-	1850
Gates River	-	780	-	-	-	-	-	780
Lillooet River	**2370**	8090	**515**	2890	-	1450	**2970**	12430
Fraser TSA								
Hannah Creek-4 barrel main	**155**	50	-		-	-	**155**	50
Hannah-Francis lakes	**440**	290	-		-	30	**440**	320
Nahatlatch River-Kookipi Creek	**150**	-	-	-	-	-	**150**	-
Total	**3200**	14230	**515**	5420	-	1480	**3715**	21130

Forecast

An average of 38 egg masses/10m^2 of foliage (range 20-54) were collected at 6 locations in the Soo TSA, north of Pemberton, down 24% from the average of 50 (range 35-73) in 1992 (Table 2). In the Fraser TSA, the average number of egg masses more than doubled to 109 from the 49 recorded in 1992. The egg mass data indicates the potential for continued light defoliation in the Soo TSA, while moderate defoliation is predicted for the Fraser TSA in 1994. The presence of disease in some areas may, however, have a detrimental effect on budworm populations and resulting defoliation.

Table 2. Predicted 1994 spruce budworm defoliation based on egg mass surveys, Vancouver Forest Region, 1993.

Location	Avg. no. of egg masses/10m² of foliage/plot		% increase decrease	Defoliation[1]	
	1993	1992		1993	**1994(predicted)**
Soo TSA					
Birkenhead R.	**38**	60	-37	Trace	**Trace-Light**
8-Mile Cr.	**20**	46	-57	Trace	**Trace-Light**
Haylmore Cr.	**54**	35	+54	Trace	**Light**
Blackwater Cr.	**52**	38	+37	Trace	**Light**
North Cr.	**25**	47	-47	Trace-Light	**Trace-Light**
Salal Cr.	**37**	73	-49	Light-Moderate	**Trace-Light**
Average	**38**	50	-24		
Fraser TSA					
Hannah Creek	**109**	49	+122	Light-Moderate	**Moderate**

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

The pheromone trapping portion of a budworm sampling project started in 1987 to detect increasing populations continued in 1993. The larval sampling phase of this project was dropped in 1992. Pheromone-baited dry "Multipher" traps to attract adult males (Table 3) were placed (5/site) in each of four areas of previous infestation; Skagit Valley, North Bend, Anderson River and Rutherford Creek. The Rutherford Creek site replaced the Devine site, sampled prior to 1993, because traps at this site had been saturated due to the presence of adjacent infestations, yet no defoliation was recorded at the site. The Rutherford Creek area has a history of budworm outbreaks, yet is far enough removed from current infestations. The average number of moths per trap decreased at the 3 sites trapped previously, no defoliation was recorded at any of the sites.

The North bend site was logged in late summer/early fall of 1993 and so will be discontinued. The continuing high fluctuation of adult males in the traps, and lack of defoliation at the sites, makes the data difficult to interpret. Initial data suggests that, depending on how defoliation is classified, anywhere from 275-450+ moths indicate a 70-90% chance of light to severe defoliation. Work is continuing at determining threshold levels, based on results from traps at theses and other sites province-wide. Results of the trapping program to date will be available later in 1994.

FIDS will be reviewing this pheromone trapping program, and a decision to continue the program will be made pior to the 1994 field season.

Table 3. Comparison of 1993 and 1992 pheromone sampling results at spruce budworm calibration plots in the Vancouver Forest Region, 1993.

Location	Avg. no. moths/trap 1993	1992	Average defoliation at plots 1993	1992
Soo TSA[1]				
Devine	-	306	**none**	trace
Rutherford Creek	141	-	**none**	none
Fraser TSA				
North Bend	*28	127	**none**	none
Anderson R.	68	257	**none**	none
Skagit Valley	<1	**16	**none**	none

[1] Devine site dropped, Rutherford Creek added
* Count from 1 trap, four destroyed
** Average of 4 traps, One destroyed

Douglas-fir beetle
Dendroctonus pseudotsugae

Following two consecutive years of decline, the area containing recent beetle-caused Douglas-fir mortality increased to 360 ha in 312 infestations from 170 ha in 210 infestations in 1992 (Table 4). Most of the mortality continues to occur in the Interior Douglas-fir Biogeoclimatic Zone in the Fraser TSA, especially near Boston Bar. Increased mortality was recorded in the Fraser and Soo TSA's, while new mortality was recorded in the Mid-Coast TSA near Bella Coola.

Table 4. Area of Douglas-fir beetle caused mortality, Vancouver Region, 1993.

TSA	Area (ha) 1993	1992	No. of Infestations 1993	1992
Fraser	**240**	140	**155**	175
Mid-Coast	**80**	-	**125**	-
Soo	**40**	30	**32**	35
Totals	**360**	170	**312**	210

In the Fraser TSA the area of beetle-attacked Douglas-fir increased to 240 ha in 155 infestations, from 140 ha in 175 infestations in 1992. Almost half of the total regional area, and one third of the infestations, occured along the Fraser River and associated side drainages between Yale and the mouth of the Nahatlatch River. Single tree and groups of up to 15 trees were once again mapped in the Anderson River area south and east of Boston Bar. In the Chilliwack River Valley, new mortality was mapped at Tamihi Creek, with infestations continuing in the Skagit Valley from Maselpanik Creek to Ross Lake, and a few spots along the Skagit River south of Manning Park. Infestations on the Foley Creek area, a tributary of the Chilliwack River, declined. Several spots totaling 30 ha, up from 15 in 1992, were mapped on the northeast side of Sumas Mountain.

In the Soo TSA the area of recently killed Douglas-fir increased to 40 ha in 32 infestations from 30 ha in 35 infestations in 1992. Most of the increase was recorded near Glacier Lake, between Lillooet and Harrison lakes. Infestations in this area appear to have been ongoing for a couple of years, both old and recent mortality was observed. Fewer spot infestations were recorded along the east side of Lillooet River and Lake, from Rogers Creek to Joffre Creek, including the Twin One, Twin Two and Lizzie creek areas. A few small areas were also mapped in the Mt. Currie, Birkenhead River and Gates Lake areas. No recent mortality was seen along the west side of Lillooet Lake opposite Lizzie and Twin One creeks where large areas of beetle-killed timber were mapped in 1991.

In the Mid-Coast TSA, 80 ha of recent mortality was mapped, a significant increase from the few spots recorded in 1992. Mortality was recorded in the Dean, Talchako, and Atnarko river valleys near Bella Coola.

Populations are expected to remain at similar levels for 1993, based on historical patterns. The beetle prefers material such as felled trees, slash (over 20 cm diameter), stumps, overmature trees, and trees damaged by drought, root rot, logging and road building.

Douglas fir tussock moth
Orgyia pseudotsugata
Rusty tussock moth
Orgyia antiqua badia

The outbreak of Douglas-fir tussock moth in the Fraser Valley collapsed as predicted. No defoliation was seen or reported from Chilliwack to the Clearbrook area, where populations caused local defoliation of roadside, hedgerow, highway median and golf course trees from 1990 to 1992. A few rusty tussock moth larvae were collected by B.C. Forest Service staff at the Chilliwack Golf and Country Club, these are endemic populations and caused no visible damage.

A nuclear polyhedrosis virus (NPV), which killed 25% of a mass collection made in late June 1992, was probably responsible for this collapse. Two previous outbreaks, in the same general area in 1971-72 and 1982-83, were also thought to have collapsed from virus. Another factor in the collapse were two late spring, 1992, applications of *Bacillus thuringiensis,* var. *kurstaki*, (Btk), at the Chilliwack Golf and Country Club. High egg mass numbers detected at this location during an early May, 1992, egg mass survey prompted the golf course to take control action. This was the third time in the last 15 years that the golf course used insecticides to control tussock moth outbreaks. Additionally, the Meadowlands Golf Club east of Chilliwack used ORTHENE by aerial application to control the tussock moth.

Damage

Damage of up to 1m top kill, or very thin crowns was observed in about 25% of trees at the Chilliwack Golf and Country Club. Over the next few years, trees with thin crowns should recover. The most severely top-killed trees may not fully refoliate. About 10 trees along the southern edge of the Trans-Canada Highway west of Chilliwack, severely defoliated by the tussock moth in 1991 and '92 were removed by the highways department by the fall of 1992. No other mortality was seen or reported.

Forecast

Populations are expected to remain at endemic levels, based on the history of outbreaks in this area. FIDS will monitor populations next year.

Armillaria root disease
Armillaria ostoyae
Laminated root rot
Phellinus weirii

These two root rots are chronic problems and were commonly found in all age classes of Douglas-fir stands throughout the Vancouver region in 1993. The information on detection of these root rots came mainly through young stand surveys (see POYS section) conducted annually in the region. Random collections, specific requests for identification of causes of tree mortality, as well as Parks surveys, provide further data on these diseases.

Tree mortality caused by *A. ostoyae* was detected in 38% of young stands surveyed for pest problems on Vancouver Island and mainland locations. Mortality averaged <2% (range 1-3) in these stands. Armillaria root disease also killed young to semi-mature trees near the ARNEWS plot in the Seymour Demonstration Forest. Although *P. weirii* is mainly associated with semi-mature to mature trees, it was also detected in young stand surveys. Six percent of young stands had mortality due to laminated root rot, although <1% of trees were killed. Laminated root rot is widespread throughout the Fraser Canyon and Anderson River areas where Douglas-fir beetle attacks are associated with root rot-stressed trees.

Mortality from these diseases occurs annually, and will continue to occur throughout the range of Douglas-fir. Planting root rot resistant tree species, including some hardwoods, and push-over logging in some sites, are some of the management tools used in areas where severe root rot problems occur.

These root rot pathogens also infected other conifer species. Incidences are listed in the Other Noteworthy and Minor Pests section of this report.

Pine Pests

Mountain pine beetle
Dendroctonus ponderosae

The area of lodgepole pine killed by mountain pine beetle attacks decreased by about one third, following last years first recorded increase in seven years (Figure 4). About 11 025 trees were killed over 525 ha in 144 infestations in 1993, down from an estimated 15 375 trees killed over 775 ha in 152 infestations in 1992. (Table 5). Although the area and number of trees declined, volume loss increased to approximately 8085 m^3 from 5100 m^3 last year. This volume increase is due to some infestations classed in a higher severity rating, which results in more volume loss. Mountain pine beetle attacks were recorded in the Soo, Fraser, and the Mid-Coast TSA's (Figure 5).

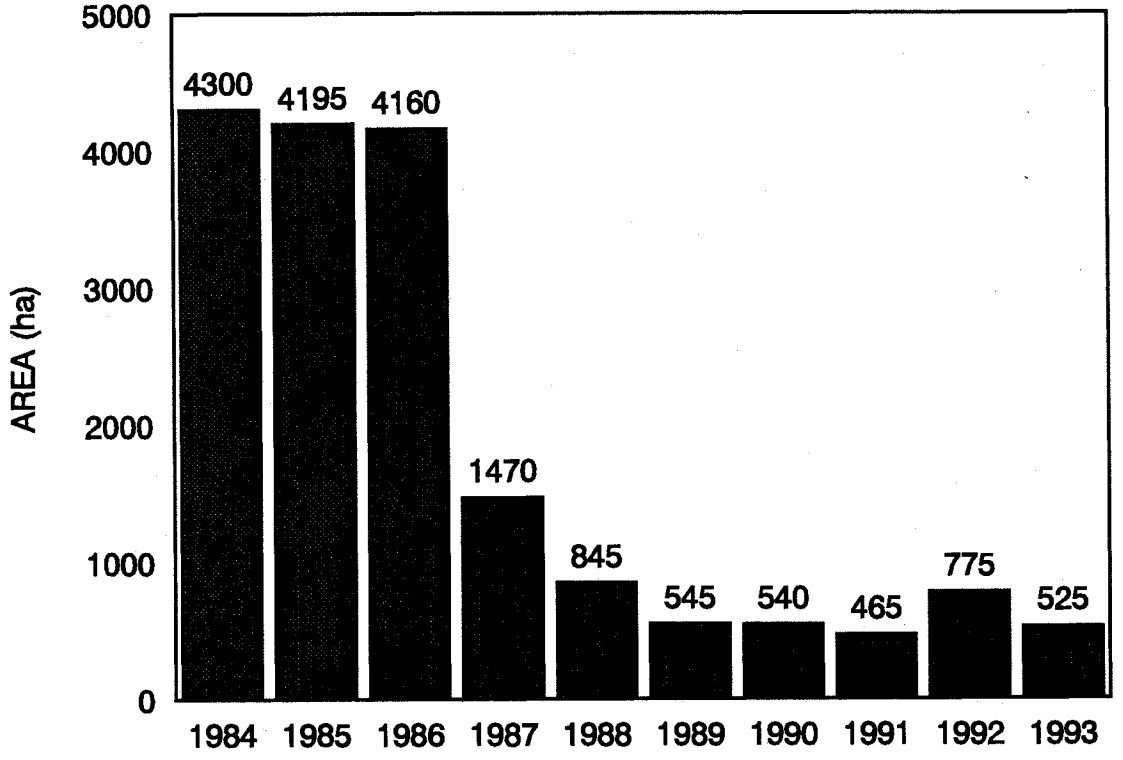

Figure 4. Mountain pine beetle, a ten year history by area, 1984-1993 Vancouver Forest Region.

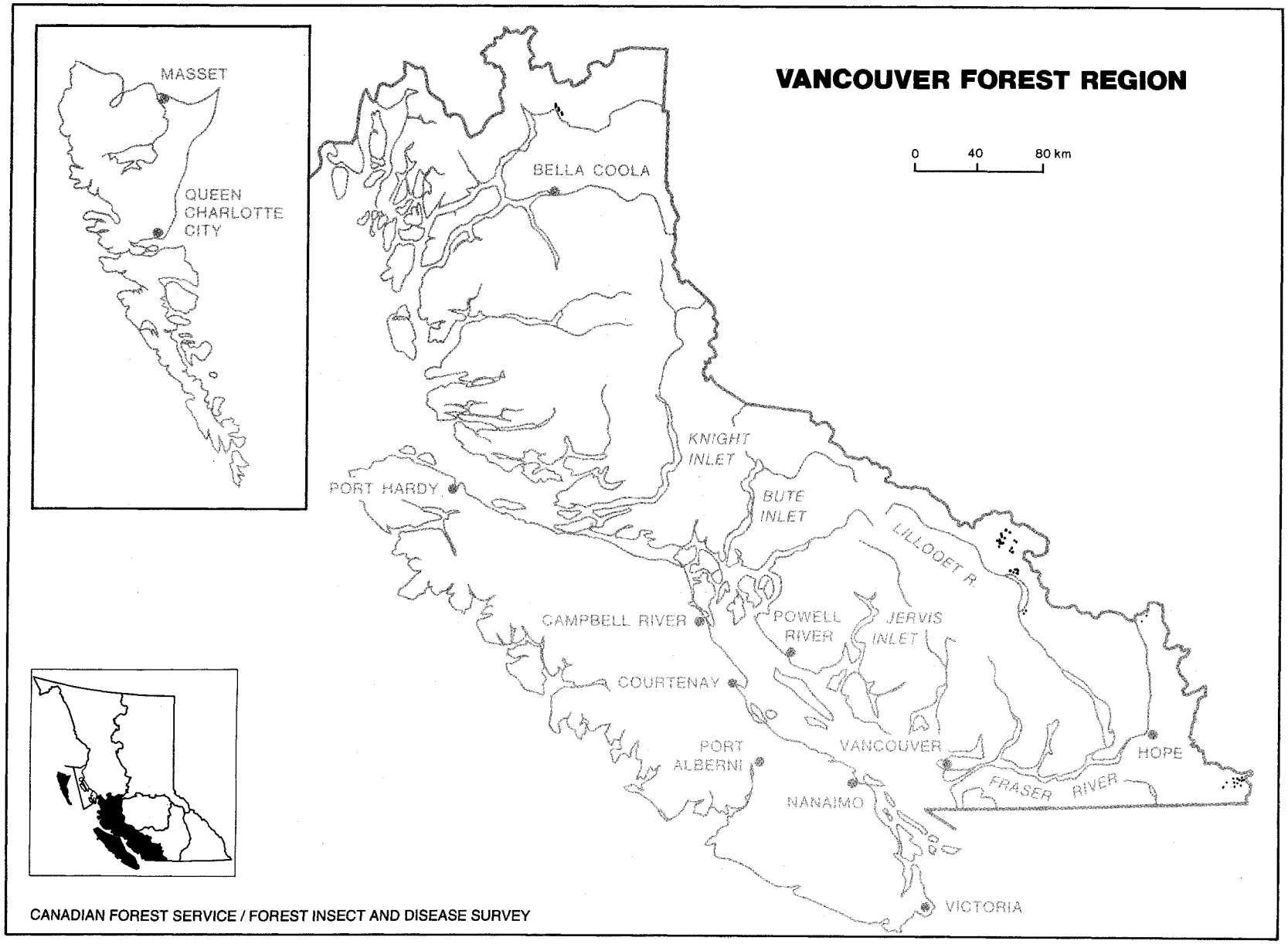

Figure 5. Areas of lodgepole pine recently killed by mountain pine beetle as determined by aerial and ground surveys in 1993.

Table 5. Recent mountain pine beetle-caused mortality in lodgepole pine as determined from aerial surveys, Vancouver Forest Region, 1993.

	Area (ha)		No. of trees killed		Vol. killed (m^3)		No. of infestations	
TSA	**1993**	1992	**1993**	1992	**1993**	1992	**1993**	1992
Soo	**470**	735	**8925**	14 775	**6545**	10 835	**70**	98
Fraser	**50**	40	**1875**	600	**1375**	440	**50**	54
Mid-coast	**5**	-	**225**	-	**165**	-	**14**	-
Sunshine coast	-	-	-	-	-	-	-	-
TOTAL	**525**	775	**11 025**	15 375	**8085**	5100	**144**	71

Soo TSA

In the Soo TSA the area of attack decreased to 470 ha from 735 ha. This was mainly due to a decrease in the number and size of infestations in the Joffre Creek area near Lillooet Lake, at Owl Creek and across from Gates Lake in the Birkenhead area. There was also a decrease in the number of small infestations along the north side of Blackwater Creek. The severity of infestations on the flats along the Birkenhead River near Birkenhead Lake remained high. A single cruise in that area found 28% current attack, 27% red attack, and only 17% of trees were healthy. Much of the pine in the Birkenhead River area is of a susceptible age, and the high mountain pine beetle populations in the area will continue to attack susceptible stands. Salvage logging, as well as pheromone trapping to contain infestations, is planned for this area in for next year.

Fraser TSA

Other than a few single tree and small group attacks totaling 5 ha near Boston Bar, no new infestations were mapped in the Fraser Canyon or associated drainages. In Manning Park, approximately 45 ha of recent mortality was mapped, almost identical to the 40 ha recorded in 1992. Most of the attacks continued to occur in the eastern portion of the park. This area is managed under contract that includes conducting ground surveys and treating attacked trees with Monosodium methane arsenate (MSMA). The continuing lack of beetle activity in the Fraser Canyon area is largely a result of host depletion and harvesting of previously infested stands.

Mid-coast TSA

Approximately 5 ha of mortality was recorded in 14 infestations in the Dean River area, northwest of Bella Coola. This is the first mountain pine beetle-caused mortality mapped in this TSA since 5 ha were recorded in 13 infestations in the same general area in 1990.

Sunshine Coast TSA

For the fifth consecutive year no beetle attacks were reported in this area. As recently as 1986, an estimated 2770 ha of infested lodgepole pine were mapped along the Homathko River. Until the remaining pine reaches maturity, mountain pine beetle populations will probably remain at endemic levels.

Pinewood nematode
Bursaphelenchus xylophilus

Surveys for the Pinewood nematode, conducted in the region in 1993, were carried out in order to obtain data for a possible exemption of yellow cedar from the ban on green lumber exports from Canada to the member countries of the European Economic Community. Additionally, bait log trials continued, to support a possible exemption for western hemlock.

Surveys were conducted and samples collected from yellow cedar logs at 18 sites in the region, including dry-land sorts and log decks. Most sites (15) were on Vancouver Island and the remainder (2) from the lower mainland and mid-coast (1). None of the 27 extracted samples contained pinewood nematode, but 45% contained other insect-associated or fungal-associated nematodes of the order Rhabditida and Tylenchida (Table 6). New or old insect activity was evident in some of the logs at 44% of the sites examined. There was no evidence of activity by sawyer beetles, *Monochamus* spp. at any of the sites examined. Sawyer beetles are suspected vectors of the nematode. Woodborer galleries identified in 5% of the logs at 33% of the sites were caused by a cedar tree borer, *Semanotus ligneus*. Ambrosia beetle, *Trypodendron lineatum,* attacks were found in about 5% of the logs at 11% of the sites. A cedar bark beetle, *Phloeosinus* sp. was found at 17% of the sites. The western cedar bark beetle, *Phloeosinus punctatus*, was found at one site, and galleries at one other location were caused by an unidentified Cerambycid.

In 1993, a follow-up to the 1992 bait log survey, again using western hemlock and lodgepole pine, was conducted. In early June, freshly cut, 1 metre long logs were taken from standing western hemlock (18), and pine (12), and placed at a site with active woodborer populations north of Pemberton. This is the same location where western hemlock and lodgepole pine bait logs were placed last year. Woodborer attacks, which were common at this site in 1992, were much lower this year. The cool, wet late spring and early summer weather has likely pushed most woodborers at this site into a 2-year life cycle, as a result, obtaining data from these trials will be delayed for a full year.

Between 1980 and 1992, periodic surveys for the nematode were conducted in natural stands throughout British Columbia and the Yukon Territory. Extractions from samples collected during these surveys found only six individual predisposed trees, from widely scattered locations, and one woodborer, *Monochamus clamator* Hald., to contain pinewood nematode. In 1992, log bolt studies were initiated at 11 sites in six regions. From the 550 extractions done during the 1992 study, pinewood nematode was present in 13% of pine, and none of the western hemlock samples.

reduce the threat of further attacks. Populations remain low throughout the rest of the region, mainly due to host depletion.

Spruce weevil
Pissodes strobi

The spruce weevil continues to be a significant pest of immature Sitka spruce leaders throughout the host range in the region. Although no specific surveys were conducted in 1993, some weevil attack was detected during young stand surveys on Vancouver Island.

Sitka spruce was a minor component in young stands surveyed on Vancouver Island, it averaged 10% of the stand (range 2-17) in seven of 14 stands surveyed. Weevil attack was found in only one stand, 18% of spruce in this stand, near Sooke, had current attack.

Weevil attack has been a chronic problem in the Vancouver region for several decades. Mild winters and warm summers, along with the establishment, through reforestation, of abundant preferred host material, have resulted in continued weevil attacks. Repeated attacks by the weevil can lead to a reduction of merchantable volume at rotation age due to crook, stem decay, and other deformities. Current research efforts at the Pacific Forestry Centre are focusing on resistant trees, biological control, stand density and species mix, and deciduous overstory/overtopping effect.

Spruce aphid
Elatobium abietinum

Defoliation of native and ornamental spruce by the spruce aphid declined this year following high populations and widespread defoliation in 1992. The cold weather experienced throughout southwestern B.C. in Febuary, 1992, is largely responsible for the decline in aphid populations this year.

Scattered light defoliation occurred throughout eastern Vancouver Island with some noticeable pockets of heavier defoliation on mature trees occurring in the Campbell River area. On the lower mainland, and Coastal inlets north to Port Hardy, no significant populations or damage was observed or reported. Trees that were infested last year, especially those infested for the first time in Fraser Valley areas, show little evidence of damage from last years attack.

True Fir Pests

Western balsam bark beetle-fungus complex
Dryocoetes confusus, Ceratocystis dryocoetidis

Balsam bark beetle killed some 9340 alpine fir over 530 ha in 1993, compared to 7300 trees over 625 ha in 1992. The volume of timber killed increased to 10 170 m^3 from 7965 m^3 in 1992 (Table 7). Although the area of mortality declined, because some locations in the Mid-coast TSA were classified as moderately attacked, the number of trees and volume increased.

Table 7. Estimated true fir mortality by western balsam bark beetle-fungus complex, by TSA, as determined from aerial surveys, Vancouver Forest Region, 1993

	Area (ha)		Number of trees killed		Volume killed (m^3)	
TSA	**1993**	1992	**1993**	1992	**1993**	1992
Fraser	**280**	475	**3150**	5345	**3430**	5820
Soo	**100**	150	**1125**	1970	**1225**	2145
Mid-Coast	**150**	-	**5065**	-	**5515**	-
Total	**530**	625	**9340**	7315	**10 170**	7965

This beetle is a chronic pest in many subalpine fir stands in the Region. The sporadic and frequently remote occurrence and the retention of red foliage for several seasons makes a consistent and accurate assessment of the damage caused by this pest difficult. Surveys to delineate damage caused by the bark beetle-fungus complex will continue next year.

Balsam woolly adelgid
Adelges piceae

Populations of balsam woolly adelgid (BWA) were found outside the revised (1992) quarantine zone and beyond it's previously known distribution, on mature amabilis fir in the Oyster River drainage west of Campbell River, and on amabilis fir regeneration northwest of Spuzzum in the Fraser Canyon. Damage was also found, for the first time, on amabilis fir regeneration in several widely scattered patches near Port Alberni, within the quarantine zone on Vancouver Island.

In the Oyster River drainage near Campbell River aphids were found in severely gouted buds at tops of trees from which a large cone crop was collected. There was no evidence of populations on regeneration in the area. The collection on amabilis fir, from Tikwalis Creek near Spuzzum in the Fraser Canyon, was submitted by a forest consultant. Subsequent collections from amabilis fir regeneration in drainages north and west of the original collection were negative.

Leader dieback, reduced height growth, and gouting of branch nodes caused by increased adelgid populations occurred on 20- to 25-year-old amabilis fir regeneration in small 0.5 ha pockets in higher elevation sites throughout the Cameron River drainage, southeast of Port Alberni. Damage at two sites was moderate to severe on 20% of the trees, and light on 15%. Although the remaining regeneration had no visible damage symptoms, 70% and 80% of the trees in each of the two sites had active populations. This was the first record of significant damage to managed young stands on Vancouver Island.

In 1992, the BWA Regulations were revised by an Order in Council under the B.C. Plant Protection Act. The revision included an expansion of the quarantine zone to include infested areas of the mainland and islands previously outside the zone. The quarantine zone

boundaries may undergo further revisions due to these new distribution records. FIDS will continue to survey for the presence of this pest in 1994.

Hemlock Pests

Western blackheaded budworm
Acleris gloverana

Blackheaded budworm populations on northern Vancouver Island, which collapsed in 1991 following three years of recorded defoliation, remained at endemic levels. For the third consecutive year, no defoliation was observed or reported, down from 630 ha in 1990, 7400 ha in 1989, and 4830 ha in 1988.

Although some top-kill was reported, no area or percent figures are available, due to reduced ground and aerial surveys. Populations will be monitored in 1994.

Hemlock woolly adelgid
Adelges tsugae

Very high populations resulting in masses of white cottony tufts were again common on western hemlock at the Canadian Pacific Forest Products (CPFP) seed orchard in Saanich (Hovey Road). Successive years of high populations have reduced tree vigor, and resulted in the initiation of a cooperative BCFS/industry/FIDS study on the predator-parasite complex. Preliminary findings will be available later this year. High populations also infested trees at Canadian Forest Products (CanFor) Sechelt seed orchard. Three applications of an insecticidal soap were made at the seed orchard to combat the infestation, the most serious yet found here. Branch die-back in heavily infested trees was observed for the first time.

Additionally, populations very lightly infested a small number of western hemlock at sites including the PFC Research Forest at Shawnigan Lake and along the Westside Road. At Quinsam Seed Orchard (BCFS) at Campbell River, about 3% of trees were lightly infested, up from <1% last year. One percent of the foliage on less than 5% of the trees was infested at Hart Lake, near Campbell River, and lightly infested trees were common near Mt. Arrowsmith, Coombs, Swan Lake Conservancy in Saanich, and in ornamental plantings in Comox and Port Alice. Light populations were also found in a single, windthrown tree near Maple Ridge.

Cedar Pests

Cedar leaf (keithia) blight
Didymascella thujina

Infections by this leaf blight fungus were found throughout the host range in 1993. This disease is common in stands on the north shore of Vancouver, the upper Fraser Valley, the Whistler and Pemberton areas and Vancouver Island. Moderate infection levels occured in the Kelsey Bay area this year. Surveys found an average of 45% (range 25-60) of trees affected, mainly in spaced stands. Infections are most common on lower branches.

The diseased branchlets may be mistaken for natural flagging that commonly occurs on western red cedar. In both cases, foliage turns reddish over the summer. In the case of the leaf blight, the older branches become gray and small black fruiting bodies or remaining holes can be found on the upper side of infected leaves. Heavy infections may cause branch mortality on older trees and possibly contribute to mortality of understory cedar saplings.

Multiple Host Pests

Pests of young stands

A total of 35 young stands were surveyed for pest incidence and intensity in the Vancouver region in 1993. These stands ranged in age from 6-to 30-years old, and were located in 3 Biogeoclimatic zones; Coastal Western Hemlock, Coastal Douglas-Fir, and Interior Douglas-Fir. A total of 3738 trees representing 12 species were examined, of which 2735 or 73% were pest free. Most surveys were in stands that had been treated under the Forest resources Development Agreement (FRDA). The different silvicultural treatments examined were: spacing, 76% of stands; fertilizing, 9% of stands; and planting, 6% of stands. Three other treatments including: chemical brushing and weeding ground injection; mechanical brushing and weeding; and pruning, were each 3% of stands examined. The results of the survey are summarized in Table 8.

Fourteen of the 35 young stands surveyed had a level or type of pest damage that indicates a resurvey (within 2-5 years) of the stand might be necessary to asssess stocking levels and acceptability of stem form. Root diseases and top deformities were the main reason for this recommendation.

Needle diseases were the most common pest encountered, affecting 280 trees overall, or 8% of all trees surveyed. The cooley spruce gall adelgid was the next most common pest, affecting 269 trees or 7% of the total examined. The most damaging pests were: dead and multiple tops or leaders, affecting 79 trees or 2% of the total trees examined; tree competition, affecting 55 trees or 1.5% of the total surveyed; and root diseases, including Armillaria root disease and laminated root rot, which affected 16 trees or less than 1% of the total trees surveyed. These damaging pests were found on about 4% of the total trees and were present in 40% of the stands surveyed.

Although 12 tree species were recorded during the young stand survey, only 9 are included in the table. The other 3 species, Engelmann spruce, red alder, and black cottonwood totalled less than 10 trees surveyed each. The alder was pest free, and low levels of an leaf blight was found on the cottonwood. Galls caused by *Adelges cooleyi,* and *Pineus* sp. were found on the Engelmann spruce, as well as some multiple leaders.

Table 8. Summary of pests of young stands surveys, by host and pest in descending order of importance, Vancouver Forest Region, 1993.

Host/pest	Severity index[1]	Affected no. of trees	Affected no. of stands	% of trees affected[2] average	% of trees affected[2] range
Douglas-fir - 1781 trees in 25 stands, 1281 trees (72%) pest free					
Armillaria root disease	6	11	8	1	1-2
Laminated root rot	6	4	2	2	2
Tree competition	4-6	20	2	9	5-13
Abiotic damage	4-5	17	2	8	1-15
Spruce budworm	2-4	79	1	100	100
Poor form (crook, fork, sweep, multi-top, dead top)	2-4	75	17	4	1-13
Animal damage	2-4	79	5	16	1-54
A cone midge	3	17	1	15	15
Woody tissue feeders	2-3	23	4	5	1-14
Cooley spruce-gall adelgid	2-3	268	4	65	35-86
Needle disease	2	5	1	5	5
Western hemlock - 990 trees in 29 stands, 909 trees (92%) pest free					
Competition	6	6	1	6	6
Root disease (unknown)	6	1	1	1	1
Animal damage	6	1	1	1	1
Dwarf mistletoe	4	7	1	6	6
Poor form (crook, fork, sweep, multi-top, dead top)	2-4	27	11	2	1-8
Sirococcus tip blight	2	31	3	10	6-17
Western red cedar - 232 trees in 19 stands, 197 trees (85%) pest free					
Competition	6	10	1	12	12
Blowdown	5	4	2	7	5-8
Abiotic (poor form)	3-5	12	3	8	1-12
Keithia blight	2	21	3	71	13-100
Cedar flagging	2	18	3	21	3-33
Amabilis fir - 116 trees in 8 stands, 16 trees (14%) pest free					
Browse	4	1	1	1	1
Fir-fireweed needle rust	2	63	6	8	4-30
A needle blight	2	42	2	19	18-20
Lodgepole pine - 68 trees in 6 stands, 2 trees (3%) pest free					
Pine needle cast	2-4	63	4	17	1-26
Animal damage	2	7	1	6	6
Northern pitch twig moth	2	10	2	4	1-8

Table 8. (Cont'd)

Host/pest	Severity index[1]	Affected no. of trees	Affected no. of stands	% of trees affected[2] average	% of trees affected[2] range
Sitka spruce - 66 trees in 7 stands, 62 trees (94%) pest free					
Spruce weevil	4	2	1	2	2
Poor form (multi-top)	3	2	1	2	2
Ponderosa pine - 44 trees in 1 stand, 4 trees (9%) pest free					
Poor form (dead, broken top)	4	4	1	4	4
Pine needle cast	3-4	35	1	32	32
Northern pitch twig moth	2	1	1	1	1
Grand fir - 42 trees in 4 stands, 17 trees (41%) pest free					
Browse	4	2	1	2	2
A tip blight	3	19	1	18	18
Poor form (multi-top)	3	1	1	1	1
Fir-fireweed needle rust	2	3	2	2	2
Western white pine - 22 trees in 6 stands, 13 trees (59%) pest free					
White pine blister rust	3-5	7	5	1	1-3
Poor form (multi top, fork)	3	4	1	4	4

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

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

Biomonitoring/Acid Rain National Early Warning System (ARNEWS) plots

Annual assessments of tree condition, mortality, acid rain symptoms, and insect and disease conditions were made at the 11 Biomonitoring/ARNEWS plots in the Vancouver Region. These plots were established to detect early signs of damage to Canadian forests due to aerial pollutants, and to monitor changes in forest vegetation and soils. No acid rain symptoms were recorded on any vegetation at any of the sites.

Information on percent foliage retention and condition, and shoot length, was gathered at the Saturna Island plot (916, newly established in 1992) this fall. In addition, soil and foliage samples were collected for chemical analysis. This sampling contributes to baseline data collected for all plots, and is repeated every five years.

Foliar discoloration, cause by a needle blight, *Phaeocryptopus nudus,* was recorded on amabilis fir for the second consecutive year. This foliar discoloration was again found in 1993 in plots 910, 912, and 914, all located in the north shore watersheds of Greater Vancouver. An average of 10% of the foliage, in the lower to mid crown, was discolored on most (98%) of the trees. Discoloration was most pronounced in the Capilano watershed, plot 910. Natural foliar die-back in dense, closed canopy stands also occurred.

About 10% of all western hemlock in the mainland plots had <5% foliar discoloration, mainly chlorotic older foliage in the lower crowns. This was attributed to natural shading and competition in closed canopy coastal stands.

Less than 5% of the foliage was chlorotic on <5% of Douglas-fir in the mainland plots. The chlorosis was restricted to older foliage in the lower crown, and was also attributed to natural die-back. Additionally, foliar thinning and discoloration caused by Swiss needle cast, *Phaeocryptopus gaeumannii,* was recorded on Douglas-fir adjacent to plot 904 near Campbell River.

A die-back in salal was observed adjacent to plots 901, 903, and 916. A die-back caused by *Phyllosticta gaultheriae* was isolated from diseased samples collected near these plots.

Tree mortality was recorded in six plots where a total of 10 trees died (Table 9). The largest single cause of mortality was shading out and suppression which killed 7 trees. Three trees died as a result of storm damage, one tree was blown down, and two trees damaged in past years died this year. The 1993 mortality represents <2% of the total number of trees in all the Biomonitoring/ARNEWS plots in the Vancouver region. To date 111 trees, or 15% of the total, have died, all from natural causes.

Evidence of an *Armillaria* sp. was found in a recently dead amabilis fir off-plot tree in the Coquitlam Lake plot (914); and in a recently dead Douglas-fir off-plot tree in the Seymour Demonstration forest plot (911). *Armillaria ostoyae* was collected from a recently dead western hemlock just outside the UBC Demonstration Forest plot (902) boundary.

The total number of trees at the time of plot establishment of plots 901-904 included trees less than 10 cm dbh. These tree were included before guidelines for minimum tree diameter were introduced. Most of the accumulated mortality in these plots has been a result of small diameter trees dying due to shading, suppression, and competition in dense, closed canopy stands. The dead trees in plot 916 were standing dead at the time of plot establishment.

These plots will continue to be monitored in 1994.

Table 9. Current and cumulative tree mortality in Biomonitoring/ARNEWS plots, Vancouver Region, 1993.

Plot number and location	Tree sps[1]	Total trees at plot est.	Mortality			
			1993	1984-1992	Total	**Cause in 1993**
901-Shawnigan Lk.	dF	120	**1**	24	25	**shaded/suppressed**
	W	8	-	4	4	- -
	wwP	2	-	-	-	- -
902-UBC forest	wH	32	-	14	14	- -
	wrC	15	-	6	6	- -
	B	3	-	1	1	- -
903-Saltspring	dF	100	**4**	21	25	**shaded/suppressed**
	wrC	2	-	-	-	- -
904-John Hart Lk.	dF	30	-	1	1	- -
	lP	1	-	-	-	- -
909-Jones Lake	wH	57	-	8	8	- -
	dF	2	-	-	-	- -
	wrC	1	-	-	-	- -
910-Capilano R.	aF	57	**2**	8	10	**shaded/suppressed**
	wH	17	-	-	-	- -
	wrC	1	-	-	-	- -
911-Seymour R.	dF	36	**1**	5	6	**storm damage**
	wH	2	-	-	-	- -
912-Seymour R.	dF	24	-	4	4	- -
	wH	23	**1**	-	1	**storm damage**
	aF	5	-	-	-	- -
913-Or Creek	wH	46	**1**	-	1	**storm damage**
	wrC	20		2	2	- -
	aF	3	-	-	-	- -
	dF	2	-	-	-	- -
914-Coquitlam Lk.	aF	36	-	-	-	- -
	wH	29	-	-	-	- -
916-Saturna	dF	56	-	2	2	- -
	lP	1	-	-	-	- -
	wrC	1	-	1	1	- -
Total		732	**10**	101	111	
Percent mortality			**<2**	14	15	

[1] dF-Douglas-fir; W-willow; wwP-western white pine; wH-western hemlock; wrC-western red cedar; B-birch; lP-lodgepole pine; aF-amabilis fir

Seed orchard and nursery pests

Eleven seed orchards were assessed for pest conditions in the region in 1993. The most damaging pest was balsam woolly adelgid, *Adelges piceae*, which severely infested and distorted growth on up to 90% of the amabilis fir at four of five true fir orchards. This included gouting from previous years attacks on 30% of the trees.

Most western hemlock at one seed orchard were severely infested by increased populations of the hemlock woolly adelgid, *Adelges tsugae*. Three percent of the trees were lightly infested at a second orchard, and light populations were present at three others. Two western hemlock in a seed orchard near Sechelt were recently killed by Armillaria root disease, *Armillaria ostoyae*. Follow-up surveys by seed orchard personnel found an additional 15 infected trees. This resulted in root raking to remove inoculum at a proposed new hemlock seed tree site at this same orchard.

The most common pest in Douglas-fir seed orchards was the Cooley spruce gall adelgid, *Adelges cooleyi*. Galls formed by the adelgid were present on about 20% of the tips on 20% of the Sitka spruce in four orchards. Additionally, ten percent of the trees at five Douglas-fir orchards, and all the trees in an additional two orchards were lightly infested. Douglas-fir needle midge, *Contarinia pseudotsuga,* lightly infested 10% of the trees in five orchards. Fir coneworm, *Dioryctria abietivorella,* lightly infested two percent of the cones at five orchards and mined under the bark of 7-10% of the trees at two other orchards.

Climatic damage

Cold, windy weather experienced throughout southwestern B.C. in January and February, 1993, caused foliar discoloration on conifer species in the Fraser Valley. Flagging became evident by late spring, particularly on young to semi-mature Douglas-fir and western red cedar. Foliage on the east side of many of these trees, the side exposed to the dessicating effects of the wind, was most severely discolored. Additionally, chlorotic and banded lodgepole pine folige in the western half of Manning Park, and in some areas near Pemberton, was caused by winter damage. Other than premature foliar loss, these trees should suffer no long term effect.

Cold temperatures in the late spring of 1993 moderately to severely discolored amabilis fir and, to a lesser degree, western red cedar at Stowe Creek, east of Sayward, on Vancouver Island. Discoloration (reddening) of year-old fir needles, affected most trees above about 350m elevation throughout the northeastern part of the drainage. The damage affected lateral branches and occasionally leaders, with some bud mortality. Less severely affected amabilis fir were common at higher elevations in adjacent drainages. Although highly visible, the damage is only short-term and affected trees are expected to fully recover in 1994.

Deciduous Tree Pests

Gypsy moth
Lymantria dispar

No adult male gypsy moths were caught in 88 pheromone-baited sticky traps placed by FIDS at 76 sites throughout the Vancouver Region in 1993, this included 3 traps in the Bella Coola area. This compares with single males in 3 of 105 traps at 84 sites in the region in 1992. The traps were mainly located in Provincial Parks and private campgrounds.

Province-wide, about 141 adult males were caught in 100 traps in 15 locations, placed mainly by Agriculture Canada. This compares with 166 males caught in 24 areas in 1992. The 1993 catches were all in the Vancouver Region and included two of the Asian biotype of gypsy moth as confirmed by DNA analysis. These are the first asian biotype caught since 1991 when the type was first introduced into B.C. Additionally, 10 female gypsy moths and 11 egg masses have subsequently been found during ground searches at Vancouver, Hope, and Victoria.

Most adult males trapped in 1993, including the two Asian biotypes, were trapped at previously active areas from Vancouver to Hope, and from Victoria to north of Courtenay. New catches were made at Langdale, south of Sechelt; at Vedder in the Fraser Valley; and Gabriola Island, near Nanaimo.

Catches of the European biotype in Richmond (61) in 1992 prompted aerial (640 ha) and ground (70 ha) applications of *Bacillus thuringiensis* var. *kurstaki* (Btk., Foray 48B) in late April and May 1993. Additionally, ground treatments and intensified trapping programs were implemented in 1993 in areas where high trap numbers occurred in 1992, including Hope, Whiskey Creek, and Salt Spring Island. Post treatment assessments determined continuing populations at Hope and Whiskey Creek, but none at Salt Spring Island.

This is the seventeenth year of a cooperative program with Agriculture Canada (Plant Health), the British Columbia Ministry of Forests and the Canadian Forest Service/Forest Insect and Disease Survey. Traps will again be placed and monitored by all participating agencies in 1994.

Winter moth
Operophtera brumata

Mainly light to moderate defoliation of boulevard and ornamental trees, caused by the winter moth, continued in greater Vancouver and greater Victoria areas in 1993, similar to levels recorded last year.

Defoliation of mainly Norway and bigleaf maples, birch, ornamental plum and cherry, and some fruit trees, occurred in mainland areas for the fifth consecutive year. Trace to light defoliation occurred on single trees in Langley, White Rock, and Surrey, while light to moderate defoliation occurred on trees in south Vancouver. Some areas of moderate and occasionally severe defoliation of single trees occured in southwest Vancouver and Point Grey. Defoliation was trace in the Killarney area and, for the first time, trace to light defoliation occured in some areas of New Westminster.

Defoliation of Garry oak in the Victoria capital regional area continued in 1993. The most severe defoliation was in the Lansdowne, Uplands, Christmas Hill and High Quadra Reservoir areas. Some of these locations were defoliated for the fourth consecutive year. Most trees were lightly, and some moderately, defoliated. There was some localized, occasionally severe defoliation, in the lower crowns of trees at some of these locations. Small numbers of larvae were common on Garry oak on Salt Spring Island, but defoliation was minimal. No larvae or defoliation were seen or reported elswhere on Vancouver Island or the Gulf Islands.

Parasitism, mostly by a fly, *Cyzenis* spp. possibly *C.albicans,* averaged 9% (range 5-13%) in three mass collections from south Vancouver. Bruce spanworm, *O. bruceata,* accounted for less than 1% of the larvae in the collections. In the Victoria area, parasitism by *Agrypon flaveolatum,* affected 5%, and a fungus, *Paecilomyces* sp., infected 15% of larvae collected at one of three representative sites. A nuclear polyhedrosis virus (NPV) affected 8% of the larvae at second site, and a fungus, *Beauvaria bassiana* infected 16% at a third site.

A winter moth control program, including banding, is underway in the City of Vancouver. Additionally, winter moth larvae in areas of greater Victoria with high populations of the introduced parasites, *C. albicans,* and *A. flaveolatum* will be collected by Vancouver parks staff in the spring of 1994. These larvae will be reared in hopes that high numbers of these introduced parasites will emerge. The parasites would then be introduced into the winter moth population in south Vancouver in 1995. The City of Vancouver is hoping that, by introducing these parasites, a similar level of success will occur as was seen after parasites were introduced into the winter moth population in Greater Victoria in 1979.

Monitoring and reporting of winter moth populations, their impact and trends, will continue in 1994.

A cottonwood sawfly
Nematus currani

Defoliation of mostly native black cottonwood, continued for the third consecutive year. The area defoliated increased slightly to 730 ha from 685 ha recorded in 1992. There were 170 ha of light, 390 ha of moderate, and 170 ha of severe defoliation recorded during aerial surveys in late May. This is the first recorded outbreak of this sawfly, native to the Pacific Northwest, in British Columbia. Previous records were from widely scattered single, or small groups of trees.

Defoliation was recorded mainly on Islands in, and foreshore areas of, the Fraser River. Defoliation was recorded from the northern end of the Herrling Island group, east of Agassiz, to the base of Sumas Mountain west of Chilliwack. Some defoliation was recorded on Matsqui Island near Mission. Most affected areas were in TFL 43, managed by Scott Paper. Although native black cottonwood was the main host, hybrid poplars from four clones in plantations on Herrling Island and at Scott Paper's Harrison Mills and Kilby nurseries were lightly, and in some cases moderately, defoliated.

Once again, defoliation occurred early in the season, populations were reported feeding in very late April/early May, and were finished before June, similiar to last year. Like other sawflies in B. C., larvae pupate in the duff following the larval feeding stage. Adults emerge and lay their eggs very early in the year, with larval emergence timed to coincide with foliar flush.

There was no larval parasitism, but two entomopathogenic fungi, *Beauvaria* sp. and *Entomophthora* sp. were isolated from dead larvae collected at Carey and Herrling Islands, infestated for two and three years, respectively. The presence of the fungi may contribute to a reduction in populations; however, this will be determined more precisely during larval sampling in early 1994.

Most defoliated trees refoliated by mid-summer. Tree mortality has not occurred; however, growth loss is likely in trees moderately to severely defoliated for consecutive years. Repeated moderate to severe defoliation of fast growing, high value, young hybrid trees may also result in higher volume loss than in the mature native cottonwood. FIDS will continue monitoring this pest in 1994.

A Poplar rust
Melampsora medusae f. sp. deltoideae

This rust was first confirmed in British Columbia in samples from hybrid poplar plantations in the Fraser Valley in October 1993. A week later the rust was also confirmed from a hybrid poplar nursery on Vancouver Island. Damage in British Coumbia plantations was light, due to the initial infections occurring late in the growing season. However, severe defoliation and mortality of susceptible clones may occur in the next 2-3 years.

The rust was first reported in Oregon and Washington in 1991 on hybrid poplar, *Populus trichocarpa* x *deltoides,* plantations on the lower Columbia River. Since its discovery, the rust has caused severe damage on susceptible hybrids, has spread rapidly and was detected close to the Canadian border in Bellingham, Washington, in the fall of 1992.

The rust is reported to be pathogenic to native black cottonwood and many hybrid poplar clones grown in nurseries and plantations. Susceptible clones may have to be replaced with more resistant hybrids such as *P. trichocarpa x maximowiczii.* In U.S. plantations where the rust has been established for several years, mortality in some of the more susceptible clones has been reported this year. Eurasian poplar rust, *Melampsora larici-populina,* also discovered in Washington State, has still not been found in Canada.

Jumping gall wasp
Neuroterus saltatorius

Discoloration of Garry oak by the gall wasp, resulting in premature foliage loss, although less severe overall than last year, was again widespread in Greater Victoria and surrounding areas. This is the first decline since populations were found in the area in 1986, and followed a significant expansion last year. There was, however, a slight expansion of the infested area to Ardmore in North Saanich.

Moderate discoloration was widespread from Gordon Head to Sooke, and from Beacon Hill in Victoria north to Ardmore near Sidney. Low numbers of the wasp were again common, but not damaging, on oak near Duncan and at Nanaimo, where they were found for the first time, last year. To date, populations have not been recorded on the Gulf Islands.

Gall wasp populations were parasitized by eight species of chalcid parasitoids at 20 study sites. Parasitism averaged 9.6% (range 4-12.8%), and was highest in areas where populations have persisted for the longest period of time, particularly near Thetis Lake and High Quadra areas. Increased parasitism and other mortality factors are expected to continue to

reduce populations in 1994. Damage, however, is likely to continue in most previously infested areas with possible further expansion of the outer limits of infested areas. Populations are expected to remain unchanged at Duncan and Nanaimo.

Foliage infested by the gall wasp is readily identified by the large numbers of small (1.0 to 1.5mm) round mustard seed colored galls attached to the underside of infested leaves.

An Oak leaf phylloxeran
Phylloxera sp. near *glabra*

The introduced phylloxeran (an aphid-like sucking insect) discolored and subsequently killed 25-100% of the foliage on about 10% of the Garry oaks throughout the Capital Regional district, similar to previous years. Severe scorching and defoliation also occured on individual Garry oak along the east coast of Vancouver Island as far north as Comox and on Galiano, Saltspring, Thetis and Saturna islands. Populations were found, for the first time, on Garry oak at Sumas Mountain between Chilliwack and Abbotsford.

Feeding generally occurs on the same trees each year, progressively reducing their vigour. A small number of trees died this year, the first mortality recorded during this outbreak. The phylloxeran can be identified by examining the lower surface of the affected foliage, which is covered with numerous minute orange insects resembling aphids.

Damage and increased mortality is expected to continue on chronically infested trees throughout much of the host range. FIDS will continue to monitor and report on the phylloxeran in 1994.

Northern tent caterpillar
Malacosoma c. pluviale

Increased populations of the northern (western) tent caterpillar, were common on Vancouver Island and some of the southern-most Gulf Islands this year. Alder, hawthorn, apple and other deciduous trees and shrubs in east coastal areas of Vancouver Island and in Strathcona Provincial Park were defoliated. Populations and resulting damage were most visible in the Greater Victoria area, on Saturna Island and at Myra Creek near Buttle Lake. Lighter populations were noted at Shawnigan Lake, Salt Spring Island, from Comox to Campbell River, and near Sooke and Duncan.

The highest populations and the most severe defoliation in the greater Victoria area occured in the Gorge Inlet and Colquitz Creek areas, and to a lesser extent from Oak Bay to Sidney and Esquimalt. Very high numbers of tents moderately defoliated most alder stands on Saturna Island. Only a single colony was seen on the southern part of Salt Spring Island.

In 1992, damage was noted on Vancouver Island at Myra Creek near Buttle Lake in Strathcona Park. This was the first report since 1987, when the last infestation on southern Vancouver Island collapsed, following three years of high populations. This year, defoliation continued in the same area while increasing along the east side of Buttle Lake, as well as along the east coast of Vancouver Island.

Larvae at five sites showed symptoms of viral infection and some larvae exhibited parasite eggs externally, but too few to significantly reduce populations. A few forest tent

caterpillar, *M. disstria*, larvae were also present in the Gorge, Colquitz and Blenkinsop areas in Greater Victoria.

Dogwood leaf blight
Discula destructiva

Discoloration and premature defoliation of new foliage on western flowering dogwood caused by dogwood leaf blight, was again moderate to severe throughout much of the host range. Infection by the fungus, chronic in the region for over a decade, caused branch dieback and occasional mortality of heavily blighted understory trees.

Blighted trees were highly visible from south of Boston Bar to Vancouver, from Squamish to the Sunshine Coast, and throughout most of the east coastal areas on Vancouver Island. Lower crown dieback and mortality of understory trees was common at Alexandra Bridge Provincial Park north of Spuzzum, and at Buttle Lake on Vancouver Island, where heavy blighting has persisted for several years. Trees at Alexandra Bridge had been severely defoliated by western winter moth from 1988 to 1991, thus weakening them and making them more susceptible to mortality from severe blighting.

Inoculum is retained on infected foliage on the ground, on infected leaves on the trees, and on infected twigs and branches. Infection occurs in the spring when rain splash causes spores to disperse to adjacent new foliage. Protection of ornamental trees can be aided by removing and destroying infected foliage on the ground, and pruning dead branches before leaf flush in the spring.

Bigleaf maple scorch and leafspots
Xylella fastidiosa
Rhytisma punctatum
Glomerella cinqulata

The incidence and intensity of bigleaf maple scorch in the region in 1993 declined, following widespread moderate to severe discoloration in 1992. Damage was less common, and was found at lower intensity in stands on the lower mainland and the Sunshine Coast. Trees on southern Vancouver Island and the Gulf Islands were more noticably affected. Leaf spots were also common but not as widespread or severe as in 1992.

By late summer, lightly scorched leaf margins were noticeable on about half the maple between Lund to Gibsons, on the Sunshine Coast. Very little scorch was seen in previously affected areas in the lower mainland and Fraser Valley. On Vancouver Island, scorched foliage again was common throughout much of the host range, particularly near Goldstream Provincial Park and the Malahat.

A bacterium, *Xylella fastidiosa*, was identified for the first time in 1992 in some, but not all, of the scorched maple leaves from Goldstream and Victoria on Vancouver Island, and from Stanley Park, Gates Lake, and Powell River on the mainland. This was determined by tests at the Pacific Forestry Centre in Victoria using an Enzyme-Linked Immunosorbent Assay (ELISA) kit.

A leaf spot fungus, *R. punctatum* was again common in mainland and Sunshine Coast areas. A leaf blight caused by *G. cingulata (Colletotrichum gloeosporioides)* was common in the Sumas Mountain area between Chilliwack and Abbotsford. A combination of leaf margin

scorching and leaf spot and/or blight on bigleaf maple can mimic a fall-like appearance by mid-summer, particularly the upper Fraser Valley, the Sunshine Coast, and southeastern Vancouver Island. This early season discoloration and premature leaf loss are the most visible effects of these conditions.

Birch leafminer
Fenusa pusilla

The birch leafminer, *F. pusilla,* moderately discolored most birch trees throughout the mainland for a second consecutive year. Discolored trees were common from near Yale, throughout the Fraser Valley, the north shore, and lower mainland areas, similar to last year. There was no evidence of the ambermarked birch leafminer, *Profenusa thomsoni*, which, along with F. pusilla, discolored white birch throughout the lower mainland in 1992.

Larvae mine the foliage, causing wrinkled and blotched leaves, turning the foliage prematurely brown, which gives the trees a scorched appearance. Repeated severe infestations, which in ornamental or shade trees may cause some die-back, can be controlled with proper use of a systemic insecticide. Damage in natural stands is mainly aesthetic and control is usually not warranted.

Fall Webworm
Hyphantria cunea

Defoliation of hardwood trees and shrubs by this common defoliator was again widespread in the Lower Mainland and east coastal Vancouver Island, but declined in severity following four consecutive years of severe defoliation.

Tents were common on alder, poplar, willow and various fruit, ornamental and shade trees, in the upper Fraser Valley from Mission to Yale, the Sunshine Coast, and to a lesser extent, between Squamish and Pemberton. Populations declined in east coastal areas of Vancouver Island, where defoliation of branches and occasional small trees was common in 1992.

When epidemic, entire trees can be defoliated, however, usually only individual branches are defoliated. These infested branches can be clipped and burned to protect fruit and shade trees. Pesticides registered for use against leaf-chewing insects should be effective if applied when young caterpillars are spinning webs, usually in early summer.

Western winter moth
Erranis tiliaria vancouverensis

No defoliation by western winter moth was observed or reported in the region in 1993. This followed a population collapse in 1992 after widespread defoliation was recorded from 1988-91 in the upper Fraser Valley. The collapse was attributed to infection of larvae by a nuclear polyhedrosis virus (NPV).

Tree mortality was not seen, but die-back in understory dogwood trees at Alexandra Bridge Provincial Park may have been a result of defoliation in addition to infection by dogwood leaf blight.

New Records of Occurrence and Distribution

A total of 8 disease collections were new records in 1993. There were six new host and two new distribution records. Four records each were recorded on coniferous and deciduous hosts.

Other Noteworthy and Minor Pests

Table 10. Other noteworthy and minor pests, Vancouver Forest Region, 1993.

Host and pest	Location	Remarks
CONIFERS		
Amabilis fir		
A bark beetle, *Pseudohylesinus* sp.	Upper Squamish River	-Killing overmature trees in 1-2 ha pockets.
A needle blight, *Lophodermium uncinatum*	Stave Lake and Whistler areas	-Common, in conjunction with fir-fireweed rust.
A needle blight, *Phaeocryptopus nudus*	North Vancouver	-average of 10% of foliage on most trees infected
A shoot boring sawfly, *Pleroneura* sp.	Higher elevation mainland stands	-Light to moderately infested shoots in scattered locations.
Armillaria root disease, *Armillaria ostoyae*	Coquitlam Lake,	-From recently dead off-plot trees at ARNEWS plot 914.
	Seymour River	-In recently windthrown, semi-mature trees
Fir engraver, *Scolytus ventralis*	Coquitlam Lake	-In recently dead off-plot trees at ARNEWS plot 914.
Fir-fireweed rust *Pucciniastrum epilobii*	Stave Lake and Whistler areas, North Vancouver Island	-Common, light to moderate blighting on 80% (range 32-100) of regeneration.
Fir root bark beetle, *Pseudohylesinus granulatus*	North-central Vancouver Island	-Common in predisposed trees in pockets in Salmon and Nahmint River drainages.

Table 10. (Cont'd)

Host and pest	Location	Remarks
Grand fir		
A bud midge, *Dasineura* sp.	Chemainus, Sooke	-rare, a few trees infested at these locations.
Douglas-fir		
Silver spotted tigermoth, *Lophocampa argentata*	Southern Vancouver Island	-Scattered light defoliation, larval parasitism and disease averaged 47% (range 12-90%).
Swiss needle cast *Phaeocryptopus gaeumannii*	Campbell River	-Common in second growth stands, including near ARNEWS plot
Larch		
Larch sawfly, *Pristiphora erichsonii*	Victoria and Vancouver areas	-Scattered light to moderate defoliation of ornamentals
Ornamental cedar, cypress, juniper		
Cypress tip moth, *Argyresthia* sp.	Greater Victoria	-Widespread severe discoloration of ornamentals for 10th year.
A branch fungus *Scirrhia conigena*	Cowichan Station	-15% of branches killed on mature Port Orford cedar in hedgerow.
Pines		
A needle blight, *Lophodermium pinastri*	Duncan Lillooet Lake	-Shore pine lightly blighted -Ponderosa pine infected in plantations
A needle cast, *L. seditiosum*	Skagit Valley	-Common, light damage on lodgepole pine
White pine blister rust, *Cronartium ribicola*	Host range	-Branch and stem cankers common on whitebark and western white pine.
Western hemlock		
A shoot blight, *Sirococcus strobilinus*	North Vancouver Island	-common on regeneration and young growth.

Table 10. (Cont'd)

Host and pest	Location	Remarks
Armillaria root disease, *Armillaria ostoyae*	Sechelt Maple Ridge, UBC Research forest	-Killing seed orchard trees, 2 recently dead, 15 more infected. -In standing, live trees. No crown symptoms, some basal resinosus. Mycelial fans under bark to 1.5m up bole from root collar.
Dwarf mistletoe, *Arceuthobium tsugense*	Host range	-Endemic, widespread.
Laminated root rot *Phellinus weirii*	Seymour River	-in recently windthrown trees.
Western hemlock looper, *Lambdina f. lugubrosa*	Mainland areas	-A few Larvae in beating samples some pupae and adults in traps.
Western yew		
A bud insect *Ptilinus basilis*	Saanich	-New record: in English yew
A die-back fungus, *Apostrasseria* sp.	Upper Lillooet River	-Common causing die-back on branches. New host record
A shoot blight, *Dothiora taxicola*	Squamish and Birkenhead River areas	-Common, causing minor branch tip die-back
Yew big bud mite, *Cecidophyopsis psilaspis*	Host range	-Common in coastal areas, kills 25% of buds annually, not found past Whistler (interior sites).
Yellow cedar		
A tip gall midge, *Chamaediplosis nootkatensis*	Host range	-Buds of high elevation trees very lightly infested.
Cypress twig mite, *Triseticus chamaecypari*	Vancouver Island	-On ornamentals and in seed orchards
DECIDUOUS		
Alder		
A leaf spot, *Passalora alni*	Spuzzum	-Common in this area

Table 10. (Cont'd)

Host and pest	Location	Remarks
A leaf spot, *Septoria alnifolia*	Texada Island	-Common, most trees with light leaf spotting.
Alder woolly sawfly, *Eriocampa ovata*	Southwestern B.C.	-Common, causing scattered light to moderate defoliation
Obliquebanded leafroller, *Choristoneura rosaceana*	Boston Bar area	-Common, light to moderate defoliation on 50% of trees
Striped alder sawfly *Hemichroa crocea*	Comox, De Courcy Island	-Groups of 2-5 trees defoliated for second consecutive year.
Apple		
Apple ermine moth, *Yponomeuta malinella*	Victoria to Campbell River, Port Alberni,	-Common throughout area, moderate to severe defoliation of single branches, but rarely whole trees.
	Fraser Canyon	-Occasional tents on trees at private residences.
Arbutus		
Winter injury	Host range	-Common, up to 95% of the foliage discolored on some trees. New flush not affected on most trees
Cherry		
A leaf spot, *Phloeosporella padi*	Lower mainland, Fraser valley, Sunshine Coast	-Common, native and ornamentals infected. Causing discoloration, Shot-holes and premature foliar loss.
Chokecherry leaf miner, *Eriocrania* sp.	Greater Victoria	-Severe discoloration of many trees throughout the area.
Poplars		
A bud midge, *Dasineura* sp.	Southwestern B.C.	-Common for seventh consecutive year, causing mainly light bud kill on black cottonwood.
A leaf spot, *Drepanopeziza populorum*	Harrison Mills	-Common on some hybrid poplars.

Table 10. (Cont'd)

Host and pest	Location	Remarks
A leaf spot, *Taphrina populina*	Southern Vancouver Island	-Common, widespread throughout host range.
Septoria leaf spot, *Mycosphaerella populicola*	Harrison Mills	-Causing light-moderate leaf spot, common on hybrid poplar.
Salal		
A leaf miner, *Cameraria gaultheriella*	Shawnigan Lake	-About 5% of the year-old leaves blistered/mined in patches throughout the area. Periodically of economic significance to commercial pickers.
A dieback disease, *Phyllosticta gaultheriae*	Shawnigan Lake, Saltspring and Saturna islands	-Recently dead, dying branches common in patches. Adjacent to Biomonitering/ARNEWS plots.
Willow		
Willow tar spot, *Rhytisma salicinum*	Northern Vancouver Island	-Common, widespread on widely scattered trees.
Multiple Deciduous Hosts		
Cherry ermine moth, *Yponomeuta padella*	Greater Victoria	-increased numbers of colonies of this introduced defoliator on hawthorn, cherry plum, cherry, Saskatoon and mountain ash.

Queen Charlotte Islands

Summary

Western blackheaded budworm populations remained low and assessments of the previous outbreak show negative effects of defoliation. Small populations of **hemlock sawfly** were found at a number of locations on the Queen Charlotte Islands, but no defoliation was recorded.

The **spruce aphid** infestation collapsed due to cold winter temperatures, only localized light attack of older foliage was found. Galls on spruce caused by **cooley spruce gall adelgid** were again found at Sandspit but not at three other sites where the alternate host, Douglas-fir, was present. **Large-spored spruce-labrador-tea rust** infections expanded, causing light to severe discoloration of current spruce foliage from Tlell to near Masset and near Juskatla.

An unknown **abiotic** agent caused severe reddening of all forest cover species over 25 ha near Grus Lakes in Naikoon Provincial Park. At Lyell Point on Lyell Island, unknown agents continued to kill trees over a 235 ha area at a current rate of about 2%.

In three young stands surveyed, 67% of trees were pest free, while 5% of primarily understory regeneration or young trees were killed, or severely damaged, mostly due to canopy closure and overstocking.

Several pests currently causing minor damage or noted at endemic levels are included in table 10 at the end of this report, notable among them is the greenstriped forest looper found in small numbers at several sites for the first time in several years.

Hemlock Pests

Western blackheaded budworm
Acleris gloverana

Western blackheaded budworm populations remained at endemic levels in 1993. No larvae were collected in 14 standard fids larval samples throughout accessible areas of Graham and Moresby islands. There was also no evidence of defoliator activity during an overview aerial survey of part of the district. This continues the low level of budworm population found since its collapse in 1987.

In continued assessment of long term effects of the western blackheaded budworm/hemlock sawfly infestation of 1985-1988 in young stands, two plots (#7 and #8) were sampled near South Bay on Moresby Island. These plots were part of a large system of plots established by BCFS in 1987 throughout the infested areas. Each consisted of a large number of trees tagged and tallied with defoliation estimates documented on the majority of the trees. Cores were taken from 10 trees at each site, primarily from larger diameter trees with defoliation estimates included. Overall defoliation of trees sampled in 1987 was moderate to severe. Based on aerial survey maps, defoliation also occurred in this area in 1986 (moderate) and 1988 (light).

No mortality or top-kill was noted at either plot location although stands were too dense to see the upper crowns of many of the trees. An assessment of incremental growth from the cores show a dramatic reduction in radial increment in 1988, the year following the most severe defoliation. Radial increment averaged 0.66 mm in 1988 which was only 21% of the growth average in 1984 (3.03 mm), the year before the start of the outbreak (see figure 6). Recovery began in 1989, and by 1992 radial increment averaged 2.38 mm. This was not up to pre-outbreak levels, but was 3.6 times greater then during the height of the attack.

This stand was defoliated for three years and loss of increment, clearly reflected the pattern and intensity of the outbreak. As in the assessment in the previous two years at Tarundl Creek and Aliford Bay, it appears that while losses were significant, these young vigorous stands seemed to sustain less damage then older semi-mature to overmature stands and they recover fairly quickly. The previous two stands assessed were subsequently spaced with the result that post outbreak growth rates were higher than pre-outbreak growth rates. This did not occur at the South Bay site, likely because only this stand had not yet been spaced.

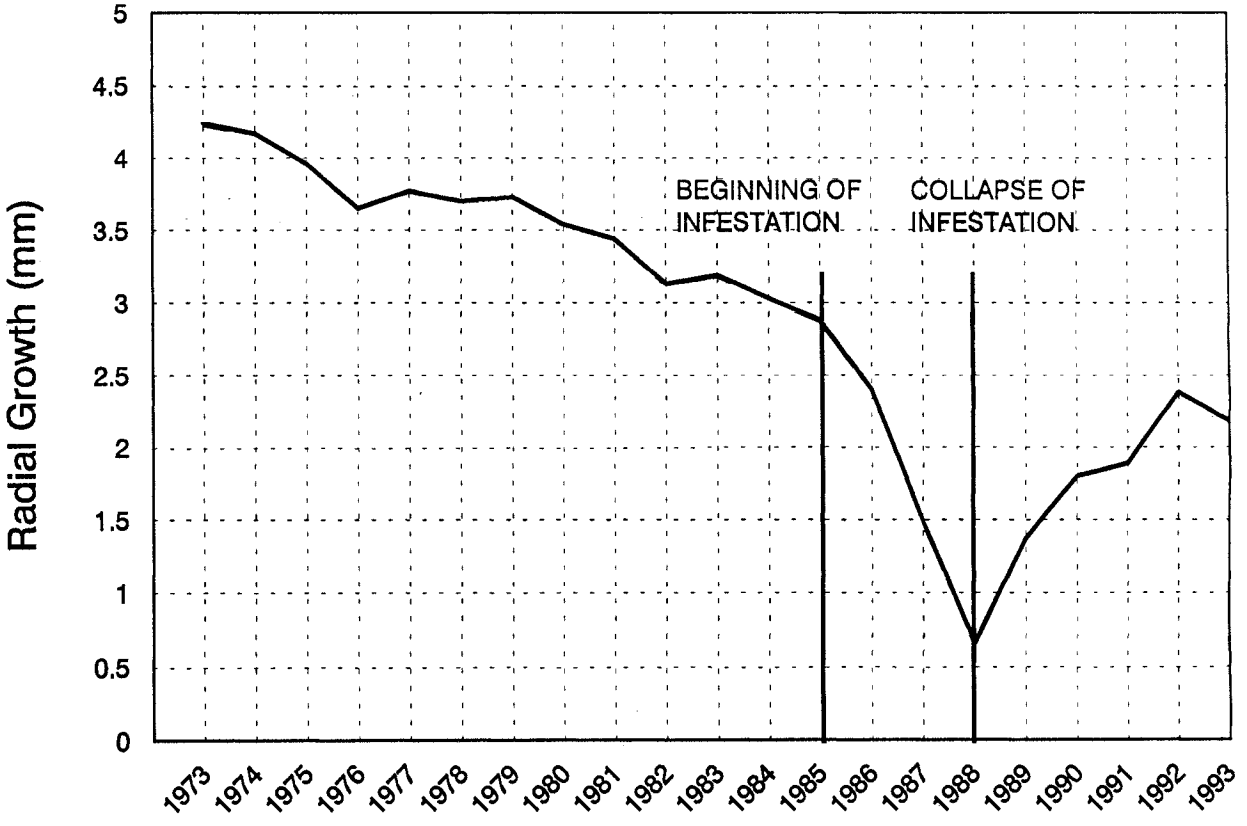

Figure 6. Radial increment of western hemlock in the South Bay area plots defoliated by western blackheaded budworm. Queen Charlotte Islands, 1993.

Hemlock sawfly
Neodiprion tsugae

No defoliation was recorded in the district. A maximum of 25 larvae were collected in a standard three-tree beating sample at Marie Lake, where trace defoliation was recorded in 1991. Only six larvae were found at Hangover Creek and one at Gregory Creek in the South Moresby Forest Replacement Account (SMFRA) #13.3 study area. In 22 other standard samples throughout the district, a maximum of six larvae were found. Monitoring of this pest will continue in 1994.

Spruce Pests

Spruce aphid
Elatobium abietinum

Spruce aphid populations declined dramatically in 1993 and defoliation was generally limited to localized pockets of light attack on older foliage.

In 1992, only ground surveys were done and area of defoliation was estimated at 3145 ha. Aerial surveys in 1993 identified 13 additional pockets totalling 305 ha severely defoliated in 1992. These additional pockets of defoliation bring the total area defoliated in 1992 to 3450 ha over 26 infestations. Based on anecdotal information, numerous other areas were infested in 1992, but defoliation was not sufficient to leave visible evidence in 1993.

The additional areas of severe defoliation were noted on the south end of Lina Island, and on Moresby Island near Cumshewa; on Louise Island at Skedans Bay and west of Breaker Bay. One area was mapped on the east side of Talumkwan Island, two on the east edge of Tangil Peninsula and two on east facing slopes of Lyell Island.

At the Heather Lake study plot, in a young mixed stand with spruce representing about 25% of crop trees, overall attack severity in 1993 was very light. This was a significant reduction from the moderate to severe defoliation recorded over each of the previous two years. In 95% of trees, 25-80% of older foliage was missing due to successive years of attack, with greater then 80% defoliation on only 5% of trees. Overall, 56% of foliage was affected as compared to 57% in 1992. Despite the minimal 1993 attack, branch tip length averaged only 8.6 cm compared to 8.9 cm in 1992, suggesting an additive effect on growth reduction from repeated years of defoliation. More than one year of pest free growth is probably required before substantial recovery occurs.

Twenty trees assessed for levels of defoliation at each of two sites in semi-mature spruce stands in 1992 were re-assessed in 1993. At Chinukundl Creek, little new attack occurred and no mortality or branch dieback was found. Recovery was minor, with most trees still moderately to severely defoliated from the 1992 attack. Only three trees showed no evidence of aphid damage or activity.

At Gray Bay, 13 of 20 trees were severely defoliated in 1992 and 5 trees moderately defoliated. Very little 1993 attack was found, but little recovery was noted. One defoliated intermediate Sitka spruce was killed, probably by the severe aphid attack followed by secondary attack of *Dryocoetes affaber*. Severely defoliated trees at both these sites may continue to be susceptible to attack by secondary invaders. Monitoring will continue.

Cooley spruce gall adelgid
Adelges cooleyi

In Sandspit, two of eight young Sitka spruce assessed had new galls. These spruce were in close proximity to several semi-mature, infested Douglas-fir which have recently been removed due to concern over this pest. Near Queen Charlotte City, three young Douglas-fir continued to be heavily infested for at least the fourth consecutive year. Efforts at systemic insecticide control in 1992 were ineffective. No galls were found on spruce in the vicinity of this site. At Port Clements, Douglas-fir was noted at two sites. No adelgids were visible on either host in the vicinity.

Galls on spruce can significantly affect growth and form of young trees. Beyond the few infested trees in Sandspit, surveys over the past three years indicate no establishment of *A. cooleyi* in young Sitka spruce managed and natural stands. Complete removal of Douglas-fir continues to be the recommendation to combat this potential threat.

Large-spored spruce-labrador-tea rust
Chrysomyxa ledicola

Infection of current foliage of young Sitka spruce by *C. ledicola* expanded dramatically this year. Light to severe discoloration over the entire crowns of roadside and bog spruce occurred from north of Port Clements to near Masset, where it had been confined to an estimated <1 ha patch in previous years. Similar discoloration was noted from Port Clements to near Tlell wherever the host was available. Scattered, generally light to moderate, discoloration was also noted along the mainline and in adjacent stands between Juskatla and the Yakoun river bridge. A single 2 ha patch of young spruce was moderately discolored near Skowkowa Creek, north of Queen Charlotte City.

Losses of up to 90% of current year's needles have been reported in Western Canada. Such epidemics have serious effect on the following year's growth. The use of suitable fungicides or removal of alternate hosts are effective, but impractical and rarely economically justified.

Multiple Host Pest

Abiotic Damage

In Naikoon Provincial Park, several plant species over an area of about 25 ha, just off the beach near Grus Lakes were severely discolored. All cover from minor understory brush species to dominant conifers appeared similarly affected, suggesting an isolated episode, possibly wind, causing salt damage. The area was not readily accessible to confirm any cause.

In an area of approximately 235 ha on Lyell Island east of Lyell Point, two percent of trees were red and about 20 percent grey. This appears to be a continuing problem, possibly related to the site, a rocky plateau with little soil which may flood in winter and dry out in summer. Only an overflight was possible in this area.

Pests of Young Stands

Three young recently spaced stands were surveyed as part of the ongoing province-wide program to assess pests in young stands. Locations were selected primarily on the basis of having been treated under SMFRA or the Forest Resource Development Agreement (FRDA). In addition to insect and disease concerns, environmental damage, mammal damage and other conditions affecting the health and growth of young stands were examined.

Overall, 67% of trees were pest-free and only 5% were dead or severely affected. Of this 5%, almost all were suppressed trees in control (unspaced) plots at the Brent Creek spacing and fertilizing trials. The only other serious problem was occasionally severe browsing of young cedar at Canoe Creek.

Minor forking, crooks and mechanical damage was found at all three sites, while minor sapsucker damage occurred at Brent and Canoe creeks. Low levels of defoliation by a spruce bud moth, *Zeiraphera* sp. occurred at Copper River and Canoe Creek while minor conifer sawfly, *Neodiprion* sp., feeding and cedar foliar blight, *Didymascella thujina* was noted at Canoe Creek. Sirococcus shoot blight, *Sirococcus strobilinus*, caused minor damage on a single hemlock at Brent Creek. The only significant damage in the three stands examined was to non-crop, suppressed spruce and hemlock and browsed cedar which were primarily understory regeneration. Monitoring of the health of young treated stands will continue in 1994.

Other Noteworthy and Minor Pests

Table 11. Other noteworthy and minor pests, Queen Charlotte Islands, 1993.

Host and pest	Location	Remarks
Pines		
Fir coneworm, *Dioryctria abietivorella*	Sheldens Bay	-Minor attack at nodes in 3% of western white pine.
Pine needle cast, *Lophodermella concolor*	Riley Creek	-Common on young roadside and bog pine.
Mammal damage	Drill Cr.	-21% of young western white pine with moderate to severe scarring.
Sitka spruce		
A spruce bud moth, *Zeiraphera* sp.	Scattered	-common, light defoliation
Spruce needle blight, *Lirula macrospora*	Throughout district	-Scattered trace to light discoloration at Marie lake and several other areas.
Western hemlock		
Hemlock dwarf mistletoe, *Arceuthobium tsugense*	Throughout district	-Chronic, continues in old growth and in younger stands where 'seed' trees remain.
Greenstriped forest looper, *Melanolophia imitata*	Yakoun River, Riley Creek, Marie Lake.	-Low larval numbers, first positive collections in several years.
Western yew		
Yew big bud mite, *Cecidophyopsis psilaspis*	Heather Lake	-100% of trees with light to severe bud mortality.

Appendices

The following related reports are available on request from FIDS.

i. Detailed seed orchard report, 1993.
ii. Forest pest conditions in the Vancouver Watersheds and Seymour Demonstration Forest, 1993.
iii. Forest pest conditions in Provincial Parks, Vancouver Forest Region, 1993.

Detailed copies of aerial survey maps, pest reports, leaflets, monographs and other maps and reports in addition to those listed above are available from the Pacific Forestry Centre upon request.