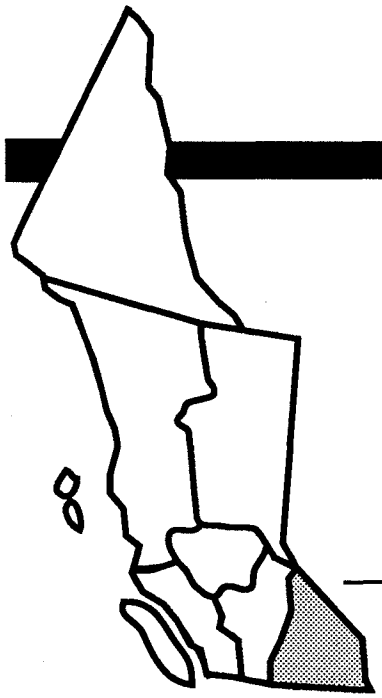

Forest Insect and Disease Conditions

Nelson Forest Region 1988

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Forestry Canada Forêts Canada

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

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II Maps of major beetle and defoliator infestations in the Nelson Forest Region.

III Summaries of pest problems in provincial and national parks in and adjacent to the Nelson Forest Region.

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INTRODUCTION

This report outlines the status of forest insect and disease conditions in the Nelson Forest Region and Mt. Revelstoke and Glacier national parks in 1988, and attempts to forecast population trends and highlight pests that are capable of sudden damaging outbreaks resulting in forest management problems. Pests are discussed by host, in order of importance, and occasionally within the context of a management unit or Timber Supply Area (TSA).

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

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

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

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

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

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

Close liaison with federal, provincial and local government agencies and industry is essential for effective fulfillment of these requirements.

The 1988 field season extended from mid-May to mid-October. A total of 310 insect and disease collections were submitted to the Pacific Forestry Centre (Map 1). Approximately 200 contacts and on-site pest examinations were made with British Columbia Forest Service (BCFS), other government agencies, forest industry personnel and private individuals.

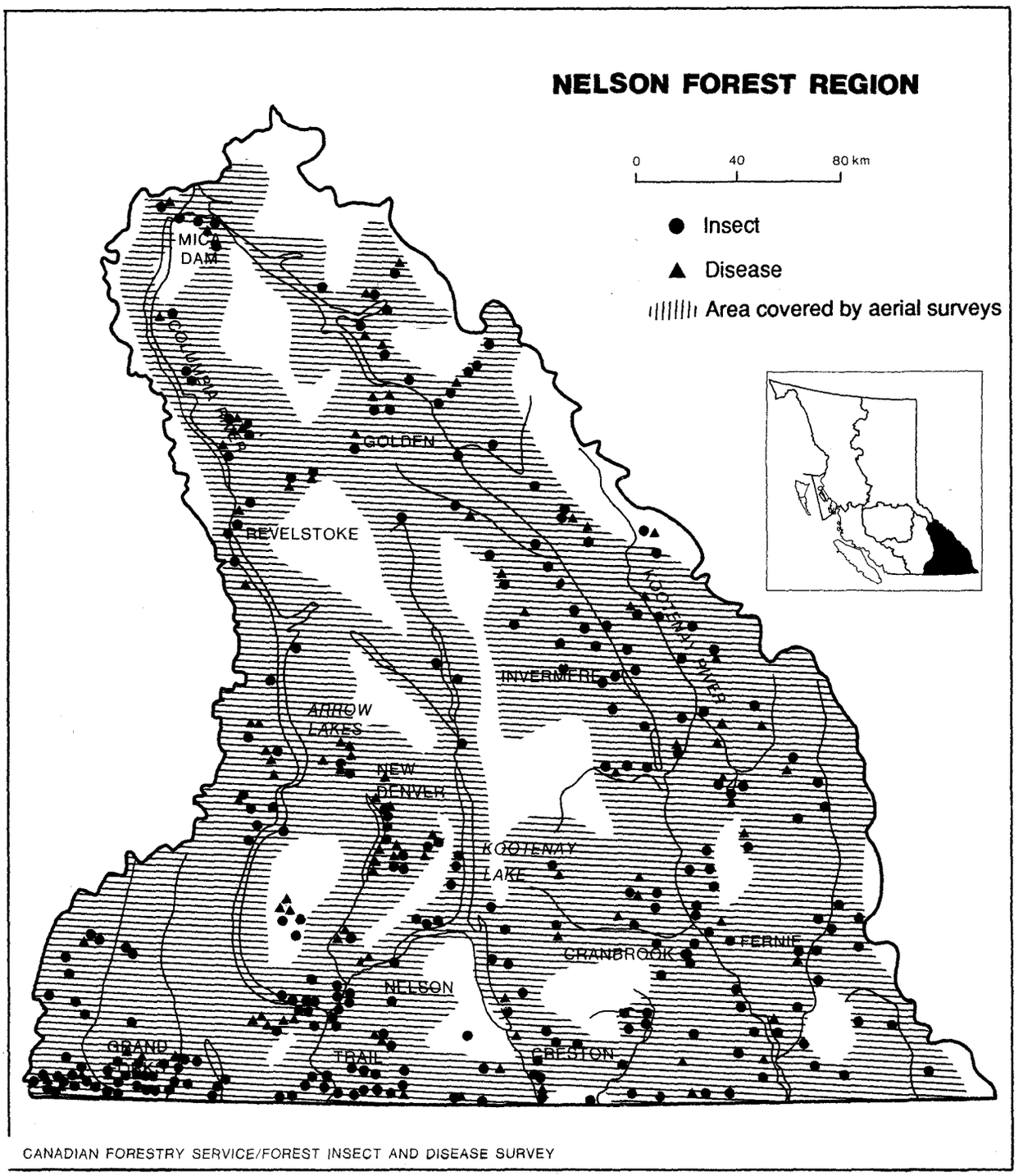
Special thanks are extended to the British Columbia Forest Service for the provision of 57 hours of fixed-wing aerial survey time and assistance in producing preliminary regional sketch maps, to Crestbrook Forest Industries for six hours of helicopter aerial survey time and to Evans Products for helicopter transportation to examine root rot-infected stands along McNaughton Lake. The area covered by aerial surveys is shown on Map 1.

During the Forest Insect and Disease Survey field season from May to October, correspondence can be directed to:

Forest Insect and Disease Survey
Box 120,
Wasa, B.C.
V0B 2K0 Ph. 422-3465

Forest Insect and Disease Survey
Box 7,
New Denver, B.C.
V0G 1S0 Ph. 358-2264

or, throughout the entire year to: Forest Insect and Disease Survey
Forestry Canada, Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5 Ph. 388-0600



Map 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1988.

SUMMARY

The following summary of pest conditions in the Nelson Forest Region groups pests by host(s), generally in order of importance.

Mountain pine beetle continued to be the most damaging pest in the region, killing more than 1.3 million lodgepole and western white pines over 25 575 ha as compared to 1.2 million trees on 22 310 ha in 1987. An additional 42 000 pines were killed over 605 ha in Kootenay, Glacier and Mt. Revelstoke national parks. **Pine needle sheathminer** populations on lodgepole pine declined in the East Kootenay, but increased in the West Kootenay where moderate defoliation occurred near Grand Forks. Infection of western white pine by **red band needle disease** increased in the Slocan Valley. **Lodgepole terminal weevil** damage was light in several young managed lodgepole pine stands in the region. All **Scleroderris canker** examinations proved negative. **Warren's root collar weevil** and **stem cankers** caused less than 5% tree mortality in widely scattered plantations. **Pine needle cast** infections on lodgepole pine were common in the Cranbrook TSA.

Light defoliation of Douglas-fir by **western spruce budworm** increased to 3275 ha in the Boundary TSA from 1043 ha in 1987. Twelve scattered spot infestations of **Douglas-fir beetle** were detected in the region, with numerous additional pockets of current attack noted by the fall. **Douglas-fir tussock moth** populations remained at endemic levels, but pheromone-baited traps indicated an upward trend for 1989 at Rock Creek. **Melampsora foliage rust** moderately infected Douglas-fir at widely scattered areas of the region. **Cone and seed pest** damage declined in light to moderate cone crops.

Spruce beetle populations continued at generally endemic levels throughout the region, but several blowdown areas had high populations. **Spruce weevil** killed 17% of the spruce leaders in plantations near Golden. **Foliage rust** severely infected current year's spruce foliage in the Beaverfoot and Upper Kootenay river drainages. **Cone and seed pests** infested over 50% of the cones at four of six locations.

Larch casebearer populations generally increased and moderately defoliated western larch over 486 ha at widely scattered locations primarily in the West Kootenay. **Larch sawfly** caused light to moderate defoliation of larch stands on 512 ha along the Elk and Granby river valleys. **Larch needle diseases** defoliated over 650 ha of larch along the Kootenay and White rivers area but generally decreased throughout the host range of larch in the region. **Larch budmoth** remained at endemic levels in the region.

Two-year-cycle spruce budworm caused minor defoliation of alpine fir and spruce; bud counts indicate continuing defoliation in 1989. Recent tree mortality caused by the **western balsam bark beetle** covered nearly 1700 ha at widely scattered locations of the region. Surveys of **balsam woolly adelgid** were again negative in true fir stands along the Canada-USA border. Several **needle diseases** caused widespread light to moderate discoloration on alpine fir.

Root rots, primarily **Armillaria root disease**, infected an average of 7.9% of the trees in 10 Douglas-fir stands and caused over 5% recent mortality in two young plantations. **Black army cutworm** larvae severely defoliated coniferous

seedlings and ground cover in plantations in the Golden and McNaughton Lake area. **Rhizina root disease** killed an average 15% of the recently planted seedlings in recently burned cutblocks examined, primarily in the wetter portions of the region. **Animal damage** was prominent in a plantation near Erie Creek. Symptoms of **drought damage** were common throughout much of the southern portion of the region.

The **forest tent caterpillar** moderately to severely defoliated 1500 ha of primarily trembling aspen in 24 infestations mostly in the East Kootenay. **Pacific willow leaf beetle** defoliated willow between Fauquier and Mica Dam. **Birch leafminer** discolored birch stands in the northern half of the region for the fourteenth consecutive year. Aspen was defoliated by an **unidentified defoliator** over 300 ha near Greenwood. No **gypsy moth** adults were caught in pheromone-baited traps placed at 34 locations in the region.

Throughout the text references to "light", "moderate" and "severe" defoliation by larval defoliators may be assumed to mean 1-25%, 26-65% and 66+% defoliation, respectively.

Mountain pine beetle
Dendroctonus ponderosae

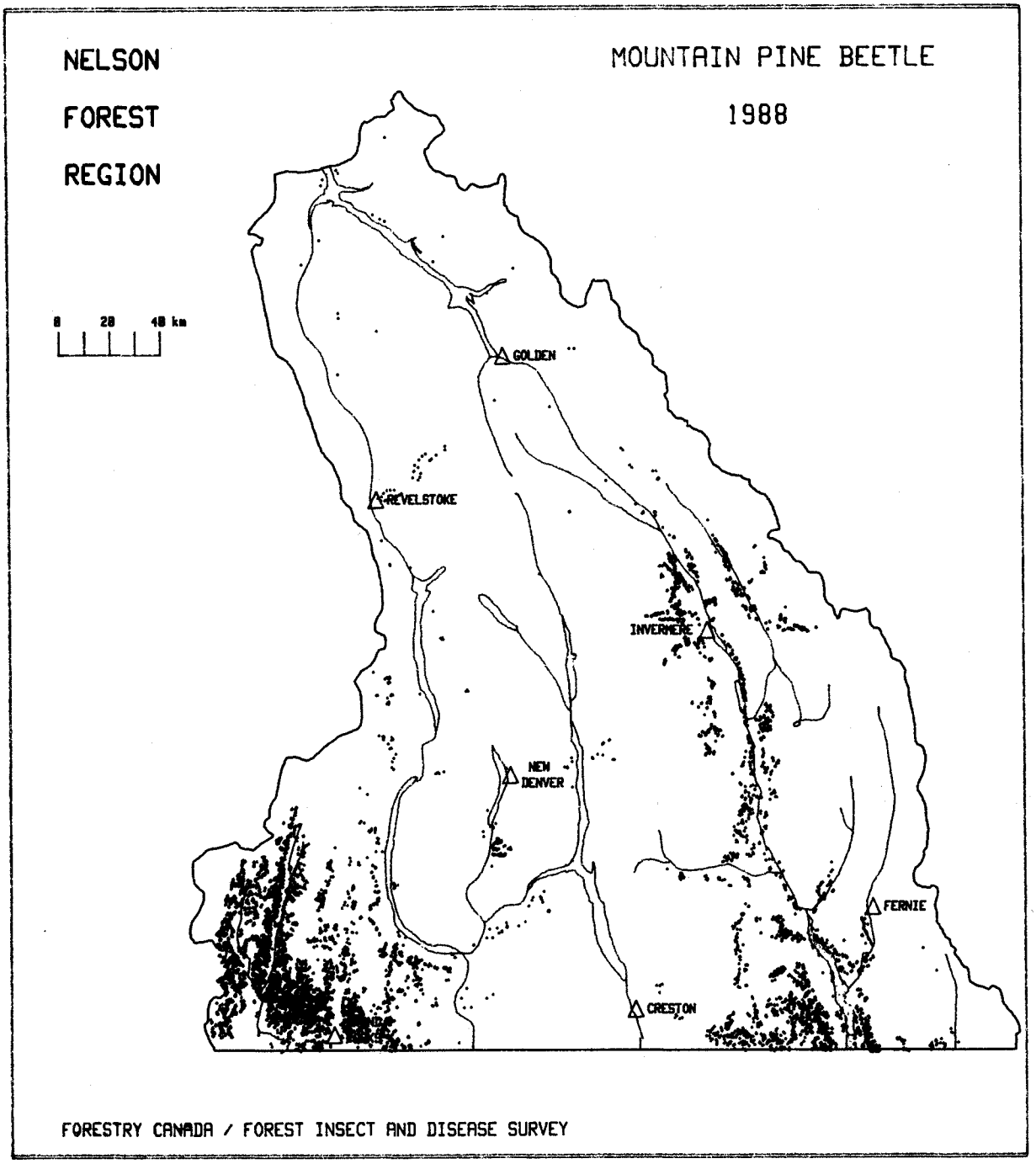
Mountain pine beetle killed more than 1.29 million lodgepole and western white pines over 25 575 ha in 4692 infestations and an additional 42 125 trees over 605 ha in Kootenay, Glacier and Mt. Revelstoke national parks (Table 1, Map 2). This is an increase from 22 310 ha in 1987 and similar to 25 670 ha recorded in 1986 in the region.

Table 1. Location, number, area and volume of pine recently killed by mountain pine beetle as determined from aerial and ground surveys, Nelson Forest Region and National Parks, 1988.

TSA or Park	Tree species[1]	No. of infestations	Area (ha)	Trees killed (faders)[2] No.	Vol.(m^3)
Boundary	lP,wwP	2354	15 461	820 061	295 243
Arrow	lP,wwP	322	1 298	56 693	23 301
Revelstoke	wwP	34	9	270	270
Kootenay Lk.	lP,wwP	180	147	4 331	2 563
Cranbrook	lP,wwP,pP	1125	5 250	204 000	73 000
Invermere	lP,wwP	645	3 400	200 000	72 000
Golden	lP,wwP	32	10	1 300	500
Subtotal		4692	25 575	1 286 655	466 877
Kootenay N.P.	lP	63	600	42 000	15 000
Glacier N.P.	wwP	2	2	35	35
Revelstoke N.P.	wwP	10	3	90	90
Subtotal		75	605	42 125	15 125
Total		4767	26 180	1 328 780	482 002

[1] lP-lodgepole pine; wwP-western white pine; pP-ponderosa pine
[2] Trees attacked in 1987, discolored in 1988

The main increase in activity occurred again in the Boundary TSA although increases were also recorded in the Cranbrook TSA, while substantial reductions in infestation levels continued primarily in the Invermere TSA. Changes in other TSAs were smaller and while locally significant, contributed less to the overall picture. Changes reflect, in part, the variability over the region in terms of climatic conditions, proximity to influences from outside the region, timber types and age structures, harvesting and management philosophies;



Map 2. Areas of lodgepole pine recently killed by mountain pine beetle determined by aerial and ground surveys in 1988.

stand management practices being the greatest influence in some areas and host susceptibility of importance elsewhere. Logistics in terms of the scattered or concentrated nature of the host and infestations and accessibility continue to influence management activity.

Boundary TSA

In the Boundary TSA, 2354 infestations covered approximately 15 461 ha, expanding for the fifth consecutive year from 1736 infestations over 10 700 ha in 1987. In the eastern part of the TSA, the number of infestations continue unabated at Texas Creek and along McRae Creek with notable expansions along Sutherland Creek and associated drainages. In the south, only minor changes in number of infestations were noted in the area between Christina Lake and Granby River after a doubling of activity the previous year. Although infestations were relatively recent and host was plentiful, limited cruising and walk-through surveys at Sand Creek indicate reduced activity (Table 2). Some expansions were noted in the Rathmullen Creek area despite continued active pheromone-baiting and salvage programs. Between Midway and Grand Forks south of Eholt Creek, dramatic expansions continued, especially the Eholt area, Providence Creek, Twin Creek and Lind Creek through to the Phoenix Mountain area. The Jewel Lake area north of Highway 3 had continued expansions in number and size of infestations. Expansions continued in the Deadwood Creek area west of Greenwood. The Ingram Creek drainage continued at high infestation levels similar to those of 1987. North along Granby River there was generally little change; however, isolated major expansions occurred in some side drainages: Pass Creek, where an estimated quadrupling of area infested occurred; Rock Candy Creek, a doubling in number of infestations; and notable expansions in Kennedy, Gable and the top end of Knappen creeks. Boundary Creek and many of its side drainages, especially Windfall, Henderson and Clement creeks, had expanding infestations, with spot activity continuing almost to Terraced Peak. In the west along the Kettle River, beetle infestations continued unabated from Steep Creek north with notable increases in activity in many side drainages especially Fiva, David, Paturages and Crouse creeks. In the north, infestations continued from Copperkettle and Nevertouch creeks to the regional boundary, especially in the Grano-Hellroarer creek drainages where last year's spot infestations have become 5- to 10-ha infestations with new spot attacks common. Goatskin, Arthurs and Cochrane creeks off Rendell Creek also showed expansions. Along the West Kettle River, there were expansions mapped in the Tuzo and Carmi creek drainages and continued activity elsewhere. In the southwest, further expansion occurred only in the upper Rock Creek area with spot infestations to the top of the drainage and light to moderate infestations to 15 ha in size common.

Arrow TSA

In the Arrow TSA a total of 322 infestations covered 1298 ha, a continued increase in area from 950 ha in 1987. Expansions occurred southwest of Renata, mainly in the Dog Creek drainage. Beetle activity continued at levels similar to 1987 in the Chapleau and Dayton creek drainages where logging following road building and pheromone trapping was delayed due to concern among water users. In the Shields Creek and Nancy Greene Lake areas, infestations approximately doubled and were under active management. These increases were somewhat balanced by a general reduction in attack on white pine through much of the TSA, with increased activity noted only in the Gladstone Creek area and continued but reduced numbers of faders from Whatshan Lake north to South Fosthall Creek.

Revelstoke TSA

In the Revelstoke TSA there were 34 infestations totaling 9 ha, a continued and substantial decrease in beetle activity from 1987. Mountain pine beetle attack on western white pine continued to decline along the Illecillewaet River, was reduced north of Revelstoke and also decreased south of Revelstoke along the Arrow Lakes and associated drainages. Similar declines of beetle activity were also noted in Revelstoke National Park where only 10 small pockets totalling 3 ha were noted during aerial surveys.

Kootenay Lake TSA

In the Kootenay Lake TSA, infestations covered 147 ha, an increase from 130 ha in 1987. The main increase occurred in the Hawkins-Freeman creeks area, where 130 spot infestations of from 5 to 50 trees each were widely distributed throughout the drainages, up from only three spots in 1987. Much of the increase could be attributed to beetles migrating into the area from nearby drainages with large infestations. Large stands of both immature and mature lodgepole pine in the valley contained faders and concentrated control efforts have been directed at both. The greatest potential for local population buildup remains in the larger patches of mature pine.

In other parts of the TSA, mountain pine beetle activity in white pine continued in the Little Glacier Creek area with a few spot infestations noted along Fry Creek. Some increase in activity was recorded east of Nelson on Lasca Creek but was generally reduced along the north shore. Activity continued along Sandy Creek southwest of Nelson where harvesting continues to address these infestations. Infestations along Kootenay Lake, Lardeau River and Trout Lake continued to decline to very low levels. Groups of 5-30 western white pine were killed along the lower Goat River and along Kitchener Creek between Kitchener and Yahk. Along Skelly Creek, scattered white pine faders had large beetle broods but no attack was found in adjacent mature lodgepole pine.

Cranbrook TSA

In the Cranbrook TSA, infestations increased to over 5250 ha, up from 3450 ha in 1987 and 3800 ha in 1986. In the older and major infestation areas in the lower Gold, Caven, Bloom and Linklater creek drainages, concentrated attack continued despite extensive logging. Infestations in the Galton Range continued to intensify, largely unchecked by limited control efforts. The numerous small pockets of beetle activity in the Mount Baker, Yahk River, Teepee Creek, Moyie Lake, lower Bull River, Couldrey Creek and Rocky Mountain Trench areas increased in both size and number. Infestations in small pockets along the lower and mid slopes near St. Mary Lake and along Lost Dog Creek continued at levels similar to 1987. Only scattered small groups of 10-50 faders were evident along the lower Elk River. There was a significant increase in ponderosa pine mortality (205 ha) from only scattered individual trees during the previous few years, especially along the Kootenay River Valley from Elko to Roosville. Attack was frequently accompanied by turpentine beetle attack at the tree base.

Invermere TSA

Infestations in the Invermere TSA declined to 3400 ha from 6800 in 1987 following a similar decline the previous year. The reduction was largely due to older infestations declining to small spot infestations along their fringes as the beetle and harvesting depleted host availability. These areas included most of the Kootenay drainage north of Canal Flats, and the White River system, but pockets of activity remained at several river junctions: Albert Creek and Palliser River, Cross and Mitchell rivers and at Cochran Creek and Kootenay River. Expansion in the number of faders was most significant in the Toby Creek drainage and on the west aspect slopes of the Rocky Mountain Trench from Columbia Lake north to Radium, with several smaller patches extending northward to Cedared Creek. Aggressive logging has kept the actual area of infestation mapped similar to 1987 in the Steamboat Mountain-Frances Creek area despite a vigorous beetle population. In the Findlay and Dutch creek areas, logging has removed many of the susceptible pine stands but increased beetle activity continued in the less accessible areas.

In nearby Kootenay National Park, an estimated 42 000 lodgepole pine were killed over 600 ha based on aerial surveys and ground cruise data collected in the Redstreak Creek area. These figures vary greatly from an aerially estimated 3800 trees obtained by the staff from the Northern Forestry Centre in Edmonton. Although only one 15-ha infestation was prism-cruised in 1987 (red in 1988), it averaged 600 1987-attacked trees per hectare.

Golden TSA

Both the number and area of beetle infestations continued to decline in lodgepole and western white pine stands with only 10 ha of recently killed trees mapped in 32 infestation pockets. Scattered small groups of 20-25 western white pine were present along the Columbia Reach between the Bush and Wood Arms of McNaughton Lake and along Beaver River into Glacier National Park. Several small groups of 20-30 fading lodgepole pine were present along the Blaeberry River where salvage logging was underway.

Influencing factors in population dynamics

The character of the current infestation has been influenced by climatic factors and stand composition. Climatic factors affected both the beetle and the host. During the prevailing drought conditions, brood size was reduced as the sex ratio changed, greatly favoring the attacking female. At the same time stressed trees were offering little resistance to beetle attack as evidenced by the lack of pitch tubes even in lightly attacked trees. Normally this is a sign of heavy mass attack on trees within a 24-hour period. This concentrated attack is especially crucial for small pockets of infestations where the total beetle population is limited. Small infestations on more moist north aspects frequently had staggered adult emergence resulting in a high percentage of pitchouts or partial attacks. Similarly, when numerous small groups of attacked trees first appear in a drainage, a large number of the pocket infestations die out as flight periods for the small numbers of beetle are too staggered to allow for mass attack. However, those small infestations that are successful tend to expand rapidly as a result of population buildup within the pocket and by attracting beetles from nearby small pockets. Where attacks were concentrated and host resistance was low, progressive observations through the summer

indicated that parent adults frequently were attacking two or more stressed trees.

Where the stand composition consisted of varying age classes, large broods were produced in the larger-diameter trees which in turn attacked nearby smaller trees. In these small trees larval mortality due to dehydration was extensive due to drought stress during the fall and early spring larval feeding period of 1987/88. Where beetle activity is present in young stands, control priorities must continue to focus on the mature stands, the source of most of the beetle population.

Natural control agents were active in many populations. Woodpeckering was noted at most sites during spring sampling with extensive activity especially noted at several sites where hosts tended to be dry. At three sites, Coeloides rufovariegatus was found in 30 to 50% of samples; levels of this larval parasite were not determined and controlling effect of these natural agents on epidemic populations appears minimal.

Populations of various Ips spp. as well as Pityophthorus spp. were common in a number of locations but invariably in association with mountain pine beetle attacks; in only isolated cases was Ips noted as the primary causal agent of mortality.

Table 2. Status of lodgepole pine in stands affected by mountain pine beetle, Nelson Forest Region, 1988.

Location	Percent of pine attacked[1]				
	Current(1988)	Partial(1988)	Red(1987)	Grey(pre 1987)	% Healthy
Rock Cr.	7	0	7	0	84
Ingram Cr.	25	1	25	6	37
Rathmullen Cr.	13	0	17	24	41
Shields Cr.	11	0	3	6	76
Crouse Cr.	26	2	15	0	52
Hellroarer Cr.	21	2	4	0	73
Carmi Cr.	27	3	9	0	61
Sand Cr.	1	2	3	19	74
W. Boundary Cr.	26	0	18	5	51
Boundary Cr.	25	3	14	35	20
Eholt	41	0	7	9	42
Phillips Cr.	32	0	18	1	49
Steamboat Mtn.	43	6	17	8	26
Frances R.	30	1	17	24	28
Bloom Cr.	62	3	0	2	33
Average %	26	2	12	9	50

[1] Totals may not equal 100% due to mortality from other causes.

Forecasts

Overall in 1989, the number of discoloring trees should be similar to or slightly greater than in 1988, with notable exceptions in portions of the Cranbrook TSA and the Boundary TSA where infestations will increase. This was indicated by spring "R" values ranging from 2.8 to 7.0 and averaging 4.6 (Table 3) and by cruise results (Table 2) and encompasses considerable variability as noted for the various TSAs and even drainages within TSAs. Of 18 smaller infestation areas examined in the East Kootenay, 12 indicated a static to slightly increasing population based on current to red attack ratios. No drastic increases or declines were noted in most areas other than in small individual pockets within drainages; however, in mature stands along the Canada-USA border, beetle population migrations were large and very concentrated attacks could occur (e.g. 62% current attack at Bloom Creek). Consequently, the increase in number and size of infestations experienced in 1988 could likely be duplicated in 1989. In addition, beetle flights should continue to spill over into the Hawkins-Freeman creeks and the Moyie Lake and River drainages, contributing to local population buildups. Other areas with high infestation expansion threats were in the large and frequently less accessible infestations in the Steamboat Mountain area and those along the west aspect of the Rocky Mountain Trench. As local pine stands become depleted, adult beetles will migrate at an increasing rate into other susceptible stands, especially to the north along both sides of the Columbia River and into the Bugaboo and Spillimacheen river drainages.

Conditions similar to those that affected the Hawkins-Freeman creek drainages also occurred in the West Kootenay, where despite aggressive logging and long-term attack, some increases in faders could occur due in part to healthy, local populations in the Ferroux Creek, Carmi Creek and other drainages (Table 3), but also to migration from major infestations in the Kamloops Region. Major expansions were also expected in the Hellroarer-Grano creeks area and possibly north into Cochrane Creek where pheromone trapping and MSMA control programs had only limited success and large susceptible stands occur. Roads now in place may reduce the risk by allowing active control. Continued increasing numbers of new faders will also become evident, especially in the Eholt area but also in several drainages off Boundary Creek.

The preceding predictions are based on the biological capabilities of the beetle, but dynamic management activities or natural conditions can often change the picture and projection in a relatively short time frame.

Table 3. Spring "R" values and 1989 population status, Nelson Forest Region, 1988.

Location	"R" values[1]	Population status[2]	Remarks
Skelly Cr.	7.0	I	scattered mature wwP,1P in area
Redstreak Cr.	6.4	I	rapid expansion for past 2 years
Hellroarer Cr.	6.0	I	rapid expansion, good host availability
Blind Canyon Cr.	5.5	I	dry, woodpeckering, parasites common
Wigwam Cr.	5.5	I	small new pockets of 50 trees
Ferroux Cr.	5.3	I	continued local and immigrating broods
Bull R.	4.9	I	small pockets of +/- 50 trees
Nancy Greene Lk.	4.5	I	should return to normal static population
Bloom Cr.	4.4	I	ongoing major infestation
Frances Cr.	4.1	I	ongoing major infestation
Hawkins Cr.	4.1	I	recent increase in no. of pockets
Rathmullen/Brown crs.	4.1	I	heavy woodpeckering, possible reduction
Steamboat Mtn.	3.8	S	ongoing major infestation
Twin Cr./Phoenix Mtn.	3.8	S	heavy woodpeckering, continuing infestation
Elko	3.5	S	dry site, small dbh pP,1P
Blaeberry R.	2.8	S	South aspect mature 1P
Forster Cr.	2.8	S	small diameter 1P
Average	4.6		

[1]"R" value = an average population trend derived from the number of insects relative to the number of parent galleries originating within a representative bark sample.

2.5	decreasing
2.6-4.0	static
4.1+	increasing

[2] I-increasing, S-static

Pine needle sheathminer
Zelleria haimbachi

Defoliation of lodgepole pine increased to 235 ha in the May-Gibbs-Stacey creek drainages west of Grand Forks, an increase from the 150 ha infested in 1987. Overall damage was moderate with defoliation limited to current foliage averaging an estimated 70% on upper crowns, 50% in mid crowns and 40% on lower crowns. Roadside defoliation in the district was reduced, with moderate discoloration of current foliage prominant only in the area from 10 km east to 2 km west of Greenwood. Needle miner populations further declined in 1988 in the East Kootenay with only minor feeding on terminal foliage noted near St. Mary Lake and over approximately 200 ha of young lodgepole pine at Driftwood Creek.

This miner is generally of limited importance. No tree mortality has been recorded from this pest, but as considerable top-stripping was noted in the Gibbs Creek area, a third consecutive year of severe feeding may result in some top and branch dieback. Some growth reduction is expected and economic losses are generally limited to arboreta, ornamentals or Christmas tree plantations.

Red band needle disease
Dothistroma (Scirrhia) pini

The incidence and severity of infections by this needle disease in western white pine and ponderosa pine increased in the region after two years of very low attack levels. Dry spring weather probably reduced early infection but increased rainfall and relatively cooler temperatures starting near the end of May improved both spore dispersal and infection rates throughout much of the infection period.

A general increase in discoloration of white pine throughout the Slocan Valley was noted with spot light to moderate infection centers common. At Winlaw young ponderosa pine were infected over a 0.2-ha area with two trees severely discolored. Sporadic infection was also noted from New Denver north to Galena Bay. From Shelter Bay to Revelstoke, 90% of young, roadside white pine were 30% discolored (range 5-70%) with infections noted predominantly in lower crowns and 1987 foliage. Pruned plantations in this area were conspicuously lacking in infections, possibly related to improved air circulation and absence of lower crown needles available for attack.

In the one-hectare permanent plot established in 1982 near Summit Lake, discoloration and needle loss were slightly reduced to an average of 64% compared to 68% in 1987 in the 20 plot trees assessed. While the disease continues to be active on an annual basis, no mortality has been recorded. Height and diameter increment has been reduced.

This needle blight has a one year cycle; spore dispersal and infection can occur from May to October with cool moist conditions such as occurred during some periods of the 1988 season accelerating the success of the fungus. Discoloration is generally noted in June, but may not occur until the following spring. Predictions for infection by this blight in 1989 parallel predictions for moist, cool weather in 1989 and are equally reliable.

Lodgepole terminal weevil
Pissodes terminalis

Weevils killed up to 5% (average 3%) of the lodgepole pine terminals in four of five stands examined in the East Kootenay. Five percent of the pine were infested in a recently spaced young stand in the Spillimacheen River drainage and 4% in a spaced stand along the White River. Other stands examined in the Beaverfoot and St. Mary river drainages had only minimal weevil incidence. Weevils favour open growing trees and incidence of attack will generally increase following spacing. Although the killed leader will usually be quickly replaced, previous observations showed that 36% of the weevil infested trees developed forked tops.

Scleroderris canker
Gremmeniella abietina

No evidence of this canker was found in a survey of 100 lodgepole pine at a site 1.6 km west of Nancy Greene Lake. Two subsequent surveys within two kilometers of the site from which the canker was ostensibly identified in 1976 (presumably pathogenic but possibly only saprophytic in nature) were also negative. A further follow-up survey carried out by pathologists with technical support gave identical results. Samples from two young lodgepole pine stands in the Spillimacheen River and Matthew Creek drainages were also negative.

This canker in young pines is an important pest in Eastern Canada where it has caused extensive damage in plantations and nurseries and concern exists that it may become a problem disease in British Columbia. It was apparently identified in four locations in the province between 1968 and 1978 on whitebark, ponderosa and lodgepole pines. Its pathogenicity at time of collections is now in question and it has only recently again been identified in the province but only as a saprophyte.

Warren's root collar weevil
Hylobius warreni

Weevil-killed lodgepole pine were present at low levels in four of five pine stands examined in the East Kootenay. A maximum of 3% recent tree mortality was found in three plantations in the White, Beaverfoot and St. Mary river drainages and only 1% of the pine was infested in a strip at Blackwater River. At Trapping Creek, both group and scattered mortality occurred over an approximately two-hectare section of a spaced young pine plantation. H. warreni and Pissodes sp. were both active at root collars of dead and dying trees.

Weevil damage continues into mature stands, reducing growth and occasionally killing trees of all ages. Clear-cutting and slash-burning both greatly increase weevil mortality and are the most practical control mechanisms when populations are high; however, the flightless adults will gradually reinvade the burned cutblocks from adjacent stands. In earlier studies in the Prince Rupert Region, tree mortality was 0.5% in burned sites compared to 8% in unburned sites in the center of 15-year-old plantations.

Pine stem cankers
Cronartium comandrae
Endocronartium harknessii

Pine stem cankers were generally of minor importance in the stands examined; however, significant damage was recorded at two stands in the Blackwater River drainage and at Fiva Creek, where 5% of the trees were infected by Comandra blister rust, C. comandrae, and western gall rust, E. harknessii, respectively. The former canker, the most aggresive of the pine stem rusts, killed 51% of the young lodgepole pine over a six-year period in a study in northcentral B.C. Occasionally E. harknessii was present in two other young pine stands surveyed at Spillimacheen and Beaverfoot river drainages.

Pine needle cast
Lophodermella concolor

Pine needle cast infections were common on one-year-old lodgepole pine needles in the Cranbrook and portions of the Kootenay Lake TSAs. The most extensively infected areas were along the Canada-USA border from the Bloom-Ward creeks area east, including the Yahk River and Freeman Creek areas. Severe infection was most common on slopes with a north aspect, where moist conditions favour rapid spore germination. On these slopes an average of 75% of the 1987 foliage was infected on 100% of the trees with progressively less infection in stands on flat ground and on a south aspect. Other areas with lower incidence and intensity included the Moyie Lake and Perry Creek areas. Light infections occurred in the West Kootenay in two plantations with 54% and 43% of the 1987 lodgepole pine needles affected at Fiva and Erie creeks, respectively.

Cone and seed pests

Cone and seed insects destroyed less than 7% of seeds at four collection locations in the West Kootenay (Table 4). The cone moth, *Cydia piperana*, which can cause considerable loss of seed, was the only pest common to all sites and was found in 60% of cones at Grand Forks. It damaged a maximum of 33% of seed in infested cones. All other pests combined damaged only 4% of cones. At all sites cone crops were medium and a large volume of healthy seed could have resulted from collections in Grand Forks TSA.

Table 4. Location, cone and seed pests of ponderosa pine, Nelson Forest Region, 1988.

Location	Percent of cones affected				Total percent cones affected	Crop[1] size
	Cydia piperana	*Dioryctria auranticella*	*Megastigmus* sp.	*Resseliella* sp.		
Grand Forks	60	0	0	0	60	M
Johnstone Creek Park	6	6	0	0	12	M
Rock Creek Canyon	6	2	6	2	16	M
Laurier	20	0	0	0	20	M
Average %	23	2	<2	<1	27	

[1]light (L) - few cones on >25% of trees
medium(M) - many cones on 25-50% of trees
heavy (H) - many cones on >50% of trees

DOUGLAS-FIR PESTS

Western spruce budworm
Choristoneura occidentalis

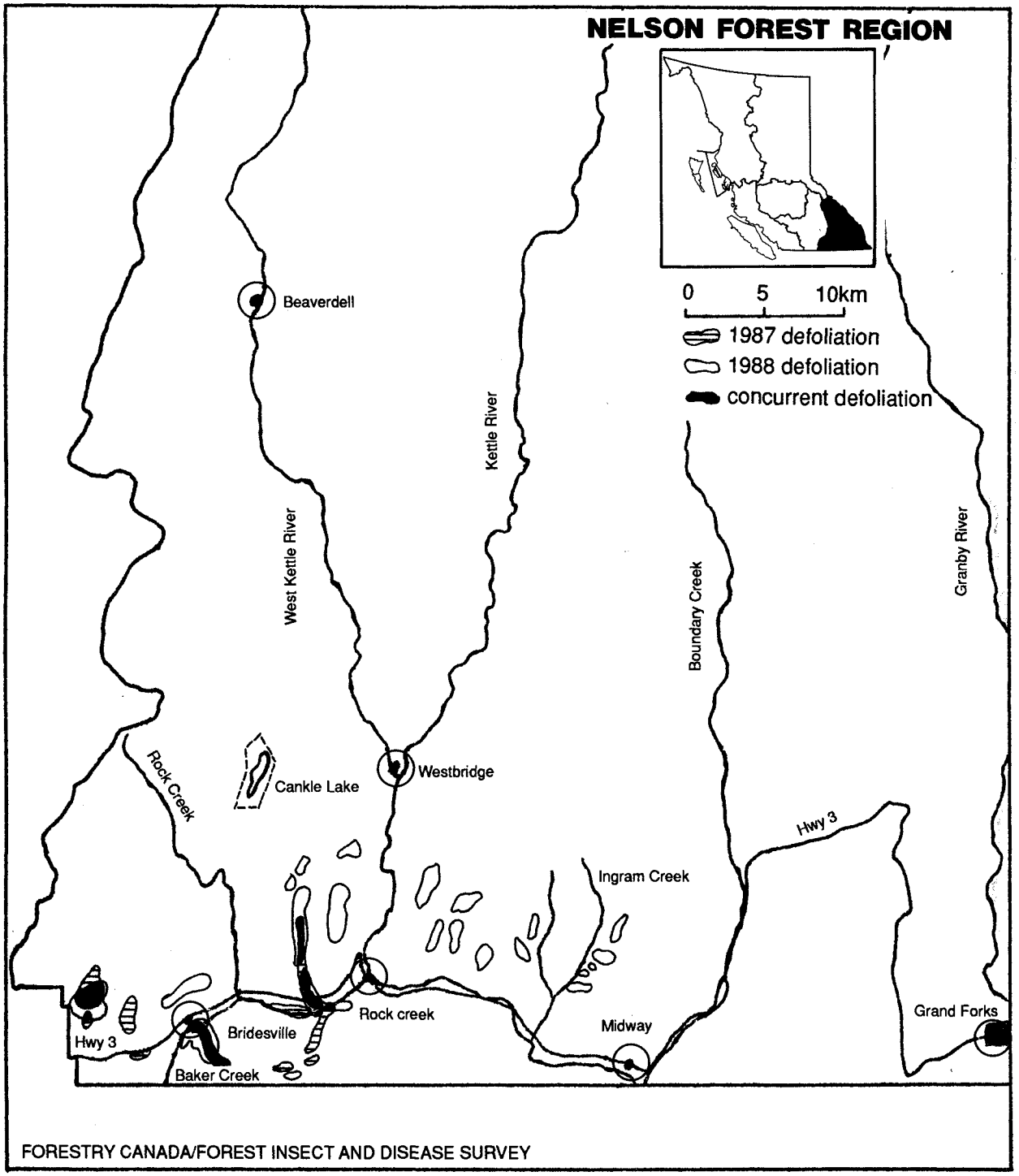
Western spruce budworm lightly defoliated Douglas-fir over 3275 ha in 27 infestations, tripling the 1043 ha infested in 1987 but down from 3688 ha infested in 1986 (Map 3). Budworm populations have persisted in the Rock Creek to Anarchist Mountain area for the past 11 years, especially in the Johnstone Creek Park area.

Light defoliation was recorded in all areas including Johnstone Creek Park and Bridesville where moderate to severe defoliation of some regeneration was visible from the ground. Moderate defoliation was also noted on roadside regeneration along Conkle Lake Road and in the McKinney Creek area. The light defoliation noted in the Nicholson, Bubar and Ingram creek drainages was a major eastward expansion for the budworm. Trace but increasing defoliation was noted in the Kettle River Recreation Area as well as from Greenwood to Phoenix Mountain.

Numbers of larvae averaged 74 (range 2-185) per standard beating sample in six Douglas-fir stands between Anarchist Mountain and Rock Creek, higher than the 57 larvae per sample in 1987 which resulted in mostly light defoliation. Up to 125 larvae per three-tree beating sample were also found on Engelmann spruce and western larch. Two mass collections of larvae were reared to determine parasitism. At Johnstone Creek, parasitism was 7.3% by Diptera and 14.6% by Hymenoptera as compared with only 9.5% total in 1987. At Bridesville, parasitism was 7% by Diptera and 10% by Hymenoptera, an increase from the total 2.8% parasitism found in 1987.

Egg sampling at nine locations to determine potential larval populations and related defoliation in 1989 indicated severe defoliation in six areas, moderate defoliation in two areas and light defoliation in only one area (Table 5). Severe defoliation is predicted for McKinney Creek, Bridesville, Johnstone Creek, Rock Mountain Road and the newly infested areas at Nicholson and Ingram creeks. Second-instar larval (L2) sampling and analysis is to be completed in the new year to further aid in predictions.

Fall egg sampling and L2 collection are useful early indicators of building populations; however, natural agents can severely affect overwintering larvae. Therefore, bud sampling in the spring augments forecasting information. Bud sampling in May 1988 dramatically altered defoliation estimates from 1987 egg mass sampling at several locations; these revised forecasts were a more accurate predictor of actual larval activity (Table 5). Although predictions for the Nelson Forest Region are for increased activity in 1989, this is the reverse of what is anticipated for the main body of spruce budworm activity centered in the Kamloops Region.



Map 3. Areas where Douglas-fir was defoliated by western spruce budworm determined by ground and aerial surveys in 1988.

Table 5. Location, 1987 and 1988 western spruce budworm egg mass samples, 1988 bud samples, predicted and actual defoliation for 1988 and 1989, Nelson Forest Region, 1988.

Location	No. eggs[1] per 10 m²		Percent[2] buds infested	1988 defoliation[3] predicted by			1989[3] predicted
	1987	1988	1988	eggs	buds	actual	defoliation
Anarchist Mtn.	49	72	12	light	light	light	moderate
Conkle Lk. Rd.	33	65	-	light	-	light	moderate
Johnstone Cr.	558	359	26	severe	moderate	light	severe
McKinney Cr.	159	311	15	severe	light	light	severe
Bridesville	536	326	23	severe	moderate	light	severe
Rock Cr.	295	270	15	severe	light	light	severe
Phoenix Mtn.	19	10	2	light	light	light	light
Nicholson Cr.	-	425	-	-	-	light	severe
Ingram Cr.	-	208	-	-	-	light	severe

[1] No. egg mass/10 m2 foliage — predicted defoliation
1-50 — light
51-150 — moderate
151+ — severe

[2] Percent buds infested — predicted defoliation
1-15 — light
16-30 — moderate
31+ — severe

[3] light - discoloration barely visible
moderate - pronounced discoloration, some top stripping
severe - bare branch tips, complete defoliation.

A pheromone-baited trap calibration project designed to detect increasing populations and predict infestations continued in 1988. Larval sampling, pheromone trapping (multipher type) and defoliation estimates continued at the two sites in the region (Table 6). Several more years of field work at many locations in the province are projected before meaningful relationships are formulated.

Table 6. Location, number of larvae, adults and defoliation at spruce budworm pheromone calibration plots, Nelson Forest Region, 1988.

Location	Avg. no. larvae/tree[1]		Avg. no. adults/trap[2]		Defoliation	
	1987	1988	1987	1988	1987	1988
Conkle L. Rd.	5	7	183	417	nil/trace	trace(1%)
Phoenix Mtn.	<1	<1	46	256	nil	nil/trace

[1] sampling method consists of beating 3 branches on each of 25 trees over a 60x90 cm sheet.
[2] five multipher traps spaced at more than 30 m intervals using the lure .03% trans-11-tetradecenal + cis-11-tetradecenal.

While larval parasitism has increased, it is insufficient to significantly affect populations. Barring severe overwintering larval mortality, an increase in severity of attack and a possible expansion in total area infested is indicated. Severe localized defoliation in areas of repeated attacks such as Johnstone Creek Park and Bridesville, could result in significant top-kill and branch dieback, particularly of understory trees. There is an increasing trend for mortality possible with increasing number of successive years of defoliation, especially with understory regeneration.[1]

Douglas-fir beetle
Dendroctonus pseudotsugae

Douglas-fir beetle infestations occurred in 12 scattered small pockets in 1988 in the Nelson Region, the first significant increase since the early 1970s. During fall surveys numerous groups of up to 40, 1988-attacked discoloring trees were noted. Approximately 50% of the current attack had faded. In the East Kootenay, the most significant increase (average current to red attack ratio, 5:1) was in the Rocky Mountain Trench with spot infestations prevalent from the Grasmere-Koocanusa Lake-Bloom Creek area north to Invermere. Although not all potential beetle problem areas were visited during the fall period, some drainages with frequent patches of current tree attack included Whiteswan Lake, Brewer Creek, Wildhorse Creek, Elko, Grasmere and the Gold-Bloom creeks area.

In the West Kootenay, an estimated 125 trees were killed in seven scattered pockets of Douglas-fir beetle in the Beaverdell area. This is the first report of infestations in the Boundary TSA since 1984 and the first for the West Kettle River drainages since 1972. While scattered pockets of attack have been reported periodically, the last major losses occurred in the period of 1967-69 when an estimated 2400 trees were killed in the West Kettle and Kettle river drainages.

At Carmi Creek where six green attack and 15 red were noted in early August; during fall surveys, there was no brood development (Table 7). At Nelse Creek south of Beaverdell only two of eight green attacks contained broods. At East Trapping Creek only two of ten currently attacked trees contained substantial broods. Several other small scattered infestations were also noted in the TSA including approximately 10 red and grey trees near Midway, a pocket of 20 trees near the Blueberry-Paulson Bridge and a pocket of 10 to 15 red and grey but no current attack at Ingram Creek. In a logged area along Conkle Lake Road, low stumps contained no brood; high stumps contained large healthy broods. Improved logging practices should preclude development of infestations in the Conkle Lake Road area. The need for a trap-tree program has not been clearly demonstrated.

Overall "R" value ratings indicate expanding populations at the West Kettle sites based on limited samples and a modified sampling method (samples taken at 1-m rather than 3-m height). The fact that a number of the locations were exposed sites, that there was possible stress to the host from several years of below-normal precipitation, that brood was lacking in many trees, coupled with an apparent return to near-normal conditions might suggest a decline in the beetle activity for 1989 at these sites.

[1] VanderSar, T. 1987. The western spruce budworm feeding on Douglas-fir. Information Forestry, CFS, Vol. 14 No. 2, 10 pages.

A hymenopterous parasite, Coeloides vancouverensis, was common in galleries at most sites examined for brood development. Its effect on beetle populations has not been determined at this stage.

Although basically the same site and climatic factors affected the beetle populations in the East Kootenay, the broods were consistently larger, with less parasitism, and attack was frequently associated with Armillaria root disease or blowdown trees. Significant expansion will become evident when all of the 1988-attacked trees turn color by the spring of 1989. Where mature Douglas-fir is present, increased current attack can be expected in 1989.

Table 7. Douglas-fir beetle infestation size and brood vitality, Nelson Forest Region, 1988.

Location	No. current attacks	"R" values[1]
Koocanusa Lake	16	6.6
Wickman Creek	19	7.2
Brewer Creek	40	4.8
Whiteswan Lake	19	7.1
Nelse Creek	25	3.2
E. Trapping Creek	30	2.3
Carmi Creek	15	0.0

[1]"R" values are based on the ratio of entrance holes to progeny. For Douglas-fir beetle, an "R" value of 1.4 or greater indicates an increasing population.

Douglas-fir tussock moth
Orgyia pseudotsugata

The tussock moth population remained at endemic levels in 1988. No larvae were found in beating samples in the region. Six pheromone-baited traps (0.01% Z-6-heneicosen-11-one) at each of two previous outbreak areas resulted in no adults trapped at Christina Lake Golf Course and only eight trapped at Rock Creek (Table 8).

Table 8. Location, average number of tussock moth adults trapped 1986-88, Nelson Forest Region, 1988.

Location	Avg. no. tussock moth adults per trap			Number of traps
	1986	1987	1988	
Rock Creek	0.2	0.8	1.3	6
Christina Lake Golf Course	0.2	1.2	0	6

Trap catches in 1987 indicated a possible upward trend similar to the Kamloops Region where defoliation occurred in 1988 and is expected in 1989. An average catch of 8-10 adults per trap is a useful general predictor that an outbreak may follow two years later. Outbreaks traditionally occur at 8- to 14-year intervals; the last outbreak in Nelson Region was in 1982-83. Since the upward trend did not continue, an outbreak in these traditional areas is not anticipated before 1992 and no defoliation is expected in 1989. Monitoring will continue.

Melampsora foliage rust
Melampsora medusae

This rust caused light to severe discoloration of Douglas-fir in many areas in the Nelson Region. At Cariboo Creek, an average of 25% (range 20-40%) of current foliage on 80% of the plantation Douglas-fir was infected. At Fitzstubbs Creek, 100% of plantation trees were lightly to severely infected; roadside regeneration throughout the drainage was similarly affected. Light infection was also common throughout the Mosquito Creek drainage from Arrow Park to South Fosthall Creek. Most of the young growth Douglas-fir in the Donald-Quartz Creek area was moderately infected with 25% of the 1988 foliage severely discolored while trees within 5 m of infected aspen (the alternate host) had from 60-95% of current foliage infected. Other areas through the host range were infected but generally incidence and intensity was very light.

The alternate host, Populus tremuloides, is required to complete the life cycle of this rust. In 1987, trembling aspen was commonly infected in many areas and severely infected from Rock Creek to Anarchist Mountain causing up to 100% defoliation in many isolated pockets. The presence of infected alternate host and cool, moist conditions for spore germination and dispersal in the spring resulted in the increased attack on Douglas-fir this year. While some growth reduction may result from loss of current foliage, no dieback or mortality has been recorded and no control is required except at nurseries or Christmas tree plantations.

Cone and seed pests

Damage by cone and seed insects in the light to medium Douglas-fir cone crops was minimal at four of six collection sites: Fenwick, Enterprise, Pass and Bluewater creeks; only at HaHa Creek were over 50% of the seed destroyed (Table 9). Attack by the Douglas-fir cone moth, Barbara colfaxiana, one of the most damaging cone insects, was relatively low (13%) compared to the previous seven-year average when 33% of the cones were infested. The presence of only a single larva is sufficient to destroy 65% of the seeds in a cone. Equally common in the cones was the Douglas-fir seed wasp, Megastigmus spermotrophus, infesting 17% of the cones compared to a seven-year average of 31%. This insect, however, is less destructive with each larva destroying only a single seed. The Douglas-fir cone scale midge, Contarinia washingtonensis, although common in cones has little effect upon the seeds.

Table 9. Percent Douglas-fir cones infested by insects, Nelson Forest Region, 1988.

Location	Barbara colfaxiana	Megastigmus spermotrophus	Contarinia spp.	Dioryctria abietivorella	Crop size[1]
Fenwick Cr.	5	12	15	-	L
HaHa Cr.	48	42	4	-	L/M
Bluewater Cr.	2	4	14	8	L/M
Steamboat Mtn.	22	24	34	10	M
Enterprise Cr.	-	-	5	-	L/M
Pass Cr. Rd.	-	20	15	-	L/M
Average	13	17	14	3	

[1]L - light, few cones on >25% of trees
M - medium, many cones on 25 to 50% of trees

SPRUCE PESTS

Spruce beetle
Dendroctonus rufipennis

Spruce beetle-related tree mortality was mapped over 225 ha in 12 infestations in the Nelson Region in 1988, up from 8 ha in 1987; however, 185 ha of tree mortality consisted of beetle-infested flood-damaged spruce.

In the West Kootenay spruce beetle infestations in mature spruce stands covered only 39 ha in two infestations. Blowdown along the edge of a clearcut at Kirbyville Creek north of Revelstoke created the condition for attack of standing trees over an estimated 39 ha with a further spot (0.5 ha) infestation along the same drainage adjacent to a slide area.

In the Arrow TSA, harvesting removed all attacked trees over 200 ha in the Airy Creek infestation south of Slocan. Three areas adjacent to this clearcut were examined to determine the success of the control project. No infested trees were found in over 200 trees examined. Monitoring will continue in 1989.

The Upper Duncan-Glacier National Park spruce beetle problem continued with the slashing of a boundary within the park in 1985. Approximately 100 Engelmann spruce were felled in July/August during a period when the beetle was still epidemic in the area. The presence of remaining small populations of beetle, in conjunction with fire-scorched, blowdown and felled spruce suitable as breeding sites presented a real threat to the resurgence of the infestations. By July 1986 adults, eggs and young larvae were found in felled trees and a co-operative decision between Parks Canada, CFS and Ministry of Forests was made to protect standing trees. In August, trees were bucked to 75-cm lengths and 15-cm tops and placed in upright positions. The rationale was that since the beetle was not projected to fly until spring 1988, this would allow sufficient

drying time to preclude successful maturation of brood. On examining a number of bolts in July of 1987, the ratio of live larvae to dead was 8:1; the ratio of live callow adults to dead was 177:1. A final examination of bolts on June 15/88 with the flight already in progress showed an average of 13.7 combination on adults plus exit holes per 1000-cm^2 bark sample. A resident population therefore remains to attack blowdown and stressed trees and possibly initiate an infestation. It was noted during the June survey that bolts which had fallen over or were leaning against some object, as well as bolts protected by a heavy canopy retained considerable moisture and contained the largest populations. Those bolts clearly exposed to the sun and standing unsupported were much drier and harbored few adults. In future the success of this method of control may be enhanced, depending on the conditions available and the care in implementation. Surveys will continue in 1989 to determine if healthy trees have been attacked.

No major infestations were noted in the East Kootenay in 1988 but some potential problem areas were developing at the head of several drainages. Three drainages, Redding and Vowell creeks and Beaverfoot River had sufficient material to sustain brood and therefore warrant close monitoring of population development. At Redding and Vowell creeks, recent blowdown absorbed large populations, resulting in eight and 14 current attacks per 1000-cm^2 bark sample, respectively. The lower attack density at Redding Creek was due to more extensive blowdown, with groups of up to 15 trees down over an 8-km stretch, compared to a single group of 25 blowdown trees at Vowell Creek. In portions of the Redding Creek area, log decks left from winter logging had absorbed over half of the 1988 flight. In the Beaverfoot River area, recent flooding damage over 185 ha had locally increased beetle populations resulting in 16 attacks per 1000-cm^2 bark sample on blowdown and in scattered current attacks adjacent to the flooded areas. In the Glenogle, Skelly and Summer creek drainages, blowdown due to root rot or fringe exposure was sufficient (approximately 1-2 trees per hectare) to maintain the current population levels. In Kootenay National Park extensive recent blowdown was centered near the Simpson-Vermilion rivers junction, but smaller pockets of blowdown were common in numerous areas of mature spruce in the park. Subsequent tree mortality will likely follow when adult beetles emerge in 1990.

Spruce weevil
Pissodes strobi

Leader mortality caused by spruce weevil averaged 17% in three of five young spruce plantations in the Golden TSA (Table 10). The level of current attack indicates that the weevil population has been increasing since the early 1980s, when leader mortality ranged from 0 to 5% in the same areas.

Table 10. Location and percent spruce weevil attack in 1987 and 1988, Nelson Forest Region, 1988.

Location	Percent current weevil attack 1987	1988
Blackwater River	0	3
Beaverfoot River	5	13
Quartz Creek	30	35
Average	12	17

Programs utilizing leader clipping for cold treatment or storage of clipped leaders in screened containers to allow parasitoid emergence have proved effective in reducing weevil-caused damage in recent research trials (J. Harris, Forestry Canada, Victoria, personal communication).

Spruce-Labrador tea rusts
Chrysomyxa ledi and *C. ledicola*

These rusts moderately to severely infected the current year's spruce foliage in the upper Kootenay-Beaverfoot river drainages. Severe infection was also noted along the Simpson and Vermilion rivers in Mt. Assiniboine Provincial Park and Kootenay National Park. In a survey of a 15-year-old spruce plantation in the Beaverfoot River drainage, 30% of the trees had 50% or more of the foliage severely infected, with less infection on the remaining trees. Severe foliage infection affects foliage production and tree growth the following year.

Spruce gall adelgids
Pineus spp.
Adelges cooleyi

Adelgid damage to young Engelmann spruce was recorded in two of five plantations examined. One 13-year-old stand near Boundary Creek had an average 29% of the current year's shoots infested by *Pineus* spp. on 81% of the trees, with 28% of the trees having over 50% of the shoots infested. *Adelges cooleyi* was present to a lesser degree in a young stand at Quartz Creek where 29% of the trees had 16% of the shoots infested. Previous studies on tip galls indicated that when more than 50% of the shoots of young trees were infested, the tree height and radial growth was reduced by 32% and 18% respectively.

Cone and seed pests

Cone and seed insects destroyed more than 50% of a generally moderate cone crop at four of six collection sites (Boundary Creek, St. Mary, Spillimacheen and upper Kootenay rivers) (Table 11). Although insect damage was light (15%) in the White River drainage, cone rust destroyed an additional 21% of the cones leaving only a marginally collectable cone crop. Single larvae of the two major cone insects, *Strobilomyia neanthracium* and *Cydia strobilella*, can destroy 50% and 20%, respectively, of the seed in a cone.

Table 11. Percent of Engelmann spruce cones damaged by insects and disease, Nelson Forest Region, 1988.

Location	*Strobilomyia neanthracinum*	*Dasineura rachiphaga*	*Dasineura canadensis*	*Resseliella* sp.	*Mayetiola carpophaga*	*Cydia strobilella*	*Megastigmus latedius*	*Chrysomyxa pirolata*	Crop size[1]
Boundary Cr.	5	-	-	-	-	100	-	-	L/M
E. White R.	15	7	-	-	-	-	2	21	L/M
St. Mary R.	60	-	-	2	-	2	-	7	L
Spillimacheen R.	48	8	-	-	2	18	-	5	M
Upper Kootenay R.	42	2	-	18	2	-	-	5	L/M
Enterprise Cr.	10	-	5	-	-	15	-	5	L/M
Average	30	3	1	3	1	23	1	7	

[1] L - light - few cones on >25% of trees
M - medium - many cones on 25-50% of trees
H - heavy - many cones on >50% of trees

Tomentosus root rot
Inonotus tomentosus

Five semimature to mature Engelmann spruce sampled at Kettle Valley Recreation Area north of Rock Creek were severely infected by tomentosus root rot. Blowdown in the campsite initiated a survey of the area which confirmed a widespread, long-standing active root rot problem. While the survey confirmed only five trees infected, the nature of this root rot would indicate a large number of trees were infected, even though no crown symptoms were visible.

While incidence of infection in many stands including lodgepole pine in northern British Columbia is high, the Nelson Region has had only occasional reports of isolated infection centers with a 12-tree root rot center in lodgepole pine being the most severe situation recorded. Specific surveys in 1984 to determine the presence of root rot in young spruce stands were all negative. The current situation is therefore the most significant recorded to date in the region and may suggest a need for a closer examination of this pest in future surveys.

LARCH PESTS

Larch casebearer
Coleophora laricella

Larch casebearer defoliation increased dramatically in the Nelson Region to 486 ha of light to moderate defoliation, mostly in the West Kootenay, from less than 100 ha in 1987. Light to moderate defoliation occurred in over 31 infestations, while activity continued generally negligible to light and spotty at most parasite release sites.

Moderate defoliation in the Castlegar pulp mill area expanded to 140 ha in nine infestations from 20 ha lightly defoliated in 1987. Moderate defoliation occurred along Arrow Lakes in the Stoney Creek, Gustafson to Graham creek drainages and at Arrow Park. Moderate defoliation was also recorded in the Rossland area and for the first time, at Summit Lake, in the Duncan Lake area at Howser Creek and from Puddingbowl to Tiger creeks. Scattered moderate defoliation was noted over 10 ha in the Thrums area and in roadside western larch west of Castlegar. Light defoliation was noted over 5 ha at Bridesville; over 0.2 ha in the Fisherman Creek area; for 2 km along Slocan River in the Crescent Valley area, and along roadsides from Meadow Creek to Argenta. Trace defoliation also occurred at Enterprise Creek, New Denver, Aaron Hill and Shelter Bay, which remains the most northerly distribution of the pest and host in the Nelson Region.

In the East Kootenay, larch casebearer populations increased slightly throughout much of the southern range of larch. In areas defoliated in 1987, intensity increased to light with occasional patches of moderate defoliation of open-growing and fringe trees. These areas included Galloway, Cranbrook, Wycliffe, Kimberley, along Kootenay Lake from Boswell to Crawford Bay and near Newgate. The most severe defoliation occurred over 20 ha of mature larch at Mause Creek.

Assessments of overwintering larval populations at 18 locations in the region indicate defoliation potential for 1989 at those areas sampled varying from negligible to light in the region. This is a reduction from 1988 when moderate defoliation was predicted and found at Castlegar and Rossland. Predictions are based on the number of larvae per 100 fascicles (Table 12) and do not include several of the inaccessible new infestations.

Table 12. Predicted defoliation of western larch in 1989 by larch casebearer based on overwintering larval populations, Nelson Forest Region, 1988.

Location	Avg. no. overwintering larvae per 100 fascicles			Predicted defoliation[1]	Increase/ decrease
	1986	1987	1988		
Jaffray	1.0	0.8	1.6	negligible	-
Koocanusa L.	0.1	0.2	0.1	negligible	-
Ellenvale Cr.	2.7	8.7	13.1	light	I
Six Mile Lane (Cranbrook)	3.5	6.7	18.8	light	I
Wycliffe	23.9	35.5	3.8	negligible	D
Cranbrook Reservoir	22.5	38.5	15.0	light	-
Cranbrook	0.2	1.8	5.8	negligible	-
E. Arrow Cr.	0.8	1.4	0.7	negligible	-
Rykerts	10.1	12.7	9.8	negligible	D
Salmo	1.6	0.4	0.2	negligible	-
Fruitvale	32.1	4.2	0.9	negligible	-
Beaver Falls	64.3	66.7	3.9	negligible	D
Rossland	54.9	91.0	10.2	negligible	D
Thrums	10.2	23.8	2.6	negligible	D
Castlegar (pulpmill)	66.2	115.0	28.2	light	D
Castlegar West	31.2	71.4	35.9	light	D
Johnstone Cr.	5.8	2.2	1.5	negligible	-
Anarchist Mtn.	13.8	5.8	4.2	negligible	
Average	19.2	27.0	8.7		

[1]negligible 0.6-11.5 larvae per 100 fascicles - no visible defoliation
light 11.6-60.4 larvae per 100 fascicles - up to 25% defoliation
moderate 60.5-136.5 larvae per 100 fascicles - 26 - 50% defoliation
severe 136.6+ larvae per 100 fascicles - 51%+ defoliation

The incidence of pupal parasitism by both native and introduced parasites in May at 17 sites increased to an average of 32.2% (range 0-81.6%) from 18% in 1987 and 5.5% in 1986. The biological control program initiated by the Canadian Forestry Service, Forest Insect and Disease Survey, and consisting primarily of the release of the introduced parasites, Chrysocharis laricinellae and Agathis pumila from Austria and Switzerland was discontinued, although monitoring of the release sites continue. To date there has not been a clear link between pupal

parasitism levels and fall larval counts; however, previous casebearer infestations have subsided whenever parasitism reached 35% or greater.

A recent study of two severely defoliated small mixed eastern larch stands in Quebec revealed radial increment loss of 48% to 70% during one or two years of severe defoliation by larch casebearer with recovery to normal or near normal following. No similar growth losses and no mortality have been recorded in B.C. on western larch although damage studies are in progress. The necessity for control of this pest in the forest has not been definitively demonstrated; however, long-term studies on the value of introduced parasites are still in progress.

Larch sawfly
Pristiphora erichsonii

Larch sawfly larvae moderately to severely defoliated 512 ha of western larch, down from 700 ha in 1987. Infestations occurred in patches up to 90 ha along the Elk River Valley from Hosmer south to Elko and at the junction of Lodgepole Creek and Wigwam River. Increasing numbers of larvae were also found near Plumbob Mountain, Teepee Creek, and in the Findlay Creek drainage; very light defoliation was evident at the latter location.

In the West Kootenay, larch sawfly lightly to moderately defoliated 112 ha of western larch in six infestations in the Miller Creek-Granby River area. This is the first recorded infestation in the West Kootenay since 1972 and the first in the Grand Forks area since 1967, when defoliation was moderate to severe.

Assessments of overwintering cocoons were made in early October at four areas to determine population trends for 1989 and associated levels of parasitism and disease (Table 13). Samples of single 1000-cm^2 areas of duff were taken from beneath each of 10 defoliated trees in each area. Although the number of cocoons present would indicate continuing defoliation for 1989,very few (4%) healthy cocoons were present in a subsample of x-rayed cocoons. Parasitism accounted for 84% cocoon mortality. Limited parasite data indicated high numbers of Dibrachys saltans at the Wigwam River site; however, further cold treatment is required for the emergence of the more common native parasitoid, Tritneptis klugii. Pending rearings and further x-ray, findings suggest a population collapse at all sites.

Table 13. Location, average percent defoliation of western larch by larch sawfly, numbers of overwintering cocoons per 1000 cm^2 of duff and predicted defoliation, Nelson Forest Region, 1988.

Location	Average % defoliation	Average no. cocoons/ 1000 cm^2	Percent of cocoons			Predicted defoliation 1989
			Parasitized	Dead other causes	Healthy	
Wigwam Cr.	80	45	81	12	7	nil
Elko	85	30	76	23	1	nil
Miller Cr. (Granby R.)	65	28	98	0	2	nil
Hosmer	50	19	81	12	7	nil
Average	70	30	84	12	4	

Larch needle diseases
Meria laricis
Hypodermella laricis

While the incidence of needle diseases on larch continued unabated, the intensity decreased substantially throughout the Nelson Region. Dry warm conditions early in the spring during needle elongation and initial spore dispersal period in the West Kootenay reduced infection by *Hypodermella laricis* which is unable to penetrate the hardened cuticle of the mature needle, and delayed infection by *Meria laricis* until after May when cool moist periods which favor infection became more prevalent. Discoloration caused primarily by *M. laricis* and less commonly by *H. laricis* and even occasionally by the needle rust *Melampsora medusae* was less visible early in the season but became common but light in many locations by July.

Meria laricis was common throughout the Slocan Valley to New Denver and north, infection was generally light but occasionally severe in lower crowns. In a pine plantation at Mosquito Creek, occasional 5-m larch were severely infected while in a South Fosthall Creek plantation, all larch were moderately infected. At a larch plantation at Smallwood Creek, 54% of 1-m planted larch were lightly infected (average 10% of needles discolored). At Gem Creek near Nancy Greene Lake only light infection by *M. laricis* was found at a *H. laricis* monitoring plot. *H. laricis* was not identified from any samples sent for analysis including those from Johnstone Creek where all trees were lightly infected the previous year. At this site and at Anarchist Mountain, *M. medusae* was common but on average affecting only 1% of foliage.

In the East Kootenay, *H. laricis* severely infected semimature western larch over 650 ha along the Kootenay River between Fenwick Creek and the White River junction. Generally light infection, but with moderate infection in the lower crown to individual trees, was common beyond the aerially mapped areas including the Palliser River in the north and the Whiteswan Lake area in the south. Similar patchy light to moderate defoliation also occurred near Premier Lake and in the Findlay Creek drainage.

Larch budmoth
Zeiraphera improbana

Larch budmoth continued at endemic levels throughout the region with only trace damage found at one site and endemic level populations at two other sites. At Johnstone Creek Park, early indications were of a slightly expanding population but later observations showed that damage did not increase beyond trace levels. Populations were noted at Anarchist Mountain and Aaron Hill but continued at endemic levels. No larvae or damage were noted at previous infestations in the Hanna and Murphy creek drainages. No evidence of this pest was noted in the East Kootenay; monitoring will continue in 1989.

TRUE FIR PESTS

Two-year-cycle spruce budworm
Choristoneura biennis

No budworm defoliation was mapped in alpine fir-spruce stands in the region in 1988. Only understory and lower crown defoliation was present in areas defoliated in 1987. Ground assessments to determine bud feeding activity of second and third instar larvae were carried out at several sites including the Barnes Creek area, where evidence of light 1987 defoliation, not previously noted, was found from km 34 to 38 and included some minor top stripping (average 15 cm) on 10% of semimature spruce. Bud assessments in May indicated the potential for light to severe defoliation (Table 14) for the main feeding year in 1989, presuming conditions remain favorable for the survival and development of budworm larvae. At Plant Creek, an average of 19.5% (range 8-42%) of alpine fir and spruce buds were infested while at Airy Creek and Barnes Creek, 17.7% (range 8%-23%) and 51.7% (range 44%-56%), respectively, of spruce buds were attacked.

In the Purcell Mountains, severe feeding occurred on 1988 foliage on understory trees at Vowell Creek (Table 14), while at Bobbie Burns, Dewar and McMurdo creeks only light to moderate feeding was evident. In Kootenay National Park, first year defoliation was evident along the Vermilion River with up to 80% of the current years foliage of overstory trees destroyed in several side drainages.

In most of the province, the budworm has its peak feeding period in even numbered years, out of synchronization with the major activity in the Nelson Region. Larvae do, however, also mature in even years in some parts of the region and trace defoliation of roadside spruce and alpine fir has been noted from this population in previous years.

Table 14. Location, host, percent buds infested by two-year-cycle spruce budworm and predicted 1989 defoliation, Nelson Forest Region, 1988.

Location	Host[1]	Percent buds infested	Predicted defoliation 1989[2]
Plant Cr. # 1	eS	28	moderate
Plant Cr. # 2	eS	19	moderate
Plant Cr. # 3	alF	12	light
Airy Cr.	eS	18	moderate
Barnes Cr.	eS	52	severe
Vowell Cr.	alF,eS	80	severe
Bobby Burns Cr.	alF,eS	35	moderate
Dewar Cr.	alF,eS	31	moderate
McMurdo Cr.	alF,eS	29	moderate
McNaughton Lk.	D-fir,eS	15	light
Baker Cr.	alF,eS	6	light

[1]eS - Engelmann spruce; alF - alpine fir; D-fir - Douglas-fir
[2]Predicted defoliation: light - 1-15% of buds infested
moderate - 16-30% of buds infested
severe - 31% + of buds infested

Western balsam bark beetle
Dryocoetes confusus

Recent tree mortality, as detected by aerial surveys, over 1700 ha ranged from 5-15% of the alpine fir component in 121 infestations in the Nelson Region, an increase from 800 ha in 1987. Most of the areas mapped were larger concentrations of recent tree mortality at Quartz Creek and in the Kinbasket, Bush, Blaeberry and Spillimacheen river drainages.

Due to stand types and the pattern of bark beetle attack, the area and intensity of attack does not fluctuate dramatically; however, consistent mapping is difficult due to the scattered nature of attack over large areas, as well as the variabilities of annual priorities given to aerial surveys of the beetle damage. Actual changes in the number of trees attacked annually are usually related to the extent of recent alpine fir blowdown and summer temperatures which can delay or accelerate development.

Balsam woolly adelgid
Adelges piceae

Examination of grand fir and alpine fir for balsam woolly adelgid continued for the fifth consecutive year in stands in areas near the Canada-USA border. Reports of continued and intensified pockets of activity affecting true firs in Northern Idaho in 1987 prompted continued surveys in 1988. Examinations were negative at King George VI Park, at six locations along the Pend-d'Oreille River, at Nelway, Rykerts, East Arrow Creek and in Kokanee Creek Park. Symptoms such as crown thinning or flattened tops, and signs such as gouting or woolly tufts on stems were not found. Monitoring will continue in 1989.

Foliar diseases
Pucciniastrum epilobii
Isthmiella quadrispora
Delphinella sp.

Foliar diseases continue to commonly infect primarily current foliage of true firs in many widely varied locations in the Nelson Region. The rust, *Pucciniastrum epilobii*, lightly infected current foliage of alpine fir for 8 km along Koch Creek with severe infection on occasional trees. Similar infections occurred in the Dago Creek side drainage. Generally light to occasionally severe infection of alpine fir was noted for 2 km along Enterprise Creek, at a Woolsey Creek plantation and on grand fir in an Erie Creek plantation. On the east side of the Purcell Mountains from the Spillimacheen River south to Matthew Creek near Kimberley, 30 to 50% of the alpine fir had 70% of the current foliage severely infected by *P. epilobii* in portions of most major drainages. Other locations with similar levels of infection included the Glenogle River area, the Vermilion River area of Kootenay National Park and in Mt. Revelstoke National Park. The latter location, along with the Mt. Fernie area, had an additional 20-30% of the current foliage destroyed by *Delphinella abietis*.

MULTIPLE HOST PESTS

Root diseases
Armillaria ostoyae and *Phellinus weirii*

Armillaria root disease is common throughout the Nelson Forest Region, causing growth loss and tree mortality throughout the stand rotation age. The most frequently infected species were Douglas-fir and alpine fir but infection centers also included all pine species and western larch.

In a series of 500x5-m strips in 40- to 100-year-old Douglas-fir stands, an average of 7.9% of the trees were either dead or had above-ground symptoms. The percent of ground area occupied by disease centers averaged 3.6% (Table 15). Areas were randomly selected with no prior knowledge of the occurrence of root disease. In each infection center, roots were excavated for positive identification. While these figures may be fairly typical of average stand conditions at this age class, earlier studies which concentrated only in stands with known root rot problems found an average of 14% of the stems infected over 22% of the area. Although no actual strips were established in several areas along McNaughton Lake, walk-through probes of mixed Douglas-fir-white pine stands indicated extensive Armillaria infection; estimates from four areas ranged between 10 and 30%. When infection levels become this high, serious regeneration problems are encountered and unless some remedial programs are employed, future stands will progressively be further depleted by expanding root rot infection centers.

Table 15. Incidence and area of root rot infection, Nelson Forest Region, 1988.

Location	Stand age	Tree sp.[1]	% trees infected	% area infected	No. centers per ha
Palliser R.	65	D-fir	0	0	0
Kid Cr.	42	D-fir	5	4	12
Sanca Cr.	60	D-fir,pP	15	9.2	24
Premier Lk.	100	D-fir	26	4.2	16
Canal Flats	100	D-fir	5	2.2	24
Bush Arm	65	D-fir	7	4	16
Blaeberry R.	70	D-fir	3	1.2	8
Nicholson Cr.	70	D-fir,wL	4	3.6	12
Wilson Cr.[2]	80	D-fir	6	4.2	12
Smallwood Cr.	65	D-fir	8	3.2	8
Average			7.9	3.6	

[1]D-fir - Douglas-fir, pP - ponderosa pine, wL - western larch.
[2]Phellinus weirii, all other locations were Armillaria root disease.

In a young spruce plantation in the St. Mary River drainage, 8% of trees were infected. Infected trees were generally adjacent to old stumps. Although these old stumps no longer showed positive signs of Armillaria, in an adjacent mature Engelmann spruce-alpine fir stand, 70% of the alpine fir were infected.

At the Mountain Creek campground in Glacier National Park, 40% of the trees or 50% of the alpine fir had advanced root decay due to Armillaria root disease, based on the examination of the two major roots of all trees in three fixed-radius plots. Scattered blowdown was common through the stand, partially due to root decay but also the consequence of a wet gravelly soil type which resulted in shallow root development. Further breakage was associated with the heart rot, Echinodontium tinctorium.

In a 32-ha private woodlot at Arrow Park, some sections had up to 25% of trees dead or infected by Phellinus root rot, including western larch and ponderosa pine.

In an approximately 12-year-old Douglas-fir plantation at Fitzstubbs Creek near Wilson Lake, 16 permanent plots were established in 1986 to moniter all pests, especially root rots. In 1988, three of 47 Douglas-fir (6%) were killed by A. ostoyae as compared to one confirmed infection in 1986. Overall root rot mortality (all species) increased from 1% in 1986 to 5% in 1988 (includes two alpine fir recently infected and killed). Root rot centers were noted throughout the plantation and results from the plots clearly show the destructive capability of A. ostoyae in young stands. Such a dramatic spread at this site indicates the potential development of large openings and substantial volume losses to rotation age.

During pre-harvest stand cruising or assessment, crews need to be alert to conditions that may indicate root rot problems such as thin or chlorotic crowns, distress cone crops, basal resinosis, windthrow or small pockets of dead trees. Specific surveys can then assess the extent of the problem and form the groundwork for remedial action following harvest.

Black army cutworm
Actebia fennica

Black army cutworm infestations continued in the Nelson Region in 1988. The main focus of the damage shifted to the Golden-McNaughton Lake area from the wildfires in the White River drainage system. High populations were present in numerous recently burned cutblocks in the Hunter Creek area, Marl Creek-Blackwater River to Bush Harbour area and at Redrock Harbour. Early- to mid-instar larval counts in the Blackwater River and Giby fire areas averaged 14 and three, respectively, per 1000-cm^2 duff sample. Pupal counts in late June had dropped to an average of less than 1 pupa per 1000-cm^2 sample in the Blackwater River area but remained at moderate levels at Redrock Harbour (8.5) and low at the Giby Fire (2.4). Starvation and parasitism of mid- to late-instar larvae appeared to have been a major factor in the reduction. During pupal counts, dead partially pupated larvae were common and suggested an energy reserve too low to complete pupation. Larval and pupal collections from the Blackwater River and Giby Fire areas were reared at Pacific Forestry Centre in Victoria with both having 25% emergence. Hymenopterous parasites were the most common (37%) from the Giby Fire population while the disease, *Beaveria bassiana*, infected 42% of the Blackwater River population.

Five recently planted, 1986-burned cutblocks were surveyed for seedling damage. The greatest damage was recorded at a Douglas-fir plantation near Bush Harbour, where 88% of the seedlings were totally stripped of foliage over most of the cutblock. At Redrock Harbour one 107-ha 1987 plantation had 45% of the Engelmann spruce seedlings 100% defoliated over 50% of the plantation, with the remaining seedlings 95% defoliated. Adventitious budding later refoliated most of the seedlings at most sites. In the Giby Fire area (1985), during the second year of the infestation, cutworm larvae totally defoliated 16% of the Douglas-fir seedlings. At this site, seedling quality was poor and natural mortality averaged 24% before cutworm feeding commenced. Properly planted, healthy seedlings are remarkably rugged and studies in pine and spruce have indicated that less than 10% mortality of totally defoliated seedlings that have been in the ground for one year prior to defoliation should be expected.

Pheromone trapping results further indicated a general decline in the cutworm population for 1989 (Table 16); however, several potential infestation areas remain, including cutblocks at Chatter Creek and in the Beaverfoot River drainage. Due to extensive black army cutworm trapping and research programs by BCFS and Forest Resource Development Agreement contracts in the area, the FIDS trapping schedule was reduced to minimize the possibility of different pheromones on the same cutblocks affecting research results, therefore precluding a more detailed prediction for 1989.

Table 16. Average number of black army cutworm moths caught in pheromone-baited traps and predicted hazards for 1989, Nelson Forest Region, 1988.

Location		No. moths per trap (1% concentration)[1] Average[2]	Range	Potential hazard levels, 1989
Golden TSA				
Chatter Cr.	CP 11-4/5	16	5-22	moderate
Beaverfoot R.	CP 87-2/4	12	5-28	moderate
	CP 24-1	11	5-15	moderate
	CP 70-1	7	3-12	low
Bush R.	CP 43-3	6	4-7	low
	CP 43-24/25	3	2-3	minimal
Cranbrook TSA				
Elk R.		3	1-4	minimal
Redding Cr. (km 32+/-)		1	0-3	nil
Revelstoke TSA [3]				
Redrock Harbour		3	1-5	minimal
Downie Cr.		2	1-5	minimal
Mica Dam		1	0-3	nil
Cariboo Cr.		1	0-3	nil

[1]Five sticky traps baited with 1% cis-7-dodecenyl and cis-11-tetradecenyl were used at each site.
[2]Previous infestations have developed only when trap counts averaged more than 10 moths per trap.
[3]Low numbers of Euxoa lewisi were present at these sites.

As well as Actebia fennica, the cutworm, Euxoa lewisi, and the tortricid, Cnephasia argentana, were common in traps. Although not reported as pests, other species of Euxoa have been noted to feed on seedlings elsewhere and a species of Cnephasia has caused severe defoliation to seed orchard seedlings on Vancouver Island.

While trap results generally predict minimal feeding damage in 1989, spring examinations prior to planting may be an essential step. Careful examination of duff for larvae, or feeding on emerging herbaceous material will provide indicators of cutworm populations.

Rhizina root disease
Rhizina undulata

Seedling mortality attributed to this root disease was found in general walk-through surveys in 11 cutblocks in the wetter portions of the Nelson Forest Region (Table 17). Where the fungus was present 15% of the seedlings were

killed, although generally only on the drier slopes and ridges of the cutblocks, possibly due to more intense burning in those portions of the blocks. When fruiting bodies were immediately adjacent to dying or dead seedlings, mortality was classified as Rhizina caused.

Table 17. Incidence of Rhizina root disease, Nelson Forest Region, 1988.

Location	No. cutblocks	Percent of seedlings infected	Percent of cutblock affected	Tree sp.
Chatter Cr.	2	4	100	pine
Bush R.	1	44	60	spruce
Beaverfoot R.	2	14	80	spruce/pine
Redding Cr.	2	33	25	spruce
Downie Cr.	1	15	100	spruce
Cariboo Cr.	1	6	100	Douglas-fir
S. Fosthall Cr.	1	2	100	larch/pine
Upper Koch Cr.	1	2	100	Douglas-fir
Redrock Harbour	1	0	-	spruce
Mica Dam	1	0	-	spruce

Although the fungus can cause extensive seedling damage in specific cutblocks when conditions are favorable, the only previous record of significant seedling mortality was in 1968/69 when primarily Douglas-fir seedlings were killed on the coast. The inoculum from the fungus persists as a saprophyte in most forested areas, especially in acidic soil types, but becomes a forestry problem only under ideal combinations of burn intensity, climatic conditions and other unknown factors. All known Rhizina epiphytotics in B.C. have followed wild fires or prescribed burns which increased spore germination while temporarily reducing competing organisms from the sites. Under most situations seedling mortality is confined to one year following the burn but it can persist at a reduced level into the second year. Based on these observations the 1989 infection levels should be greatly reduced. As a precaution, fill planting of openings created by seedling mortality should be delayed until 1990. Several management options have been developed in Europe where the fungus originating in burned areas continues to spread unchecked into adjacent unburned young stands. These include delay of burning for several years after logging, and soil treatment with lime to reduce acidity.

Pest of young stands

The following is a summary of the pests of young stands and where appropriate, the pests are discussed in greater detail by pest under specific hosts.

Armillaria root disease, Armillaria ostoyae, was the most serious disease problem in young stands and caused mortality of several coniferous species over several plantations including:

Fitzstubbs Creek	D-fir, alF	6%,50%
Mosquito Creek	lP,pP	3%,13%
Erie Creek	lP	5%
Fiva Creek	lP	1%
St. Mary River	eS	8%

In the Fitzstubbs Creek plantation, there was an expansion of the root rot of from 2 to 6% in planted Douglas-fir over two years and from 0 to 50% in naturally regenerated alpine fir over the same period. Continued activity will lead to large openings and substantial volume losses.

White pine blister rust, Cronartium ribicola, occurred in five of eight plantations wherever the host was found, killing or infecting from a low of 4% of the white pine at Mosquito Creek to 52% at Fitzstubbs Creek. At Fitzstubbs Creek, where healthy white pine were noted in root rot centers, the infection increased from 33% to 52% over two years which, unfortunately, precludes this species as an alternative in root rot-plagued plantations. The stem cankers, Comandra blister rust, Cronartium comandrae, and western gall rust, Endocronartium harknessii, were present at 5% levels in plantations at Blackwater River and Fiva Creek, respectively. Both cause growth loss, but the former is capable of rapidly spreading and killing trees.

Black bear, Ursus americanus, killed or severely scarred 34% of the lodgepole pine at an Erie Creek plantation causing substantial openings in the stand. This was, fortunately, an isolated condition not noted at other plantations assessed.

Spruce weevil, Pissodes strobi, infested spruce leaders in plantations at Quartz Creek (35%), Beaverfoot River (13%), Woolsey Creek (6%) and Blackwater River (3%). The spruce weevil was not found at four other Engelmann spruce plantations assessed; monitoring for this pest should continue as it can increase rapidly, causing volume loss and quality degrade. Lodgepole terminal weevil, Pissodes terminalis, killed an average 3% of the lodgepole pine leaders in four of seven stands at Spillimacheen, White and Beaverfoot rivers and at St Mary Lake.

Conifer-aspen rust, Melampsora medusae, moderately to severely infected current foliage on 100% of the Douglas-fir at Fitzstubbs Creek and Quartz Creek and 83% at Cariboo Creek. This needle disease could reduce photosynthetic capacity if infections continued for several years. Similarly, spruce needle rust, Chrysomyxa ledi, severely infected 30% of the Engelmann spruce in a plantation in the Beaverfoot River drainage.

Animal damage

Bears caused extensive damage in a 40-ha 10- to 12-year-old lodgepole pine plantation at Erie Creek. Bark-stripping mortality occurred on 10% of the trees with a further 25% of trees severely scarred. Activity was scattered throughout much of the plantation and occasionally in pockets causing substantial openings. In the Summs Creek area semimature alpine fir were also killed by bear activity but attack was very light and over several years.

Drought damage

Symptoms of drought damage were common on young lodgepole pine in the Boundary TSA, especially along Trapping Creek and near McKinney Creek. Early surveys in June indicated approximately 20% of saplings over 20 ha, usually in groups of 20-100, were severely browned at a Trapping Creek/Highway 33 site. Recently dead sapling-size pine were also common for 5 km along Trapping Creek Road. In the McKinney Creek area, 30-40% of 1-m high, naturally regenerated, lodgepole pine over 5 ha were severely browned. A secondary fungus, Sclerophoma pithyophila, was present. An inspection of this site in October revealed that 20% of previously browned young trees had developed green healthy terminals and a further 20% were only top-killed. Tree mortality was therefore reduced to less than 25% and was sufficiently scattered and initial stocking sufficiently high to minimize the effect at this site.

The drought stress and mortality was probably brought about by several seasons of below-normal precipitation in conjunction with coarse sandy rocky soils.

Acid rain monitoring

Annual monitoring of the Acid Rain National Early Warning System (ARNEWS) plot along Bulldog Road in the Blueberry-Paulson summit area of the Nelson Forest Region continued in 1988 to identify changes in vegetation and tree vigour possibly due to aerial pollutants or acidified precipitation. Assessment of plot trees, off-plot trees, regeneration in subplots and ground vegetation was done as part of the survey.

Discoloration identified as 'winter flecking' was common on older foliage of all Engelmann spruce plot trees; spruce gall adelgid, Adelges cooleyi, was also very common, including both old and current galls. The needle disease, Delphinella balsameae, and the needle blight, Isthmiella quadrispora, caused occasional very light needle browning of older foliage on alpine fir. The presence of these common pests had little effect on the trees and no other anomalies were found on plot trees, regeneration or ground vegetation. No evidence of pollution effects was noted. Further assessments will be done in 1989.

DECIDUOUS TREE PESTS

Forest tent caterpillar
Malacosoma disstria

The forest tent caterpillar moderately to severely defoliated approximately 1500 ha of primarily trembling aspen, but also black cottonwood, white birch, fruit trees and roadside shrubs in at least 24 infestations. This was a decrease from 7200 ha in 119 infestation in 1987. Defoliation to 100% of the foliage occurred in the Fort Steele and surrounding area. Additional small patches of lightly to moderately defoliated aspen extended from Wardner north along the Rocky Mountain Trench to the Golden and Blaeberry River areas. Moderate defoliation continued near Kitchener, Creston, along the Moyie River north of Yahk, and a new infestation was recorded near Hosmer.

Forest tent caterpillar collapsed in the West Kootenay in 1988, except at Ymir where spot moderate to severe defoliation occurred. Of the 7000 ha of infestation mapped in the West Kootenays in 1987, no areas remained with aerially visible defoliation. Only trace defoliation was noted where moderate to severe defoliation occurred the previous year and where egg mass surveys predicted continued moderate to severe defoliation.

Dramatic collapses caused by natural agents occur although no definitive causal relationship has been determined. At an infestation site near Castlegar, efforts to collect late-instar larvae for parasite rearings turned up only two specimens, both externally parasitized by flies of the family Tachinidae. An examination of egg masses from infestations at Rossland, Casino and Castlegar indicated an extremely thin froth layer common at all sites, exposing eggs to parasitism. A high level of egg parasitsm was noted but a relationship to the collapse could not be established.

Egg mass surveys at five sites during fall surveys to determine potential for future defoliation suggest continued and increased defoliation intensity in many 1988 infestation areas (Table 18).

Table 18. Location, average number of 1988 egg masses per tree and predicted defoliation of deciduous stands by forest tent caterpillar, Nelson Forest Region, 1988.

Location	Average[1] dbh (cm)	Average no. egg[2] masses/tree	Predicted defoliation
Hosmer	15	169	severe
Wardner	10	73	severe
Fort Steele	10	68	severe
Blaeberry	13	48	severe
Creston	4	5	moderate/severe

[1]No. egg masses by tree diameter that will cause complete defoliation

DBH	No. egg masses
2.5	2
5.0	5
7.5	9
10.0	11
12.5	14
15.0	19

[2]Three trees sampled per location, all new egg masses tallied per tree.

Pacific willow leaf beetle
Pyrrhalta decora carbo

Skeletonizing of primarily willow by the Pacific willow leaf beetle continued for the third consecutive year in the Revelstoke area. Including plantations, roadsides, clearcuts and powerline corridors, there was over 1000 ha

infested, similar to 1987. Damage was almost continuous from Revelstoke, including Mt. Revelstoke Park, to Mica Dam and expanded north to Redrock Harbour with total discoloration ranging from <10% to 90% of the trees and averaging about 50%. Moderate to severe roadside feeding damage was noted east along the Illecillewaet River to Jumping Creek. Moderate to severe foliage browning was common south of Revelstoke to Shelter Bay, from Galena Bay to Fauquier, and expanding southeast to Summit Lake. Light to moderate feeding damage was again noted in the Mosquito Creek drainage to South Fosthall Creek. In the Bush Arm area, moderately to severely skeletonized patches of roadside willow were common.

Infestations by this common skeletonizer are generally limited to skeletonizing of willow and to a lesser degree, black cottonwood, trembling aspen, alder and birch along roadsides and in clearcuts. No mortality has been recorded, no parasites were found from a mass-rearing of adults, and no predictive methodology has been developed for this pest although infestations have been reported to last from 2 to 10 years.

Birch leafminer
Lyonetia saliciella

For the fourteenth consecutive year, discoloration of birch stands was prominent in the northern half of the region. In the West Kootenay, 147 ha of moderate to severe defoliation in 17 widely scattered infestations were mapped during aerial and ground surveys. Infestations causing mainly moderate defoliation were noted along Duncan Lake and River as far north as Km 93 including some side drainages such as East, Giegerich and O'Brien creeks. Moderate foliar discoloration continued along Kaslo Creek from Keen Creek to Kaslo. Severe browning was recorded along the Illecillewaet River from Albert Canyon to Cougar Brook in Glacier National Park. In the East Kootenay, skeletonization of up to 75% of the foliage occurred along drainages in the Purcell Mountains from Gray Creek along Kootenay Lake and Horsethief Creek near Invermere north to the Golden, Donald and Glacier National Park area. At the latter area most of the birch in slide paths were severely discolored by late spring.

Despite chronic infestations in the same areas, no mortality, top-kill or dieback have been recorded.

Aspen defoliator

Trembling aspen was moderately to severely defoliated by an unidentified microlepidoptera over a more than 300-ha area in aspen groves of from 2- to 30-ha in the Greenwood area. Defoliation was first noted in a 3-ha patch near Boundary Falls in 1987 but no larvae were found. The pest is active early in the spring, is a wasteful feeder and shows a clear preference for upper crowns.

Efforts to rear larvae to adult stage to facilitate identification were unsuccessful. Surveys to assess damage and collect material for identification will continue in 1989.

Gypsy moth
Lymantria dispar

For the tenth consecutive year, no moths were caught in pheromone-baited traps placed at 35 locations in the region to detect possible gypsy moth incursions. Traps were distributed primarily in forested recreation areas in provincial and national parks and in areas adjacent to the Canada-USA border because of substantial increases in trap catches in Idaho. Approximately 300 traps were distributed province-wide by Forestry Canada-FIDS as part of an interagency cooperative program with Agriculture Canada (Plant Health). A total of 12 adult males were trapped this year including four near Kelowna and one near Sicamous. This program will continue in 1989.

OTHER NOTEWORTHY PESTS

A number of other pests which were common but currently not causing significant damage were also noted, including those capable of causing prominent damage or which to date have caused only minor damage in the region. New host records for several diseases are also listed.

Pest	Host[1]	Location	Remarks
Chionaspis pinifoliae pine needle scale	pP	Midway	Average 1% lower crown foliage, 90% of trees.
Coleosporium asterum western pine-aster rust	lP	Nancy Greene L. Jaffray	Average 5% infection on 100% of fringe regeneration over .1 ha.
Eucosma sonomana western pine shoot borer	pP	Christina L.	Light occasional attacks to leaders and laterals continue.
Chrysomyxa arctostaphyli spruce broom rust	eS	Enterprise Cr.	Occasional brooming in a number of areas in West Kootenay.
Chrysomyxa weirii spruce cushion rust	eS	Redding Cr.	Moderate to severe infection.
Phoma sp. dieback fungus	eS	Joker Cr.	New host record.
Pikonema alaskensis yellowheaded spruce sawfly	eS	Cariboo Cr.	Trace defoliation 12% of spruce in one plantation.
Rhizosphaera kalkhoffii spruce mottled needle cast	eS	Corbin Pass	New host record.

Pest	Host[1]	Location	Remarks
Stomiopeltis sp. flyspeck fungus	eS	Dago Cr.	4 saplings severely affected, new host record.
Adelges oregonensis woolly aphid	wL	Cedrus, Findlay creeks	Light to moderate defoliation.
Nectria sp. canker fungus	wL	S. Fosthall Cr.	New host record.
Phoma sp. dieback fungus	wL	S. Fosthall Cr.	New host record.
Pleospora sp. saprophyte	aL	Invermere	Common on spurs.
Sirodothis sp. bark fungus	wL	Rock Cr.	New host record.
Truncatella sp. seedling blight	wL	Nelson	New host record, on germinant in nursery.
Valsa abietis canker fungus	wL	S. Fosthall Cr.	New host record.
Maurodothina farriae sooty mould	gF	Nelway	Caused severe discoloration and needle loss to lower crowns over 3 ha.
Pleroneura sp. balsam shoot-boring sawfly	gF	East Arrow Cr., Rykerts	Mining 1% of the new shoots; first collection in 20 years.
Adelges tsugae hemlock woolly aphid	wH	Glacier N.P., Boundary Cr.	Severe on individual branches.
Neodiprion sp. hemlock sawfly	wH	Keen Cr.	Populations continue causing very light local defoliation, 4th consecutive year.
Pucciniastrum vaccinii hemlock-blueberry rust	wH	Revelstoke to Donald	Average 5% of foliage infected.
Semiothisa signaria unipunctaria conifer looper	wH	Goldstream Cr.	Common late looper north of Revelstoke.
Altica corni dogwood leaf beetle	red osier dogwood	Summit L.	Moderate defoliation over 0.2 ha.

Pest	Host[1]	Location	Remarks
Cryptomycina pteridis leaf parasite	bracken	Box L.	Common along roadsides.
Enargia decolor Aspen twoleaf tier	tA	Bridesville	Large population, damage minimal.
Eriocampa ovata woolly alder sawfly	Al	Castlegar	Common on alder in former tent caterpillar infestation area.
Fenusa dohrnii alder leaf miner	Al	Whiteswan L.	Light defoliation.
Gnomonia veneta anthracnose	oak	Revelstoke	New host record.
Gonioctena americana american aspen beetle	tA	Fruitvale	Moderate defoliation of fringe young trees over 0.1 ha.
Hyphantria cunea fall webworm	decid.	Christina L. to Grand Forks, Slocan Valley	Occasional colonies.
Malacosoma californicum pluviale western tent caterpillar	decid.	Nelson Region	Occasional colonies throughout.
Rhytisma arbuti tar spot	false azalea	Steamboat Mtn.	Severe infection.
Septoria alni alder leaf spot	Al	Nelson Region	Common throughout causing moderate to severe discoloration.
Tingidae lace bug	willow	Grand Forks	Discoloration of willow for 10 km along Granby R.
Venturia spp. poplar leaf and shoot blight	tA, bCo	Nelson Region	Common but light throughout host range.
Zotheca tranquilla viridulata	elder	West Kootenay	Variable defoliation and dieback continue through host range.

[1]pP-ponderosa pine, lP-lodgepole pine, eS-Engelmann spruce, wL-western larch, aL-alpine larch, gF-grand fir, wH-western hemlock, tA-trembling aspen, Al-alder, bCo-black cottonwood.