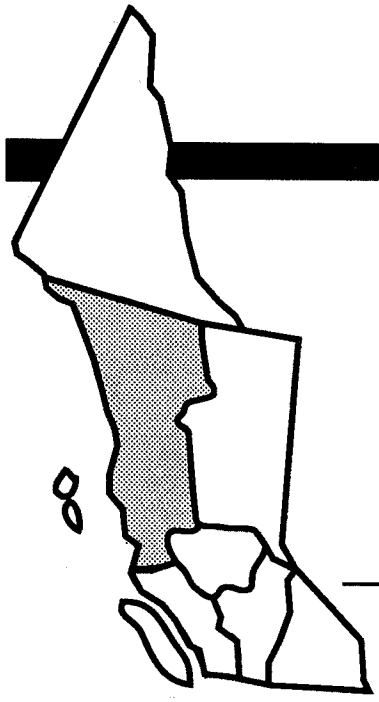
FIDS 89-5



Forest Insect and Disease Conditions

Prince Rupert 1988

R. Garbutt & A. Stewart

Forestry Canada Forêts Canada

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APPENDICES

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

I. Aerial survey maps of pests. Prince Rupert Forest Region, 1988.

II. Hylobius warreni in Prince Rupert Region - A Special Report. Prince Rupert Forest Region, 1988. R. Garbutt.

III. Rhizina root disease in B.C. (including Prince Rupert Forest Region)- A Pest Report. R. Garbutt.

IV. Pests of young stands survey data, Prince Rupert Forest Region, 1988.

V. Black army cutworm pheromone trap locations and results, Prince Rupert Forest Region, 1988.

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INTRODUCTION

This report outlines the status of forest pests surveyed in the Prince Rupert Region in 1988 and forecasts some of the pest population trends. Insects and diseases are discussed by host, generally in order of importance and often within the context of a management unit or Timber Supply Area (TSA). The Queen Charlotte Islands are surveyed by Forest Insect and Disease Survey (FIDS) rangers in the Prince Rupert Forest Region, but the information is now reported in the Vancouver Forest Region report.

FIDS is a national network within Forestry Canada with the responsibility of: (1) producing an overview of forest pest conditions and their implications, including predictions when possible; (2) maintaining records and surveys to support quarantines; (3) supporting forestry research with records, herbaria and insect collections; (4) providing advice and extension on forest insect and disease conditions; (5) developing and testing survey techniques; and (6) conducting related biological and impact studies. The co-operation of provincial, industrial, and municipal agencies is essential for the effective fulfillment of these mandates.

The 1988 field season extended from mid-May to late October. A total of 420 insect and disease collections were submitted by the authors to the Pacific Forestry Centre (PFC) for identification and verification (**Map 1**). An additional five collections were submitted from the northwestern limits of the region during the FIDS survey of the Yukon, and ten collections were received from B.C. Forest Service (BCFS) staff throughout the region. In cooperation with research programs at the Pacific Forestry Centre and other institutions, 20 special collections were made in 1988. Approximately 200 contacts and on-site pest examinations were made with the B.C. Forest Service and industry personnel during the field season. Pest survey data were summarized and presented to the BCFS and industry at the Regional Forest Pest Review meeting in November.

The co-operation and assistance of district and regional staff of the B.C. Forest Service with aerial sketch maps of bark beetle infestations in interior districts, and 27.9 hours of fixed-wing aerial time for FIDS to map pest problems, was greatly appreciated. Information and resources were also provided by industry personnel.

Throughout this report, intensities of aerially observed bark beetle mortality are defined as follows: light - 10% or less of stand recently killed; moderate - 11-30% of stand recently killed; severe - >30% of stand recently killed.

Within the report biogeoclimatic units are given in the abbreviated form to conserve space. In alphabetic order they are:

BWBSe - Boreal white and black spruce, cordilleran
CWHws1 - Coastal western hemlock, wet submaritime, submontane
CWHvm - Coastal western hemlock, wet maritime
ICHmc2 - Interior cedar-hemlock, moist cold, upper Nass Basin
ICHmc3 - Interior cedar-hemlock, moist cold, lower Nass Basin
ICHvc - Interior cedar-hemlock, very wet cold
SBSmc - Sub-boreal spruce, moist cold

In the text and tables the common names of trees are often abbreviated. In alphabetic order they are:

alF - alpine fir
bCo - black cottonwood
bS - black spruce
D-fir - Douglas-fir
dM - Douglas maple
lP - lodgepole pine
mAl - mountain alder
mH - mountain hemlock
rAl - red alder
sAl - Sitka alder
sS - Sitka spruce
tA - trembling aspen
wB - white birch
wrC - western red cedar
wH - western hemlock
wS - white spruce

The results of pest surveys in the Prince Rupert Forest Region have been reported by Forestry Canada since 1939. Field stations currently are located in Smithers and Terrace and from May to October correspondence can be directed to:

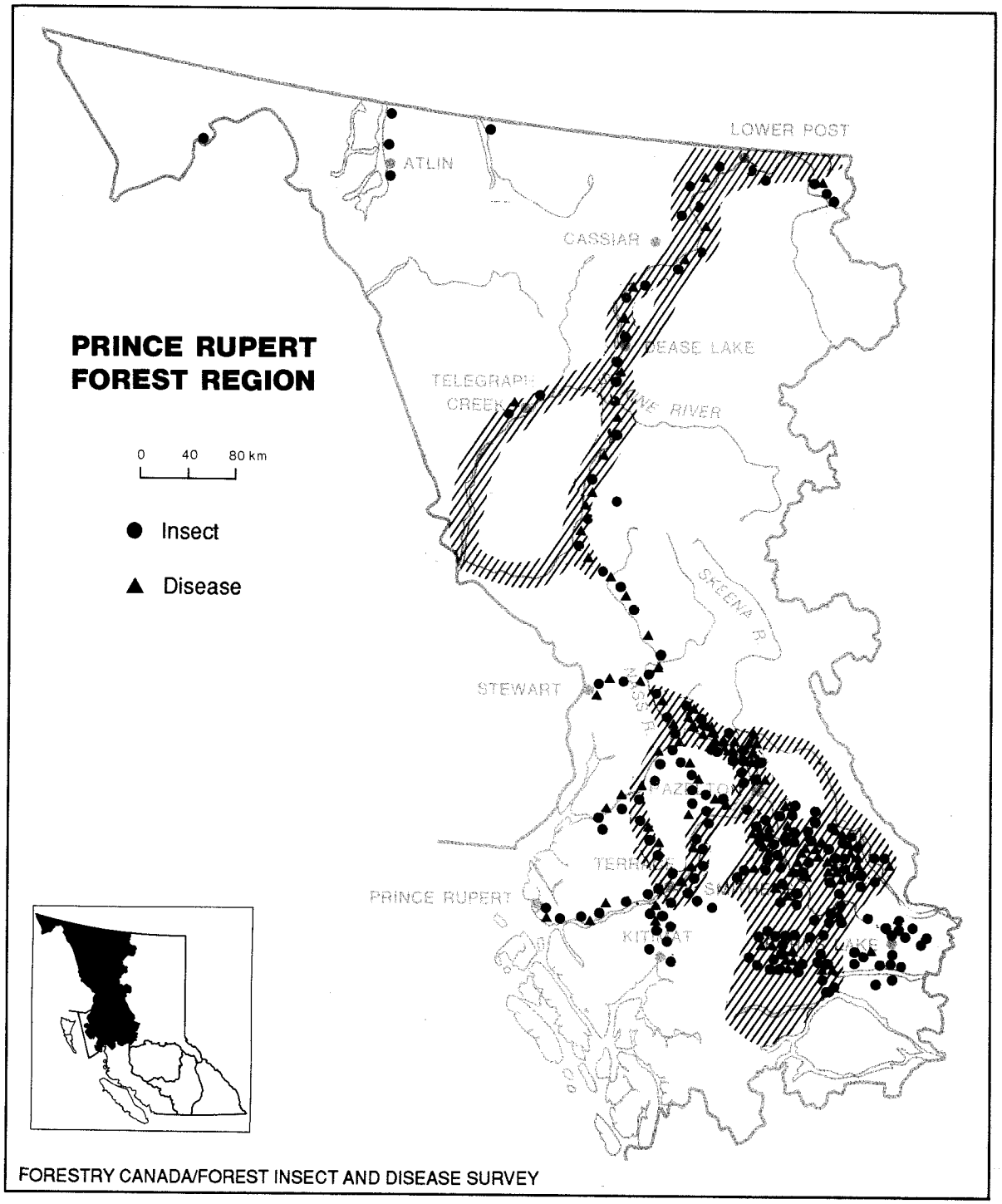
Forest Insect and Disease Survey
Box 2259
Smithers, B.C.
V0J 2N0 Ph. 847-3174

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

For the remainder of the year, FIDS rangers are located at the Forestry Canada headquarters for the Pacific and Yukon Region:

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

Additional copies of this report and copies of other publications such as provincial and national pest survey overviews, forest pest leaflets and regional forest pest histories can be obtained from the Forest Insect and Disease Survey at the above address.



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

Mountain pine beetle killed an estimated 768 400 m^3 of lodgepole pine over 13 060 ha, primarily in the Kispiox and Kalum TSAs. **Lodgepole pine beetle** in combination with **engraver beetles** killed an estimated 9000 lodgepole pine over 5870 ha adjacent to the 1982 Cot Fire in the Dease and Cottonwood river valleys in the third consecutive year of infestation. **Warren's root collar weevil** recently killed up to 15% and infested up to 90% of young lodgepole pine in five young stands near Hazelton. **Lodgepole terminal weevil** killed an average 10% of the leaders in four young stands in the interior of the region. **Pine needleminers** killed 30% of the current year's growth on 80% of the young trees in a large plantation near McBride Lake. **Pine needle sheathminer** killed 30% of the current growth in a young pine stand near Decker Lake in the third consecutive year of infestation. **Jack pine midge** caused significant crooking of latera and terminal shoots in three interior stands. **Lodgepole pine needle diseases** caused varying levels of damage to primarily northern stands. Five surveys in immature pine stands could detect no **tomentosus root rot**.

Surveys of **spruce weevil** in the western portion of the region refined the known distribution limits and identified areas of low, moderate and high hazard. **Spruce beetle** populations continued to decline throughout the region. Chronic infestation by **spruce gall adelgids** continued primarily in the western portion of the region. Generally light damage to current growth of white, Sitka, and hybrid spruces by **spruce budmoths** was widespread throughout the host ranges. **Spruce needle rusts** damaged current foliage of Sitka spruce near Prince Rupert and white spruce near the Yukon border. **Spruce needle cast** lightly to moderately defoliated current growth throughout the range of Sitka spruce. An outbreak of the **eastern spruce budworm** lightly to moderately defoliated white spruce in the northeastern corner of the region, an extension of an ongoing infestation in the Prince George Region.

Western balsam bark beetle killed an average 2% of alpine fir over 57 700 ha, primarily in the south central portion of the region. The **western blackheaded budworm** destroyed up to 80% of the current growth of alpine fir and white spruce over 58 000 ha in the Bulkley and Morice TSAs. **Fir-fireweed rust** infected current growth of alpine fir over broad areas in the wetter portions of the region causing light to moderate needle loss.

Larch sawfly populations declined, causing light defoliation to tamarack from north of Boya Lake to the Yukon border.

Up to 18% of lodgepole pine, Sitka spruce and white spruce seedlings were killed by **Rhizina root disease** in 10 separate plantations, primarily in the wetter areas of the region. Severe defoliation of white spruce seedlings by the **black army cutworm** was limited to less than one hectare in one of seven infested plantations. Light mortality to newly planted white spruce and lodgepole pine seedlings was attributed to a range of **seedling diseases**, one of which had never before been identified from either host.

Porcupine populations remained high throughout the region killing and deforming young western hemlock on the coast and all age classes of lodgepole pine in the interior. Populations of **snowshoe hare** have continued to increase and are expected to peak in 1990. Though greatly reduced from 1987, **vole**

feeding damaged up to 56% of the seedlings in Sitka spruce and lodgepole pine plantations in four western drainages.

A total of 520 ha of **blowdown** was mapped during aerial and ground surveys: 220 ha of lodgepole pine near Houston, and 300 ha of trembling aspen, west of Francois Lake. Light damage caused by **spring frosts** affected new growth in many species of conifer in young stands throughout the region. **Winter drying** caused dieback of 1987 growth of western hemlock and Sitka spruce saplings in two plantations near Terrace.

Pests of young stand surveys in primarily lodgepole pine plantations identified **Warren's root collar weevil**, **stem rusts**, and **western gall rust** to be the most damaging pests. Severe defoliation of trembling aspen by the **large aspen tortrix** and several other **leafrollers** was mapped over 3200 ha in the southern and eastern Cassiar TSA and west of Kitsumkalum Lake. No moths were caught in 42 **gypsy moth** traps placed in provincial parks, private campgrounds and port facilities throughout the region. **Cone and seed pests** were assessed at 58 locations throughout the region; **spiral spruce-cone borer** and a **spruce seedworm** remained the most important.

Important **chronic diseases** which vary little from year to year and are not usually surveyed, as well as **other noteworthy insects and diseases**, occurring at relatively low levels in 1988, are tabulated at the conclusion of the report.

PINE PESTS

Mountain pine beetle
Dendroctonus ponderosae

Lodgepole pine mortality decreased to 768 400 m^3 over 13 060 ha in 1988 from 869 000 m^3 over 18 400 ha in 1987 (Table 1, **Map 2**). As in prior years, the greatest concentrations of red trees were mapped in the Nass, Cranberry and Skeena river drainages, within a triangle drawn between Terrace, Hazelton and the south end of Meziadin Lake. Local concentrations were also mapped along the Telkwa River, and on hillsides adjacent to Coffin Lake. All other infestations within the region were small and scattered, containing from one to 300 trees, mainly in the Bulkley, Morice and Lakes TSAs. Totals reflect infestations mapped by FIDS with the exception of the Lakes TSA and the northeast corner of the Morice TSA, which were mapped by the B.C. Forest Service.

Table 1. Area, volume and number of lodgepole pine recently killed by mountain pine beetle, Prince Rupert Forest Region, 1988.

Location (TSA)	Area (ha)[1] light	moderate	severe	total	Volume (m^3)	No. of trees
Kalum	640	450	750	1 840	120 000	193 000
Kispiox	3 140	2 200	4 150	9 490	617 000	996 000
Bulkley	690	280	50	1 020	26 000	31 200
Morice	490	20	0	510	3 500	5 300
Lakes	200	0	0	200	1 900	2 800
Regional total	5 160	2 950	4 950	13 060	768 400	1 228 300

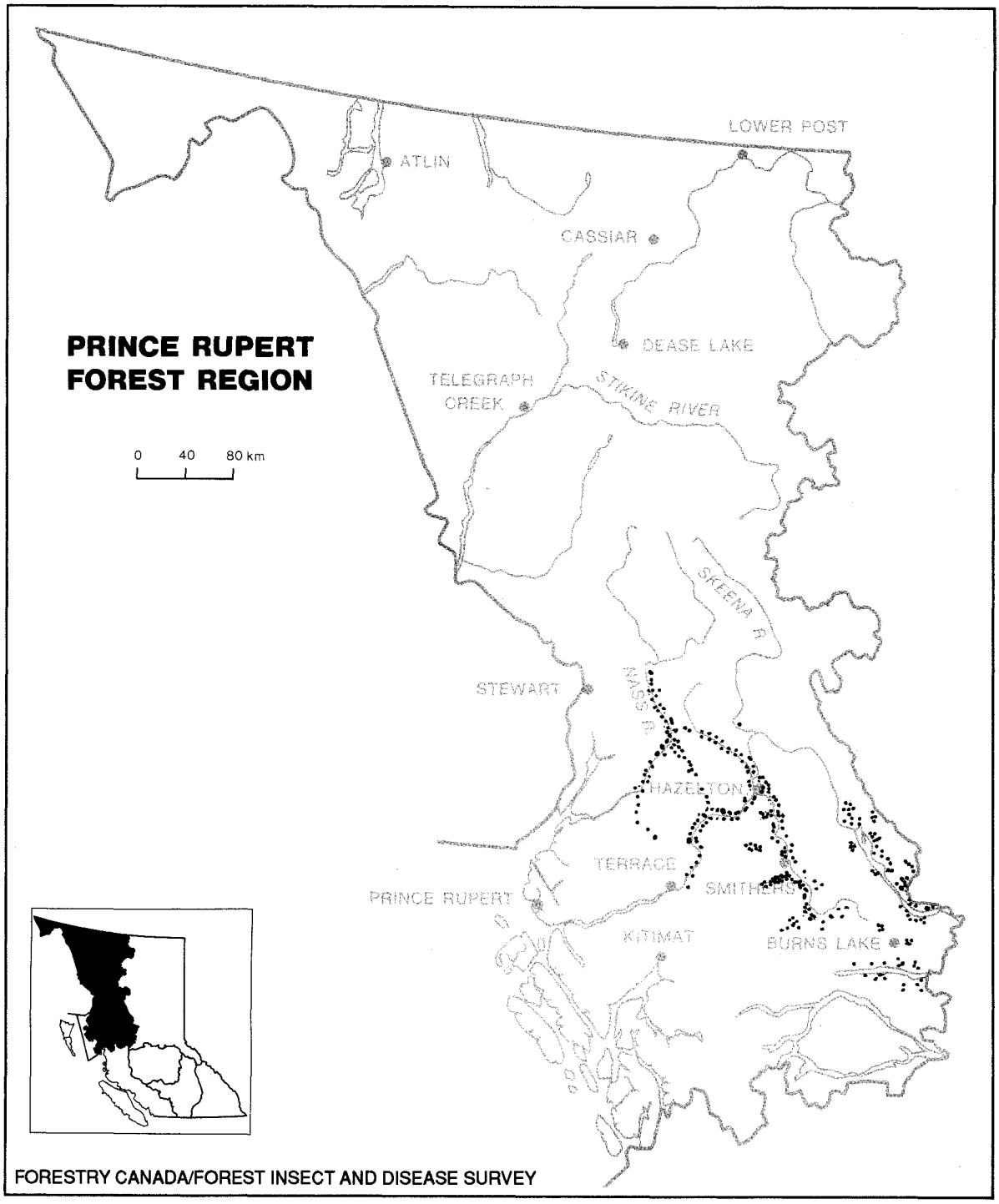
[1]Areas were computed from FIDS aerial survey sketch maps except for the Lakes and part of the Morice TSAs which were mapped by the B.C. Forest Service.

Kalum TSA

The area of infested timber declined to 1840 ha in 1988 from 3600 ha in 1987. Most of the decline occurred in the Skeena Valley from the effects of B.C. Forest Service winter fall-and-burn programs in the Terrace area, and from host depletion in mixed stands with a long history of attack towards the TSA boundary at Oliver Creek. The incidence of attack also declined in mixed stands in the lower Nass Valley except for a small local increase near the western limit of the Tseax lava flow.

Kispiox TSA

As in previous years the greatest volume of mortality was mapped within the recently extended boundary of the TSA, but infested area declined slightly to 9490 ha in 1988, from 11 100 ha in 1987. Some of the most severe and visible mortality continued along the north side of the Skeena River from Hazelton, southwest to the Kalum TSA boundary. Infestations in this area have continued



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

unabated since 1970, gradually eliminating the mature host from most stands. Reflecting the host depletion was the increased migration of beetles to the mixed pine-western hemlock-western red cedar stands on the steep north-facing slopes on the opposite side of the river, where 11 000 trees were killed this year near Carnaby and west of Kitseguecla Mountain. On the hillsides above New Hazelton about 30 small infestations contained 500 trees. North of Hazelton more than 80 groups ranging from 5 to 300 trees were scattered on both sides of the Kispiox River as far north as Corral Creek.

In the Nass Valley, the most extensive tree mortality occurred in mixed stands on slopes and ridges surrounding Cranberry Junction, and in valley bottom stands as far north as the Nass River Crossing. This occurred despite active logging and host depletion from infestations which have been ongoing since the early 1970s.

Bulkley TSA

The area of infested timber estimated during aerial surveys declined by a factor of three this year to 1020 ha from 3300 ha last year. The distribution of infestations has changed little from 1987, and the changes can largely be attributed to variations in aerial survey techniques between FIDS and the BCFS. Over 60% of total mortality was concentrated along the Telkwa River where over 21 000 red trees (19 000 m^3) were mapped, mainly on the hillsides along the west side of the river between Pine and Jonas creeks. Migration of beetles across to the east side of the river resulted in increased numbers of red trees in numerous smaller infestations, which are now almost continuous with well-established infestations, on the hills overlooking Coffin Lake (10 200 trees, 4700 m^3). This largely inaccessible hillside timber has been virtually written off in terms of potential timber supply. An aggressive MSMA treatment program was initiated by the BCFS to prevent brood migration from the hillside to the more valuable mature pine on the flats below.

Infestations on the steep slopes above Trout Creek declined to 400 trees, due largely to timely salvage logging. The risk of expansion remains, however, in valley bottom stands east and west of Kitseguecla Lake and south along the Kitseguecla River, where 30 small infestations (ranging from one to 50 trees) totalled over 400 trees. Numerous spot infestations totalling 250 trees persisted on the west side of the Bulkley River between Evelyn and Moricetown, and a further scattering of small infestations around McDonell Lake totalled 265 trees. Around Seymour Lake, just south of Smithers, eight infestations totalled 65 trees. On the east side of the river, 300 red trees were centered near Gramophone Creek.

Chronic infestations in the northern portion of the TSA continued to decline with only small sporadic infestations along Harold Price Creek and the upper Fulton River, and small concentrations totalling 300 trees on Holland Hill. Seventy-five infestations numbering between one and 30 trees each were scattered over a broad area along Nilkitkwa Lake, the upper Babine River and Nichyeskwa Creek.

Morice TSA

A total of 5300 trees were killed in 260 infestations over 510 ha. Here also the drop from reported losses of 25 000 trees in 1987 can be attributed

largely to aerial survey interpretation.

In the northern part of the TSA scattered mortality between Morrison and Babine lakes continued at reduced levels with mortality recorded over 200 ha in 60 infestations. Mortality along Hagan Arm (Babine Lake), Natowite and Tochcha lakes was similar to 1987, totalling 1800 trees, though contained in fewer more concentrated patches. The most significant increases within the TSA were near Skinhead Lakes just west of Granisle, where mortality increased from 50 to 1250 trees concentrated in seven infestation areas, many of which are as yet unaccessed.

Farther south, damage was limited to scattered small patches of mortality, most notably: Dockrill Creek, 145 trees; Emerson Creek, 60 trees; Morice River, 100 trees; Houston Tommy Creek, 170 trees; Buck Creek, 80 trees, and Aitken Creek, 90 trees. Smaller scattered pockets totalling 38 trees peppered stands on Mount Harry Davis and north of Bennett Lake.

Lakes TSA

Of the 1880 red trees tallied over 200 ha during BCFS aerial surveys, compared with an estimated 6000 trees over 100 ha in 1987, 30% (560 trees) were north of Babine Lake in 28 scattered patches ranging from one to 125 trees. Along the south shore of the Lake, an additional 22% (420 trees) in 26 patches ranged up to 60 trees per location. The remaining mortality was widespread within the central portion of the TSA with concentrations near Sheraton Creek, 160 trees, Binta Lake, 62 trees and along the north side of Francois Lake, 271 trees.

Overwintering survival

The regional average reproductive ratio, or "R" value, declined slightly to 4.5 in 1988 (Table 2) from 5.4 in 1987, but still indicated overall increasing populations. In the Nass and Skeena valleys, populations of the beetle in chronic infestations were limited by host availability and lower brood survival in smaller-diameter trees. Extensive logging and up to 20 years of infestations in the Cranberry Junction and Kitwanga-Cedarvale areas has also resulted in dispersion of beetles into less desirable higher-elevation stands and into mixed, younger stands to the west, reducing brood survival. Where suitable host trees were found, and broods were largely unaffected by parasites and predators, survival was usually very good, resulting in populations which, overall, were static to increasing.

Table 2. Mountain pine beetle overwintering survival, Prince Rupert Forest Region, 1988.

Location	"R" value[1]	Population status[2]	Remarks
Tochcha Lake	10.5	increasing	stand scheduled to be logged in summer 1988
Trout Creek	8.4	increasing	survival highly variable from 0-64 larvae per 225 cm^2
Coyote Creek	6.3	increasing	continuing buildup in new stands near chronic outbreaks
Cranberry Junction	5.8	increasing	extensive host depletion, good survival in remaining trees
Sideslip Lake	5.2	increasing	good brood survival in area north of chronic infestation
Telkwa Road	5.0	increasing	moderate-heavy woodpeckering, progeny development variable but vigorous
Kitwanga	4.3	increasing	chronic infestation area, surviving broods vigorous
Oliver Creek	3.8	static	limited host availability, low survival in smaller trees
Toboggan Creek	3.8	static	some Ips + partial attacks, some woodpeckering
New Aiyansh	3.3	static	limited host availability, low survival in smaller trees
Corral Creek	3.2	static	some Ips sp. attacks, attacks light in area
Cedarvale	2.5	decreasing	limited hosts, woodpeckering and parasitism common
Kwinatahl River	1.6	decreasing	limited hosts, low survival in smaller trees
Telkwa-Morice Road	1.0	decreasing	some Ips sp. in trees, only 5 trees available
Usk	0.5	decreasing	limited hosts, low survival in smaller trees
Regional average	4.5		

[1]"R" value = an average ratio of the numbers of counted brood in 225 cm^2 bark samples vs. the number of beetle entrance holes.

[2]Interpretation of "R" values:

≤ 2.5 - decreasing population
2.6-4.0 - static population
≥ 4.1 - increasing population

Fall Surveys

Six stands in the region were cruised to determine current and previous attack levels in terms of the proportions of both volume and numbers of trees affected (Table 3). The average volume of current attack declined to 14% from 42% in 1987, and 36% in 1986, due to a combination of host depletion, predation, lower brood survival and weather-induced lengthening of the life cycle.

Table 3. Status of lodgepole pine in representative stands infested by mountain pine beetle, determined from fall prism cruises, Prince Rupert Forest Region, 1988.

	Percentages of attacks (volume and number of trees)									
	Healthy		Current		Partial		Red		Grey	
Location	vol.	trees	vol.	trees	vol.	trees	vol.	trees	vol.	trees
Cedarvale	31	45	13	13	4	3	22	17	31	22
Kitwanga	54	70	10	8	3	2	28	17	5	4
Cranberry Junction	71	78	9	10	0	0	20	12	0	0
Sideslip Lake	35	59	36	25	3	3	27	14	0	0
Telkwa River	69	80	3	4	-	-	24	14	3	3
Trout Creek	48	51	15	21	5	4	28	20	5	4
Regional average	51	64	14	13	2	2	25	16	7	6

In the Kispiox and Kalum TSAs, ratios of current to red attack (C/R ratios) in chronic infestations near Cranberry Junction and in the Kitwanga-Cedarvale area averaged 0.7:1 based on numbers of trees, indicating a decline in the proportions of stands attacked in these areas, probably due to host depletion. In the same areas, the C/R ratio in terms of volume was 0.5:1, indicating that remaining beetles were attacking smaller trees, which could result in lower brood survival. In stands north of Cranberry Junction near Sideslip Lake, the C/R ratios were 1.8:1 (tree numbers) and 1.3:1 (volume), indicating that, though smaller trees were attacked, infestations should continue to intensify in 1989.

Cruises in the Telkwa River and Trout Creek infestations found C/R ratios of 0.2:1 and 0.6:1, respectively. Preliminary BCFS probes in the Bulkley TSA indicate an average C/R ratio of 0.6:1, significantly reduced from an average of 8:1 recorded in five cruises in 1987. The cool moist weather conditions which prevailed throughout the maturation period were largely responsible for reduced attacks, particularly in the Bulkley TSA. An average 25% of surviving brood remained in red trees as pupae or teneral adults and will emerge in the spring of 1989. The cool weather also resulted in a delayed and ill-defined flight period, with beetles unable to mount the concentrated attacks necessary to overcome natural tree defenses. This was evident from the great variation in progress toward gallery excavation and brood establishment between and within trees, in October. Woodpeckers had also contributed to brood reductions in most areas. Under the bark, predators such as Clerid beetles were prevalent in cruised stands and an estimated 5% of all broods had been killed in the pupal

stage by infections of the fungus Beauveria bassiana. Much of the holdover brood in 1987-attacked trees will likely succumb to one of the above factors before increasing spring temperatures allow for resumed flights in 1989.

In the southern Morice TSA, the average C/R ratio of 1.2:1 indicated slightly increased populations. Limited information was available from northern stands, but a single BCFS probe near Wright Bay on the east side of Babine Lake found a C/R ratio of only 0.3:1.

In the Lakes TSA, a 1.5:1 C/R ratio was the highest for interior stands but was still much reduced from the 1987 average of 4:1.

Forecasts

Observations and surveys from 1988 indicated that in the Kispiox and Kalum TSAs, beetle populations will remain static or increase in most areas; however, the availability of susceptible hosts is a limiting factor. Accordingly, older infestations in the Cranberry Junction and Kitwanga-Cedarvale areas should continue to decline with most attacks restricted to valley bottom stands north of Cranberry Junction, and less desirable higher elevation stands on ridges and benches. Infestations should continue to decline in mixed younger stands to the west of chronic outbreaks in the lower Skeena and Nass valleys. Declines are also expected in almost all infested areas east of Hazelton with the possible exception of the Lakes TSA where current attacks outnumbered reds. The effects of natural controls and aggressive cut-and-burn programs in the Bulkley and Morice TSAs will combine to decrease populations by as much as 50% in 1989.

Lodgepole pine beetle
Dendroctonus murrayanae

About 9000 mature lodgepole pine over 5780 ha in the Cassiar TSA were recently killed due to attacks by the lodgepole pine beetle at the root collar, and the pine engraver, Ips pini, in the bole. The incidence of mortality was greatest near recent large forest fires, particularly west of the Cot Fire, where a patch of moderate attack within 2 km of the fire-edge decreased to a light incidence of individual or small groups of red trees in the Dease and Cottonwood river valleys. Small numbers of scattered red trees were also mapped west of the Eg Fire, east of the Hyland River. Both fires burned in 1982. The bark beetle populations increased in scorched and dying trees before dispersing into the healthy trees which have been observed dying (red stage) since 1986.

Warren's root collar weevil
Hylobius warreni

Increased populations of Warren's root collar weevil infested an average of 76% of the 4- to 20-year-old lodgepole pine in five stands in the ICHmc3 biogeoclimatic zone near Hazelton (Table 4). Although these are some of the highest infestation levels recorded in young stands in B.C., tree mortality in 1988 averaged only 5%.

In a 13-year-old plantation near Kispiox all of the 28 trees randomly selected for examination were infested; 20% were completely girdled by larval feeding. The freshness of pitch exudate at the root collar and the absence of

visible symptoms of stress in the trees suggests a recent rapid rise in weevil populations at this site.

Despite the high infestation levels, tree mortality in the five stands averaged only 5% (range 1-15%), the highest occurring in a 4-year-old plantation on the Salmon Road just north of Hazelton. Unlike other stands, this site was not burned prior to planting but was mechanically prepared using a 'V-plow', a treatment thought to provide some protection from weevil attack. The small diameter (2-3 cm) of the young trees made them susceptible to girdling by only one larva, and aggravating this condition was initial growth suppression caused by root binding, a common problem of plug-planted pine.

Table 4. Status of five young stands infested by Warren's root collar weevil, Hylobius warreni, Prince Rupert Forest Region, 1988.

Location	Age	Percent trees infested	Percent girdling[1]	Percent 1988 mortality	Study
Km 9 Date Creek	13	100	62	1	- growth loss and mortality plot 28 trees - screefing[2] and pruning 57 trees
Km 1 Babine Slide Rd.	4	60[3]		15	- no formal study but stand is being closely monitored by BCFS and Forestry Canada
Km 13 Kitseguecla Lake Rd.	20	80	63	2	- screefing and pruning 30 trees
Km 8 Telkwa Hi-Rd.	15	75	28	2	- growth loss and mortality 26 trees
Km 6 Collins Lake Rd.	18	64	43	5	- growth loss and mortality 22 trees

[1]Infested trees only - defined as the percent of the circumference at the root collar coated with exuded pitch.

[2]Screefing involved the removal of duff for a radius of 30 cm around the circumference of the tree. In the eastern U.S. screefing effectively protected trees from attack by H. radicis (a species closely related to H. warreni) for at least six years (L. Wilson, 1967, Journal of Economic Entomology, 5 pp.)

[3]Does not include recent mortality.

Two long-term studies were initiated in the region in the summer of 1988: the first to measure mortality and growth reduction due to weevil feeding (four areas); and the second to test the effects of stand treatments on weevil survival and as protection against future attacks (two areas). In each study the degree of girdling was used as the measure of damage, and changes in diameter breast height (dbh) for growth. Uninfested trees, where available, were included as controls. The second study, in co-operation with the B.C. Forest Service, will test screefing and pruning as means of controlling existing populations, and preventing new attacks in uninfested trees.

Farther east, weevils had killed approximately 1% of the trees in two young pine stands near Maxan Lake in the Lakes TSA. Surveys in both stands, one naturally regenerated (logged in 1978) and the other planted in 1976, determined 5% of all trees in both areas to be currently infested. Most infested trees could be easily recognized by their reduced leader growth. At km 5 of the West Palling Road north of Decker Lake, 55% of the pine, planted in 1973, had been infested (avg. 20% circumference girdled), but in 80% of the affected trees there was no evidence of recent larval feeding.

Larvae of H. warreni feed on the cambial tissue at the root collar of host conifers. Lodgepole pine is the preferred host, but other pines as well as spruces, true firs, and larches are also attacked. Larvae normally live for two years, boring around the circumference of the tree, before pupating in sealed pitch chambers. In addition to disrupting the flow of water and nutrients within the tree, larval feeding provides entrance courts for root rots and other fungi. Adults live up to five years and during that time can lay as many as 40 eggs in bark niches or in the duff. Adults feed on the bark of young roots, twigs, and needles, but cause no significant damage.

In B.C., little operational control of the weevil has been attempted because losses to the insect have remained within acceptable limits. On the basis of damage recorded in 1988 and the apparent health of weevil populations, mortality may increase significantly within the next few years.

Additional surveys are planned to determine the distribution and extent of damage in this coast transition biogeoclimatic zone and elsewhere in the region. All study areas will be revisited in 1989 to measure the continuing effects of weevil feeding on growth loss and mortality, and to evaluate the effectiveness of control techniques.

Lodgepole terminal weevil
Pissodes terminalis

Terminal weevil damage was widespread but sporadic and generally light within the region in 1988. Only four surveyed young stands in the interior contained significant levels of attack, averaging 10% (Table 5), compared with 20% in seven stands in 1987.

Table 5. Incidence of damage by lodgepole terminal weevil and prediction of 1989 populations, Prince Rupert Forest Region, 1988.

Location	Percent terminals attacked	Average number progeny[1]	Relative 1989 populations
Kitseguecla L.	18	1.00	increasing
Km 65 Morice L. Rd.	5	0.60	static
Km 8 Gloyazikut Cr. Rd.	6	2.06	increasing
McKilligan L.	12	1.67	increasing
Average	10	1.33	increasing

[1]Counts of numbers of exit holes and teneral adults in each terminal. Previous studies within the region have found that populations increased above 0.62 progeny per terminal (FIDS Report 88-5)

The decrease in populations in 1988 was partially due to parasites which in 1987 killed up to 65% of the broods and resulted in an average of only 0.2 progeny per leader. This year parasitism was much reduced, affecting less than 10% of the developing progeny.

The terminals of approximately 30% of the leaders at both Kitseguecla Lake and McKilligan Creek were killed before significant terminal elongation had occurred, indicating a late flush or early weevil attack. The cool late spring weather had likely delayed shoot elongation and shoots were girdled by second-instar larvae, which spiral upward in the cambium. Single exit holes or single pupae were found in most of these tufted terminals.

Though population assessments were made in July after the weevil would normally have matured and left the terminals, because of the cool summer weather, half of the progeny remained as pupae or teneral adults. These adverse conditions, however, were offset by a prolonged mild fall and populations are expected to increase slightly in 1989.

Pine needleminer
Coleotechnites sp.

Needleminers infested an average of 30% of the current year's needles on 80% of the lodgepole pine in a 15-year-old plantation near McBride Lake, southwest of Houston. In addition to laterals, 56% of the terminals were infested. No evidence was seen of any prior attacks though light damage was reported in the same plantation in 1983. Between 1979 and 1983, needleminers killed 25% of the terminals in a young pine stand along the Topley Landing Road, the most severe damage reported within the region.

Coleotechnites is a chronic pest of all ages of lodgepole pine, often causing top and branch dieback following successive years of attack. It has caused extensive tree mortality in the United States but only occasional light mortality has been reported in B.C. in the Rocky Mountains. Temperature seems to be the major factor limiting needleminer populations. Severe larval mortality has resulted from a few days of sustained -40°C temperatures. Barring this, attacks are expected to recur in 1989.

Pine needle sheathminer
Zelleria haimbachi

Damage characteristic of that caused by sheathminers killed 30% of the current year's needles on all lodgepole pine in a 15-year-old plantation near Decker Lake, examined in September. Attacks had occurred early in the season during shoot elongation and affected needles on the lower half of laterals and terminals only. An almost identical pattern of needle loss had occurred in 1986 and 1987. The effect was striking with three symmetrical whorls of healthy needles alternating with equal lengths of bare branch.

Despite the three successive years of defoliation, growth losses were minimal and will remain so unless attacks intensify in the future. An early season evaluation in 1989 will confirm identification of the insect, and provide information on the health of the population.

Jack pine midge
Cecidomyia piniinopsis

Pitch midges attacked branch and terminal shoots on 80% of the 8-year-old lodgepole pine in a plantation on the North Owen Forest Road, south of Houston. Many trees sustained two or more attacks to lateral shoots, while 10% of the leaders were also attacked. Single branches were attacked on 5 and 10% of the young pine, respectively, at Elizabeth Lake north of Kispiox and near Knockholt, east of Houston.

Attacks result in formation of characteristic crooks in the young shoots. Repeated attacks cause malformation and stunting of growth. Locally, damage is limited to the occasional death of new shoots and the formation of branch crooks, which are subsequently prone to breakage under load.

Pine needle casts
Lophodermella spp.

Foliar diseases of lodgepole pine were collected in northern areas of the region in 1988. A pine needle cast, *Lophodermella montivaga*, heavily infected the current growth of lodgepole pine in patches from the Mud Hill area to the Yukon border. Another pine needle cast, *L. concolor*, lightly infected the older (1987) foliage of lodgepole pine in the Cormier Creek area. Infections by these needle casts are only significant if severe in intensity, and repeated in successive years.

Tomentosus root rot
Inonotus tomentosus

The discovery of tomentosus root rot infecting young lodgepole pine stands in recent years prompted further surveys in 1988 to determine the distribution and intensity of the disease within naturally regenerated stands in the Bulkley and Morice TSAs. Five stands, with average ages ranging from 38 to 62 years, were sampled. All sample trees were cut at ground level. Disks were removed from any trees suspected of harboring the disease and sent to the PFC herbarium for culturing. No root rot was found in any of the samples. Further surveys are planned in 1989.

Pinewood nematode
Bursaphelenchus xylophilus

Following five years of intensive sampling for evidence of nematode damage in the forest, the pinewood nematode program was scaled down in 1988 to the collection of woodborers (suspected nematode vectors). Of 117 wood and vector samples collected prior to 1988, *B. xylophilus* was isolated from only two, and there has been no evidence that it is pathogenic in its native habitat. Three collections of woodborers submitted in 1988 have not yet been fully evaluated.

The perceived risk of introduction of *B. xylophilus* into European forests has threatened the export of green wood products from North America. Though the threat of embargo remains, the program has demonstrated convincingly that, at least in the forests of British Columbia, the nematode lacks the virulence that it has demonstrated in the pine forests of Japan.

SPRUCE PESTS

Spruce weevil
Pissodes strobi

The spruce weevil is a chronic pest of young stands in several southern areas of the region and is of particular concern in hybrid Sitka and white spruce planted extensively in the Kitimat, Skeena, and Nass river drainages. Infested trees generally lose two years of height growth with each successful attack. The incidence of current attack in 1988 averaged 31%, 19% and 3% at locations assessed in the Kitimat, Skeena and Nass river drainages, respectively (Table 6). Proximity of a young stand to a watercourse again appeared to affect the incidence of attack, varying within the general hazard of spruce weevil attack in the area.

Table 6. Surveys of the incidence of current attack by the spruce weevil in sapling-aged stands of Sitka spruce and hybrid Sitka X white spruce in the Kitimat, Skeena, and Nass river drainages, Prince Rupert Forest Region, 1988.

Location	Stand age	No. trees assessed	Current weevil attack (%)	Watercourse proximity (m) elevation above	Watercourse proximity (m) distance from
Kitimat River drainage					
Kitimat River, km 6 north mainline	15	43	44	5	100
Hirsch Creek, near highway crossing	15	168	31	5	25
5 km NW Kitimat	14	100	41	20	100
Little Wedeene River	9	63	6	20	60
Skeena River drainage					
1 km. S. Lakelse	10	54	7	10	1000
0.5 km E. Lakelse	13	83	28	5	500
Terrace Townsite	15	60	27	10	500
Zymacord River	12	68	38	5	50
Kalum Forest Road km 3	18	37	14	15	50
Kitsumkalum Mountain	25	26	15	50	500
Kalum Forest Road km 22	20	49	20	50	300
Nelson River	14	39	23	5	25
Mayo Creek	15	30	7	10	100
Kitsumkalum River Beaver Flats	13	210	28	5	50
Cedar River	18	32	19	10	50
Copper River Road km 20	15	110	27	5	50
Skeena River, 32 km NE Terrace	11	114	26	5	80
Cedarvale	13	42	5	10	100
Kitwanga	10	21	5	10	100
Nass River drainage					
1 km W. Dragon Lake	14	101	5	10	1000
Hoodoo Forest Road	10	80	0	200	9000

Of particular concern are extensive stands of spruce regeneration recently planted throughout the Hanna Ridge and Bell-Irving Valley areas, just north of the current limit of weevil distribution near Meziadin Lake, and spruce plantations in rehabilitated brushed-over sites in the lower Skeena Valley, west of the current limit of weevil distribution in the Exchamsiks River-Salvus area.

With reference to biogeoclimatic zones, areas with moderate to severe levels of current weevil attack (more than 10%) occurred exclusively in the coastal western hemlock zone (CWH), mostly in the "wet submaritime" (ws) subzone with minor extensions into the "very wet maritime" (vm) subzone in the lower Skeena and Kitimat valleys. The incidence of current attack has remained below 10% within the distribution of the weevil in the Interior Cedar Hemlock (ICH) zone, and consistently less than 5% in the "very wet cold" (vc) subzone at the northern distribution limit near Meziadin Lake.

Spruce beetle
Dendroctonus rufipennis

Spruce beetle populations continued to decline within the region after killing over 6 000 000 m^3 of white spruce in the ten years prior to 1987. No mortality was mapped during aerial surveys. In a single small infestation beside the North Owen Road in the Morice TSA, three trees were killed by attacks in 1987 and an additional seven were partially attacked. About 80% of the beetles responded to mild winter conditions and cycled in one year instead of the normal two. Much of the emerging brood reattacked the partials while the remainder was attracted to local pheromone-baited trees. All trees were scheduled for removal during the summer.

In the Cassiar TSA, the spruce beetle population remains active in the Haines Road area near the B.C.-Alaska border where windthrown trees contained healthy brood. Active adults were also collected in lethal trap trees treated and felled by the BCFS. Early sanitation of infested trees could minimize a potentially serious problem in adjacent mature spruce stands. A previous infestation in the area was controlled in a program carried out by FIDS and Public Works Canada in 1983.

Most of the remaining populations of spruce beetle within the region will be maintained at near endemic levels in slash and windthrow. This will probably continue until a major storm blows down significant volumes of inaccessible spruce providing the beetle with a means to successfully multiply, and subsequently attack healthy timber. Right-of-way clearing for road construction and logging have, until recent years, been significant factors in causing or aggravating beetle outbreaks. Recent increases in hazard awareness have led to more effective methods for disposal of potential breeding material.

Spruce beetle populations are expected to remain low in 1989.

Spruce gall adelgids
Pineus spp.

Chronic infestations by spruce gall adelgids continued throughout the region, most commonly in young stands of hybrid Sitka X white spruce planted in the Terrace and Kitimat areas (Table 7). As the genus *Pineus* requires revision, identification to the species level is not possible. Spruce gall adelgids in the region were previously known as *P. pinifoliae* and *P. similis*.

Table 7. Incidence and intensity of gall formation by spruce gall adelgids, Pineus spp., on the current growth of hybrid Sitka X white spruce in plantations, Prince Rupert Forest Region, 1988.

Location	Stand age (yrs)	Percent of trees infested	Intensity: Percent of infested trees[1] Light	Moderate	Severe
Annual assessments					
Skeena R.	13	12	100	0	0
Copper R.	12	40	100	0	0
Zymacord R.	10	0	-	-	-
Kalum L.	12	44	100	0	0
Coldwater Rd.	14	53	88	12	0
Branch 77 Rd.	11	60	93	7	0
Wedeene R.	8	48	100	0	0
Nahlbeelah Cr.	11	0	-	-	-
Regional average 1988	11	32	97	3	0
1987	10	46	90	8	2
1986	11	50	78	16	6
New assessments					
Little Wedeene R.	1	11	0	50	50
NW Lakelse	1	32	50	50	0
Coldwater Rd.	2	69	73	16	11

[1]Categories of intensity used in the survey:
Light - <10% of tips infested/tree
Moderate - 10-30% of tips infested/tree
Severe - >30% of tips infested/tree

A declining trend has emerged in sapling-aged stands after three years of monitoring the incidence and intensity of infestations in eight areas. Further surveys will clarify annual variations in gall adelgid activity and provide a base to evaluate longer-term changes, particularly as the availability of hosts increases in extensive new plantations.

In addition to the annual assessments of sapling-aged stands, surveys of three new plantations in the Kitimat Valley revealed that an average of 37% of the seedlings were infested by gall adelgids (Table 7). Due to the relatively low number of new shoots on seedlings, the intensity of infestation was high compared to saplings in the area. These surveys reveal the speed with which new plantations can be infested by spruce gall adelgids in the Kitimat Valley.

The impact of feeding and gall formation in young stands has not been quantified but is usually low because only a portion of the current growth is affected. However, consecutive years of moderate or severe infestation cause

noticeable thinning of the foliage, particularly when combined with additional stresses such as frost damage or infestation by spruce budmoths.

Spruce budmoths
Epinotia radicana
Zeiraphera spp.

Defoliation of expanding shoots on an average of 72% (range 48-100%) of Sitka and hybrid Sitka X white spruces, in young stands in the southwestern portion of the region, was caused by the larvae of spruce budmoths, Epinotia radicana (previously known as Zeiraphera radicana) and Z. canadensis. A needleminer, Coleotechnites sp., was found associated with light budmoth feeding damage near Hazelton and Houston.

After three years of monitoring these insects in the same areas the incidence and intensity of defoliation has remained fairly constant, particularly over the last two years (Table 8). Further monitoring will reveal if any longer trends exist, particularly as the availability of hosts increases in extensive new plantations.

Table 8. Incidence and intensity of feeding on flushing buds of Sitka and hybrid Sitka X white spruce in young stands by spruce budmoths, Epinotia radicana and Zeiraphera canadensis, Prince Rupert Forest Region, 1988.

Location		Stand age (years)	Infestation incidence (%)	Intensity: Percent of infested trees[1] Light	Moderate	Severe
Skeena R.		13	100	93	8	0
Copper R.		12	76	95	5	0
Zymacord Rd.		10	48	100	0	0
Exstew Rd.		9	52	100	0	0
Kwinitsa Valley		7	52	100	0	0
Work Channel Rd.		11	84	100	0	0
Prudhomme L.		15	96	54	33	13
Kitsumkalum L.		12	72	100	0	0
Coldwater Rd.		14	84	95	5	0
Branch 77 Rd.		11	96	92	8	0
Wedeene R.		8	48	100	0	0
Nalbeelah Cr.		11	64	100	0	0
Kitimat		10	68	100	0	0
Regional average	1988	11	72	94	5	1
	1987	10	72	98	2	0
	1986	11	80	71	24	5

[1]Categories of intensity used in the survey:
Light : <10% of buds infested/tree
Moderate: 10-30% of buds infested/tree
Severe : >30% of buds infested/tree

In the northern half of the region, the purple striped shootworm, Z. unfortunana, was common in planted and natural stands of white spruce, generally at light to moderate intensity. In the Hyland River area, the intensity of feeding increased to moderate-severe levels in the current growth of all age classes of white spruce.

In the Morice River area of the Morice TSA, Z. unfortunana larvae were consistently collected along with the western blackheaded budworm and were responsible for between 5 and 10% of the defoliation to white spruce and alpine fir, attributed to the latter pest (also see western blackheaded budworm section). Zeiraphera spp. larvae also consumed an average of 5% of the current growth within a limited area near km 20 of the Salmon River Road north of Hazelton, and km 6 of the McKilligan Lake Road east of Houston.

The impact of feeding on the flushing spruce buds is usually minimal at current levels and becomes less significant as the shoot reaches its full length. However, consecutive years of moderate or severe infestation cause noticeable thinning of the foliage, particularly if combined with one or more additional stresses such as drought, frost damage, or infestation by gall adelgids, Pineus spp.

Spruce needle diseases
Chrysomyxa spp.
Lirula macrospora

Recent wet years have favored the development of foliar diseases, particularly in northern and western portions of the region. Infections on up to 30% of current needles by the small-spored spruce-Labrador tea rust, Chrysomyxa ledi, were widespread on white spruce from the Tanzilla River area to the Yukon border. Large-spored spruce-Labrador tea rust, Chrysomyxa ledicola, infected up to 100% and 10% of the current growth of Sitka spruce in boggy sites near Lachmach Road and Diana Lake, respectively.

A needle cast, Lirula macrospora, caused the characteristic dieback of two-year-old needles at 5% to 30% intensity throughout the range of Sitka spruce in the region.

Eastern spruce budworm
Choristoneura fumiferana

An outbreak of the eastern spruce budworm, underway since 1985 in northern Prince George Region, recently defoliated white spruce in the northeast corner of the Prince Rupert Region. Defoliation of current growth observed from east to west along the Alaska Highway is as follows: Liard River Crossing to Smith River - moderate to severe; Smith River to Coal River - trace/light with patches of moderate; Coal River to Fireside - trace levels with moderate to severe on several hectares at Whirlpool Canyon; Fireside to Eg Fire - trace. No defoliation occurred west of the Eg Fire. Since the outbreak has been declining for the last two years in the Prince George Region, any further defoliation in the few infested stands in the Prince Rupert Region should be minimal.

Leader and lateral bud necrosis

As large areas of spruce plantations reach sapling age, the occurrence of lateral buds and leaders which have not flushed is becoming more apparent. The spruce bud midge, Rhabdophaga swainei, infested 16 of 25 hybrid spruce in a plantation near the Wedeene River, preventing bud flush of laterals and, in one case, of a leader.

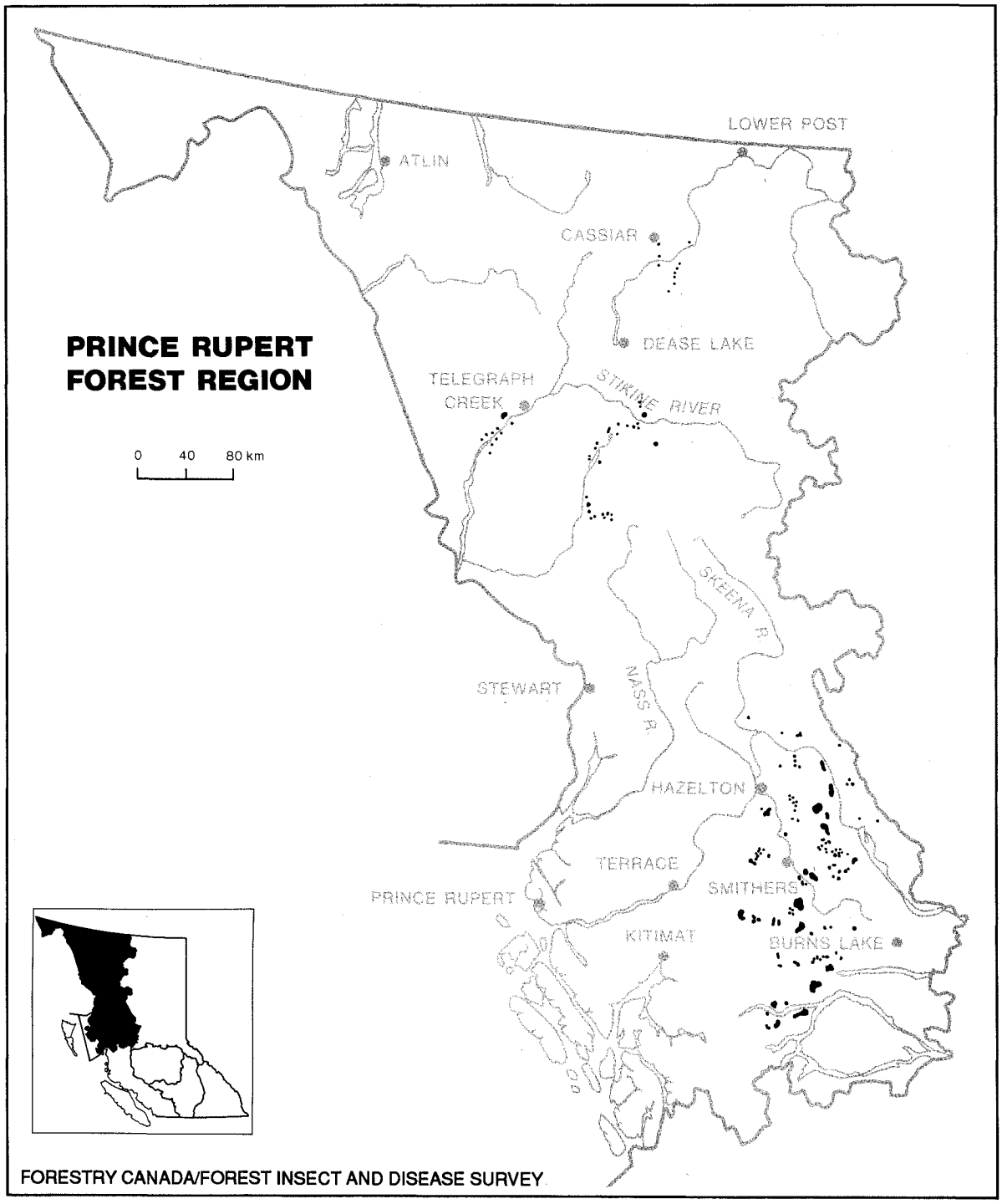
In the Kwinitsa Valley, 15% of 8-year-old planted Sitka spruce had terminal bud necrosis and 59% had some unflushed lateral buds from which a fungus, Ramichloridium sp., was collected for the first time in B.C. One species of this fungus causes a tip blight of pine in Great Britain, while others are saprophytic.

Unflushed leaders occurred throughout the range of white spruce in the Cassiar TSA at an incidence of less than 5%. In the Hyland Valley, no specific agents could be identified from a collection of unflushed white spruce leaders, but environmental damage could not be excluded. Throughout the region, fluctuating spring temperatures can lead to bud mortality. Early warm spells cause terminal bud scales to partially open, allowing moisture to penetrate into the bud. Subsequent cool or freezing temperatures lead to partial or complete bud mortality.

ALPINE FIR PESTS

Western balsam bark beetle-fungus complex
Dryocoetes confusus
Ceratocystis dryocoetidis

Active balsam bark beetle infestations covered an estimated 57 700 ha in 1988, slightly over half of the area mapped in 1987 (**Map 3**). The difference in area is a reflection of variations in aerial survey coverage and mapping technique, and until both become standardized, yearly fluctuations will persist. As in previous years, most of the mortality, 20 600 and 32 290 ha, was mapped in the Bulkley and Morice TSAs, respectively. During a partial overview flight of the Cassiar TSA, 3350 ha of scattered mortality was mapped in portions of the Dease, Cottonwood, Eagle, Stikine and Iskut river drainages. In the Kispiox TSA, a total of 1460 ha of mortality was mapped within two drainages (Table 9). No balsam bark beetle mortality was recorded during BCFS aerial surveys in the Lakes TSA.



Map 3. Areas of mature alpine fir recently killed by western balsam bark beetle, determined by ground and aerial surveys in 1988.

Table 9. TSA, locations and area of alpine fir recently killed by the balsam bark beetle-fungus complex, mapped during aerial surveys, Prince Rupert Forest Region, 1988.

TSA	Location	Area (ha)
Morice	Houston Tommy Creek	13 150
	Morice River	5 500
	Shelford Hills	3 480
	Whitesail Range	4 600
	Troitsa Lake	2 400
	Nadina Lake	1 730
	Mosquito Hills	1 430
Bulkley	Tsezakwa Creek	5 500
	Harold Price Creek	4 050
	Coffin Lake	2 700
	Deception Lake	2 700
	Telkwa River	1 430
	Blunt Creek	1 400
	McKendrick Pass	1 200
	Cronin Creek	1 100
	Trout Creek	520
Kispiox	Natlan Creek	860
	Babine River	600
Cassiar	Dease and Stikine river drainages	3 350
Regional total		57 700

Infestation intensities were low everywhere, affecting between 1 and 10% of the trees in the stands (average 2% within the region). A characteristic of infestations which consistently inflates estimates of mortality is the retention of needles for up to five years following attack. This also tends to reduce yearly variations in perceived beetle activity because the same trees can be counted in successive years.

Five of seven recently killed trees examined in the Blunt Creek infestation contained bark beetles in all stages of development from early-instar larvae through preflight adults. The crowns of all trees examined were red, some a deep dull red, suggesting that they had been dead for more than two years. The lower two meters on the bole of the other two trees were unattacked but beetles had presumably attacked further up the tree. Similar conditions were seen in the McKendrick Pass infestation where 9 of 10 trees examined contained beetles in all stages of development and a single red tree contained a strip of current attack on the lower bole.

The life cycle of D. confusus is prolonged and complex compared with other major bark beetles. Adults attack trees in July or August and lay eggs before overwintering. The same egg galleries are elongated the following spring and a second brood is produced. The same beetles then emerge, reattack and produce a third brood during the second summer. Broods require a full two years to reach maturity and later broods do not mature until three years following initial attack. Beetles and brood, therefore, are sustained for up to three years after the death of their host, feeding on a combination of the lesion-forming fungus Ceratocystis dryocoetides, other fungi, and stored nutrients within the cambium. Every female carries and introduces these fungi into the phloem of the tree where they proliferate rapidly. Studies have indicated that because of its virulence, C. dryocoetides is responsible for up to 65% of tree mortality associated with D. confusus attack.[1]

Beetles are attracted to particular trees by highly specific chemical signals released into the air. A key component of the primary attractant is a volatile chemical released only when the tree is stressed by any one of a variety of biological or environmental influences. Some of the agents thought to predispose alpine fir to beetle attacks in north central B.C. are root rots such as Inonotus tomentosus and Armillaria ostoyae. At least two roots of the 17 beetle-attacked trees at the two sites were assessed this year but no signs of either root rot were found.

In no other forest region in B.C. is there comparable consistent alpine fir mortality attributed to D. confusus. Alpine fir is becoming an increasingly important timber species in the region, as the higher elevation spruce-alpine fir stands become the focus of timber harvesting. Along with this new focus has come an increased awareness of the sustained destructive nature of the beetle, and of the need for further research into its biology. Ongoing semiochemical research at Simon Fraser University may soon result in isolation of a specific balsam bark beetle pheromone, a key factor in the development of future management strategies.

Further brood and root rot assessments are planned for 1989.

[1]Doidge, D.F. 1981. Western balsam bark beetle in British Columbia. Canadian Forestry Service, Forest Pest Leaflet 64. 4 p.

Western blackheaded budworm
Acleris gloverana

Light defoliation of alpine fir and to a lesser degree, white spruce, covered approximately 58 000 ha in primarily the Bulkley and Morice TSAs (Table 10) for the third consecutive year.

Table 10. Area, by location, lightly defoliated by blackheaded budworm, Prince Rupert Forest Region, 1988.

TSA	Location	Area (ha)	No. of larvae[1]	Percent defoliation[2]
Bulkley	Hudson Bay Mountain	2 400	31	20
	McKendrick Pass	14 900	55	30
	Nilkitkwa	800	218	80
Morice	Morice River	35 700	321	70
	Byman Creek	900	254	60
Lakes	Francois Lake	3 300	-	40

[1]Collected from standard three-tree beating sample.
[2]Current foliage only

Area figures are based on ground surveys since defoliation was concentrated in lower crowns and understory and could not be seen from the air. Feeding intensity appeared similar to that reported in 1987, being confined to current growth, but the distribution of high populations has shifted in some areas. The stand most severely defoliated (80% of current growth) this year, centered at Km 19 along the Nilkitkwa Road, showed no signs of previous year's feeding. Though larval counts were high throughout the Morice River area west of Fenton Creek in 1987, defoliation was visible only near Lamprey Lake. This year uniform light defoliation was visible throughout the area. High numbers of larvae were collected in standard three-tree beating samples from Burns Lake to Hazelton in 1987, but this year positive collections were limited to the area between Perow and Smithers. Of 29 permanent sample points east of Hazelton only 12 (41%) yielded *Acleris* larvae compared with 23 (80%) last year; larval numbers in positive beatings averaged 70 (range 1-321).

Egg counts from branch samples taken at four locations within the most severely defoliated stands indicated continued light defoliation in 1989 (Table 11).

Table 11. Location, number of eggs and predicted defoliation of alpine fir by western blackheaded budworm, Prince Rupert Forest Region, 1988.

Location	Avg. no. eggs/50 cm branch	Predicted 1989 defoliation[1]
McKendrick Pass	8	light
Byman Creek	11	light
Km 19 Nilkitkwa Road	22	light
Km 57 W. Morice Road	24	light

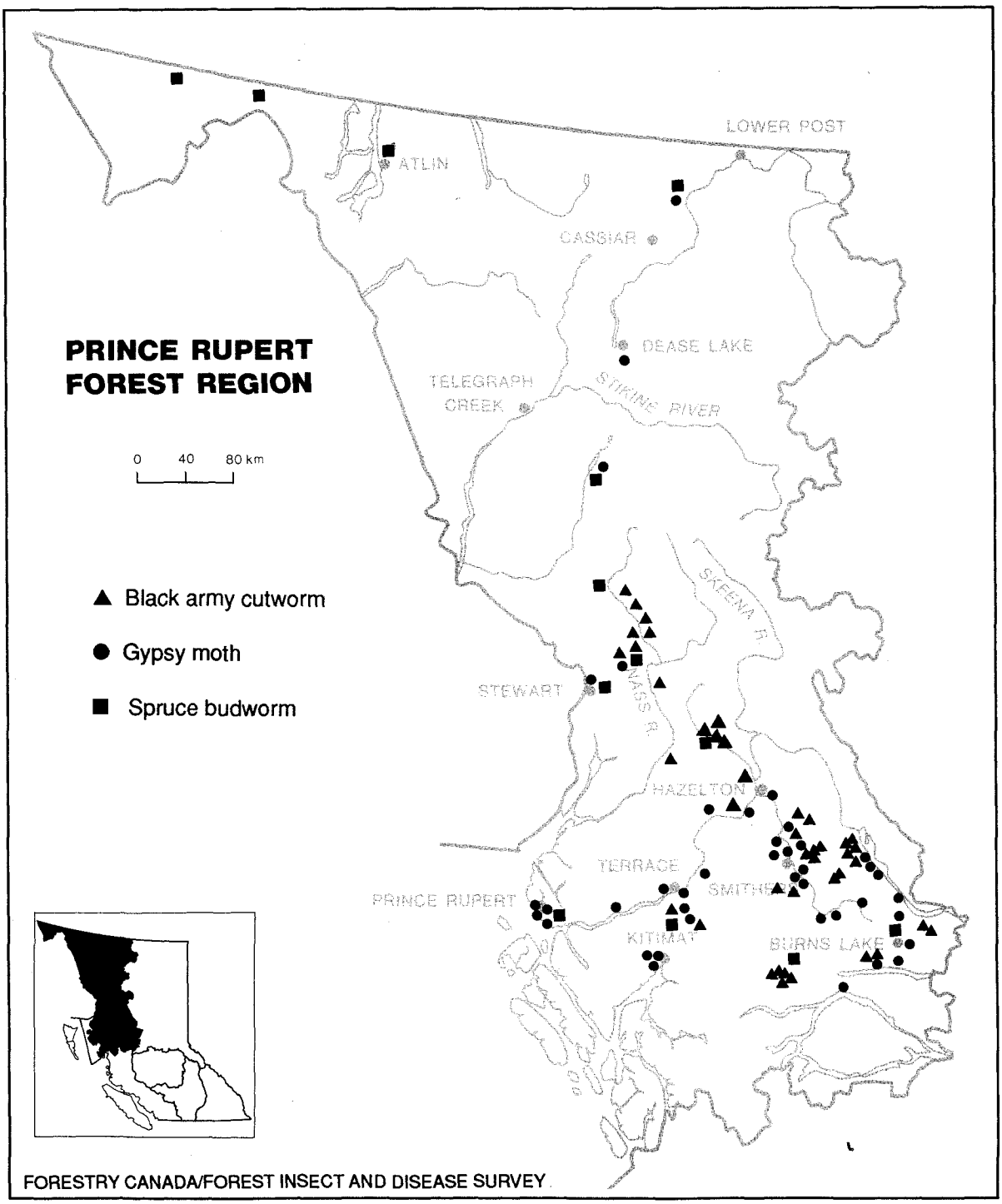
[1]Prediction categories are based on infestations in coastal western hemlock:
1-5 eggs - trace defoliation
6-26 eggs - light defoliation
27-59 eggs - moderate defoliation
60+ eggs - severe defoliation

Fir-spruce budworms
Choristoneura spp.

No significant defoliation attributed to fir spruce budworms was recorded within the region in 1988.

To improve and calibrate methods of detecting fir-spruce budworms, pheromone-baited plastic container traps ("Multipher") were deployed near the Kispiox, Telkwa, and Morice rivers and at Meziadin and Onion lakes (**Map 4**). Twenty-five trees were marked at each site for annual larval counts and defoliation estimates which could be related to the number of male moths captured. Few larvae were collected and only low numbers of moths were trapped, indicating a continuing endemic population with no defoliation expected next year.

In a study to gain information on the distribution of four species of Choristoneura, pheromone-baited plastic container traps ("Universal") were deployed at Prudhomme, Clements, Burns, Kinaskan, Como, Tutshi, and Boya lakes and at the Bell-Irving River (second crossing) and Blanchard River (**Map 4**). Taxonomic analysis of the moths is in progress. No defoliation was observed at the trap locations and catches were low, averaging 23 moths (range 3-85) with the C. fumiferana/occidentalis/biennis bait, and five (range 0-16) with the C. orae bait.



Map 4. Pheromone trap locations, Prince Rupert Forest Region, 1988.

Fir-fireweed rust
Pucciniastrum epilobii

For the third consecutive year, infection of the current growth of alpine fir by fir-fireweed rust was widespread in the western part of the region, from the Nass River north to Burrage Creek (Table 12). A 1987 exotic plantation of grand fir at Nalbeelah Creek near Kitimat was also heavily infected.

Table 12. Incidence and intensity of infections by the fir-fireweed rust, Pucciniastrum epilobii, on the current growth of alpine fir in representative stands, Prince Rupert Forest Region, 1988.

Location (south to north)	Biogeoclimatic zone	Stand maturity	Incidence of infection[1]	Intensity of infection[2]
Nass River	ICHmc2	sapling	moderate	light-moderate
Bell-Irving Crossing	ICHvc	sapling	high	moderate
Deltaic Creek	ICHvc	mature	moderate	moderate
Oweegee Creek	ICHvc	mature	moderate	light-moderate
Burrage Creek	BWBSe	sapling	high	light

[1]Incidence of infection - proportion of host trees infected: light, <10%; moderate; 10-30%; high >30%.
[2]Intensity of infection - proportion of current growth damaged: light, <10%; moderate, 10-30%.

In the drier east, infection centers were limited to more discrete areas. At 8 km of the Telkwa Road, an average of 10% of the needles on all sapling-aged alpine fir were infected in a 5-ha plantation. Near Chapman Lake, 10% of the needles in the lower crowns of all semi-mature trees were infected over 100 ha. An average of 90% of the new needles on all young-growth alpine fir were infected for 2 km along the Coal Mine Road in the Telkwa River drainage. Though identical in appearance to P. epilobii, the rust on the Coal Mine Road was identified as P. goeppertianum, whose alternate hosts are blueberries (Vaccinium spp.). This fungus was heavily hyperparasitized by Darluca filum, a mycoparasite never before found in association with this rust.

The buildup and continuing infection by P. epilobii was facilitated by the abundance of the alternate host, fireweed, in the large numbers of recently burned clearcuts. The impact of the disease is usually limited to growth reduction, of greater importance in younger trees with a higher proportion of current foliage.

Delphinella tip blight
Delphinella abietis

Newly flushed tips of alpine fir at two locations were infected by this chronic tip blight, a reduced incidence from 1987. At Elizabeth Lake in the Kispiox TSA, all young trees lost 50% of their growing tips on five hectares. Near km 1 of Blunt Creek Forest Road in the Bulkley TSA, an average 80% of the tips were killed on all understory trees in a small infection center covering

one hectare. Infection incidence was much reduced in the west where several centers were identified in 1987.

Since only the current year's growth is affected in any given year, growth loss effects are minor and, unless infections persist, trees normally recover fully the following year.

LARCH PEST

Larch sawfly
Pristiphora erichsonii

Populations of larch sawfly declined in tamarack stands from north of Boya Lake to the Yukon border. Defoliation intensity declined to trace - light levels, from moderate in 1987.

In Terrace, the larch sawfly was first collected in 1987, and is becoming more widespread on ornamental larch. Moderate to severe defoliation was scattered throughout the western half of Terrace, while trace - light levels occurred in eastern areas of town, and across the Skeena River in Thornhill. Larvae were found in a local nursery on larch brought from Prince George in 1983 and 1987; however, it is not known if this stock was the source of the introduction.

Rhizina root disease
Rhizina undulata

Seedling mortality linked to infection by Rhizina root disease was found on ten recently planted sites (24% of those surveyed) burned in 1987, primarily in the wetter parts of the region. An average of 9% (range 3 to 18%) of the white spruce, Sitka spruce and lodgepole pine seedlings were killed in ten plantations from Guess Creek north of Houston, to the Kispiox, Nass and Bell-Irving river valleys (Table 13, Photo 1). This was the first significant mortality attributed to this pathogen in the province since 1969. Additionally, an average 5% (range 0 to 17%) of seedlings found within 0.6 m of fruiting bodies showed definite symptoms of infection such as chlorosis and/or suppressed growth, and many would not be expected to survive the winter.

Photo available upon request from
Pacific Forestry Centre

Table 13. Location and damage to seedlings in 1988 plantations by Rhizina root disease, Prince Rupert Forest Region, 1988.

Location	Biogeoclimatic zone	Tree sp.	Percent of seedlings alive infected[1]	alive healthy	dead infected	dead other causes[2]
Kalum TSA						
5 km NE Meziadin	ICHvc	lP	17	64	17	3
Lake (Hanna Ridge)		sS	4	93	0	4
Nass River Crossing	ICHmc2	lP	5	61	18	17
Kiteen River	ICHmc2	sS	16	65	14	4
8 km S. Terrace	CWHws1	sS	4	96	0	0
Kispiox TSA						
Bridge Main CP 017	ICHmc3	lP, wS	4	87	8	1
Bush Main CP 019	ICHmc3	lP, wS	1	95	4	0
Corral Creek CP 314	ICHmc3	wS, lP	6	89	2	3
Corral Creek CP 316	ICHmc3	wS, lP	0	94	6	0
Morice TSA						
Guess Creek CP 321 Blk. 1	SBSmc	lP, wS	0	95	3	2
Guess Creek CP 321 Blk. 2	SBSmc	lP, wS	0	85	13	2
Regional average			5	84	8	3

[1]seedlings with fruiting bodies within 0.6 m and showing symptoms of infection such as chlorosis and/or suppressed growth
[2]mortality due to vole damage, planting stress or other fungal agents

In the Kalum TSA, the greatest impact of Rhizina root disease occurred in the Nass drainage from the Kiteen River to Hanna Ridge. Occasional fruiting bodies were seen in the Bell-Irving Valley and areas south of Terrace, but no seedling mortality was recorded. Voles appeared to be the main cause where mortality was not associated with fruiting bodies of the fungus.

In the Kispiox TSA, fruiting bodies were concentrated in discrete infection centers on all affected blocks. Both the Bush and Bridge Main blocks had dry rocky ridges running down the center. Mortality was far more prevalent along the ridge tops and affected the lodgepole pine more than the white spruce that were planted on the moister lower slopes. In the sloped Corral Creek blocks both pine and spruce were affected, but again mortality was most severe on drier sites where the burn was hotter and the charring deeper. An estimated 5% of the seedlings, especially the spruce, were severely chlorotic and may not have survived the winter.

The Guess Creek blocks north of Houston in the Morice TSA were flat, and both the spruce and pine were equally affected. Table 13 does not include an estimated 5% of primarily spruce seedlings that were surrounded by fruiting bodies, but showed no symptoms of infection in the middle of September. Some of these seedlings may subsequently have died. Rhizina fruiting bodies were also seen on CP 517 Block 2 near Bill Nye Lake south of Houston, but there was no associated seedling mortality.

When they have occurred, mass fruitings of Rhizina root disease in forest situations have always followed wild fires or prescribed burns. The heat generated by fire greatly increases the frequency of spore germination and temporarily eliminates competing organisms from the soil.[1] Rhizina favors temperatures between 35° and 45°C but spores can withstand high temperatures which kill most other organisms.[2]

Rhizina fruits from early summer through to fall frost. Fruitings occur a minimum of four months following a burn, and since it is a poor competitor, the fungus survives for only a few years after which it is succeeded by more aggressive fungi. Most seedling mortality occurs within the first year but Douglas-fir mortality on the south mainland coast and Vancouver Island was reported from the same sites in 1968 and 1969. In the same two years, light mortality of lodgepole pine and exotic western larch seedlings was closely associated with Rhizina fruiting bodies in two plantations in the Prince Rupert Region though a relationship was never confirmed by laboratory culture.

The moist early summer weather in 1988 proved ideal for mycelial growth and attack of freshly planted seedlings. The hazard is not limited to second fruitings on the same sites, however, as many of the spores released in the late summer and early fall of 1988 were blown to fresh clearcuts, which were subsequently broadcast burned. If sufficient moisture is available in the summer of 1989 unprecedented fruitings may be seen on fresh plantations. Both the 1988 and 1989 plantations will be closely monitored.

[1]Funk, A. Mycologist, Canadian Forestry Service, personal communication.
[2]Baranyay, J.A. Rhizina Root Rot of Conifers, Canadian Forestry Service, Forest Pest Leaflet 56. 5 p.

Black army cutworm
Actebia fennica

Cutworm populations increased this year causing light seedling damage at two locations in the Corral Creek drainage in the Kispiox TSA. Variable levels of herbaceous defoliation occurred in two plantations in the Morice and Lakes TSAs and similar damage was widespread but light in the Bell-Irving Valley (Table 14).

Table 14. Damage due to black army cutworm feeding on seedlings and/or herbaceous ground cover on 1986 prescribed burns, Prince Rupert Forest Region, 1988.

Location	Area defoliated	Remarks
Corral Creek CP 315 Blk. 7	3 ha	100% herbaceous defoliation, white spruce seedlings average 30% defoliated, 20 seedlings stripped
Corral Creek CP 304 Blk. 1	1 ha	80% herbaceous defoliation, lodgepole pine seedlings average 20% defoliated (up to 90%)
Guess Creek CP 160 Blk. 16	5 ha	90% herbaceous defoliation only
Augier Lake	2 ha	10% herbaceous defoliation only
Bell-Irving Valley	900 ha	5-10% patchy herbaceous defoliation

Some seedlings at both Corral Creek locations were severely defoliated in June and appeared to be dead. Cool moist weather throughout the early summer, however, applied no further stress, and by August they had initiated from 23 to 45 adventitious buds apiece. These trees should recover fully by next year. The vigorous recovery of these seedlings emphasizes the need for late season surveys to determine stocking levels following cutworm infestations rather than accepting early-season evidence of apparent mortality. If July weather had been hot and dry, some or all of the severely stressed seedlings would probably have died.

In the Kalum TSA, the only significant black army cutworm activity continued in the Bell-Irving River Valley where extensive annual slashburning has led to a population buildup. Larvae were numerous in 1988, averaging 5.5, 5.8, and 1.0/1000 cm^2 of duff at Taft Creek, Bell-Irving River first crossing, and Hanna Ridge, respectively. No seedling damage was observed in these areas, but defoliation of abundant fireweed ranged from light to severe.

Rearings of larval mass collections from four locations and pupae from a single location found variable levels of parasitism by Hymenoptera and Diptera (Table 15).

Table 15. Emergence, parasitism, and mortality determined from rearing larval and pupal collections of the black army cutworm, Prince Rupert Forest Region, 1988.

Location	Stage collected	Number reared	Percent adult emergence	Percent parasitism		Mortality[1] percent
				Hymenoptera	Diptera	
Bell-Irving R.	larva	118	42	24	0	34
Taft Cr.	larva	119	26	3	0	71
Guess Cr. CP 160 Blk. 16	larva	27	22	63	4	11[2]
Corral Cr. CP 315 Blk. 1	larva	103	34	21	19	26
Corral Cr. CP 315 Blk 7	pupa	70	58	9	13	20
Regional average			37	24	7	32

[1]Mortality during rearing
[2]Includes 7% mortality due to infection by Beauveria bassiana

Though the feeding intensity within the herbaceous ground cover at Guess Creek was severe, only 27 larvae could be found for parasite rearing. Adjacent to some of the buried larvae were cocoons of the braconid parasite, Glyptapanteles alticola. Mature larvae of this species had emerged from cutworm larvae and pupated in the soil. A later attempt to collect cutworm pupae for future rearings was unsuccessful as the population had collapsed. In addition to parasites, predators such as birds and voles, and viral and bacterial diseases also play a role in black army cutworm population control.

To aid in forecasting 1989 populations, sets of five attractant-baited sticky traps were placed at each of 42 locations throughout the region (**Map 4**). The only high hazard was indicated by an average of 19.4 moths/trap (range 2-27) at Corral Creek, CP 314 Block 6, adjacent to the two blocks most severely damaged by cutworm feeding in 1988. Average catches at three other locations indicated moderate hazards: 9.0 moths/trap (range 1-16) at Cancel Main CP 017 Block 17; 6.9 moths/trap (range 0-14) on a massive burn at Km 7 of the Granisle cutoff road, and 4.4 moths/trap (range 0 to 6) at a second Corral Creek block (CP 314 Block 4). Average catches on the remaining 38 burns ranged from 0 to 3 moths/trap and represent little or no hazard. Further information on the black army cutworm trapping program is detailed in Appendix V which can be obtained upon request from the authors at the Pacific Forestry Centre.

Seedling mortality

During the course of plantation surveys, individual and small groups of well-planted dead lodgepole pine and white spruce seedlings, not associated with Rhizina fruiting bodies, were collected from ten plantations throughout the eastern portion of the region. Six diseases were isolated from the samples, one of which, Tryblidiopycnis sp., was recognized as a new host record on both white spruce and lodgepole pine. Two diseases, Cylindrocarpon sp. and Phoma sp., were found beyond their previously known range (Table 16).

Table 16. Summary of diseases infecting lodgepole pine and white spruce seedlings outplanted in 1987, Prince Rupert Forest Region, 1988.

Location	Tree sp./incidence	Pathogen	Remarks
Kispiox TSA			
CP 313 Blk. 7 Corral Creek	1 lP	Tryblidiopycnis sp.	pathogenicity unknown new host record
CP 304 Blk. 1 Corral Creek	7 wS	Sclerophoma pithyophila Tryblidiopycnis sp.	probably secondary pathogenicity unknown; new host record
CP 316 Blk. 4 Corral Creek	10 lP	Phoma sp.	probably secondary new distribution record
CP 102 Blk. 5 Burdick Creek	<1% lP (patchy)	Fusarium sp.	probably nursery origin
Bulkley TSA			
CP 516 Blk. 2 Telkwa River	<5% lP	Phoma sp.	probably secondary
CP 301 Blk. 5 McKendrick Pass	1 wS	Cylindrocarpon didymum	probably secondary
CP 518 Blk. 1 Nilkitkwa Road	5 wS	Hyalodendron sp.	pathogenicity unknown
CP 001 Blk. 3 Nilkitkwa Road	5 lP	no fungi	probably environmental
Morice TSA			
CP 518 Blk. 4 Bill Nye Lake	5 lP	Phoma sp.	probably secondary
CP 321 Blk. 2 Guess Creek	5 lP 5 wS	Cylindrocarpon sp. Phoma sp.	probably secondary probably secondary

Fusarium proliferates well under nursery conditions but does poorly in most forest soils so was probably transplanted to the site on the seedlings. Both Phoma sp. and Cylindrocarpon didymum have been identified from native soils but primarily farther south. Both diseases are normally secondary agents attacking seedlings that have been stressed by environmental or biotic agents. Tryblidiopycnis sp., in contrast, is little known from either nursery or native environments.

These findings suggest a need to devote more attention to the causes of plantation seedling mortality and to quantify the impact of specific agents, biotic or otherwise. Often such mortality is attributed to environmental stresses or poor planting. Considerable information is available on pathogens affecting stock in controlled nursery situations, but little has been gathered for those causing plantation mortality.

To further understanding of the causes of outplanted seedling mortality, special attention will be paid to the collection of stressed and dead plantation seedlings in 1989.

MAMMAL DAMAGE

Porcupine

Dieback and mortality caused by porcupines continued at levels similar to 1987, particularly in sapling to semi-mature age classes. Debarking of lodgepole pine regeneration was most common in the Kalum Valley and east of Dease Lake. Western hemlock, and to a lesser extent Sitka spruce, were most severely damaged in regeneration along coastal inlets from north of Prince Rupert to the Stewart area. Smaller areas of activity were observed in regeneration near the Copper River, Williams Creek, and in the Whitebottom block where lodgepole pine and western hemlock were the preferred hosts, although feeding was occasionally seen on Sitka spruce and on true firs.

Farther east 29 small patches of lodgepole pine sapling and young growth mortality were mapped over 300 ha between Fort Babine and Mount Horetzky in the Bulkley and Morice TSAs. Porcupine activity appears to be increasing in this area. One additional small patch containing 200 recently killed young lodgepole pine was mapped just east of the Smithers airport.

Factors contributing to currently high porcupine populations include: recent mild winters; trapping of fishers, the only known effective predator of porcupines; and pole-sized slash left in thinned stands which provides cover for the porcupine. The silvicultural trend to fewer but heavier thinnings increases the value of remaining stock and the impact of porcupine feeding.

Active control efforts include a BCFS program to release and monitor fishers along coastal inlets north of Prince Rupert, and a bounty on porcupines, limited to registered trappers, in the Kalum Forest District.

Snowshoe hare

Typical snowshoe hare damage, mainly the clipping of terminal and/or lateral buds, affected 8 and 25% of lodgepole pine seedlings in two plantations

in the Kalum Valley. Near Lakelse, 21% of Sitka spruce and 6% of cedar seedlings were lightly damaged. In 10- to 15-year-old Sitka spruce plantations near Kitsumkalum Lake, Nalbeelah Creek and Branch 77 Road, light damage was sustained due to the clipping of lower branches on 20, 67 and 92% of the trees, respectively. In a 10-year-old white spruce plantation at Blue River, 50% of the terminals were clipped during feeding in high-snowpack conditions.

Populations of snowshoe hare have been increasing in recent years and are expected to peak in 1990. At current levels the impact of clipping is low, but increased damage could cause severe stunting in young plantations where seedling growth relies on successful development of relatively few buds.

Vole

Vole populations declined throughout the region but still caused light to severe damage in twelve plantations in the west (Table 17).

Table 17. Current vole damage in recent plantations in the Bell-Irving, Nass, Skeena, and Kitimat river drainages, Prince Rupert Forest Region, 1988.

Location	Year planted[1]	Host	No. seedlings assessed	Percent seedlings damaged
Bell-Irving Valley				
Taft Creek	1987	sS	238	5
Fell Creek	1986	sS	36	6
Bell-Irving Crossing	1987	sS	183	4
	1986	sS	88	2
Nass Valley				
NE of Meziadin Lake	1987	sS	54	2
SE of Meziadin Lake	1988	lP	84	17
Kwinatahl River	1987	lP	90	45
Skeena Valley				
Kalum Forest Road:				
Km 12	1987	lP	73	56
Km 21	1987	lP	107	22
Km 24	1986	lP	120	5
Km 45	1987	lP	99	5
Little Oliver Creek	1987	sS	48	60
Kitimat Valley				
Kitimat River	1988	sS	92	10

[1]All locations had been slash-burned in the year prior to planting.

Levels of seedling mortality as a direct result of this year's feeding are as yet unknown and will depend upon the viability of buds below the point of excision, and the degree of root establishment. Previous observations found that about half of the seedlings died within a year of being damaged.

Historical patterns suggest that vole populations will continue to decline next year.

CLIMATIC INJURY

Blowdown

The only current blowdown seen in the region this year affected patches of trembling aspen over a total area of more than 300 ha west of Francois Lake, in the Morice TSA. The trees, most of which were open growing, were uprooted during a storm on September 28.

During aerial surveys a total of 220 ha of older, mostly lodgepole pine blowdown was mapped in three areas south of Houston in the Morice TSA: Chisholm Lake, 150 ha; Parrott Lakes, 40 ha; and Pimpernel Creek, 30 ha. The damage likely occurred in 1986 or 1987, as the first two areas were bounded by a total of 35 red-topped pines indicating probable attacks by engraver beetles, Ips sp., originating from the blowdown.

Frost damage

Damage to current growth caused by late spring frosts was generally light but widespread, particularly in young stands and understory trees. White spruce in the interior of the region was particularly susceptible, as was western hemlock in the coastal transition zone.

The most severe damage, affecting an average of 60% of the growing tips of sapling-aged western hemlock, was widespread but patchy near Dasque Creek and along the Ishkheenickh River. Less than 10% of the tips of sapling-aged mountain hemlock were killed in stands along the Lachmach Road. Damage to white spruce in the interior averaged 5% of the growing tips in young stands at km 60 Kispiox Forest Road, km 40 Smithers Landing Road and km 62 Chapman Lake Road.

Some frost damage occurs almost every year particularly in the spring when a hard frost follows budbreak. The young tender tissues of newly flushed buds are particularly susceptible to freezing.

Winter flecking of lodgepole pine foliage occurred at varying intensity in the Dease Lake area. The chlorotic patches on the needles are caused by the magnification of sunlight through frozen water droplets.

Winter drying

Localized winter drying caused severe dieback of 1987 foliage on western hemlock and Sitka spruce saplings on Thornhill Mountain near Terrace, and light damage to 80% of the 1987 western red cedar seedlings in a mixed plantation near Lakelse.

In some years whole hillsides turn red from the effects of winter drying or 'red belt'. Though not fully understood, it is thought to result from desiccation due to accelerated transpiration in warm early spring weather while ground water is still frozen.

PESTS OF YOUNG STANDS

In addition to the survey of many specific pests affecting young planted and natural stands (refer to sections on black army cutworm, Rhizina root disease, etc.), FIDS has developed specialized young stand surveys to identify a range of forest pests and their impact. This year nine young interior lodgepole pine and/or white spruce stands were surveyed (Table 18).

Surveys involved establishment of fixed diameter plots every 50 meters. Every plot tree above one meter in height was sampled. An average of 12 plots were established in each stand. Numbers of trees per plot averaged 8.6 in the nine stands, and of these an average of 5.6 were identified as good potential crop trees (those of commercial species, well spaced and healthy). These numbers scaled up to average 1933 plot trees/ha (range 1000-3862) and 1259 crop trees/ha (range 651-2515).

Major pests of lodgepole pine stands included the Warren's root collar weevil, western gall rust and Cronartium sp. stem rusts. With the exception of the root collar weevil which caused growth reduction and threatens significant mortality in two surveyed young lodgepole pine stands, the frequency of major pests in both pine and spruce was low.

Table 18. Pests of young stand surveys, Prince Rupert Forest Region, 1988.

Host	Plantations[1]	Pest	Frequency (no. of plantations)	Average percent trees affected	Range	Remarks
lP	6	Hylobius warreni	2	80	75-85	mortality averaged 2%, study plots established to monitor impact over time
		Endocronartium harknessii	2	4	0.5-10	branch galls only
		Cronartium sp.	2	2	103	branch and stem cankers generally on non-crop trees
		Coleotechnites sp.	1	95	-	74% branch tips lost 30% needles, 53% terminals also infested
		Petrova albicapitana	1	74	-	all old pitch masses
		Pissodes terminalis	1	3	-	
		Cecidomyiidae	1	2	-	light branch crooking
		deer	1	16	-	light-severe browsing damage
wS	6	Pineus sp.	3	50	12-80	average <5% galling of branch tips
		Zeiraphera spp.	1	24	-	average 30% tips infested
		frost	2	26	3-58	light tip damage

[1]Number of plantations where tree species comprised >20% of stand.

More detailed information on young stand surveys at specific locations including frequency and severity data for each pest are in Appendix IV and may be obtained by writing to the authors at the Pacific Forestry Centre.

An expanded young stand survey program is planned for 1989.

CONE AND SEED PESTS

Spruce

White spruce cone crops were generally light to moderate in the southern half of the region in 1988, similar to 1987, but increased to moderate-high levels in the Cassiar TSA. Sitka spruce cone crops remained light in 1988.

A spiral spruce-cone borer, Strobilomyia neanthracina, and spruce seedworm, Cydia strobilella, remained the most important pests of both Sitka and white spruce cones (Table 19). Other insect pests included a seed chalcid, Megastigmus atedius, spruce seed midge, Mayetiola carpophaga, and spruce coneworm, Dioryctria reniculelloides, each remaining at relatively low incidence in 1988. Spruce cone gall midge, Dasineura canadensis, spruce cone axis midge, Dasineura rachiphaga, and a cone resin midge, Resseliella sp., which do not usually damage seeds directly, remained generally of minor significance in the region. Further information is available in Appendix VI.

Table 19. Summary of major insect pests infesting Sitka and white spruce cones and impact on seed production, Prince Rupert Forest Region, 1988.

			Strobilomyia neanthracina		Cydia strobilella	
TSA	Number of collections[1]	Percent healthy seeds	Percent cones infested	Percent seeds destroyed	Percent cones infested	Percent seeds destroyed
Kalum[2]	11	71	18	16	21	11
Kalum	2	-	33	-	3	-
Cassiar	9	27	28	32	3	3
Kispiox	1	48	20	22	55	30
Bulkley	6	44	48	45	29	11
Morice	6	52	38	42	16	9
Lakes	5	51	49	45	16	8
Regional average		47	34	32	16	8

[1]Each collection consisted of 20 randomly selected cones.
[2]Sitka spruce cones, all other collections were from white spruce.

Spruce cone rust, Chrysomyxa pirolata, favored by wet weather conditions, increased throughout the region, reaching particularly high levels of infection (56% of cones) in the Cassiar TSA. The pycnidial stage of Sirococcus tip

blight, Sirococcus strobilinus, was collected on old (1987) cones at Stewart, an extension of the known range.

Alpine fir

Thirty-five percent of alpine fir cones collected at Hudson Bay Mountain were infested by a fir seed maggot, Earomyia abietum, destroying 32% of the seeds in the collection. At Burrage Creek in the Cassiar TSA, 50% of cones were infested by the spiral spruce-cone borer, 55% by the spruce cone axis midge, and 5% by a cone resin midge.

Lodgepole pine

Lodgepole pine cone crops were light to moderate in the region in 1988, and no damaging insects were found in cone collections from the Kitimat River, Kitsumkalum River, Kitwanga, Dragon Lake, Cranberry Junction, Burrage Creek, Stikine River, Dease Lake and Cottonwood River areas. Assessments to determine the distribution of a pine cone beetle, Conophthorus ponderosae, were negative at Kitwanga, Cedarvale, Telkwa River and Knockholt.

Western red cedar

Twenty percent of cones in a collection from Rosswood were infested by a western red cedar cone midge, Mayetiola thujae.

Western hemlock

No pests were found in a collection of western hemlock cones from Rosswood.

DECIDUOUS PESTS

Large aspen tortrix
Choristoneura conflictana

Severe defoliation of trembling aspen, mainly by the large aspen tortrix, Choristoneura conflictana, was mapped in 18 separate infestations over 2850 ha in the eastern and southern portions of the Cassiar TSA, and on 350 ha west of Kitsumkalum Lake in the Kalum TSA. Other insects associated with the defoliation, often as common as the tortrix, included: aspen leaftier, Sciaphila duplex, and aspen twoleaf tier, Enargia decolor, in the Dease River valley; aspen leafroller, Pseudoexentera oregonana, paleheaded aspen leafroller, Anacampsis niveopulvella, birch-aspen leafroller, Epinotia solandriana, and aspen leaftier near Kitsumkalum Lake. Defoliation of willow and alder also occurred in the affected areas.

Scattered periodic defoliation of aspen by the tortrix is common and, although consecutive years of moderate to severe defoliation will reduce growth, tree mortality is uncommon. Infested trees may refoliate in the same year if the feeding concludes by midsummer.

Gypsy moth
Lymantria dispar

Gypsy moth pheromone-baited traps were placed at 42 locations in the region as part of an ongoing program designed to prevent the introduction of this pest into B.C. (**Map 4**). No moths were caught.

Trapping was focused in areas frequented by travellers such as provincial parks, private campgrounds, major highway rest areas and port facilities. Recreation vehicles visiting from the east and south, where the gypsy moth is well established, are considered the primary vectors in the spread of the pest.

Repeated light catches of male adults in traps in the Okanagan Valley, Lower Mainland and Vancouver Island have served to re-emphasize the need for vigilance with regard to this potentially destructive defoliator.

The trapping program will continue in 1989.

CHRONIC DISEASES

Several chronic diseases (Table 20) are important in the region in terms of damage and losses, but are not usually surveyed because they are perennial and fluctuate little from year to year. Management of these diseases is most practical as preventative treatments combined with stand management practices during the harvest-regeneration phase or juvenile stand tending.

Table 20. Important chronic diseases, Prince Rupert Forest Region, 1988.

Disease	Host(s)	Occurrence	Remarks
Annosus root disease, *Heterobasidion annosum*	aF, sS, wH	southwestern part of region	infecting stumps in thinned stands, spreading to leave trees
Atropellis canker, *Atropellis piniphila*	lP	southern half of region	sporadic occurrence of stem deformation, locally severe impact
Comandra blister rust, *Cronartium comandrae*	lP	throughout region	particularly damaging in young stands, up to 50% mortality recorded
Hardwood trunk rot, *Phellinus igniarius*	tA	throughout region	causing extensive decay in trembling aspen
Hemlock dwarf mistletoe, *Arceuthobium tsugense*	wH	throughout host range	widespread, particularly severe in remaining old-growth stands

Disease	Host(s)	Occurrence	Remarks
Lodgepole pine dwarf mistletoe, *Arceuthobium americanum*	lP	southeastern part of region	widespread but sporadic in mature stands causing significant growth loss but little or no mortality
Red ring rot, *Phellinus pini*	sS, wS, wH, alF, aF	throughout region	widespread, particularly in remaining old growth stands
Rust-red stringy rot, *Echinodontium tinctorium*	wH	southern half of region	widespread, particularly severe in remaining old-growth stands
Spruce broom rust, *Chrysomyxa arctostaphyli*	wS	throughout host range	widespread, particularly common in northern half of region
Stalactiform blister rust, *Cronartiuim coleosporioides*	lP	throughout region	particularly damaging in young stands, most common in interior
Western gall rust, *Endocronartium harknessii*	lP	throughout region	infections widespread in all age classes

Other Noteworthy Pests

Insect populations fluctuate from year to year, and, in any one year populations of some potentially damaging pests are sufficiently low that little damage is reported. Occurrences of these insects are reported in Table 21. Minor damage caused by disease is reported in Table 22.

Table 21. Other noteworthy insects, Prince Rupert Forest Region, 1988.

Pest	Host	Location	Description
An Agriomyzid fly, *Hexomyza shineri*	tA	Telkwa	localized light galling of leaves
Bark beetle, *Hylurgops porosus*	lP	Cranberry Junction	secondary attack, associated with Warren's root collar weevil
		Corral Creek	found in butt of mountain pine beetle-killed tree
Birch-aspen leafroller, *Epinotia solandriana*	mAl	Houston	10% leaves infested over 1 ha
Conifer aphid, *Cinara* sp.	bS	Km 15 Smithers Landing Road	moderate-severe defoliation of 10 trees in 1987; collapsed in 1988
Conifer sawfly, *Neodiprion* sp.	wH	Skeena Valley Exchamsiks River	no defoliation, larval counts increasing
Cooley spruce gall adelgid, *Adelges cooleyi*	aF, sS	Kinskuch River	light galling on sS, associated with exotic D-fir plantation
Deciduous defoliator *Archips rosanus*	cherry	Prince Rupert	light defoliation of ornamentals in campground
Engraver beetles, *Ips* spp.	lP	Toboggan Creek Corral Creek Decker Lake	secondary attacks in mountain pine beetle-killed trees; secondary attacks to root rot-killed trees
European alder leafminer, *Fenusa dohrnii*	rAl	lower Skeena River	average 20% foliage infested

Pest	Host	Location	Description
European birch leafminer, *Fenusa pusilla*	wB	Smithers Terrace	25% leaves mined on ornamentals; first time collected in Terrace
Gall aphid, *Pemphigus* sp.	tA	Telkwa Skeena River	localized light galling of leaves
Green velvet looper, *Epirrita autumnata*	wH alF wS	Hazelton-Houston	average 7 larvae (range 1-25) from 21 positive beating samples
Leaf beetles, *Altica* sp.	rA	Kitsumkalum Lake	scattered small patches of severe leaf skeletonization
Chrysomela semota	bCo	Copper River	scattered light defoliation
Poplar and willow borer, *Cryptorhynchus lapathi*	tA willow	Skeena, Nass, and Kitimat river drainages	average 5% (range 2-20%) stems attacked
Poplar leafminer, *Phyllocnistis populiella*	bCo	Echo Lake	light damage to all trees
Root borer, *Spondylis upiformis*	lP	Decker Lake (larvae) Houston (adults)	secondary beetles in roots of recently killed lodgepole pine at both locations
Western hemlock looper, *Lambdina fiscellaria lugobrosa*	wH	Cedarvale to Kitwanga	population increasing though no defoliation yet, moths common

Table 22. Other noteworthy diseases, Prince Rupert Forest Region, 1988.

Pest	Host	Location	Description
Alder leaf blight, *Gnomonia alni*	sAl	Tanzilla River	moderate infection of foliage of all trees in area; first collection in British Columbia
Bark fungi, *Apostrasseria* sp.	sS	Kiteen River	infected single dead seedling; new host record
Tryblidiopycnis sp.	lP, wS	Corral Creek	infected few dead seedlings of both species; pathogenicity unknown; new host records
A black spot disease, *Pollaccia borealis*	tA	Boya Lake Cormier Creek Salmon River Rd.	light leaf spotting, widespread
Canker diseases, *Sageria tsugae*	wH	Thunderbird Main	light incidence of top dieback
	alF	Cottonwood River	killed leader on single tree
Cytospora sp.	willow	Telkwa	killed 20% stems on clump of roadside trees
	wH	Terrace	light incidence of shoot dieback
Cytospora abietis	wH	Thunderbird Main	light incidence of top dieback
Dieback fungus, *Xenomeris abietis*	wH	Salmon River Road	light incidence of top dieback
Epiphyte, *Hormonema* sp.	wH	Thornhill Main	associated with winter drying
Epiphytic coelomycete, *Phialopycnidiineae*	mH	Lachmach Road	associated with localized shoot dieback
Foliar rust, *Melampsora epitea*	wH	Thunderbird Main	average 5% needles infected on 20% trees

Pest	Host	Location	Description
Leaf spots,			
Hyponectria populi	tA	Dease Lake	10% leaves on 5% trees
Mycosphaerella populicola	bCo	Chapman Lake	average 60% leaves infected on all trees over 5 ha
	tA	Echo Lake Broman Lake	average 10% foliage average 70% leaves infected on all trees over 1 ha; new host records
Mycosphaerella tassiana	tA	Boya Lake	trace occurrence; new host record
Phaeoramularia maculicola	bCo	Cedric Creek Smithers	50% leaves spotted both locations; new host records
Septoria aceris	dM	Kiteen River	reddening of upper leaf surfaces common throughout host range
Marssonina blight, *Marssonina populi*	tA	Warm Bay, Atlin, Dease Lake	light infections; extension of known range
A needle blight, *Isthmiella quadrispora*	alF	Elizabeth Lake	co-infecting needles of young trees with *Pucciniastrum epilobii*
Needle casts, *Isthmiella abietis*	alF	Dease River	light infection of 1987 foliage
Lirula macrospora	sS	throughout host range	10-20% 1987 needles infected
Lophodermium juniperi	juniper	Boya Lake	5% older foliage infected
Needle rust, *Chrysomyxa weirii*	wS	Hazelton	70% 1987 needles infected on single tree

Pest	Host	Location	Description
Poplar twig and shoot blights			
Venturia populina	bCo	Hudson Bay Mountain	5% leaves on 70% trees over 1 ha
Venturia macularis	tA	host range	infections remained light for second year
Sydowia blight, *Sydowia polyspora*	D-fir	Kinskuch River	high incidence of top dieback in exotic plantation
Tar spots, *Rhytisma arbuti*	false azalea	Terrace	high incidence, light intensity throughout host range
Rhytisma salicinum	willow	Tanzilla River Meziadin Lake	high incidence, moderate intensity throughout drainages
A tip blight, *Coccomyces* sp.	wH	Km 50 Salmon River Road	5% branch tips infected, localized
White-spored fern rust, *Uredinopsis struthiopteridis*	alF	Km 15 Kwun Creek Road	average 40% 1988 needles in lower crowns and under story trees, 100+ ha

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