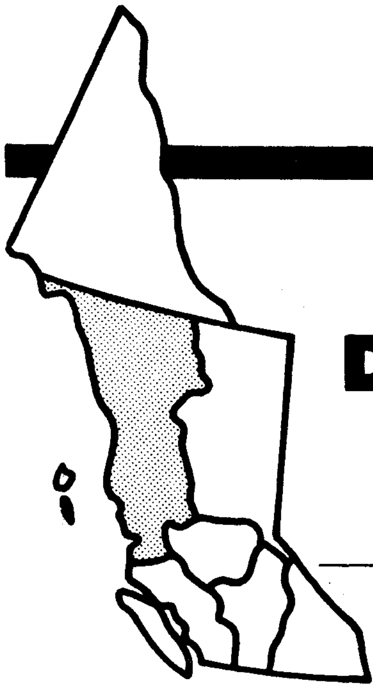
FIDS 88-5



Forest Insect and Disease Conditions

Prince Rupert Forest Region
1987

L. Unger and A. Stewart

Government of Canada
Gouvernement du Canada

Canadian Forestry Service
Service canadien des forêts

CONTENTS

PAGE

INTRODUCTION 1
SUMMARY 4
PINE PESTS 6
Mountain pine beetle 6
Mammal damage 13
Tomentosus root rot 16
Engraver beetles 18
Lodgepole pine beetle 19
Lodgepole terminal weevil 20
Western gall rust 21
Comandra blister rust 21
Lodgepole pine dwarf mistletoe 22
Lodgepole needleminer 23
Foliar diseases 23
Cone and seed pests 23
SPRUCE PESTS 23
Spruce beetle 23
Spruce weevil 25
Cone and seed pests 28
Black army cutworm 31
Spruce bud mortality 33
Spruce budworms 33
Spruce budmoths 34
Spruce gall adelgids 36
Spruce aphid 37
Tomentosus root rot 37
Rhizina root disease 37
Spruce leader dieback 38
A dieback fungus 38
Needle casts and a bud blight 38
Needle rusts 39
Porcupine 40
TRUE FIR PESTS 40
Western balsam bark beetle 40
Western blackheaded budworm 42
Foliar diseases 43
Green velvet looper 44
Balsam twig aphid 44
HEMLOCK PESTS 44
Western blackheaded budworm 44
Hemlock dwarf mistletoe 45
Porcupine damage 45
Rust-red stringy rot 45
A tip blight 45
CEDAR PESTS 46
A gall midge 46
Cedar leaf blight 46
Dieback of western red and yellow cedars ... 46

PAGE

LARCH PEST 47
Larch sawfly 47
DECIDUOUS TREE PESTS 47
Poplar leaf and shoot blights 47
Deciduous tree defoliators 47
Poplar-and-willow borer 48
SPECIAL SURVEYS 48
Nursery pests 48
Exotic plantations 48
Pinewood nematode 49
Gypsy moth 52
ARNEWS 52
OTHER INSECTS, DISEASES AND DAMAGE 52

INTRODUCTION

This report outlines the status of forest pests surveyed in the Prince Rupert Forest Region in 1987 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 still surveyed by Forest Insect and Disease Survey (FIDS) rangers in the Prince Rupert Forest Region, but the information is now reported in the annual Vancouver Forest Region report.

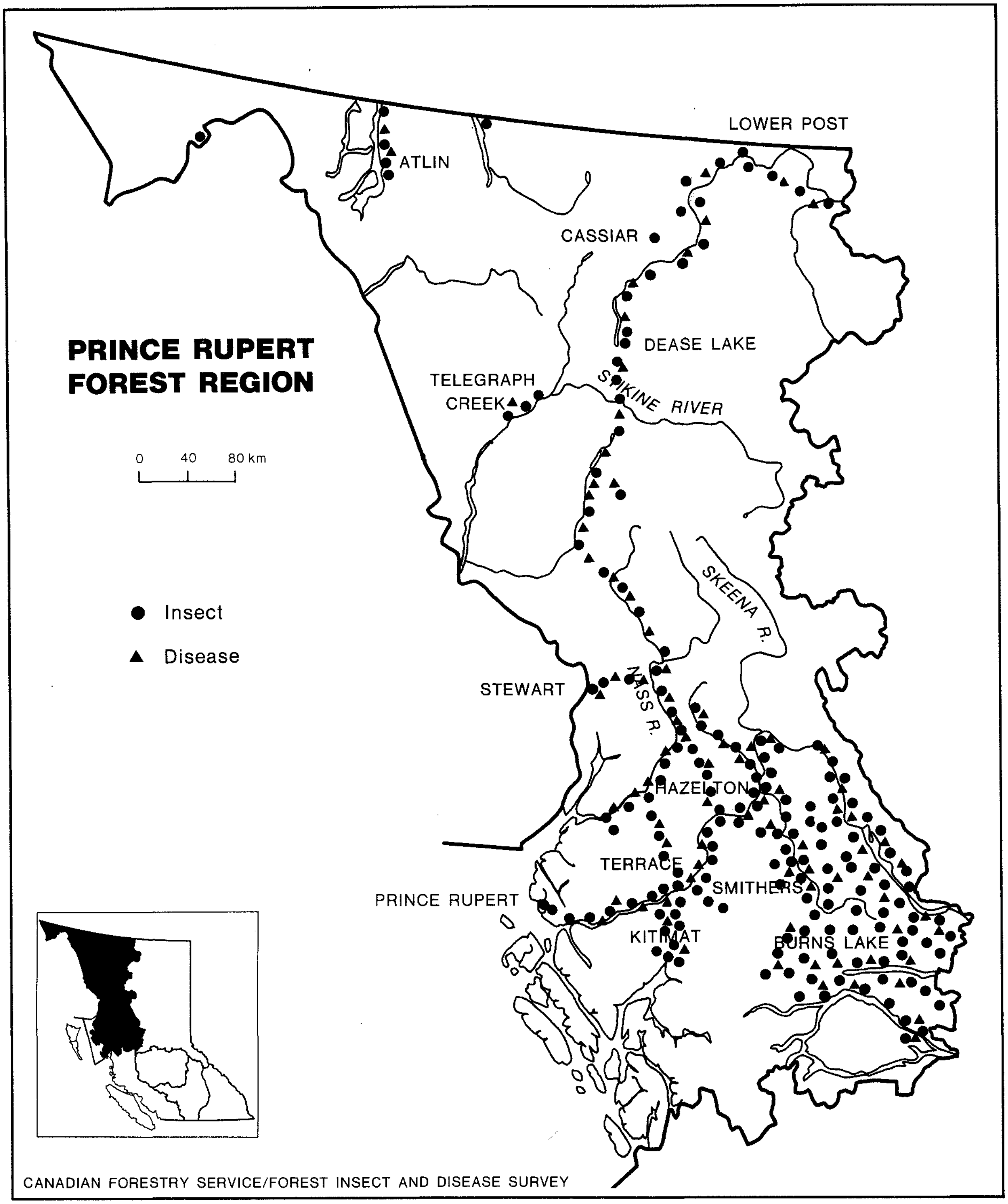
FIDS is a nationwide network within the Canadian Forestry Service (CFS) with the responsibility of (1) producing an overview of forest pest conditions and their implications, including predictions when possible; (2) maintaining records and surveys to support quarantines; (3) supporting forestry research 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 1987 field season extended from mid-may to late October. A total of 394 insect and disease collections were submitted by the authors to the Pacific Forestry Centre for identification and verification **(Map 1)**. An additional 10 collections were submitted from the northern limits of the region during the FIDS survey of the Yukon, and 24 collections were received from B.C. Forest Service staff throughout the region. In cooperation with research programs at the Pacific Forestry Centre and other institutions, 62 special collections were made in 1987. Approximately 157 contacts and on-site pest examinations were made with the B.C. Forest Service (BCFS) and industry personnel during the field season and the insect portion of a B.C. Forest Service and industry forest pest identification course was conducted for the coastal half of the region. Pest survey data were summarized and presented to the BCFS Joint Protection/Silviculture and Regional Forest Pest Review Committee meetings in November.

The District and Regional staff of the B.C. Forest Service are thanked for their co-operation and assistance for the following: aerial sketch maps of bark beetle infestations in interior districts, 6.5 hours of fixed-wing aerial time to survey pest problems in the western districts, and occasional ground transportation. Information and resources were also provided by industry personnel.

Throughout this report, defoliation intensity is defined as follows:

trace	- evidence of feeding barely detectable close up;
light	- some branch and/or upper crown defoliation, barely visible from the air;
moderate	- pronounced discoloration and noticeably thin foliage, severe top defoliation common;
severe	- top + many branches completely defoliated, most trees more than 50% defoliated.



Map 1. Locations where one or more forest insect and disease samples were collected in 1987

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

Forest Insect and Disease Survey
Box 2259
Smithers, B.C.
VOJ 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 CFS Headquarters for the Pacific and Yukon Region:

Forest Insect and Disease Survey
Canadian Forestry Service
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.

SUMMARY

In the following report of pest conditions in the Prince Rupert Forest Region, the pests are grouped by host(s), generally in order of importance.

Mountain pine beetle killed an estimated 869 000 m^3 of lodgepole pine over 18 400 ha. **Small mammals** severely damaged or killed 46% of the seedlings and young trees in 20 plantations. **Porcupine** damage continued at high levels. Preliminary studies indicate that **Tomentosus root rot** reduces annual increment of severely infected young lodgepole pine by half. An increasing **engraver beetle** population continued to kill lodgepole pine along cutblock perimeters and wildfire fringes. **Lodgepole pine beetle** killed scattered groups of pine in the northern portion of the region. There was a twofold increase in **Lodgepole terminal weevil** attack. **Western gall rust** was associated with volume loss of young lodgepole pine in a study plot near Ootsa Lake. **Comandra blister rust** killed 51% of the trees in a study plot near Burns Lake. **Dwarf mistletoe** shoot production on lodgepole pine increased while hyperparasitism decreased. **Lodgepole needleminer** populations increased in the southeastern portion of the region. **Foliar diseases** moderately to severely infected young pine near the Yukon border.

Spruce beetle populations were generally at low levels, with only small active pockets in the Kispiox River and Goathorn Creek areas. The incidence of successful attack by **spruce weevil** appeared to be associated with the proximity to a water course. **Cone and seed pest** activity was varied in a generally light to moderate cone crop. **Black army cutworm** populations subsided to non-damaging levels. **Spruce bud mortality** affected an average of 31% of surveyed young spruce. **Spruce budworm** populations increased in the Bell-Irving and Morice river areas. **Spruce budmoth** lightly damaged buds on 72% of the Sitka spruce examined. **Spruce gall adelgid** damage declined. **Spruce aphid** populations increased with damage mapped over 150 ha. **Rhizina root rot** fruiting bodies present in high numbers in recent burns north of Hazelton endangered newly planted seedlings. **Spruce leader dieback** infected young white spruce in the Klappan and Hyland river areas. **A dieback fungus, Sclerophoma sp.**, was associated with the mortality of recently planted spruce in the Suskwa River drainage. **Needle casts and a bud blight** moderately infected spruce in the southwestern portion of the region. **Needle rusts** severely infected spruce in the Dease Lake area and near the Yukon border.

Western balsam bark beetle killed alpine fir over 73 000 ha. **Western blackheaded budworm** populations caused light defoliation of alpine fir and spruce in the interior. Infections by **foliar diseases** continued at high levels on alpine fir in the central portion of the region. A **green velvet looper** lightly defoliated 150 ha of alpine fir and spruce in the Blunt Mountain area. **Balsam twig aphid** populations increased in the southwestern portion of the region.

Western blackheaded budworm populations collapsed after defoliating 11 900 ha of western hemlock near Kitimat in 1986. Chronic pests noted in hemlock stands included **dwarf mistletoe**, **porcupines** and **rust-red stringy rot**. **A tip blight, Coccomyces sp.**, infected up to 20% of the hemlock shoots in the Kisgegas area.

Surveys were initiated to determine the distribution of a new species of

gall midge on yellow cedar. **Cedar leaf blight** severely infected localized pockets of cedar north of Hazelton. Long-term **dieback** of western red and yellow cedars continued in the region.

Larch sawfly moderately defoliated tamarack near the Yukon border.

Infection of trembling aspen by **poplar leaf and shoot blights** continued to decline to trace levels in the western and northern portions of the region. Several **deciduous tree defoliators** lightly to moderately defoliated trembling aspen and willow over 175 ha in the Trout and Pine creek areas. Trees killed by **poplar-and-willow borer** were common in the Kitimat, Skeena and Kalum river valleys.

Special surveys included a **variegated cutworm** trapping program at Thornhill Nursery, re-examination of **exotic plantations**, surveys for **pinewood nematode**, continuing participation in a province-wide **gypsy moth** trapping program, and reassessment of an **acid rain** plot.

Other noteworthy but less damaging forest insect and diseases are listed.

Mountain pine beetle
Dendroctonus ponderosae

An estimated 1 436 000 lodgepole pine (869 000 m^3) were recently killed over approximately 18 400 ha from the eastern boundary of the region to Terrace (Table 1, Map 2), up from 946 000 trees in 1986. While increased numbers of recently killed trees were recorded in all TSAs except the Morice TSA, generally, the increase was reflected more in the number of trees than in the volume, as smaller diameter trees were attacked. Maps showing intensity and size of infestations were provided by the British Columbia Forest Service from the Lakes, Morice, Bulkley and Kispiox TSAs. The Kalum TSA and portions of the Kispiox TSA were mapped by FIDS personnel. These maps, along with ground observations and surveys by FIDS rangers, provided the basis for evaluating the progress and current biology/ecology of outbreaks throughout the occurrence.

Table 1. Area, volume, and number of lodgepole pine recently killed by mountain pine beetle, Prince Rupert Forest Region, 1987.

Location	Area (ha)[1]				Recently killed[2]	
(TSA)	Light	Moderate	Severe	Total	Volume (m^3)	No. of trees
Kalum	200	1 500	1 900	3 600	210 000	360 000
Kispiox	100	9 200	1 800	11 100	440 000	820 000
Bulkley	-	3 300	-	3 300	200 000	225 000
Morice	-	300	-	300	15 000	25 000
Lakes	-	100	-	100	4 000	6 000
Regional Total	300	14 400	3 700	18 400	869 000	1 436 000

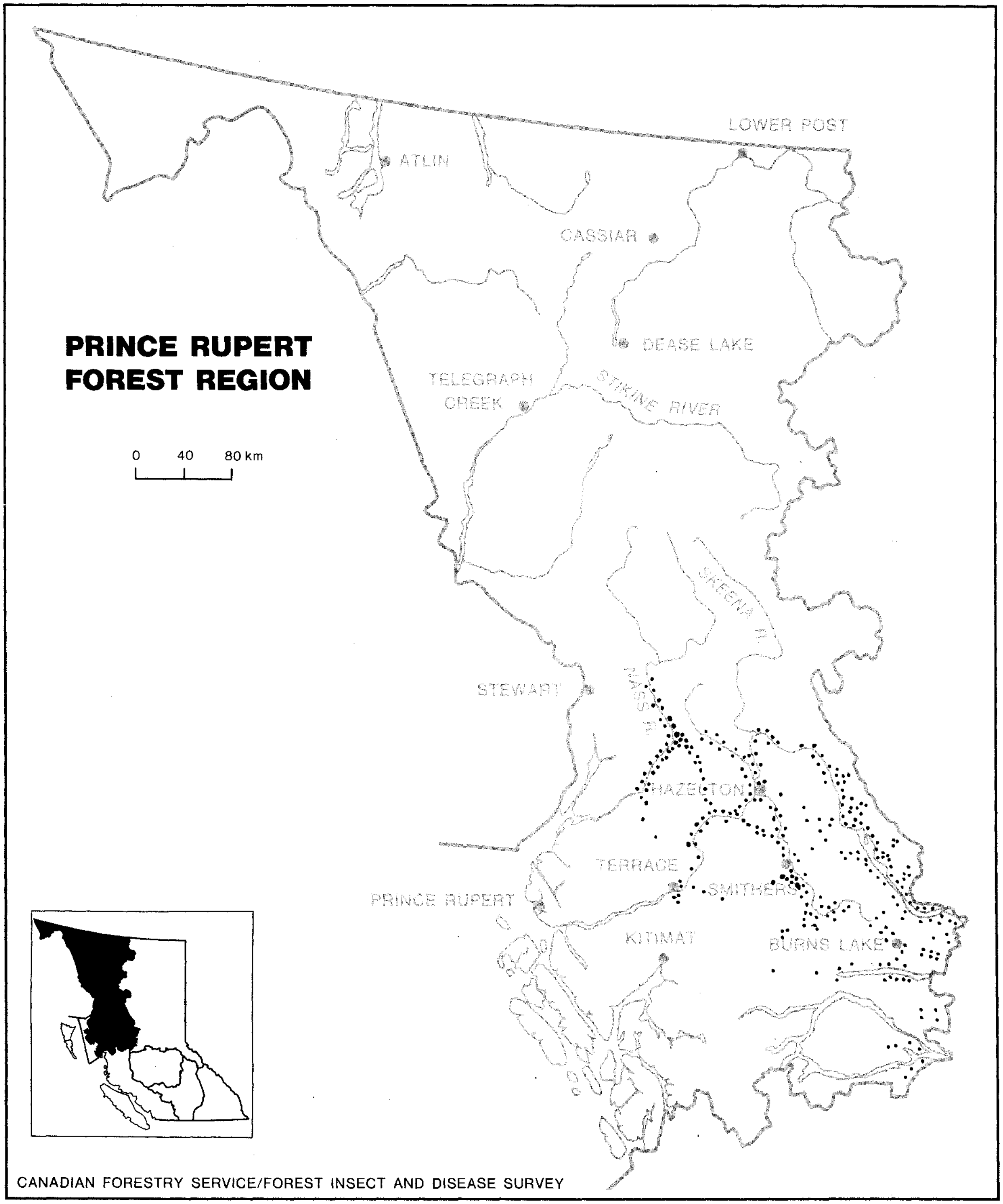
[1]Areas were computed at the Pacific Forestry Centre from maps provided by B.C. Forest Service district offices, except for the Kalum TSA and portions of the Kispiox TSA which were mapped by the authors.

Light - <10% of pine recently killed
Moderate - 10-30% of pine recently killed
Severe - >30% of pine recently killed

[2]Volumes and numbers of trees were calculated using CFS-FIDS field data - representative stands were cruised to provide conversion factors to relate area (ha) to volume and number of trees.

Kalum TSA

Due to the transfer of the heavily infested Cranberry Junction area into the Kispiox TSA, the area of infestation in the Kalum TSA declined to 3600 ha in 1987. Detailed maps of the TSA are not available from 1986 but ground observations indicate that although the incidence of attack varied, the total remained



Map 2. Areas of lodgepole pine recently killed by mountain pine beetle determined by aerial and ground surveys, 1987

comparable to 1986 levels. From Lakelse to Rosswood, a B.C. Forest Service fall-and-burn program in the winter of 1986/87 reduced the incidence of new attack in 1987. In the Skeena River Valley from Terrace to the Oliver Creek area, the incidence of attack increased slightly, particularly in newly attacked stands across the river (south side) from existing infestations. A high porcupine population continues to contribute to the numbers of red lodgepole pine in the western portion of the TSA, particularly on eastern slopes above Lakelse and in the Tseax River Valley.

Kispiox TSA

The greatest increase in recorded mountain pine beetle-caused tree mortality mapped in 1987 was in the Kispiox TSA, where the area increased to 11 100 ha from 4 300 ha in 1986. Several factors influenced the increase, including the transfer of part of the chronic mountain pine beetle area of the Cranberry Junction area from the Kalum TSA. In addition, the mapping criteria had been changed due to the lack of an intensive beetle control program in the TSA; as a result, less detailed maps were prepared by BCFS personnel.

The most intensive tree mortality again occurred in the Skeena River corridor from Hazelton southwest to the Kalum boundary (4 400 ha). The beetle had initially attacked trees on the south aspect slopes in 1970 when 200 trees were mapped near Burdick Creek; by 1976 close to 8 000 trees were mapped in the area, including 1 000 trees near Ritchie. As large susceptible pine stands were successively killed, portions of the beetle population dispersed at an increasing rate into the highly mixed western hemlock-lodgepole pine stands toward the southwest and to the south and east sides of the Skeena River.

In the upper Skeena River drainage north of Hazelton (2 500 ha), beetle activity decreased in the lower portion near Shegunia River where logging has depleted much of the susceptible host. An increase was noted along the Babine River where no control has been exercised.

The portion of Tree Farm Licence (TFL) 1 in the Cranberry Junction area, transferred into the Kispiox TSA, increased the area of beetle infestations by 2 200 ha. Infestations in this area started in 1971 and were well distributed throughout the Nass and Cranberry rivers area by the mid-1970's. Extensive logging and continuing beetle activity has eliminated many of the larger pine stands in the valley bottom; trees on slopes and ridges continue to harbor large beetle populations. Due to host depletion, current attacks were common on trees within previously attacked stands. Susceptible stands of primarily lodgepole pine are mixed with a predominance of western hemlock; as a result, the spread of beetle-killed trees has been a mosaic of recently attacked, old-killed and unattacked mixed stands.

The 1 500 ha of tree mortality mapped in the Kispiox River drainage consisted primarily of scattered small groups in leave blocks and scattered pine within immature western hemlock stands. The drainage has been heavily logged and few susceptible pine stands remain.

Bulkley TSA

The total area of beetle-killed lodgepole pine in the TSA has remained fairly constant over the past four years. However, the major infestation locations have shifted from the Harold Price Creek drainage to the lower-elevation Bulkley Valley area including the Telkwa and Trout Creek areas (3 100 ha). This was the only area of increased attack in the TSA. Infestations in the lower Telkwa River drainage and on the steep slopes southeast of Telkwa are the main concentrations of recent tree mortality. In addition, numerous widely scattered patches of 10 to 200 infested trees originated from these beetle incubation areas. In the Trout Creek area, the major infestation area has declined, but numerous small groups of recently killed pine persist, especially near the junction of Trout Creek and the Bulkley River valley. The effectiveness of extensive control programs including fall-and-burn, brood removal, pheromone trapping and specifically directed logging has been counterbalanced by the reserve of beetles migrating off the slopes to the pine stands below. Recent logging on the steep slopes has begun to address this problem.

The area of beetle-killed pine in the Chapman Lake-Harold Price Creek area had declined to 120 ha from 1 600 ha at its peak in 1981 and 1982. Several concentrations of up to 100 recently killed trees remain centered around Holland Hill and near Chapman Lake. A light scattering of generally less than 10 trees per group was mapped from Smithers Landing west to Paask Creek in the Harold Price Creek drainage and in the Nilkitkwa-Babine rivers area. In the latter area infestations have declined to 20 ha from 400 ha in 1986. Control programs combined with two consecutive winters (fall 1984 and 1985) of very high brood mortality and cool summers which extended life cycles have reduced the populations, especially in the relatively flat, mixed pine and spruce stands. Several scattered groups of recently killed pine continued in the Hankin Lake area, but vigorous broods were generally confined to the lower half-meter of the bole. With these restrictions, the beetle populations are expected to remain at static to decreasing levels.

Morice TSA

The major concentration of beetle activity in the TSA continued in the Morrison Lake area and the north side of Babine Lake (200 ha). The area mapped was slightly less than in 1986, with some of the older infestation largely depleted of mature pine. However, these were replaced by an increase in area and number of trees on the slopes along Hagan Arm. Control programs are ongoing, but with the widely scattered small groups of recently attacked trees, limited access, and the high susceptibility of the overmature, root-rotted pine in the area, the effectiveness has been limited. The greatest control factors have been both cool summer and cold winter conditions.

In the Topley-Houston-Morice River area the beetle activity increased, with tree mortality widely scattered over 40 ha. The most notable increase occurred on the slopes of Mt. Harry Davis and along the Morice River. The Morice River infestation was relatively new, with initial attack occurring in 1985 and only scattered individual trees evident in 1986. However, by 1987 several groups of 20-50 faders were evident on the south aspect slopes along the river. These and several other groups of mountain pine beetle-killed trees have resulted from brood build-up in 1984 wind-damaged trees.

Beetle populations in the Tanglechain and Fulton lakes area (20 ha) and in the Nadina River area have been reduced to widely scattered small groups of 5-20 and 1-5 trees, respectively. Climatic conditions have been the main controlling factor, augmented by control programs in the Tanglechain-Fulton lakes area. In the Nadina River to Sweeney Lake area, two years were generally required to kill trees, with partial attacks the first year followed by reattack the second year.

Lakes TSA

The 100 ha of recently killed lodgepole pine in the TSA continued in scattered groups of generally less than 30 trees. Although increases were recorded throughout the TSA, the majority of activity remained along the north shore of Babine Lake where close to 100 patches were recorded and between Tchesinkut and Francois lakes, with 15 groups of up to 75 trees. Across Francois Lake, new pockets of infestation were mapped on the south shore near Uncha Creek and to the west on both sides of the lake to the Morice TSA boundary. The number of small widely scattered groups of up to 20 red trees was similar to 1986 in the Cheslatta River, Knapp Lake, Chelaslie River and in the Decker Lake-Forestdale areas.

Although beetle populations have been present in most of the infestation areas in the TSA for the past ten years, there have been only small changes in the annual rate of tree mortality. The constancy of tree mortality has been due in part to control programs, especially of the larger infestations. Equally important have been climatic conditions which have suppressed brood production, especially in the small groups of attacked trees with only localized increases occurring in the more favorable micro-climatic habitats.

Not all of the red trees mapped have been caused by mountain pine beetle attack; both porcupine and Ips populations have been responsible for an increasing amount of tree mortality. Additional localized beetle infestations, along with Ips, have developed around recent wind-damaged lodgepole pine in the Loon, Pinkut and Francois lake areas. Root rot has also played a role in individual tree and stand susceptibility, with only half a dozen attacks per tree associated with recently killed root rot-infected lodgepole pine trees throughout the TSA.

Overwintering beetle survival

Overwintering beetle survival during the 1986-87 winter was one of the best that has occurred during the current infestation period. Climatically induced brood mortality was restricted to the broods caught in the egg and early-instar stage in infestations above 1100 m elevation. Adult survival averaged 60-80% in the Bulkley Valley and to the west and decreased to 40-60% in the eastern portions.

Conditions for good brood survival also aided predator survival as indicated by high mortality rates (30-80%), especially in localized spots within some of the older infestation areas in the Kispiox TSA. In these areas, 225 cm^2 bark samples from 45% of the trees contained up to 75 predators, primarily Clerid larvae. As a result the reproductive ratio, or "R value" (Table 2), was reduced to less than 1 in these trees.

Generally, "R" values increased in the interior infestations (avg. 6.9) but remained similar to or decreased (avg. 4.3) from the 1986 values in the western portion of the region due to depletion of optimal hosts in chronic infestations. However, high "R" values from infested trees near Rosswood and

Coyote Creek reflect the potential for further expansion through remaining stands with optimal host trees in the western portion of the region. Brood development during 1987 progressed favorably; with ideal fall conditions, overwintering survival should again be high.

Table 2. Mountain pine beetle reproductive ratios, Prince Rupert Forest Region, 1987.

Location	R value[1]	Population status[2]	Remarks
Hagan Arm	11.1	increasing	south aspect slopes
Telkwa River	10.8	"	" " "
Nilkitkwa River	9.7	"	in small pockets
Trout Creek	8.0	"	old infestation area south aspect slopes
Shegunia River	7.4	"	lP patches in wH stand
Cranberry Jct.	5.9	"	
Rosswood	5.4	"	recent outbreak
Coyote Cr.	5.0	"	new outbreak on south side of Skeena R.
S. Babine Lake	4.2	"	small pockets <20 trees
Loon Lake	3.8	static	small pockets <20 trees on ridges
Salmon River Rd.	3.7	"	wH mixed stands
Sideslip Lake	3.6	"	
Cedarvale	2.8	"	south aspect slopes, chronically infested
Kispiox River	2.7	"	old infestation area, host scarce
Kitwancool	1.9	decreasing	
Hankin Lake	0.7	"	small pockets new area
Regional average	5.4		

[1]"R" value = an average population trend ratio derived from counts in representative bark samples of numbers of insects divided by numbers of galleries originating within the sample area. Values are derived in June to reflect the population status early in the field season and after the effects of any overwintering stress.

[2]Interpretation of "R" values to determine population status:
$\leq$2.5 - decreasing population
2.6-4.0 - static population
$\geq$4.1 - increasing population

Fall surveys

Twelve stands in the region were cruised to determine current attack levels and brood development (Table 3). The average level of current attack (volume) climbed to 42%, up from 36% in 1986. The high current attack levels reflect the excellent overwintering brood survival and indicate an overall vigorous beetle population.

Table 3. Status of lodgepole pine in stands infested by mountain pine beetle determined from fall prism cruises in representative stands, Prince Rupert Forest Region, 1987.

Location	No. of trees assessed	Percentages of pine, volume and no. of trees attacked									
		current		partial		red		gray		healthy	
		vol.	trees	vol.	trees	vol.	trees	vol.	trees	vol.	trees
Sideslip L.	85	17	12	3	2	33	20	4	2	43	64
Nass R.	60	15	11	0	0	37	20	11	6	37	64
Cedarvale	70	36	26	3	4	13	12	12	9	37	49
Kitwanga	78	26	28	4	5	31	22	14	10	26	36
Kispiox R.	47	68	68	2	3	13	11	0	0	17	18
Trout Cr.	101	40	30	6	3	12	7	2	2	40	58
Telkwa R.	139	58	58	0	0	7	5	7	4	28	33
Coffin L.	86	56	55	0	0	8	7	0	0	36	38
Nilkitkwa R.	45	52	52	2	2	3	2	0	0	43	44
Houston	40	39	35	0	0	3	3	3	3	55	59
Morice R.	110	50	39	6	8	4	2	0	0	40	51
Francois L.	48	49	46	2	2	0	0	0	0	49	52
Regional averages	-	42	38	2	3	14	9	4	3	38	47

The parent beetle survival resulted in a small early flight, with attack generally centered on previous partially attacked trees. The combination of early attack and dry climatic conditions resulted in up to 20% of the 1987 attacked trees fading by fall. These early-attacked trees were frequently the focusing point of a high percentage of the progeny from nearby small pockets of beetle activity. This was particularly noticeable in infestations at Nilkitkwa and Morice rivers, and Francois Lake where current attack was concentrated in occasional large patches. General walkthrough surveys in these areas indicated only individual or small groups of current attack near most of the pockets of red trees. In general, the ratio of current to red attack indicated increasing populations; the average ratio was 1.7:1 but ranged up to 4:1.

In large infestation areas cruise strips were usually placed along the advancing edge of the infestation, adjacent to the fringe of red trees. This results in a relatively high current attack level compared to the level of previously killed pine and indicates the annual fluctuations in population vitality. Additional observations indicated that the number of small infestation pockets was spread out farther from the main infestation centers than in recent years. In the Nass River and Sideslip Lake areas a reduction in the proportion of volume and numbers of trees currently attacked reflected both the scarcity of optimal hosts and the attack of smaller less susceptible hosts in an area of chronic infestations.

Infestations at Francois Lake, Houston, Loon Lake, Morice River and Nilkitkwa River were developing around wind-damaged pine consisting of blowdown, broken stems, and partially uprooted trees. Beetle attack was noted on these trees in 1984, with much of the brood developing over two years. A detailed cruise in two relatively isolated beetle areas near Francois Lake had four and seven current attacks in 1985, 12 and 15 in 1986 and 42 and 60 attacks in 1987.

Conditions and sites must be favorable for beetle populations to develop in these situations but it appeared to have been a major contributing factor in a number of new infestation areas. Ips populations are frequently associated with blowdown trees and occasional adjacent red trees; therefore, mountain pine beetle often is not suspected until infestations increase in size several years later.

Porcupine-damaged trees frequently had mountain pine beetle attack but there was no evidence of significant local population buildup as a result.

Forecasts

Observations and surveys from 1987 indicate that beetle populations should increase in 1988. Most broods developed to a winter-hardy mid-instar stage and, combined with a long gradual cooling during the fall acclimatization period, mortality levels should be low. Some of these favorable conditions may be offset locally by a reduced availability of large-diameter mature pine stands leading to a decrease in brood survival and productivity. This was especially evident in some of the older infestations in the vicinity of the Cranberry-Nass rivers, and Kispiox and Skeena rivers.

Populations are expected to continue to move westward along the Skeena and Nass drainages where suitable hosts are available. The outbreak could continue to be minimized in the Terrace area (Lakelse to Rosswood) if a fall-and-burn program is continued by the B.C. Forest Service to treat infested trees as they are located. Additional measures, such as pheromone-baited lethal trap trees, could also be useful while the population is still manageable.

Static populations can be expected to continue in the Chapman Lake, Harold Price Creek, Guess Creek and Nilkitkwa Lake areas where extensive control programs have reduced beetle populations. Major beetle activity should continue in the large infestation centers along the Bulkley and Telkwa rivers, as not only the infestation size increases but populations continue to widely disperse from the steep slopes into the surrounding mature pine stands. Increased attack can be expected also on the north side of Babine Lake and in the scattered pockets of beetle attack in the Lakes TSA and the southern part of Morice TSA. Some of these forecasts, based on brood productions, may be offset by intensive control programs, or climatic conditions.

Mammal damage

Populations of small mammals, particularly voles, increased to epidemic levels and caused considerable damage in young stands. Porcupines remained at high numbers, damaging trees in all age classes.

Voles

Small mammal populations (primarily voles) increased to epidemic levels in late 1986 and into 1987. Extensive damage was recorded in numerous plantations in the Lakes, Morice and Bulkley TSAs. Extensive debarking of willow and downed trees from the Nilkitkwa River area south to the Tahtsa Lake region were further evidence of large population increases. Overall, 46% of the seedlings and free-to-grow trees were damaged or killed in the 20 most affected plantations (Table 4). An additional 25 plantations examined had only minor (<5%) damage to seedlings. The greatest impact was to 1986 plantations, but severe damage also extended to plantations up to 12 years old. Surveys consisted of evenly spaced 10 m^2 plots along three to five randomly placed strips in a cutblock.

Table 4. Incidence of small mammal damage to lodgepole pine and white spruce in the 20 most severely affected plantations, Prince Rupert Forest Region, 1987.

Location	Tree species	Number of seedlings per hectare			Burned[2]
		Healthy	Damaged[1]	Dead	
Crow Cr.	lP	100	450	450	Y
Lamprey Cr.	lP	150	650	150	N
Maxan Cr.	lP	200	500	500	N
Harold Price Cr.	lP	300	250	400	Y
Poplar L.	lP	350	600	250	N
Crow Cr.	lP	400	300	450	Y
Lamprey Cr.	lP	450	600	150	N
Owen L.	lP	500	400	100	N
Covert Cr.	lP	500	350	350	N
Ootsa L.[3]	lP	550	500	100	N/A
Lamprey Cr.	lP	650	450	100	Y
Tanglechain L.	lP	700	350	150	N
Poplar L.	lP	700	400	100	Y
Covert Cr.	lP	750	200	250	Y
Lamprey Cr.	wS	750	350	100	N
Crow Cr.	wS	800	150	150	Y
Ootsa L.[3]	lP	800	250	150	N/A
Maxan Cr.[3]	lP	850	250	100	N/A
Smithers Ldg.	wS	950	200	50	Y
Ootsa L.	lP	950	250	0	Y
Average		570	375	200	
Percent		46	30	16+ dead other causes 8	

[1]Damaged seedlings refers to seedlings with severe damage to the cambial layer of the stem but seedlings should survive.
[2]Burned = cutblocks that were prepared for planting by slash burning.
[3]These were older lodgepole pine plantations aged 4 to 12 years. All other plantations were one or two years old.

Lodgepole pine was damaged more frequently and more severely than white spruce but occasional patches of severe damage were also recorded in spruce plantations (Table 4). A comparison of damage indicated that the frequency of damage was greater in non-burned sites than in the burned, 61% versus 45% (Table 5). However, of the seedlings fed on, the mortality rate was higher in the burned sites (42%) than in the non-burned (31%).

Table 5. A comparison of vole damage in burned and non-burned cutblocks, Prince Rupert Forest Region, 1987.

Location	Percent of seedlings			
	Healthy	Damaged	Dead	Dead other causes[1]
Burned	45	26	19	10
Non-burned	31	42	19	8

[1]primarily poor planting sites or poor planting stock

Damage to recently planted seedlings (1985-1987) generally consisted of bark feeding at or near ground level during the winter period when foliage, bark and cambium of woody vegetation became an important part of the diet. Most partially girdled, but properly planted healthy seedlings, should survive. Similarly, most seedlings completely chewed off above ground but with live laterals in the upper duff layer, growing under otherwise favorable conditions will likely recover. This was indicated on re-examination of 50 lodgepole pine seedlings severely damaged by voles in 1983; of the seedlings chewed off above the first live lateral, 20% died, 30% had two or more saplings growing from a single root stock and 50% had a single normally growing stem.

Damage tends to be patchy in affected plantations, creating large, poorly stocked openings. Although only one of the plantations examined had fewer than 700 live seedlings per hectare, at least half of the plantations will require fill-in or replanting in order to maintain a well-spaced stocking.

Of 15 damaged plantations in the free-growing stage in the Andrews Bay area, only three had significant small mammal damage (Table 4). Light damage was extensive, but often damage did not extend to the cambial layer; these trees were considered healthy. Up to 10-ha patches had an average of 14% of the trees girdled at ground level and an additional 21% were girdled above the bottom whorl. Although these latter trees will be severely deformed initially, they will likely recover rapidly under the open-growing conditions.

Vole populations are highly cyclical with peak levels occurring approximately every four years. Climatic conditions during the fall and winter affect overwinter survival, but equally important are the spring and summer conditions which influence the prolific reproductive capacity of one or more litters averaging five young. Several long warm summers combined with relatively mild winter conditions allowed the current cyclic peak to climb much higher than the previous peak in 1983, when only small portions of several plantations were severely damaged. Several other factors appear to be involved in population increases in specific areas. Logging disturbance increases the herbaceous food source available. Increased populations have also been associated with areas of high-sodium content in the soil, such as found in recent slash burns, with peaks being 10 times higher than in low-sodium sites.[1]

[1]Aumann, G.D., 1965. Microtene abundance and soil sodium levels. J. Mam. 46:495-604.

Based on general observations, the population level remained high during the fall of 1987 and further damage can be expected over the winter period. The literature indicates, however, that major collapse may be initiated during high-population levels when intraspecific pressures result in birth abnormalities of the overwintering populations.

Although voles and small mammals, in general, are a major pest when populations are high, they serve as a primary vector in the dispersal of hypogeous mycorrhizal fungi.[1] These fungi are necessary for the survival and health of all conifers.

Porcupines

Dieback and mortality caused by porcupine feeding remained generally at the same levels reached in 1986 throughout the range of lodgepole pine in the region. Damage was usually observed in sapling to semimature lodgepole pine, which is the preferred host. Though patchy in occurrence, the annual rate of current attack is usually less than 5% of a stand overall, generally 1 to 3%.

In northern areas porcupine damage was most common in sapling regeneration, along the eastern slopes above Dease Lake and near the Hyland River. Farther south, as scattered patches of damaged trees turn red, they resemble spot outbreaks of the mountain pine beetle which is also active in several of the older porcupine-damaged stands. In dense stands, scattered porcupine feeding acts as a natural thinning agent, particularly if whole trees die. In thinned stands, however, such as in the Kalum Valley, damage to the remaining trees becomes significant.

Several factors have contributed to the current high porcupine population. These include recent mild winters, trapping which has reduced predator numbers, particularly the fisher, and pole-sized slash commonly left in thinned stands which provides ground cover refuge for the porcupine and may impede predator movement. The trend to fewer but heavier thinnings increases both the value of remaining stock and the impact of porcupine feeding. The B.C. Forest Service is attempting to lower the porcupine population in the Kalum District, particularly in managed stands in the Kalum Valley, by implementing a bounty and testing several traps.

Tomentosus root rot
Inonotus tomentosus

Young lodgepole pine stands (30 to 65 years old) were surveyed to determine the incidence of the root rot. Based on 10 trees examined at each of 10 natural pure pine stands, light infection first became evident as rot-stained root cross-sections where trees were about 30 years old. By 50-60 years of age, most of the trees were infected and 50% of the cross-section of the main root was infected (Table 6).

[1]Maser C., Trappe, J.M., Nussbaum, R.A., 1978. Fungal-small mammal interrelationships with emphasis on Oregon coniferous forests. Ecology 59(4):799-809.

Table 6. Incidence and intensity of tomentosus root disease in 10 young lodgepole pine stands, Prince Rupert Forest Region, 1987.

Stand age	Average incidence - %	Main root cross-section % stained	Main root cross-section Standard deviation
<30 yrs.	20 (1 stand)	7	± 2.5
31-50 yrs.	80 (70-100%)	24	± 15
51+ yrs.	100 (N/A)	50	± 18

During stand examination for incidence, it was observed that tree growth was reduced in the infected trees. As a preliminary assessment to determine the impact of the root rot, trees were classified into infection categories by examining the major root at the root collar area. Previous studies had indicated that this root rot first became evident and was at its most advanced stage at this point.[1] Increment cores were taken at breast height and measured by Addo-x.

A comparison of the annual radial increment from a pre-infection period when the trees were 16-25 years old, was done for two different infection intensity categories. These trees at this age were assumed to be free of root rot due to the absence of infection found in trees under 25 years. The results indicated that I. tomentosus was the causal agent and it was infecting the most vigorous and fastest growing young trees (Table 7). Annual radial increment was reduced from 1.76 mm prior to infection to .58 mm during the most recent 10-15 years in the most severely infected trees. However, annual radial increment naturally declines with increase in age and diameter, averaging 16% with the healthy trees in the sample plots. The additional reduction to 34% in the 5-50% infection category and to 67% in the 51%+ infection category was assumed to be due to root rot. In comparison, the healthy trees had annual radial increments close to double that of the severely infected trees.

The effect of spacing in root rot-infected stands was given only a cursory examination. In the two spaced stands adjacent to unspaced stands, the root rot incidence was 15% higher in the spaced stands. However, the intensity of infection was much less in the spaced stands with only an average of 9% of the root cross-section infected compared to 33% in the adjacent unspaced portion of the stand. Further studies are being planned to evaluate the full impact of the root rot in both natural and managed pine stands.

[1]Forest Insect and Disease Conditions, Prince Rupert Forest Region, 1986.

Table 7. Impact of Tomentosus root disease on lodgepole pine radial increment at two levels of infection intensity, Prince Rupert Forest Region, 1987.

Infection intensity[1]	No. of trees	Avg. age	Average annual radial increment (mm)			
			Pre-infection[2]	S.D.[3]	During infection[4]	S.D.
Healthy	12	44	1.36	±0.10	1.14	±0.29
5-50%	40	48	1.54	±0.16	1.01	±0.28
51%+	8	59	1.76	±0.03	.58	±0.19

[1]the percent of stain in the main root's cross-section
[2]average annual increment at dbh when the trees were 16-25 years old
[3]Standard Deviation
[4]average annual increment during the most recent 10-15 years

Engraver beetles
Ips spp.

Engraver beetle activity, particularly _I. pini_, remained high after significant increases resulted from extensive lodgepole pine blowdown in 1984. Large broods had been produced in the blowdown, especially on southerly aspect slopes in the drier southern Morice and Lakes TSAs.

Frequently both engraver and mountain pine beetles were present in the small groups of recently killed pine. Current engraver beetle-attacked trees are suspected when fading trees are found during the last two weeks of July. In contrast most of the previous year's mountain pine beetle-attacked trees will have turned a more reddish color by this time.

Fringe tree mortality along recent unburned cutblocks and road construction areas continued with frequent groups of 5 to 35 dying trees throughout the Morice and Lakes TSAs. Five recent engraver beetle-attacked trees in representative stands near Pinkut Lake, the west end of Francois Lake and in the Nadina River area were infected by _Inonotus tomentosus_. Infection ranged from advanced decay in one main root to extensive decay of the whole root system.

Groups of 15 to 20 currently attacked trees, a fourfold increase from 1986, were common along the fringe of the Swiss Fire in the Buck Creek-Parrot Lakes area. The beetles have recently been migrating from the fire-damaged trees into the relatively healthy trees, especially trees with slight scorching on parts of the root system.

Both _Ips pini_ and _I. mexicanus_ were collected from stands chronically infested by the mountain pine beetle near Kitwanga and Cranberry Junction. Populations have increased locally in slash piles and killed trees to about 20 m into some surrounding stands.

The current practice of piling or windrowing slash without further treatment provides a much more favorable environment for brood production than evenly scattered slash throughout the cutblock. In the latter, slash will dry out rapidly, increasing brood mortality and rendering host material unacceptable.[1] Crucial to population buildup is the availability of late-winter or early-spring logging slash during the initial spring attack period. Depending on climatic conditions one generation can develop within a three to seven week period with two to three generations commonly occurring each year. Therefore, large engraver beetle populations breeding in windrowed slash during the summer months will significantly increase the hazard to surrounding stands.

Lodgepole pine beetle
Dendroctonus murrayanae

Patches of up to 50 mature lodgepole pine attacked in 1986 and 1987 were scattered from the Dease River Valley to the Cottonwood River Valley and north of Blue River. The lodgepole pine beetle was the primary agent with numerous attacks at the root collar and lower bole of dead and dying trees. Trees were also heavily infested by the pine engraver, Ips pini. Other secondary bark beetles, Hylurgops porosus and H. rugipennis, were collected at the root collar.

Populations of bark beetles near the Dease and Cottonwood rivers may have increased following large forest fires in 1982, breeding in singed and dying trees before dispersing to healthier hosts. The scattered infestation north of the Blue River is in older trees, about 175 years old, where age and root rot may be contributing factors.

Lodgepole terminal weevil
Pissodes terminalis

An average of 20% of young lodgepole pine leaders were recently attacked by terminal weevil at seven plots in the interior of the region (Table 8). This was a twofold increase over 1986 and a fourfold increase since 1985.

Although the attack level was high, the impact was reduced with 54% of the attacked leaders only partially killed. The greatly reduced impact was due to the effect of parasitism, climatic conditions and the timing of the egg laying flight. In samples of 1986-attacked leaders examined in May 1987 at Andrews Bay, up to 65% contained parasites. Additionally, recently killed late-instar larvae and pupae were common in the spring, possibly due to the extended cool conditions. Climatic factors also affected the degree of damage. The adult flight period was delayed and attack was concentrated near the tip of the growing terminal which resulted in primarily the terminal buds or only the upper few inches of the 1986 growth being killed. Early attacks usually are concentrated near the base of the terminal and the whole year's growth is killed. In addition, about 40% of the 1986 progeny died from unknown causes during the egg and early-instar larval stage before the shoot had been girdled. This resulted frequently in mortality of only one side of the terminal bud causing stunted terminal growth in 1987.

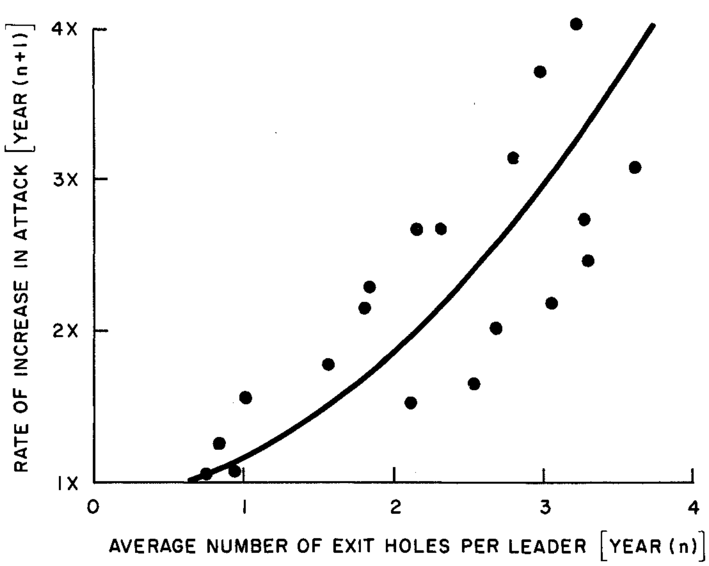
[1]Andrews, R.J. 1988. Pine engraver beetle, Ips pini, in British Columbia, Canadian Forestry Service, Pacific Forestry Centre, Forest Pest Leaflet (in prep.).

Table 8. Incidence and intensity of lodgepole pine terminal weevil attack in young lodgepole pine plantations, Prince Rupert Forest Region, 1987.

Location	Percent 1986 attack	Average number of exit holes per attacked leader in 1987[1]
North Road	35	0.2
Nilkitkwa L.	32	0.0
Topley Ldg. Rd.	26	0.8
McBride L.	18	0.2
Andrews Bay	17	0.2
Collins L.	9	0.2
Andrew Main	4	0.0
Average	20	0.2

[1]Studies in the Prince Rupert Region to date have indicated that populations will decrease when there are fewer than .62 exit holes per leader (Figure 1).

Figure 1. Relationship of Pissodes terminalis exit holes in previous year to increase in incidence of leader attack in the following year, Prince Rupert Forest Region, 1984-87.



The average number of exit holes per leader provides some indication of the degree of attack that can be expected the following year (Figure 1). Data from three years of observations indicate that in all but one case a major decline in 1987 attack occurred. A follow-up on the 1987 emergence, which was the lowest observed in the three years, is not included.

Indications were that the flight was delayed again in 1987 with all of the attacks located within 5 cm of the terminal buds, based on 10 currently attacked leaders examined at both Andrews Bay and Nilkitkwa Lake in October. Single late-instar larvae were present in 70% of the attacked leaders; the remainder had small dead early-instar larvae in the cambium area.

Western gall rust
Endocronartium harknessii

This common gall-forming rust causes stem or branch dieback and reduces the growth of infected lodgepole pine. In 1981, a plot was established near Ootsa Lake to determine the effect of stem galls on the volume increment. Fifty trees with stem galls and 50 uninfected adjacent trees were identified in a recently spaced 45-year-old fire-origin stand. On re-examination in 1987 the volume of the infected trees averaged 14% less than the uninfected trees (.105 m^3). Both diameter and height growth were affected (Table 9). Additional volume was lost with the breakage of 8% of the infected trees. All the breakage occurred following spacing, when the crowns of the leave trees were more exposed to wind.

Table 9. Average annual diameter and height growth of healthy (n = 50) and western gall rust-infected (n = 50) lodgepole pine between 1981 and 1987, Prince Rupert Forest Region, 1981-87.

	Average dbh (cm)[1] (± standard deviation)	Average ht (m)[2] (± standard deviation)
Healthy	.71 (± .07)	.46 (± .09)
Infected	.59 (± .05)	.34 (± .09)

[1]dbh was field-measured at marked point on trees
[2]heights were obtained by Suunto clinometer readings

Surveys to evaluate the occurrence of this rust in northern areas of the region found about 5% of regeneration in the Hyland Valley was infected, saplings near Blue River were infected at trace incidence, and infections were common in a mature stand near Glenora. In each area less than 5% of branches or stems were galled.

Comandra blister rust
Cronartium comandrae

Infections by Comandra blister rust in lodgepole pine have been recorded in most areas of the region at varying levels. This stem rust grows, girdles, and kills young lodgepole pine faster than other blister rusts. It is during the first 2 to 10 years after seedling outplanting that much of the infection occurs. In a study plot near Burns Lake established in a 10-year-old plantation in 1981, 47% of the stems were initially infected. This increased to 61% over the following 7 years to an average of 2% a year (Table 10) and mortality of infected trees increased from 1% to 51%. By 1987 all the trees infected in 1981 had died; an additional 4% died from infections that became evident after 1981.

Table 10. Infection and mortality of young lodgepole pine caused by Comandra blister rust, Prince Rupert Forest Region, 1981-1987.

Year of examination	Stand age	Healthy (%)	Infected (%)	Dead (%)
1981	10	53	46	1
1983	12	48	28	24
1987	16	39	10	51

Surveys to evaluate the occurrence of this rust in northern young stands found small numbers of dead or dying infected trees near the Hyland River, 3 km south of the Yukon border on Highway 37, and near Logjam Creek on the Alaska Highway.

Lodgepole pine dwarf mistletoe
Arceuthobium americanum

Production of new mistletoe shoots doubled at four locations in 1987. An average of 65% of the infections examined produced shoots (Table 11), compared to 31% in 1986. The incidence of hyperparasitic fungi, however, was reduced to 18% of the male shoots infected, half the incidence of 1986. The most common hyperparasitic fungus was *Wallrothiella arceuthobii*, which killed more than 90% of the shoots. Infection by *Colletotrichum gloeosporioides* decreased from about 70% over the past three years, especially on female shoots, but was still the most frequent cause of male shoot mortality.

Table 11. Effect of hyperparasitic fungi on lodgepole pine dwarf mistletoe, Prince Rupert Forest Region, 1987.

Location	Percent of mistletoe infections with mistletoe shoots	Percent of shoots hyperparasitized	
		male	female
McBride L.	50	0	0
Pinkut Cr.	70	70	20
E. Francois L.	65	15	27
W. Francois L.	75	0	25
Average	65	21	18

Lodgepole needleminer
Coleotechnites sp.

A needle miner lightly defoliated terminals and upper crown foliage of lodgepole pine in young stands from the Andrews Bay area to east of Burns Lake. During a previous infestation in 1980-83, terminal mortality reached 56% following two consecutive years of feeding. After three consecutive years, all of the trees had dead terminals and 75% had lost at least 2 years of terminal growth, resulting in bushy or forked tops.

Foliar diseases

Foliar diseases of lodgepole pine were common in the northern areas of the region in 1987.

Elytroderma needle disease, Elytroderma deformans, infected 30-80% of the needles on 40% of the lodgepole pine in the Hyland Valley. Light infections by a needle cast, Lophodermella concolor, were common on saplings near Partridge Creek on the Alaska Highway. The impact of these needle casts on young pines is variable. Infections by L. concolor are significant only if severe and repeated in successive years, while infections by E. deformans are systemic and gradually reduce the vigor of host trees.

About 12 km north of Blue River, 30% of the needles on 10% of the lodgepole pine were tentatively identified as infected by red band needle blight, Scirrhia pini. If confirmed by further sampling in 1988, this will be a significant northern extension of the known distribution from the center of the region.

Desiccation of foliage caused by winter drying occurred at moderate incidence in a stand 2 km south of the Yukon border on Highway 37.

Cone and seed pests

Lodgepole pine cone crops were light to moderate in the region in 1987 and no damaging insects were found in cone collections from Tsaybahe Creek, Glenora, near Kitimat, and from near Houston.

SPRUCE PESTS

Spruce beetle
Dendroctonus rufipennis

For the first time since 1975 no recent spruce beetle-killed trees were mapped during aerial surveys. During the infestation period from 1976 to 1986 an estimated 6 292 000 m^3 of mature spruce were killed by the spruce beetle. Despite the lack of aerially observed infestations, spruce beetle populations remained active in several areas, mostly in windfall and some standing mature trees.

Kispiox TSA

The upper Kispiox River drainage continues to maintain a relatively active population, with groups of 5 to 25 1986-infested trees. During spring examinations, an average of 40 adults per 225 cm^2 bark sample was found at breast height of mature fringe trees. Farther into the stand, the 1986 broods did not mature until late summer when equally large numbers of adults were present. These beetles will overwinter and fly in 1988. Although the beetles have been present in the drainage for a number of years, the current attack level has been maintained by recent road construction which has disturbed the drainage system, creating pockets of stressed trees vulnerable to beetle attack. Similar extensive road construction in the Gail Creek area has resulted in current attack to scattered individual trees, and further population expansion can be expected.

Bulkley TSA

Current beetle attacks were found during probe surveys in several areas of the Bulkley TSA. The most extensive attack was in the Goathorn Creek area where several small patches of spruce over up to 1 ha had up to 31% current attack. The infested trees were located primarily along hillside streams feeding into Goathorn Creek and above the areas of recent logging for spruce beetle control. In the Hankin Lake area, severely attacked roadside log decks were removed by late fall. Only scattered standing attacks were noted in the surrounding area. In the Trout Creek area, scattered pockets of standing attack were associated with *Inonotus tomentosus*-infected mature spruce. Near Walcott, the limited number of remaining mature spruce harbored a declining beetle population.

Morice TSA

Spruce beetle populations generally remained static in the TSA. Despite significant overwinter mortality in 1985-86, large broods were found in windfall in the Shelford Hills and the upper Klo-Dungate creeks areas. The potential for local population increases exists in extensive blowdown in upper Klo-Dungate creek where groups of five trees and 1/10-ha pockets occur every 20 to 100 meters over approximtely 100 ha. In the small pockets of 1986-attacked standing spruce in the Lamprey Creek to Nadina River area, beetle populations were controlled largely by heavy woodpecker feeding. In the 5-10% of the trees not woodpeckered, however, broods of 25 to 50 late-instar larvae and pupae per 225 cm^2 indicate the low to moderate potential for population increases in the area.

Cassiar TSA

An active local outbreak of the spruce beetle has killed white spruce around the perimeter of a large cutblock in the Hyland River area near the Liard River junction since 1985. Earlier logging resulted in the buildup of beetle populations in slash and abandoned log decks. Dead spruce extended up to 50 m into the surrounding stand along about 1 km of cutblock edge. A low level of current strip attack still persists in some of the remaining "leave" trees.

An endemic spruce beetle population in the Haines Road area near the B.C.-Alaska border increased slightly in recently windthrown trees. Early sanitation of infested windthrown 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.

Role of blowdown in spruce beetle population increases

Since spruce beetle population increases often follow a period of extensive blowdown, a plot was established in 1984 in a blowdown area along the upper Kispiox River. Data indicated an average of 5.5 blowdowns per hectare; previous studies had indicated that 1-2 mature blowdown or equivalently susceptible trees per hectare will maintain a beetle population. In 1987, broods from each blowdown tree had killed an average of 2.2 standing trees in 1986. Further tree mortality is expected to occur in the stand in 1988 when adult populations (40 adults per 225 cm^2 bark sample) in these trees emerge.

Forecasts

In general, spruce beetle attacks in 1988 should remain at low levels. Several exceptions exist, however, specifically along the upper Kispiox River where large numbers of adults continue to threaten mature spruce stands and in the Gail Creek area where potentially increasing populations should be closely monitored. Some beetle populations developing in unsalvaged 1984 blowdown areas in the southern portions of the region may become more evident in 1988 or 1989. In 1989, some increased beetle attack could develop in extensive 1987 blowdown in areas such as in upper Klo Creek and elsewhere where blowdown occurs.

Spruce weevil
Pissodes strobi

The spruce weevil is a chronic pest of young spruce stands in several southern areas of the region and is of particular concern in hybrid Sitka X 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.

In 1987, surveys were conducted to assess a) the variation in the occurrence of successful current attack near watercourses, and b) the western distribution limits of successful attacks in the western (Skeena Valley) and northern (Nass River Valley-Meziadin Lake) areas. One of the factors influencing the incidence of successful attack by the spruce weevil in northwestern B.C. may be the proximity of a river, stream, or bog. This effect was first broadly assessed at several locations in 1986. Surveys in 1987 were placed to assess the gradation of the effect with respect to distance and elevation from two rivers in the Kitimat Valley (Table 12). Although elevation and distance from the rivers increase together, elevation appears to be a more consistent influence on the occurrence of current attack. It is not known which biological and/or ecological factors are regulating the variations observed in the incidence of successful attacks.

The western and northern distribution limits of successful current attacks in the Skeena and Nass valleys, respectively, were also assessed (Table 13). In the Skeena Valley no attacks were detected farther west than the Exchamsiks River, although in 1968, attacks were found 5 km farther west at Salvus. It is not known if additional westward distribution could occur from these areas due to climatic fluctuation and/or the increased availability of susceptible hosts in brushed-over sites currently being rehabilitated to spruce in the valley bottom.

Table 12. Incidence of successful current attack by the spruce weevil as related to proximity of a river, comparing relatively pure plantations without brush competition, Prince Rupert Forest Region, 1987.

Location and proximity to river	Stand age	Elevation above river (m)	No. of trees assessed	No. of trees percent attacked
Kitimat R. Valley				
Kitimat R. (50 m)	14	2	56	63
Kitimat R. (50 m)	11	2	177	50
Kitimat R. (50 m)	10	2	58	60
0.3 km NW of river	9	10	52	27
1.4 km NW of river	10	30	55	11
1.6 km NW of river	12	55	123	3
2.8 km NW of river	12	100	112	2
Little Wedeene R. Valley				
50 m N of river	13	10	65	28
200 m N of river	13	20	62	15
300 m N of river	13	55	73	10
400 m N of river	12	55	78	10

There was not a clear trend in the distribution of successful current attacks through the Nass Valley north of Cranberry Junction (Table 13). The most northerly population recorded, in a plantation east of Meziadin Lake, infested about 3% of the trees. Large plantations of spruce in recent clearcuts north of Meziadin Lake to the Bell-Irving Valley may provide enough susceptible hosts to allow a population buildup.

Table 13. Distribution limits of successful current attacks by the spruce weevil in the Skeena and Nass river valleys, Prince Rupert Forest Region, 1987.

Location	Stand age	No. of trees assessed	Percent attacked
Skeena Valley			
Exstew R. 30 km W Terrace	10-15	47	26
Exchamsiks R. 52 km W Terrace	10-20	150	14
Kasiks R. 60 km W Terrace	17	68	0
Kwinitsa Cr. 79 km W Terrace	5-10	500	0
Khyex R. 97 km W Terrace	10-30	150	0

Location	Stand age	No. of trees assessed	Percent attacked
Nass R. Valley			
8 km SE Cranberry Junction	10-15	143	2
25 km N Cranberry Junction	15-20	140	7
47 km N Cranberry Junction	12-18	153	12
Meziadin Lake	7-15	190	3

Fall collections of spruce weevil-infested leaders from near the western and northern distribution limits were assessed for parasites and predators at the Pacific Forestry Centre[1] (Table 14). Values were very variable, a reflection of the small sample size and the variability of parasitism between infested trees. A dipteran larval predator, *Lonchaea* sp., was common at each location and was also collected earlier in the year farther north at Meziadin Lake. The levels of four hymenopteran larval parasites were too low to significantly affect the weevil population.

Table 14. Insect predators and parasites of the spruce weevil in infested leaders, collected in October near the western and northern limits of distribution in the region, Prince Rupert Forest Region, 1987.

Insect	Average number and range of insects per weeviled leader at Exchamsiks R.		Nass R.	
	avg.	range	avg.	range
Lonchaea sp.	19	0-39	10	0-30
Eurytoma pissodis	1	0-2	13	1-32
Bracon pini	3	0-8	0	
Rhopalichus pulchripennis	3	0-6	3	0-14
Dolichomitus terebrans	0.3	0-1	0.2	0-1
Chip cocoons	35	11-77	60	13-106

[1]Dissections of leaders and identification of parasites and predators by A.F. Dawson, Pacific Forestry Centre.

Cone and seed pests

White spruce cone crops were generally light to moderate throughout the region in 1987, down from moderate to heavy crops in 1986. Sitka spruce cone crops were very light in 1987 following a heavy crop in 1986.

The spruce cone maggot, Lasiomma anthracinum (previously Hylemya anthracinum) infested white spruce cones at all but one of the eight locations sampled (Table 15)[1]. An average of 37% of the seeds were destroyed in the 33% of the cones infested. The greatest damage and impact was recorded in the northern collections where the cone crop was considerably smaller than in 1986. The spruce seedworm, Cydia strobilella, the second most damaging insect, destroyed 17% of the seeds in the 29% of cones infested. Populations were more spotty and damaged more than 50% of the seeds at three of the eight areas. Other insects including the spruce seed chalcid, Megastigmus atedius, and the spruce seed midge, Mayetiola carpophaga, infested relatively low numbers of cones from the Klappan River and Skins Lake collections. The spruce cone axis midge, Dasineura rachiphaga, and the spruce cone gall midge, D. canadensis, do not damage seeds directly and are generally of minor significance, were present in up to 70% of white spruce cones.

The spruce seedworm infested 5% of the Sitka spruce cones from the Coldwater Road southwest of Terrace.

Incidence and intensity of cone insect attack by crown level

Cone collections from three crown levels of spruce at three locations were analysed for insect distribution in the tree. Due to the small sample size and the variability between trees no clear conclusions were evident. There did appear, however, to be more insects on mid- and lower-crown cones. Similarly, the upper-crown cones from dominant trees generally had less insect damage than those from the upper crown of codominant trees.

Annual variation of cone crops and cone and seed insects

Five permanent collection areas in the region have been monitored annually since 1981. Observations included the relationship between cone crop size and insect activity, and the consistency and stability of insect activity at specific locations (Fig. 2). In this section reference to a good cone collecting area or year means that less than 50% of the seeds were insect-damaged.

Good cone collecting generally occurred when a moderate or heavy cone crop followed a year of very low or no cone crop (1982 and 1985). These years had low levels of insect damage. Despite a decrease in cone crop size from 1986, 1987 was also a very good year for cone collections. In 1983, the worst collection year, only 24% of the seeds were not insect damaged. In 1987, the cone crop size decrease was accompanied by a decreasing insect population, making it the least insect-infested cone crop during the observation period, with 63% of the seeds uninfested.

[1]Dissections of cones, assessment of seed damage and identification of insects was done by D.S. Ruth, Pacific Forestry Centre.

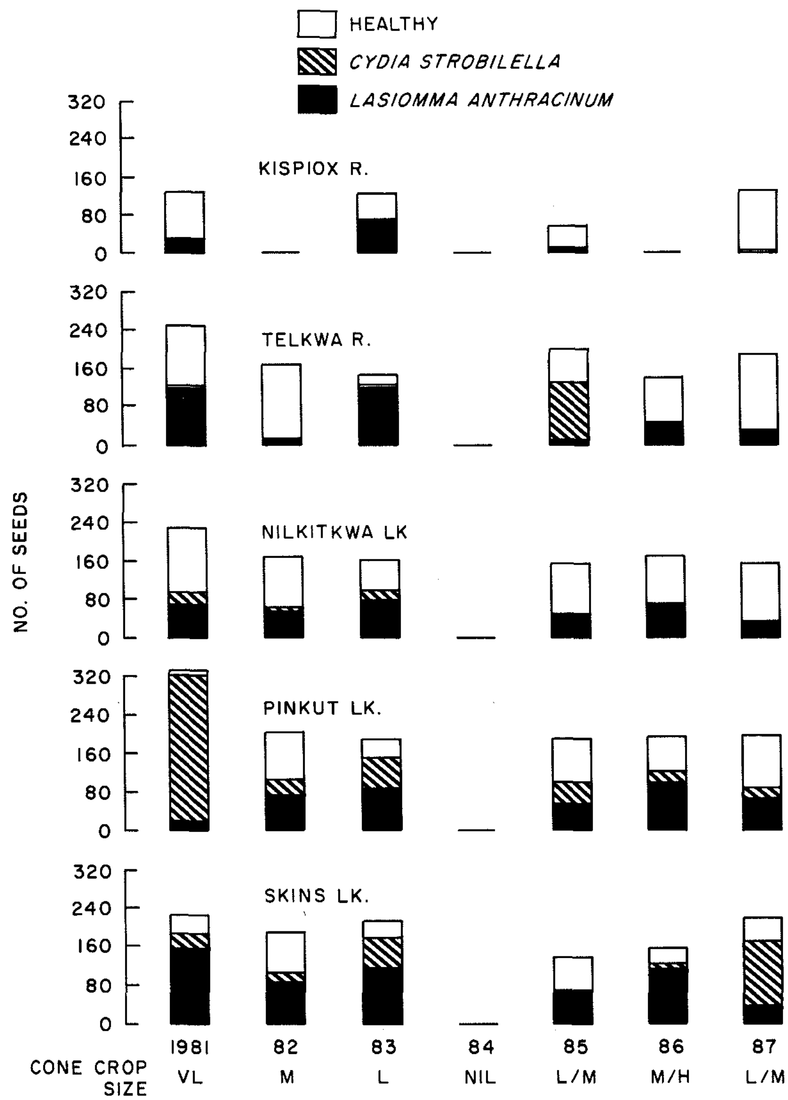
Table 15. Infestation of white spruce cones by insects and disease and impact on seed production based on longitudinal cross-section assessments of cones, Prince Rupert Forest Region, 1987.

Location	*Lasiomma anthracinum* Inf.[1]	*Lasiomma anthracinum* Imp.[2]	*Cydia strobilella* Inf.	*Cydia strobilella* Imp.	*Megastigmus atedius* Inf.	*Megastigmus atedius* Imp.	*Mayetiola carpophaga* Inf.	*Mayetiola carpophaga* Imp.	*Dasineura canadensis* Infested	*Dasineura rachiphaga* Infested	*Chrysomyxa pirolata* Infected	Cone crop size
Skins L.	25	16	70	60	5	1	0	0	15	0	2	L
Babine R.	25	21	0	0	0	0	0	0	10	30	2	M
Kispiox R.	0	0	5	4	0	0	0	0	0	70	4	M
Telkwa R.	25	17	0	0	0	0	0	0	0	0	0	L
Pinkut L.	35	32	35	12	0	0	0	0	0	10	2	L
Ealue L.	35	56	40	67	0	0	0	0	35	10	10	L
Klappan R.	40	61	80	56	10	26	5	7	35	55	0	L
Blue R.	80	94	0	0	0	0	0	0	0	30	0	L
Average	33	37	29	17	2	3	1	1	12	26	3	

[1]Infested - percent of cones infested

[2]Impact - percent of seeds destroyed

Figure 2. Fluctuating impact of Lasiomma anthracinum and Cydia strobilella on white spruce seed production between 1981 and 1987, Prince Rupert Forest Region.



Some areas were consistently good collection areas while others were consistently poor collecting sites. At Babine River healthy seeds averaged 61% over the 6 years and in only 1 year were more than 50% of the seeds damaged. At Telkwa an average of 58% of the seeds were healthy over the same period but insect populations were more erratic and seed damage ranged from 4% in 1982 to 85% in 1983. At Skins and Pinkut lakes in particular, an average of 72% and 62% of the seeds were destroyed and there was only 1 year when less than 50% of the seeds were destroyed.

Erratic population fluctuations were commonly associated with C. strobilella and extremely large populations occurred with no preceding warning of a population buildup. At Skins Lake, the 60% of seeds damaged in 1987 was preceded by 7% and 0 in 1986 and 1985. Similarly, the 60% damage in 1985 at Telkwa was the only year during which more than 2% seed damage by the seedworm occurred.

Black army cutworm
Actebia fennica

Black army cutworm populations were dramatically reduced from the high levels recorded during the previous five years. Only one unplanted cutblock in the Harold Price Creek area averaged 10 larvae per 0.1 m^2 of duff on approximately 10 ha. Near Smithers Landing and at Morrison Lake, one to three larvae per 0.1 m^2 were found within scattered pockets of 0.1 ha or less.

Both pupal counts and adult moth trapping in 1986 indicated a major reduction in population levels for 1987, but not to the extent that occurred. The collapse of the cutworm population was in part attributed to the wide distribution of up to 65% parasitism in 1986. Other factors that affected population levels included a prolonged cool spring and concentrated moth trapping in the fall of 1986 which may have reduced localized populations. An additional control factor included predation by birds, especially crows, and voles. Vole populations were at the highest levels observed in recent history in the region. Typical small mammal destruction of pupae and feeding on adult moths was observed during the fall of 1986.

Low population levels are forecast for 1988 based on the very low numbers of moths caught in attractant-baited traps deployed in 28 recently burned sites (Table 16).

Table 16. Average number of black army cutworm moths caught in attractant-baited[1] traps and predicted hazard for 1988, Prince Rupert Forest Region, 1987.

Location	Average no. moths[2]	Predicted hazard
<u>Lakes TSA</u>		
Loon Lake CP 140	3	low
Loon Lake CP B-2	1	trace
Augier Lake 9921	1	trace
Cross Creek CP 146	1	trace
Taltapin Lake CP 26-3	1	trace
<u>Morice TSA</u>		
Tanglechain Lake CP 415-1	7	low/moderate
Tanglechain Lake CP 407-1	4	low
Smithers Landing CP 318-4	3*	low, spotty, moderate
Nilkitkwa Rd. Jct. CP 406-2	3	low
Granisle	2	trace
Smithers Landing CP 318-8	2	trace
Tanglechain Lake CP 433-1	1	trace
Betty Lake CP 004-6	0	nil
<u>Bulkley TSA</u>		
Harold Price Creek CP 27-2	5*	low, spotty, moderate
Harold Price Creek CP 28-3	2	trace
Harold Price Creek EM7-514	2	trace
McKendrick Pass CP 300	2	trace
Telkwa River	1	trace
Harold Price Creek CP 22 & 23	1	trace
Chapman Lake Rd.	1	trace
Nilkitkwa Lake Rd. CP 068-8	0	nil
McKendrick Pass CP 301	0	nil
Goathorn Creek	0	nil
Tenas Creek EM7-509	0	nil
<u>Kispiox TSA</u>		
Gail Creek Rd.	5	low
Dennison Main	3	low
Salmon River Rd.	1	trace

[1]Five traps baited with 1% cis-7-dodecenyl+cis-11-tetradecenyl were used at each site.
[2]Previous infestations have developed only when trap counts averaged more than 10 moths per trap.
*Individual traps had 10 or more moths.

Spruce bud mortality

In five interior spruce stands, cumulative (over 5 years) terminal bud mortality averaged 31% (Table 17). Annual bud mortality averaged 9% and ranged from 1% in 1983 to 13% in 1985. Between 1983 and 1986, an average of 47% of the trees with bud mortality (11% of the spruce in the stand) developed more than one leader. In the three transitional areas with better growing sites, 38% of the trees with dead terminals developed multi-leaders compared to 71% in the two less favorable interior sites.

Table 17. Incidence of cumulative leader mortality and multiple leaders in young spruce stands, Prince Rupert Forest Region, 1983-1987.

Location	No. trees examined	Percent of trees with	
		dead terminals[1]	multiple leaders[2]
Kuldo Cr.	78	21	12
Date Cr.	78	33	11
Suskwa R.	67	55	9
Goosly L.	96	16	12
Houston	81	30	12
Average	80	31	11

[1]cumulative from 1983 to 1987 inclusive
[2]does not include dead terminals recorded in 1987

The cause of bud mortality appears to be related to widely fluctuating spring temperatures. 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 due to freezing or rotting of the meristematic tissue. Some of the swollen buds resembled those damaged by *Rhabdophaga* sp. larvae; however, no insects have been found in samples collected during the past 7 years. Similar damage has been recorded on Sitka spruce on the Queen Charlotte Islands since the 1950s. Other agents associated with dead terminals include spruce budmoth, *Zeiraphera* sp., a needleminer, *Epinotia* sp., and the fungus *Acremonium* sp., but no single insect or disease causal agent has consistently been identified with bud mortality. Further examinations will be made in 1988 in an attempt to identify factors leading to bud mortality.

Spruce budworms
Choristoneura spp.

An isolated pocket of about 10 ha of white spruce and alpine fir near the Bell-Irving River second crossing had almost all current growth defoliated due to feeding by spruce budworms, probably the two-year-cycle budworm, *C. biennis*. This was the first record of defoliation in the area since 1983. Populations increased in the Morice River area where an average of six larvae per standard beating sample were collected. Eastern spruce budworm, *C. fumiferana*, populations in the northern areas of the region remained endemic.

Portions of two pheromone trapping studies were conducted in the Prince Rupert Region. In a study to confirm the taxonomic distribution of four species of Choristoneura, pheromone-baited plastic container traps ("Universal") were deployed at Prudhomme Lake, Clements Lake, and the Bell-Irving River second crossing. Taxonomic identification[1] of representative male moths captured determined that most were C. biennis, with only one moth from the Bell-Irving River location identified as C. fumiferana. If confirmed by further sampling, this will represent a significant extension of the known range of C. fumiferana into the center of the region.

In the first year of a program to improve and calibrate methods to detect spruce budworm in fir-spruce forests, pheromone-baited plastic container traps ("Multipher") were deployed near the Kalum, Kispiox, Telkwa, and Morice rivers and Meziadin Lake. Twenty-five trees were marked at each site for annual counts of larvae and estimates of defoliation to relate this information to the number of male moths captured. Few larvae were collected from foliage and no defoliation was found.

Spruce budmoths
Zeiraphera spp.

Feeding by spruce budmoths in the flushing buds of Sitka and hybrid Sitka X white spruces in young stands in the southwestern portion of the region averaged 72% of trees assessed (Table 18), similar to an average of 80% in 1986. The larvae most commonly associated with the damage were Zeiraphera radicana and the western blackheaded budworm, Acleris gloverana, Z. canadensis and a needleminer, Coleotechnites sp., were also collected, but less frequently.

Light feeding was recorded on an average of 98% (range 76 to 100%) of infested trees; an average of 2% (range 0 to 24%) of infested trees were infested at moderate intensity (Table 18). The average intensity of feeding declined in 1987, shifting generally from the moderate and severe categories, 24% and 5% of infested trees, respectively, in 1986, to only light and moderate intensities in 1987. This shift probably represents a natural fluctuation within the populations of the insects involved, though it is not known which factors are regulating the variation. Further assessments will clarify the extent of annual variation in budmoth activity and provide a base to evaluate long-term changes as the availability of hosts increases in new plantations.

The impact of the feeding on the flushing spruce buds is minimal in most cases. Sequential photography of a heavily infested sapling and individual branches confirmed observations that the amount of feeding on an expanding shoot generally became insignificant when the shoot reached its full length. However, saplings with a history of moderate to severe infestation by both spruce budmoths and spruce gall adelgids, Pineus spp., have noticeably thinned foliage and visibly slower growth. Further surveys will attempt to clarify the impact of budmoth activity, both alone and in combination with other agents.

[1]T. Gray, Pacific Forestry Centre

Table 18. The incidence and intensity of feeding on flushing buds of Sitka and hybrid Sitka X white spruces in young stands by spruce budmoths, *Zeiraphera* spp., the western blackheaded budworm, *Acleris gloverana*, and a needleminer, *Coleotechnites* sp.

Location	No. of trees assessed	Stand age (yrs)	Infestation incidence (%)	Intensity: % of infested trees[1] Light	Moderate	Severe	Insects collected
Skeena R.	25	10	100	100	0	0	*Z. radicana* *Coleotechnites* sp. *A. gloverana*
Copper R.	25	14	100	100	0	0	*Z. radicana* *A. gloverana*
Zymacord Rd.	25	9	64	100	0	0	*Z. radicana* unknown tortricid
Exstew Rd.	25	8	68	100	0	0	*Z. radicana* *A. gloverana*
Kwinitsa Valley	25	6	8	100	0	0	*Z. radicana*
Work Channel Rd.	25	10	76	100	0	0	*Z. canadensis*
Prudhomme L.	25	10	100	76	24	0	*A. gloverana* *Z. radicana*
Kalum L.	25	10	48	100	0	0	*Z. radicana*
Coldwater Rd.	50	13	80	98	2	0	*Z. radicana* *Coleotechnites* sp. *A. gloverana*
Branch 77 Rd.	53	10	77	100	0	0	*Z. radicana* *Coleotechnites* sp.
Wedeene R.	25	6	56	100	0	0	*Z. radicana* *A. gloverana*
Nalbeelah Cr.	25	8	60	100	0	0	*Z. radicana*
Kitimat	25	8	96	100	0	0	*Z. radicana* *A. gloverana*
Regional average - 1987		10	72	98	2	0	
- 1986		11	80	71	24	5	

[1]Light - up to 10% of buds infested per tree; Moderate - 10 to 30% of buds infested per tree; Severe - more than 30% of buds infested per tree.

Spruce gall adelgids
Pineus spp.

Chronic infestations of spruce gall adelgids continued in the southwestern portion of the region, most common in young stands of hybrid Sitka X white spruce planted throughout the Kitimat Valley area (Table 19). Low levels of galling were observed and collected from white spruce farther north in the region at Kinaskan and Boya lakes. As the genus *Pineus* is under revision, identification to the species is not yet possible. Spruce gall adelgids in the region were previously known as *P. pinifoliae* and *P. similis*.

Table 19. 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, 1987.

Location	No. of trees assessed	Stand age (yrs)	Infestation incidence (%)	Intensity: % of infested trees[1]		
				Light	Moderate	Severe
Skeena R.	25	10	28	100	0	0
Copper R.	25	14	28	71	29	0
Zymacord Rd.	25	9	12	100	0	0
Kalum L.	25	10	40	90	10	0
Coldwater Rd.	50	13	56	79	14	7
Branch 77 Rd.	53	10	55	96	4	0
Wedeene R.	25	6	56	100	0	0
Nalbeelah Cr.	25	8	56	100	0	0
Kitimat	25	8	84	71	19	10
Regional average - 1987		10	46	90	8	2
- 1986		11	50	78	16	6

[1]Categories of intensity used in the survey:

Light - <10% of tips infested per tree
Moderate - 10 to 30% of tips infested per tree
Severe - >30% of tips infested per tree

On Hudson Bay Mountain, a gall adelgid was found for the first time on whitebark pine. The only alternate hosts previously recorded are eastern and western white pines. However, it appears that *Pineus* sp. can cycle entirely on spruce as five-needle pines do not occur in most areas where infestations are occurring.

An average of 46% (range 12-84%) of trees were infested in plantations where the gall adelgids were collected, similar to the 1986 average of 50% (Table 19). The average intensity of infestation declined slightly from 1986 in the moderate and severe categories by 8% and 4%, respectively, with a corresponding increase in the average proportion of infested trees damaged at light intensity. Further surveys will clarify annual variations in gall adelgid activity, and provide a base to evaluate longer-term changes as the availability of hosts increases in extensive new plantations.

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 if combined with one or more additional stresses such as drought, frost damage or infestation by spruce budmoths, Zeiraphera spp. Surveys in 1988 will attempt to clarify the impact of gall adelgid activity.

Pineus spp. galls collected near Kitimat and on the Coldwater Forest Road contained dipteran larvae, possibly syrphid or cecidomyiid predators; larvae of the spruce coneworm, Dioryctria reniculelloides, were feeding occasionally on the galls.

Spruce aphid
Elatobium abietinum

Populations of the spruce aphid increased in 1987 following a mild winter after two years of decline due to low winter temperatures. During an overview flight in August, coastal Sitka spruce infested by the spruce aphid were mapped over 150 ha scattered in small patches from Porcher Island north to Jap Point, near Metlakatla. Any change in the population and extent of damage in 1988 will again depend on the weather over the winter, particularly the length and intensity of severe cold spells.

Tomentosus root rot
Inonotus tomentosus

Tomentosus root rot is a widespread and damaging decay of spruce throughout the region. Infected trees sustain increasing growth loss, susceptibility to being blown down, and occasional mortality as the infection intensifies. Spreading infections result in patches of dying and windthrown trees; after logging in these areas residual inoculum can infect the regenerating stand. Collections in 1987 were from a representative northern infection epicenter over about 0.5 ha of white spruce at Ealue Lake.

Measures to minimize the occurrence of this decay in plantations include the identification of infection epicenters before logging, planting of less susceptible or resistant trees in these sites and/or the removal of most of the inoculum from the soil by pulling and burning infected stumps. Trials of both stump-pulling and planting white pine in infected sites have been initiated by the B.C. Forest Service in the southeastern portion of the region.

Rhizina root disease
Rhizina undulata

Fruiting bodies of this root rot fungus which has been recorded only at sporadic intervals in the region were present at very high numbers in cutblocks along the Skeena River north of Hazelton. The recently planted spruce seedlings in the cutblocks were highly susceptible to infection in 1987, which may lead to mortality in 1988. In 1968 surveys indicated that the root rot killed up to 38% of recently planted seedlings in this general area. Tree mortality attributed to this fungus has always been associated with recently burned sites, particularly in the northern drier maritime subzone of the coastal western hemlock zone (whf) and in the transitional subzone of the interior cedar-hemlock zone (Ichg). Although occasional fruiting bodies have been collected in the eastern portion of the region, no seedling mortality has been associated with it. The scarcity of collections may be due in part to the seedling symptoms resembling that of drought-caused foliage discoloration. Severely infected seedlings will have extensive white mycelium attached to the roots.

Spruce leader dieback

Dead white spruce leaders and top laterals were collected near the Klappan and Hyland rivers. No significant pest damage, however, could consistently be identified as causing the dieback. Some of the dead leaders had been girdled or partially girdled by the larvae of a pyralid moth, Dioryctria sp., and smaller wounds may have been caused by the maturation feeding of weevils such as Warren's root collar weevil. A minor surface fungus was identified from the Klappan River sample. Environmental factors could be responsible in part. Further surveys in 1988 will attempt to determine the extent of the problem and detect a consistent cause.

A dieback fungus
Sclerophoma sp.

Recently planted spruce seedlings were infected with this generally weak parasitic fungus in the Suskwa River drainage. Small groups of 2-5 dead or dying seedlings clumped around severely infected residuals were scattered throughout the cutblocks. The various species within the genus are present in a wide range of hosts and are generally associated with weakened or stressed tissue. Significant impact is normally restricted to seedlings where outplanting or other stress factors reduce their resistance to the fungus, and can often result in mortality. The previous stand type in the current infection areas was decadent western hemlock and alpine fir which commonly harbor Sclerophoma sp. in weakened tissue. When these stands are logged, young damaged residuals can become severely infected and these in turn infect the vulnerable newly planted seedlings.

Needle casts and a bud blight
Lophodermium piceae,
Lirula spp. and
? Cucurbitaria piceae

Needle casts again caused dieback and premature drop of older foliage in scattered patches throughout the southwestern portion of the region (Table 20). Both Lophodermium piceae and Lirula spp. caused the characteristic dieback and drop of 2- and 3-year-old needles. Although the impact of these diseases is not great in British Columbia, they have caused significant damage in northern Europe.

A bud blight, tentatively identified as Cucurbitaria piceae, extensively infected the mid- and lower crown buds of occasional white spruce along the lower Babine River. This blight is a common cause of bud mortality in Europe but has not been collected previously in British Columbia.

Table 20. Incidence and intensity of infections of spruce by needle cast fungi, Prince Rupert Forest Region, 1987.

Location	Needle cast(s)	Incidence[1]	Intensity[2]	Stand maturity
Bitter Creek	*Lirula macrospora*	low	light	young growth
Kitwancool Village	*Lirula brevispora* *Lirula macrospora*	low	moderate	semimature
Ishkheenickh R.	*Lophodermium piceae* *Lirula* sp.	high	moderate	sapling
Exchamsiks R.	*Lophodermium piceae*	low	light	young growth
Porcher Island	*Lirula macrospora* *Lophodermium piceae*	moderate	moderate	sapling
Skeena-Babine rivers junction	*Lirula macrospora*	low	severe	semimature

[1]Incidence - a general categorization of the proportion of trees in a stand infected:
low - <10% of trees infected; moderate - 10-30% of trees infected;
high - >30% of trees infected.

[2]Intensity - the proportion of 2- and 3-year-old needles infected:
light - <10% of needles infected; moderate - 10-30% of needles infected;
severe - >30% of needles infected.

Needle rusts
Chrysomyxa spp.

The current growth of white spruce was again infected by the large-spored spruce-Labrador tea rust, *C. ledicola*, in northern areas of the region. First observed in 1986, infections were severe from northeast of Dease Lake to Beady Creek but farther north, infections were patchy and of lighter incidence. A plantation near Blue River was infected at trace levels and severe infections were noted in a stand 20 km south of the Yukon border.

Conspicuous yellow "brooms" of infected foliage caused by the spruce broom rust, *C. arctostaphyli*, are a chronic infection throughout the range of white spruce in the region. Branches with large brooms may break and multiple brooms have been shown to weaken and slow the growth of host trees. Near the Stikine River a large broom close to the main stem of a mature tree was observed to have killed the top one-third (15 m) of the tree above it.

Infection by Weir's spruce cushion rust, *Chrysomyxa weirii*, increased along the Skeena River area north of Hazelton, between McCutcheon and Bretson creeks. An average of 30% of the foliage on 40% of the spruce was infected. The rust has little effect on tree growth during the initial infection period but a study in the region in 1983 indicated that increment was reduced by 75% following three to four years of moderate to severe infection.[1]

[1]Forest Insect and Disease Conditions, Prince Rupert Forest Region, 1983.

Porcupine damage

Current high porcupine populations continued to damage and kill spruce in the southern half of the region in 1987. Although not as favored a host as lodgepole pine or western hemlock, sapling to pole-sized spruce stems were debarked in thinned and unthinned stands, generally in scattered patches of 1 to 15 trees. Spruce regeneration will continue to be damaged while populations remain at current levels.

TRUE FIR PESTS

Western balsam bark beetle
Dryocoetes confusus

The balsam bark beetle killed alpine fir over an estimated 107 400 ha which contained 226 000 m^3 in the region in 1987 (Map 3), down from 121 000 ha in 1986. Updated figures from the BCFS were available only for the Bulkley TSA; 1986 figures were used for the other TSAs. Due to the stand types and the pattern of balsam bark beetle attack, the area of attack does not fluctuate greatly from year to year but consistent mapping is difficult.

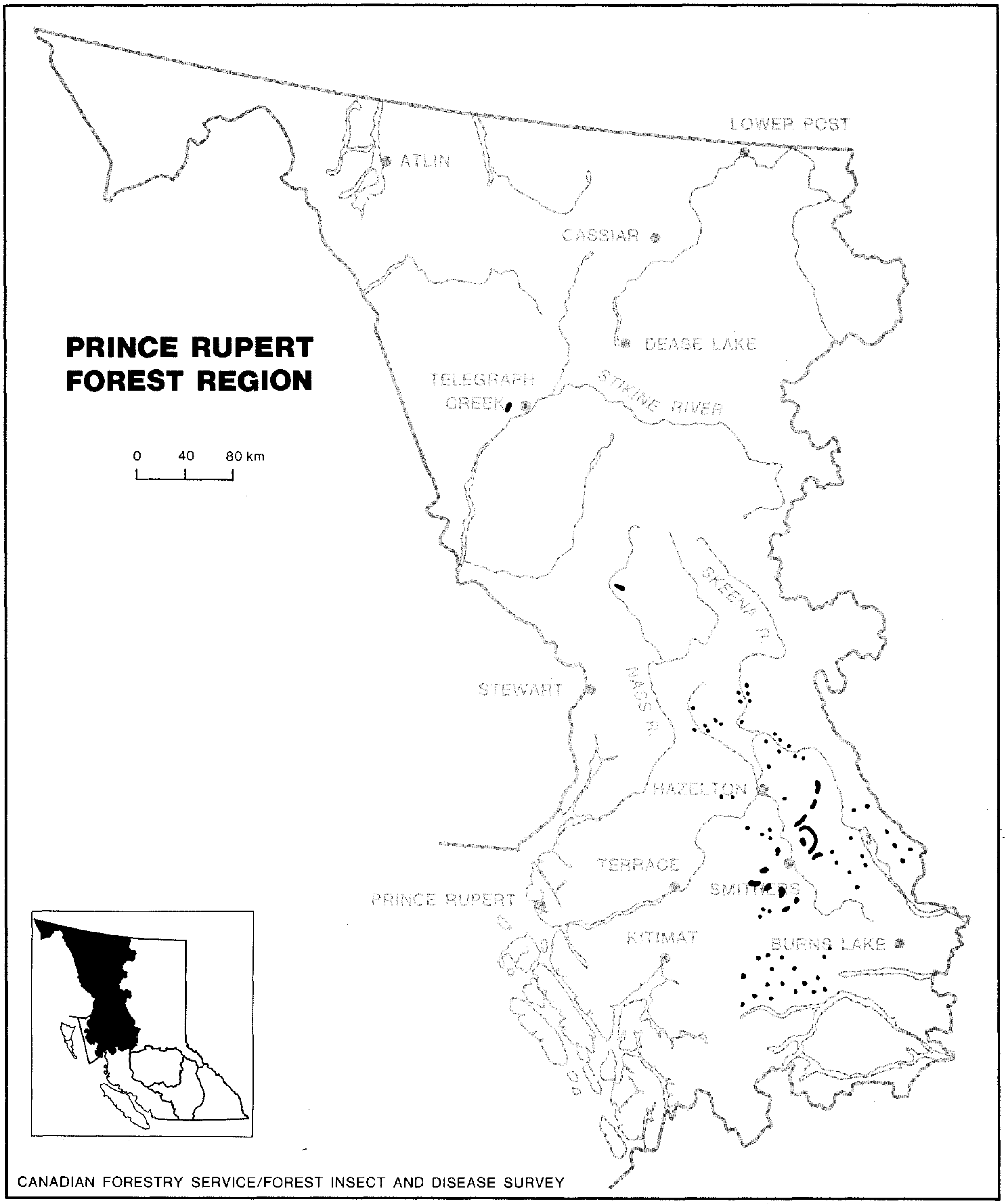
In the Bulkley TSA, the bulk of the tree mortality (166 000 m^3 over 73 000 ha) remains in the McKendrick Pass area northwest along the east side of the Mt. Cronin area and into the Harold Price Creek drainage (29 000 ha). Some expanded infestations were mapped in the Telkwa and Telkwa River area (25 000 ha). Much of the area (7 000 ha) mapped in the Trout to Boulder creeks area was new in 1987. There was a 35% decrease in the area mapped in the Reiseter to Kwun creeks area to 7 000 ha).

In the Morice TSA (28 000 ha, 45 000 m^3), the most concentrated beetle activity in the southwestern portion of the district included 11 000 ha mapped in the Walcott to Houston Tommy Creek area and 5 000 ha in the Pimpernel Mountain area. To the south, in the Morice and Ootsa lakes area, numerous smaller areas of 300 to 400 ha contained recent tree mortality.

In the Lakes TSA (6 000 ha, 14 000 m^3), the main areas of beetle-caused tree mortality were in the Allin-Foxy creeks area (2 800 ha), Taltapin Lake (1 000 ha), Pierre Creek (1 000 ha) and Tildesley Creek (1 000 ha) areas.

In the Kispiox TSA (400 ha, 1 000 m^3), most of the beetle activity was in small groups of less than 300 trees in the upper Skeena and Kispiox rivers area.

In the Kalum and Cassiar TSAs, trees killed by the western balsam bark beetle are scattered throughout the range of mature and overmature alpine fir, generally at trace to light incidence (<10%). Ground observations of dead and dying trees scattered through the Bell-Irving River Valley were at light incidence (about 5%), and by aerial observation on Dodjatin Mtn. near Telegraph Creek, at moderate incidence (about 20%). The damage observed may have accumulated over several seasons as red foliage can stay on dying or dead alpine fir for several years.



Map 3. Areas of alpine fir killed by western balsam bark beetle, determined by ground and aerial surveys, 1987

A slight decrease in beetle attack level was indicated in stand examinations at McKendrick Pass, Shelford Hills and Blunt Creek. There was an average of 0.9 current attacks for each 1986-killed tree. This was the second consecutive year of decline following several years with increasing populations. In areas with widely scattered pockets of less than 10 recently attacked trees, 55% of the 1986-attacked trees were re-attacked in 1987. In large chronic beetle areas re-attack was less common. The initial attacks frequently were concentrated only in the mid- and upper crown with the lower crown remaining green. The following year the emerging brood and parent beetles re-attacked the lower crown and the main bole of the tree, rather than attacking more beetle-resistant healthy trees. This behavior is common but seldom to the degree recorded in 1987.

Western blackheaded budworm
Acleris gloverana

Western blackheaded budworm populations increased throughout the interior of the region, while collapsing in the Kitimat area. Moderate to severe defoliation (50-90% of the current mid- and lower-crown foliage) occurred along the Morice River near Lamprey Lake, McKendrick Pass and Byman Creek. Most stands with an alpine fir or white spruce component from Hazelton to the Burns Lake area exhibited trace to light defoliation. In this area, 80% of the three-tree beating samples had an average of 58 larvae. The most severe defoliation occurred in the mid- to lower-crown, while upper crowns were very lightly defoliated. This was due largely to early-instar larvae dropping from the upper crown to complete their most voracious feeding during the late instar in the mid- to lower crown. Consequently, all of the defoliation was identified from ground observations and no defoliation was recorded during aerial surveys.

Blackheaded budworm populations in the interior alpine fir-white spruce stands have increased periodically, causing light defoliation approximately every four to five years. Defoliation has generally persisted for two to three years, with no record of top-kill or mortality.

Standard egg samples consisting of two 50-cm branch tips from mid-crown indicated moderate defoliation in 1988 at four sample locations and light at two (Table 21). Since this was the first year for egg sampling in interior boreal stand types, the predictions are adopted from criteria developed for infestations in coastal hemlock stands. Based on historical population dynamics in interior stands, these predictions may prove too high. Population predictions from egg samples will be calibrated further with follow-up larval and defoliation surveys in 1988.

Table 21. Numbers of eggs and predicted defoliation of alpine fir and white spruce by western blackheaded budworm in 1988, Prince Rupert Forest Region, 1987.

Location	Avg. no. eggs per 50-cm branch	Predicted defoliation 1988[1]
Morice R.	52	moderate
Byman Cr.	48	moderate
Natlan Cr.	34	moderate
Nadina R.	32	moderate
Grizzley L.	21	light
McKendrick Pass	17	light

[1]The following 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.

Foliar diseases

Needle rust and needle cast fungi again damaged the current foliage of alpine fir, generally in the same areas as in 1986 (Table 22).

In the last two years, infections by the fir-fireweed rust, *Pucciniastrum epilobii*, were common in all age classes of alpine fir in patches from Kitwanga to the Bell-Irving River Valley. The buildup of this fungus may have been facilitated by the abundance of the alternate host, fireweed, in the large numbers of recent clearcuts. A needle cast of alpine fir, *Delphinella abietis*, was also common in patches, from the Kalum Valley into the Nass Valley and north to Stewart where infections were common throughout the townsite. Generally, the impact of these two infections is limited to growth reduction which is of greater importance in younger trees with a higher proportion of current foliage. Another needle cast, *Lirula abietis-concoloris*, lightly infected amabilis fir west of Jackpine Flats near Terrace.

Table 22. Incidence and intensity of infections by *Pucciniastrum epilobii* and *Delphinella abietis*, on the current growth of alpine fir, Prince Rupert Forest Region, 1987.

Location	Stand maturity	Disease	Incidence[1]	Intensity[2]
Kitwancool	semimature	*P. epilobii*	high	moderate
Meziadin L.	sapling	*P. epilobii*	high	light
Stewart	sapling	*D. abietis*	high	severe
Cranberry Junction	mature	*D. abietis*	high	severe
Kalum Lake	sapling	*D. abietis*	moderate	moderate

[1]Incidence of infection - proportion of host trees infected:
moderate - 10-30% high - >30%

[2]Intensity of infection - proportion of current growth damaged:
light - <10%; moderate - 10-30%; severe - >30%

Green velvet looper
Epirrita spp.

Looper populations increased in 1987 causing 80-100% defoliation of the current foliage on alpine fir and white spruce over at least 100 ha and 50 ha in the lower Blunt Creek and upper Kwun Creek areas, respectively. Although this pest is generally not considered a major defoliator, this was the most severe damage on record for this pest in the Prince Rupert Region. In the western half of the region, populations remained low with an average of only 2 (range 1 to 4) larvae collected per standard three-tree beating at 16 locations.

Balsam twig aphid
Mindarus abietinus

High numbers of the balsam twig aphid were observed in the spring feeding on the flushing new growth of alpine and amabilis fir in the southwestern portion of the region. Representative collections were made from alpine fir near Cedarvale and amabilis fir in the Kitimat Valley. No significant dieback was noted later in the season, suggesting that impact was probably limited to a slight growth loss during the early summer. Recent mild winters may have contributed to high populations of these insects.

HEMLOCK PESTS

Western blackheaded budworm
Acleris gloverana

Populations of this defoliator declined to endemic or trace levels in the Kitimat and Douglas Channel areas where western hemlock had been defoliated over up to 11 900 ha the last two years. The intensities of defoliation predicted for 1987, based on egg sampling near Kitimat in October 1986, were slightly higher than actually happened in 1987. There was no feeding detected in both areas where trace defoliation was predicted, and of three areas where light defoliation was predicted, one had no defoliation and two had defoliation at trace intensity. Larval counts in the egg-sampling areas in July averaged two budworm larvae per standard three-tree beating sample, consistent with an endemic to trace level population. Thresholds for predictions of defoliation from egg-sampling data were derived from increasing populations. These may have to be adjusted to reflect a different rate of population change during decline since the outbreak near Kitimat appeared to decline faster than it increased.

Significant defoliation of western hemlock continued on the Queen Charlotte Islands, but decreased in extent and intensity. An aerial survey on the adjacent mainland and islands, from the Observatory Inlet to Grenville Channel, did not find any defoliation attributable to the budworm. Larval sampling in July was negative for the budworm in three-tree beating samples near Prince Rupert. The hemlock sawfly, *Neodiprion tsugae*, has remained endemic on the coastal mainland but continued to cause defoliation and mortality of western hemlock on the Queen Charlotte Islands, often in association with the budworm.

Hemlock dwarf mistletoe
Arceuthobium tsugense

Hemlock dwarf mistletoe is a chronic and common parasite which significantly reduces the growth of western hemlock throughout its range in the Prince Rupert Region. No hyperparasites were found in collections of mistletoe plant clusters from heavily infected stands in the Kitimat Valley, Lakelse Lake, and Thunderbird Main areas. Removal of mistletoe-infected trees from buffer zones around clearcuts would minimize the spread of this parasitic plant into susceptible regeneration.

Porcupine damage

Western hemlock, mostly sapling to young growth classes of regeneration, in the southwestern portion of the region was damaged again by high numbers of porcupine. Accumulated damage from several years of high populations was mapped over 1 170 ha along coastal inlets from Grenville Channel to Observatory Inlet in the North Coast District, during an August aerial survey. A B.C. Forest Service project to release and monitor natural predators, fishers, is continuing along coastal inlets north of Prince Rupert.

Rust-red stringy rot
Echinodontium tinctorium

Previously known as the Indian paint fungus, this disease causes a common heart rot of western hemlock and alpine fir in the south and central areas of the region. Representative collections in 1987 were from mature western hemlock heavily infected at moderate incidence near Kalum Lake and near the Nass River southeast of Meziadin Lake; alpine fir was also infected at the Nass River site, though generally at lower levels.

The disease is spread by airborne spores released from the distinct conks, which cause new infections through wounds or old branch stubs. The incidence and intensity of infections generally increase as a stand ages. Losses can be reduced by adopting shorter rotations and thinning/logging practices that minimize wounding of residual trees.

A tip blight
Coccomyces sp.

Western hemlock terminal and branch tip mortality was associated with what appears to be a new species of Coccomyces. Very light tip mortality was common along the lower Babine River between Kisgegas and the junction with the Skeena River. Within this area patches of 0.1 ha had 20% of the terminals and branch tips infected. Another species, Coccomyces heterophyllae, which also occurs on western hemlock, is generally considered a weak parasite associated with stem or bark diseases, but not on shoots, and has longer apothecia, asci and ascospores.

A gall midge
Contarinia n. sp.

Representative collections of this gall midge, a new record in British Columbia, were made throughout the coastal host range of yellow cedar in the region. The midge forms small tip galls, 1 to 3 mm in diameter, on either vegetative growth or on developing cones and male flowers[1]. Collections from Ridley Island and Oliver Lake Provincial Park indicated that populations were at trace levels and did not appear to have a significant effect on the host trees.

Cedar leaf blight
Didymascella thujina

Infection of western red cedar caused by cedar leaf blight increased along the Skeena River area north of Hazelton. Approximately 15% of the foliage was infected on 20% of the trees. Individual understory trees and lower branches of mature trees had up to 80% of the foliage infected. The disease is common but generally has a limited effect upon older trees. However, understory trees in high snowfall areas or in a constantly moist atmosphere will die during a severe infection period, and can affect the future cedar component of a stand.

Dieback of western red and yellow cedars

Dieback of both western red and yellow cedars is common throughout their range in the southwestern portion of the region. Generally, the trees grow well through sapling and young growth age classes before starting to die back at semimature or mature stages. The dieback slowly occurs from the top down, leaving a progression of dead tops and branches above the remaining live portion of crown, continuing until the whole tree dies. The progression of dieback is not constant; occasionally it is interrupted by the growth of secondary or "recovery" branchlets with foliage close to the main stem only.

Surveys by the Forest Insect and Disease Survey and studies in Alaska by the USDA Forest Service[2, 3] have not found a consistent link between any insect or disease agent and the long-term dieback. Environmental factors, such as a subtle long-term climatic change, have not been excluded.

[1] Midge and galls were identified at the Pacific Forestry Centre, Victoria.

[2] Frear, S.T. 1982. What's killing the Alaska yellow cedar? Amer. Forests 88:41-44.

[3] Shaw, C.G. III, Eglitis, A., Laurent, T.H., and Hennon, P.E. 1985. Decline and mortality of *Chamaecyparis nootkatensis* in southeastern Alaska, a problem of long duration but unknown cause. Plant Disease 69:13-17.

LARCH PEST

Larch sawfly
Pristiphora erichsonii

Patches of tamarack were moderately defoliated by the larch sawfly along Highway 37 from about 70 km south of the Yukon border north into the Yukon. Periodic defoliation of these stands has occurred in the past; previous collections were recorded in 1959, 1964-68, and 1977. The importance of the defoliation is not considered significant in the northern limit of the region, because of the limited distribution of tamarack which is often in bogs.

Larch sawfly were also collected by the BCFS from a residential property in Terrace where several larch trees, originally removed from an exotic plantation in the Nelson River area, were severely defoliated. The source of this localized outbreak remains unknown as the larch sawfly had never been collected before in or near Terrace. No defoliation was found in exotic larch plantations in the Kalum Valley or in the ornamental larch trees in Terrace.

DECIDUOUS TREE PESTS

Poplar leaf and shoot blights
Venturia spp.

The intensity of damage to the foliage of trembling aspen by Shepherd's crook, Venturia macularis, decreased for the second consecutive year in 1987. Infections were observed at trace to light intensity throughout the western half of the region and north to the Yukon. Stem cankers were collected from the Kitwanga area on saplings severely infected by V. macularis in 1986; however, there was no consistent recovery of fungi in culture and the infected trees refoliated in 1987.

A new species of leaf spot fungus, Pollaccia n. sp., infected trembling aspen from Boya Lake, Blue River, and in the Yukon. The new disease causes a more defined spotting damage to the foliage compared to the broader blotching and shoot dieback caused by V. macularis. Further collections of damaged foliage in 1988 will clarify the distribution of the new fungus.

Infections of Venturia blight of cottonwood, V. populina, remained at trace to light intensity on the foliage of black cottonwood in the southwestern portion of the region.

Deciduous tree defoliators
Choristoneura conflictana, Campsolechia niveopulvella, Operophtera bruceata, and Fenusa pusilla

Generally light defoliation of trembling aspen by a combination of the large aspen tortrix, C. conflictana, and lightheaded aspen leafroller, C. niveopulvella occurred on approximately 50 ha of southerly slopes in the Trout Creek Valley. The large aspen tortrix, together with the Bruce spanworm, O.

bruceata, moderately defoliated 50 ha and lightly defoliated 75 ha of willow and trembling aspen along Pine Creek near Smithers.

Ornamental birch foliage in Smithers was lightly to moderately mined by the European birch leaf miner, F. pusilla. This was the first time that the insect was collected beyond the Fraser Valley in B.C. The leaf miner has become established in native birch stands in Eastern Canada but its greatest potential impact is on open-growing ornamental trees.

Poplar-and-willow borer
Cryptorhynchus lapathi

Infestations of this beetle were chronic in the southern half of the region, killing individual willow stems and branches often within the multi-stemmed clumps caused by attacks in previous years. Current attacks were commonly observed in the Kitimat, Skeena, and Kalum River valleys and were more numerous than in 1985 or 1986.

SPECIAL SURVEYS

Nursery Pests

A sequence of single pheromone-baited sticky traps was used in 1987 to monitor populations of the variegated cutworm, Peridroma saucia, at the B.C. Forest Service Thornhill Nursery. Although low numbers of moths were caught by most trap changes, the only adults confirmed as P. saucia were eleven caught in the first trap, collected June 8. The larval population was again treated by permethrin to prevent a recurrence of damage noted in 1986. The absence of moths during the rest of the season indicates that only one generation was produced in 1987, generally a cool and wet season.

Exotic plantations

Winter damage

Snow-loading during the growth of four exotic tree species surveyed in the Kalum Valley (Table 23) deformed stems at such a high incidence that this factor alone could preclude further use of these trees where conditions are similar. Snow damage was first recorded in Scots pine in 1970, 9 years after planting and following years with leader growth up to 60 cm. Damage on European and Japanese larches was first recorded nine and three years, respectively, after establishment, again following good leader growth.

Also included is the proportion of remaining trees with forked tops, which is attributed to top breakage when the trees were loaded with wet snow or ice, then followed by the fast growth of lateral shoots competing for dominance. Multiple leaders were first recorded on European larch saplings in 1968, ten years after planting. Most of the high number of forked tops in the Scots pine stand originated in the same year, 17 years after planting, probably the result of particularly severe winter conditions.

Table 23. Incidence of snow damage to conifers, in exotic plantations west of Kalum Lake, Prince Rupert Forest Region, 1987.

		Trees		Percent trees			
Tree species	Date established	Number assessed	Avg. dbh (cm)	Un-damaged	Snow-damaged	Forked tops	Dieback by porcupines
European larch *Larix decidua*	1958	45	25	27	40	9	51
European larch *Larix decidua*	1958	30	18	0	53	3	99
Japanese larch *Larix leptolepis*	1958	44	18	34	41	9	45
Scots pine *Pinus sylvestris*	1961	17	15	0	100	77	24

Porcupine damage

Exotic conifer plantations in the Kalum Valley were damaged by high populations of the porcupine in the last 2 to 3 years (Table 23). The extent of accumulated dieback was variable within and between stands. The high proportion of larch, particularly European larch, debarked by porcupines implies that they are a preferred host, sustaining considerably more damage than other exotic or native trees.

Conifer-aspen rust
Melampsora medusae

Eight remaining trees of a 1958 plantation of interior Douglas-fir near the Nelson River were found in 1987. Following a buildup of the Cooley spruce gall adelgid, *Adelges cooleyi*, in the 1960s, most of this plantation was removed. One of the remaining trees was infected at low intensity by conifer-aspen rust, which was first recorded as infecting all the current foliage of the whole plantation in 1966.

Cone and seed pests

Cones from a Japanese larch plantation established in 1958 near the Nelson River were free of damage from cone and seed pests in 1987. Good cone crops were first reported in 1970 and 1972; there is no record of damaging pests from a cone collection in 1972.

Pinewood nematode
Bursaphelenchus xylophilus

Surveys continued across Canada in 1987 to evaluate the occurrence of the pinewood nematode in host trees and suspected insect vectors. Although surveys to date suggest the nematode is of minor significance in B.C., in Japan it has caused widespread mortality of pine. Scandinavian countries have placed embargoes on some wood products, particularly chips for pulp, from countries where the nematode occurs, including Canada, to protect their forests from the introduction of this perceived threat.

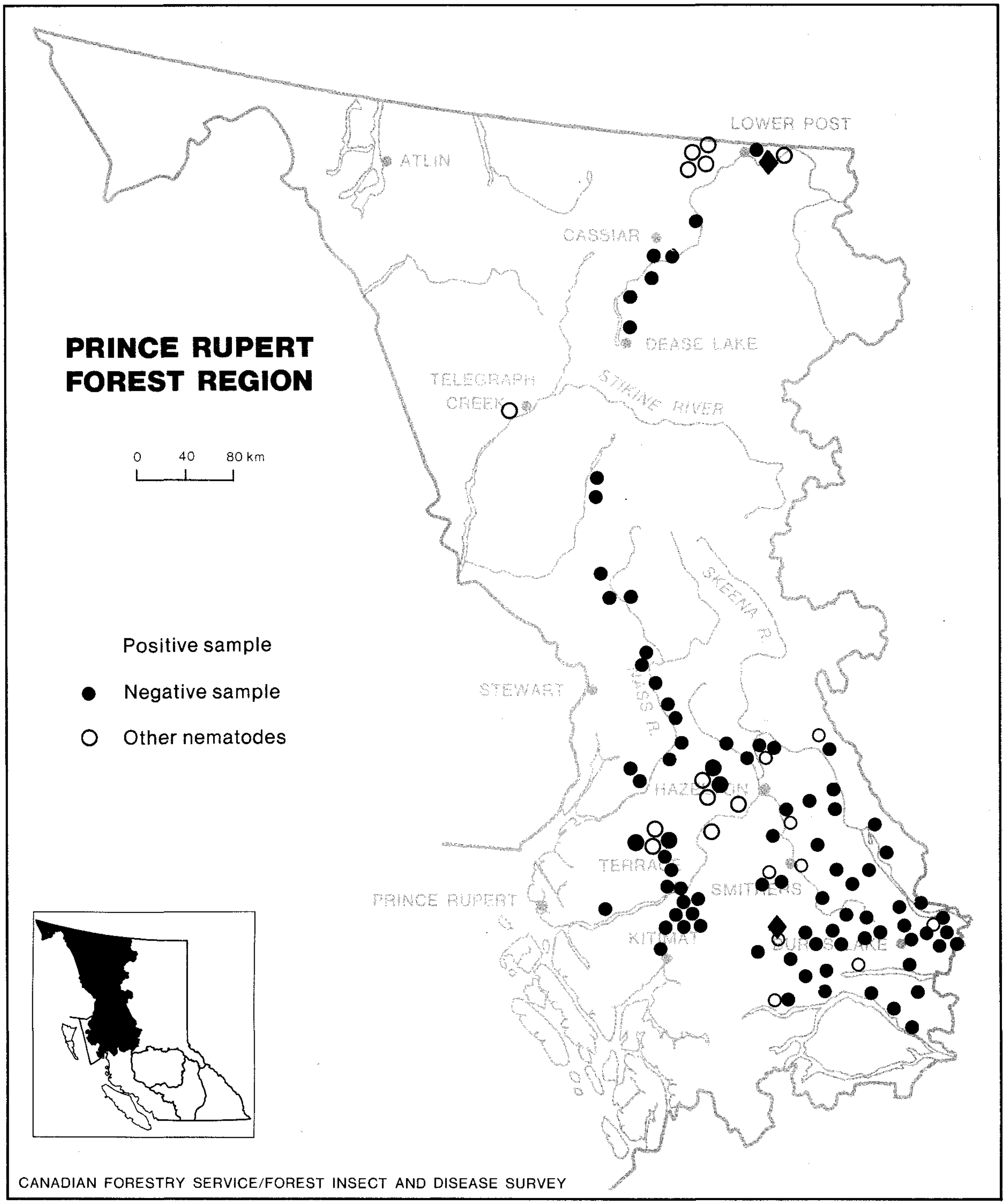
Of 31 collections made from dead or dying trees throughout the region in 1987, one new positive collection[1] of B. xylophilus was recorded, from an abandoned lodgepole pine log deck in the Hyland Valley infested with woodborers. A collection from the same location in 1986 was negative. One additional positive collection was made from a dying roadside tree near Houston that had originally been identified as infested by the pinewood nematode in 1986. Four collections reported in 1986 contained other native non-pathogenic nematodes. Four woodborer adults, Monochamus sp., suspected vectors of the pinewood nematode, were collected in 1987 south of Houston and Smithers but were not infected by the nematode.

The results of five years of sampling for the pinewood nematode in the region are summarized on **Map 4**. Of a total of 117 collections, largely from dying or dead lodgepole pine, positive collections have been confirmed only at the two locations discussed above; locations where samples contained other native nematodes are also shown. Background information on these nematodes is summarized in Table 24. Locations where non-target nematodes were collected are considered as "representative" of their occurrence in the region because in samples from several locations, the non-target nematodes were not identified to the genus level.

Table 24. Ecology and representative locations of additional nematodes identified in samples submitted for detection of the pinewood nematode, Prince Rupert Forest Region, 1987.

Nematode (genus)	Ecology[1]	Representative locations[2]
Aphelenchoides	plant ecto/endo parasites, mycophagous, saprophagous	Yukon border, Kitwancool L., Coyote Cr., Kitwanga, Blue R.
Bursaphelenchus	found in frass of bark beetle galleries, mycophagous	Babine R.
Ditylenchus	general plant feeder, mycophagous	Smithers, Babine R., Blue R.
Ektaphelenchus	bark beetle galleries: adults in frass, larvae penetrate beetle larva and pupae	Babine R.
Heterocephalobus	saprophagous	Blue R.
Panagrolaimus	found in bark beetle frass, saprophagous	Babine R.
Rhabdontolaimus	saprophagous	Yukon border, Kitwancool L., Coyote Cr., Rosswood, Hyland Valley

[1]Ecology: a brief summary of available information on the habitat and/or feeding habits known within the genus. Mycophagous - feeds on fungi. Saprophagous - feeds on decaying/dead plant tissue. Source: Goodey, T. and J.B. Goodey, 1963. Soil and freshwater nematodes. John Wiley and Sons, Inc., N.Y. 544 p.
[2]Locations: localities with collections containing additional nematodes which were identified to the genus level.



Map 4. Locations where one or more wood and/or insect vector samples were collected to detect the pinewood nematode and where other nematodes were identified, 1983-87

Gypsy moth
Lymantria dispar

Pheromone-baited sticky traps were again used to detect any introduction of the gypsy moth to the region in 1987. Forty-seven traps were deployed by CFS-FIDS in forested areas especially frequented by tourists, including campgrounds, and at international port facilities in Kitimat, Prince Rupert and Stewart. Although no moths were caught in traps this year, or in additional traps placed by the B.C. Forest Service and Agriculture Canada, continued monitoring is essential to quick detection and eradication of any moths introduced from infestations to the east and south of B.C.

Acid rain national early warning system (ARNEWS)

As part of a national network, a 10 x 40 m plot was established in the Terrace Watershed in 1985 to detect and monitor any impact due to acidic or toxic rain on native trees and indicator plants. Chemical analysis of conifer foliage and soils will be conducted periodically to detect any significant changes.

Annual visual assessments of plot vegetation and pest conditions in 1987 recorded only the same minor pests that were present in 1985 and 1986. No symptoms of damage from acidic or toxic rain were found.

Table 25. Other insects, diseases, and damage, Prince Rupert Forest Region, 1987.

Pest	Host[1]	Location	Remarks
Insects			
Alder woolly sawfly *Eriocampa ovata*	Al	Prince Rupert	continued to cause patches of defoliation up to 1 ha
An engraver beetle *Ips tridens*	sS	Haines Rd.	secondary beetle from windfall infested by spruce beetle
Aspen serpentine leafminer *Phyllocnistis populiella*	tA	B.C.-Yukon border	<5% of foliage infested on all aspen
Bark beetles			
Hylurgops porosus *H. rugipennis*	lP	Rosswood	bark beetles present in mountain pine beetle-infested trees felled but not burned
Crane fly *Tipula* sp.		Telkwa	in nursery stock

Pest	Host[1]	Location	Remarks
European leafroller *Archips rosana*	sS	Exstew R.	usually on deciduous trees, low incidence and intensity on flushing buds
Foliar aphid *Pemphigus* sp.	bCo	Dasque Cr.	foliar galls at low intensity, patchy incidence
Four-eyed spruce beetle *Polygrapha rufipennis*	wS	Bell-Irving R.	secondary bark beetle in slash
Gall midge Cecidomyiidae	bCo	Terrace	common at trace to light intensity
Gall mite *Phytoptis laevis*	Al	Stewart	causing galling on foliage, low intensity
Leaf beetles			
Chrysomela sp.	bCo	Dasque Cr.	skeletonizing foliage, low intensity, patchy occurrence
Pyrrhalta punctipennis	Al	Kwinitsa R.	causing light 'shothole' damage to foliage
Pine needle scale *Chionaspis pinifoliae*	Scots pine	Smithers	discoloring foliage
Willow defoliators			
Argyresthia pymaella	W	Coldwater Rd.	common at moderate intensity
Epinotia solicitana	W	Coldwater Rd.	common at trace intensity
Diseases			
Bark epiphyte *Karschia* sp.	wbP	Hudson Bay Mtn.	new record for B.C.
Bear damage	lP	Burrage Cr.	widespread scarring of sapling pole-sized trees

Pest	Host[1]	Location	Remarks
Canker fungi			
Nitschkia molnarii	wbP	Hudson Bay Mtn.	new host record
Ophiovalsa sp.	Al	Granisle	light alder dieback
Clavariform juniper rust *Gymnosporangium clavariiforme*	Jc	Warm Bay (Atlin)	significant northern extension of distribution; previous limit in southeastern area of region
Decay fungi			
Pholiota squarrosa	sS	Shegunia R.	new host record
Polyporus picipes	wH	Zymagotitz R.	from logged trees
Fluoride damage	Al, bCo, W	Kitimat	characteristic foliar tip necrosis collected from foliage adjacent to aluminum smelter
Foliar rusts			
Melampsora sp.	wH	Kalum Valley	common at light intensity on current growth
Melampsora epitea	W	southern portion of region	caused early yellowing and leaf drop on scattered willows
Fomes trunk rot of birch *Fomes fomentarius*	wB	Terrace	collected from standing dead host
Needle cast of true fir *Lirula abietis-concoloris*	aF	Thunderbird Main	trace levels in upper crown of mature trees
Pika damage	sS	Little Oliver Cr.	damaged seedlings common near talus slopes
Tar spot *Rhytisma salicinum*	W	Kitimat, Skeena and Nass river drainages	occasional patches with light to moderate intensity

[1]lP - lodgepole pine; wbP - whitebark pine; wS - white spruce; sS - Sitka spruce; aF - amabilis fir; wH - western hemlock; tA - trembling aspen; bCo - black cottonwood; wB - white birch; Al - alder; W - willow; Jc - common juniper