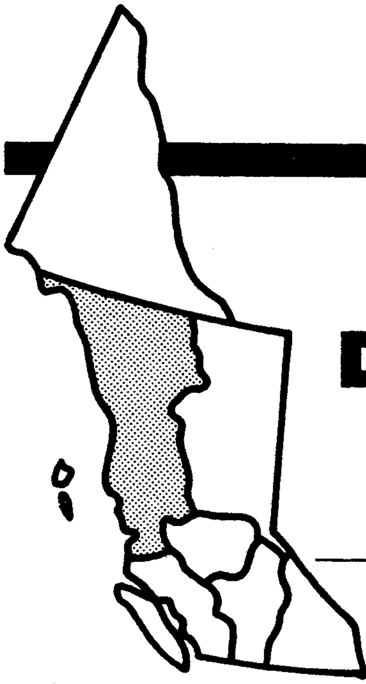
FIDS File Report 87-5



Forest Insect and Disease Conditions

Prince Rupert Forest Region 1986

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Government of Canada
Canadian Forestry Service

Gouvernement du Canada
Service canadien des forêts

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INTRODUCTION

This report outlines the status of forest pests in the Prince Rupert Forest Region and the Queen Charlotte Islands (Vancouver Forest Region) in 1986 and attempts to forecast some of the pest population trends. Pests are discussed under host, generally in order of importance, and often within the context of a management unit or Timber Supply Area (TSA).

The Forest Insect and Disease Survey (FIDS) is a nationwide network within the Canadian Forestry Service with the responsibility of: (1) producing an overview of forest pest conditions and their implications; (2) maintaining records and surveys to support quarantines and facilitate predictions; (3) supporting forestry research with records, herbaria and insect collections; (4) providing advice on forest insect and disease conditions; and (5) developing and testing survey techniques and conducting related biological studies. The cooperation of provincial, industrial and municipal agencies is essential for the effective fulfillment of these mandates.

The 1986 field season extended from mid-May to late October. A total of 476 insect and disease collections were submitted by FIDS staff for identification and verification to the Pacific Forestry Centre (Map 1). In cooperation with research programs at the Pacific Forestry Centre, Forest Pest Management Institute, and other research institutions, 159 special collections were made in 1986. Approximately 130 contacts and on-site pest examinations were made with British Columbia Forest Service (BCFS) and industry personnel during the field season.

We thank personnel of the following organizations for their assistance during the field season: aerial sketch maps of beetle infestations were provided by BCFS personnel from Mainland districts; similar maps of defoliation on the Queen Charlotte Islands were provided by district BCFS and industry personnel; five hours of fixed-wing aerial time was provided by the BCFS for FIDS to survey defoliation in the Kalum TSA; transportation, accommodation and assistance with western blackheaded budworm larval (July) and egg (October) sampling on the Queen Charlotte Islands were provided by the BCFS, Western Forest Products Ltd., MacMillan Bloedel Ltd., and Crown Forest Products Ltd.

The Forest Insect and Disease Survey of the Canadian Forestry Service has conducted an annual survey of forest pest conditions in the Prince Rupert Forest Region since 1949. Field stations are located in Terrace and Smithers; during the field season (May-October), correspondence can be directed to:

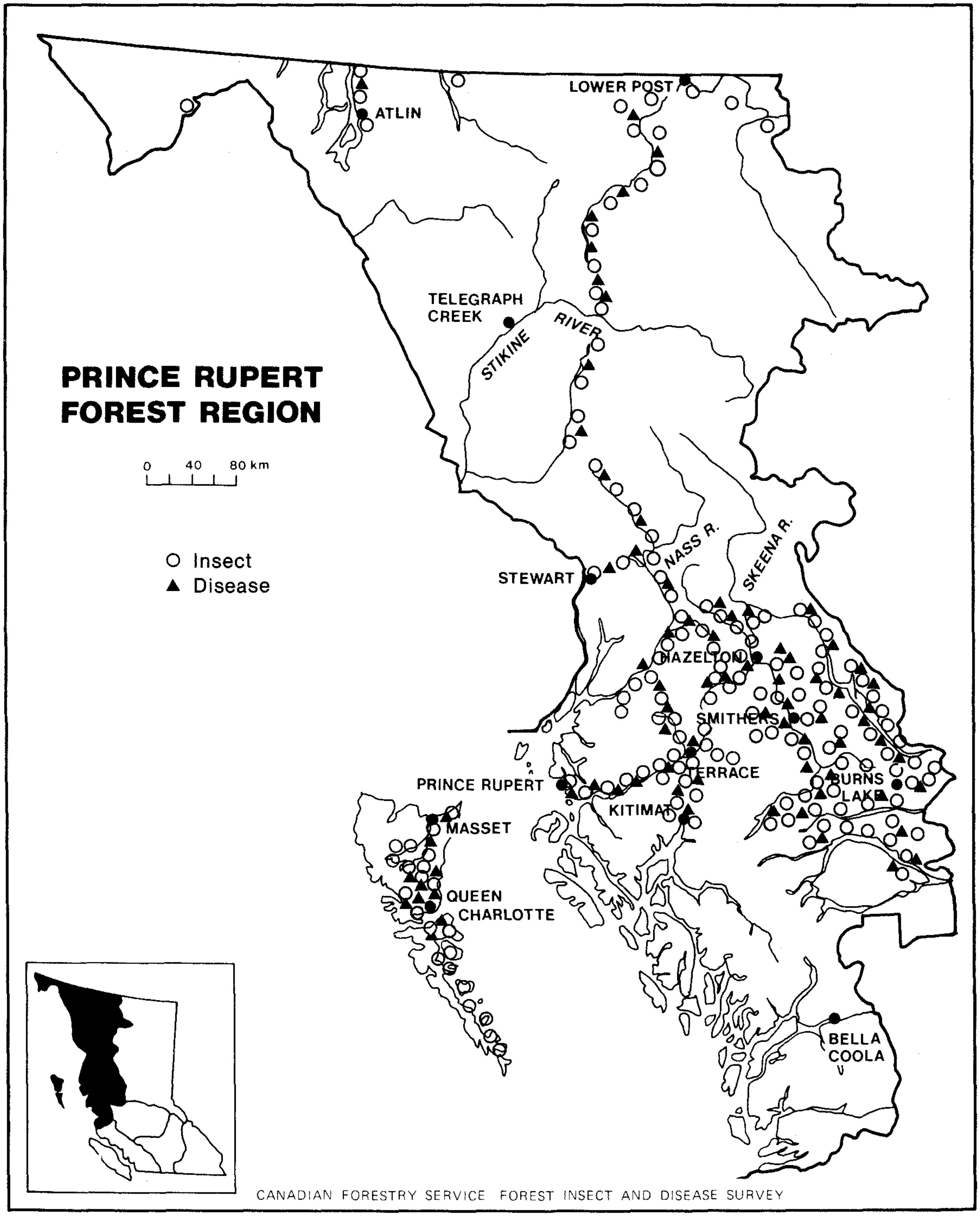
Forest Insect and Disease Survey
Box 2259
Smithers, B.C.
V0J 2N0
Ph. 847-3174

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

FIDS personnel are located at the CFS Headquarters for the Pacific and Yukon Region the remainder of the year:

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

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



Map 1. Locations where one or more forest insect and disease samples were collected in 1986.

SUMMARY

In the following summary of pest conditions in the Prince Rupert Forest Region the pests are grouped by host(s), generally in order of importance. From coniferous hosts at permanent sampling locations the percentage of **foliage beating collections** containing insects capable of causing serious damage increased to 43% from 35% in 1985.

The volume of lodgepole pine recently killed by the **mountain pine beetle** declined by 6% to 689 000 m^3 over approximately 14 000 ha. An increase was recorded in the Kispiox TSA while all other TSAs had less area under attack than in 1985. Populations of **Ips beetles** continued to increase in conjunction with the mountain pine beetle and in unburned logging slash. Initial surveys indicated that **tomentosus root rot** was present in 89% of the mature and overmature lodgepole pine stands examined. There was close to a twofold increase in **lodgepole terminal weevil** activity with an average of 9% of the leaders killed. **Porcupine damage** continued to intensify and was of particular concern in thinned stands in the Kalum TSA. Seed production by **lodgepole pine dwarf mistletoe** declined due to hyperparasites. Pine **foliar diseases** generally decreased and **drought-stressed** trees were shedding old foliage in western and northern portions of the Region. **Pitch twig moth** damage was light in several Interior plantations and pheromone-baited trap catches were greatly reduced. The **pinewood nematode** was extracted from stressed lodgepole pine in five areas.

Recent tree mortality caused by the **spruce beetle** was mapped over 1 050 ha with most infestations associated with nominal lingering populations in old outbreaks. Some of the current attack was from beetles emerging from 1984 windthrow. The **black army cutworm** was again active in the Harold Price Creek drainage, destroying 6 000 seedlings. Attractant-baited trap catches suggested a decreasing population for 1987. **Spruce budmoths** were the most commonly collected defoliators from both Sitka and white spruce. Data from cruise strips implied that the incidence of **spruce weevil** attack was closely related to the proximity of a watercourse. Damage from **cone and seed insects** was generally light to moderate in a medium to heavy cone crop on both white and Sitka spruce. **Spruce budworm** populations returned to endemic levels; moths caught on the Queen Charlotte Islands were identified as Choristoneura biennis. Damage caused by **spruce gall adelgids** in young stands increased twofold. Spruce **foliar diseases** increased in the western and northern portions of the Region. **Frost damage** to flushing new growth was greatly reduced from 1985 levels. Patches of **winter drying** were observed in the northern portion of the Region. **Spruce aphid** activity remained at a low level on the Queen Charlotte Islands.

The **western blackheaded budworm** defoliated 56 200 ha of western hemlock on the Queen Charlotte Islands and near Kitimat. Top-kill and tree mortality followed two years of defoliation; egg counts indicated a greatly reduced population for 1987. **Hemlock sawfly** populations increased in conjunction with the budworm and contributed significantly to the defoliation on the Queen Charlotte Islands. **Porcupine damage** continued to increase, of particular concern in young, managed stands. Heavy western and mountain hemlock cone crops were generally free of **cone and seed pests**.

The area of **western balsam bark beetle** mapped in alpine fir stands continued to increase, although current attack was down slightly from the previous two years. Accumulated mortality reached 67% of the trees in chronic infestations. **Tomentosus root rot** was present in 24% of the mature alpine fir trees examined.

The incidence of **poplar shoot blight** in trembling aspen was greatly reduced to small patches of less than 10 ha. The **Pacific willow leaf beetle** severely defoliated willow from Kitwanga to Meziadin Junction. Pheromone-baited traps placed at 50 locations to detect the introduction of the **gypsy moth** into the Region were negative. Pheromone-baited traps for **clearwing moths** were examined weekly or bi-weekly at eight sites in the Region for taxonomic and distribution studies.

PINE PESTS

Mountain pine beetle, *Dendroctonus ponderosae*

Mountain pine beetle recently killed an estimated 946 000 lodgepole pine (689 000 m^3) on 14 000 ha in the Region (Map 2, Table 1). This represents a slight increase in area from 13 000 ha and 896 000 trees in 1985, but a decrease in volume from 734 000 m^3. The beetles remained most active in the western TSAs and portions of the Bulkley TSA, but fewer beetle-killed trees were mapped in the Interior TSAs than in 1985. Maps showing intensity and size of infestations were provided by the British Columbia Forest Service.

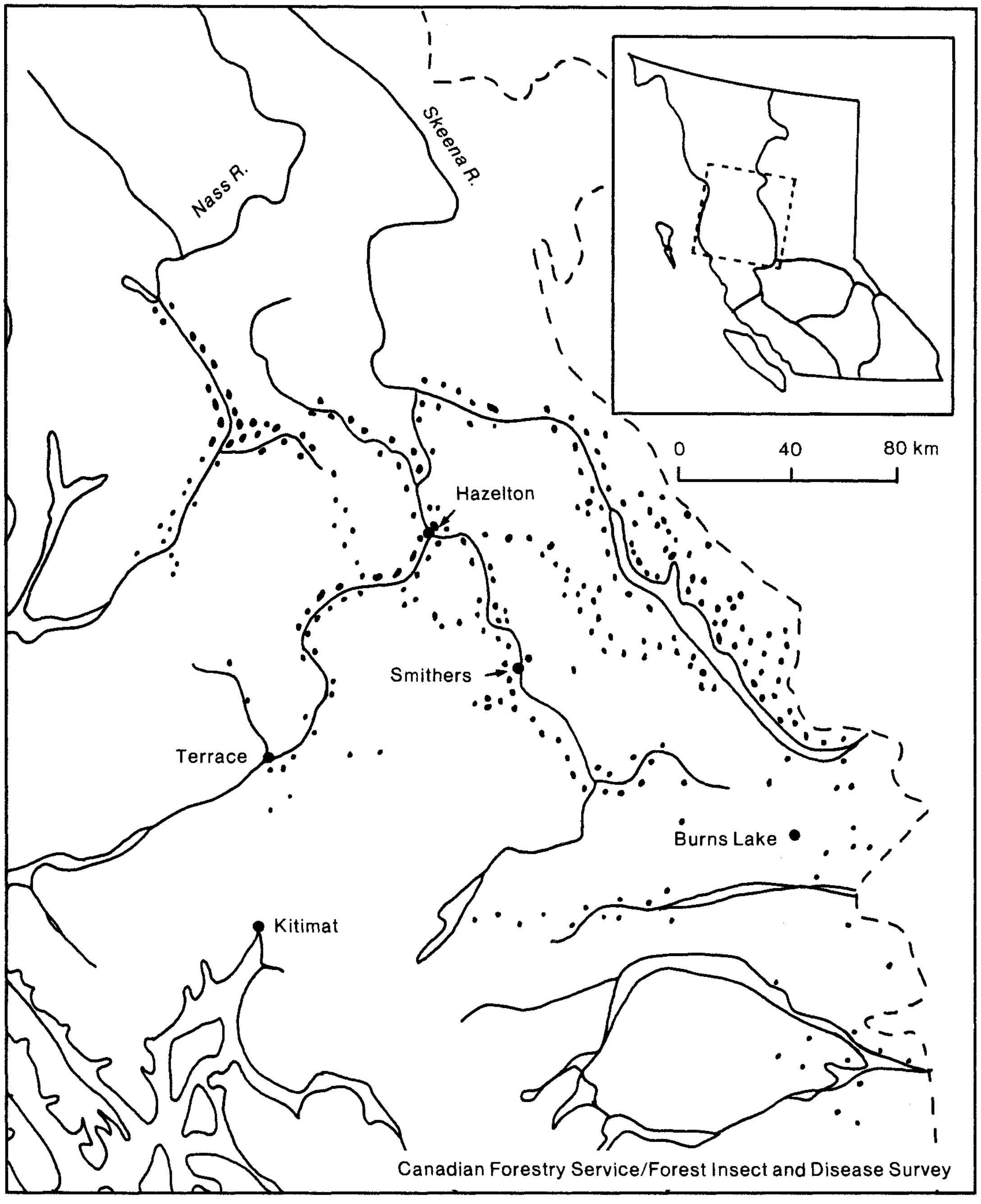
Table 1. Area, volume and number of lodgepole pine recently killed by mountain pine beetle, Prince Rupert Forest Region, 1986.

Location (TSA)	Area (ha)[1]	Volume recently killed (m^3)[2]	Number of trees killed
Kalum[3]	6 100	328 000	506 000
Kispiox	4 300	105 000	228 000
Bulkley	3 100	214 000	178 000
Morice	450	39 000	31 500
Lakes	50	3 000	2 500
TOTAL	14 000	689 000	946 000

[1] Areas were computer calculated from maps provided by the BCFS district offices.
[2] Volumes were calculated using CFS-FIDS field data.
[3] Kalum TSA data based on 1985 maps and FIDS ground observations.

Kalum TSA

In the Kalum TSA approximately 506 000 lodgepole pine were recently killed on an estimated 6 100 ha. Since no detailed aerial sketch maps were available, the figures for this TSA were based on the 1985 maps and ground observations of beetle activity, along with only limited logging of beetle-killed pine. The major epidemic population remains in the Cranberry and Nass rivers junction area. However, a westward movement of the population is occurring with increasing numbers of small groups of red trees appearing in the relatively younger pine stands along the Nass River Valley to Canyon City and south into the Tseax River area. Similarly, a westward movement has been noted over the past four years along the Skeena River drainage with numerous groups of 5 to 10 beetle-killed trees appearing in the Terrace area, south to Lakelse and north to Rosswood. A growing porcupine population is also contributing to the increasing numbers of red trees through most of the western portion of the TSA, especially from the Terrace area north into the Nass River drainage.



Map 2. Areas of lodgepole pine recently killed by mountain pine beetle, determined by aerial and ground surveys, Prince Rupert Forest Region, 1986.

Due to lodgepole pine being a relatively minor species in the TSA, no extensive control programs have been implemented by the BCFS. This factor along with a warmer climate than the Interior of the Region allows the beetle population to continue relatively unchecked.

Kispiox TSA

In the Kispiox TSA an estimated 228 000 lodgepole pine were recently killed over 4 300 ha in the same general areas as in 1985. Although the area mapped increased by 3 000 ha, it was due more to a change in mapping procedure than increased beetle activity. The most extensive area of red trees remains along the Skeena River corridor from near Hazelton, southwest to the Kalum TSA boundary (approximately 3 000 ha). The majority of the mature pine on valley benches and adjacent slopes have been killed since the infestations were first recorded in 1969, near Hazelton. However, beetle activity continues, reinfesting the remaining green trees in previously attacked stands, attacking younger pine stands, and searching out small pine pockets scattered within predominantly hemlock stands. In the Kispiox River drainage (300 ha), Upper Skeena River area (500 ha), and the Kitwanga River Valley (350 ha), recently killed trees were primarily in small groups of less than 100 trees. However, logging has rapidly removed most of the larger-diameter pine stands, especially in the Kispiox River Valley, reducing the availability of trees capable of producing large broods. Further groups of 5 to 20 trees were mapped in the Kitseguecla, Bulkley, Suskwa and Shegunia river drainages.

Bulkley TSA

In the Bulkley TSA, the 214 000 m^3 of pine recently killed over 3 100 ha is only slightly less than that recorded in 1985. The major infestations remained in the lower-elevation stands of the Bulkley River drainage, including Telkwa River and Trout Creek, where infestations have increased to 2 100 ha. The large infestations on steep slopes in this area continue to expand and to disperse into surrounding mature pine stands. Much of the remaining beetle--killed pine is in groups of 10-100 trees in the Chapman Lake-Harold Price Creek area (825 ha), where several larger inaccessible beetle-infested mixed stands persist near Holland Lake and near Maish Creek. Similarly, small pockets of recent red trees continue in the Babine River-Nilkitkwa Lake area (400 ha). The number of fading trees has been declining in most of the latter two areas due to extensive logging of most of the infested stands at an early stage of the infestations, especially in the Harold Price Creek area. In the Babine Lake-Nilkitkwa River area an extensive program of fall and burn, combined with pheromone-baiting and logging as the beetles initially moved into the area, has kept beetle populations at a low level despite large tracts of highly susceptible mature pine.

Morice TSA

In the Morice TSA, the 31 500 recently killed lodgepole pine continue the declining trend of 1985. Although there was less area mapped with fewer trees, there was an increase in the number of groups of trees throughout the TSA, primarily due to large infestations having been logged. A major area of concern remains in the Morrison Lake area and along Babine Lake, where numerous small infestations continue and new ones have developed to cover 255 ha. Most of the infestations remain in groups of 5-50 trees, but several old and currently inaccessible infestations have increased to 300+ trees. Extensive mixed pine and spruce stands remain highly susceptible to continuing beetle attack. Historically this has been the most chronically beetle-infested area in the Region.

Along the Nadina River drainage over 50 groups of generally one to five trees were mapped, an increase from only the occasional red tree mapped in 1985. Although some mountain pine beetle is present in this area, a number of other causes of tree mortality have also been identified. Most frequently, Inonotus tomentosus was found in combination with Ips spp., Hylobius warreni, and Monochamus spp. Occasional Hylurgops sp. were found in dying trees but not as a primary cause of tree mortality. Since FIDS began monitoring pest conditions in the Region, no significant beetle activity has been recorded through this general area.

In the Houston-Topley area the number of groups of 5-10 recently killed trees increased slightly covering an estimated 25 ha. A decrease was recorded in the Tanglechain-Fulton lakes area (155 ha). Despite the overall decrease in the latter area several patches of up to 50 ha persist in the Covert Creek and Port Arthur areas. An aggressive program of fall and burn, pheromone-baiting, brood removal and logging has kept most infestations to small groups of trees.

Lakes TSA

In the Lakes TSA, only 50 ha of recently killed lodgepole pine were mapped. The small groups of red lodgepole pine (generally 5-50 trees) were scattered over the whole TSA, with the greatest concentration on the north side of Babine Lake where one infestation expanded to include 300 trees along Tildesley Creek. South of Babine Lake between Taltapin Lake and the Forestdale-Maxan Lake area, widely scattered groups of 5-50 fading lodgepole pine continued, while in the Tchesinkut Lake and Creek areas increased beetle activity was recorded in several patches of 50 red trees. South of Francois Lake widely scattered groups of 5-10 red trees were noted in the Knapp Lake area, south to Ootsa and Tetachuck lakes. However, as in the adjacent Morice TSA to the west, most of the red trees examined in the areas south of Francois Lake and in the Maxan Lake-Forestdale to Taltapin Lake areas were not mountain pine beetle-killed trees. Root rot-caused tree mortality was frequently accompanied by secondary insects, most commonly Dendroctonus murrayanae and Ips spp. Where mountain pine beetle attack was present, attack levels and brood production were generally very low, often less than 10 parent galleries per tree.

Generally, the Lakes TSA has a high potential for major mountain pine beetle infestation expansion with approximately 50% of its forest inventory in a susceptible age category of pine. However, climatic conditions appear to be the major limiting factor, preventing rapid beetle expansion over much of the TSA.

Overwintering Mortality

Extended cold periods during November 1985 caused extensive beetle mortality with virtually all adults, eggs and early-instar larvae destroyed in some areas. Approximately 50% of the broods had developed to the mid-instar larval stage for overwintering. Overwinter larval mortality averaged 80% in eastern TSAs in a comparison of reproductive ratios (R values) from the fall of 1985 to that of spring 1986. Samples at Telkwa had 65% mortality compared to 91% in the Nilkitkwa Lake-Babine River area. Very similar results were obtained by a BCFS study in March of 1986. The development of the surviving larvae was slowed by cool spring weather, resulting in a delayed flight period in 1986. However, with extended warm weather in the fall through to the beginning of November, most of the broods established in 1986 developed to a more winter-hardy mid-instar stage.

Predictive larval sampling

Spring brood sampling, to determine population trends for 1986, generally indicated static to increasing populations for the lower elevation infestations. Reproductive (R) values included: Bulkley River, Kitwanga and Cranberry Jct. - 3.3, Kispiox River - 4.0, Trout Creek - 4.9, Terrace - 5.0 and Telkwa River - 9.0. In higher elevation Interior stands, spring R values indicated static to decreasing populations: Houston - 4.0, Morrison Lake - 3.8, Natowite Lake - 2.2 and Nilkitkwa Lake-Babine River area - 1.2. Current interpretation of R values indicates that static populations can be expected from values of 2.6-4.0, with values above and below this indicating increasing and decreasing populations, respectively.

The spring R value predictions of beetle activity were generally correct when compared to fall stand examinations. The values became less accurate in larger infestations where high R values resulted in relatively static populations, but at high attack levels. However, these infestations were on steep slopes and had a high dispersion rate to highly susceptible adjacent pine stands.

Fall Surveys

Eleven pine stands were cruised during September and October to determine the current attack levels and brood development (Table 2). The current attack continued at high levels averaging 36%, a slight increase from 32% in 1985. However, the cruise strips were established along the fringes of discolored trees where the highest current attack levels occur. These figures do not necessarily reflect an increasing population but rather a continued highly vigorous population. They also need to be viewed in conjunction with local infestation conditions such as size and age of the infestation and stand types. The Harold Price Creek area is an example where annual current attack levels have reflected the declining vigor of the beetle population. Since 1981 a series of cruise strips have been run along the advancing fringes of several infestations; current attack levels ranged from 32-38% during 1981-83 and declined to 22% in 1984 and to 13-14% in 1985-86.

Table 2. Status of lodgepole pine in stands infested by mountain pine beetle, Prince Rupert Forest Region, 1986.

	Percent of pine volume attacked				
Location	current (1986)	pitchout/partial (1986)	red (1985)	gray (prior to 1985)	Healthy
Sideslip L.	43	4	8	7	38
Cranberry Jct.	25	0	40	19	16
Kitwanga	28	6	17	0	49
Woodcock	51	4	13	3	29
Terrace Airport	40	2	15	2	41
Kispiox R.	22	2	29	11	36
Trout Cr.	43	0	11	5	41
Telkwa R.	56	1	6	1	36
Coffin L.	50	1	6	2	41
Covert Cr.	24	0	40	0	36
Harold Price Cr.	14	4	28	18	36
Average	36	2	19	6	37

As the relative size of infestations continues to decline in areas of active control programs or logging, or as outbreaks spread into new areas, the data were combined from several shorter cruise strips in a drainage. Where infestation pockets were too small to be cruised, ratios of 1986- to 1985-attacked trees were determined. Ratios in the Nilkitkwa Lake-Babine River area were generally 0.5 to 1.0 (1986 attack:1985). Similar ratios were present in most infested areas to the south and west of Babine Lake. In the Morrison Lake area, Bulkley River Valley drainage and the western TSAs, most infestation ratios averaged 1:1 with occasional patches indicating increased attack with up to 3:1 ratios.

Management Considerations

The control programs currently employed - fall and burn, pheromone-baiting and brood removal - are primarily a short-term holding action until susceptible host trees can be logged. If used over extended periods, these control efforts tend to prolong the duration of infestations at low to moderate levels. The degree of beetle activity will depend on site-suitability for brood production and the thoroughness of locating and treating infested trees. However, wide dispersion is common and attacks are highly successful in overmature stands where the trees lack vigor, partially due to the high incidence of root rot in older stands. Even though only a few beetles may migrate into a specific spot, successful attack is a high probability. With successful attacks widely dispersed, the proportion of currently attacked trees detected decreases along with control of the beetle population.

While stand conditions may favor major beetle infestation expansion, the climatic conditions are often less than optimum for brood development and population vigor. The Interior portion of the Region is part of the northern fringe of the mountain pine beetle range, and cool summers can greatly delay brood development, leaving the beetle at a vulnerable stage for high mortality overwinter. Consequently the rate of expansion, especially of small groups of infested trees, is reduced. However, in the climatically more favourable south-facing slopes and knolls, brood production is greatly enhanced and much of the beetle dispersion originates from these sites.

Forecasts

The predictions for beetle activity in 1987 are highly variable due to a wide range of climatic conditions, infestation age and size, suitable stand types remaining, and the intensity of control efforts.

In the western TSAs, where unattacked mature pines are available, attack levels will remain high. The general westward movement of infestations along the Nass and Skeena river valleys should continue to intensify. Due to generally favourable climatic conditions, control becomes increasingly difficult. However, many of these stands are relatively young and should provide some resistance to a rapid increase in infestation expansion.

In the Interior TSAs, the beetle attack levels should increase in 1987 following favourable summer and fall weather which allowed most of the 1986 brood to develop to a winter-hardy larval stage. This is especially true in the lower elevation stands in the main valleys and on southerly aspect slopes but it will also greatly increase the 1987 adult population in the less hospitable areas of the Region. Populations in areas such as in the Babine River-Nilkitkwa and Babine lakes areas will become more active. In the southern Nadina River-Ootsa Lake area, where minor populations exist, beetle populations could become more of a problem. However, in these fringe beetle areas, several consecutive years of optimum summer and fall climatic conditions are required for the establishment of an adequate population size to sustain an outbreak. A population of sufficient size and vigor is required so that enough beetles will survive the frequent years of unfavourable weather and enable it to rebound quickly during favourable years.

Pine engraver beetles, *Ips* spp.

Pine engraver beetle populations have been increasing during the past few years causing scattered lodgepole pine mortality. Small groups of 5-15 beetle-killed trees continued in the Francois Lake-Nadina River area where mortality has been noted since 1981. Similar small groups of recently killed trees were recorded at Pinkut, Taltapin , Ootsa, Maxan, Morrison, Fulton, and Goosly lakes. North of Dease Lake, scattered tree mortality was noted over three hectares of roadside mature lodgepole pine.

Increased Ips populations were associated with unburned logging slash and recent road construction. Large broods develop in the slash and, upon maturing, migrate to fringe mature pine. Insects frequently active in conjunction with *Ips* included woodborers, *Monochamus* spp., lodgepole pine beetle, *Dendroctonus murrayanae*, and *Hylobius* sp. (also migrating from slash to fringe trees). In addition, root rot, *Inonotus tomentosus* frequently had destroyed a portion of the root system, greatly reducing resistance to beetle attack.

Ips pini and *I. mexicanus* also increased and were maintained at high levels during mountain pine beetle infestations. Mountain pine beetle-attacked trees were frequently infested by *Ips* spp., especially when the mountain pine beetle attacks occurred during late summer or early fall. Both late summer and early spring Ips attacks concentrated on these trees, while the mountain pine beetle broods were still in the egg to early instar larval stage. Similarly, Ips populations prospered in the upper portion of mountain pine beetle-killed trees.

Severe Ips attack was present in 9% of the trees currently attacked by mountain pine beetle in cruise strips run in the small diameter lodgepole pine stands in the Kispiox TSA. Similar levels of Ips attack were present in localized mountain pine beetle infestations near Fulton Lake, Telkwa, and along Babine Lake.

Ips populations associated with mountain pine beetle infestations decline with decreasing mountain pine beetle activity. However, when mountain pine beetle populations collapse rapidly, Ips populations may persist for one or two years but are generally unable to maintain high populations in healthy unstressed pine. For a more detailed discussion on the association between these two beetles, see Forest Insect and Disease Conditions, Cariboo Forest Region, 1986.

Tomentosus root rot, Inonotus tomentosus

In an initial survey to determine the incidence of tomentosus root rot in lodgepole pine stands, 89% of the mature to overmature pine were found to be infected (Table 3). Root rot related mortality averaging 9.5% was present in 9 of 14 stands. However, in the four stands under 60 years old examined, no active infections were noted although occasional infected roots have been collected in young stands.

In lodgepole pine stands, root rot symptoms are much less pronounced than in spruce stands. Pine growth appears to be little affected by the root rot until the mature period when the tree vigor declines, unlike in spruce where mortality begins during the 10-15-year-old period. In fact, the root rot in the infected roots in young pine had been actively resisted and pitched out. The pattern of infection, especially in mature stands, suggests that pine sapwood is highly resistant to infection. When all of a tree's roots were examined, the most advanced decay was found in the heartwood portion of the root closest to the stump and decreased in the younger root portions farther from the tree stump. This was true even where the smaller diameter roots were in contact with severely infected white spruce roots. As overmature trees weakened and succumbed to the root rot, the decay progressed rapidly to the smaller roots and into the sapwood.

Table 3. Incidence of *I. tomentosus* in lodgepole pine stands in Prince Rupert Forest Region, 1986.

Location	Stand composition[1]	Stand maturity[2]	Per cent of trees infected	Remarks
Dungate Cr.	wS/lP	om	80	decay not identified
Trout Cr.	lP/wS	om	100	
Doris L.	lP/wS	m	80	
Morice R.	lP/wS	om	100	2% mortality
Morrison L.	lP/wS	om	100	5% mortality
Goosly L.	lP/wS	m	100	2% mortality
Guess Cr.	lP/wS	om	100	20% mortality
Taltapin L.	lP/wS	om	100	
Nadina R.	lP	om	60	
Francois L.	lP	m	80	1% mortality
Fleming Cr.	lP	om	100	1% mortality
Pinkut Cr.	lP	m	80	3% mortality
White Eye L.	lP	om	100	50% mortality
Pinkut L.	lP	m	60	2% mortality
Taltzen L.	lP/wS	im	0	
Telkwa R.	lP/wS	im	0	
Goosly L.	lP/wS	im	0	
Maxan L.	lP/wS	im	0	

[1]wS - white spruce; lP - lodgepole pine
[2]om - overmature; m - mature; im - immature

The first few stands examined were mixed lodgepole pine-white spruce stands, due to the assumption that pine was a secondary host and became infected when associated with infected spruce trees. The average infection rate was higher (97%) in the mixed stands. However, in pure pine stands, 80% of the trees were infected indicating that infection is not dependent on root contact with infected spruce. At this stage, it would appear that high infection levels can be maintained within pure pine stands with tree growth little affected until maturity. The main problem occurs if pine stands are reverted to a mixed or pure spruce stand.

Root rot-infected trees become more susceptible to bark beetle activity. At two plot areas (Morrison Lake and Fleming Creek), mountain pine beetle attack was directly related to the severity of infection in the trees. The areas sampled had scattered patches of 2-3 red beetle-killed trees which had well advanced root rot in infection centers. The general areas were not typically productive beetle sites, having a northerly aspect, and being in a mixed spruce stand along the historical northern fringe of beetle activity. Generally the beetles have very low reproductive capacity except during warm summers. It is especially in these types of areas that diseased trees are a contributing factor to beetle infestation spread. The very light beetle attack densities which cause tree mortality would readily be pitched out by healthy trees.

In drier pure pine sites, Ips spp. and root collar weevil were more common but tree mortality was usually associated with recent road right-of-way construction or unburned slash in cutblocks. As these beetles left the slash they moved to, and killed, diseased fringe trees. These trees already had several dead major roots and relatively light attack at the root collar caused mortality even where only Hylobius warreni or Monochamus spp. were involved.

Lodgepole terminal weevil, Pissodes terminalis

An average of 9% of young lodgepole pine had tops recently killed by terminal weevil in continuous strips of 300 to 600 meters surveyed at 12 locations (Table 4). This represents nearly a twofold increase over the 4.75% terminal mortality in the same stands in 1985. In addition to leader mortality, only stunted 1986 leader growth of 5 to 20 cm occurred on 3.1% of the 1985-attacked pine.

Table 4. Incidence and intensity of lodgepole terminal weevil attack in young lodgepole pine plantations, Prince Rupert Forest Region, 1986.

Location	Percent 1985 attack	Average number of exit holes per leader
North Rd.	16	1.9
Nilkitkwa L.	15	3.2
Topley Ldg. Rd.	14	2.7
Andrew Main	12	2.7
Andrew Bay Rd.	12	1.5
Collins L.	11	0.9
Taltzen L.	10	3.6
McBride L.	7	3.6
Andrew Bay	6	1.3
Andrew Main	3	0.7
Walcott	1	3.6
Augier L. Rd.	1	0.5
Regional Average	9	2.2

The increase in 1985 attack was compared to the number of exit holes from 1984-attacked leaders (Table 5). A minimum of 25 leaders were examined at each of eight sites, with an average of 1.9 exit holes per leader resulting in an average increase of attack at those sites by 2.5 times in 1985. As indicated in Table 5, the decrease in attack incidence very closely follows the decrease in the number of exit holes, down to the point of no attack increase at 0.6 exit holes per leader. Based on these observations, an assumption could be made that when half of the attacked leaders have an exit hole the incidence of attack remains relatively stable.

Table 5. A comparison of the number of exit holes per leader to the resulting attack, Prince Rupert Forest Region, 1986.

	Rate of increase in attack from 1984 to 1985	Number of exit holes per leader in 1984
	1.0X	0.6
	1.5X	1.0
	1.7X	1.6
	2.3X	1.8
	2.7X	1.9
	3.0X	2.4
	3.7X	2.6
	4.0X	3.0
Average	2.5X	1.9

Average numbers of exit holes per leader in areas surveyed in 1986 (Table 4) indicate that terminal mortality should continue to increase in most areas in 1987 at a rate similar to 1986. Further follow-up will compare the number of exit holes in 1985-attacked leaders to 1986 attack.

The short-term damage to all the trees with leaders killed in 1984 showed that 36% had not established a dominant leader but were developing two or more distinct leaders. This effect becomes more prominent as repeated attacks occur on individual trees. This was the second or third year of attack on 6% of the 559 trees attacked in 1984 and 1985. The long-term impact based on the preceding averages, damage figures and the period of time the trees are most susceptible indicates an estimated 15% of the pine in plantations will develop forks or major crooks between the two and seven meter portion of the bole due to weevil attack.

Porcupine

The extent and intensity of porcupine feeding increased considerably within the last year in the western half of the Region (Table 6). Most often the feeding occurred in 20- to 40-year-old lodgepole pine stands, though damage was occasionally found in younger sapling stands and older mature stands. As the damaged trees turn red they resemble spot outbreaks of mountain pine beetle which is also active in small patches in several of the porcupine-damaged stands.

In dense, unmanaged stands the porcupine damage may not be detrimental because the scattered feeding acts as a natural thinning agent. However, in thinned stands, such as in the Kalum Valley, damage to the remaining trees becomes more significant.

Several factors may have contributed to the recent growth of the porcupine population: a climatic warming trend in recent years; the cumulative effect of many years of trapping may have reduced predator numbers, particularly the fisher which has a high value pelt; pole-sized slash commonly left behind in thinned stands provides both ground cover refuge for the porcupine and an impediment to predator movement. Continuing and probably increasing stand losses will have to be accepted if conditions favourable to the porcupine persist or are enhanced.

Table 6. Porcupine feeding damage observed in lodgepole pine stands, Prince Rupert Forest Region, 1986.

Location	Stand age class (years)	General extent of current feeding	Remarks
NE of Lakelse	30-40	patches of 5-25 trees	secondary infestation by mountain pine beetle in 5 trees
Williams Cr.	30-40	patches of 1-5 trees	scattered activity near mouth of valley
Kalum Valley	15-30	patches of 1-15 trees	feeding in thinned and untreated stands throughout the valley
Copper R. Valley	30-50	patches of 5-10 trees on sw-facing slopes	
Lava L.	40-60	scattered patches over about 6 ha	continuation of damage recorded last year
Tseax Valley	50-70	patches of approx. 5 trees	
Morchuea L. airstrip	10-15	<10% of sapling regen.	
Dease L.	20-30	<10% of young growth stand	

Lodgepole pine dwarf mistletoe, <u>Arceuthobium americanum</u>

Dwarf mistletoe-caused brooms are common in pine stands in the sub-boreal spruce biogeoclimatic zone in the Region, most extensively in subzone d. In B.C. average losses due to this mistletoe have been estimated at 1.4 m^3/ha/yr[1] within the infected acreage.

In older infestations new shoots are normally produced annually and remain intact for 2-3 years. However, at five areas examined, disease (primarily *Colletotrichum gloeosporioides*) during the previous two years has greatly reduced the number of infections with living mistletoe plants to an average of 31% (Table 7). Those infections with mistletoe plants generally had only a low to moderate number of shoots. Assuming a normal 1:1 male to female

[1]Paper presented by G.A. Van Sickle and R.B. Smith at "A Symposium: Dwarf Mistletoe Control Through Forest Management", Berkeley, California, April 1978.

ratio, only 15% of the infected branches had low numbers of seed producing plants, of which an average of 36% were diseased or failed to produce seeds.

Table 7. Effect of hyperparasites on lodgepole pine dwarf mistletoe, Prince Rupert Forest Region, 1986.

Location	Percent of infections with mistletoe shoots	Percent of pistillate plants diseased[1]
Morice R.	10	46
McBride L.	40	31
Ootsa L.	25	26
Pinkut C.	50	36
Francois L.	30	40
Average	31	36

[1]Includes primarily Wallrothiella arceuthobii, Colletotrichum gloeosporioides, and some unknown causes of shoot mortality.

Current seed production was extensively destroyed by Wallrothiella arceuthobii infection, ranging from 40% at Morice River to 22% at Ootsa Lake. Even though the outer plant structure is destroyed, the systemic infection remains viable and new mistletoe plants will be produced while the host remains alive. However, low seed production decreases the rate of spread and intensification of the disease within the host and stand.

Foliar diseases

Scirrhia pini infection of lodgepole pine foliage continued in the western portion of the Region, while it declined in the east in 1986. Light infection was observed on 1985 lodgepole pine foliage along the Skeena River near Little Oliver Creek and on shore pine near Pure Lake on Graham Island.

At a chronic 10-ha infection centre near Kisgegas, infection was reduced to only trace levels. This is the first year that most of the previous year's foliage has not been prematurely cast in the four years of monitoring this stand. Dry conditions during spore dispersion in 1985 greatly reduced infection establishment and hence foliage discoloration in 1986. However, cool moist weather during the spring of 1986 may lead to increased discoloration in 1987.

Western pine-aster rust, Coleosporium asterum, caused generally light infections with occasional half-hectare patches of severe in the Walcott, Topley Landing, McBride Lake, and North Road lodgepole pine plantations. Other foliar diseases causing foliage discoloration at low levels included Lophodermium pinastri at Pure Lake on Graham Island and Lophodermella montivaga at small scattered locations in the Decker Lake to Endako area.

Winter drying caused extensive desiccation of lodgepole pine foliage over 600 ha on a south-facing slope near Good Hope Lake.

Extended dry periods during mid-summer combined with a relatively dry 1985 resulted in widespread discoloration of 1985 and older foliage. The most extensive foliage loss occurred in much of the western and northern portions of the Region from the Skeena Valley to Boya Lake, north of Dease Lake.

Pitch twig moths, *Petrova* spp.

Light damage by maturing pitch twig moth larvae was present at 6 of 12 Interior young lodgepole pine stands. Nodules at branch crotches on the main stem were on 2-3% of the trees at Nilkitkwa Lake, Walcott and Augier Lake Road, while less than 1% of the pine had stem nodules at Taltzen Lake, Topley Landing Road and Andrew Bay. Long-term damage was usually minimal but occasional top-kill at Augier Lake was attributed to previous feeding.

Adult trapping was continued in 1986 with low numbers of moths caught, presumably reflecting the second or non-flight year of a two-year life cycle (Table 8). In areas trapped for two consecutive years in the Interior portion of the Region the number of moths dropped to 21% of the 1985 catches. In the western portion, seven moths were caught in one location in 1986 compared to an average of 13 in all traps in 1985. All moths caught in the Region have been *P. metallica*.

Table 8. Number of pitch twig moths caught in pheromone-baited traps, Prince Rupert Forest Region, 1986.

Location	Number of moths per trap
Harold Price Creek	48
Hannay Rd.	47
Nilkitkwa L.	30
Granisle	25
Fulton R.	21
Telkwa R.	17
Kitwanga	7
McBride L.	5
Cranberry Jct.	0
Terrace Airport	0
Rainbow L.	0

A discomycete on pine, *Claussenomyces pini*

This new micro-fungus was isolated from one collection of diseased young lodgepole pine near Houston. Apothecia were found at the edge of a stalactiform rust canker, *Cronartium coleosporioides*. Although its pathological status is not known, it would appear to be a secondary invader of diseased bark.

SPRUCE PESTS

Spruce beetle, *Dendroctonus rufipennis*

An estimated 24 000 m^3 of spruce were recently killed over 1 050 ha in the Region (Table 9) calculated from aerial survey maps provided by the BCFS (Map 3). This was a major decrease from 1985, when 106 000 m^3 of spruce were killed over 15 200 ha. Populations have been declining rapidly from the 1 616 900 m^3 of beetle-killed spruce recorded in 1982. While the large areas of previously killed (gray) trees may contain occasional fading trees, these have generally not been included in the 1986 figures.

Table 9. Area and volume of spruce recently killed by spruce beetle, Prince Rupert Forest Region, 1986.

Location (TSA)[1]	Area (ha)[2]	Volume recently killed (m^3)[3]
Kispiox	550	10 000
Bulkley	200	5 000
Morice	300	9 000
Total	1 050	24 000

[1]In the Lakes TSA, 6 300 ha were mapped but mortality was not distinguished between alpine fir and spruce mortality. In the Kalum TSA no recent spruce beetle activity was noted.

[2]Areas were computer-calculated from maps provided by BCFS district offices.

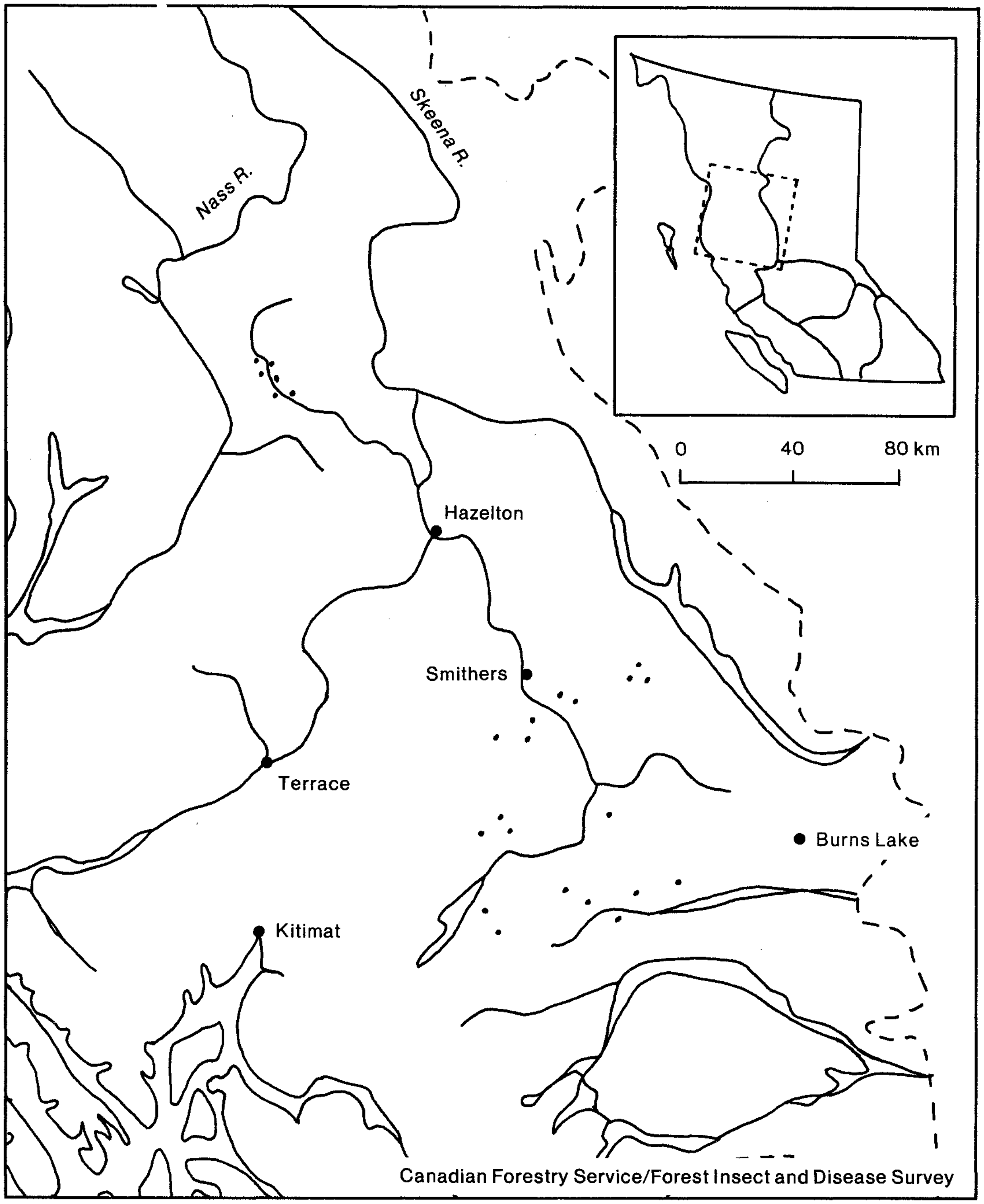
[3]Volumes were determined using CFS-FIDS field data. 'Recently killed' refers to discoloring trees, primarily 1985 attack.

TSA reviews

In the Lakes TSA, 6 300 ha of tree mortality were mapped; however, no distinction was made between spruce and alpine fir and therefore it is not included in Table 9. Although occasional recent beetle-killed trees may have been present in those stands, most were old infestations consisting primarily of gray trees or alpine fir mortality.

In the Morice TSA, most of the 300 ha of recently killed spruce were in small scattered pockets of less than 10 trees. Although a few small groups of trees were mapped in the Gosnell Creek area south of Fulton Lake and near Goosly Lake, most of the activity occurred between Owen and Morice lakes. In several larger patches of primarily gray trees at Nadina Mountain, Tableland Mountain and Nado Creek up to 10% recently killed spruce were present.

In the Bulkley TSA currently active beetle areas covered 200 ha in several small infestations continuing in the Goathorn-Tenas creeks area, and in a small area near Hankin lake.



Map 3. Areas of mature spruce recently killed by spruce beetle, determined by aerial and ground surveys, Prince Rupert Forest Region, 1986.

The Kispiox TSA remains the most active beetle area in the Region, with 550 ha of recent beetle-killed spruce. The infestations are in generally inaccessible areas in the upper Kispiox River area and have persisted since 1979. In areas examined the discoloring trees were primarily water-stressed.

In the Kalum TSA, no recent spruce beetle-caused tree mortality was mapped. This TSA had 4 300 ha of spruce mortality mapped in 1985, but most of the area encompassed trees killed prior to 1984.

Along the Haines Road, near the Alaska border, 15 to 20 1984-attacked trees were found. The adults had flown at the time of examination and, based on the large number of exit holes, populations are being maintained at slightly above endemic levels. Although no currently attacked trees were found, the area will continue to be monitored in 1987.

Overwintering mortality

High mortality of overwintering adult spruce beetles greatly reduced the 1986 beetle flight in the Region (Table 10). Low snow levels left many of the adults in 1984 blowdown exposed to extremely low temperatures during November 1985, and to some degree in February 1986, causing extensive adult mortality. Overall, populations appear to be just above endemic levels with occasional small infestations continuing where stressed trees or extensive blowdown was present.

Table 10. Overwintering adult spruce beetle mortality, Prince Rupert Forest Region, 1986.

Location	Percent mortality	Remarks
Klo Creek	75	98% mortality above 30 cm from ground
Nadina River	75	blowdown
Shelford Hills	75	"
Lamprey Creek	70	"
Walcott	40	"
Taltapin Lake	10	scattered blowdown

Fall surveys

In the one beetle-infested stand cruised in the Region, near Walcott, 45% of the volume was currently attacked (27% of the trees). However, this was in an area where 45% of the spruce had been windthrown and attacked in 1984 and the emerging beetles had killed most of the remaining large diameter spruce. An extensive salvage logging program in most of the major blowdown areas has greatly reduced the threat of a resurgent beetle population from the maturing brood.

Additional areas examined for spruce beetle included the Nangeese River area where scattered water-stressed trees were maintaining a low beetle population. At Lamprey Creek, scattered logging block fringe trees were attacked. In this general area, creek fringe trees with water-logged root systems were currently attacked. In several areas in the Shelford Hills, additional fringe blowdown was absorbing the emerging adult beetles. Along the Nilkitkwa Lake Road the occasional currently attacked trees were root rot or water-stressed. In the upper Klo Creek area scattered current attack averaged close to 2% of the fringe trees along the edge of extensive older infestations. In the Taltapin Lake area all currently attacked trees had pitched out the attacking beetles. In the Nadina River area, discoloring trees currently attacked by beetles had been severely water-stressed during the prolonged cool, wet spring conditions and spruce beetle was not the initiator of tree mortality. In all of the above areas this was a common cause for many of the small groups of discoloring spruce. The broods observed were developing in primarily a two-year life cycle, except for approximately 15% of the lower elevation infestations in the Walcott, Goathorn Creek and Nangeese River areas.

Forecasts

The general prediction for 1987, based on field observations and brood development, is that populations should continue to decline. However, in undetected or unsalvaged areas of 1984 blowdown, the 1986-attacked trees will discolor and become evident in 1987 in unpredicted areas. Additionally, numerous small areas had trees stressed or killed by extended periods of excess water covering the root systems during the early part of the growing season. Severe current beetle attack on these trees may create localized population increases in 1987 and 1988.

Black army cutworm, *Actebia fennica*

Black army cutworm larvae destroyed an estimated 6 000 recently planted white spruce and lodgepole pine seedlings in the spring of 1986 in the Region. During the current infestation period, starting in 1982 at Guess Creek, an estimated 400 000 seedlings have been destroyed.

The most severe infestations in 1986 were spread over three cutblocks in the Harold Price Creek drainage, all of which had low levels of primarily white spruce seedling mortality (Table 11). The relatively low number of seedlings killed in relation to the infestation severity was greatly influenced by the planting schedule. The three major infestations had been planted in 1985 allowing for seedling establishment for one year prior to severe defoliation. Although 90% of the spruce over portions of the cutblocks had been totally defoliated, seedling mortality was low. Had these areas been planted during the spring of 1986, during or just prior to cutworm activity, an estimated 85 000 seedlings may have been killed. This was borne out in study plots over the past four years where seedlings planted both one year prior to and during an infestation were examined for the ability to recover from total defoliation (Table 12). Mortality of both white spruce and lodgepole pine seedlings was significantly reduced by planting the spring immediately following a fall slash burn. Black army cutworm eggs would be laid in such sites the summer following the burn, after spring planting, and larval feeding would occur one year after planting.

Table 11. Assessments of 1986 black army cutworm areas in decreasing order of severity[1], Prince Rupert Forest Region, 1986.

Location	Planting period	% seedling mortality	Herbaceous feeding % of area	Herbaceous feeding % of growth destroyed	Pupal counts per 1000 cm^2
Torkelsen Cr.	1985	6	85	90	20
Harold Price Cr. (27/72)	1985	4	80	80	5
Harold Price Cr. (23-2)	1985	1	60	80	16
Burdick Cr.	1986	0	10	50	6
Suskwa R.	1985	0	10	20	2
Chapman L.	1986	0	10	20	1
Telkwa	1985	0	5	20	3
Nose Bay	1985	0	3	25	4
Jinx Rd.	1985	0	2	20	2
Taltapin L.	1985	0	10	5	<1
Pop Fire[2]	N.A.	-	70	2	0
Decker L.	1986	0	5	trace	<1
Natlin Cr.	1985	0	5	trace	<1

[1]Severity of infestations was determined by a combination of area covered and severity of defoliation.
[2]The Pop Fire infestation died during the early stage of development.

Cutworm larvae feeding on the bark of seedlings was a major cause of mortality. Of the seedlings that died in plantations established for one year prior to defoliation, 82% died with 25% or more of the stem girdled. Comparatively, 63% of the seedlings that died in plantations planted during the spring of the infestation died with a similar level of bark feeding present. However, these newly planted seedlngs appeared to be a more preferred food source than the established seedlings, with 28% of the totally defoliated established seedlings having bark feeding compared to 80% of the totally defoliated newly planted seedlings. In an additional aspect of the same study, three 200-seedling plots were used to compare the mortality rate of totally defoliated seedlings without bark feeding. Of the established seedlings only 8% died, while 74% of the seedlings planted the spring of the infestation died. This indicated that a much smaller cutworm population, and hence lighter feeding, can destroy seedlings in newly planted sites than that required to cause equal mortality in an established plantation.

Table 12. A comparison of two planting schedules in relation to mortality of seedlings totally defoliated by black army cutworm in fall burns[1], Prince Rupert Forest Region, 1986.

Host	Percent seedling mortality	
	planted spring following burn Avg. (range)	planted second spring following burn Avg. (range)
lodgepole pine	1.5 (0-5)	14 (10-25)
white spruce	10 (0-15)	45 (25-90)

[1]The fall burns were done after the major black army cutworm flight period.

Examination of a planting site at Poplar Lake during the early instar period indicated an infestation-size population was developing. However, unseasonal cold, damp conditions, which prevailed through much of the early feeding period, appeared to have destroyed most of the cutworm population. Other areas, especially on the east side of Babine Lake, although not examined during the early larval stage, displayed similar signs of early larval mortality. These areas had extensive early feeding which was abruptly halted as the larval population collapsed.

Natural biological control factors were present at increased levels from 1985, averaging 20% in first year infestations and 65% from one collection in a two-year-old infestation near Telkwa. Tachinids were present in all of the samples and caused most of the larval and pupal mortality in the first year infestation areas. In the two-year-old infestation, additional cutworm mortality was caused by high numbers of braconids. Black army cutworm population control trials using a bacterium, Bacillus thuringiensis, indicated that excessively large dosages were required to cause significant mortality.

Pupal counts had declined to ten per 1 000 cm^2 in areas with significant cutworm populations in 1986, from an average of 20 in comparable areas in 1985 (Table 11). However, these numbers are high enough to maintain a continuing potential for major infestations in 1987, especially in the Harold Price Creek drainage.

Attractant-baited traps also indicated a reduced population from 1986 (Table 13). Although a change in pheromone formulation strength (currently 0.4%, previously 0.1 and 1.0%) does not allow direct comparison to previous years trapping, the adult populations remain high enough to indicate a continuing potential for major infestations in 1987. High moth counts do not necessarily result in infestations in the cutblock, but major infestations have not occurred in areas where moth counts have been low, less than 10 moths with the 1.0% concentration and less than 4 with the 0.1% concentration. The hazard ratings in Table 13 are based on the extrapolation of observed results from these two concentrations over the previous four years of trapping.

Table 13. Average number of black army cutworm moths caught in pheromone-baited traps and predicted hazard for 1987, Prince Rupert Forest Region, 1986.

Location		Average # moths	Predicted hazard 1987
Kispiox TSA			
Andi Cr.		3	low
Burdick Cr.	(C.P. 200)	1	trace
Suskwa R.	(C.P. 30)	1	trace
Bulkley TSA			
Torkelsen Cr.	(C.P. 18) Pheromone trials caught approximately 35 000 moths.		
Smithers Ldg.		12	moderate/severe
Smithers Ldg.	(318-7)	7*	spotty moderate infestations
Harold Price Cr.	(10-2)	6*	spotty moderate infestations
Chapman L.	(C.P. 502)	5	low
Harold Price Cr.	(15-1)	4	low
Telkwa	(512)	2	trace
McKendrick Pass	(301)	1	"
Morice TSA			
N. Babine L.	(C.P. 110)	10*	moderate/spotty severe
Smithers Ldg.	(318-5)	7	moderate
Natowite L.	(C.P. 047)	5*	spotty moderate
Babine L.	(C.P. 502-HFP)	5	low
Fulton L.	(C.P. 430)	4	"
Hagen Rd. Jct.	(C.P. 122-3)	4	"
Babine L.	(C.P. 122-2)	4*	spotty moderate
Nadina Main	(C.P. 050)	3	low
Babine L.	(C.P. 110-9)	3	"
Poplar L.	(C.P. 107)	2	trace
Guess Cr.	(C.P. 160)	2	"
Morrison L.	(C.P. 515)	2	"
Tanglechain L.	(C.P. 408)	2	"
Nado Cr.	(C.P. 520)	2	"
Covert Cr.		2	"
W. Francois L.	(C.P. 133)	1	"
Lamprey Cr.		1	"
Babine L.	(C.P. 110-7)	1	"
Nado Cr.	(C.P. 027)	1	"
Franc Fire/Babine L. N.W. Camp		0	nil
Tochcha L. (048), Babine L. (122-5)		0	nil

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Location	Average # moths	Predicted hazard 1987
Lakes TSA		
Pinkut Cr.	3	low
Cross Cr.	2	trace
Johnson Rd.	2	"
Crow Cr.	2	"
Ramsay Cr.	1	"
Anders Rd.	1	"
Taltapin L.	1	"
E. Ootsa (051)(071)	0	nil
Kalum TSA		
Bell-Irving R.	9	moderate
Kitimat Main	1	trace
Little Wedeene R.	1	"
SW Lakelse	1	"
SW Lakelse	1	"
S + NW Lakelse, SW + NW Kalum L.	0	nil

*Individual traps had high numbers of moths

Early spring site examination for black army cutworm should be a regular aspect of the spring planting program where moderate to high hazard levels are indicated by moth trapping. When small feeding holes are evident on emerging vegetation, especially arnica and fireweed, over large portions of a cutblock and early instar black army cutworm are present, planting should be delayed. Table 14, which has been revised from 1985, provides a basic guideline. Delaying planting until most cutworm are in late instar and pre-pupal stages in early to mid-June will practically eliminate seedling mortality. Preliminary studies indicate that early instar larvae can be detected by using a somewhat time-consuming procedure of collecting duff samples in large buckets along with small amounts of fresh green vegetation. The young larvae will crawl onto the vegetation to feed where they can be easily counted over a two to three day period.

Table 14. Instar larval counts and potential seedling damage, Prince Rupert Forest Region, 1986.

Larval instar	No. of larvae/1000 cm^2	Potential damage to newly planted seedlings
2-3	3-5	expect mortality, delay planting until better assessment of population size can be made
4-5	5-10	expect patches of mortality on drier knolls and some south slopes
5+	15	major infestation

Spruce budmoths, Zeiraphera spp.

Spruce budmoth populations increased in 1986 in the Region. The most significant feeding, particularly by Z. canadensis, occurred in young Sitka spruce plantations in the Kitimat, Skeena and Nass river valleys where 23% of the trees had current growth moderately to severely infested (Table 15). This pest has potential for considerable damage to young Sitka spruce stands. In previous severe infestations (1961-64 and 1975-79), terminal mortality to regeneration Sitka spruce averaged 38 and 44%, with multiple leaders forming on 25% of all the trees.

Table 15. Evaluation of feeding by spruce budmoths (Zeiraphera spp.) and the western blackheaded budworm (Acleris gloverana) on flushing Sitka spruce buds in the Kitimat, Skeena, and Nass river drainages, Prince Rupert Forest Region, 1986.

Location	No. of trees assessed	Stand age (yrs)	[1]Intensity: % of assessed trees affected				
			none	trace	light	moderate	severe
8 km NW Kitimat	25	9	4	32	40	20	4
8 km SW Onion L.	25	10	-	-	40	44	16
Copper River	25	14	24	36	40	-	-
Prudhomme L.	27	10-20	7	19	33	26	15
Exchamsiks R.	27	12	4	15	26	56	-
Shames R.	24	9	25	63	13	-	-
Kalum R.	20	12	70	25	5	-	-
Cranberry Jct.	25	9	24	44	20	12	-
Nass Valley	25	10	20	24	44	12	-
Regional Average		11	20	28	29	19	4

[1]None - no buds infested per tree.
Trace - only 1 or 2 buds infested per tree
Light - up to 10% of " " " "
Moderate - 11-30% " " " " "
Severe - 31% + " " " " "

In Interior white spruce stands, an average of 3.5 Z. destitutana larvae were present in 53% of the annual three-tree beating locations. Comparatively, an average of 1.5 larvae were present in 12% of the samples in 1985. The effect on white spruce is generally minimal.

Spruce weevil, Pissodes strobi

The spruce weevil continues to be a significant pest of young Sitka spruce stands in some areas of the Region, particularly the Kitimat, Skeena and Kalum river drainages. Surveys in 1986 were placed to test a hypothesis that the incidence of successful attack by the weevil was related to distance from a stream, river or bog, possibly due to a buffering of climatic extremes such as drought. Stands adjacent to a watercourse, within 30 m, were compared with those at least a kilometer distant (Table 16).

Table 16. Incidence of current attack by the spruce weevil as related to proximity to a main watercourse, Prince Rupert Forest Region, 1986.

Location	Stand age	% of Sitka spruce in stand	% of Sitka spruce currently infested	Proximity to a main watercourse
Kitimat Main Rd.	8	68	0	> 1 km
N. Kitimat Main Rd.	15	16	0	"
Coldwater Rd.	12-15	81	2	"
Branch 77 Rd.	10	93	0	"
Branch 77A Rd.	10	78	0	"
Nalbeelah Cr.	10-20	75	34	Adjacent
Kitimat R.	8	65	35	"
Humphreys Cr.	10-20	66	38	"
Copper R.	16	100	39	"
Skeena R.	10	96	45	"

Empirical observations suggest that the incidence of attack drops off sharply at much closer distances less than 1 km, generally from 50 to 400 m depending on the terrain. Additional surveys next year should further substantiate and refine this hypothesis.

Cone and seed pests

Cone collections during August indicated generally low to moderate levels of insect damage in a moderate to heavy cone crop of both white and Sitka spruce (Table 17). In white spruce, all sites had insect-damaged cones, while Sitka spruce cones from the Queen Charlotte Islands and two locations on the Mainland were pest-free.

Table 17. Percent of spruce cones infested by major pests, Prince Rupert Forest Region, 1986.

Location	Host[1]	*Hylemya anthracinum*	*Cydia strobilella*	*Dasineura canadensis*	*Dasineura rachiphaga*	Other pests
Bell-Irving R.	wS	65	40	5	0	
Dease L. (36 km S)	wS	20	5	30	0	20% *Mayetiola carpophaga*
Cedarvale	wS	10	0	0	0	
Alice Arm Rd.	wS	5	0	0	0	
Dease L. (64 km N)	wS	35	0	0	15	
Cassiar (50 km S)	wS	10	10	0	70	
Boya L.	wS	5	0	5	0	
Echo L.	wS	55	5	10	0	
Meziadin	wS	45	5	15	0	
Kinaskan L.	wS	15	5	10	15	5% *Diocyctria abietivorella*

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Location	Host[1]	Hylemya anthracinum	Cydia strobilella	Dasineura canadensis	Dasineura rachiphaga	Other pests
Iskut	wS	10	10	5	10	5% Mayetiola carpophaga
Skins L.	wS	65	10	25	30	
Kispiox R.	wS	10	5	45	0	5% Chrysomyxa pirolata
Telkwa R.	wS	40	0	0	15	
Nilkitkwa L.	wS	40	0	0	20	
Pinkut L.	wS	45	25	5	0	7% C. pirolata
Average		30	7	10	11	
Terrace, bench	sS	40	25	5	0	
Terrace (Skeena R.)	sS	5	0	0	0	
Lakelse L.	sS	10	5	0	0	
Kalum Forest Rd.	sS	5	0	0	0	
Tseax Lava Flow	sS	20	15	5	0	
Nass R. (w. bridge)	sS	15	0	5	0	
Kitwancool (39 km N)	sS	10	0	0	0	
Stewart (25 km NW)	sS	10	0	0	0	
Stewart	sS	35	15	5	0	
Kasiks R.	sS	5	0	0	0	2% Chrysomyxa sp.
Terrace (31 km NW)	sS	) negative				
Dasque Cr.	sS	) negative				
Massett	sS	)				
Miller Cr.	sS	)				
Lawnhill Pt.	sS	)				
Average (excluding Q.C.I.)		13	5	2	0	
Dease L. (44 Km S)	bS	0	0	35	10	5% Resseliella sp.

[1]sS - Sitka spruce, wS - white spruce, bS - black spruce

The two most common and damaging pests, spiral spruce-cone borer, *Hylemya anthracinum*, and the spruce seedworm, *Cydia strobilella*, can destroy all the seed in a cone with only two to three larvae present. *Hylemya anthracinum* was present in an average of 30% (range 5 to 65%) of all the white spruce cones, while an average of only 11% (range 0 to 40%) of the Sitka spruce cones in the 12 Mainland collection sites were infested. Similarly, *Cydia* strobilella was less common on Sitka spruce with an average of 5% (range 0 to 25%) of the cones infested in mainland locations compared to an average of 7% (range 0 to 40%) of the white spruce cone collections.

Other pests present, occasionally in high numbers, which do not directly destroy the seeds included: spruce cone gall midge, Dasineura canadensis, infesting an average of 2% (range 0 to 5%) of cones in Mainland Sitka spruce cone collections and an average of 10% (range 0 to 45%) of white spruce cones collected; spruce cone axis midge, D. rachiphaga, infesting an average of 11% (range 0 to 70%) of white spruce cones collected and none of the Sitka spruce cones. The spruce seed midge, Mayetiola carpophaga, present only in two northern collections, usually causes only minor seed damage.

Spruce budworms, Choristoneura spp.

Spruce budworm populations continued to decline, with only occasional larvae collected in three-tree beatings from the Kispiox and Telkwa river valleys and along Harold Price Creek.

Pheromone-baited sticky traps were deployed at two areas to assist in species identification (Table 18). The number of moths in traps to date does not reflect relative population size but only the presence of the insect. This was the first time that Choristoneura spp. adults have been collected from the Queen Charlotte Islands in the two years of trapping (only occasional larvae have been previously collected). The species caught, C. biennis (tentative identification) is the same as those most frequently caught on the Alaska Panhandle, but differs from the most frequently trapped species, C. orae, of the adjacent coastal Mainland.

Table 18. Number of Choristoneura spp. moths caught in pheromone-baited sticky traps, Prince Rupert Forest Region, 1986.

Location	Stand type[1]	Target insect	Pheromone and concentration	Avg. no. moths/trap	Remarks
Wedeene R.	wH, alF overmature	C. orae	E-Z-11-tetradecanol E-11-tetradecanol 0.1%	35	
Wedeene R.	wH, alF overmature	C. fumiferana/ biennis	E-Z-11-tetradecanol 0.1%	0	Avg. 14 moths/trap of Acleris emergana
Port Clements	sS overmature	C. orae	E-Z-11-tetradecanol E-Z-tetradecanol 0.1%	0	
Port Clements	sS overmature	C. fumiferana/ biennis	E-Z-11-tetradecanol 0.1%	11	

[1] wH - western hemlock, alF - alpine fir, sS - Sitka spruce

Porcupine

High porcupine populations have damaged Sitka spruce in the Region. Eleven patches of from 1 to 15 trees each in 15- to 25-year-old stands were fed upon between Km 13 to 29 of the Kalum Forest Road. In 10 of the 11 feeding patches observed, the stands had been thinned and the slash left. Damage was also noted in thinned stands in the rest of the Kalum Valley, on the south side of the Skeena R. near Dasque Cr., and in unthinned mixed stands near Gainor Lake and 10 to 20 km east of Stewart.

Spruce gall adelgids, *Pineus* spp.

Incidence of adelgid-caused galls on the flushing shoots of Sitka and white spruce increased in 1986. Both *P. pinifoliae* and *P. similis* galls were present, with 38% of the spruce in eight plantations lightly to severely infested (Table 19). In the Interior, at Chapman Lake, the number of infested white spruce shoots increased by more than twofold from 1985, with an average of 12% of the shoots infested on 100% of the trees in 1986.

P. similis, the most common adelgid on white spruce in the Region, remained at levels similar to previous years in several chronic infestation areas at: Blunt Creek - 16%, Guess Creek - 15%, Kuldo Creek - 25% and at Nose Bay 18% of the trees were moderately to severely infested. Lightly to moderately infested trees were also observed in the Kiteen River Valley. Low levels of an unidentified *Pineus* sp. were also collected at Kinaskan and Boya lakes.

Table 19. Evaluation of gall formation by pineleaf adelgids, mainly *Pineus pinifoliae* and occasionally *P. similis*, on flushing Sitka and white spruce buds in Prince Rupert Forest Region, 1986.

Location	No. of trees assessed	Stand age (yrs)	Intensity:% of assessed trees affected[1] None	Trace	Light	Moderate	Severe
8 km NW of Kitimat	25	9	40	24	32	4	0
8 km sw Onion L.	25	10	28	32	20	12	8
Coldwater Rd.	57	14	60	0	26	9	5
Copper River	25	14	68	20	8	4	0
Kalum Valley	20	12	90	10	0	0	0
Cranberry Jct.	25	9	84	4	12	0	0
Nass Valley	25	10	32	4	44	16	4
Chapman L.	25	12	0	0	76	16	8
Regional average		11	50	12	27	8	3

[1]None - no buds infested per tree
Trace - Only 1 or 2 buds infested per tree
Light - up to 10% of " " " "
Moderate - 10 to 30% " " " " "
Severe - more than 30% " " " "

P. pinifoliae has previously been recorded on spruce only when in association with white pine, which serves as the alternate host. On white pine it has caused up to 18% mortality in young stands. However, the locations of current infestations suggest that the adelgid may be able to complete its life cycle using whitebark or lodgepole pine as an alternate host, and also that it may be able to complete its life cycle on spruce without an alternate host. Further sampling will be done in 1987 in an attempt to clarify this aspect of its life cycle.

Severe infestations of spruce gall adelgids are required to affect tree performance. Similar damage caused by the Cooley spruce gall adelgid, Adelges cooleyi, near Houston[1] reduced height growth by 32% and caused a diameter reduction of 18% when 50% or more of the shoots were killed.

Foliar diseases

The incidence and intensity of spruce foliar diseases increased in 1986. Chrysomyxa spp. (likely C. ledicola) severely infected the current year's growth of spruce over approximately 7 500 ha along the north end of Dease Lake to the Beady Creek area. All age classes of valley bottom and west aspect spruce were affected. A needle cast, Lirula macrospora, destroyed 90% of the 1985 foliage in scattered patches of mature spruce along the Skeena River north of Hazelton. At Bitter Creek, near Stewart, young Sitka spruce were moderately infected.

The fluctuation of these pathogens is highly dependent upon climatic conditions, especially moisture during sporulation. The Chrysomyxa spp. require moist spring conditions and L. macrospora, moist summer conditions. The effect on the infected trees is generally light; however, annual rusts such as C. ledicola can destroy all of the current year's foliage. When infection occurs for consecutive years, or when combined with pests feeding on the older foliage, (e.g. spruce aphid on the Queen Charlotte Islands in the 1970's), tree mortality can result. Similarly, high localized populations of Pikonema alaskensis combined with the rust have caused tree mortality of open-growing white spruce.

Frost

The incidence of frost damage on the flushing new growth of Sitka spruce saplings was greatly reduced in 1986. Damage was only occasionally observed scattered through small patches of less than a hectare in the Kalum and Kitimat valleys and on white spruce near Hazelton. This compares to an average of 56% of Sitka spruce saplings affected in the stands surveyed in 1985.

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[1]See Forest Insect and Disease Conditions, Prince Rupert Forest Region, 1981.

Winter drying

Winter drying caused light discoloration of white spruce and alpine fir over about 960 ha in patches on Mt. Pendleton, Needlepoint Mtn., and Northwest Mtn. along Dease River. Near Hazelton on a southfacing aspect in the Suskwa River Valley, spruce seedlings planted in 1985 had 8% of the terminal growth killed by winter dryng. No seedling mortality is expected. This foliar desiccation is usually caused by a warm spell of spring weather which activates the needles to photosynthesize while the roots are still frozen.

Spruce aphid, *Elatobium abietinum*

Spruce aphid activity continued to decline with no significant feeding observed or reported. Cold temperatures during November of 1985 presumably were a major factor in population reductions.

HEMLOCK PESTS

Western blackheaded budworm, *Acleris gloverana*

Blackheaded budworm defoliated western hemlock on an estimated 44 300 ha and 11 900 ha on the Queen Charlotte Islands (Q.C.I.) and near Kitimat, respectively (Map 4, Table 20). This was an increase from 28 600 ha and 2 200 ha in the same general areas in 1985. Area figures were derived from the FIDS computerized mapping system based on aerial sketch maps of the infestations provided by BCFS and industry personnel on the Q.C.I., and by the authors in the Kalum TSA.

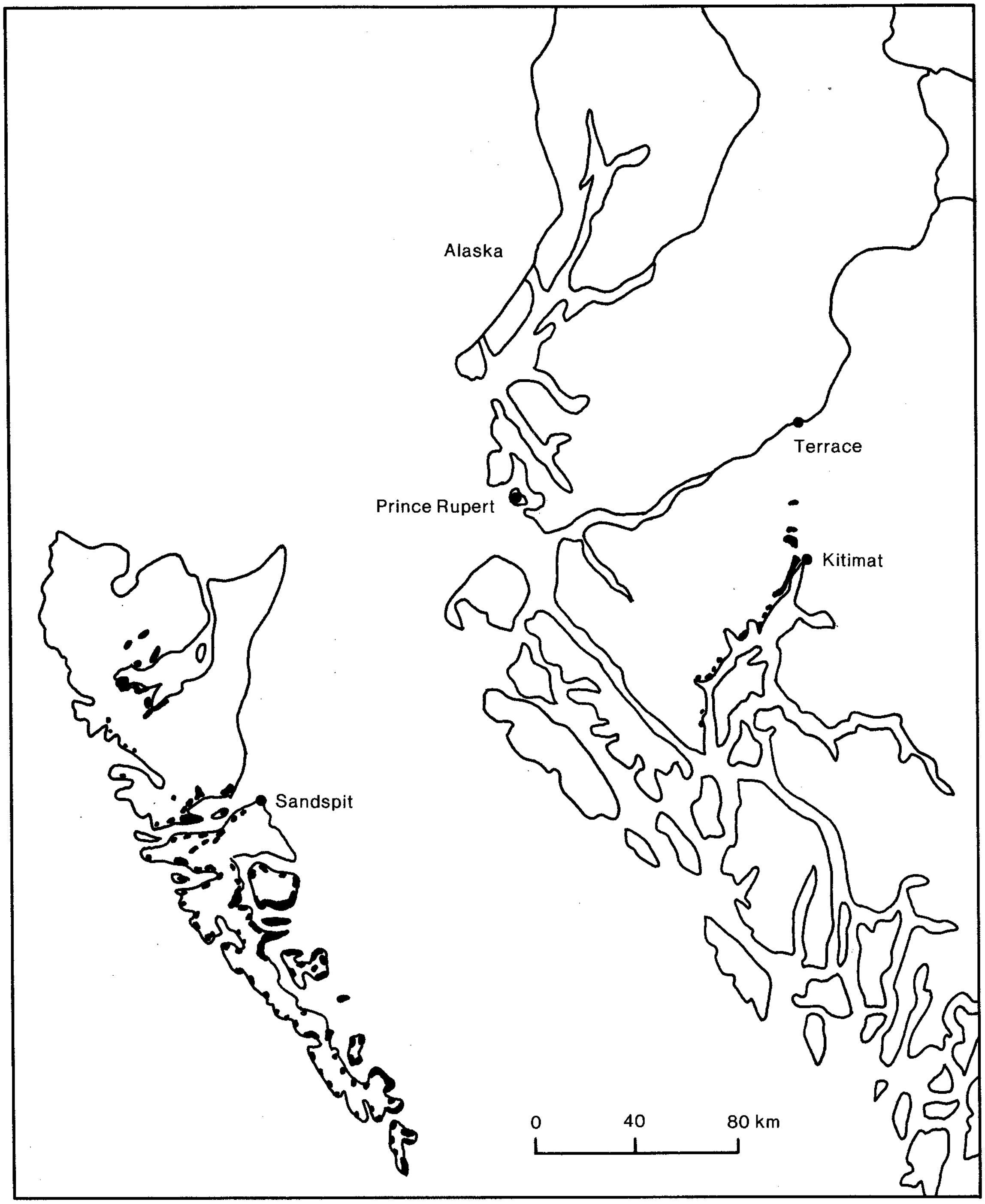
Defoliation Assessments

The majority of the severe defoliation (6 150 ha) on the Q.C.I. occurred in the mid-Moresby Island area between Richardson Island and southern Louise Island (4 400 ha), while decreasing in intensity to the south of Talunkwan Island where most of the severe defoliation was recorded in 1985. Further areas of severe defoliation were recorded in the Skidegate Channel area (1 400 ha) and at Wathus Island. Intermingled moderate (22 800 ha) and light (15 350 ha) defoliation were mapped in most hemlock stands on Moresby Island, southern Graham Island and in the western Masset Inlet area. The greatest increase occurred in the north Moresby Island-Skidegate Channel area along with an extension and coalescing of infestations in the western Masset Inlet and Ian and Awun lakes areas. In the mid-instar larval sampling during July an average of 800 larvae per three-tree beating were collected, with over 500 larvae in 14 of 23 samples ranging up to 2 800 larvae in a Skidegate Channel sample.

Table 20. Areas and severity of defoliated western hemlock by western blackheaded budworm in British Columbia, 1986.

Location	Severity of defoliation	Stand Maturity: Less than 20 yrs	20-100 yrs	100+ yrs	Total(ha)
Q.C.I.	light	350	3 200	11 800	15 350
	moderate	1 900	4 400	16 500	22 800
	severe	850	3 100	2 200	6 150
Coastal Mainland	light	0	0	2 300	2 300
	moderate	0	0	9 100	9 100
	severe	0	0	500	500
Total (ha)		3 100	10 700	42 400	56 200

The Kitimat area infestation expanded north to the Wedeene River and south along Douglas Channel to Kiskosh Inlet, but declined in the Alan Reach area. The 500 ha of severe defoliation was centered in several small pockets between Bowbyes Creek and Emsley Cove, while moderate defoliation was most frequent in the same general area but also extended north to include the Little Wedeene River drainage.



Map 4. Areas of western hemlock defoliated by western blackheaded budworm, determined by aerial surveys, Prince Rupert Forest Region, 1986.

Impact Assessment

Defoliation increased by an average of 20% at seven of nine study plots in the Q.C.I. (Table 21). However, in two plots, immature hemlock defoliation decreased by 35%. In those two plots defoliation decreased to light, following moderate and severe defoliation in 1985. Top-kill was 62% following severe defoliation compared to only 7% after one year of moderate defoliation. When individual trees with severely defoliated upper crowns in 1985 were lightly defoliated in 1986, increased foliage growth occurred in the lower living branches.

Table 21. Degree of defoliation and top-stripping in blackheaded budworm-defoliated western hemlock stands, Prince Rupert Forest Region, 1986.

Location	Stand maturity	Avg. defoliation by crown Upper	Mid	Lower	Avg. length of top-kill (m)	Percent of trees with top-kill
Atli Inlet	immature	72	38	15	2	62
Powrivco Bay	immature	37	20	16	3	7
Sewell Inlet	immature	80	67	52	9	50
Thurston Harbour	immature	100	85	55	9	100
Talunkwan I.	immature	100	98	80	14	100
Jedway	mature	83	77	75	3	43
Burnaby I.	mature	71	53	31	3	90
Forsyth Pt.	mature	97	87	60	4	100
Ramsay I.	mature	92	77	64	4	94

Top-kill was greatly increased in all plots, affecting an average of 72% of the trees in 1986 compared to 44% in 1985. Along with increased incidence, length of top-kill increased to an average of 7.4 m from 1.3 m in 1985. Length of top-kill is not necessarily indicative of infestation severity because of the variation in crown depth. The close-growing advanced regeneration stands tend to have shallow crowns.

In immature stands the percentage of trees with top-kill increased slightly to 66% in 1986 from 56% in 1985. Based on ground checks of aerial mapping, an estimated 3 100 ha of immature hemlock had an average of 8 m top-kill on 75% of the trees. On an additional 4 400 ha, 56% of the trees had an average of 4 m top-kill.

In the 18 700 ha of moderately to severely defoliated mature stands, an estimated 82% of the trees had an average of 3 m top-kill. This is a major increase from the 6% recorded in 1985. In the Kitimat area infestation, an aerially estimated 5 100 ha should have similar levels of top-kill.

Tree mortality to date has been recorded only in immature stands with both blackheaded budworm and sawfly populations. In the Talunkwan Island plot, 36% of the advanced second growth hemlock were killed. Overall, 18% tree mortality has occurred in the severely defoliated young stands with a further 16% having only minimal foliage remaining with little chance of recovery. Although no mortality has been recorded in the mature stand plots, 10% of the trees were very severely defoliated and recovery appears unlikely.

Natural Control Factors

Natural control factors increased in 1986, especially in the Kitimat area where parasitism ranged from 12% during the early instar stage to 40% of the late instar larvae. Parasitism on the collections from the Q.C.I. was only 2%. Parasites were identified only as Hymenoptera and Diptera.

Large numbers of larvae infected by Entomophthora sp. and Cladosporium sp. were collected from a young stand in the Honna River drainage on the Q.C.I. However, the young larvae were in a stressed condition due to forced migration when spacing was conducted during the feeding period, and even the low levels of pathogens present resulted in larval mortality. The diseased larvae were found only in the stand spaced during larval feeding.

Forecasts

The results of egg sampling conducted in October, with assistance from BCFS and industry personnel, indicated a greatly reduced population for 1987 in most areas (Table 22). The average egg count in 1986 was only 18 per 50-cm branch, compared to an average of 118 in 1985. Starvation in the previously severely defoliated stands contributed to decreased egg counts. Early instar larvae are especially vulnerable to starvation. The small amount of foliage remaining had record numbers of eggs present in 1985 and the very limited new growth in 1986 was insufficient to maintain the population through to pupation.

Severe defoliation is forecast at one location (3%), moderate at 7 (21%) and trace to light at the other 25 (75%) locations (Table 22). Generally, moderate defoliation was indicated for the northern end of Moresby Island (South Bay and East Narrows), Masset Inlet (Harrison Island and Begbie Bay) and Louise Island. Primarily light defoliation is predicted for the south Morseby Island area, including Lyell Island, much of southern Graham Island, portions of Masset Inlet and in the Kitimat area. Stands moderately to severely defoliated during the past two years should generally have trace to light defoliation in 1987.

Table 22. Numbers of eggs and predicted defoliation of western hemlock by blackheaded budworm in the Queen Charlotte Islands and near Kitimat in 1987, Prince Rupert Forest Region, 1986.

	Avg. no. eggs per 50- cm branch		Predicted defoliation[1]
Location	1985	1986	1987
QUEEN CHARLOTTE ISLANDS			
Crown Forest			
South Bay spur 60		66	severe
East Narrows spur 84		54	moderate
South Bay spur 40		53	"
East Narrows spur 84 (immature)		45	"

Location	Avg. no. eggs per 50- cm branch		Predicted defoliation[1]
	1985	1986	1987
MacMillan Bloedel			
Harrison Island		32	moderate
Begbie Bay		31	"
Louise Island		27	"
Ain R.		19	light
Honna R. br. 308		6	"
Wathus Island	35	4	trace
Peel Inlet		2	"
BCFS			
West Honna (pre-spaced)		28	moderate
Honna (spaced)		24	light
Honna br. 182 (pre-spaced)		23	"
Honna br. 182 (spaced)		15	"
Honna (unspaced)		13	"
Collision Pt. (spaced)		1	trace
Western Forest Products			
Wilson Creek		23	light
Sewell Inlet	123	19	"
Sewell Inlet (immature)		12	"
Windy Bay		11	"
Thurston Harbour	219	11	"
Lyell Island west br. 63	21	8	"
Powrivco Bay	71	6	"
Forsyth Pt.	135	6	"
Jedway	186	6	"
Talunkwan Island south	111	4	trace
Ramsay Island	170	1	"
KITIMAT AREA			
Eurocan			
Hirsch Cr.		13	Light
Little Wedeene R.		9	"
Lower Wedeene R.		6	"
Wedeene R. spur 1026		3	Trace
Bowbyes Cr.	129	2	"

[1]
1- 5 eggs - trace defoliation
6-26 eggs - light "
27-59 eggs - moderate "
60+ eggs - severe "

Hemlock sawflies, Neodiprion spp.

Hemlock sawfly populations continued to increase on the Queen Charlotte Islands. Damage attributed primarily to sawfly feeding was noted in young plantation stands in the South Bay (300 ha) and the Honna River (1 000 ha) drainages. Significant populations of blackheaded budworm were also present. Due to the presence of both insects, area estimates are based largely on ground observations. Of 23 larval sampling (three-tree beatings) locations within infestation areas on the Q.C.I., 8 (35%) had more than 500 larvae per sample and ranged up to 2 600. Only one sample had no sawfly larvae. The largest populations were encountered on Talunkwan Island, Skidegate Channel and Wathus Island, where sawfly populations equalled or exceeded that of blackheaded budworm.

In blackheaded budworm study plots, tree mortality has occurred only in the areas where large populations of both budworm and sawfly have been present for two consecutive years. When both insects feed in combination, tree mortality can be very rapid as both the old and new foliage are consumed. In a young regeneration stand (<20 years) in the Honna River drainage where spacing was taking place during the larval feeding period, the leave trees were 80% defoliated with only a portion of the 1986 foliage remaining. In comparison, defoliation in adjacent unspaced stands averaged 35-40%. The severe defoliation within the spaced stand was attributed to larvae migrating from the cut trees to the leave trees in concentrated numbers to continue feeding. The greatest impact was upon the scattered Sitka spruce in the stand which generally had the upper one to two meters totally defoliated. However, the sudden change in diet combined with the stress of migration and low levels of Entomophtora sp. infection appeared to be major factors in the very high level of sawfly mortality on spruce. Similar mortality was not found on hemlock or spruce in the adjacent unspaced stands.

Sawfly egg counts were done at 25 sites in order to obtain some indication of defoliation that could occur in 1987 (Table 23). In the absence of a proven sampling technique for predicting sawfly defoliation, egg counts were done on the current foliage of five twig tips from each of six to ten midcrown branches from three to five trees per site. Due to the pattern of egg laying, a hazard rating was tentatively compiled by multiplying the percent of twigs with eggs by the average number of eggs per twig. These hazard predictions will be followed through in 1987 for calibration of egg counts to resulting defoliation.

Table 23. Hazard rating and predicted defoliation of western hemlock by hemlock sawfly, Prince Rupert Forest Region, 1986.

Location	Hazard Index[1]	Predicted defoliation
Honna R. br. 182 spaced	561	severe
Wathus I.	260	"
Thuston Harbour	168	"
Harrison I.	164	"
Honna R.	106	"
South Bay (spur 40)	103	"
Powrivco Bay	92	moderate
Honna R. (spaced)	76	"
Ain R.	66	"
Sewell Inlet	49	light
Skidegate Narrows (spur 84)	14	"
Begbie Bay	10	"
Talunkwan I.	7	"
Louise I.	5	trace
South Bay (spur 60)	2	"
Jedway, Wilson Cr., Honna (prespaced)	1	"
Peel Inlet, Windy Bay, Honna br. 308, Forsyth Pt., Sewell Inlet (immature), Ramsay I., Atli Inlet	0	nil

[1]Hazard index was obtained by multiplying percent of twigs with eggs by average number of eggs per twig:

1-5 hazard index - trace defoliation
6-50 " " - light "
51-100 " " - moderate "
101+ " " - severe "

Porcupine

High porcupine populations have caused increased levels of damage to western hemlock throughout its range in the Region (Table 24). Significant new feeding damage was generally in sapling to young growth age classes and was of greater importance in thinned stands than in dense unmanaged stands where the feeding acted as a natural thinning agent.

Reports continue of current porcupine damage along coastal inlets. Release of natural predators, fishers, by provincial agencies will continue.

Table 24. Porcupine feeding damage observed in western hemlock stands, West Prince Rupert Forest Region, 1986.

Location	Stand age class	General extent of current feeding	Remarks
NW Lakelse L.	30-40	occasional trees, low incidence	
Dasque Cr.	20-30	scattered feeding, <10% of stand	observed in thinned stands near Skeena Valley
Copper R. Forest Rd.	20-25	patches of 3-10 trees at 7 locations from Km 10 - 20	all activity noted in thinned stands
Kalum Forest Rd.	15-30	patches of 1-11 trees noted at 10 locations from Km 13 - 29	90% of damage in thinned stands where slash was left
Gainor L.	10-25	10-20% of stems affected	a natural thinning agent in dense unmanaged stand
Bitter Cr.	10-20	scattered damage, <10% of stand	continuation of previous activity, acting as a natural thinning agent
Nass R. Rd., W.	10-20	scattered damage, <10% of stand	acting as a natural thinning agent in an unmanaged stand

Cone and seed pests

Hemlock cone crops were heavy in most parts of the Region in 1986. Eight random cone collections from throughout the Mainland range of western hemlock were negative in assessments for cone and seed pests except for a 5% level of infestation by a coneworm, Dioryctria sp., in a sample from Lakelse Lake.

Western blackheaded budworm, Acleris gloverana, larvae were observed to be feeding heavily on western hemlock cones in areas of the Queen Charlotte Islands where defoliation was severe.

Collections of mountain hemlock cones from 18 km east of Alice Arm and from Wesach Mtn. were not damaged by cone and seed pests.

Foliar rust

A foliar rust, Pucciniastrum vaccinii, was collected from the current growth of sapling western hemlock near the Deena Cr. Rd. on Moresby Island. This disease was also observed at other locations on the Queen Charlotte Islands but was always at low intensity and did not cause significant damage.

TRUE FIR PESTS

Western balsam bark beetle, *Dryocoetes confusus*

Balsam bark beetle-killed alpine fir were mapped over 121 000 ha (Table 25, Map 5) in the Region in 1986. This is a considerable increase from the 44 000 ha recorded in 1985. The most extensive mortality occurred on the Interior edge of the coastal range. The increase in area mapped over the past few years was more a result of increased aerial coverage and added emphasis on including numerous areas with only scattered groups of red trees, rather than an indication of major beetle infestation expansion. The volume losses (267 200 m^3) were based on limited ground surveys correlated to aerial surveys. However, due to the varied methods of mapping the scattered small groups of recently killed alpine fir, it was difficult to integrate the maps with ground observations and arrive at relatively accurate loss figures.

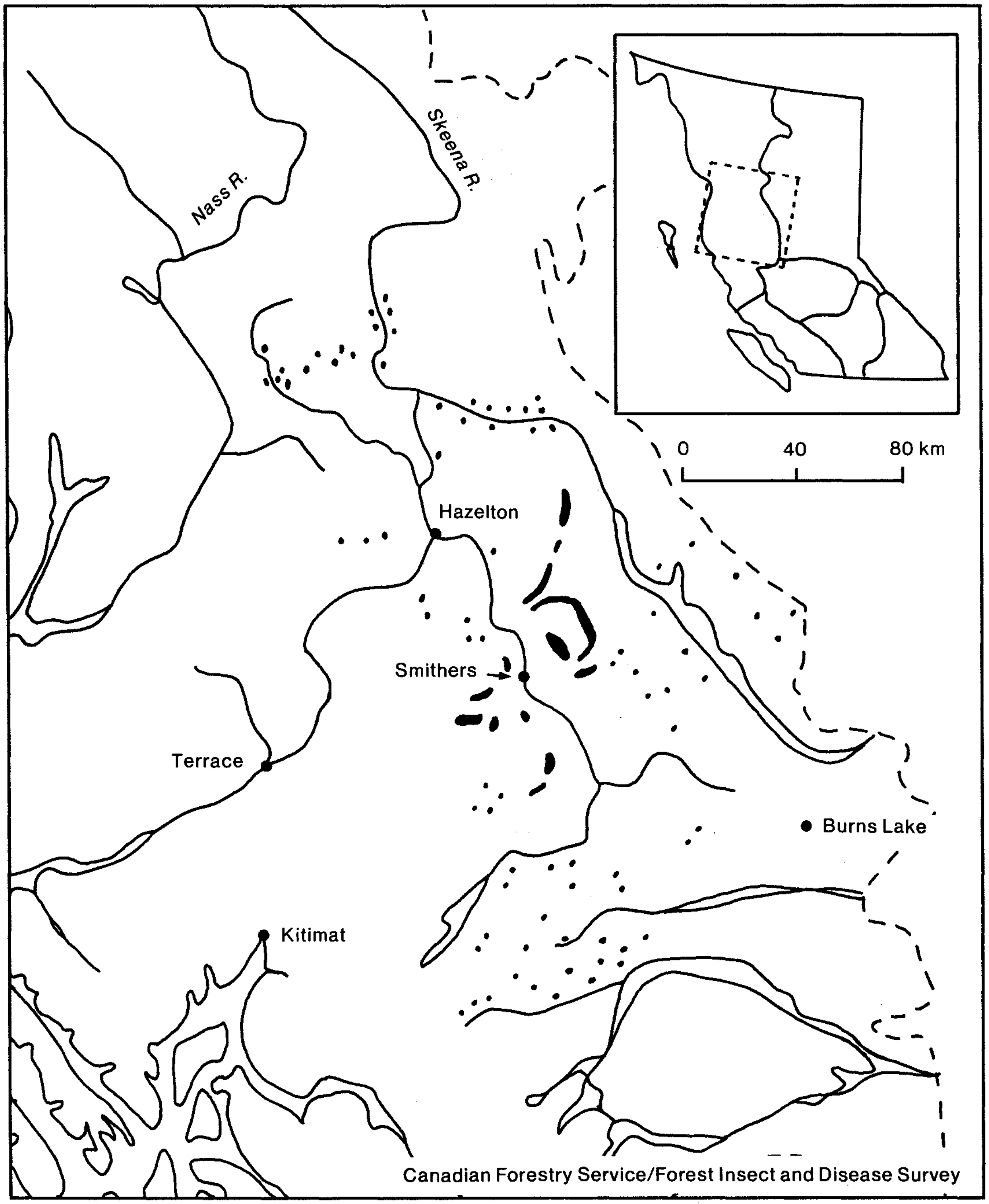
Table 25. Area and volume of alpine fir killed by western balsam bark beetle, Prince Rupert Forest Region, 1986.

Location (TSA)	Area (ha)[1]	Volume recently killed (m^3)[2]
Lakes	6 300[3]	14 000
Morice	28 500	45 000
Bulkley	85 900	207 000
Kispiox	400	1 200
Total	121 100	267 200

[1] Areas were computer-generated from maps provided by BCFS districts.
[2] Volumes were calculated from CFS-FIDS field data.
[3] In the Lakes TSA no distinction was made by BCFS mappers between alpine fir mortality and some of this area includes old spruce beetle infestations.

In the Lakes TSA the largest area of tree mortality was mapped in the Allin-Foxy creeks area (2 800 ha), much of which was previously associated with spruce beetle infestations. Smaller infestations of 200-500 ha were mapped at Taltapin Lake (1 000 ha) and at Twain-Pierre creeks (1 000 ha). Previously recorded areas at Tildesley Creek (1 000 ha) and at Ootsa Lake (500 ha) were only slightly expanded from 1985. Because no distinction was made between alpine fir and spruce mortality during mapping, some of those areas undoubtedly included areas of primarily gray, spruce beetle-killed trees.

In the Morice TSA most of the recent alpine fir mortality was in the southwestern portion, on the Interior portion of the Coast Mountains. Several large blocks in the Walcott-Houston Tommy Creek area (11 000 ha) and Pimpernel Mtn. (5 000 ha) account for much of the concentrated attack. The more southern Ootsa-Morice lakes area contained numerous smaller areas (300-400 ha) with only scattered recent mortality. North of the Bulkley River to Babine Lake only scattered small groups of red alpine fir were recorded.



Map 5. Areas of mature alpine fir recently killed by western balsam bark beetle, determined by aerial and ground surveys, Prince Rupert Forest Region, 1986.

In the Bulkley TSA very large areas with pockets of recently killed alpine fir were mapped in most alpine fir stands. In the Telkwa River (20 000 ha), McKendrick Pass - Upper Fulton River (19 000 ha), and in the Blunt-Harold Price creeks (16 000 ha) areas, generally 2-5% of the alpine fir were recently killed. Additional extensive areas with beetle-killed alpine fir included: Reiseter Creek (11 000 ha), Tsezakwa Creek (7 000 ha), Smithers-Trout Creek (5 000 ha) and the Nilkitkwa River drainage (2 000 ha). This TSA has nearly 50% of its timber resource in highly susceptible mature to overmature alpine fir stands.

In the Kispiox TSA most of the alpine fir mortality was mapped in small groups of less than 300 trees throughout the Upper Kispiox River, eastward to the Upper Skeena River area and into the lower Babine River drainage, totalling 350 ha. Additional small groups of 5 to 100 recently killed trees were mapped in each of the Suskwa River and Kitseguecla River drainages, near Mt. Seaton, and in the Kitwancool area.

Stand examinations in the Shelford Hills, Walcott and Blunt Creek areas indicate a slight decrease in current attack with 0.8 current attack to each 1985-attacked tree. This follows increased attack levels for at least the previous two years. Accumulated mortality reached 67% of the trees over 20-cm diameter in a mixed alpine fir-white spruce stand in the Shelford Hills. Not all the tree mortality prior to 1985 could be attributed to balsam bark beetle, but in severely chronic infestations, an annual mortality rate of up to 25 m^3/ha has accumulated to 230 m^3/ha. However, as this mature volume is being lost it is being replaced by understory alpine fir, and in mixed alpine fir-spruce stands it may encourage the maintenance or, in some stands, increase the spruce component.

Tomentosus root rot, *Inonotus tomentosus*

In five mature alpine fir stands examined, an average 24% of the alpine fir had *I. tomentosus*-infected roots (Table 26). The root rot was restricted only to alpine fir roots in contact with infected white spruce or lodgepole pine roots. In stand types where white spruce was the major species (e.g. more than 50%) 52% of the alpine fir were infected, largely due to multiple root contacts with infected white spruce roots. Comparatively, in stand types where spruce averaged 21% of the stand, 6% of the alpine fir had at least one major root infected. One infection was found where infected lodgepole pine roots were in contact with alpine fir roots.

I. tomentosus generally did not appear to be the major cause of tree mortality, with only occasional recently dead standing alpine fir in which root rot was the only attributable factor. However, blowdown was common and 65% of the recent blowdown had significant root rot, a contributing factor. These windthrown trees had been severely infested with *Dryocoetes confusus*, indicating that root rot may be a contributing factor in the patchy distribution of beetle activity. As with lodgepole pine, the older trees (150 years plus) were the most severely infected. No advanced infection was found on alpine fir under 80 years.

Aphids

Thecabius populi monilis caused severe galling on a black cottonwood sapling near the Terrace Airport. *Pemphigus* sp. aphids were collected on black cottonwood foliage at Boya Lake, where galling was common in patches of trees.

LARCH PESTS

Ascocalyx canker

A new species of *Ascocalyx* (unnamed) was isolated from larch dieback on a western larch plantation near Lamprey Lake. The infection source is unknown. While approximately 20% of the larch had varying degrees of dieback, this fungus was isolated from only one of six trees sampled. A related micro fungus, *Ascocalyx* (*Encoeliopsis*) *laricina*, has caused significant shoot blight and dieback on western larch in southeastern B.C. Also belonging to the same genus is *Ascocalyx* (*Scleroderris*) *abietina* which has caused extensive mortality to seedlings and young growth in conifer plantations and forest nurseries in eastern Canada.

Porcupine

High populations of porcupine in the western portion of the Region have fed upon trees in exotic plantations in addition to native hosts. Plantations of European larch, *Larix decidua*, were heavily fed upon between Km 40 and 41 of the Kalum Forest Road. The stands had been thinned and the slash left, favoring the porcupines by providing an impediment to predators and a ground cover refuge. The intensity and extent of the feeding, affecting most of the 24-year-old plantation, suggests that larch is the preferred host for porcupine feeding when available, followed by the native lodgepole pine. This host preference was also noted in surveys of porcupine damage in previous years. Surveys in 1987 will determine the extent of mortality and condition of the remaining trees.

SPECIAL SURVEYS

Pinewood nematode, Bursaphelenchus xylophilus

Pinewood nematodes were extracted from five of 41 lodgepole pine wood samples submitted (identification tentative). Positive collections came from north of Dease Lake, south of Cassiar, near Terrace Airport, Kalum Valley, and from Nado Creek near Morice Lake. The nematode samples were taken from trees stressed or killed by mountain pine beetle (1986 attack), fire, or road construction.

The pinewood nematode has been considered a native nematode which may complete its life cycle feeding on blue stain fungi in recently dead or dying trees.[1] Transmission from tree to tree appears to be by insect vectors, primarily woodborers, cerambycids. This is in contrast to the life cycle being completed in living trees in Japan, where extensive tree mortality has occurred. The interaction between the vector and tree begins with adult woodborers introducing the nematode to healthy pine while feeding on new shoots and foliage. Rapid reproduction of the nematode within the tree causes mortality within three months. As the trees die they provide wood essential for developing woodborers which spread the nematode to new hosts when they disperse. In North America the exotic tree species, especially Scots pine, appear to be the most sensitive to the nematode but seedlings of native trees have been killed following inoculation of the nematode under laboratory conditions.

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 monitor any injury due to acidic or toxic rain on native trees and indicator plants over the next 25 years. Chemical analysis of conifer foliage and soil assessments will be conducted quinquennially to detect any significant changes.

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

Gypsy moth, Lymantria dispar

Pheromone-baited sticky traps were again used to detect any introduction of the gypsy moth to the Region in 1986. Fifty traps were deployed: in areas frequented by tourists, especially campgrounds; at international port facilities near Kitimat, Prince Rupert and Stewart; and at the Masset Canadian Armed Forces Base. No gypsy moths were caught in the traps this year; additional traps placed by the BCFS were also negative.

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[1]Wingfield, M.J., et al. 1984. Is the pinewood nematode an important pathogen in the United States? Journal of Forestry 82:232-235.

Clearwing moths, Sesiidae

Adult clearwing moths were surveyed with eight pheromone-baited traps in the Terrace and Smithers areas. Traps were monitored weekly or bi-weekly throughout the field season. Synanthedon culiciformis was the most commonly collected species, and the only species found in white spruce/alpine fir stands. It was most frequently caught in June, compared to S. novaroensis which was more frequently collected in July and early August. No damage attributed to this insect, pitch masses on boles of infested trees, was observed in the study areas.

Table 27. Numbers of Sesiidae adults caught in pheromone-baited traps in different stand types, Prince Rupert Forest Region, 1986.

	Species caught	
	S. culiciformis	S. novaroensis
(Dates of positive collections)	June 10 - July 14	June 9 - August 5
Stand types[1]		
lP	8	9
wH,lP	0	2
tA,lP	0	6
Al	0	1
wS,alF	31	0
alF	1	1

[1] lP - lodgepole pine, wH - western hemlock, tA - trembling aspen, Al - alder, wS - white spruce, alF - alpine fir.

Beaver

High populations of beavers caused local damage by damming water which flooded trees in all age classes. Managed sapling stands of regeneration sustained pockets of flooding in the Kitimat and Kalum valleys and near Deena Creek on Moresby Island. Mature stands were similarly damaged in the Skeena and Kalum river valleys, and in the Terrace Watershed where beavers have been a chronic problem.

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