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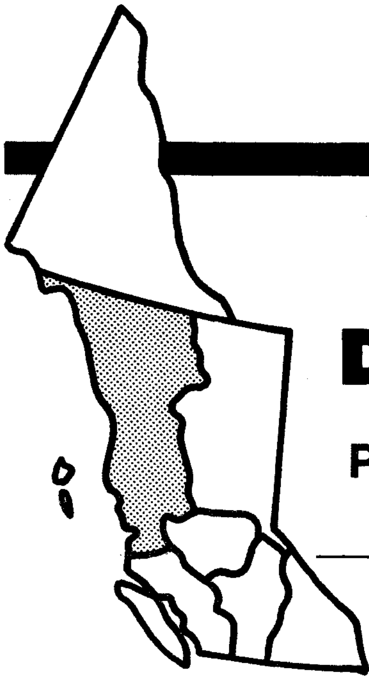

Forest Insect and Disease Conditions

Prince Rupert Forest Region 1984

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Government of Canada
Gouvernement du Canada

Canadian Forestry Service
Service canadien des forêts

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SUMMARY

This report outlines the status of forest pests in the Prince Rupert Forest Region in 1984 and attempts to forecast some of the pest population trends. Pests are listed by host in order of importance.

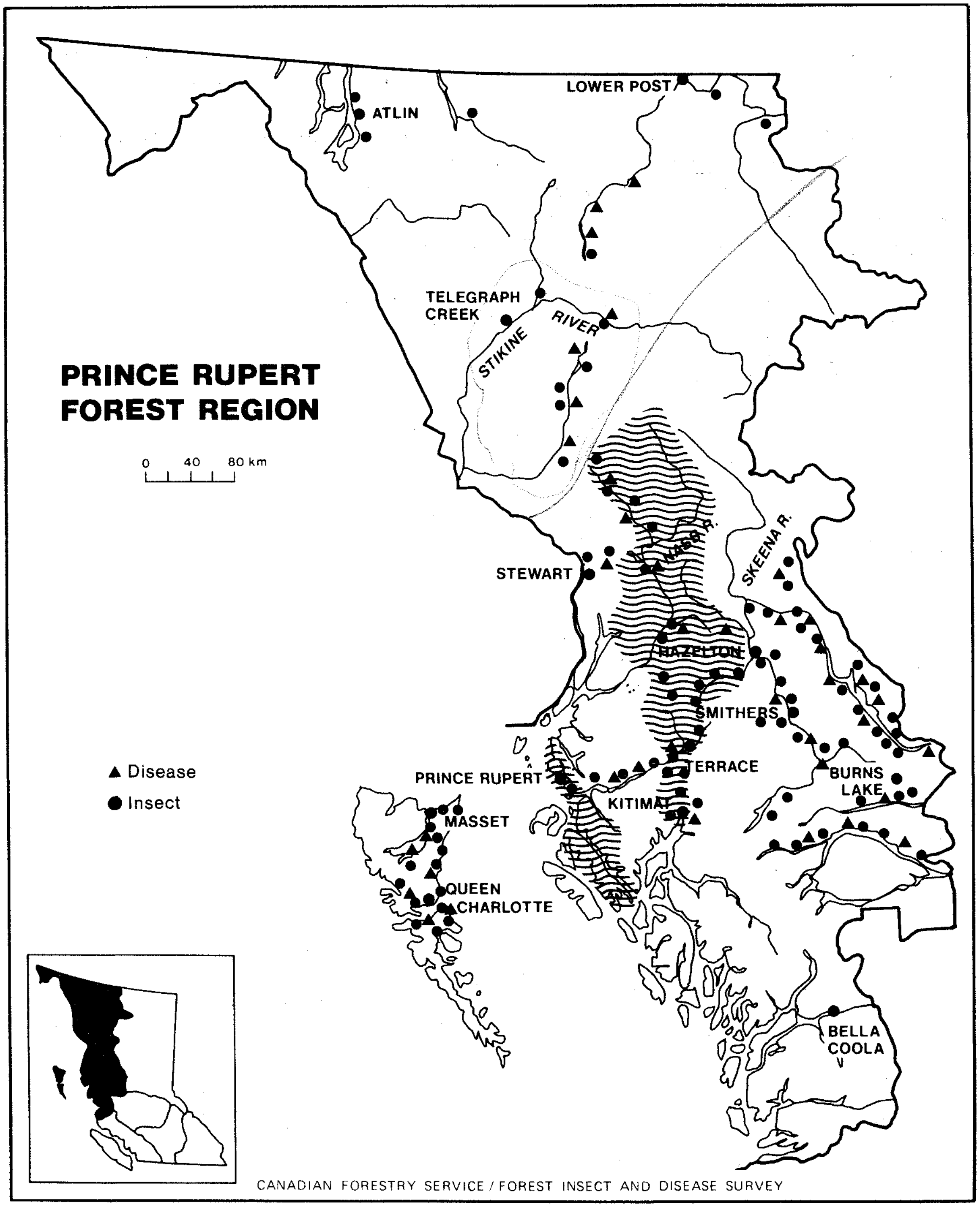
The area of spruce recently killed by spruce beetle declined by 18% to 13 600 ha. Spruce budworm populations collapsed in the Nass, Bell-Irving, Kispiox and Babine river drainages, while the area of defoliation in the Kitimat River Valley increased to 2 800 ha. Black army cutworm populations decreased, but persistent populations remain throughout the interior districts. Root rots killed immature spruce in 7 of 9 plantations. Spruce aphid feeding persisted in coastal areas and caused severe defoliation of seedlings on the Queen Charlotte Islands. A spruce foliage rust caused up to 75% height increment loss in young stands at Boulder Creek and Telkwa River.

Lodgepole pine killed by mountain pine beetle were mapped over 14 500 ha, a 10% increase from 1983; however, current attack levels declined in the interior portions of the Region. Defoliation of shore pine by pine sawfly expanded on the Queen Charlotte Islands. Pine foliage diseases were more widespread in 1984 than in recent years. Western gall rust caused 3% volume loss in young lodgepole pine plantations.

Forest tent caterpillars severely defoliated trembling aspen over 1 000 ha in the Moricetown to Kitwanga area. Poplar shoot blight caused extensive discoloration of trembling aspen foliage between the eastern Regional Boundary and Kitwanga.

The forest pest survey field season extended from mid-May to late September. A total of 236 insect and 123 disease collections were submitted to the Pacific Forest Research Centre by FIDS survey personnel. Map 1 shows the locations where one or more samples were collected. The percentage of collections containing potentially damaging insects was 54% compared to 76% in 1983. Twenty-eight special collections for research programs were collected, including spruce budworm, spruce weevil and black army cutworm. Gypsy moth catches in traps placed in 14 potential problem areas were all negative. Pest problems in accessible provincial parks were assessed.

Aerial sketch maps of infestations were provided by the BCMF personnel from the Lakes, Morice, Bulkley and Kispiox TSAs. In the Kalum and North Coast TSAs, 15 hours of fixed wing aerial time was provided by the BCMF, 3 hours by CFS and 4 hours of helicopter time by industry (Map 1).



Map 1. Locations where one or more forest insect and disease samples were collected, and area covered by FIDS aerial surveys, 1984

SPRUCE PESTS

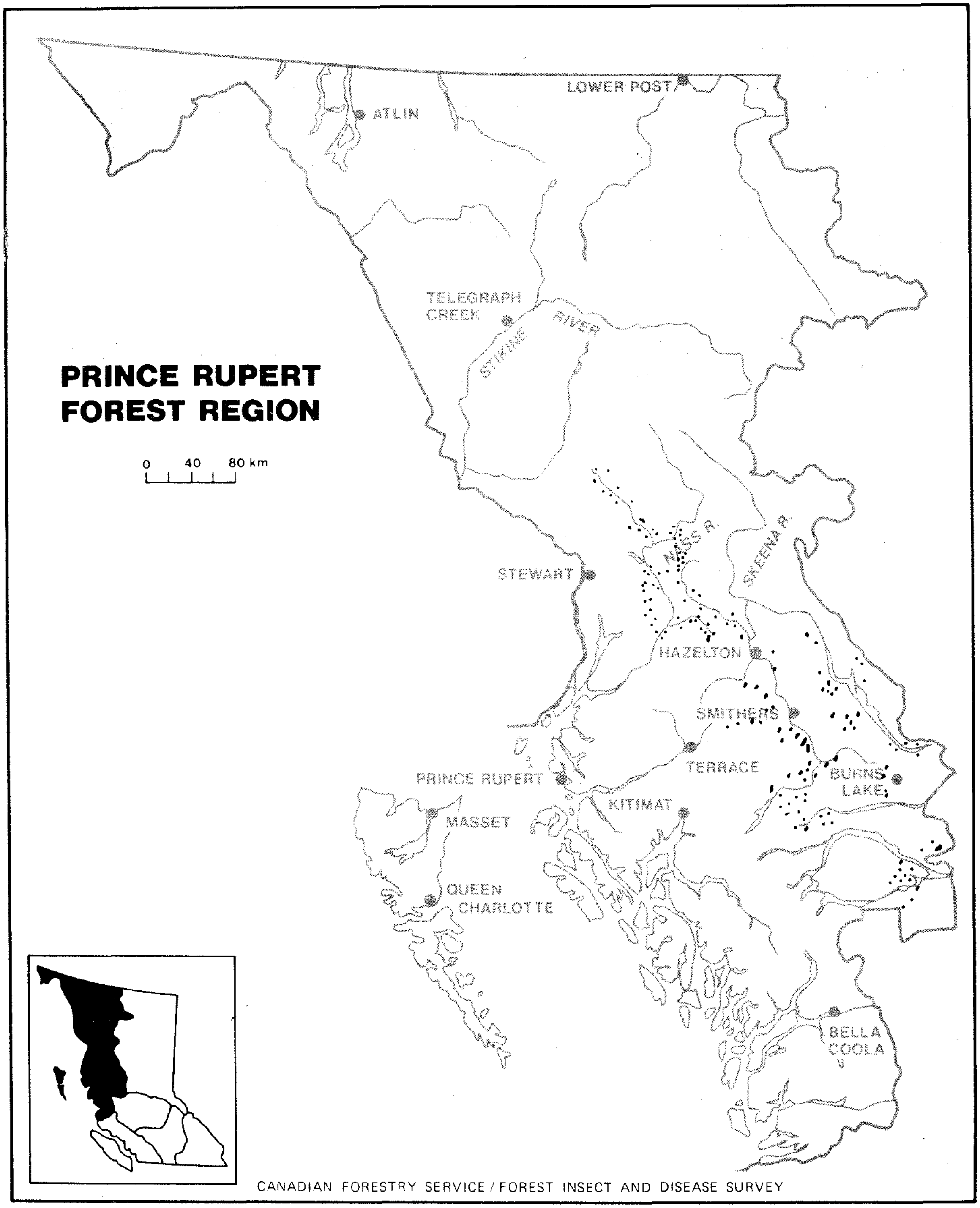
Spruce beetle, *Dendroctonus rufipennis*

Spruce beetle killed an estimated 717 000 m^3 of mature spruce over 13 600 ha in the Region in 1984 (Table 1, Map 2). This represents a decline from 1 100 000 m^3 killed on 16 500 ha in 1983. The decline is attributed to extensive logging within major infestation areas, along with host depletion in many of the older infestation areas.

Throughout the Region, the general locations where beetle-killed trees were mapped varied little from 1983. Local increases were most notable in the Bulkley TSA, in the Telkwa and Nichyeskwa river drainages, and along Stephens Lake in the Kispiox TSA, where smaller infestations coalesced into fewer but larger infestations. Minor spread was also recorded around many of the older infestations, but with primarily light attack in scattered pockets.

A small spruce beetle infestation along the Haines Road was greatly reduced by a program of felling and partial peeling. However, broods remained in 15 standing trees as well as in some of the remaining bark on 8 of the partially peeled logs. A followup program to remove or treat infested trees is necessary to reduce the beetle population to endemic levels.

Small groups of stressed Sitka spruce near Phantom Cr. (50 ha) and between Gregory and Bonanza creeks on Rennell Sound on Graham Island were successfully attacked by spruce beetle. Further unconfirmed reports of beetle-caused tree mortality at Dinan Bay, Ian Lake and Gray Bay were received from BCMF and Industry. Although spruce beetle has previously caused tree mortality on the Queen Charlotte Islands, no extensive outbreaks have been recorded.



Map 2. Areas of spruce recently killed by spruce beetle, determined by aerial and ground surveys, 1984

Table 1. Area and volume of spruce recently killed by spruce beetle, Prince Rupert Forest Region, 1984.

Location (TSA)	Area (ha)[1]	Volume (m^3) recently killed[2]	Volume (m^3) under attack[3]
Lakes	1 900	113 000	527 000
Morice	3 600	258 000	1 080 000
Bulkley	2 600	117 000	780 000
Kispiox	920	92 000	322 000
Kalum	4 600	137 000	1 044 000
TOTAL	13 620	717 000	3 753 000

[1]Areas provided by British Columbia Ministry of Forests

[2]Volume of 1983 attacked trees as determined by CFS-FIDS cruise data.

[3]Total volume of spruce in the mapped infestation area.

Fifteen stands were cruised during September to determine the current attack levels and the brood status (Table 2). Current attack in standing trees declined in most areas to an average of 8%, ranging from 0 to 22%. This was the second consecutive year of declining current attack. Several factors have contributed to the decline. Initially, the 1984 standing attack levels were reduced by blowdown absorbing much of the 1984 flight throughout most of the beetle infested area. Also, suitable host material is becoming scarce in a number of stands. In addition, the beetle vigor has declined during the past two years.

Table 2. Status of spruce stands infested by spruce beetle in the Prince Rupert Forest Region, 1984.

Location	Percent of stems attacked				
	1984	1984 pitchout/partial	1983	Before 1983	Healthy
Maxan Lk.	12	19	15	20	34
Dunegate Cr.	22	4	22	16	36
Lamprey Cr.	8	15	17	26	34
Betty Lk.	10	5	10	16	58
Morrison Lk.	7	7	4	11	71
Fulton Lk.	5	15	39	8	33
Walcott	3	29	15	10	43
Babine Lk.	3	18	14	23	42
Chapman Lk.	5	3	43	17	32
Sweetin R.	7	14	13	9	57
Steep Canyon Cr.	13	26	18	11	32
Van Dyke Is.	0	0	0	88	12
Richie Cr.	10	7	19	48	16
Delatic Cr.	7	2	12	32	47
Oweegee Cr.	8	3	3	46	40
Regional Average	8	11	16	25	40

Blowdown, which resulted from strong winds in late March, attracted a high percentage of the 1984 beetle flight. The most extensive areas of blowdown extended generally southeast of Telkwa to the east end of the Ootsa Lake chain. Most of the large areas and fringe blowdown are being logged which will reduce the chance of greatly increased beetle populations in 1986 when the broods emerge. However, individual and small groups of mature spruce blowdown were scattered throughout much of the remainder of the region. These broods developing freely under ideal, in-stand conditions have the potential to revitalize a population that was slowing down. In stands of similar type and a similar recent beetle history, the absence of blowdown resulted in an approximate doubling of the current attack levels in the surrounding standing timber.

Pitchouts and partial attacks accounted for 11% of the trees tallied in cruise strips and ranged as high as 29%. The increasing percentage of unsuccessful attacks indicate a weakening vigor in the beetle population. This, in conjunction with smaller more vigorous and younger trees which are more able to resist attack, is reducing the beetle population and its spread in many areas.

The 1984 broods are developing almost exclusively in a two-year life cycle, thus allowing for a longer period of time for removal of attacked blowdown. Following two years (1981, 1982) of mixed one- and two-year development period as a result of weather variability, the size of the adult population in 1983 and 1984 has been relatively equal each year, as opposed to having large flights every second year.

The degree of standing attack for 1985 should in general be similar or slightly higher than in 1984 (8%). With the absence of blowdown to absorb the adult population more standing attack can be expected, assuming adequate suitable host material is available. It is in 1986, when adults emerge from the blowdown, that a major increase in standing attack can be expected.

Spruce budworm, Choristoneura spp.

The area of spruce-balsam stands defoliated by spruce budworm (Map 3) dropped dramatically overall to 2 850 ha from 153 000 ha (Table 3) in 1983. The area defoliated in 1984 in the Kitimat River Valley increased to 2 850 ha from 300 ha in 1983. This increase was due primarily to more extensive aerial survey coverage. Over half of the defoliation (1 450 ha) was in the Wedenne and Little Wedeene river drainages, with the remaining 1 400 ha in the Kitimat River, Coldwater, Dahl, Hirsch and Chist creek drainages (Table 3).

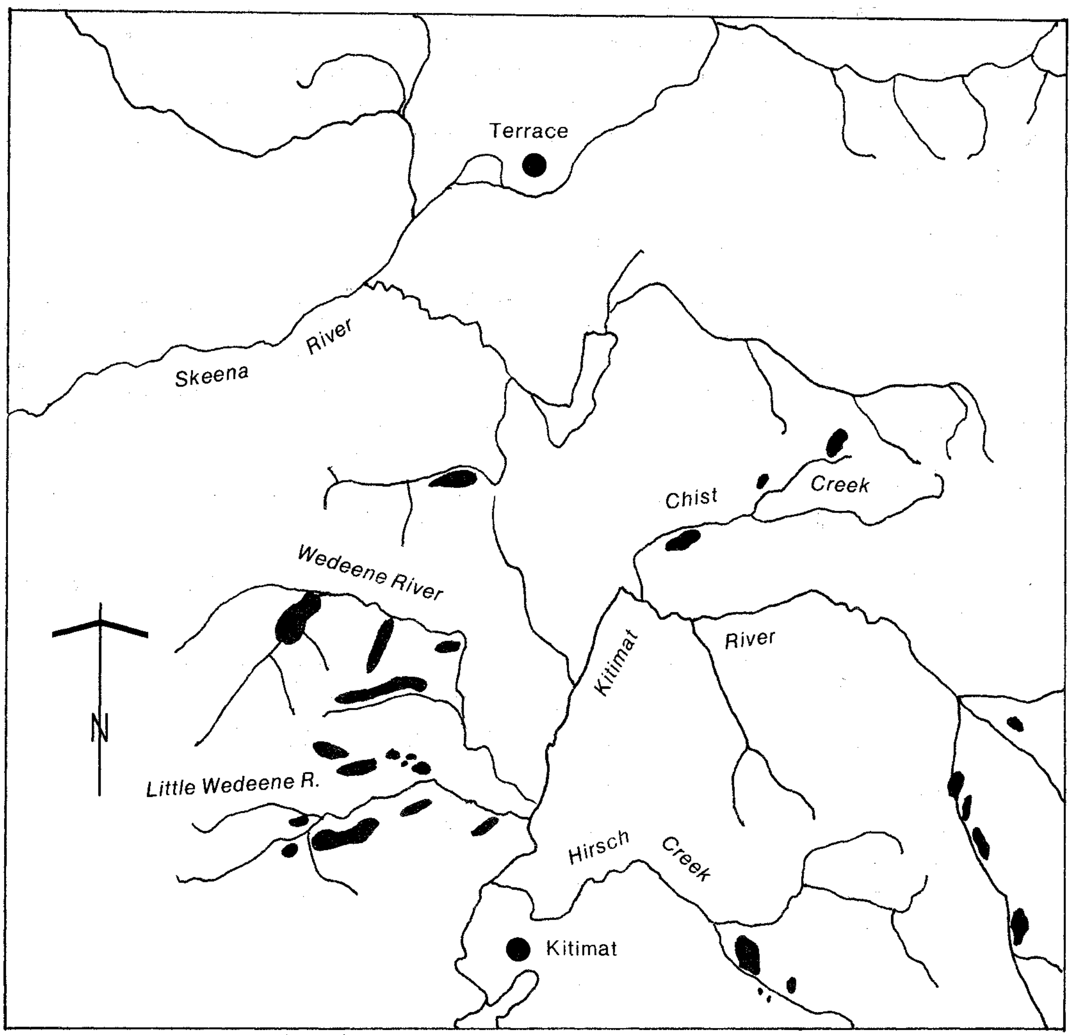
Table 3. Areas defoliated by C. orae, Prince Rupert Forest Region, 1984.

Location	Area defoliated (ha)		
	Light[1]	Moderate[2]	Severe[3]
Coldwater Cr.	240	-	-
Wedenne R.	190	-	600
Dahl Cr.	75	-	200
Little Wedenne R.	450	-	210
Hirsch Cr.	290	-	-
Kitimat R.	420	-	-
Chist Cr.	180	-	-
TOTAL	1 845		1 010

[1]Light - barely visible, with some branch tip and upper crown defoliation, including up to 50% current year's foliage.

[2]Moderate - pronounced defoliation, top third severely defoliated and some top stripping.

[3]Severe - totally defoliated upper crown and most trees more than 50% defoliated.



Map 3. Areas of fir-spruce defoliated by spruce budworms, Prince Rupert Region, 1984

Larval sampling within 1983 infestation areas in the Nass, Bell-Irving, Kispiox and Babine river drainages reflected the declining populations. The number of larvae per three-tree beating declined from 290 to 12. Similar declines were evident in the previously uninfested stands with only 2 larvae per positive collection, compared to 8 in 1983. The percentage of samples containing larvae declined to 53% from 87% in 1983.

The collapse is attributed in part to the pathogen *Beauveria bassiana*, which greatly reduced the population in 1983 when diseased larvae were present in 75% of the samples. However, egg counts in the fall of 1983 indicated continuing defoliation for 1984 but at reduced levels from 1983. Adverse climatic conditions during the early spring larval-feeding period may have further contributed to the population collapse. Under normal circumstances populations cycle up and down, based on the reproductive rate and food supply. However, when new variables are introduced such as unfavourable weather, parasites and disease, the cycle becomes unstable and ultimately chaotic.

Pheromone traps continued to be used in areas of potential budworm population buildup. High moth counts may be used as predictors of increasing populations and defoliation the year before increased number of larvae appear in beatings (Table 4).

Table 4. Average number of male spruce budworm moths caught in pheromone-baited traps, Prince Rupert Forest Region, 1984.

Location	Species pheromone with which traps were baited[1]	
	C. biennis	C. orae
Kispiox R.	28	66
Nilkitkwa Lk.	69	42
Telkwa R.	8	172
Morice R.	8	198
Augier Lk.	36	13
Dease Lk.	1	40
Meziadin Lk.	25	6
Tlell	0	0

[1] At this stage of development it appears that *C. orae* is attracted only to *C. orae* baited traps, but *C. biennis* may appear in both baited traps.

In the interior areas which were not a part of the 1981-83 infestation area, the number of moths per trap increased from less than 1 to 30 (*C. biennis*) and 106 (*C. orae*). Dramatic increases occurred in the Morice and Telkwa river areas, to 198 and 172 moths per trap from none in 1983 and only 5 in 1982. However, there was no increase in mature larval counts from the beatings during the spring sampling period.

Egg mass counts were made at Dahl Creek and at Wedeene River. In both areas counts were down considerably to 3 per 10 m^2 of foliage from 109 in 1983, indicating only trace defoliation can be expected in 1985.

Black army cutworm, Actebia fennica

Black army cutworm populations decreased in 1984. Low larval populations persisted in 18 of 21, 1982-burned cutblocks examined during early spring (Table 5). Only along the Morice River in the Swiss Fire area were populations high enough to stop planting. Some light and occasional small patches of moderate feeding of white spruce seedling buds occurred where second to third instar larvae counts exceeded two to three per 1 000 cm^2. On drier slopes at Duck Lake and Walcott, 30 to 35% of the spruce terminal buds were partially destroyed which could result in very scattered seedling mortality on 2 ha at Duck Lake. Lodgepole pine seedlings were not affected in any of the sites.

Table 5. Number of black army cutworm larvae and pupae and resulting seedling damage, Prince Rupert Forest Region, 1984.

Location	Average number of larvae per 1000 cm^2 soil sample	Defoliation of fireweed[1]	Defoliation of seedlings[2]	Pupal counts
Walcott	3.5	M/S[3]	M	8
Guess Cr.	3.5	L/M	V.L.	3
Guess Cr.	1	V.L.	Nil	1
Guess Cr.	1	V.L.	Nil	1
Harold Price Cr.	1	V.L.	Nil	1
Harold Price Cr.	0	Nil	Nil	0
Morice R. (Swiss Fire)	10	M/S	not planted	11
Morice R. Km 39	4.5	M	L	5
Nanika R.	2.5	M	Nil	5
Nanika R.	5	L/M	L	3
Nanika R.	1.5			
McBride Lk.	0			
John Brown Cr.	3		–	–
Kuldo Cr.	1	–	–	–
Duck Lk.	2.5	M/S	M	7
Nadina R.	1		–	–
Hill Tout Lk.	0		–	–
Telkwa R.	1	–	–	–
Helene Lk.	2.5	L	Nil	2
Helene Lk.	1	–	–	–
Pendleton Lk.	1	V.L.	Nil	1

[1] Fireweed was the major herbaceous species present at the time of examination.

[2] Categories refer to damage to 1984 buds/shoots.

[3] V.L. - very light feeding
L - light feeding
M - moderate feeding
S - severe feeding

Vegetation tallies were made at the same time as the early larval counts (Table 5). For the low larval populations present there was no correlation between seedling damage and the amount of herbaceous growth present. Tender spruce buds appeared to be as favoured a food source as the young fireweed foliage, which was the primary vegetation that had emerged by the early larval stage. Early instar larvae appear to be less particular in their host species preference, while later instar larvae show a greater preference for several herbaceous species before feeding on coniferous seedlings.

Pupal counts, from areas where populations were evident, increased to an average of 6 (range 2-11) per 1000 cm^2 soil sample. This compares with averages of 10 in 1982 and less than 2 in 1983. These previous averages corresponded to major infestations in 1983 and generally very light to light seedling damage in 1984.

The attractant-baited trapping program was continued in 1984 (Table 6). Ninety-one traps averaged 10 male adults per trap with a maximum of 32 per trap at Smithers Landing. These figures compare with moth counts averaging 1 per trap in 1983 (range 0-5) and 30 in 1982 (range 5-52). Based on the resultant seedling damage during the past two years, the categories in Table 7 are suggested as temporary rough guidelines for potential seedling damage. Research work is continuing on attractant refinement and trap design improvement which will influence trapping effectiveness and result in revised guidelines.

Table 6. Average number of black army cutworm moths caught in attractant-baited traps. Prince Rupert Forest Region, 1984.

Location	Number of Traps	Number of Cutblocks	Average number of moths per trap
Bulkley TSA			
Taltzen Lk.	4	1	7
Telkwa R.	5	1	10
Chapman Lk.	5	2	15
Smithers Ldg.	3	1	27
Morice TSA			
Dunegate Cr.	2	1	1
Goosley Lk.	2	1	6
Morrison Lk.	9	3	9
Betty Lk.	9	3	10
Poplar Lk./Nadina R.	22	7	10
Nanika R.	3	1	12
Walcott	3	1	16
Lakes TSA			
Uncha Lk.	4	1	3
Pendleton Lk.	8	3	7
Taltapin Lk.	12	5	11
Total/Average	91	31	10

Table 7. Potential seedling damage guidelines based on moth and pupal counts. Prince Rupert Forest Region, 1984.

Potential seedling damage	Average number of moths per trap	Average pupal counts per 1000 cm^2 [1]
Occasional light bud feeding	10	1 - 2
General light bud feeding, patches of moderate feeding and scattered mortality	11 - 20	3 - 9
Major infestation	21+	10+

[1] The potential damage levels are not likely to occur in the cutblocks where the pupae were counted but in more recently burned areas within moth flight distance.

A red root and butt rot, Polyporus tomentosus

This root rot was present in 24 of 31 stands examined. In the Terrace to Watson Lake area, and on the Queen Charlotte Islands, 12 of 17 stands over 45 years old had some incidence of P. tomentosus. No infection was found in stands under ten years old.

All twelve 13-45-year old spruce stands examined for incidence of P. tomentosus were positive (Table 8). An average of 5% of the trees showed root rot symptoms, ranging from 1% at Sweetin River to 14% at Kuldo Creek. However, only trees dead or with root rot symptoms along a 300-500 meter strip were sampled for positive identification and included in the data. Additional adjacent trees would be expected to have early stages of infection without any visible symptoms. Typical root rot symptoms, especially in the 15-20-year old plantations, were a gradual slowing of terminal increment over a four to five year period, followed by chlorosis and mortality. In 45 years and older natural stands, stress cone crops and thinning of the crown accompanied the slower growth.

Table 8. Incidence and frequency of Polyporus tomentosus in 13-45 year old stands. Prince Rupert Forest Region, 1984.

Location	Stand type	Number of trees examined	Percent of trees symptoms	Percent of trees dead	Percent of trees total	Number of centers
Kuldo Cr.	24 yr. plantation	200	8	6	14	8
Sweetin R.	15 yr. plantation	500	1	1	1	2
Mitten Lk.	15 yr. plantation	200	3	1	4	3
Mitten Lk.	15 yr. plantation	200	3	0	3	4
Suskwa R.	13 yr. plantation	300	3	1	3	3
Boulder Cr.	20 yr. plantation	200	3	0	3	2
Taltzen Lk.	16 yr. plantation	300	5	1	5	9
Telkwa R.	19 yr. plantation	200	3	1	4	2
Chapman Lk.	16 yr. plantation	300	1	1	2	5
Morice R.	45 yr. natural	300	6	3	9	8
Erickson Lk.	45 yr. natural	250	4	1	5	5
Goosley Lk.	35 yr. natural	200	7	1	8	4
Average			4	1	5	5

The percentage of trees infected increased with the age of the stands. Those stands less than 20 years old averaged 3% (1-5%) infection, compared to 9% (5-14%) for those over 20 years. The greatest level of infection was recorded in a 24-year old plantation.

Of the nine plantation stands, six had *Hylobius* sp. damage on the infected trees, while none was found in the natural stands. Within these six plots, 20 (29%) of the 69 infected trees had *Hylobius* sp. feeding at the root collar. However, incipient to advanced root rot preceded weevil damage in all but two of the trees.

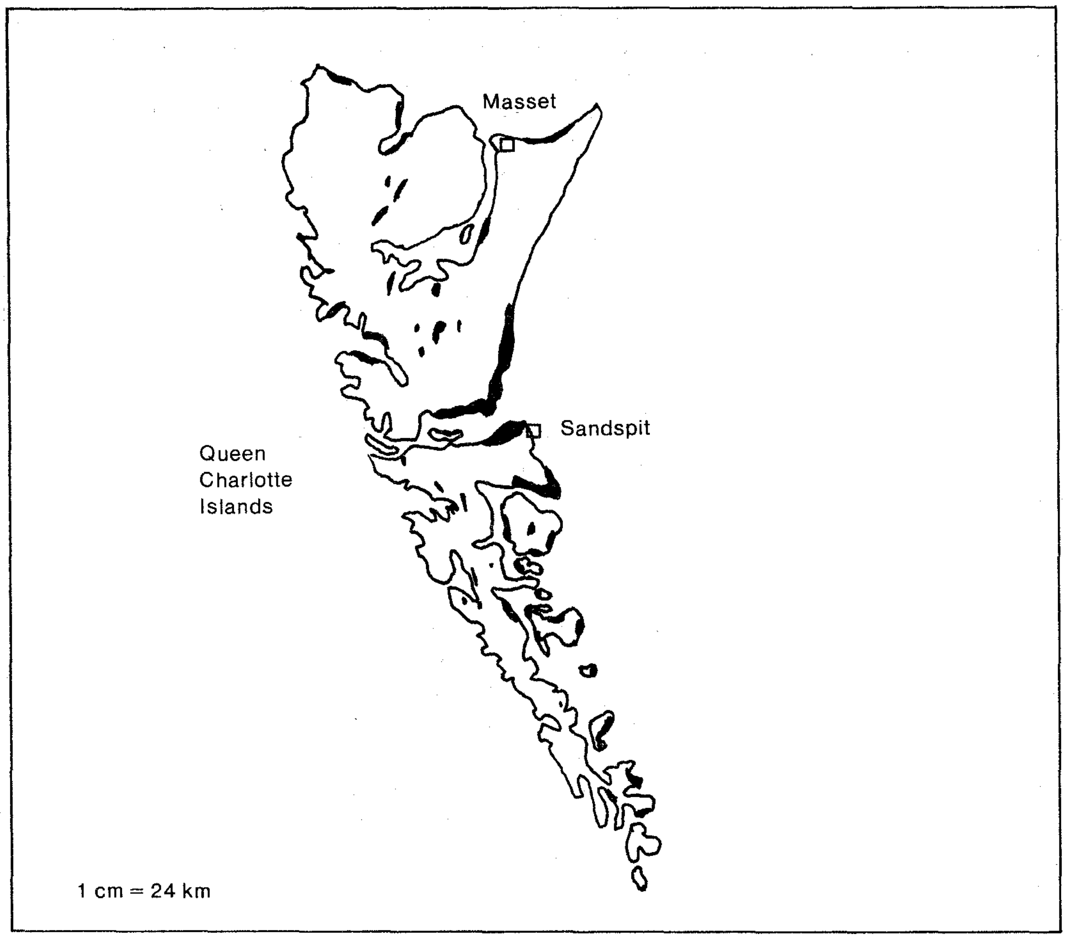
The frequency and distribution of infection centers is a major factor in the spread of the disease within a stand. Numerous small infection centers, e.g. Taltzen Lake, will continue to spread around the circumference of each center and in time many will coalesce into a continuous infection area. Consequences of growing infection centers include: direct tree mortality beginning at 15 years and continuing through to maturity; increased blowdown, as decay advances in maturing trees, providing favourable conditions for spruce bark beetle population buildup; and increases in the frequency of inoculum sources throughout the area, thereby reducing the potential of subsequence spruce stands.

Although no proven control measures can be recommended at this stage, the identification of major infection areas is an important initial step. Where sites permit, the planting of less susceptible tree species should be considered.

Spruce aphid, *Elatobium abietinum*

Increased spruce aphid populations severely defoliated all age classes of Sitka spruce throughout the Queen Charlotte Islands and the coastal mainland in 1984 (map 4). The severest defoliation occurred on the east coast of Graham Island. Light to moderate defoliation was also recorded on the north and west coasts of both Graham and Moresby Islands. This is the first year that Sitka spruce seedlings have been severely defoliated in plantations on both Graham and Moresby Islands. Defoliation of 10-20-year old stands was recorded last year but there was no report of plantation feeding.

Two Sitka spruce plantations planted in 1983 with two-year old stock were surveyed for aphid damage. One hundred trees were tallied at each location for defoliation and mortality. Defoliation ranged from 10-100% with all seedlings exhibiting some damage. Only 2% mortality was recorded at this time, but more seedlings, weakened by defoliation, will probably die this winter. Terminal leader growth was recorded in both plantations and Table 9 shows the relationship between the percentage of defoliation to the average length of leaders.



Map 4. Areas of Sitka spruce defoliated by spruce aphid, determined by aerial surveys, Queen Charlotte Islands, 1984

Table 9. Reduction in leader length related to percentage aphid defoliation at two Sitka spruce plantations on Moresby Island. Prince Rupert Forest Region, 1984.

Avg. leader length (cm)		Range		Percent
Tlell	Chinukundl Cr.	Tlell (cm)	Chinukundl Cr. (cm)	Defoliation
4.4	4.8	2.0–7.0	1.0–9.5	30%
3.6	2.9	0.5–6.5	0 –6.0	31–89%
2.3	0.6	0.5–6.5	0 –2.5	90%

Terminal growth of seedlings at Chinukundl Creek defoliated 90%+ and 30–89%, was reduced by 1/8 and 3/5 respectively when compared to seedlings in the 30% defoliation group. The growth reduction was less pronounced in the plantation at Tlell. Terminal growth of seedlings defoliated more than 90% was reduced by half and by 20% on seedlings 30–89% defoliated relative to seedlings in the 30% group. Even if aphid feeding ceases in 1985 it could take up to 3 years before normal growth resumes.

A natural stand of 5–10-year old Sitka spruce was examined for terminal and lateral leader growth at MacMillan Creek on Moresby Island. Sample trees here were selected to represent the extremes in defoliation. Ideally unattacked trees would have been compared to 90%+ defoliated trees, but as all trees were defoliated to some extent, 25 trees with 10% defoliation were compared to 25 trees with 90% defoliation.

Table 10. A comparison of terminal and lateral leader growth in two groups of spruce aphid defoliated trees.

% Defoliation	Avg. length of Terminal leaders (cm)	Range of Terminals (cm)	Avg. length of Lateral leaders (cm)	Range of Laterals (cm)
90%+	8.9	1–16	5.2	1–11
10%	43.2	31–52	29.1	17–46

The severely defoliated trees exhibited terminal and lateral growth that is only 20% and 17% respectively, of the growth recorded on the lightly defoliated trees. It is obvious that severe aphid feeding causes considerable growth loss in Sitka spruce, but what is of greater concern is that continued successive years of feeding will cause mortality.

Spruce weevil, Pissodes strobi

An average of 19% of the 500 Sitka spruce leaders examined in six 10-20-year old stands in the Prince Rupert-Terrace-Kitimat-Greenville area were killed by spruce weevil in 1984 (Table 11). This indicates a reduction from an average of 30% in 1983. Leader mortality ranged from 9% at Nalbeelah Creek to 34% at the Exstew River. The reduction in the number of attacks could be attributed to the clipping program and/or predation by the predator Lonchea sp. Extensive leader clipping programs were carried out by BCMF in the fall of 1983 and again this year. No data is available yet as to whether the 1983 clipping has been successful in decreasing the incidence of attack in 1984 or not. However, in the Kitimat River area Sitka spruce was clipped in 1983 for spruce weevil and this year there was an increase in the incidence of attack. The clipping program is expected to continue.

Table 11. Incidence of spruce weevil attack in Sitka spruce for 1983 and 1984, Prince Rupert Forest Region, 1983.

Location	Stand Age	# of trees examined	% of 1984 attack	% of 1983 attack
Exstew River	15	100	34	90
Kitimat River	15	100	10	6
Nalbeelah Cr.	10	100	9	15
Stirling Cr.	10	100	23	40
Greenville	20	100	18	22

Porcupine Damage

Mortality of immature western hemlock and Sitka spruce by porcupines increased in the western portion of the Region. The major areas with dead trees and tops occurred in the Khutzeymateen Inlet. Porcupines killed 5% of the 10-30-year old spruce over 900 ha along the east sides of Khutzeymateen Inlet and over 600 ha in the Portland Canal area. In the Dasque Creek area south of Terrace, 20% of the western hemlock over 35 ha were killed. Natural predators (Fishers) to control porcupine populations have been introduced into the areas by provincial agencies.

Spruce budmoths, Zeiraphera spp.

Spruce budmoths were common and caused light to moderate damage of Sitka and white spruce in the western portion of the Region. In mid-June, *Z. vancouverana* larvae damaged 30-40% of the lateral tips of Sitka spruce over 50 hectares at the Exchamsiks River and over 20 hectares at Salvous Slough. On the Queen Charlotte Islands this budmoth has become more widespread than in the previous 2-3 years. Feeding occurred on semi-mature and mature Sitka spruce throughout Graham and Moresby Islands, but causing damage to only 5-10% of the buds. Defoliation of the same intensity has been recorded on 15 hectares of Sitka spruce at Hirsch Creek north of Kitimat. *Z. canadensis* has defoliated white spruce from Kitwanga north to Meziadin in scattered patches with damage ranging from 5-40% of the buds.

A spruce foliage rust, *Chrysomyxa weirii*

The foliage rust, *C. weirii*, was present at low levels in most young spruce stands in the interior of the Region. Two areas with significant foliage loss since 1980 were at Telkwa River (light-moderate) and at Boulder Creek (moderate-severe). Twenty-five trees were assessed in each of three damage categories (Table 12). The average annual height increment during the four years of infection was compared to that of the five years prior to infection. The first two years of infection indicated little change in height increment. However, by the fourth year all of the infected trees in the second and third damage categories displayed slowing of height increment. In the lightest damage category, height growth had been affected on 70% of the trees by the fourth year.

Table 12. Effect of *Chrysomyxa weirii* on spruce height increment, Prince Rupert Forest Region, 1984.

Damage category	Reduction in height increment[1]
1. Lower 1/2 of crown primarily 1984 foliage	25%
2. Lower 3/4 of crown primarily 1984 foliage	50%
3. Most of the crown with primarily 1984 foliage	75%

[1]Average height increment during the infection period compared to the pre-infection period.

Late Spring Frost

Late frost damaged or killed terminal and lateral spruce buds over widespread areas. Terminal bud mortality averaged 5% in plantations at Kuldo Creek and Nilkitkwa Lake. In addition up to 90% of lateral buds (avg. 10 and 25% respectively) were destroyed on 70% of the trees.

Table 13. Incidence of bud mortality by late spring frost, Prince Rupert Forest Region, 1984.

Location	Percent terminal mortality	Lateral bud mortality	
		Percent of trees affected	Percent of buds affected
Kuldo Cr.	5	70	10 (5-60%)
Sweetin R.	1	5	5 (0-20%)
Suskwa R.	1	10	10 (0-25%)
Chapman Lk.	1	10	10 (0-25%)
Nilkitkwa Lk.	5	70	25 (5-90%)

Trees with frost-killed terminal buds frequently develop multi-leaders resulting in loss of form during the several years required to develop a single leader. Only 5% of trees similarly damaged in 1981 had developed single new leaders by 1984.

A spruce needle cast, Lophodermium piceae

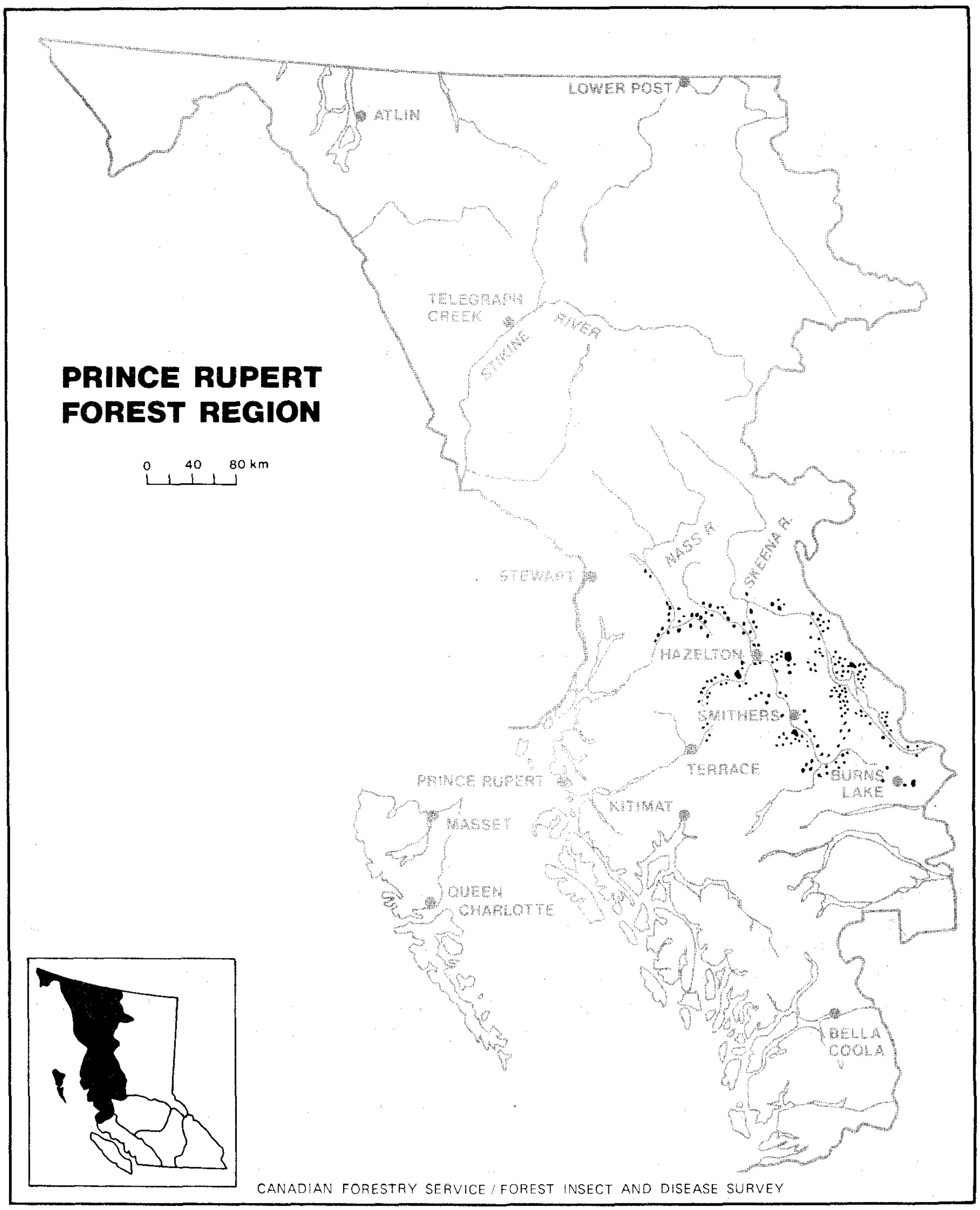
This needle cast infected an average of 30% of the foliage on 40% of the spruce in a 24-year old plantation near Kuldo Creek. A further 10% of the trees had lost 75% or more of their foliage due to infection. Since only two years and older foliage is infected, the growth is only minimally affected.

PINE PESTS

Mountain pine beetle, Dendroctonus ponderosae

An estimated 1,103,000 recently beetle-killed lodgepole pine (1,212,000 m^3) were mapped over 14 500 ha in the Region in 1984 (Table 14, map 5). This represents a 15% increase in the number of trees and a 10% increase in the area of pine killed from 1983. Most of the increase was recorded in the Kalum TSA, while slight decreases occurred in the Lakes and Morice TSAs.

In the Lakes TSA, most of the reduction, to 850 ha from 1 800 ha in 1983, has been in the removal of scattered infestations along Babine Lake and the Fleming Creek area (775 ha). Small scattered pocket infestations along the Endako River drainage (75 ha) from Broman Lake to the Prince Rupert boundary have continued relatively unchanged over the past three years.



Map 5. Areas of lodgepole pine recently killed by mountain pine beetle, determined by aerial surveys, 1984

Table 14. Area and volume of lodgepole pine recently killed by mountain pine beetle, Prince Rupert Forest Region, 1984.

		Volume (m^3)	
Location (TSA)	Area (ha)[1]	Recently killed[2]	Under attack[3]
Lakes	850	31 000	229 600
Morice	2 600	265 000	780 000
Bulkley	3 500	341 000	1 050 000
Kispiox	1 850	117 000	499 500
Kalum	5 700	458 000	1 287 000
TOTAL	14 500	1 212 000	3 846 100

[1]Areas provided by BCMF, except for Kalum TSA.

[2]Volume of 1983 attacked trees as determined by CFS-FIDS cruise data.

[3]Total volume of lodgepole pine in the mapped infestation area.

The 2 600 ha of beetle-killed pine in the Morice TSA was largely scattered in small pockets along Babine, Morrison, Fulton and Chapman lakes (2 200 ha). In this area, most of the larger infestations have been logged, while the number of small pocket infestations increased dramatically. Further small new patches were also mapped along Natowite and Tochcha lakes (250 ha) to the east of Babine Lake. The more accessible small infestation areas along the Bulkley River (150 ha) near Houston have been greatly reduced in number and area by harvesting.

In the Bulkley TSA, much of the 3 500 ha of beetle-killed pine was centered around the Harold Price Creek area (1 350 ha). However, there has been a tremendous increase in the number of small infestations (generally less than 25 trees) scattered northward along Babine Lake, Tsezakwa and Nichyeskwa creeks and along Babine River (550 ha). Similar increases in the number of small infestations were recorded in the Telkwa River-Coffin Lake area (700 ha) and to a lesser extent in the McDonell Lake area (50 ha). In the Trout Creek and adjacent Bulkley River drainage (450 ha) little change has occurred from 1983.

In the Kispiox TSA, the 1 850 ha of infestation has remained relatively constant for the past four years. The major infestations remain in the Kispiox (200 ha) and Skeena (1 200 ha) river drainages, with small pockets in the Kitwanga (150 ha), Kitsquecla (25 ha), and Babine (50 ha) river drainages. In the Suskwa River drainage (25 ha), limited suitable host material is reducing beetle activity in the valley.

In the Kalum TSA, beetle expansion continued for the second consecutive year, with 5 700 ha of recently killed pine, double the area of 1983. The major areas of increase were in the Cranberry Junction area and along the Skeena River between Kitwanga and Terrace. Several small new infestations appeared in the Aiyansh-Nass Camp area.

Fourteen stands were cruised during September to determine the current attack levels and the brood development (Table 15). Current attack in standing green trees ranged from 6 to 42% within the same infestation area. The regional average (28%) remained the same as in 1983, while in interior stands the average dropped to 22% from 30%.

Table 15. Status of lodgepole pine in stands infested by mountain pine beetle, Prince Rupert Forest Region, 1984.

Location	Percent of Volume Attacked				Healthy
	1984	1984 pitchout/partial	1983	Prior to 1983	
Hearne Hill	20	3	36	3	38
Fulton Lk.	15	5	27	15	38
Harold Price Ck.	42	6	25	7	20
Harold Price Ck.	19	3	24	12	42
Harold Price Ck.	6	11	37	5	41
Coffin Lk.	18	15	34	11	22
Telkwa R.	34	4	6	3	53
Kispiox R.	48	4	21	1	27
Kispiox R.	36	3	11	0	50
Nass R.	47	7	27	14	0
Cranberry R.	16	2	28	37	17
Cranberry R.	36	9	23	4	28
Kitwanga	28	8	12	14	38
Cedarvale	27	22	18	14	19
Regional Average	28	7	24	10	31

Several factors influenced the attack levels in the Bulkley, Morice and Lakes TSAs, including overwintering mortality, unfavourable in-tree environment and 1 1/2 to 2 year life cycles. Due to the late flights of a large portion of the population in 1983, overwintering mortality occurred at the adult or egg to early instar larval stages.

With the exception of the populations in the main Bulkley and Telkwa river valleys, mortality of these stages was high, reaching 75% egg and 50% larval mortality at Guess and Harold Price creeks, and generally averaging 50% in the Babine Lake-Harold Price Creek area. The egg mortality has been attributed to overwintering mortality, since egg niches were evident on the parent galleries but with few viable eggs and very few lateral larval galleries. However, there is some indication that it may also involve factors within the tree environment which greatly inhibit brood production. When a healthy population was allowed contact with a frass-cambium mixture from these trees, they exhibited the same minimal broods while the control population produced normal large broods.

Additionally, much of the surviving broods from the late 1983 flights did not mature in 1984. These broods will fly in early 1985 following a 1 1/2 to 2 year development period. However, this additional time period in the development stage allows for greater mortality due to disease, predation and environmental exposure. These same hazards threaten populations which reattacked those trees which were attacked in the fall of 1983. Fifty per cent of the 1983 attacked trees tallied in the cruise strips had been reattacked in 1984. When previously attacked trees are reattacked, a resident disease, parasite or predator population present in the tree can much more rapidly destroy the new young beetle broods.

The reduction of new 1984 attacks was most common in the small pocket infestations of the Nilkitkwa River and Morrison Lake areas. The average ratio of current to red attacked trees was 1 to 7 and 1 to 3 respectively at the above areas, only in several patches at Morrison Lake did the ratio reach 1 to 1. In addition to current attack, there were several partially attacked trees, 1983 attacked trees reattacked in 1984 and light attack at the base of trees which were broken at 5 to 10 meters above ground during the winter.

In the larger infestations, 1984 beetle flights were sufficient to cause a high percentage of current attack but generally with less expansion than in previous years. Similarly, the number of new small pockets of less than 10 currently attacked trees caused by beetles originating from large infestations, should be greatly reduced from the past three years.

Control measures are being used extensively by BCMF and Industry throughout most of the Region, where large components of mature pine are being threatened. Falling and burning of beetle-infested stems is a major priority in areas of numerous small pocket infestations. This treatment is effective as a short term measure of slowing a beetle population buildup in situations where beetles from nearby large infestations are not annually reinvading the treatment area. Pheromone-baiting was applied as a treatment over widespread areas, with highly variable results. The long delay between bait placement and beetle flight may have reduced their effectiveness.

Forecasting the infestation trend for 1985 is difficult due to the variability in percentage of successfully established broods in 1984. Similarly, the 1985 flight will be variable from area to area. In general, the flight should be of similar size or slightly larger than in 1984. In areas where the 1983 broods failed to mature in 1984, a spring or early summer flight should occur during the first major warming period. Several factors could influence the attack levels in 1985 including mortality due to the unseasonable cold conditions during late October, extended cold periods through the winter period or an increase in the incidence of minimal brood production.

Pine sawfly, Neodiprion sp.

The defoliation of shore pine that was reported last year at Nadu Creek on Graham Island has expanded this year to include several hundred hectares. Shore pine has been severely defoliated in Naikoon Park, along Masset Sound and Masset Harbour, trees of all ages have been defoliated. In 1976, over 92 000 ha of shore pine were defoliated by this pest with heavy tree mortality resulting from 2 years of severe defoliation on the outer islands south of Prince Rupert. No tree mortality is expected from the 1984 defoliation on the Queen Charlotte Islands, however, mortality could occur following additional severe defoliation. Infestations usually last only one to three years before native parasites, viruses, and fungi cause a collapse of the population.

Pine foliage diseases, Scirrhia pini, Lophodermella montivaga, Coleosporium asterum

Pine foliage diseases remained at relatively light infection levels despite favourable climatic conditions during the 1983 spore release period. A needle blight, S. pini, caused light infection through much of the area from Hazelton to Endako. The most severely infected area was along the Babine River at Kisgegas. Occasional tree mortality was present, tree growth was reduced and 20% of the trees had 80% of the pre-1984 foliage infected. On the remaining trees an average of 20% of the old foliage was infected.

Localized stands between Burns Lake and Endako were moderately infected with S. pini and a needle cast, Lophodermella montivaga. The climatic conditions in 1984 were again favourable for successful infection during the spore release period and indicate potentially moderate infection in 1985.

A pine needle rust, Coleosporium asterum, lightly infected several young pine plantations near Houston. Typically, 40% of the trees had 5% (ranging up to 50%) of the 1981-82 foliage infected. Little damage generally occurs, as only severely infected foliage is dropped prematurely. Climatic conditions during the past two years have been favourable (moist during the spread from the main alternate hosts, aster and goldenrod, in late August to early September) for intensification of the rust.

Western gall rust, Endocronartium harknessii

In a young spaced stand near Ootsa Lake, 8% of the trees with stem galls were broken at the gall. This occurred as a result of strong winds snapping weakened stems during early spring. Breakage was closely related to the height (avg. 10 m) of the crown above the stem gall. All of the broken trees had major stem galls, at least half of the stem circumference between 1.5 and 2.5 meters above ground level. As the crown height increases above the galls, further breakage can be expected.

General surveys of young stands elsewhere in the Region during the past three years indicated that an average of 15% of the pine in young stands have major stem galls. Based on this average, a 30 year old rust infected stand's volume would be reduced by 3%. Severely infected stands had up to 11% volume loss from a combination of stem breakage and growth loss due to gall rust. Growth loss figures are based on comparative studies done in 1983, which indicated 14% reduced increment of young trees with stem infections. Further losses attributed to galls can be expected during harvesting and milling.

Lodgepole terminal weevil, Pissodes terminalis

Lodgepole pine terminal weevil killed 4% of the leaders over 20 ha along the Terrace-Kitimat road, 1 km north of Sockeye Creek. Leader mortality will probably increase in this stand as mortality can reach 40% when infestations remain unchecked. The weevil is most destructive in stands between two and eight metres.

Warren's collar weevil, Hylobius warreni

Root collar weevil was causing light mortality of lodgepole pine in several areas in the western portion of the region. Three young stands aged 1-15 years were surveyed. Mortality ranged from 1-5% of the stand. Weevil attacked trees were more common along the perimeter of the stand, with 90% of the attacked trees within 5 m of the edge of the stand.

Table 16. Percent of trees killed by root collar weevil.

Location	# of trees examined	% trees killed
Kitwanga-Hazelton N.	200	1
Scully Cr.	200	2
Cedarvale	200	9

Engraver beetle, Ips pini

Tops and branches of recently culled lodgepole pine in a 20 ha stand north of Oliver Creek were severely infested by the engraver beetle. Normally, the pine engraver does not kill trees even though large populations commonly infest slash. However, a warm dry spring could induce this beetle to attack standing residual healthy trees, killing trees or tops.

Squirrel Damage and Western gall rust

Dead tops and branches were evident on 16% of the shore pine over 50 ha near Pure Lake in Naikoon Park. Western gall rust, Endocronartium harknessii, infected 82% of the dead branches and 36% of the dead tops, and squirrel feeding girdled or debarked 18% of the branches and 64% of the tops.

Pinewood nematode, Bursaphelenchus xylophilus

A total of 13 samples from chlorotic lodgepole pine trees were collected to determine the possibility of nematode-caused branch wilt. All samples proved to be negative for B. xylophilus; however, native plant pathogens and saprophytic nematodes were isolated from half the samples. Adult woodborers, Monochamus sp., suspected to be vectors of nematodes, were collected near trees killed by a combination of woodborers and Hylobius sp., but had no evidence of B. xylophilus.

TRUE FIR PESTS

Western balsam bark beetle, Dryocoetes confusus

Balsam bark beetle-killed alpine fir was mapped over 23 000 ha, primarily in higher elevation stands in the Bulkley (18 000 ha) and Morice (5 000 ha) TSAs. Scattered pockets of tree mortality persisted over large areas of overmature stands from Nilkitkwa River in the north, along Babine Lake (6 400 ha), along the north slope of Mt. Cronin into McKendrick Pass (6 000 ha) and in the Upper Zymoetz River drainages (3 500 ha). More concentrated smaller patches of mortality were mapped in the Telkwa River drainage (900 ha) and in the Nadina Lake and River area (5 000 ha).

Fir needle blight, Pucciniastrum epilobii

Defoliation of current year's foliage on Abies was widespread in the western portion of the Region in 1984. Open growing alpine fir was the most severely infected due to the abundance of fireweed ground cover, the alternate host. Young trees (20 years or less) have lost up to 100% of the current year's foliage. Two areas experiencing extensive defoliation were in the Meziadin Lake area and the Mayo Creek drainage.

CEDAR PESTS

Yellow Cedar Mortality

Yellow cedar is dying on the Queen Charlotte Islands from unknown causes. One center of mortality located 5 km east of Rennel Sound covered approximately 10 hectares and had 3% mortality evident among trees of all ages. Mortality was first noted in 1982, when only a few trees were affected and was attributed to poor site and flooding. Seedlings or saplings are not evident indicating that the yellow cedar is not regenerating. Mountain hemlock and Sitka spruce in the area are stunted but otherwise healthy. Bark beetles, *Phloeosinus sequoiae*, were present in 2% of the dead trees but are not the primary cause of mortality.

Flooding would seem to be the cause of yellow cedar mortality at a 2 ha site 3 km west of Tow Hill. This site is extremely wet with up to 1 m of water surrounding the base of the dying trees. No insect activity was evident in any of the trees. Dead trees are less than 20 years old and comprise 10% of the cedar in the stand.

Several dying yellow cedar were also noticed at Peel Inlet on Moresby Island. Root samples from dying trees at both Peel Inlet and Rennel Sound indicated the presence of the forest fungi, *Armillaria* sp. This fungus can kill trees or can live on trees killed by other causes. It is not believed that this fungus is the cause of mortality. Mortality of yellow cedar has become a serious problem in Alaska. Researchers there suspect that the mortality has been triggered by subtle changes in the environment.

DOUGLAS-FIR PESTS

Spruce budworm, *C. orae*

For the second consecutive year a Douglas-fir trial plantation has been lightly defoliated by spruce budworm at Chist Creek south of Terrace. This budworm has attacked 12% of the 4 year old seedlings, a reduction from 1983 when 30% of the seedlings were damaged. Defoliation was restricted to the terminal and top lateral buds.

DECIDUOUS TREE PESTS

Forest tent caterpillar, *Malacosoma disstria*

Forest tent caterpillar moderately to severely defoliated trembling aspen over 1 000 ha from Kitwanga east to Moricetown. Defoliation is severest along the Hazelton-Kitwanga north road with spot infestations occurring along Highway 16 east to Moricetown. These are primarily expansions of areas defoliated in 1983. Willow, alder, black cottonwood and white spruce are occasionally affected.

Egg mass assessments by CFS-FIDS in late 1983 predicted increasing populations for 1984. Surveys of egg masses this year indicate continuing defoliation for 1985 (Table 17). Defoliation can be expected if there are more than 15 egg masses per tree.

Table 17. Average number of forest tent caterpillar egg masses per tree tallied on trembling aspen.

Location	No. trees sampled	Average # egg masses/tree
Kitwanga	5	25
Hazelton	3	46
Moricetown	3	31

Outbreaks have occurred in the Region on an average of every 6 to 10 years and last from 3 to 6 years. Several species of flies and wasps parasitize the eggs, larvae and pupae of the forest tent caterpillar. Most important are large gray flies, *Sarcophaga aldrichi*. Female flies deposit maggots on cocoons. The maggots penetrate the silk and move into the prepupae or pupae, killing them as well as any other parasites that may be present. Polyhedral virus disease and a fungus disease, *Entomophthora* sp., also destroy large numbers of caterpillars.

Western tent caterpillar, *Malacosoma californicum pluviale*

The three-year old infestation that extended from Meziadin Lake to Cousins Creek in 1983 has collapsed. Parasitism and/or NPV evident on larvae at Meziadin Lake in 1983 were factors in the population collapse. Dead twigs are evident throughout the area on willow, alder and black cottonwood from three successive years of defoliation.

Poplar shoot blight, *Venturia* spp.

Trembling aspen was defoliated for the eighth consecutive year over widespread areas in the eastern portion of the Region and for the first year in the western portion of the Region. Extensive areas were severely infected for several kilometres northeast of Houston and east of Burns Lake. Moderate to severe defoliation by *Venturia* was present in numerous stands between Smithers and Moricetown, along the Telkwa River and Hungry Hill. Southerly aspects generally received more severe infection. Most stands between Endako and the Kispiox River were lightly infected with small scattered areas of moderate.

Trembling aspen and black cottonwood stands in the Cranberry and Kitwanga River valleys have been severely infected by both *Venturia macularis* and *V. populina*. Dead shoots and leaves are particularly common on aspen in groves up to 20 ha from Kitwanga to Cranberry Junction. Black cottonwood saplings are commonly, but less severely, affected throughout the same general area.

The increased levels of infection were favoured by the moist spring and could result in terminal and branch dieback of saplings and some growth loss on severely infected mature trees.

Alder sawfly, Hemichroa crocea

Red alder was severely defoliated in several areas of the western portion of the Region. Alder along the north and east coast of Graham Island from Queen Charlotte City to Masset and in the Terrace area were completely defoliated, with scattered patches of up to 5 ha being common. Light defoliation was common in the Kitimat, Prince Rupert and Lakelse region. Light to moderate defoliation was recorded in mid-July, however it was not until September when the second generation began feeding that severe defoliation of trees occurred. The alder sawfly is considered beneficial as the defoliation of alder releases the Sitka spruce regeneration. This is the second year that defoliation has been recorded on the Queen Charlotte Islands.

Alder brown stripe

Interveinal discoloration of alder is widespread in the Terrace-Kitimat-Prince Rupert area. Symptoms are usually attributed to damage from fluoride emissions. The browning of the leaves has been noted in areas where there are no pollution sources. This damage may be caused by nutrient deficiency.

Alder leaf blight, Septonia alni

Widespread defoliation of red alder by the leaf blight, Septonia alni, is evident on Graham Island on the Queen Charlotte Islands. This blight causes yellowing, then browning of leaves that eventually fall off. Up to 100% defoliation of 10 year old alder occurred over 60 ha at Sue Creek.

Poplar and willow borer, Cryptorhynchus lapathi

Increased populations of the poplar and willow borer Cryptorhynchus lapathi killed extensive areas of young willow in the Nass and Skeena river valleys from Cranberry Junction to Kitimat and Hazelton to Prince Rupert where endemic populations have been common for many years.

Although of little economic importance, tree and branch mortality is a concern in urban areas. As young 'whips' and main stems are killed multi-stemmed 'clumps' develop.

SPECIAL SURVEYS

Exotic Plantations

Ten plantations of native and introduced conifers (Table 18), established between 1957 and 1963 by Columbia Cellulose (Westar Timber), in the Nelson River and Camp Creek areas north of Terrace were re-examined for the first time since 1971. The survey, to determine the condition of the trees and the incidence of forest pests, consisted of selection and examination of 25 trees in each of 8 plantations and the 7 remaining trees at 2 plantations. The survey data is to supplement the recent FIDS Report 84-4 "Surveys of exotic plantations in B.C., 1956-83".

The healthiest trees were Douglas-fir, Pseudotsugae menziesii from the B.C. interior, 71-92% of which were healthy. Cooleyi spruce gall aphid, Adelges cooleyi and snow damage were the major causes of the deformity of 8-29% of the affected Douglas-fir.

Most (88%) of the European larch at one of three sites were healthy but porcupine feeding and/or snow damage killed 28% of the larch and deformed or killed the tops of the remainder at one site and killed the tops of all the trees at a third site. Between 20-54% of the Japanese larch in three plantations were healthy. Porcupine killed 4-32% of the trees, and killed the tops of 20-24% in two sites and none in the third. Snow damage deformed 12-44% of the trees in the three plots where damage was reported in 1960.

Only 8% of both red and Scots pine were healthy; snow damage affected 92 and 76% of the pines respectively, and 16% of Scots pine were killed by porcupine feeding.

Table 18. Conditions of exotic conifer plantations near Terrace, 1984.

Tree Species	Tree Condition %				Pests	# examined	Age (yrs)	Tree Dimensions				Plot no.
								dbh (cm)		ht. (m)		
	H	DD	DF	DT				avg.	range	avg.	range	
Douglas-fir *P. menziesii*	92	0	8	0	None	25	26	16	4-25	8.7	6-10	146
	71	0	29	0	*Adelges cooleyi*	7	27	8.7	2-15	3.6	2-7	128
European larch *Larix decidua*	0	28	44	28	Porcupines	25	22	11.2	3-18	10.8	4-12	227
"	0	0	0	100	"	7	26	18.9	15-31	9.3	6-13	129
"	88	12	0	0	"	25	27	21.1	12-34	8.9	6-10	132
Japanese larch *Larix leptolepis*	24	32	44	0	"	25	22	8.6	3-14	6.4	4-9	231
"	20	20	36	24	"	25	21	11	3-25	6.6	3-11	247
"	54	4	12	20	"	25	26	15.9	9-19	7.2	3-9	130
Scots pine *Pinus sylvestris*	8	16	76	0	"	25	24	15.5	10-25	8.2	4-11	226
Red pine Pinus resinosa	8	0	92	0	None	25	23	10.2	8-20	5.5	3-7	228

H - Healthy DD - Dead DF - Deformed DT - Dead Tops

Canadä