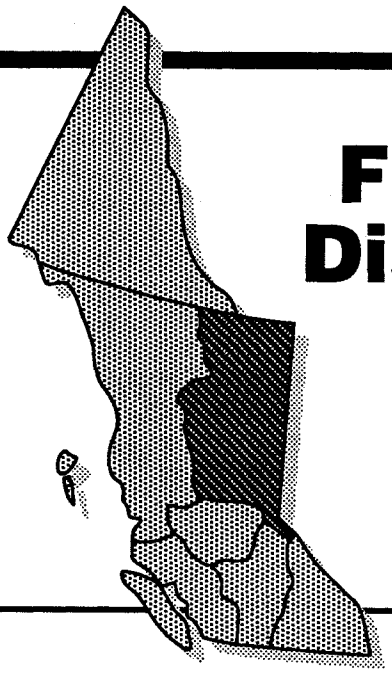
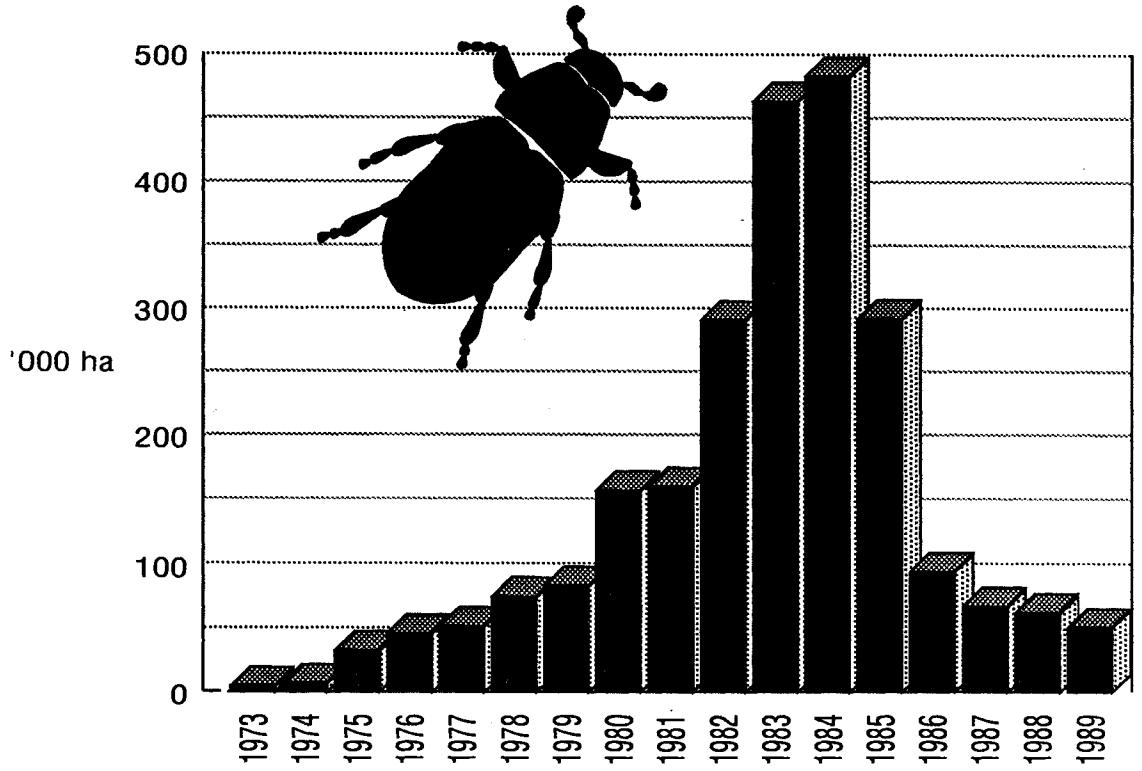


Forest Insect and Disease Conditions

Prince George Forest Region
1989

R. Turnquist & R. Ferris



Mountain Pine Beetle in British Columbia

Forestry Canada Forêts Canada

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APPENDICES

The following appendices are available upon request from:

Forest Insect and Disease Survey
Forestry Canada
506 West Burnside Road
Victoria, B.C.
V8Z 1M5

I. Maps of major bark beetle and defoliator infestations compiled during aerial surveys of the Prince George Region, 1989 (8 @ 1:100,000; 15 @ 1:250,000; 4 @ 1:125,000).

II. Summary of the spruce budworm, gypsy moth and black army cutworm pheromone trapping program, Prince George Region, 1989.

III. Summary of pest problems in provincial parks within the Prince George Region, 1989.

IV. A detailed summary of pests of young stands, Prince George Region, 1989.

V. A summary of the joint Canada-Sweden lodgepole pine trials in the Pacific Region.

Detailed copies of infestation maps, pest reports, pest leaflets and monographs, as well as regional pest histories, are also available.

INTRODUCTION

This report summarizes the findings of two Forest Insect and Disease Survey (FIDS) Rangers during summer field studies in the Prince George Forest Region in 1989. Forest pest conditions are listed by host in order of importance with emphasis given to those capable of sudden damaging outbreaks. Most of the information was gathered through the monitoring of over 50 permanent sampling stations throughout the region; the monitoring of already known or recently reported infestations or disease problems; the detection of pest problems during travels through the region; annual aerial surveys during which major pest problems were mapped with reference to area and severity; and special projects designed to gain information for ongoing research.

The FIDS field season extended from May 24 to September 30, during which over 240 insect and 70 disease collections were sent to the Pacific Forestry Centre (PFC) for identification or confirmation (**Map 1**). Some of these were added to the extensive permanent collections in the PFC insectary and herbarium.

The British Columbia Forest Service provided 22 hours of fixed-wing and 15 hours of helicopter time, and Forestry Canada provided 3 hours of fixed-wing time, for aerial and aerially accessed ground surveys during the 1989 season (**Map 1**). During aerial surveys, bark beetle and defoliator damage were quantified within damage classes and reference to these classes appear intermittently throughout this report:

Bark beetle mortality classes:
- light - 1-10% of stand recently killed
- moderate - 11-29% of stand recently killed
- severe - >30%+ of stand recently killed

Aerial survey defoliation classes:

Light - discolored foliage barely visible from the air; some branch and upper crown defoliation

Moderate - pronounced discoloration, noticeably thin foliage; top third of many trees severely defoliated, some completely stripped

Severe - bare branch tips and completely defoliated tops; most trees more than 50% defoliated

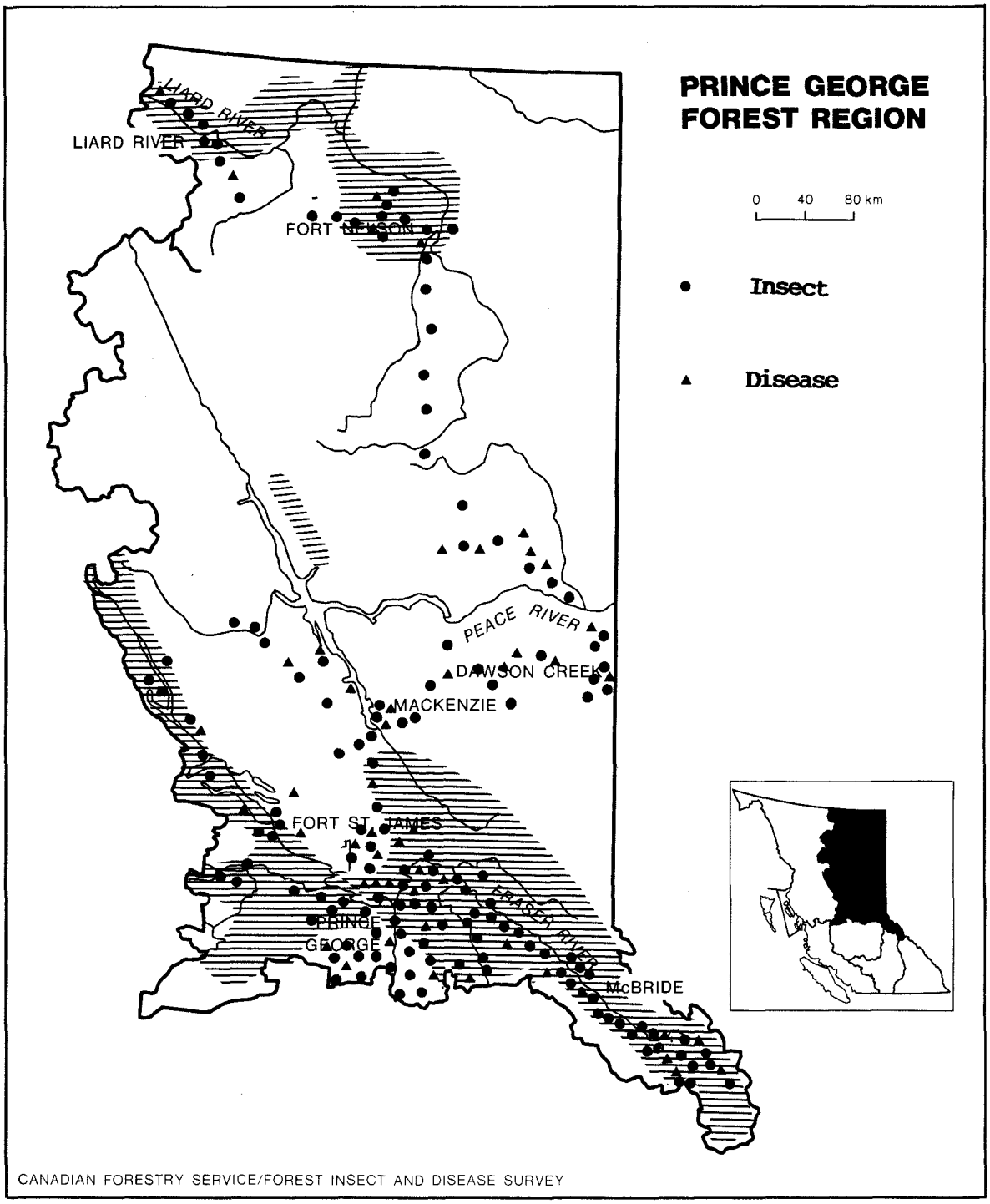
Correspondence and inquiries with respect to forest pest problems in the Prince George Forest Region can be directed to:

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

During the field season, the rangers are based at:

Forest Insect and Disease Survey
Forestry Canada
Box 687
Prince George, B.C.
V2L 4S8 Phone: 963-7238 or 963-7394

The Forest Insect and Disease Survey is a nation-wide network within Forestry Canada with the responsibility of producing an overview of forest pest conditions and their implications; maintaining records and surveys to support quarantines and facilitate predictions; supporting forestry research with records, insect collections, and herbaria; providing advice on forest insect and disease conditions; and developing and testing survey techniques and conducting related biological studies. Surveys are carried out in both British Columbia and the Yukon Territory, collectively termed the Pacific Region.



Map 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1989.

SUMMARY

After two consecutive years of decline, **Eastern spruce budworm** populations increased, causing light to severe defoliation of primarily white spruce over 123 750 ha near Fort Nelson. **Spruce beetle** populations increased for the first time in seven years, causing scattered, light mortality north of Prince George. Immature **two-year-cycle spruce budworm** populations lightly defoliated mainly white spruce over 4200 ha, primarily in the Morkill River Valley north of McBride. A **spruce budworm**, probably two-year cycle, defoliated 11 280 ha of spruce-fir forests in the Ospika River Valley, north of Mackenzie. This is the first recorded budworm outbreak in this area. **Spruce weevil** continued to infest and kill young spruce leaders in several locations in the southern half of the Region. The presence of the **eastern blackheaded budworm** was confirmed in white spruce in areas east of the Rocky Mountains. A **spruce bud midge** damaged young spruce in two locations north of Prince George.

Lodgepole pine mortality due to 1988 **mountain pine beetle** attacks declined, for the fourth consecutive year, to 97 900 m^3 over 2805 ha. Most of the mortality continued to occur in the Fort St. James District. **White pine blister rust** killed or top-killed western white pine over 450 ha along Canoe Reach on McNaughton Lake and near Albreda. **Pinewood nematode** sampling was reduced after extensive sampling province-wide found little evidence of this pest in British Columbia forests. Some log bolts with potential **nematode vectors** were collected for further study. Various **microfungi** were again found, associated with **frost** or **drought** stress at four lodgepole pine plantations established in 1986 as a joint **Canada-Sweden project.**

Balsam bark beetle killed an estimated 31 200 trees over 3900 ha in widespread high-elevation stands throughout the region. **Douglas-fir beetle** populations increased and killed an estimated 500 trees over 113 ha, mainly in the Prince George and Fort St. James districts.

Black army cutworm populations declined, no defoliation was recorded in the region. **Winter damage** caused foliar discoloration on western red cedar and western hemlock between Prince George and McBride, and caused bud kill on white spruce and, to a lesser extent, alpine fir, from Red Rock to north of Fort St. John. Some foliar discoloration was also recorded on lodgepole pine. **Animal damage** was recorded at several locations throughout the region. No **acid rain** symptoms were recorded at a long term study plot near Averil Lake.

Forest tent caterpillar populations increased in the Prince George area for the fourth consecutive year, defoliating mainly trembling aspen over 108 288 ha, more than double the area defoliated in 1988. Approximately 4 000 ha of defoliation was recorded, for the seventh consecutive year, in the Farmington and Pouce Coupe areas, and some 260 ha was recorded in the McBride area, the first since 1978. An **aspen decay** survey found some level of decay in 90% of stands surveyed, an average of 55% of the trees in these stands had some decay.

No adult male **gypsy moths** were trapped in 45 pheromone-baited traps placed in provincial parks, rest areas or private campgrounds. A total of 29 young stand surveys at widespread locations found a variety of diseases and pests, the most common being **stem rusts, environmental damage** and **adelgids.** A table summarizing **other noteworthy and minor pests** is included in this report.

SPRUCE PESTS

Eastern spruce budworm
Choristoneura fumiferana

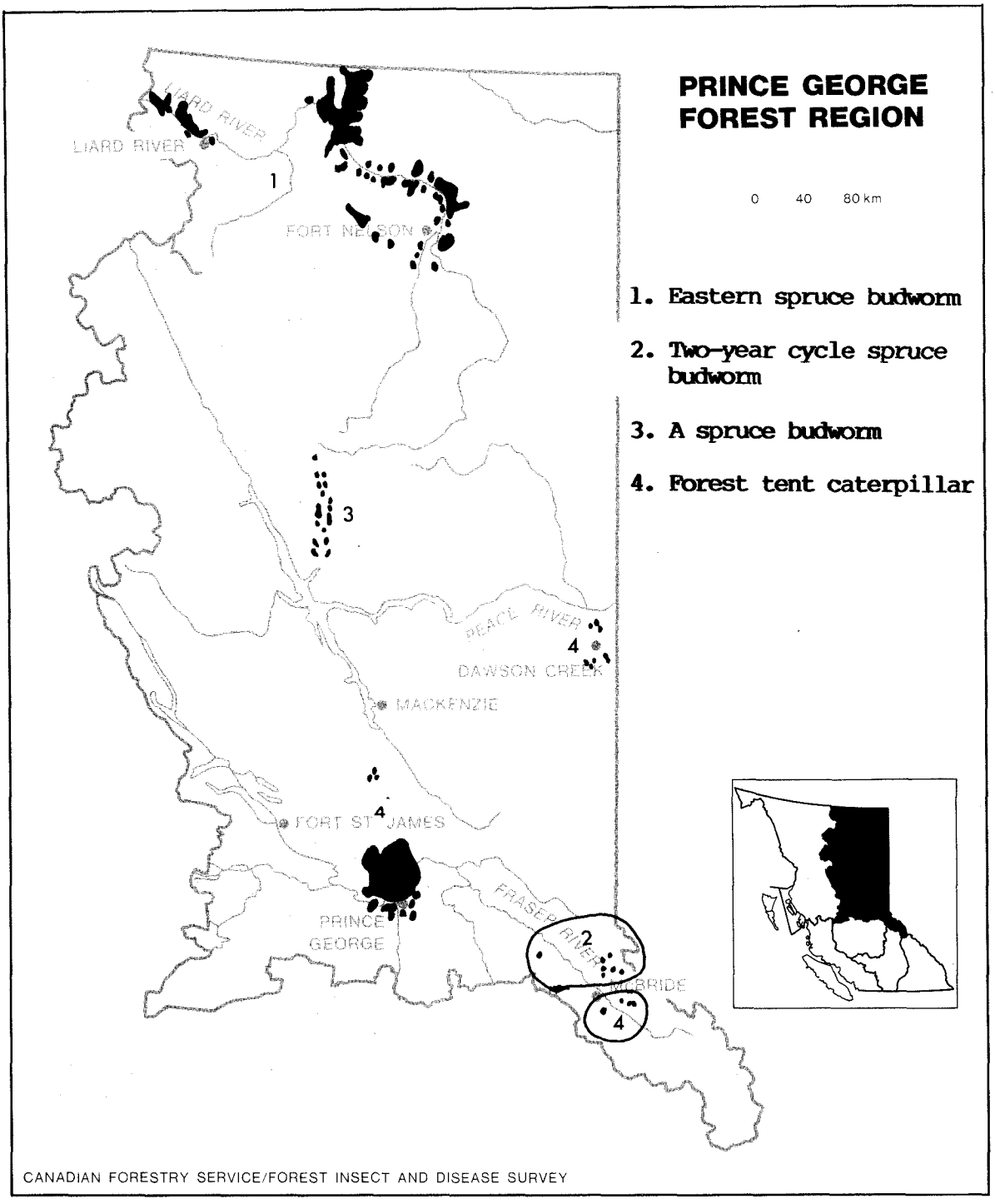
After two consecutive years of decline, spruce budworm populations in the northern part of the region increased dramatically, defoliating mainly white spruce over 123 740 ha (Map 2) up from 35 890 ha defoliated in 1988. The area affected, as delineated by defoliation classes was: light - 41 380 ha, moderate - 71 070 ha, severe - 11 290 ha. Although this is the fifth consecutive year of recorded defoliation, it is only the first year that severe defoliation was recorded during aerial surveys.

Defoliation in 1989 increased in all locations mapped in 1988. Areas of significant increases included the Ft. Nelson River and its tributaries, from the Muskwa River to the Liard River, including the Nelson Forks area; the Liard River and its tributaries, from west of the Beaver River to the Northwest Territories border, including the La Biche River Valley where defoliation was seen to continue up into the Yukon territory; and the Kledo Creek area. The only location where a large increase in the area defoliated was not recorded was along the Liard River from Coal River to Liard Hot Springs Provincial Park. New areas of defoliation included locations south and east of Ft. Nelson towards Jackfish Creek and Clarke Lake, and areas south of the Muskwa River near Akue Creek.

Defoliation was particularly severe on understory alpine fir trees, most of these trees suffered 100% defoliation of new growth, and even older growth was stripped. Heavy webbing was evident in the understory of most of the defoliated stands. Young stands adjacent to defoliated stands suffered varying degrees of damage; however, this damage tended to decrease as distance from the defoliated mature stands increased. Top deformity and damaged lateral and terminal buds were the most commonly found problems associated with budworm damaged young stands.

For the first time during this infestation, spruce foliage was examined for egg masses in order to determine if high budworm populations could be expected in 1990. The egg mass samples were provided through cooperation with the B.C. Forest Service and Tackama Forest products. Egg mass samples were obtained from five locations; Snake River, Sandy Creek, La Jolie Butte, Kledo and Steamboat Creeks. Although only limited egg mass samples were obtained from the first three locations, the samples indicate extremely high populations for these areas. An average of over 1000 egg masses per 10 m^2 of foliage was found, indicating continued severe defoliation. At the last two locations, egg mass counts averaged approximately 135 eggs per 10 m^2 of foliage. The population levels here, while lower than the first two locations, are still high enough to cause moderate to severe defoliation.

Two sets of spruce budworm pheromone-baited traps were set out in northeastern B.C. These were located at Mile 73 of the Alaska Highway, and just south of the Buckinghorse River on the Alaska Highway. An average of 1500 adult eastern spruce budworm were caught in these traps, the last traps to be put out under a long term trapping program, instituted to study the taxonomy and distribution of spruce budworms in the northwestern part of Canada. A detailed



Map 2. Areas where current defoliation was detected during ground and aerial surveys in 1989.

report on the findings will be available through the Pacific Forestry Centre at a later date.

The high numbers of egg masses from locations north of Ft. Nelson and the lack of appreciable parasitism or disease levels in budworm samples submitted to the Pacific Forestry Centre, indicate that the eastern spruce budworm population will continue at high levels, and possibly expand further in 1990. FIDS Rangers will monitor budworm populations as part of continuing surveys in 1990, and will issue updates in the form of pest reports after early season sampling is completed next year.

Spruce beetle
Dendroctonus rufipennis

Spruce beetle populations increased after six consecutive years of declining populations. About 22 ha (Map 3) of spruce beetle-caused mortality was mapped, in widely scattered pockets of from one to ten trees. Mature spruce was killed in the Weedon, Davie and Kerry Lakes areas north of Prince George, and in the Table, Anzac, Hominka and Missinka River Valleys northeast of Prince George. The B.C. Forest Service reported some spruce beetle mortality in the McGregor River and Herrick Creek areas, and in the Mackenzie Forest District. Additionally, some 600 ha of recent severe blowdown was mapped, in predominately spruce types, mainly in the Table, Anzac and Missinka River Valleys and at Hellroaring creek near McBride; approximately 1000 ha of light blowdown (1-3 trees per ha) were observed in the lower McGregor River area. Recent blowdown is attractive to spruce beetle; most major outbreaks in British Columbia originated from beetle populations breeding undetected in blowdown material.

Ground surveys in selected locations in recently windthrown spruce in the Table River Valley in July and Cargill Creek near the McGregor River in June found scattered, recent attacks. Many of these windthrown trees were blown down in the late winter and still had portions of their roots intact and in contact with the ground. These trees may remain attractive to spruce beetle for another year. Ground surveys in the Kerry Lake area in July found large, healthy beetle populations, with everything from eggs to fourth instar larvae present in recently windthrown trees. The presence of late instar larvae in early July in these 1989 attacked trees indicates that a portion of the beetle population may be entering a one-year-cycle.

After a fall visit to the Weedon Lake area, it was concluded that many of the standing red trees were attacked in 1988 and had high populations which will result in a large flight in the spring of 1990 (personal communication, Dr. L. Safranyik, PFC). B.C. Forest Service probes in the fall of 1989 found varying levels of current attack, which, along with 1988 attacks and one-year-cycle populations, indicates that beetle populations in the area are not all synchronized. As a result, spruce beetle flights will probably occur every year for a few years, or until populations are reduced through control options.

The B.C. Forest Service has proposed accelerated logging, with follow up trap tree programs over the next three years in order to control beetle populations and thus reduce subsequent mortality. A complicating factor is that some of the areas near Davie and Weedon Lakes are currently being claimed by the McLeod Lake Indian Band, and these areas are under court order to prevent

logging until the land claim case is settled.

Two-year-cycle spruce budworm
Choristoneura biennis

Light defoliation of white spruce and alpine fir by immature two-year-cycle spruce budworm was mapped over 4200 ha (Map 2) along the Morkill River and Everett and Dome Creeks in 1989. Buds were infested near areas defoliated in 1988 in the Bowron River, Everett Creek and Stoney Lake areas, but damage was not visible during aerial surveys.

Bud sampling conducted in June at six infested stands (Table 1) found an average of 31% (range 2-80%) of alpine fir buds infested, indicating light to severe defoliation throughout the infested areas. Defoliation in 1988, the last major feeding year, covered 17 520 ha and defoliation by mature larvae is expected to cover a similar area in 1990.

Table 1. Location, percent buds infested and predicted defoliation by two-year-cycle spruce budworm, Prince George Forest Region, 1989.

TSA and location	Percent[1] buds infested (1989)	Predicted defoliation (1990)
Prince George TSA[2]		
Stoney Lake	2	light
Rond Creek	6	light
68 km Bowron-Coal Road	18	moderate
76 km Bowron-Coal Road	3	light
12 km Tumuch Road	78	severe
Everett Creek	80	severe
Average	31	severe

[1]1-15% light; 16-30% moderate; 31%+ severe.
[2]Timber Supply Area

Forest Insect and Disease Survey will continue to monitor two-year-cycle spruce budworm populations in historically active areas in 1990.

A spruce budworm
Choristoneura sp.

A species of spruce budworm, probably two-year cycle, active in the Ospika River Valley was first reported by industry to FIDS, in late June, 1989. Subsequent aerial surveys in early August found white spruce and alpine fir defoliated over approximately 11 385 ha (Map 2) of which 9197 ha were classified as light, and 2188 ha classified as moderate defoliation. This is the first record of spruce budworm populations in this remote valley on the northeastern shore of Williston Lake. Although identity of the species has not been

positively confirmed, taxonomic study of adult budworms reared at the Pacific Forestry Centre from larvae collected in the Ospika Valley have shown that this is not the eastern spruce budworm, C. fumiferanae. This narrows the identification to two species, of which the two-year-cycle spruce budworm, C. biennis, is the most likely candidate.

Ongoing rearings with follow-up ground collections, observations and pheromone trapping in 1990 should provide a positive identification of the species involved.

Spruce weevil
Pissodes strobi

Spruce weevil were again active in scattered white spruce stands throughout the region. Current attack at five locations averaged 10% (range 2-40%). The highest incidence occurred at the Prince George Tree Improvement Station where 40% of the trees were infested. Approximately 2% of the trees were infested at each of two sites near the Goat River and one site on the Beaver-Holmes Road, and approximately 3% of the trees were infested at Gagnon Creek south of Mackenzie. Spruce weevil is an ongoing problem in young spruce stands in this and other forest regions, causing leader mortality in young trees and crooks in mature trees. Work continues at the Pacific Forestry Centre on a program to develop techniques for the biological control of spruce weevil.

Spruce bud midge
Rhabdophaga swainii

Damage by the spruce bud midge was found in approximately 50% of young white spruce in a stand near km 18 of the One Island Lake Road south of Dawson Creek, and in about 20% of young white spruce near Weedon Lake northwest of Prince George. This midge usually attacks the terminal buds, generally on the sunny side and tops of open growing trees. The attacked buds become rosette-like and do not flush. Height loss, during the year of attack, and multiple leaders with possible resulting crook is the usual damage caused by this pest. Unless the same tree is attacked over several consecutive years, this damage will not result in any serious defect as the tree usually grows over the minor crook caused by single attacks.

Surveys to further determine the incidence and intensity of this pest of young spruce stands in the Prince George Region will continue in 1990.

Eastern blackheaded budworm
Acleris variana

The eastern blackheaded budworm was positively identified in a special mass collection from white spruce near Liard River on the Alaska Highway. This was the first positive confirmation of the species in B.C. Budworm larvae are found, usually at low population levels, in conjunction with eastern spruce budworm from the Fort Nelson area west to Coal River. Some larvae were present, again at low levels, on the east side of Pine Pass.

PINE PESTS

Mountain pine beetle
Dendroctonus ponderosae

The area of recorded lodgepole pine mortality due to attacks by the mountain pine beetle decreased, for the third consecutive year, to 97 910 m^3 over 2805 ha in 1989, down from 3975 ha in 1988 and 4290 ha in 1987 (Table 2, Map 3).

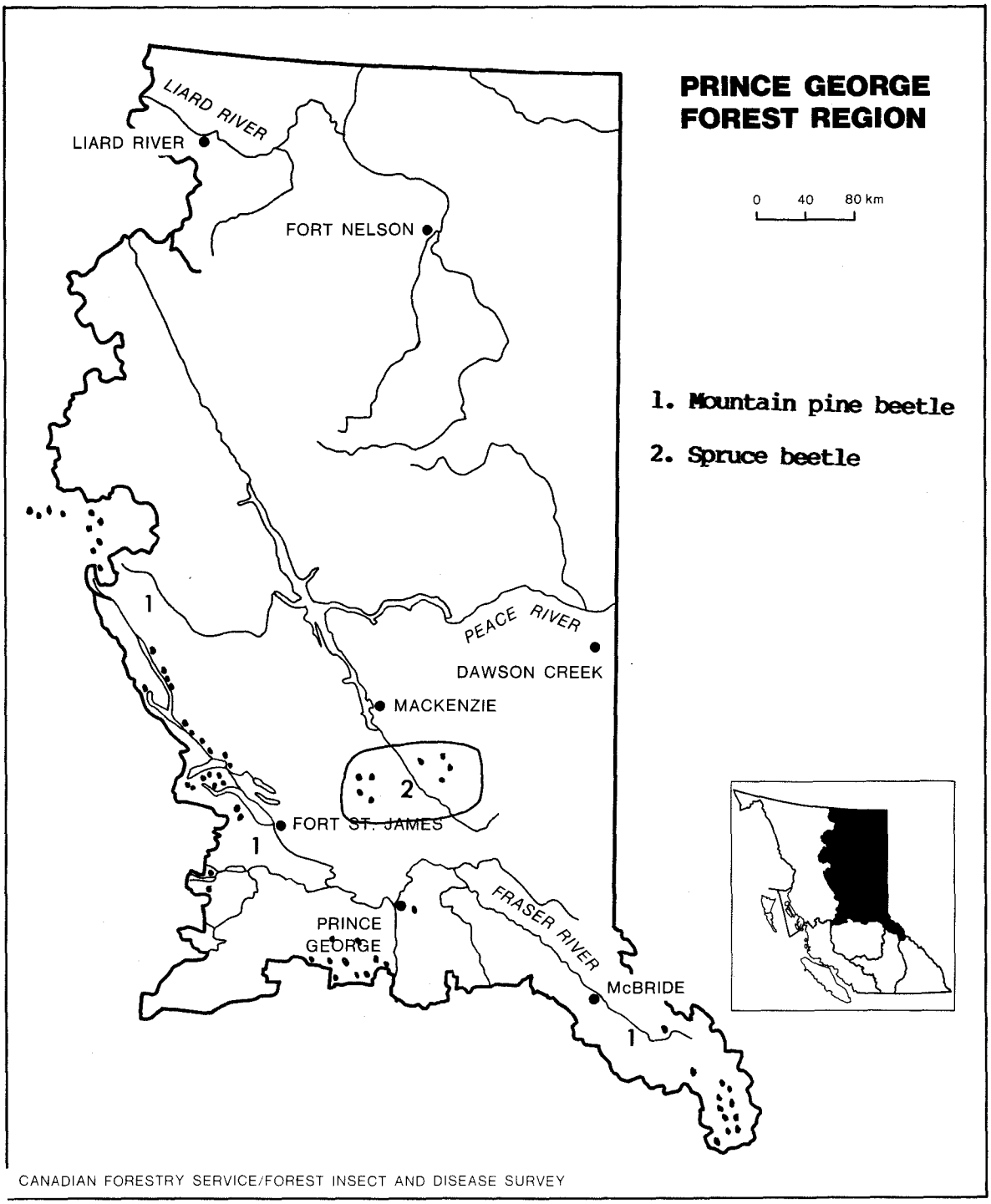
Eighty-five percent of beetle caused mortality continued to occur in areas of chronic infestations in the Fort St. James District in the Prince George Timber Supply Area (TSA), many of which are beyond road access. The area of beetle-caused mortality increased slightly in the McBride District, while declining in the Vanderhoof and Prince George Districts.

Table 2. Timber supply area (TSA), forest district, area and volume of lodgepole pine recently killed by mountain pine beetle, Prince George Region, 1989.

TSA and location	Area (ha)	Volume (m^3)
PRINCE GEORGE TSA		
Fort St. James District	2 370	74 960
Vanderhoof District	35	1 975
Prince George District	80	4 975
TSA TOTAL	**2 485**	**81 910**
McBRIDE TSA		
McBride District	320	16 000
TSA TOTAL	**320**	**16 000**
REGIONAL TOTAL	**2 805**	**97 910**

Fort St. James District

The area of recently killed lodgepole pine declined, for the third consecutive year, to 2370 ha from 3415 ha in 1988 and 3845 ha in 1987. Most of the decline occurred in the Middle River area between Takla and Trembleur Lakes, partly due to logging of previously inaccessible stands. Lower levels of attack in 1988 also contributed to the decline (trees mapped in 1989 are ones that were attacked in 1988). An increase in beetle activity was noted in the southern and



Map 3. Areas of lodgepole pine recently killed by mountain pine beetle and white spruce killed by spruce beetle, determined by aerial and ground surveys in 1989.

western portions of T.F.L. 42, however the majority of beetle activity in the T.F.L. continues to be centered between Tarnezell Lake, the Tachie River, and the south shore of Trembleur Lake. An increase in beetle caused mortality was also noted on the Cunningham Lake-Nancut area. Infestations in the Sustut-Skeena Rivers area, while continuing at levels similar to 1988 are spreading in the Birdflat Creek area and locations north and south of Bear Lake. Other chronic infestations along Takla Lake declined slightly while areas of attack in the Dust Creek area past the Northwest arm of Takla Lake showed a slight increase. Areas of attack along the north shore of Trembleur Lake also decreased.

Spring brood assessments at seven locations had an average 'R' value (ratio of brood plus adults to entrance holes) of 4.8, indicating expanding populations. This is similar to 4.2 in 1988, but considerably lower than 16.0 in 1987. Brood development ranged from eggs and first instar larvae through to callow adults, with last years adults still alive and active in parent galleries in several of the locations sampled, which indicates the possibility of off-cycle populations.

Table 3. Mountain pine beetle "R" values and population trends, Fort St. James District, Prince George Forest Region, 1989.

Location	"R" Value	Population trend[1]	Remarks
Nancut, northeast shore of Cunningham Lake	3.8	static	all brood in larval stage, over 50% mortality
T.F.L. 42, C.P. 12	4.6	increasing	early instar larvae and pupae present
T.F.L. 42, C.P. 13	6.7	increasing	mainly late instar larvae, some eggs
Natazutlo Creek, Middle River	4.0	static	50% of trees with high mortality and pitchouts
Takla Narrows, west side of lake	1.3	decreasing	poor brood production and high mortality
Hudson Bay Creek, Takla Landing	10.1	increasing	mostly late instar larvae and adults
Dust Creek, Northwest Arm Takla Lake	2.8	static	mostly early-instar larvae, high mortality
District average	4.8	increasing	

[1] R value — Population trend
≤ 2.5 — decreasing
2.6-4.0 — static
4.1+ — increasing

Fall cruises in TFL 42 found an average 14% current attack (Table 4), a slight increase from an average of 11% found in 1988, but still considerably lower than 34% found in 1987, thus indicating that beetle populations, while increasing, are doing so at low rates. This average current attack level, while influenced by the widespread use of pheromone baits, confirmed spring assessments of slightly increasing populations.

Table 4. Status of lodgepole pine in stands infested by mountain pine beetle, Prince George Forest Region, 1989.

Location	Percentage of stems				
	Healthy	Current	Red	Grey	Partial
Strip 1, C.P. 13 BLK 28, TFL 42	66	20	0	9	5
Strip 2, C.P. 13 Blk 28, TFL 42	83	4	7	5	1
Strip 3, C.P. 104, TFL 42	17	29	23	26	5
Strip 4, 600 Road, TFL 42	84	5	5	2	4
Average	62	14	9	11	4

[1]Current attack - 1989, Red attack - 1988, grey attack - prior to 1988, Partial/Pitchout - 1989

Brood assessments made during fall cruising in TFL 42 found most currently attacked trees treated with Monosodium Acid Methanaearsonate (MSMA). In most cases, in the areas examined, the MSMA application appeared to have achieved its purpose, i.e. prevent successful brood establishment. While some live adults were found in a few of the MSMA treated trees, most trees had no brood production and dead adults, or arrested larval development. In the few locations where currently attacked trees were found with no MSMA treatment, mainly early instar larvae were present. In some of the locations examined during fall surveys, larvae and pupae were found under the bark of red (1988 attacked) trees. Normally, there would be no brood under the bark of red trees in the fall.

The considerable variation in brood development found during spring and fall sampling points to continued off-cycle populations, with resulting slower infestation rates, particularly in the more northerly infestations. This fact is clearly demonstrated in populations sampled in the spring at several locations along Takla Lake. At Dust Creek, along with Takla Narrows and, particularly, Hudson Bay Creek near Takla Landing, several of the trees had pupae and callow adults present under the bark. In a normal life cycle, beetle progeny in trees attacked in 1988 would be in mid- to late-instar stages by early June of 1989, (spring sampling period). With the beetle flight in these areas usually occurring as late as August (1988) and sometimes extending into September, their progeny development by the following spring (1989) would not be at the pupal or callow adult stage, particularly in these northerly infestations

where spring comes late and the developmental season is not long. It would take another year to get that far, thus indicating the presence of extended or two-year-cycle populations.

With the 'R' value and current attack status being similar to 1988, and continued evidence of extended life cycles, mountain pine beetle populations will probably continue to increase at a slow pace. The B.C. Forest Service and Industry continue to use pheromone baiting in conjunction with MSMA applications on the more remote infestations, and logging, as stands become more accessible due to increased road building, to successfully combat beetle populations in the District.

Prince George Forest District

Lodgepole pine damage was mapped over 80 ha in 1989, down from 255 ha in 1988. Most of the mortality occurred throughout the southwest portion of the district. Pockets of one to ten red trees occurred at scattered locations including the Bobtail Mountain area, along the Chilako River, in TFL 5 west of the Fraser River, in the Telegraph Range and near the Blackwater River. In the southeastern portion of the district only two infestations were noted - mortality occurred northeast of Hixon and along Taspai Creek.

Pheromone baits were used by the B.C. Forest Service to attract beetle populations in preparation for disposal and logging operations. These management options, along with good road access are proving successful in combating beetle populations in the district.

Vanderhoof Forest District

Tree mortality declined to 100 trees scattered over 35 ha, down from 200 trees over 45 ha in 1988. The main area of active beetle populations was near Fraser Lake where some 80 red trees were mapped. Approximately 10 trees were mapped near Francois Lake, down from 75 trees in 1988. Beetle activity declined in the southern part of the district, only 10 trees were mapped in the Bobtail area near the Prince George District boundary.

McBride Forest District

Mountain pine beetle mortality in lodgepole pine was mapped over 320 ha, up from 245 ha in 1988. Beetle activity continued near Canoe Arm, Albreda and Mt. Thompson. Near Kinbasket Lake along Canoe Reach, beetle populations have been active since 1977 with scattered pockets of 1 to 20 trees from Dave Henry to Harvey Creeks, on both sides of the lake. Near Albreda, another chronic beetle area, several pockets of 1 to 5 trees were mapped.

Probe lines by the B.C. Forest Service located 117 green attack trees at Shale Hill, 57 at Swift Current Creek and 60 near Robson Shadows Campsite east of Tete Jaune Cache. These trees will be disposed of before next May to reduce the 1990 beetle flight in the area. There is still concern that mountain pine beetle could spread from the Robson Corridor through the Yellowhead Pass into Jasper National Park and Alberta.

Logging, along with pheromone baiting and single tree disposal is used to reduce beetle populations in this district.

White Pine Blister Rust
Cronartium ribicola

White pine blister rust-caused mortality was mapped over 455 ha, mainly along the southwestern end of Canoe Reach on McNaughton Lake, similar to damage in 1988. There were seven patches mapped on the west side of the reach and six on the east.

Mortality caused by blister rust is differentiated from mortality caused by the mountain pine beetle, which is also active in the same areas, by being limited to the minor western white pine component of the stands, many of which are only top-killed. Blister rust-caused mortality is a chronic problem in five-needle pine, and infections in this species are expected to continue in the future.

Pinewood nematode
Bursaphelenchus xylophilus

Sampling of material for the pinewood nematode program was reduced in 1989. Based on more than 1200 samples from trees and potential vectors collected throughout B.C. since 1982, this nematode remains at extremely low levels in the Pacific Region, with only individual, predisposed trees affected at a few widely distributed locations.

Collections of woodborer infested lodgepole pine, spruce and Douglas-fir bolts were made in the southern half of the Prince George Region as part of a province-wide study to determine the potential for various wood boring insects to vector the nematode. Results of this study will be reported at a later date.

Joint Canada-Sweden lodgepole pine trial

The four existing lodgepole pine trial sites established in 1986 in the Prince George Forest Region were examined by Forestry Canada's Forest Insect and Disease Survey in June and July 1989. The following is a brief summary of conditions found during the survey. The results of the survey in the fifth plot near Whitehorse are summarized in the 1989 FIDS Yukon report 90-7.

At the Fort St. James plot an average of 10% of the foliage on 50% of the lodgepole and Scots pine seedlings suffered some foliar discoloration and browning, likely caused by winter damage(winter flecking/winter drying).

Siberian larch continued to have problems at the Mackenzie plot. About 25% of the larch suffered frost damage, resulting in bushy, stunted form. Approximately 25% of the lodgepole pine had light winter flecking, and some 5% of the lodgepole pine had multiple tops.

There were few problems at the Fort St. John plot. A pine adelgid, Pineus coloradensis, continued to be common on lodgepole pine at this site. Competition from natural pines could be a factor at this location.

The Fort Nelson plot continues to exhibit more problems than the other B.C. locations. Some pockets of Siberian larch suffered top die-back and tree mortality, these problem areas appear to be associated with low, wet spots within the plantation. Two parasitic microfungi, Ascocalyx sp. and Didymella

sp., usually associated with stressed seedlings were found on samples of Siberian larch from this location. Both of these collections represent new host records. An average of 10% of the foliage on 50% of the lodgepole pine suffered foliar discoloration caused by winter flecking.

ALPINE FIR PEST

Western balsam bark beetle-fungus complex
Dryocoetes confusus, Ceratocystis dryocoetidis

Scattered pockets of light to severe mortality of alpine fir caused by this insect/disease complex killed an estimated 31 200 trees over 3900 ha of high-elevation balsam stands up from 9950 trees over 1225 ha in 1988. Damage occurred throughout the region, with the largest areas at Moose Lake near McBride and Takla Lake near Fort St. James. The reported increase is due to expanded aerial surveys, and increased beetle activity. Balsam bark beetle is a chronic problem and mortality is expected to continue in 1990.

DOUGLAS-FIR PEST

Douglas-fir beetle
Dendroctonus pseudotsugae

Douglas-fir bark beetle killed approximately 500 Douglas-fir over 113 ha in 1989, an increase from 250 trees over 90 ha in 1988. Mortality occurred in 200 small, scattered patches over the southwestern portion of the Prince George District, and in the Fort St. James District.

Patches of 1 to 20 trees were mapped along the Blackwater River from Naltesby Lake to the Fraser River, including TFL 5, the Bobtail-Pelican Road junction, west of Gregg Creek and the Butcher Flats to Chilako River area. Douglas-fir beetle has been active in the southern part of the Prince George Region for several years. The B.C. Forest Service continued to use trap trees and logging of selected sites to combat this pest.

Along Stuart Lake northwest of Ft. St. James three scattered pockets were mapped along the east side of the lake. Light populations have been active near Stuart Lake for the past three years.

Further surveys and monitoring of populations will continue in 1990.

MULTIPLE HOST PESTS

Black army cutworm
Actebia fennica

Black army cutworm populations decreased in 1989, no defoliation of conifer seedlings or herbaceous material was recorded. In 1988 scattered light to severe damage occurred throughout the region. Pheromone traps placed at various locations in 1988 indicated low populations for most areas in 1989.

Multipher pheromone traps placed at each of 15 one-year-old prescribed burns from the Weedon Lake area south to Stoney Lake caught an average of 84 (range 0-352) adults. These figures indicate low populations (500+ moths per trap indicates potential for significant damage). The highest number of adults were caught near Weedon Lake, the same area where high numbers of adults were caught in 1988. This may indicate a population build-up in the Weedon Lake area.

The low number of adults caught in traps indicates continued endemic cutworm populations throughout the region in 1990. Monitoring of recently burned sites, as well as reported outbreaks, will continue in 1990.

Winter damage

Light scorching of western red cedar and western hemlock foliage was mapped over 2700 ha along the Torpy River east of Prince George during aerial surveys. Another approximately 10 000+ ha of light scorching was noted during ground surveys throughout the interior Cedar-Hemlock Biogeoclimatic zone from the Bowron-Coal Road near Purden Lake to Goat River west of McBride. The probable cause of the scorching is cold winter temperatures combined with high winds. This is not expected to cause significant damage to the stands.

Damage to white spruce was more severe, buds were frozen above the snow line on sapling-sized to mature white spruce from Red Rock Seed Orchard south of Prince George, to north of the Wonowon area, east to Hungry Creek, and west into the Fort St. James area. Damage was probably caused by high winds along with extremely cold temperatures which occurred throughout the region in late January and early February. An average of 50% (range 30 to 80%) of the buds on an average of 70% (range 10 to 100%) of the white spruce were affected. This may result in multiple leaders, crook and reduced height growth on the more seriously affected trees. Similar damage was recorded on alpine fir throughout this same area and, to a lesser extent, Douglas-fir.

Lodgepole pine in one location north of Fort St. James, and in another area near Brazion Creek southwest of Chetwynd were also damaged, probably by similar weather conditions. The damage consisted of dead foliage and buds at the approximate level of the snow pack during mid-winter. Foliage in the affected portion of the tree had turned red by early summer. About half of the young trees in these two areas were affected.

Further surveys will be carried out in 1990 to determine the extent, severity and effect of the damage.

Acid Rain National Early Warning System (ARNEWS)

The Acid Rain Early Warning System (ARNEWS) plot near Averil Lake, northwest of Prince George, was visited twice in 1989. No symptoms typical of acid rain damage were recorded but trace damage caused by Phaeocryptopus nudus occurred on alpine fir, and trace winter flecking was found on white spruce.

This plot is part of a national system to gather baseline data on the possible effects on the forest of acid rain. The data will be used to quantify changes to the forests by monitoring soil, vegetation and trees that may be affected by acidification of precipitation, fog, clouds or by other atmospheric

pollutants. Monitoring will continue at this plot and fourteen others in British Columbia in 1990.

Animal Damage

Porcupine (Erethizon dorsatum) caused damage was mapped over 43 ha at 13 widely scattered locations throughout the region in 1989; this is a small increase from 14 ha at 7 areas in 1988. Damage, consisting of basal and upper bole and branch girdling, is common on all age classes of trees, particularly lodgepole pine; however, similar damage can occur on spruce. Porcupine damage was also noted in one 20-year-old stand east of Fort St. James, where 10% of the lodgepole pine were top-killed. Occasional scattered lodgepole pine damage occurs throughout the region and is expected to continue in 1990.

Rodent damage, mainly in the form of chewing on galls and cankers formed by various tree rusts, was found in several young lodgepole pine stands in the region. An average of 15% of the trees (range 1-60%) in seven young stands were affected. In one young stand south of Dawson Creek, hares were suspected as the causal agent which clipped terminal and lateral buds on 60% of seedlings surveyed, causing stunted, bushy form.

Damage, in the form of browsing by deer and moose is also common in some young stands in the region. This usually causes some bushy or multiple tops, and sometimes poor form.

DECIDUOUS TREE PESTS

Forest tent caterpillar
Malacosoma disstria

The area of mainly trembling aspen defoliated by the forest tent caterpillar in the region more than doubled to 108 290 ha in 1989 from 48 315 ha in 1988. This is the fourth consecutive year of increased defoliation in the Prince George area where 103 225 ha were defoliated in 1989. Defoliation has been recorded in the Peace River area for six consecutive years although the infestation has been declining for the past three years, and 4805 ha were defoliated in 1989. Defoliation was also recorded in the McBride District, some 260 ha were mapped along Castle Creek and the Fraser River near McBride, the first recorded defoliation in this area since 1978.

In the Prince George area, defoliation was recorded from Eaglet Lake west towards the Isle Pierre area, and from the south end of Mcleod Lake to south of Buckhorn Lake, including areas within the city of Prince George. The major part of the infestation continued to be centered in the Salmon Valley area. Mixed and pure aspen stands were completely defoliated throughout the deciduous belt north of Prince George, including several kilometers along Highway 97 north of Prince George. In the Peace River area, defoliation was once again recorded in the Farmington and Pouce Coupe areas, with defoliation also occurring south to the Tomslake area.

A total of 15 mass collections of forest tent caterpillar larvae were made throughout the Prince George area in June. Parasitism levels, which averaged less than one percent in these samples, should not affect populations

next year.

The large increase in forest tent caterpillar populations in the Prince George area, and the continued infestation in the Peace River country was predicted by FIDS following egg mass surveys in the fall of 1988. Egg mass surveys completed in the fall of 1989 indicate continuing high populations with resulting widespread moderate to severe defoliation in the Prince George area in 1990. An average of 38 new egg masses (range 14-105) per 10 cm dbh trees were found during egg mass surveys in September 1989 (Table 5). Counts greater than 10 egg masses usually result in severe defoliation. Defoliation will likely continue in the same areas defoliated in 1989, with populations increasing in the southern part of the infestation, while declining slightly in the northern areas. Defoliation of ornamental and shade trees will likely occur again in the city of Prince George. The infestation near Dawson Creek is predicted to continue, at reduced levels, in 1990.

The Forest Insect and Disease Survey will continue to monitor forest tent caterpillar populations in 1990, and issue pest updates on the population status early in the 1990 field season.

Table 5. TSA, location, dbh, number of new and old egg masses of forest tent caterpillar and predicted 1990 defoliation, Prince George Forest Region, 1989.

TSA and location	Ave. dbh (cm)	Ave. no. egg masses/tree new	old	Predicted[1] defoliation 1990	Ratio	Population Status
PRINCE GEORGE TSA						
Hwy 97 N of Salmon R.	12	43	51	severe	1:1	Static
McBride Forest Rd. (W. of Chilako R.)	10	30	33	severe	1:1	Static
Eaglet Lake	12	105	13	severe	8:1	Increasing
Hospital Cr. (Willow R. North)	12	40	5	severe	8:1	Increasing
Tabor Mountain	10	15	8	severe	2:1	Increasing
Airport Hill	10	27	13	severe	2:1	Increasing
Cranbrook Hill (S)	8	41	5	severe	8:1	Increasing
Hoodoo Lakes	12	21	19	severe	1:1	Static
Jct. Chief and Ness L. Roads	10	14	34	severe	1:2	Decreasing
5 Km., Salmon Forest Road	13	17	27	severe	1:2	Decreasing
Homestead Road, Hart Highlands	10	66	43	severe	2:1	Increasing
AVERAGE	11	38	23	severe	2:1	Increasing
PEACE RIVER TSA						
Pouce Coupe	12	9	8	moderate	1:1	Static
6.5 km S. of Farmington	12	11	30	moderate	1:3	Decreasing
AVERAGE	12	10	19	moderate	1:2	Decreasing

[1]Based on a model developed by Hildahl and Campbell at the Northern Forestry Centre, Edmonton, Alberta, May 1975.

Aspen decay

Decay was present in 90% of trembling aspen stands surveyed in the Prince George Region in 1989. White trunk rot, caused by Phellinus tremulae (=Fomes ignarius) was the most common decay encountered in ten stands surveyed from the Blueberry River near Wonowon to the Stoney Lake area, east of Hixon. A core sample taken from each of ten trees per site showed an average of 55% (range 0-100) of all trees with some level of decay. An average of 26% (range 0-88) of the radius of the trees at breast height were affected by decay (Table 6).

Table 6. Summary of trembling aspen decay survey, Prince George Region, 1989.

	Number of cores			Percent	Average percent of core (at dbh)		Average	
	stained	decayed	healthy	of trees decayed	stained	decayed (range)	dbh (cm)	height (m)
Prince George TSA								
Salmon Forest Road*	7	5	1	50	36	43(11-88)	23	12
Hoodoo Lakes*	8	6	0	60	19	22(9-60)	25	17
Blackwater River	4	4	4	40	25	39(15-76)	28	22
West Lake	4	2	4	20	59	16(11-20)	18	20
Dawson Creek TSA								
Taylor*	6	7	1	70	25	31(13-48)	24	16
Farmington*	8	8	0	80	22	32(13-63)	23	13
Pouce Coupe*	10	7	0	70	40	14(5-31)	21	16
Fisher Creek	10	8	0	80	37	31(6-56)	27	21
Fort St. John TSA								
Blueberry River	6	10	0	100	31	30(6-68)	22	15
Charlie Lake	7	0	3	0	16	0	18	13
Average percent	70	57	13	55	31	26(0-88)	23	17

*Stands with 2 to 4 years tent caterpillar defoliation.

Five of the stands surveyed had 2 to 4 years of consecutive defoliation by the forest tent caterpillar, Malacosoma disstria. There appears to be some correlation between increased levels of stain and decay and decreased height growth in tent caterpillar damaged stands. Although not statistically based, trees with a history of defoliation seemed to have more stain and decay and reduced height growth.

The Forest Insect and Disease Survey will continue to monitor the occurrence of pests in trembling aspen forests, particularly in light of the increasing importance of this tree species in the Prince George Region.

Gypsy moth
Lymantria dispar

Gypsy moth pheromone traps were placed at 45 locations by FIDS in the Prince George Forest Region as part of a continuing interagency monitoring program. Traps were placed at provincial parks, rest areas and private campgrounds; no moths were caught in any of the traps. A program of trapping and egg mass surveys is carried out by Forestry Canada and the B.C. Forest Service in cooperation with Agriculture Canada to detect the establishment of this potentially serious pest.

PESTS OF YOUNG STANDS

A total of 28 planted and natural 1- to 20-year-old stands between one and twenty years old were surveyed for pest problems in 1989. The most frequently occurring pests are summarized in Table 7. A detailed description of individual stands is available upon request (Appendix IV).

The most damaging pests encountered were the Cronartium stem rusts, *C. coleosporioides* and *C. commandrae*. Although these rusts were found in only two stands surveyed in the Salmon River area, the damage caused was significant; an average 9% of young lodgepole pine stems were killed and an average of 6% of trees had stem cankers, which will probably result in mortality.

Table 7. Summary of pests of young stands, Prince George Region, 1989.

Host	Stands[1] examined	Pest	No. of stands affected	Percent of trees affected: Average	Percent of trees affected: Range	Remarks
Lodgepole pine	20	*Endocronartium harknessii*	6	7	1-19	causing stem and branch galls
		winter flecking	6	52	10-100	generally light, on older needles
		rodent damage	6	15	1-60	leader clipping, feeding on rust cankers
		poor form	5	5	1-13	crooked, forked stems, bushy tops possibly frost or browse related
		Cronartium sp. rust	2	12	6-17	killing 8% of trees in two stands, 15% of trees in two stands with stem cankers
White spruce	9	environmental damage	7	39	6-82	dead terminal and lateral buds, killed by extreme temperatures and wind. No damage below snow level
		poor form	5	6	1-12	bushy, multiple tops, possibly caused by browse or environmental damage
Douglas-fir	1	*Adelges cooleyi*	1	47	_	generally light infestations
		frost	1	16	_	light damage

[1]Number of surveyed stands in which tree species comprised >20% of stand

The most common pest in young lodgepole pine stands was western gall rust, Endocronartium harknessii, which mainly formed branch galls on an average of 7% of the trees in 21% of stands surveyed. This disease frequently kills branches and can girdle stems, killing trees or weakening and predisposing them to wind or snow damage. Rodent damage, which also occurred in 21% of stands surveyed, was mainly associated with feeding on branch and stem galls caused by various rusts. Some of the rodent damage involved clipping of tender young shoots from recently planted seedlings. Other significant pests of lodgepole pine were Warren's root collar weevil, Hylobius warreni, affecting one percent of the trees in three areas, the lodgepole pine terminal weevil, Pissodes terminals, which damaged an average of two percent of the trees in two areas,and environmental damage, which affected an average of 20% of the trees in four areas surveyed.

Environmental damage was the most common problem in spruce stands, occurring in 67% of stands surveyed. Poor form, spruce weevil, Pissodes strobi and adelgids, Adelges cooleyi and Pineus similis were also common in spruce stands.

The cooley spruce-gall adelgid, Adelges cooleyi, along with frost damage were the most common pests in young Douglas-fir stands.

As further emphasis is placed on intensive management, interest in pests of young stands and their impact will grow. FIDS will continue to monitor young stands in the Prince George Region in 1990.

OTHER NOTEWORTHY AND MINOR PESTS

Table 8. Other noteworthy and minor pests.

Host and Pest	Location	Remarks
White Spruce		
An adelgid Pineus?similis	Brazion Creek, Manson River	common on young spruce low incidence and intensity
Blackheaded budworm Acleris gloverana	Red Pass	2 larvae collected in a three-tree beating
Cooley spruce gall aphid Adelges cooleyi	Prince George Forest Region	common and widespread in the region
Pineleaf adelgid Pineus pinifoliae	Red Pass	endemic population
Redstriped needleworm Epinotia radicana	Kittle Creek	light bud mining below the snowline on 10% of spruce saplings over 100 ha

Host and Pest	Location	Remarks
Lodgepole Pine		
A die-back fungus, *Apostrasseria sp.*	Peculiar Lake	causing seedling mortality A new host record.
Gouty pitch midge *Cecidomyia piniiopsis*	Hyman Creek, Salmon River, Nation Bay	1% of the trees infected causing crooks in branches
Lammas growth	Fraser Lake, Prince George	5% of the seedling lP planted in 1985 have a profusion of branches
A needlecast fungus, *Hendersonia pinicola*	Goat River	causing a secondary needle disease
A needlecast fungus, *Lophodermella concolor*	202 km Bobtail Forest Service Road	needle discoloration, no significant damage
A needlecast fungus, *Lophodermella montivega*	Muncho Lake	20% of the foliage infected on all the young trees
Pine-aster rust *Coleosporium asterum*	202 km Bobtail Road Doc's Creek	no significant damage, 5% of the young trees have infected lower crowns
Scleroderris canker *Gremmeniella abietina*	Prince George Forest Region	surveys in four stands were negative
Alpine Fir		
Armillaria root rot *Armillaria sp.*	14 km east of Canoe	20% of the young growth infected
Confer willow rust *Melampsora abieti-capraearum*	Purden L.	light infection of foliage
Fir-fireweed rust *Pucciniastrum epilobii*	33 km Holmes River Road, Manson River, Gagnon Creek	light infection of foliage on residual trees
A needle fungus *Phaeocryptopus nudus*	Gagnon Cr.	light infections on residual trees
A needle rust *Uredinopsis sp.*	33 km Holmes River Road	endemic infection

Host and Pest	Location	Remarks
Smoky moth Lexis bicolor	Albreda	this lichen feeder was sampled in a three tree beating
A tip-blight fungus Potebniamyces sp.	Crooked River	20% of the foliage on all trees infected from Summit L. to McLeod L.
Larch		
Larch sawfly Pristiphora erichsoni	Prince George	trace defoliation on ornamentals in the City
Black Cottonwood		
Poplar leaf rolling sawfly Phyllocolpa bozemani	Bowron-Tumuch area	half the foliage on 90% of the trees were affected over 5 ha
Ugly nest caterpillar Archips cerasivoranus	Hart Highway west of Chetwynd	severely defoliated occasional roadside trees
Elm		
Elm leafminer Agromyza aristata	Prince George "Miller Creek addition"	fourth consecutive year, 65% of the foliage on all ornamental elms were mined
White Birch		
Ambermarked birch leafminer Profenusa thomsoni	Prince George	common but little damage
Willow		
Pacific willow leaf beetle Pyrrhalta decora carbo	110-190 km Alaska Highway	common, causing patchy, light defoliation
Spotted tussock moth Lophocampa maculata agassizii	Liard Highway	larvae common, causing light damage
A willow rust Melampsora epitea complex	Francois Lake	little infection of foliage
No Host		
Compton tortoise-shell butterfly Nymphalis vau-album	Mackenzie	adults common throughout the area in early August