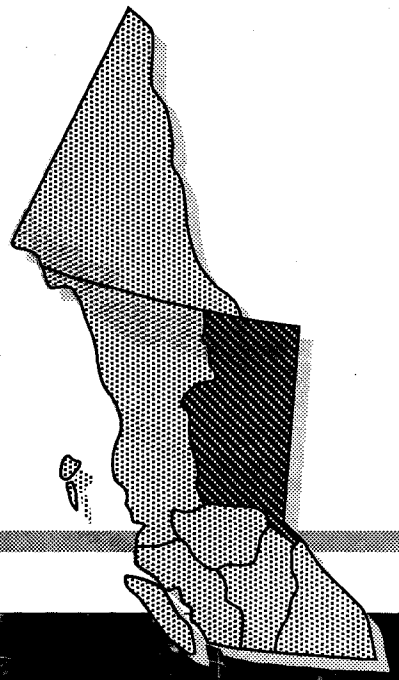
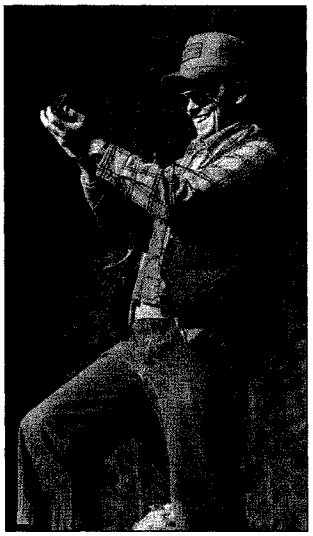
FIDS Report 94-4

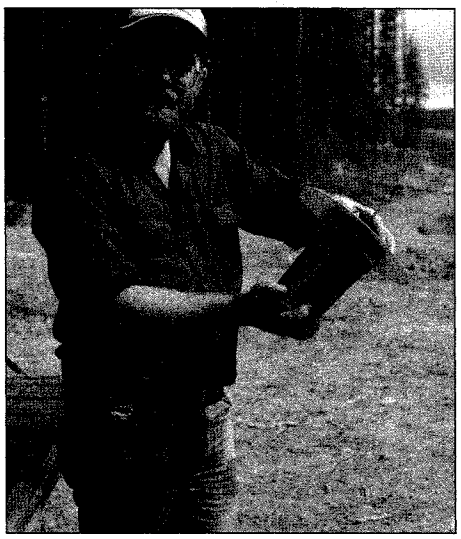


Forest Insect and Disease Conditions

Prince George Forest Region • 1993

Nick Humphreys and Bob Ferris





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Contents

Foreword

Forest Insect and Disease Survey (FIDS) is a nation-wide network within Forestry Canada with the responsibility of: (1) producing an overview of forest pest conditions and their implications, including predictions where possible; (2) maintaining records and surveys to support quarantines; (3) supporting forestry research with field studies, records and Herbarium and Insectary collections; (4) providing advice and extension on forest insect and disease conditions; (5) developing and testing survey techniques; (6) and conducting related biological and impact studies.

Correspondence and inquiries with respect to forest pest problems, and requests for publications can be directed to:

from: October to May

Pacific Forestry Centre
Canadian Forest Service
506 West Burnside Road
Victoria, B.C.
V8Z 1M5 Ph. 363-0600

from: June to September

Forest Insect and Disease Survey
Canadian Forest Service
R.R. 8, Site 25, Compartment 8,
Prince George, B.C.
V2N 4M6 Ph. 963-2213
963-2212

Definitions

During aerial surveys, bark beetle and defoliator damage has been quantified within damage classes and reference to these classes appear intermittently throughout the report:

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

Aerial survey defoliation classes:

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

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

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

In tables the common names of trees are abbreviated to nationally used conventions; in alphabetical they are:

aL - alder
alF - alpine fir
bCo - black cottonwood
bS - black spruce
DF - Douglas-fir

lP - lodgepole pine
tA - trembling aspen
sA - Sitka alder
W - willow
wB - white birch
wH - western hemlock
wrC - western red cedar

Final copies of infestation maps produced during aerial surveys were digitized into the FIDS in-house geographical information system (GIS). Computer-generated copies of these maps were sent to various co-operators and are available by request through FIDS.

TSA boundaries for the Prince George Forest Region have been included in Appendix III.

Introduction

This report summarizes the findings of two Forest Insect and Disease Survey (FIDS) technicians during summer and fall field studies in the Prince George Forest Region in 1993. 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 surveying of 49 young stands 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 25 to October 1 during which over 125 insect and disease collections were sent to the Pacific Forestry Centre (PFC) for identification or confirmation (Figure 1). Some of these were added to the extensive permanent collections in the PFC Insectary and Herbarium.

The British Columbia Forest Service provided approximately 36 hours of fixed-wing and 15 hours of helicopter time, for aerial and aerially accessed ground surveys during the 1993 season (Figure 1).

Summary of Pest Conditions

The area of **spruce beetle**-killed trees decreased after four consecutive years of increase with cumulative mortality of more than 1 220 000 m^3 over 50 000 ha, from southeast of Prince George to north of Fort Nelson. The majority of the dead trees, 47 000 ha, were recorded in the Mackenzie and Dawson Creek Forest districts. **Eastern spruce budworm** defoliation of spruce and fir increased to 169 500 ha in the Fort Nelson and Fort St. John forest districts after two years of decline. Defoliation by mature **two-year-cycle spruce budworm** decreased slightly to 97 000 ha in the Mackenzie and Fort St. James forest districts.

Lodgepole pine mortality due to 1992 **mountain pine beetle** attacks almost doubled to 521 000 m^3 over more than 12 000 ha. Most of the mortality was in the Fort St. James Forest District with over 11 000 ha recorded. The incidence of **pine needle cast** was much less widespread in the southern half of the region in 1993.

The recorded area containing mature alpine fir killed by **balsam bark beetle** mostly in the Fort St. James Forest District decreased to 30 000 ha. **Drought** caused alpine fir tree mortality occurred throughout the Prince George Forest District in 1993.

Tree mortality due to attacks by the **Douglas-fir beetle** increased for the eighth consecutive year to 3 600 ha.

Surveys of 49 young stands at widespread locations found a variety of diseases and insects. The most common of these were **stem rusts, spruce weevil** and **adelgids**. **Pinewood nematode** surveys were discontinued in 1993 in the Prince George Forest Region but could continue next year. **Environmental damage** and **stem rusts** were common at four lodgepole pine plantations established in 1986 in a joint **Canada-Sweden project**. Pest

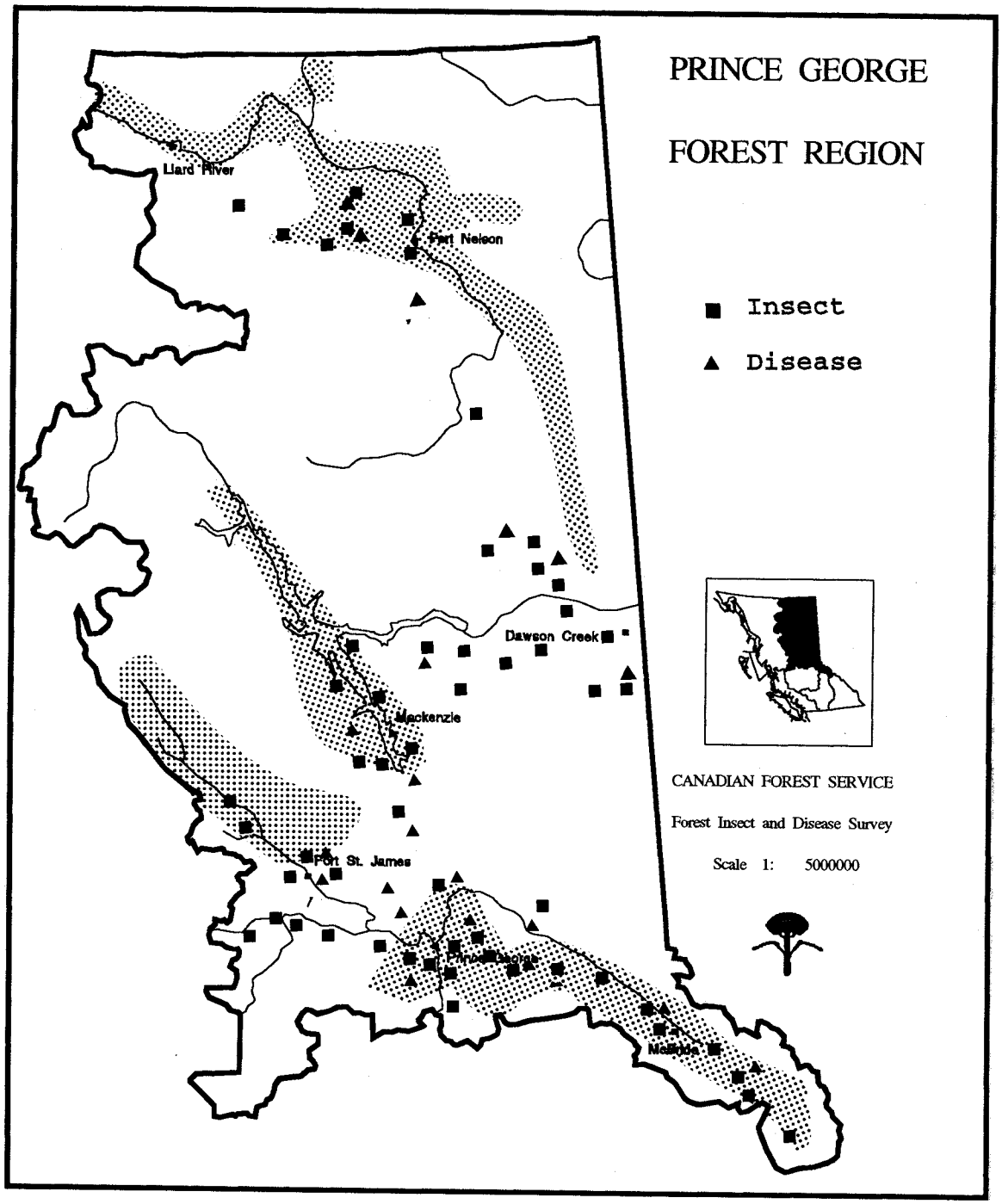

Figure 1. Location where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1993.

surveys were initiated in the **McGregor Model Forest**. **Spruce weevil** populations were monitored in 15 stands throughout the region in the first year of a cooperative project between the BCFS and the Canadian Forest Service. An estimated average 13% of the white spruce were currently attacked by the spruce leader weevil. Three new and one old **bio-monitoring plot** were examined for changes to forest trees, ground vegetation, and soils that might result from acidification of precipitation.

Defoliation of mature to overmature western hemlock and western redcedar by the **western hemlock looper** increased to over 43 000 ha up from 28 000 ha in 1992. More than 70% of the defoliation occurred in the Prince George Forest District with the remainder in the McBride Forest District. **Black army cutworm** populations continued to cause light defoliation of recent plantations in the Prince George Forest Region. **Rusty tussock moth** populations collapsed as predicted and no defoliation was recorded.

Forest tent caterpillar defoliation increased to 40 000 ha in stands dominated by trembling aspen. **Large aspen tortrix** populations decreased after four consecutive years of increase, defoliating trembling aspen over approximately 6 000 ha. No adult male **gypsy moths** were trapped in 55 pheromone-baited traps placed in provincial parks, rest areas and private campgrounds. Widespread willow mortality caused by the **poplar-and-willow borer** increased to the highest levels ever noted in the Prince George Forest Region.

A table summarizing **other noteworthy pests** is included in this report.

Spruce Pests

Spruce beetle
Dendroctonus rufipennis

British Columbia Forest Service aerial and ground surveys indicate that spruce beetle caused mortality decreased to almost 51 000 ha after four consecutive years of increase (Table 1). The decrease in area occurred mostly in the Dawson Creek Forest District which had reported 50 000 ha of infestation in 1992 but only 6800 ha in 1993 (Figure 2). Decreases in area of attack were also noted in the Mackenzie, Fort Nelson and Fort St. James Forest Districts. Timber loss has been estimated at over 1 200 000 m^3 of recently killed white spruce. Infestations ranged in size from single trees to several thousand hectares.

Forest Service and forest industry personnel found varying levels of currently attacked trees throughout the infested areas in all districts. If broods remain healthy throughout the winter of 1993-94, continued spruce mortality can be expected in 1994. The life cycle of the beetle broods were a mixture of 1, 2, and 3 years, with two-year-cycle predominating. Broods were generally smaller than in previous years, with numerous strip-attacks and pitch-outs noted during ground surveys.

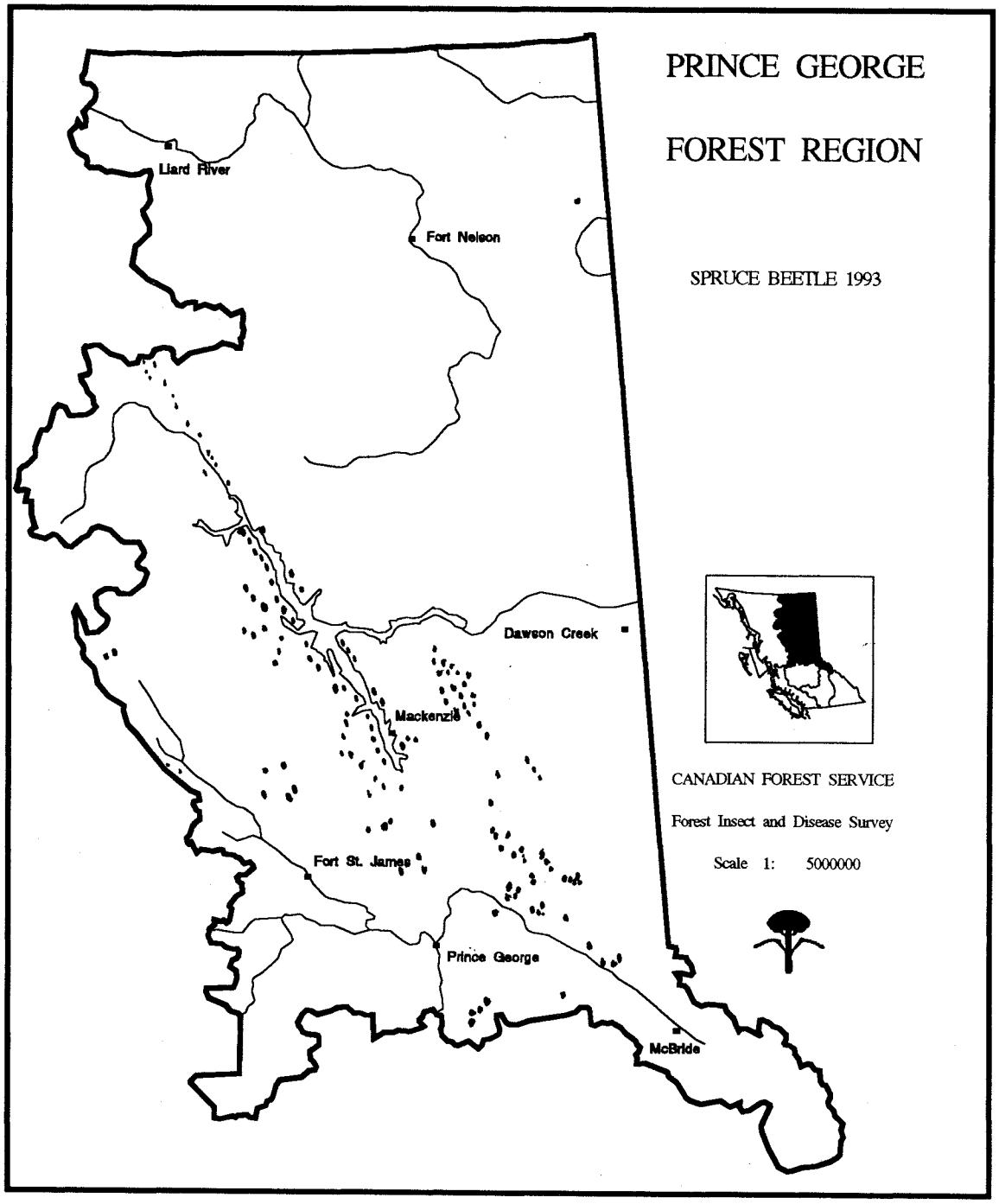

Figure 2. Areas of white spruce killed by spruce beetle determined by aerial and ground surveys in 1993.

Table 1. Timber supply area (TSA), cumulative area and volume of white spruce recently killed by spruce beetle, Prince George Forest Region, 1992 - 93.

TSA	Area (ha)		Volume (m^3)	
	1993	1992	**1993**	1992
Mackenzie	**40 900**	40 000	**1 036 000**	1 230 000
Dawson Creek	**6 800**	49 900	**94 000**	690 000
Prince George	**2 850**	9 620	**88 000**	247 000
McBride	**190**	40	**3 000**	600
Fort Nelson	*	5 900	*	82 000
Fort St. John	*	*	*	*
Regional totals	**50 740**	105 460	**1 221 000**	2 249 600

* No figures available

Mackenzie TSA

Spruce beetle caused mortality of white spruce remained static in 1993 with just over 40 000 ha of attack mapped by the BCFS over the same geographic area as in 1992. These figures will decrease somewhat when ground survey data is analyzed in early 1994. Extensive spruce beetle probes were undertaken by BCFS contractors in the summer and fall of 1993. The information from the probes will eliminate some areas that were aerially mapped but for which no beetle attack was found during ground surveys. A corresponding decrease will also occur in the volume loss figures calculated on the original area figures.

Spruce beetle-killed trees were again noted in the Clearwater River drainage northeast of Mackenzie, and in the Ross Factor Creek area south of Ingenika arm. Infestations were mapped from Mischinsinlika Creek in the south to Fox Lake in the north, and east from the junction of the Ominicetla Creek and Omineca River to the Nabeshe River.

Infestations occurred in mixed white spruce and alpine fir stands in the Phillips, Blackwater, and Chunamen creek drainages along the eastside of Williston Lake south of Omineca Arm. Infestations continued near the northeast end of Williston Lake along the Ospika, Finaly, and Messilinka rivers, between Mt. Ross and Omineca Arm, and between Collins Bay and Tobin Lake on the westside of the lake.

Dawson Creek TSA

A more precise BCFS aerial survey in this TSA resulted in a decrease in the estimated area of beetle infestation from the 50 000 ha mapped in 1992 to approximately 6 800 ha this year. Recalculation of area figures from additional ground survey data will adjust area figures for the Dawson Creek TSA. As beetle probe data becomes available, non-infested polygons will be eliminated from aerial survey maps.

Infestations continued in basically the same areas as 1992, between the Rocky Mountains and the foothills south of the western arm of Williston Lake and north of the Hart Highway. Infestations were noted in the following drainages; Eleven Mile, Carbon, McNairn, Doonan, Silver Sands, Little Boulder, Big Boulder, Peck, Callazon, Upper Moberly and Fisher creeks. Mortality was also mapped south of the Hart Highway along the eastern slopes of the Murray Range in the Mountain Creek, Sukunka and Burnt River drainages south to Windfall, Imperial, Red Deer and Wolverine creeks to Hook Lake.

Prince George TSA

The area of spruce beetle infested white spruce decreased by 70% in the Prince George TSA to 2850 ha in 1993. Light mortality was recorded over 1120 ha and moderate over 1730 ha. Mortality in the Prince George Forest District decreased to 1620 ha and in the Fort St. James Forest District to 1230 ha.

The largest infestations in the Prince George Forest District were recorded in the McGregor, Parsnip, and Missinka River drainages and along Herrick and Huble creek drainages. Southeast of Prince George scattered patches of attack were noted along the Willow River and Naver and Jerry creeks. Infestations were again noted around Ahbau Lake and Rob and Haggen creeks. In the northern portion of the district, widely scattered attacks were noted around Carp and Summit lakes.

The area of spruce beetle infestations in the Fort St. James Forest District decreased by half to 1230 ha. Over half the area of attack was between Inzana and Hatdudatehl Lakes. Most of the remaining mortality occurred along Sakeniche and Driftwood rivers and around Witch and Bear lakes.

Fort Nelson TSA

No new "faders" were noted in this TSA during aerial surveys. However, helicopter accessed ground surveys in several areas did find scattered current single tree attacks at Kotcho Lake and the Liard River. Lightly scattered old attack was noted over the same areas where widely scattered red attack was noted in 1992. Grey individual spruce trees were scattered over an area bordered by Kotcho Lake, Kotcho River, Shekillie River, and Datchin Creek.

Fort St. John TSA

Scattered individual beetle attacked trees were noted at the edge of a burn in the Graham River drainage.

McBride TSA

Spruce beetle attack increased five-fold to almost 200 ha. Dead spruce trees were noted at three locations near the mouth of Hellroaring Creek. Two infestations were mapped along the Raush River and one along the Holmes River. Ground surveys are continuing in other areas of the TSA to confirm suspected attacks.

General

The B.C. Forest Service has proposed accelerated logging in both standing infested timber and areas of infested blowdown, along with follow up trap tree programs as well as removal of existing trap trees. This will occur over the next few years in order to control beetle populations and thus reduce subsequent mortality.

Eastern spruce budworm
Choristoneura fumiferana

Eastern spruce budworm populations increased after two years of decline in this the tenth year of the current outbreak (Figure 3). The area of recorded white spruce and alpine fir defoliation increased over 20% to 169 500 ha of mainly light feeding in the Fort Nelson and Fort St. John forests districts. In 1992, aerial surveys recorded defoliation over 139 000 ha down from a high of almost 400 000 ha mapped in 1990. Severe defoliation was last reported in 1990 when over 28 000 ha were observed during aerial surveys.

Damage was mapped in many of the same areas as in 1992 in the Fort Nelson and Fort St. John forest districts (Figure 4) from Fort Nelson to the Northwest Territories, west to the Coal River area, and near Liard Hot Springs. The largest area of defoliation was along the Fort Nelson river between Klua Creek and the Snake River. The infestation extended down the Fort Nelson and Fontas rivers into the Fort St. John Forest District where 6000 ha of light defoliation was recorded.

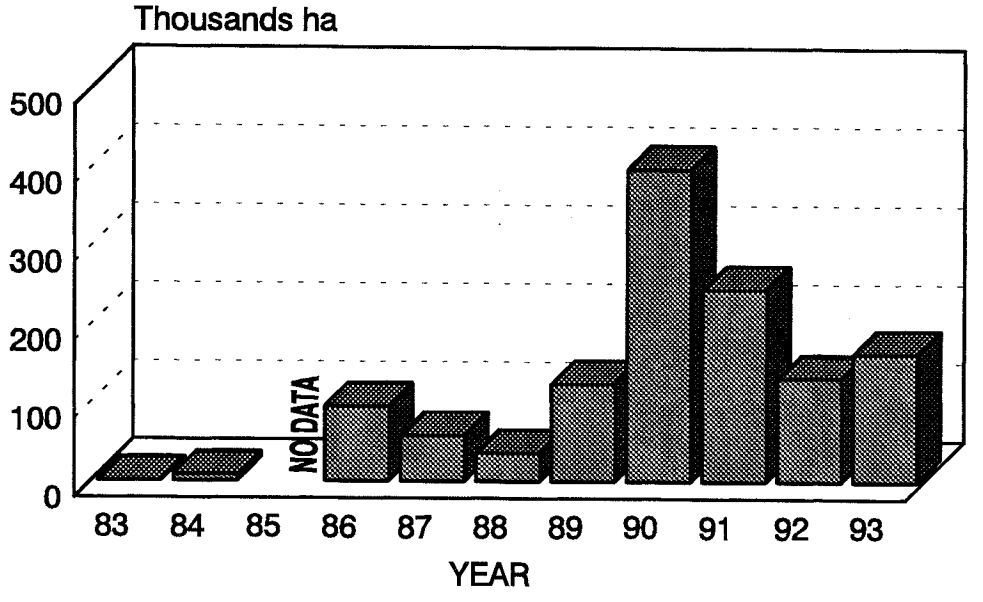

Figure 3. Eastern spruce budworm defoliation (ha) in spruce/balsam stands.

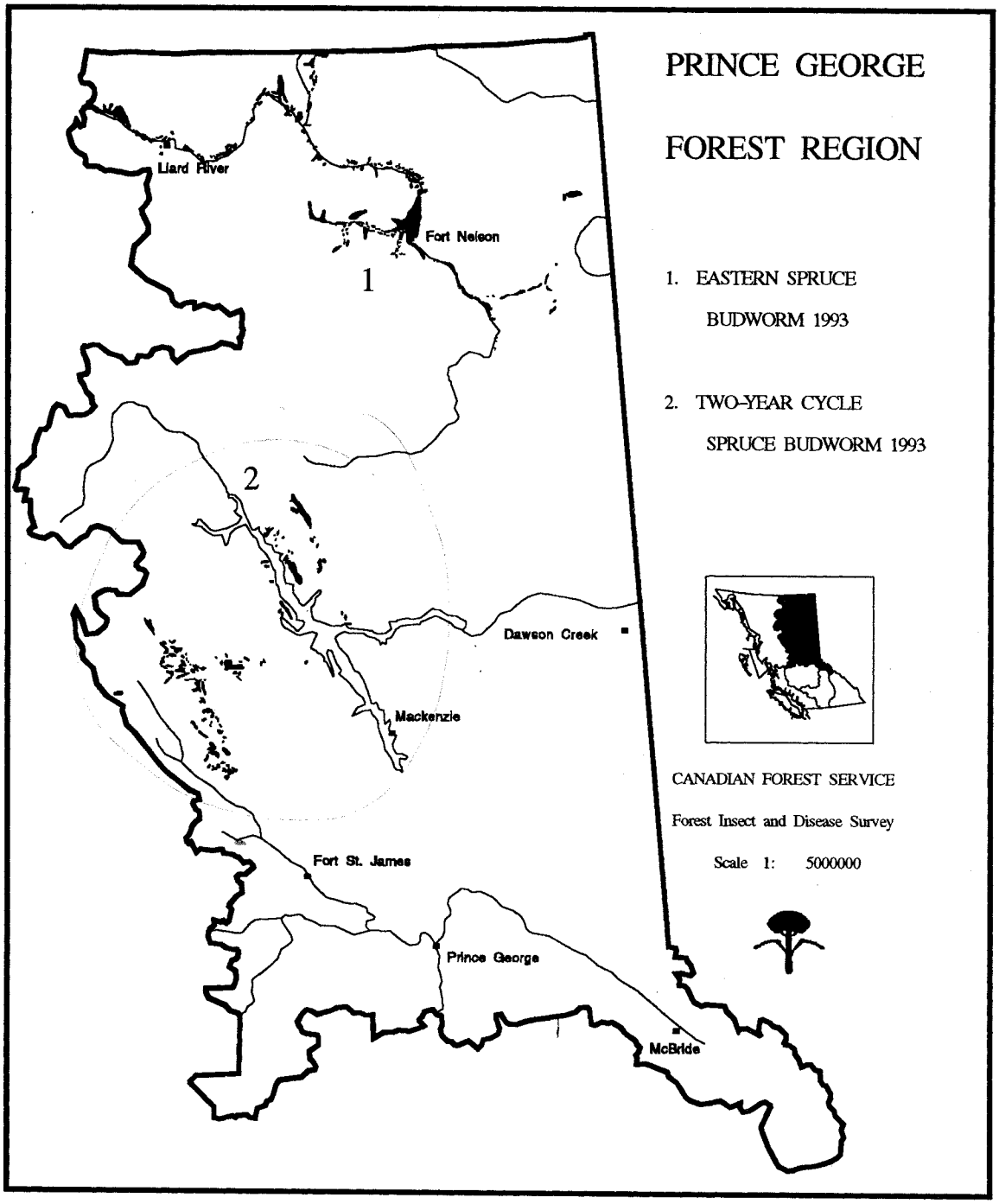

Figure 4. Areas where current defoliation of spruce/balsam stands by eastern spruce budworm and two-year cycle spruce budworm was detected during aerial surveys in 1993.

Spruce and fir foliage were examined for egg masses in order to predict budworm populations for 1994. Through cooperation with the B.C. Forest Service, egg mass samples were obtained from white spruce at three locations; Liard River, and two at the Snake River. The number of egg masses per 10 m^2 of foliage averaged 330, range (230-410), the highest since 1990.

Table 2. The average number of egg masses on white spruce and alpine fir by year and the amount of defoliation the following year, in the Fort Nelson Forest District 1988-93.

Year	Average egg masses per 10 m^2 of foliage	Defoliation the following year Area (ha)			
		Light	Moderate	Severe	**Total**
1988	unknown	41 380	71 070	11 290	**123 740**
1989	1000+	172 285	197 470	28 400	**398 155**
1990	400+	221 000	24 000	-	**245 000**
1991	230	132 000	-	-	**132 000**
1992	290	128 850	34 670	-	**163 520**
1993	330		defoliation in 1994		

The numbers in Table 2 cannot be used for accurate predictive purposes as the egg mass sampling method was calibrated for western spruce budworm, *C. occidentalis,* rather than eastern spruce budworm. However, based on previous years data the numbers suggest static or slightly increasing population causing only light defoliation for 1994. Light defoliation over a reduced area was recorded in 1991 after 400 egg masses were collected the previous year. Populations continued to decline in 1992 after an average 230 egg masses were found and a small increase in 1993 after 290 egg masses were recorded.

Two-year-cycle spruce budworm
Choristoneura biennis

Two-year-cycle spruce budworm, defoliated spruce-balsam stands over 97 000 ha, down from 104 000 ha in 1992 (Figure 4). Mostly light defoliation was mapped over 46 000 ha in the Mackenzie Forest District and 51 000 ha in the Fort St. James Forest District. The last feeding year by mature larvae occurred in these districts in 1991. Defoliation in 1992 occurred mainly in the Prince George and McBride forest districts.

Locations

In the Fort St. James Forest District defoliated stands were recorded from Kloch Lake in the south to Ferriston Creek, a tributary of the Omineca River in the north. The largest areas of infestation occurred along Silver, Fall, Ogden and Ominicetla creeks, and around Purvis, Tchentlo, Takatoot and Airline lakes. In the eastern portion of the region defoliation was noted at Ankwill Creek in the same area as in 1991.

Budworm feeding was recorded in the Mackenzie Forest District from Germansen Landing in the southwest to the Ospika River drainage in the northeast. The largest areas of infestation were along the Ospika River, between Davis and Jafferty creeks, northwest of Omineca Arm and along the Omineca River east of Germansen Landing.

The area of defoliation was probably greater than recorded in both Forest Districts due to the difficulty of observing light feeding from the air, also the red foliage was more prevalent in early June just after feeding finished, than in August when aerial surveys were completed. At several locations where no defoliation could be seen on mature trees from the air, extensive feeding had occurred on the understory trees.

Impact

The greatest impact will probably be on immature understory white spruce and alpine fir. Complete defoliation of 1-5 m trees was noted at Airline and Kloch lakes and near Germansen Landing, probably resulting in scattered mortality. The impact of budworm feeding on mature trees should be low this year as only 7 000 ha was classified as moderate defoliation with the remaining almost 90 000 ha designated light. Growth loss especially in the areas of moderate feeding around Airline Lakes and Fall Creek in the Fort St. James District is expected to be the main impact. Occasional scattered top-kill and branch dieback may also occur.

Previous studies indicate that incremental growth can be reduced by over 75% when severe defoliation has occurred. When severe defoliation occurs for several successive years, the added stress could predispose the large diameter spruce trees to beetle attack.

Forecast

Mass collections of budworm larvae and pupae reared by Insectary staff at the Pacific Forestry Centre determined less than 6% to be parasitized or diseased. Two-year-cycle budworm egg mass counts have not proven to be successful in predicting population fluctuations, unlike the fairly accurate predictions that can be made from western spruce budworm egg masses. The percentage of infested buds in 1994 would probably give a good indication of population levels expected in 1995, though inaccessibility will limit the coverage of this type of survey. Next year will be the feeding year for the immature larvae and defoliation will be greatly reduced from this year. This year, an odd year, is considered to be the major feeding of the "off-cycle" budworm north of latitude 54°30'. The two-year-cycle budworm defoliation recorded in 1992 an even year is classified as "on-cycle" budworm.

The Forest Insect and Disease Survey (FIDS) will continue to monitor the two-year-cycle budworm through larval sampling, bud counts and aerial surveys.

Pine Pests

Mountain pine beetle
Dendroctonus ponderosae

The area of recorded lodgepole pine mortality due to attacks by the mountain pine beetle increased to over 12 000 ha from over 8 000 ha in 1992 (Figure 5).

Again over ninety percent of beetle caused mortality occurred in areas of chronic infestation in the Fort St. James Forest District in the Prince George TSA (Figure 6). The area of attack increased to 11 000 ha from 8100 ha and the volume of trees killed increased to 470 000 m^3 (Table 3). The most dramatic increase was in the Vanderhoof District where 500 ha of attack was recorded, up from only scattered individual attacks in 1992. In the McBride Forest District area of mortality increased to 400 ha from 150 ha and volume was estimated at 30 000 m^3. Mortality doubled in the Prince George Forest District to over 400 ha.

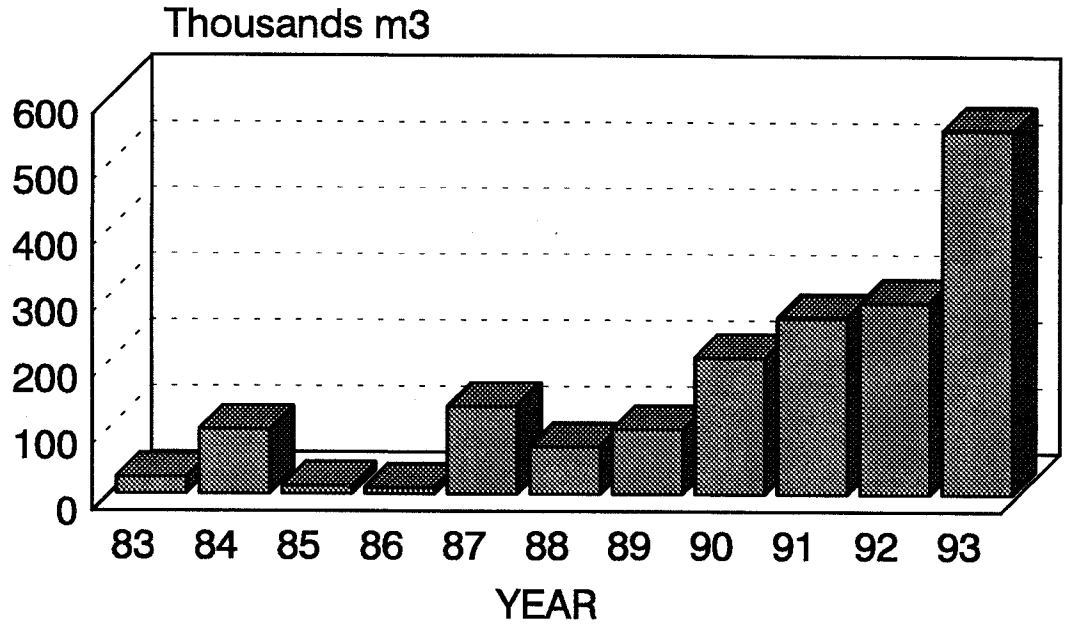

Figure 5. Lodgepole pine volume loss (m^3) caused by mountain pine beetle.

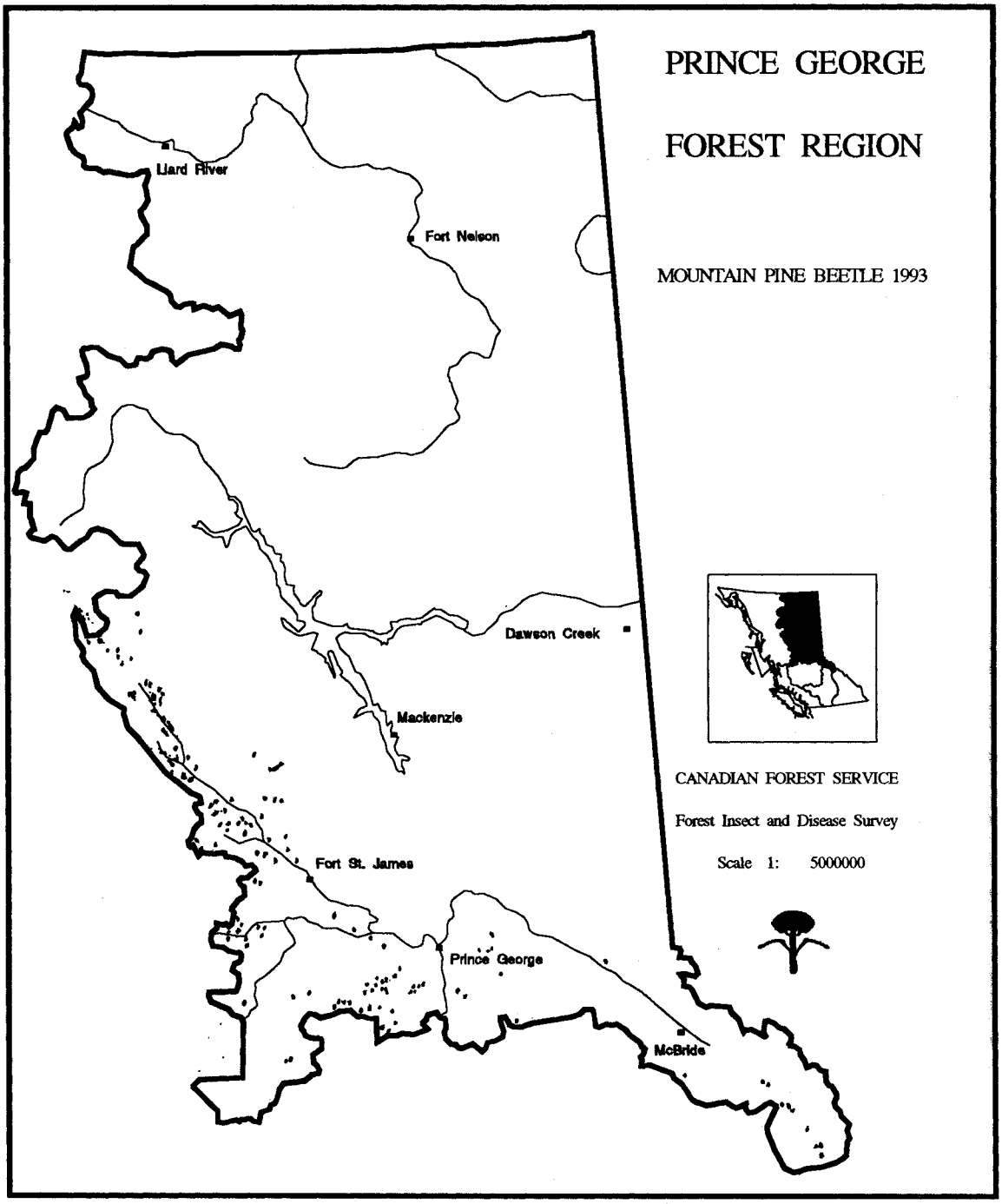

Figure 6. Areas of lodgepole pine killed by mountain pine beetle determined by aerial and ground surveys in 1993.

Table 3. Timber supply area (TSA), forest district, area and volume of lodgepole pine recently killed by mountain pine beetle 1992-93, Prince George Region, 1993.

TSA and Forest District	Area (ha)		Volume (m^3)	
	1993	1992	**1993**	1992
PRINCE GEORGE				
Fort St. James	**11 300**	8100	**470 000**	272 000
Vanderhoof	**500**	0	**25 000**	0
Prince George	**410**	180	**21 000**	10 000
TSA Total	**12 210**	8280	**516 000**	282 000
McBRIDE				
McBride	**400**	150	**30 000**	11 000
TSA Total	**400**	150	**30 000**	11 000
Regional Total	**12 610**	8430	**546 000**	293 000

Fort St. James Forest District

The area of recently killed lodgepole pine increased to over 11 000 ha from 8100 ha in 1992, 8900 ha in 1991, and 7750 ha in 1990. Light mortality was mapped over 1000 ha, moderate over 8400 ha, and severe over 1900 ha. The majority of dead trees were mapped in approximately the same areas as last year. The major areas of increase were in the Takla Lake area; along Bivouac, Hudson Bay and Ankwill creeks in the Driftwood River drainage, around Lovell Cove and Takla Landing. Mortality continued at approximately the same levels within Tree Farm Licence (TFL) 42.

Vanderhoof Forest District

According to BCFS aerial and ground surveys mountain pine beetle populations increased this year to an estimated 500 ha. Infestations expanded to areas over 100 ha from scattered 1-20 tree attacks in 1992. The majority of the attack is in the Bobtail Forest Service Road area near the Prince George Forest District boundary, bordered by the Chilako River and Naltesby and Cluculz lakes. Scattered attacks have again shown up in areas of chronic infestation southeast of Francois, Fraser and Natalkuz lakes. Mild winters over the last two years have allowed endemic populations to expand into mature susceptible pine stands throughout the District. Sanitation and salvage logging in conjunction with pheromone baiting and cut and burn projects will be required to control further spread of the beetle.

Prince George Forest District

Lodgepole pine mortality has increased for the fourth consecutive year in the Prince George Forest District with 410 ha recorded, up from 180 ha in 1992, 165 ha in 1991, and 125 ha in 1990 and 80 ha in 1989. The majority of the attack occurred along the Blackwater and Chilako rivers between the Fraser River and the Vanderhoof District boundary. Infestations were also mapped around Naltesby Lake and Mt. Baldy Hughes and along Wansa Creek.

McBride Forest District

The area of recently killed lodgepole pine covered over 400 ha of severe mortality up from 150 ha in 1992. Estimated volume losses also increased three-fold to 30 000 m^3. The majority of the dead trees in 12 infestations were mapped along the eastside of McNaughton Lake from Packsaddle to Baker creeks. New infestations were also noted along the Raush and Holmes rivers.

In the Mt. Robson corridor area, B.C. Parks disposed of approximately 100 beetle infested trees. The baiting program will continue in the Shale Hill and Swift Current Creek areas in 1994, two areas of chronic infestations. Populations appear to be on the decline in the Shale Hill area but on the increase at the Swift Current location.

Pheromone baited trees continued to be used by the Forest Service to attract mountain pine beetle in preparation for some MSMA injection, single-tree disposal, and logging operations.

Pine Needle Cast
Lophodermella sp.

Premature casting of lodgepole pine needles caused by pine needle cast infections declined considerably throughout the region in 1993.

The only area where discoloured needles were noted again this year was in the Red Rock Seed Orchard, where an estimated 10% of the foliage on over 70% of the trees were infected. The probable reason for the reduced levels of infections was the dry spring and summer of 1992.

This needle cast does not kill large trees or significantly affect their health unless heavy and repeated infections occur in successive years. Extensive defoliation affects growth and shape of trees.

Alpine Fir Pests

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

Balsam bark beetle caused alpine fir tree mortality decreased slightly to approximately 30 000 ha.

The majority again occurred in the Fort St. James Forest District with light mortality mapped over 25 000 ha, 80% of which was mapped in 90 infestations in the Takla Lake area. On the southwest side of the lake, dead balsam were noted over 11 000 ha along the Nation River, around Kloch, Elliott and Chuchi lakes, and throughout the Mitchell Range. The largest decrease in area, down by half to 9500 ha, occurred along the northeastern side of Takla Lake in the Beaverdale, Ankwill, Frypan and Condit creek drainages. In the northern portion of the district, infestations were down to 2200 ha from over 4700 ha in 1992. Mortality was noted in the Bear Lake and Bear River drainages and along the Omineca and Sustut rivers. In the south the area of balsam bark beetle-killed trees remained static with 2300 ha mapped in the Inzana, Trembleur, Whitesail, Camsell and Grassham lakes area.

In the Mackenzie Forest District mortality was reported over a wide area. However, no actual area figures are available due to lack of aerial mapping. The Forest Service estimates that the infestations have expanded for the third consecutive year to nearly 4000 ha. Over 1200 ha were mapped along the Akie River north of Williston Lake for the first time. Infestations continued in the Nation Bay-Mt. Bisson area, around Boulder, Phillips and Wasi lakes and along the Omineca River.

In the McBride Forest District the area of mortality more than doubled to almost 2500 ha, in over 100 infestations. More than half the area was recorded in the Raush River, Hugh Allan Creek and Moose Lake drainages. Other areas of attack were noted in the Dore, Milk, Goat, Holmes, Robson and Morkill river drainages.

Balsam bark beetle is a chronic problem in most districts in this region, and populations usually fluctuate little from year to year. The balsam bark beetle appears to be at the height of its population cycle with increased populations and mortality noted province-wide.

FIDS will continue to monitor this pest in 1994.

Alpine Fir Mortality

Scattered alpine fir tree mortality was observed throughout the Prince George Forest District in 1993.

Single trees and small groups of up to 20 trees of all age classes have been recorded dying from Stoner north to Bear Lake. Most of the mortality has been noted in and around the city of Prince George and surrounding farmland. Trees at the fringe of stands or open growing trees are the most affected, though dead understory and mature trees within stands are not uncommon. Trees have been assessed at several sites and it has been concluded that the trees were killed in the fall of 1992 and were basically dead standing green trees over the winter. The foliage on these trees turned red in the early spring of 1993.

All trees assessed had been attacked by secondary bark beetles and woodborers, the most common being *Pityokteines* sp. and *Cerambycidae*, both of which attack dead, dying and injured trees. A few trees had also been infested by the balsam bark beetle, *Dryocoetes confusus*, normally a primary killer, but in this instance not the major cause of mortality. No disease conditions were noted that could have contributed to the mortality. The most plausible cause of mortality of these trees is the drought conditions that prevailed in the Prince George area during the growing season, May to August, of 1992 (Table 4).

Table 4. Temperature and precipitation figures for the 1992 growing season (May-August) shows normal precipitation and temperature based on 30 year (1951-80) average, records supplied by AES Airport Weather Station, Prince George Airport.

	PRECIPITATION (mm)				TEMPERATURE (C)			
MONTH	TOTAL	NORMAL	Difference	(%)	MEAN	NORMAL	Difference	(%)
May	24.8	27.4	- 2.6		9.6	9.3	+0.3	
June	39.6	66.9	-27.3		16.6	12.9	+3.7	
July	31.2	59.7	-28.5		16.4	15.1	+1.3	
August	29.2	68.2	-39.0		15.3	14.1	+1.2	
Total/Averages	124.8	222.2	97.4	-44%	14.5	12.9	+1.4	+11%

Precipitation was 44% less than normal during those months, and the average temperature was 11% greater. Alpine fir and all other *Abies* spp. are very sensitive to any site disturbance or micro-climate change. The significant moisture deprivation and temperature increases noted above, may have caused considerable stress on alpine fir in the area, particularly on well drained sites.

Douglas-fir Pest

Douglas-fir beetle
Dendroctonus pseudotsugae

The area of mortality due to attacks by the Douglas-fir bark beetle increased for the eighth consecutive year to more than 3 650 ha (Figure 7). Expansions occurred in all Forest Districts where the beetle was mapped in 1992 except for the Prince George Forest District where there was a significant decrease (Figure 8). In the Fort St. James District beetle attacks doubled to almost 1800 ha. In the McBride District there was a slight increase to 1500 ha. Widely scattered single tree attacks in the Vanderhoof district coalesced into small but significant infestations. The area of attack decreased about two-thirds to 350 ha in the Prince George Forest District.

Fort St. James Forest District

Increased volume losses due to Douglas-fir beetle attacks were estimated to be 30 000 m^3 in 52 infestations. Infestations continued and expanded in basically the same areas as last year. Mortality was mapped along the west side of Stuart Lake from just north of Fort St. James to Tachie, between Pinchi and Tezzeron lakes, along the east side of Tachie River, and scattered along the north shore of Trembleur Lake and throughout TFL 42.

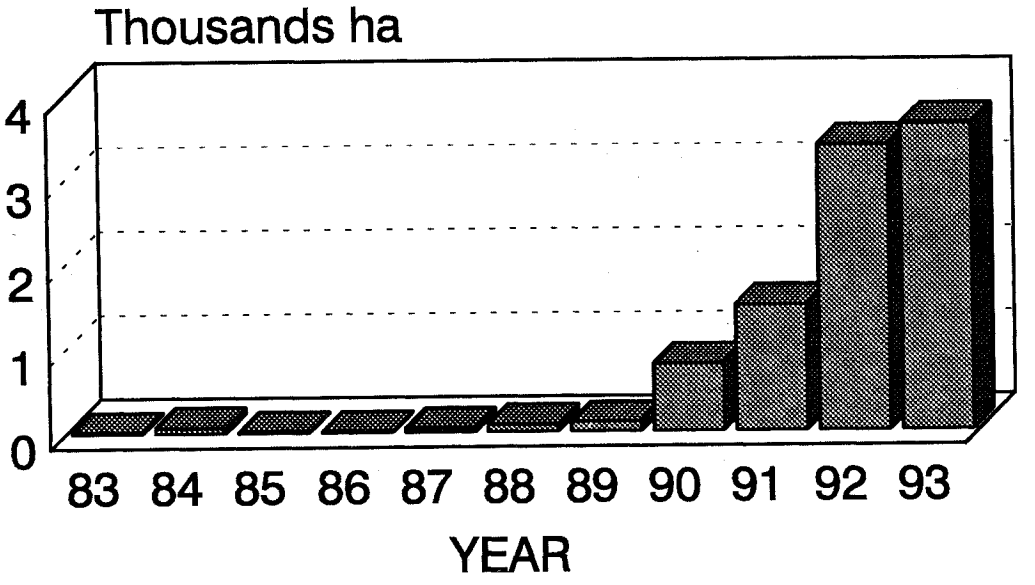

Figure 7. Douglas-fir beetle caused mortality (ha) in mature Douglas-fir stands.

Prince George Forest District

Decreased mortality was widespread causing estimated volume losses of 8 000 m^3 in over 50 infestations. Most mortality occurred along the Blackwater River, around Naltesby Lake, and in the Wansa Creek drainage. The most northerly extension of the infestations was along Arctic Lake near the Parsnip River, and in the Summit Lake area. Light scattered attacks were also noted in the Humbug and Goodson creek drainages.

McBride Forest District

Beetle-caused Douglas-fir mortality was estimated at 20 000 m^3 in 60 mostly light infestations along McNaughton Lake. Infestations occurred along the east side of the lake concentrated between Dawson and Hugh Allan creeks. Scattered patches of attack were also noted along the west side of the Lake at Windfall Creek. Attacks continued with a slight expansion near the headwaters of the Raush River.

Vanderhoof Forest District

According to the BCFS, Douglas-fir beetle attacks increased in this district though no area figures are available. Chronic 1-5 tree infestations have been noted throughout the southern portion of the district for several years. The Douglas-fir beetle has often been found in association or within close vicinity of mountain pine beetle attack.

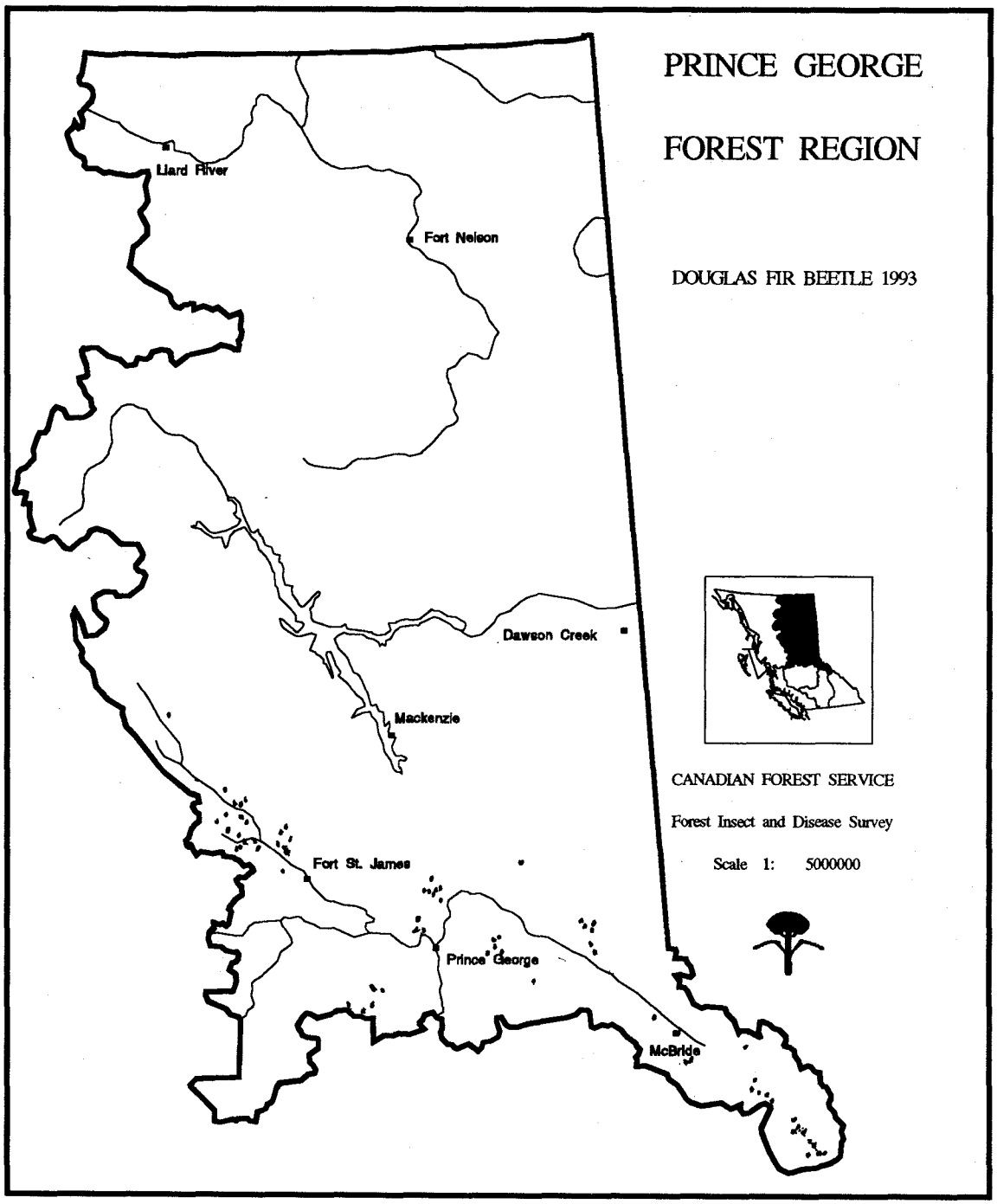

Figure 8. Areas of Douglas-fir killed by Douglas-fir beetle determined by aerial and ground surveys in 1993.

The B.C. Forest Service continues to use trap trees, pheromone traps and logging of selected sites to combat this pest.

Special Directed Surveys

Pests of Young Stands

A total of 49 plantations between 5 and 25 years old were surveyed for pest problems in 1993. The most frequently occurring pests are summarized in Table 5. Pest of low incidence, (<1%), and importance have been excluded.

Of the 49 stands examined 12 were placed in the most severe impact category (Appendix I) that suggests a more intensive survey of the stand should be conducted. The remaining stands fell into categories that suggest reassessment in 2-4 years could be warranted.

Table 5. Summary of pests of young stands, Prince George Forest Region, 1993

Host/pest	No. stands affected	Trees affected %[1]		Severity index[2]
		Average	Range	
Lodgepole pine - 2022 trees in 31 stands, 1555 trees were pest free				
Blister rusts	7	3	2 - 4	3 - 6
Mammals	4	2	1 - 3	3 - 6
Ips spp.	2	1	1	6
Western gall rust	20	7	1 - 32	3 - 5
Abiotic	7	5	1 - 19	3 - 5
Vegetative competition	3	2	1 - 4	2 - 4
Northern pitch twig moth	6	1	1 - 2	2
White spruce - 3425 trees in 41 stands, 1386 trees were pest free				
Root rots	5	1	1 - 2	6
Mammal	5	3	1 - 8	3 - 5
Spruce weevil	25	16	1 - 44	4
Spruce gall adelgid	33	26	1 - 95	2 - 4
Giant conifer aphid	2	27	20 - 35	2 - 4
Pineus sp.	3	10	2 - 24	2 - 4
Vegetative competition	15	10	2 - 22	1 - 4
Zeiraphera sp.	2	3	1 - 4	2
2-year spruce budworm	1	17	17	2

(Cont'd)

Table 5. (Cont'd)

Host/pest	No. stands affected	Trees affected %[1] Average	Range	Severity index[2]
Douglas fir - 313 trees in 10 stands; 249 trees were pest free				
Abiotic	3	10	2 - 25	2 - 3
Vegetative competition	2	11	1 - 21	2 - 3
Spruce gall adelgid	1	13	13	2 - 3
Alpine fir - 307 trees in 24 stands; 72 trees were pest free				
Mammal	6	2	1 - 8	4
Vegetative competition	4	19	1 - 65	2 - 4
Abiotic	6	2	1 - 5	1 - 3
2-year spruce budworm	6	10	1 - 13	2
Fir-fireweed rust	5	6	1 - 21	2
Western redcedar - 154 trees in 4 stands; 1 tree pest free				
Abiotic	2	8	5 - 11	3 - 5
Vegetative competition	4	18	3 - 40	3 - 4
Mammal	1	30	30	3 - 4
Western hemlock - 41 trees in 7 stands; 35 trees were pest free				
Climatic	1	15	1	4
Vegetative competition	2	2	1 - 3	3
Aspen - 156 trees in 11 stands; 145 trees were pest free				
Mammal	2	4	3 - 5	3 - 4

[1] % of trees affected includes only trees from stands in which the pest occurred.

[2] Severity index:
1. pest free
2. minor damage, minimal impact
3. significant loss of current growth potential
4. net volume loss or loss of significant long-term growth potential
5. life-threatening or severely deforming
6. recently dead

The most damaging pests encountered were the blister rusts, *Cronartium coleosporioides, C. comptoniae, C. comandrae,* and *Endocronartium harknessii* which infected 32% of the trees in stand along the Bowron River. Spruce weevil, *Pissodes strobi* was also a significant pest infesting 44% of the leaders at a site also along the Bowron River.

Pinewood Nematode
Bursaphelenchus xylophilus

No pinewood nematode surveys were conducted in 1993 in the Prince George Forest Region. Surveys and trials were expanded in the southern half of the province to obtain data to support an exemption of western hemlock and yellow cedar from a ban on non-kiln-dried exports to Europe. Several potential areas have been selected in the McBride Forest District for possible further studies in 1994.

Based on nearly 2000 samples from trees, logs, boards, and potential vectors collected from throughout British Columbia since 1980, this nematode remains at low levels in forests in British Columbia and Yukon Territory. Only individual, predisposed trees have been affected at a few widely-distributed locations.

Joint Canada-Sweden lodgepole pine trials

Four trial sites planted with lodgepole pine, Scots pine and Siberian larch trial sites established in 1986 in the Prince George Forest Region, and in the Yukon Territory, were examined by FIDS during the course of regular surveys from May to September 1993. The following is a summary of conditions found during the surveys.

Fort St. James, Teardrop Road

Western gall rust, *Endocronartium harknessii,* remains the most serious pest at this site infecting an estimated 4% of the lodgepole pine stems and branches on another 8% of the trees. **Sunscald** resulted in discoloured and deformed bark on 4% of the lodgepole pine. **Western pine aster rust**, *Coleosporium asterum,* lightly infected old foliage on 2% of the lodgepole pine trees. One *Cronartium* sp. branch canker was found on lodgepole pine. Poor form including pronounced **forks**, **multi-tops** and **basal sweep** were noted on 5%, 11% and 20% of the lodgepole pine, Siberian larch and Scots pine respectively, probably a result of previous **winter damage**. An unknown **woody tissue feeder** has killed the tops on 8% of the Siberean larch.

Mackenzie, Nation Bay

Seventy-six percent of the Scots pine were healthy as was 48% of both the lodgepole pine and Siberian larch. *Cronartium comandrae* and *C. coleosporioides* infected 18% of the lodgepole pine stems up from 10% last year. A **Cronartium sp. branch canker** was found on one Scots pine. Infections by **western gall rust** remained constant with galls found on 24% of the lodgepole pine trees.

An estimated 2% of the lodgepole pine were killed by **Warren's root collar weevil**, *Hylobius warreni.* **Northern pitch twig moth**, *Petrova albicapitana,* infested 1% of the lodgepole pine.

Poor form including dead tops was noted on 23% of the Scots pine and 52% of the Siberian larch.

Fort Nelson, Liard Highway

Winter damage caused multiple tops on 5, 10 and 15% of the Siberian larch, Norway spruce and lodgepole pine respectively. Winter damage was less than in 1992 and trees have started to recover from old climatic injuries. No **Eastern spruce budworm**, *C. fumiferana*, feeding was noted in 1993. **Western gall rust** formed branch galls on 1% of the lodgepole pine. Pitch nodules resulting from **northern pitch twig moth** attacks were recorded on 2% of the pine. **Pine needle cast**, *Lophodermella* sp., infected 60% of the foliage on 50% of the lodgepole pine.

Fort St. John, Halfway River

Few pests were recorded at the site, although **western gall rust** levels increased. Branch galls were noted on 10% of the lodgepole pine trees and stem galls on 1%. **Winter damage** was noted on 5% of the Scots pine, defoliating 20% of the needles. All trees are exhibiting good recovery from previous years climatic injuries.

McGregor Model Forest
Forest Health Surveys

The monitoring and reporting on pests in Model Forests across Canada has become an important part of the FIDS annual surveys.

During the summer and fall FIDS surveyed several areas of the McGregor Model Forest including; 6 **young stands** throughout the forest; the Petawawa National Forestry Institute **Treatment Trials**; and the **Acid Rain Early Warning System (ARNEWS)** plot near Averil Lake. Separate complete reports are available for each of the above surveys (Appendix II).

Spruce Weevil
Population Monitoring Plots

A cooperative project between the BCFS and the Canadian Forest Service (Forest Insect and Disease Survey) was initiated in 1993 to monitor spruce weevil populations in the Prince George Forest Region. The objective was to estimate the proportion of weevil infested trees in susceptible spruce stands across different biogeoclimatic subzones (BGCSZ). The stands are to be remeasured annually to obtain information on population fluctuations and to determine if biogeoclimatic factors influence susceptibility of spruce to attack.

A total of 15 suitable sites were located in 8 different biogeoclimatic subzones in 5 different Forest Districts (Figure 9). The original intent was to establish at least 2 sites in each biogeoclimatic subzone. This was accomplished in all but the SBSj2 and the ICHk subzones, where only one site was located. Additional sites will be added in these subzones in 1994.

Three locations were surveyed in the SBSf mainly because of ease of access, one of these locations may be deleted in 1994. The two locations in the BWBSa1 subzone are helicopter accessed. Due to inaccessibility no suitable sites were located in the BWBSc subzone, attempts will be made in 1994 to establish 2 helicopter accessed sites in this area.

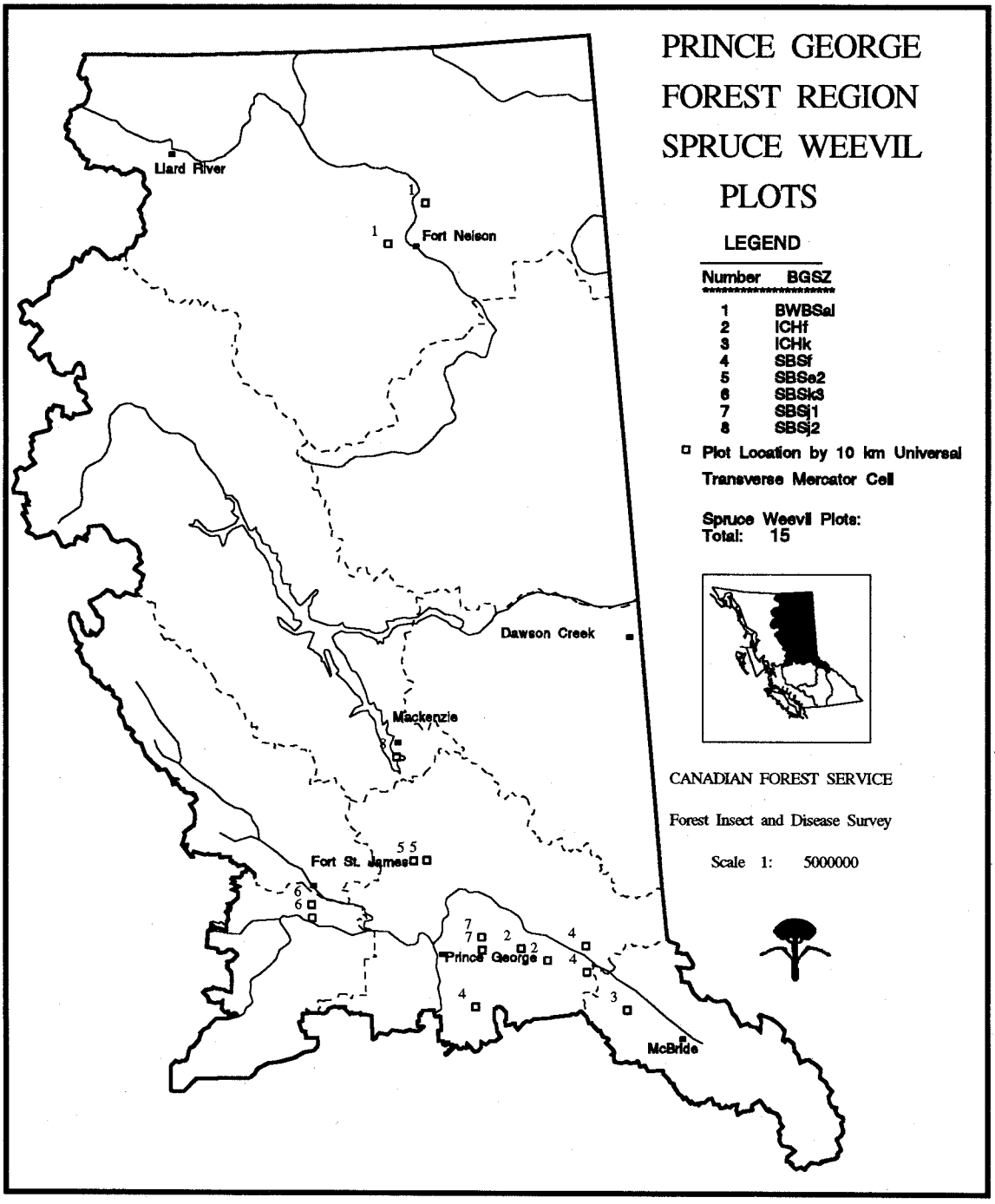

Figure 9. Location and biogeoclimatic zone of spruce weevil surveys.

Attacks varied widely between biogeoclimatic subzone and even between stands within subzones. An average 13% (range 0 - 23%) of the white spruce were currently attacked by the spruce leader weevil in the 15 stands in 1993 (Table 6). Old attack (pre-93) was recorded on an average 9% (range 0 - 16%) of the stems and 3% of the trees had both old and new attacks. Defects representing possible previous attacks were noted on an average 4% (range 0 - 20%) of the white spruce.

Table 6. Location, biogeoclimatic subzone, stand composition, percent weevil attack and defect in spruce weevil monitoring plots, Prince George Forest Region, FIDS, 1993.

Location	Biogeoclimatic subzone	Tree Species % of stand	% Spruce Weevil Attack Old	New	Both	% Defect[1]
McGregor R	SBSf	wS -83 alF-17	9	23	2	3
Humbug Cr.	SBSf	wS -29 wB -32 wrC-32 alF- 7	4	13	2	0
Bowron Rd	SBSf	wS -100	15	8	6	19
Davie Lk Rd	SBSe2	wS -64 tA -12 sA -11 lP -11 bCo- 2	13	14	7	4
Davie-Muskeg	SBSe2	wS -92 lP - 8	3	10	1	0
Gagnon Cr.	SBSj2	wS -77 tA -10 lP - 5 wB - 8	12	16	4	1
Lunate Cr.	ICHf	wS -47 wB -31 alF-11 wrC-10 wH - 1	13	16	4	0
Sugarbowl Cr.	ICHf	wS -80 tA - 7 wrC- 7 bCo- 5 DF - 1	9	15	2	3

(Cont'd)

Table 6. (Cont'd)

Location	Biogeoclimatic subzone	Tree Species % of stand	% Spruce Weevil Attack Old	New	Both	% Defect[1]
Vama Vama Cr. 1	SBSj1	wS -82 wB -15 lP - 3	14	12	4	0
Vama Vama Cr. 2	SBSj1	wS -86 wB -12 lP - 1 alF- 1	16	6	8	5
Goat R	ICHk	wS -54 wrC-42 wH - 4	16	8	4	3
Jackpine Alley 1	SBSk3	wS -54 sA -15 lP -18 alF- 8 tA - 5	4	3	0	20
Jackpine Alley 2	SBSk3	wS -57 lP -36 tA - 7	0	0	0	0
Ft. Nelson R	BWBSa1	wS -100	0	0	0	0
Muskwa R	BWBSa1	wS -100	0	0	0	0
AVERAGE			**9**	**10**	**3**	**4**

[1] Defects include forks, crooks or multiple tops that may be caused by spruce weevil attack.

Very Wet Cool Sub-Boreal Spruce (SBSf)

The highest level of current attack occurred in this subzone with 25% of the spruce attacked at one site along the McGregor River. Average old attack was 18% in these 3 stands. The second highest level of old attack, 21%, and stem defects, 19%, were reported at a site on the Bowron Road. Levels of current attack at the Humbug Cr. and Bowron Rd. sites were very similar at 15% and 14% respectively. Tree species composition varied widely with white spruce only making up 29% of the trees at Humbug Cr. compared with 100% at Bowron Road.

Mossvale-Moist Cool Sub-Boreal Spruce (SBSe2)

Weevil attacks at the Davie Lake Road location were estimated at 21% for current attack and 34% for both old and new attacks. Current attack at the Davie Muskeg site was considerably less with only 11% of the leaders currently infested. Species composition again varied at the two sites with only 64% white spruce at Davie Lake, compared with 92% at Davie-Muskeg. The total weevil attack showed an even greater difference with 34% of the trees attacked at Davie Lake and 14% at Davie Muskeg.

Finlay/Peace Wet Cool Sub-Boreal Spruce (SBSj2)

The one site in this subzone had 20% of the leaders currently attacked and 32% of all stems had either current, old or combined attacks. Spruce was 77% of the stand composition only slightly more than the 74% average for the fifteen stands.

Slim - Very Wet Cool Interior Cedar Hemlock (ICHf)

Current and old attack were less in the stand with the higher spruce composition in this subzone. Current attack was 16% and combined attack 33% at Lunate Creek which had 47% white spruce stems. At Sugarbowl Creek where spruce was 80% of the stand current attack was recorded at 15% and combined attacks at 26%.

Willow - Wet Cool Sub-Boreal Spruce (SBSj1)

Spruce weevil populations were relatively constant in both stands in this area with 16% current attack at Vama Vama #1 and 14% at #2. Total weevil attack was the same at both sites with 30% of the stems affected. Spruce composition was also relatively constant between stands with only a 4% difference noted.

Goat - Wet Cool Interior Cedar-Hemlock (ICHk)

Current attack in the one stand surveyed in this subzone was recorded at 12%. While approximately half the trees in this stand were hemlock or cedar, these species were naturally regenerated and less than half the height of the spruce.

Stuart - Dry Warm Sub-Boreal Spruce (SBSk3)

Weevil attack levels were very low at the two sites in this subzone with only 3% current attack at the #1 site at Jack Pine Alley and no attacks recorded at the #2 site. White spruce was more than 50% of the stand at both locations. The other tree species matched the spruce in height and may have contributed to the lower levels of attack often associated with mixed stands.

Fort Nelson - Moist Warm Boreal White and Black Spruce (BWBSa1)

No weevil attacks were recorded during the weevil surveys of these two stands. Further assessments were able to determine that spruce weevil were present in the stands but at such low levels that it was not detected during the original survey. The low level of weevil attack could be lack of suitable host, extreme climate and/or fluctuations in populations.

Surveys and assessments by FIDS of these stands and several additional stands will continue in 1994.

Bio-monitoring Plots

This is the second year of the expanded, 3 additional plots, bio-monitoring program in the Prince George Forest Region. New plots were established in the Prince George, Dawson Creek and Fort St. John Forest Districts. In 4 years another detailed analysis of foliage, soils, growth rates, foliar retention and general stand condition will be completed at the 3 recent plots. Annual surveys include examinations of tree mortality, abiotic foliar symptoms and pest conditions.

Foliage appeared healthy on all trees except for 2 alpine fir at Averil Lake which had less than 10% chlorotic needles probably from natural causes. One white spruce tree died from the stress of being shaded out and attacks by the secondary bark beetle, **Dryocoetes affaber**, at the Averil Lake plot.

The Willow River site was the only location with significant pest problems, 26% of the lodgepole pine was infested by northern pitch twig moth, **Synanthedon sequoiae**, 18% infected by western gall rust, **Endocronartium harknessii**, and porcupine damage noted on 3%.

Monitoring will continue at the Prince George plots in 1994.

Multiple Host Pests

Western hemlock looper
Lambdina fiscellaria lugubrosa

Defoliation of mature to overmature western hemlock and western redcedar stands, by the western hemlock looper increased to over 43 000 ha in 108 infestations, up from 28 000 ha in 1992. More than 70% of the defoliation occurred in the Prince George Forest District, with the remainder in the McBride Forest District (Figure 10). Eighty-five percent of the area was severely defoliated, with the loss of most or all foliage on more than 50% of the trees. The remainder of the feeding was moderate and light. The last recorded western hemlock looper infestation in the Prince George Forest Region was 1983, when 845 ha were attacked in the same ICH biogeoclimatic zone.

In the Prince George District the area of defoliation covered approximately 31 000 ha in 70 infestations in the southeastern portion of the district in the ICHvk2 biogeoclimatic subzone. Feeding was noted as far west as Purden Lake and east to the district boundary. The largest infestations again occurred along the Torpy River drainage, with increases noted along Dome, Slim, and Walker creek drainages. The northern limit of the infestation was in the McGregor River drainage. Defoliated trees were readily visible (on mainly crown land) from various locations on the Prince George-McBride highway. Looper populations were mostly concentrated in the mature cedar and hemlock stands again in 1993. There was some expansion noted in adjacent mature white spruce and alpine fir stands, and also into immature spruce stands along the Torpy River. Defoliation in the mature spruce-balsam stands was most severe on understory trees.

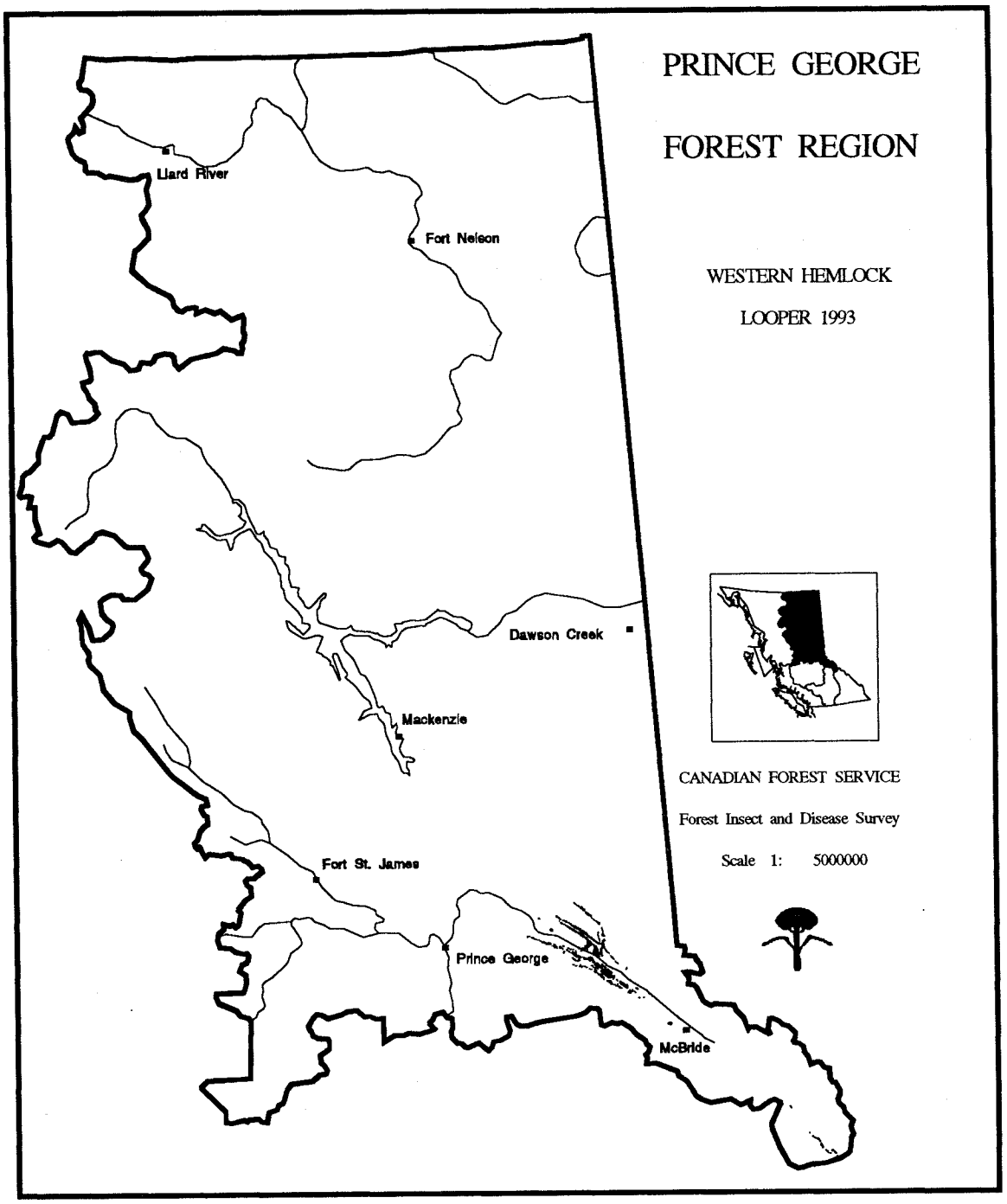

Figure 10. Areas of western hemlock and western red cedar defoliated by western hemlock looper determined by aerial surveys in 1993.

Defoliation in the McBride TSA was recorded over 12 000 ha in 40 infestations up slightly from 11 500 recorded in 1992. Most of the damage was recorded in the ICHwk3 biogeoclimatic subzone. The only reduction in area of defoliation occurred along both sides of McNaughton Lake south of Grouse Creek in the ICHmm biogeoclimatic subzone. This infestation is the northern extension of a much larger infestation in the Revelstoke TSA of the Nelson Region, which also declined this year.

Forecast

FIDS three-tree beating samples at six locations within the infested stands averaged over 300 larvae/beating, compared with approximately 275 in 1992. Mass collections of over 600 larvae were reared at the Pacific Forestry Centre to determine levels of parasites and disease. Disease and parasitism caused mortalities of 28% (range 0-72%) and 2% (range 0-5%) respectively at 6 locations sampled. The levels of parasitism remained constant from 1992 but no disease was found in the population last year. Disease levels are probably high enough to reduce population levels in 1994.

Samples of lichen were taken this fall from six representative areas within the outbreak to determine the number and viability of overwintering eggs to help forecast damage in 1994 (Table 7).

Table 7. Location, average number, and status of western hemlock looper eggs in 1992-93 and predicted defoliation for 1994, Prince George Forest Region 1993.

Location	Avg. no. eggs per 100 g lichen								Predicted 1994[1] defoliation
	Healthy		Parasitized		Infertile		Old		
	1992	1993	1992	1993	1992	1993	1992	1993	
Catfish Creek	37	**40**	1	**2**	1	**5**	3	**175**	moderate
LaSalle Lake	166	**40**	5	**1**	7	**0**	12	**131**	moderate
Hungary Creek	-	**33**	-	**1**	-	**0**	-	**60**	moderate
Walker Creek	140	**31**	6	**8**	7	**0**	6	**155**	moderate
Sugar Bowl Creek	-	**20**	-	**2**	-	**4**	-	**277**	light
Hankins Creek	47	**9**	2	**0**	0	**0**	4	**60**	light
AVERAGE	98	**28**	4	**2**	4	**2**	6	**143**	light-moderate

[1] light - 5-26 eggs; moderate - 27-60 eggs; severe - 61+ eggs

The results of fall egg mass sampling showed an overall decrease in populations for 1994. Egg counts decreased by over 70% on average indicating light to moderate defoliation in most areas for next year. The only area that egg counts increased was at Catfish Creek but the increase was so small that the population will probably remain static in that area. The decrease can probably be attributed to the disease found in the larval population and starvation. Parasitism of eggs is very low and an estimated 30% parasitism of eggs is needed to affect the population. The lowest level of egg counts was at Hankins Creek where the infestation has

been active the longest. Reduction of the infestations will probably be limited to the stands that have been defoliated for 2 years. Populations of western hemlock looper often collapse after only one year, the last recorded infestation in the Prince George Forest Region collapsed after only two years.

Impact

Nine damage appraisal plots were established in 1992 to help determine the impact of the looper, three at both Walker Creek and Catfish Creek and three at La Salle Lake (Table 8).

Table 8. Location, percent mortality, and percentage of trees with over 80 percent defoliation in western hemlock looper impact plots, Prince George Forest Region, 1993.

Location	Percent mortality				Percent trees with 80%+ defoliation for 2 consecutive years			
	wH	wrC	wS	alF	wH	wrC	wS	alF
La Salle Lake	6.5	8.0	0	0	90	36	0	0
Walker Creek	4.2	4.3	0	0	94	78	0	0
Catfish Creek	3.3	4.3	20	0	43	4	0	0
AVERAGE (weighted)	**5**	**6**	**11**	**0**	**79**	**31**	**0**	**0**

Mortality in the fall of 1993, after 2 years of defoliation was relatively light, 4.5% of the western hemlock, 6.4% of the western redcedar and 11.1% of the white spruce. One of the red cedars died from butt rot and as did the 1 dead white spruce, so the actual looper caused mortality for red cedar would be 5.3% and 0% for white spruce. All mortality occurred in small diameter understory trees.

Defoliation was mainly heavy for the second consecutive year, with 91% of the trees of all species 50% or more defoliated. About 50% of the trees that have been 80%+ defoliated for 2 consecutive years could die, though mortality may not occur until 3 years after the infestation subsides. Approximately 55% of the total number of western hemlock and western red cedar were over 80% defoliated for 2 consecutive years at the three locations.

These plots as well as looper populations will be monitored again next year by FIDS.

Black army cutworm
Actebia fennica

Black army cutworm populations continued to cause light defoliation of recent plantations in the Prince George Forest Region in 1993. Light feeding of spruce and pine plantations was noted at several locations in the Prince George Forest District. For the first time black army cutworm was found in British Columbia on the eastside of the Rockies, at a site in the Murray River Drainage south of Tumbler Ridge.

Black army cutworm larvae were noted feeding on herbaceous material and some seedlings at two 1992 wildfire sites, near Stoner and in the Willow River drainage. Pheromone trapping in 1992 had indicated the potential for damage at both these sites. Light feeding of spruce and pine seedlings was also noted at several burn sites near Weedon Lake north of Prince George. Only one of the Weedon Lake sites was predicted to have damaging larval levels.

Pheromone trapping was much more limited in 1993 due to the small number of broadcast burns in 1992. Traps were again set in the two wildfire burns near Prince George with much reduced moth catches. The average number of moths caught was 45/trap (range 14-65) in 1993 compared with 298/trap (range 18-750) in 1992.

Canadian Forest Products (Canfor) personnel at Chetwynd reported cutworm causing light to severe defoliation of lodgepole pine seedlings at four different stands in the Murray River drainage. This is the first reported incidence of black army cutworm east of the Rocky Mountains in British Columbia.

Rusty tussock moth
Orgyia antiqua badia

Rusty tussock moth populations collapsed after one year of defoliation, following the largest infestation ever reported in the province. In 1992 over 13 000 ha of mostly light defoliation was recorded on coniferous and deciduous trees in the Mt. Averil area in the, **very wet cool sub-boreal spruce (SBSf)**, biogeoclimatic subzone. The near total absence of egg masses during fall surveys of 1992 indicated a population collapse. A virus is the usual control agent of this pest.

Deciduous Tree Pests

Forest tent caterpillar
Malacosoma disstria

The area of mainly trembling aspen defoliated by the forest tent caterpillar increased to 40 000 ha (Figure 11), almost double the area recorded last year. This increase follows 2 consecutive years of decline.

Tent caterpillar populations in the Prince George Forest District increased after two consecutive years of decrease, defoliating aspen over almost 22 000 ha from Prince George to Quesnel (Figure 12). Light defoliation was recorded over 4 400 ha, moderate over 9 300 ha and severe over 8 000 ha. The largest infestations and the majority of the area of attack was noted between the Prince George Airport and Stoner. Smaller scattered patches of defoliation were mapped north of Quesnel. An additional 2 700 ha of severe defoliation was noted along the southwest side of McLeod Lake.

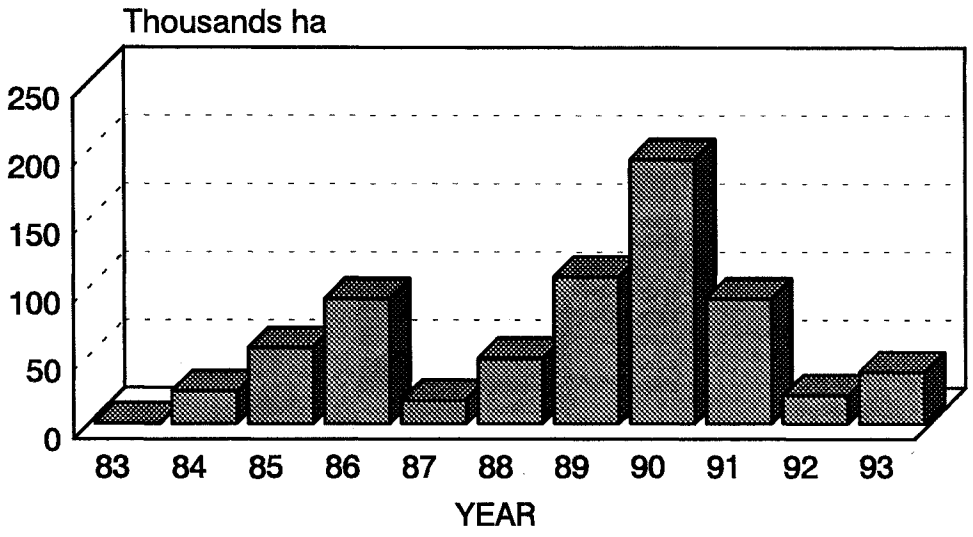

Figure 11. Forest tent caterpillar defoliation (ha) in trembling aspen stands.

In the McBride Forest District the area of feeding increased for the third consecutive year to over 16 000 ha of moderate and severe defoliation. The largest areas of defoliation occurred in the Dunster and Croydon areas with over 9 000 ha of severe defoliation. Infestations were mapped further to the southeast this year, with scattered patches totaling 2 000 ha recorded from Tete Jaune to south of Valemount. The remainder of the caterpillar feeding was noted around McBride and north to the Goat River.

Several hundred hectares of severe defoliation was reported in the Dawson Creek Forest District south of Taylor. Last year was the first time in eight years that no defoliation had been recorded in this district.

The amount of parasitism and disease in the tent caterpillar populations remained at about the same levels as 1992. Total larval mortality from parasitism and disease in the McBride area averaged 74% (range 68-80%) with the majority, 59% (range 50-68%), resulting from disease. Total mortality of tent caterpillar larvae from sites near Prince George was 78% (range 54-99%), with disease again being the predominant mortality factor 62% (range 42-75%).

The population fluctuations recorded in 1993 corresponded with the predictions derived from egg mass sampling in the fall of 1992. Populations declined in and around Prince George city but expanded south towards Quesnel and in the McBride area.

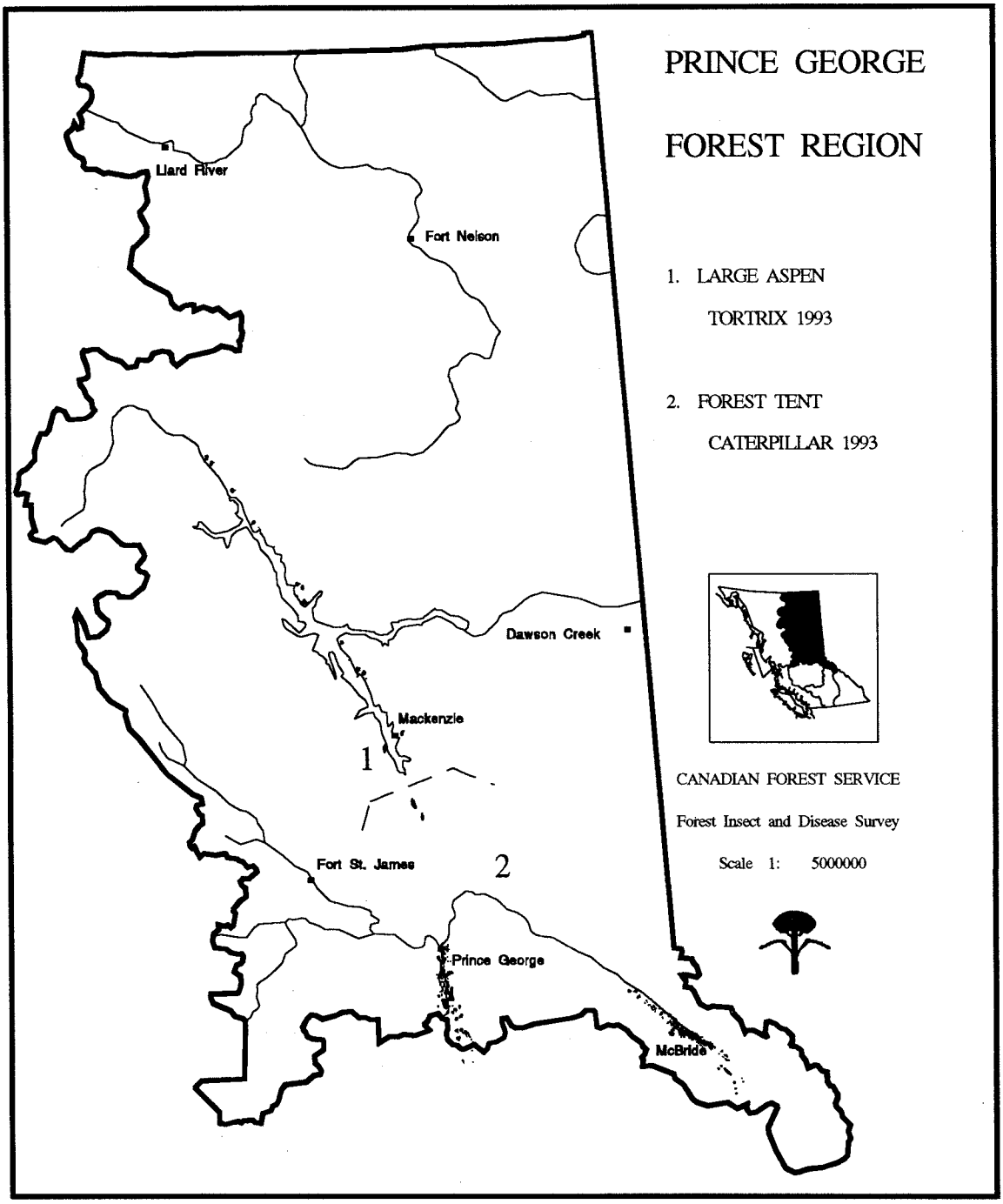

Figure 12. Areas where current defoliation of deciduous trees by forest tent caterpillar and large aspen tortrix was detected during aerial surveys in 1993.

The number of egg masses found during the 1993 fall surveys in the Prince George District increased this year to an average 23/location (Table 9). This is up from an average of only 3 in 1992 though different locations were sampled. Egg mass counts in the McBride area remained relatively constant at 17, compared with 19 in 1992.

Table 9. TSA, location, dbh, number of new and old egg masses of forest tent caterpillar, and predicted 1994 defoliation, Prince George Forest Region, 1993.

TSA and location	Avg dbh (cm)	Avg. no. egg masses/tree		Predicted defoliation 1994	Ratio of new to old egg masses	Population status
		new	old			
PRINCE GEORGE						
Trapping Lk	11	42	3	severe	14:1	increasing
Strathnaver	12	26	8	severe	3:1	increasing
Dunkley	12	17	3	severe	6:1	increasing
Stone Cr.	12	7	0	moderate	7:1	increasing
AVERAGE	**12**	**23**	**4**	**severe**	**6:1**	**increasing**
DAWSON CREEK						
Taylor	12	18	2	severe	9:1	increasing
McBRIDE						
Dunster	8	30	15	severe	2:1	increasing
Horsey Creek	9	21	12	severe	2:1	increasing
Croydon	11	18	22	severe	1:1	static
Bunbury	10	16	3	severe	5:1	increase
Small Creek	9	12	2	severe	6:1	increasing
Dore River	10	6	5	moderate	1:1	static
AVERAGE	**10**	**17**	**10**	**severe**	**2:1**	**increasing**

In areas around Prince George where defoliation has occurred for 3-5 years, top and branch dieback is evident although no whole tree mortality has been recorded. Continued defoliation leads to growth loss and increased susceptibility to attacks by other insects and diseases. Forest tent caterpillars can be a nuisance to homeowners, campers, and picnickers because of their tendency to migrate in large numbers during the larval stage. FIDS will continue to monitor forest tent caterpillar populations in 1994 (Figure. 13) and a pest report will be issued after early season sampling is completed.

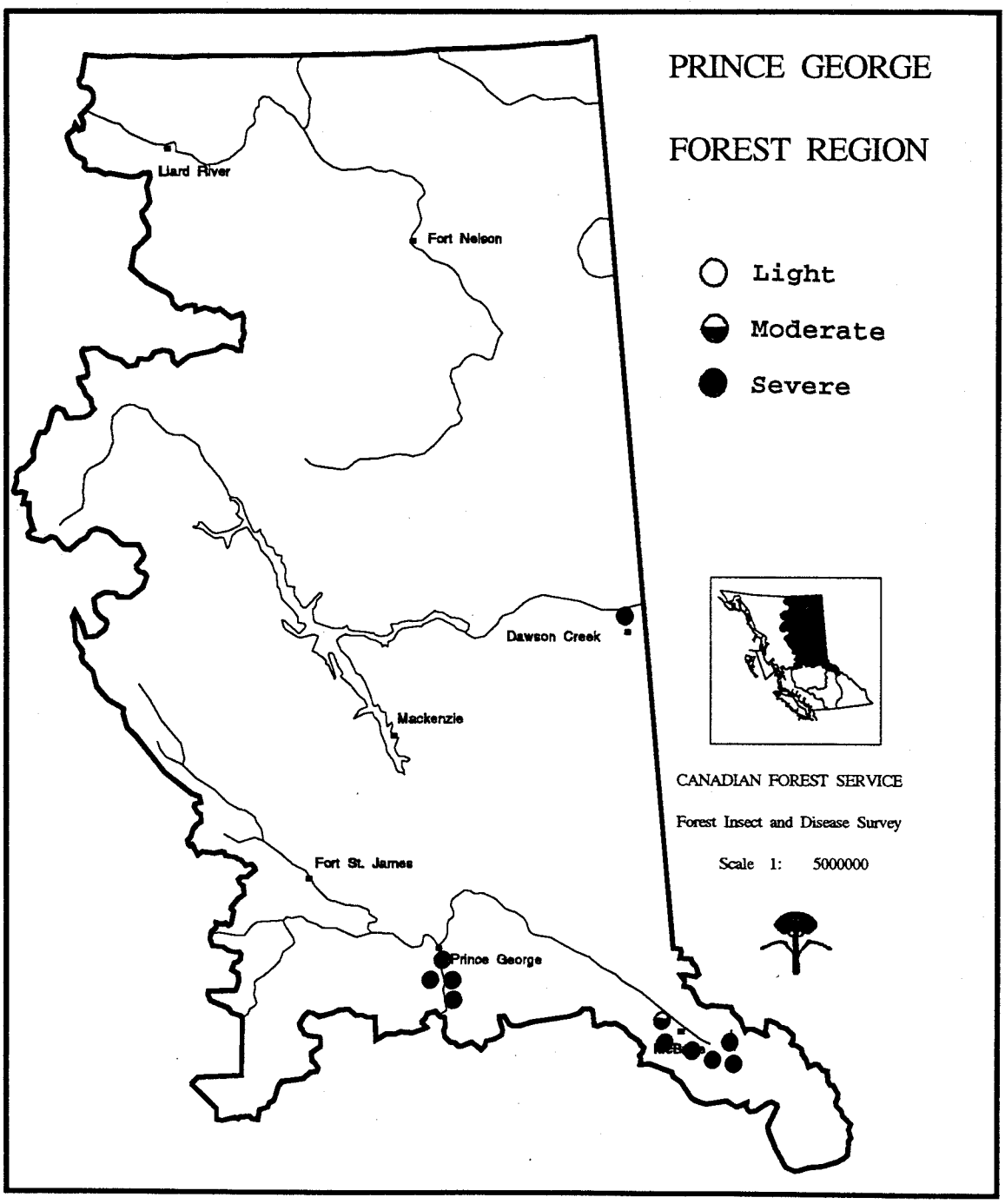

Figure 13. Forecast of 1994 defoliation by forest tent caterpillar in the Prince George Forest Region based on egg mass surveys.

Large aspen tortrix
Choristoneura conflictana

Large aspen tortrix defoliated trembling aspen over approximately 6000 ha down from the 24 000 ha recorded in 1992. This decline follows four consecutive years of increasing populations. In 1992 all defoliation was recorded in the Mackenzie Forest District, this year the area defoliated in the Mackenzie area declined to 3100 ha and the remaining 2900 ha was observed in the Vanderhoof Forest District. This is the first time in several years that large aspen tortrix has been reported in the Vanderhoof area.

In the Mackenzie District infestations were mapped during aerial surveys in June with varying intensities of feeding noted in 31 infestations. Defoliated aspen stands were mostly noted along the east side of Williston lake from Mackenzie north to Ingenika arm (Figure 12). The largest single infestation, 1200 ha, and the most severe defoliation occurred around Modeste Lake near Mackenzie.

In the Vanderhoof Forest District estimates of the area of defoliation were made from ground surveys as no aerial surveys were undertaken to map this pest. Infestations were scattered from east of Vanderhoof to Fraser Lake. Mostly mature aspen stands of 5-150 ha were noted along the Nechako River Valley, with infestations broken up by farmland and conifer forests.

Feeding on plant species other than aspen was noted at several locations indicating that the populations will probably starve themselves in these areas. The large aspen tortrix needs nutrients that can only be provided by aspen; depletion of the aspen food supply is often cited as a main cause of population collapse.

Larval collections from the Engen and Braeside areas were made to determine the level of parasites and disease in the population. Disease was non-existent and larval parasitism was low, averaging 13% (range 6-19%). These low levels of natural controlling factors indicate that the population is healthy enough to survive into 1994, the limiting factor in this area will probably be food supply.

The last infestation in this area, 1980, covered almost 40 000 ha and extended north past Fort St. James. Outbreaks usually only last 2-3 years and often precede those of the forest tent caterpillar. The feeding may result in reduced tree vigor and stem growth, occasionally killing the treetop and upper branches. Tree mortality rarely occurs directly from larval feeding because aspen trees usually refoliate within 4-6 weeks after feeding is complete. FIDS will continue to monitor this pest in 1994.

Gypsy moth
Lymantria dispar

No adult male gypsy moths were caught in 55 pheromone-baited traps placed by FIDS throughout the Prince George Forest Region as part of a continuing interagency monitoring program. The traps were placed at provincial parks, highway rest areas, and private campgrounds. A program of trapping and egg mass surveys is carried out by CFS and the B.C. Forest Service in co-operation with Agriculture Canada to detect the establishment of this potentially serious pest.

Poplar-and-willow Borer
Cryptorhynchus lapathi

Populations of the poplar-and-willow borer increased for the third consecutive year in the Prince George Forest Region. Willow mortality was noted throughout the Prince George Forest Region south of Mackenzie. Dead, dying, and partially killed willow were seen in forest stands, roadside stands, and on private property from June to September. The weevil populations are at their highest levels ever recorded in the Prince George Forest Region.

The stems of the willow become honeycombed with larval tunnels causing "breakover." Most plants are not killed outright. Rather multi-stemmed willow clumps result as old stems are killed and new ones sprout. Though most damage is done by the larvae, adults also feed on young, succulent bark of shoots, branches, and the main stem.

This weevil was introduced to North America from Europe in the late 1800 s. It was previously thought that the borer occurred primarily south of 52° north latitude but recently populations have become established as far north as 56°.

Other Noteworthy Pests

Table 10. Other noteworthy and minor pests

Host and pest	Location	Remarks
White spruce		
A bark beetle *Dryocoetes affaber*	Jarvis Creek, Ant Lake, Averil Lake	found in blowdown and trap trees
A coneworm *Hylemya anthracina*	Vama Vama Creek	infesting cones
Cooley spruce gall adelgid *Adelges cooleyi*	Prince George Forest Region	common and widespread
Fir coneworm *Dioryctria abietiverella*	Vama Vama Creek	infesting cones
Lodgepole Pine		
Atropellis canker *Atropellis piniphila*	Willow River	found at ARNEWS plot
Mammal damage	Muncho Lake Prov. Park	10% mortality over 200 ha

Table 10. (Cont'd)

Host and pest	Location	Remarks
Monterey pine ips *Ips mexicanus*	Nechako River	found in dead standing trees
Pine needle sheathminer *Zelleria haimbachi*	Red Rock	occasional and scattered
Winter damage	Stone Mtn. Prov. Park	50% of the foliage damaged on 50% of the young trees over 200 ha
Alpine fir		
Frost damage	Purden Lake	damage to 50% of the new flush on 80% of the understory over 1 ha
Elm		
Elm leafminer *Agromyza aristata*	Prince George	light damage
Trembling Aspen		
Aspen webworm *Tetralophia apostella*	Prince George, Vanderhoof	An early fall solitary defoliator. Found in forest tent caterpillar damaged stands
Hypoxylon canker *Hypoxylon novemexicanum*	Dawson Creek	found in 50 year old stand
Poplar canker *Valsa sordida*	Pouce Coupe Hoodoo Lakes	common in the stand
Willow		
Fir-willow rust *Melampsora abieti-capraearum*	Fort St. James	common throughout this area
Pacific willow leaf beetle *Pyrrhalta decora carbo*	Pouce coupe to Liard River area	declined after three years of patchy light defoliation

Appendix I

PEST IMPACT CODES

- based on the sum of % trees/severity index/stand.
- SI=Severity Index i. e. SI 1 = Severity Index 1

Impact I - No Action Required

- No impact, pest-free
- These are stands where 100% of the trees were pest-free i.e. SI 1.

Impact II - Consider Reassessment in 4 years

- Minor damage, occasional significant volume losses.
- 70%>SI3
- 25%>SI4>0
- 3%>(SI5 or SI6 or SI5+SI6)>0

Impact III - Consider Reassessment in 4 years

- Significant current volume loss and potential long-term; reassess within 2 years.
- SI3 >= 70%
- 5%> (SI5 or SI6 or SI5 + SI6) >=3%
- 50%> (SI4 or SI4+SI5 or SI4+SI6 or SI4+SI5+SI6) >=25%

Impact IV - Consider conducting a more intensive survey

- Significant long-term volume losses, possibly resulting in NSR stands. Immediate action.
- 5%>SI5 or SI6 or SI5+SI6
- 50%> (SI4 or SI4+SI5 or SI4+SI6 or SI4+SI5+SI6)

Appendix II

The following related reports are available on request from FIDS.

I. Forest Health Surveys of the McGregor Model Forest, 1993.
   i) Pests of Young Stands
   ii) Pest surveys of the Petawawa Treatment Trials
   iii) Forest Health Surveys of McGregor Bio-monitoring Plot

II. Spruce Weevil Population Monitoring Plots, Prince George Forest Region, 1993.

III. Proposal for Spruce Beetle Hazard Rating System in the McGregor Model Forest, 1993.

IV. Pest Surveys of the Joint Canada-Sweden lodgepole pine trials, 1993.

Detailed copies of aerial survey maps, pest reports, leaflets, monographs and other maps and reports in addition to those listed above are available from the Pacific Forestry Centre upon request.

Appendix III