Forest insect and disease conditions in Alberta, Saskatchewan, Manitoba, and the Northwest Territories in 1992

H.F. Cerezke and J.P. Brandt

Northwest Region • Information Report NOR-X-332

Forestry Canada Forêts Canada

Forestry Canada's Northwest Region is responsible for fulfilling the federal role in forestry research, regional development, and technology transfer in Alberta, Saskatchewan, Manitoba, and the Northwest Territories. The main objectives are research and regional development in support of improved forest management for the economic, social, and environmental benefit of all Canadians. The Northwest Region also has responsibility for the implementation of federal–provincial forestry agreements within its three provinces and territory.

Regional activities are directed from the Northern Forestry Centre in Edmonton, Alberta, and there are district offices in Prince Albert, Saskatchewan, and Winnipeg, Manitoba. The Northwest Region is one of six regions and two national forestry institutes of Forestry Canada, which has its headquarters in Ottawa, Ontario.

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Les activités régionales sont gérées à partir du Centre de foresterie du Nord dont le bureau est à Edmonton (Alberta); on trouve également des bureaux de district à Prince Albert (Saskatchewan) et à Winnipeg (Manitoba). La région du Nord–Ouest correspond à l'une des six régions de Forêts Canada, dont le bureau principal est à Ottawa (Ontario). Elle représente également deux des instituts nationaux de foresterie de ce Ministère.

Aspen pest workshop held September 2, 1992, in Riding Mountain National Park, Manitoba.

Cover illustration:

Signs of injury on trembling aspen caused by poplar borer (*Saperda calcarata* Say) on the left and false tinder conk (*Phellinus tremulae* (Bond.) Bond. & Boriss.) on the right.

FOREST INSECT AND DISEASE CONDITIONS IN ALBERTA, SASKATCHEWAN, MANITOBA, AND THE NORTHWEST TERRITORIES IN 1992

H.F. Cerezke and J.P. Brandt

INFORMATION REPORT NOR-X-332

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ABSTRACT

Forest insect and disease incidence in Alberta, Saskatchewan, Manitoba, and the Northwest Territories is summarized for 1992. Major pests and abiotic factors affecting forests are discussed, as well as special surveys of young stands, aspen forests, and a forest nursery. Additional noteworthy insects, diseases, and tree damage agents are reported in an appendix. An update of surveys for acid rain symptoms in permanently established ARNEWS (Acid Rain National Early Warning System) plots is also reported.

RÉSUMÉ

Cet ouvrage donne un résumé des conditions relatives aux insectes et aux maladies des arbres en Alberta, en Saskatchewan, au Manitoba et dans les Territoires du Nord-Ouest en 1992. Les auteurs passent en revue les insectes, les maladies et les facteurs abiotiques les plus importants. Ils présentent les résultats d'études spéciales effectuées dans de jeunes peuplements, dans des forêts de peupliers faux-trembles ainsi que dans une pépinière forestière, et ils font le point sur les relevés des symptômes de dommages par les pluies acides dans les stations permanentes du DNARPA (Dispositif national d'alerte rapide pour les pluies acides). Enfin, ils présentent en annexe un résumé de la situation concernant les autres insectes, les autres maladies et les autres agents abiotiques importants pour les arbres.

CONTENTS

APPENDIX

FIGURES

TABLES

NOTE

The exclusion of certain manufactured products does not necessarily imply disapproval nor does the mention of other products necessarily imply endorsement by Forestry Canada.

INTRODUCTION

The Forest Insect and Disease Survey (FIDS) unit at the Northern Forestry Centre (NoFC) of Forestry Canada is responsible for conducting and reporting insect and disease surveys of forests in Alberta, Saskatchewan, Manitoba, and the Northwest Territories (Fig. 1). In addition to NoFC staff, aid is received from various other federal, provincial, academic, and industrial agencies in the collection of survey data. In particular, the assistance of the following federal and provincial agencies is gratefully acknowledged: Agriculture Canada; Alberta Forestry, Lands and Wildlife; Manitoba Natural Resources; Parks Canada; Northwest Territories Renewable Resources; and Saskatchewan Department of Natural Resources.

In type and scope, the FIDS surveys have included aerially mapped pest infestations (with rated forest injury levels) and various ground plot observations for pest collection and identification, measurement of damage intensity, updating of host tree records, and descriptions of applied control projects. The conduct and assessment of many of the annual surveys could not have been completed without the close cooperation and contributions of the agencies named above.

This regional report summarizes the annual regional pest status of major forest insect and disease conditions and other tree-damaging agents within the three prairie provinces and the Northwest Territories in 1992 and is part of the annual review of national pest conditions. Collections of insect and disease specimens made during the surveys are maintained at NoFC; they provide continuity for the historical records of both a

Figure 1. Forest districts and regional boundaries of the three prairie provinces and the Northwest Territories.

permanent insect collection and a herbarium, and for the national FIDSINFOBASE (the Forest Insect and Disease Survey Information system). The collections also contribute information to support plant quarantine and special forest surveys and research projects. Two national surveys in which FIDS staff participate are the gathering of tree-damage-related information to develop pest depletion loss estimates, and a program of acid rain detection and monitoring, under the umbrella of ARNEWS (Acid Rain National Early Warning System). Results from special surveys, such as those conducted in nurseries, seed orchards, and plantations, and in permanent sample plots (PSPs) are also reported. Other tree-damaging agents that affect shelterbelts, and shade and ornamental trees in urban and high-use areas are summarized in tabular form.

Information for this report is based on forest insect and disease surveys and collections made in May–October, 1992, by the following FIDS ranger staff within the identified jurisdictions:

- Mike Grandmaison: Manitoba
- Howard Gates: Alberta, Saskatchewan, and Northwest Territories
- Colin Myrholm: Alberta, Saskatchewan, and Northwest Territories
- Daryl Williams: Alberta and Saskatchewan

Staff and departments within the federal, provincial, and industrial agencies that provided assistance are hereby acknowledged and thanked for all their help.

- Hideji Ono, Sunil Ranasinghe, Ken McCrae, Brian McIntosh, Don Law, Tom Archibald, Art Evans, Kurt Frederick: Alberta Forestry, Lands and Wildlife, Alberta Forest Service
- Bruce Walter, Gordon Frey, Garry Carter: Saskatchewan Department of Natural Resources
- Keith Knowles, Richard Westwood: Manitoba Natural Resources
- Bob Larson, Chris Carlisle: Northwest Territories Renewable Resources
- Tom Trott: Alberta Recreation and Parks
- Greg Curniski: Weyerhaeuser Canada Ltd., Saskatchewan Division
- Norman Brandt (Manitoba), Bernie Wiebe (Saskatchewan), Hiro Koga (Alberta): Agriculture Canada, Food Production and Inspection Branch
- Patrick Kyle: Environment Canada, Atmospheric Environment Service
- Leo Unger, Allan Van Sickle: Forestry Canada, Pacific and Yukon Region
- Ed Abbott: Parks Canada, Jasper National Park
- Byron Irons: Parks Canada, Kootenay National Park
- Ian Pengelly: Parks Canada, Banff National Park

At the NoFC, other contributors to this report were:

- James Brandt, FIDS Coordinator
- Herb Cerezke, Head of FIDS; Entomologist
- Yasu Hiratsuka, Mycologist; disease diagnostics
- David Langor, Entomologist; insect collection, maintenance, and diagnostics
- Ken Mallett, Pathologist; disease diagnostics
- Paul Maruyama, Mycology Technician; disease diagnostics
- Jan Volney, Project Leader for Forest Insect and Disease Survey and Management Systems; Entomologist
- Andu Yohannes, Entomology Technician

SPRUCE BUDWORM *Choristoneura fumiferana* (Clem.)

In the Northwest Region, spruce budworm infestations occurred in most of the same locations reported in 1991, but there was a decline in the size of affected area in both Manitoba and the Northwest Territories. Infestation areas in Saskatchewan increased substantially; in Alberta,

however, the areas of infestation remained similar to those reported in 1991 (Fig. 2), but the severity of defoliation in Alberta was much reduced. The infestations in the Northwest Region covered a composite area estimated at 345 906 ha, compared to the 317 000 ha in 1991 (Table 1).

In 1992, aerial spraying programs to suppress spruce budworm populations and protect foliage were implemented over commercial forests in Alberta and Saskatchewan, using the biological insecticide, *Bacillus thuringiensis* var. *kurstaki* (*Bt*) (Table 2). The total area treated in Alberta was 35 100 ha in three provincial Forest districts, and in Saskatchewan, 7734 ha were treated within one of the main outbreak areas (Table 2).

In **Alberta**, mostly light defoliation occurred on white spruce west of Bowden (a few hectares), near Millett (about 40 ha), in Big Knife Provincial Park (about 50 ha), in Elk Island National Park (a few hectares), and in Cypress Hills Provincial Park. Most of the 257 ha of infestation in the Cypress Hills was lightly defoliated, but 12 ha were severely defoliated. Small patches of severe defoliation, as well as some tree mortality, were also noted in Big Knife Provincial Park, and additional areas of moderate-to-severe defoliation (almost 200 ha) occurred near Morningside. A new infestation (about 50 ha) of moderate-to-severe defoliation occurred along the Saskatchewan River valley in Edmonton. No aerial spraying programs were completed in any of these areas, with the exception of the one near Millet where *Bt* was applied over 35 ha of private woodlot areas.

Major infestations in the Forest districts were monitored with air and ground surveys by staff of the Alberta Forest Service. These infestations continued in the Footner Lake, Peace River, Lac La Biche, and Athabasca forests, with a combined total area of 141 350 ha, of which only 24% was rated as either moderate or severe. The remaining area was lightly defoliated. An infestation in Grande Prairie

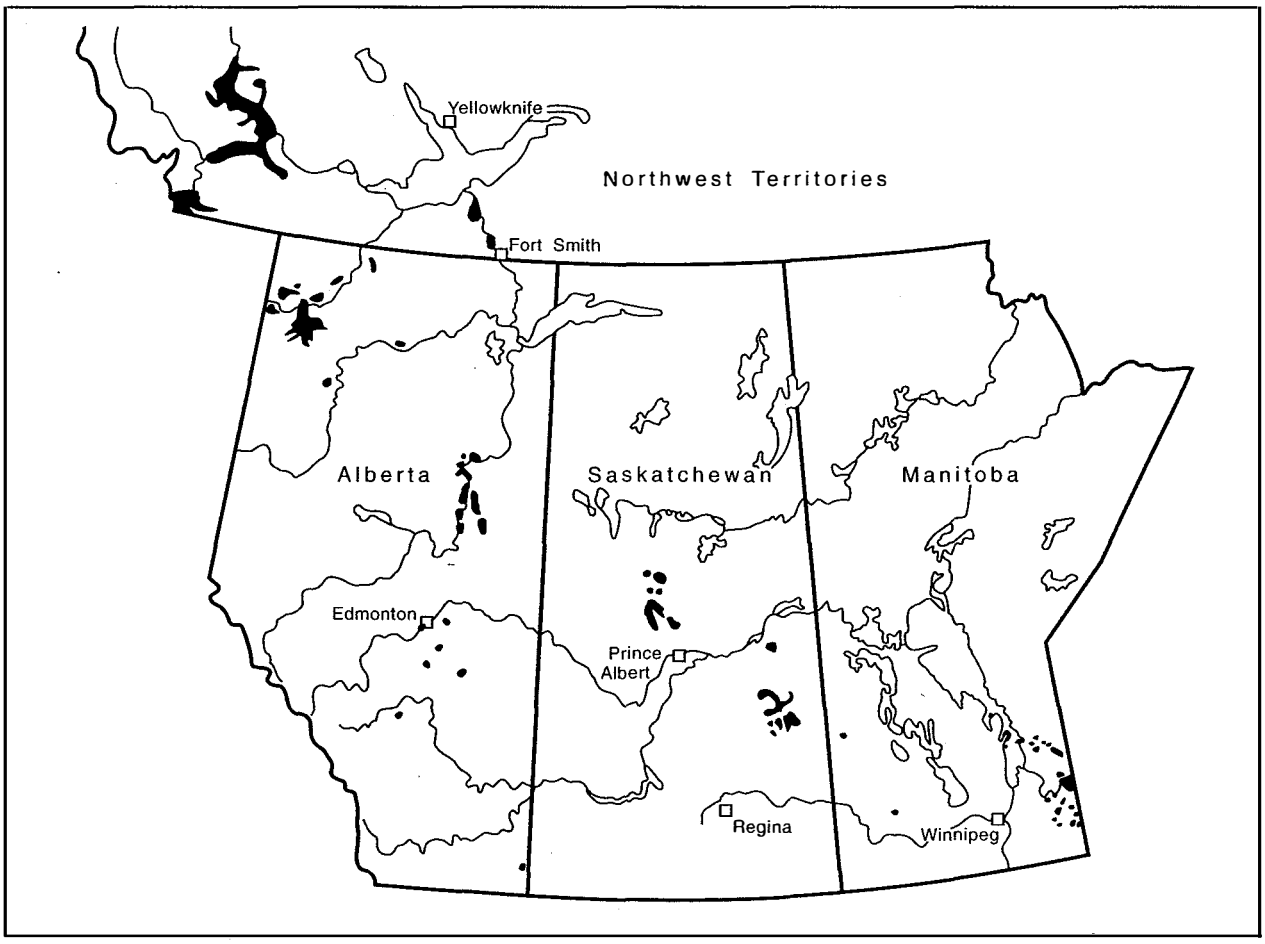

Figure 2. Areas of moderate-to-severe defoliation caused by spruce budworm in 1992.

Table 1. Summary of spruce budworm defoliation in the Northwest Region, sketch-mapped from aerial and ground surveys in 1991 and 1992

Location	Area of defoliation (ha) 1991	1992	Change (%)
Alberta	141 000	142 650	+1
Saskatchewan	15 600	87 000	+458
Manitoba	30 500	26 256	–14
Northwest Territories	130 000	90 000	–31
Total	317 000	345 906	+9

Table 2. Summary of spruce budworm infestation areas treated in commercial forests in Alberta and Saskatchewan in 1992 with aerial applications of *Bacillus thuringiensis* var. *kurstaki* (*Bt*)

Location	Area treated (ha)	Host tree species	*Bt* product	Application rate (BIU)[a] and volume/ha
Alberta				
Footner Lake District	30 000	White spruce	Dipel 132[b]	25.4 BIU; 2.0 L[c]
Lac La Biche District	4 600	White spruce–balsam fir	Foray 48B[d]	25.4 BIU; 2.0 L[c]
Athabasca District	500	White spruce–balsam fir	Foray 48B[d]	25.4 BIU; 2.0 L[c]
Saskatchewan				
Weyerhaeuser Canada Ltd.	7 734	White spruce–balsam fir	Foray 48B[d]	30.0 BIU; 2.4 L[e]

[a] BIU = Billion International Units.

[b] Oil-based formulation.

[c] Indicates two applications at the same rate, 5–7 days apart.

[d] Water-based formulation.

[e] Indicates one application.

Forest, which had persisted for 8–9 years, caused only light defoliation over 800 ha in 1992 and received no control treatment. Ground surveys by the Alberta Forest Service suggested that this infestation had collapsed, but that tree mortality from budworm defoliations was now extensive, ranging up to 40%[1] on some sites.

In Footner Lake Forest, the total area of infested white spruce forests mapped in 1992 was 122 000 ha. Most of this occurred in the same infested areas reported in 1991. The main infestation area, first reported in 1987, occurred adjacent to the Chinchaga River west of High Level, and northward along Negus Creek to the Hay River confluence; it extended over 35 townships. While the area of infestation remained similar to 1991, a general decline in intensity of defoliation in 1992 was due in part to the effects of late spring frost. The only moderate or severe patches of defoliation occurred west of Negus Creek and near the south and east ends of the infestation area.

[1] Personal communication, October 1992, from H. Ono, Manager, Insects and Diseases Programs, Alberta Forestry, Lands and Wildlife, Edmonton, Alberta.

Other mapped infestation areas with light or moderate defoliation were west of Zama Lake, along the Zama and Amber rivers, near Meander River, along the Steen and Yates rivers, and near John D'Or Prairie.

Aerial spraying programs using *Bt* were conducted in two infestation areas (a total of 30 000 ha), one west of High Level, and the other near John D'Or Prairie. Details of the spray application are described in Table 2. This was the third consecutive year of *Bt* application in Footner Lake Forest. In addition to the strategy of aerial spray application for management of spruce budworm, the province is also rescheduling harvesting plans in areas of severely damaged stands to reduce the risk of timber losses.

In Peace River Forest, spruce budworm infestations occurred over 2600 ha of white spruce forests near Hawk Hills, the same area reported in 1991. Most of the area, however, was lightly defoliated, and only 400 ha of defoliation were rated as moderate. About 1941 ha of this infestation were treated aerially in 1991 as part of a joint federal–provincial experimental program to evaluate optimal spray strategies. No spray applications were conducted in 1992; however, spruce budworm population and defoliation levels were intensively monitored.

In the Lac La Biche and Athabasca forests, a combined total area of infested white spruce–balsam fir forests covered 17 150 ha, of which 5000 ha or about 29% had defoliation classed as moderate-to-severe. The remainder, about 14 400 ha of lightly defoliated forest, occurred in Lac La Biche Forest. All infestations occurred along the Athabasca and House rivers, in the same locations as in 1991. The total area sprayed with *Bt* in 1992 was 5100 ha. This occurred over a single block within the two Forest districts and in areas adjacent to the Athabasca and House rivers. Much of this infestation is expected to continue in 1993.

The Alberta Forest Service deployed pheromone-baited (sex attractant) sticky traps in 1992 at 48 sites in nine Forest districts to monitor spruce budworm population levels. Traps were saturated with moths at many sites in eight of the Forest districts, confirming that spruce budworm presence is widespread.

In **Saskatchewan**, the total area of white spruce–balsam fir forests defoliated by spruce budworm and mapped by the Saskatchewan Department of Natural Resources and Weyerhaeuser Canada Ltd. was 87 000 ha, an almost fivefold increase over that reported in 1991 (Fig. 2; Table 1). Infestations continued in three of the same outbreak areas reported in 1991: north of Big River, near Red Earth, and southwest of Hudson Bay. Most of the expansion in 1992 occurred in areas north of Big River, within the timber lease of Weyerhaeuser Canada Ltd., where an estimated 32 000 ha had 25% or more defoliation. Most of the infestations occurred within mixedwood forests, of which 65–75% of the total volume is coniferous. Two of the infestations are now in their fifth (Taggart Lake) and sixth (Pancake Lake) consecutive years of defoliation, and some tree mortality has already occurred. Other nearby infestations occurred at Lac Voisin, along the east side of Delaronde Lake, and adjacent to the north, east, and south sides of Sled Lake.

In 1992, for the first time in Saskatchewan, an aerial spraying program using *Bt* was carried out by Weyerhaeuser Canada Ltd. over 7734 ha of white spruce–balsam fir forests to suppress spruce budworm populations and reduce the risk of timber losses (Table 2). Several blocks of timber between Big River and Sled Lake were selected for spray treatment; the single-spray application was aimed at the fifth larval instar. The treatment was considered successful in reducing budworm population densities. Additional management strategies carried out by the company included salvage cutting of severely damaged sawlog timber and containment (i.e., using adjacent nonhost stands and bog areas) to reduce the rate of spread of spruce budworm.

A moderate-to-severe infestation near Red Earth extended over about 3000 ha of white spruce–balsam fir forests and remained unchanged from 1991. Infestations southwest of Hudson Bay more than doubled in size over 1991 and occurred in at least five major patches; many of the infested spruce stands in this area are scattered. High populations of spruce budworm have been reported in both infestation areas since 1982. No aerial spraying programs have been conducted in either area, but salvage logging in both areas has been ongoing for several years and continues to be the main strategy in spruce budworm management.

In 1992, 420 pheromone-baited sticky traps were deployed by the Saskatchewan Department of Natural Resources for the second consecutive year to help assess budworm population densities adjacent to infested forests and in other, susceptible forests. The trap catches indicated relatively high population densities throughout Saskatchewan's

commercial forests, and helped to identify areas for follow-up surveys of egg-mass and young larval densities. The results of these surveys will help predict population densities for 1993.

In **Manitoba**, spruce budworm infestations were surveyed by Manitoba Natural Resources. Infestations occurred in five Section forests, over a total area of 26 256 ha of white spruce and spruce–balsam fir forests (Figs. 1, 2; Table 1). These infestations generally occurred in the same locations reported in 1991 and were all classed as having moderate-to-severe defoliation. They occurred in the following sections: Aspen Parkland (259 ha), Pineland (518 ha), Lake Winnipeg East (21 057 ha), Interlake (4222 ha), and Mountain (200 ha). The largest affected areas, where spruce budworm infestations have persisted since 1979, were within the Forest Management Licence (F.M.L.) of Abitibi-Price and included areas of tree decline and mortality.

In a recent study conducted by Manitoba Natural Resources of spruce budworm impact on the infested forests, volume losses of up to 15% of

Table 3. Summary of spruce budworm egg-mass surveys in Manitoba in 1992, and predicted defoliation in 1993[a]

Section	Location (Management Unit)	Number of egg masses/10 m^2 of foliage	Predicted defoliation in 1993[b]
Lake Winnipeg East	Abitibi-Price F.M.L. (31)		
	Quesnel Lake	126	Moderate-severe
	Manigotagan Lake	38	Light-moderate
	Happy Lake	11	Light
	Long Lake	19	Light-moderate
	Bird Lake	18	Light-moderate
	Tulabi Lake	28	Light-moderate
Lake Winnipeg East	Nopiming Provincial Park (31)		
	Bird Lake	37	Light-moderate
	Booster Lake	22	Light-moderate
	Flanders Lake	6	Light
	Beresford Lake	22	Light-moderate
Lake Winnipeg East	Whiteshell Provincial Park (30)		
	Falcon Lake	49	Light-moderate
	West Hawk Lake	17	Light-moderate
	Opapiskaw	50	Moderate
	Barrier Bay	428	Severe
	Dorothy Lake	147	Moderate-severe
	Otter Falls	116	Moderate-severe
	Nutimik Lake	34	Light-moderate
	Eleanor Lake	76	Moderate
Mountain	Duck Mountain Provincial Park (13)		
	Davey Lake	162	Moderate-severe
	Noses Lake	148	Moderate-severe
	Rock Lake	314	Severe

[a] Egg-mass density surveys were conducted by Manitoba Natural Resources.

[b] Based on egg-mass densities where light = <25% defoliation (1–15 egg masses), moderate = 26–50% defoliation (50–100 egg masses), and severe = >50% defoliation (200+ egg masses).

the spruce–fir component due to budworm defoliations were estimated (Knowles et al. 1992). The worst-affected areas occurred near Bird Lake, along the Wanipigow River, and near Long, Happy, Manigotagan, and Quesnel lakes. The study will serve to identify areas for salvage harvesting, areas of high fire hazard, and high-use areas requiring different management options.

No aerial spraying programs were conducted in 1992 for spruce budworm control, but some salvage harvesting is planned in severely damaged timber in the Abitibi-Price F.M.L. and in an infestation in Duck Mountain Provincial Forest. This infestation, reported for the first time in 1991, increased in severity during 1992.

Surveys used to forecast spruce budworm populations and predict defoliation levels expected in some Section forests in 1993 were completed by Manitoba Natural Resources in 1992. These surveys indicated that population levels will be generally lower in 1993 (Table 3). In addition, spruce budworm pheromone-baited traps (non-sticky container type) were placed at 13 fixed locations by Forestry Canada for the eighth consecutive year to record trends in numbers of male moths trapped. It is noteworthy that the numbers of moths caught showed increases at all 13 baiting sites (numbers in each trap ranged from 88 to 4085) and were likely due to a more attractive bait formulation deployed in 1992, compared to that used in 1991 (Table 4). Mid-crown foliage samples were also collected from the same locations for estimates of egg-mass densities and defoliation levels in 1993. Based on these results, moderate or severe defoliation levels are predicted for the baiting locations in Spruce Woods Provincial Forest, in Whiteshell Provincial Park, at Wanipigow, and at Rocky Lake (Table 4).

In the **Northwest Territories**, aerial surveys to map infested areas of spruce budworm were conducted jointly by Northwest Territories Renewable Resources and Forestry Canada. No new infestations were reported. Within the main infestation area along the Liard and Mackenzie rivers there

Table 4. Summary of spruce budworm moths caught in pheromone-baited traps, defoliation levels, and egg-mass density counts in Manitoba in 1992, and defoliation forecasts for 1993[a]

Site location	Numbers of moths captured[b]	Defoliation in 1992 (%)	Number of egg masses/10 m^2 of foliage	Predicted defoliation for 1993[c]
Birds Hill Provincial Park	267 (98)[d]	2 (13)[d]	0 (10)[d]	Nil
Spruce Woods Provincial Forest	4085 (290)	16 (13)	134 (76)	Moderate
Red Deer River	218 (25)	1 (<1)	0 (0)	Nil
Duck Mountain Provincial Park	92 (5)	1 (2)	0 (0)	Nil
Riding Mountain National Park	88 (13)	1 (1)	0 (0)	Nil
Northwest Angle Provincial Forest	268 (29)	2 (2)	7 (4)	Light
Whiteshell Provincial Park	2286 (455)	41 (30)	574 (279)	Severe
Wanigipow	2174 (197)	68 (30)	267 (138)	Severe
Hecla Provincial Park	253 (38)	2 (5)	0 (4)	Nil
Lake St. George	157 (32)	1 (2)	0 (0)	Nil
Rocky Lake	1681 (41)	9 (8)	76 (30)	Moderate
Simonhouse	464 (18)	4 (2)	4 (0)	Light
Pisew Falls	109 (6)	1 (3)	0 (0)	Nil

[a] Surveys were carried out by Forestry Canada.

[b] Three traps were deployed at each location in 1991 and 1992.

[c] Based on egg-mass densities where light = <25% defoliation (1–15 egg masses), moderate = 26–50% defoliation (50–100 egg masses), and severe = >50% defoliation (200+ egg masses). The predicted defoliation levels for 1993 apply only to the immediate sites of trap deployment.

[d] Values in brackets are for 1991.

was a general decline in size of infestation as well as in defoliation intensity. Defoliation of white spruce stands was rated as light to moderate from the British Columbia border, northward along the Liard River to the Muskeg River. Additional areas of infestation extended along the Liard River from the Blackstone River and north along the Mackenzie River to at least the Willowlake River, as well as in the Ebbutt Hills and in areas adjacent to the Mackenzie Highway east of Fort Simpson (Fig. 2). Some tree mortality resulting from several years of spruce budworm feeding injury occurred near the south end of the Kotaneelee River and along the Liard River south of Fort Liard.

An additional area of infestation persisting between Fort Smith and Great Slave Lake was reported to be still present in the same locations as in 1991, but its size and intensity of defoliation were not estimated.

ASPEN DEFOLIATORS
Forest tent caterpillar, *Malacosoma disstria* Hbn.
Large aspen tortrix, *Choristoneura conflictana* (Wlk.)
Bruce spanworm, *Operophtera bruceata* (Hulst)

In **Alberta**, there was a further decline in the amount of defoliation caused by aspen defoliators (forest tent caterpillar, large aspen tortrix, and Bruce spanworm) in 1992. Points of detection of defoliators are shown in Figure 3. Due to the reduction in defoliation, no aerial surveys were conducted to map areas of moderate-to-severe defoliation and no aerial spraying programs were undertaken. Forest tent caterpillar populations were generally low throughout Alberta, with the exception of Cooking Lake, Hastings Lake, and some areas within Elk Island National Park. Due to the decline in population of the forest tent caterpillar, no egg-band surveys were carried out for this insect in Alberta. Large aspen tortrix populations also decreased within the province; this insect was detected throughout Alberta at low population densities, except near Rocky Mountain House, where it caused moderate-to-severe defoliation. Light defoliation by Bruce spanworm was detected at only one location: Obed Summit, west of Edson.

In **Saskatchewan**, very little defoliation was observed for any of the major aspen defoliators in 1992 (Fig. 3). Low populations of forest tent caterpillar were found at various locations throughout the province. Populations of large aspen tortrix were also low throughout the province, except near Big River to the west of Prince Albert National Park, where there was severe defoliation. No Bruce spanworm was detected in Saskatchewan.

In **Manitoba**, areas of defoliated aspen forests decreased in 1992 to 51 153 ha, down 28% from 1991. In 1992, aspen defoliation was caused mainly by forest tent caterpillar, whereas in 1991 large aspen tortrix had been the main contributor to defoliation. Areas defoliated by forest tent caterpillar are summarized by Section and Management Unit in Table 5. Areas of moderate-to-severe defoliation in Manitoba during 1992 are mapped in Figure 3. Egg-band counts were made at 40 locations to estimate 1993 population trends for forest tent caterpillar; no egg masses were detected at these locations, so defoliation should be negligible. Large aspen tortrix was detected at one location in the province: south of Thompson. Bruce spanworm was not found in any of the surveys.

No defoliation of aspen forests was reported in the **Northwest Territories** in 1992.

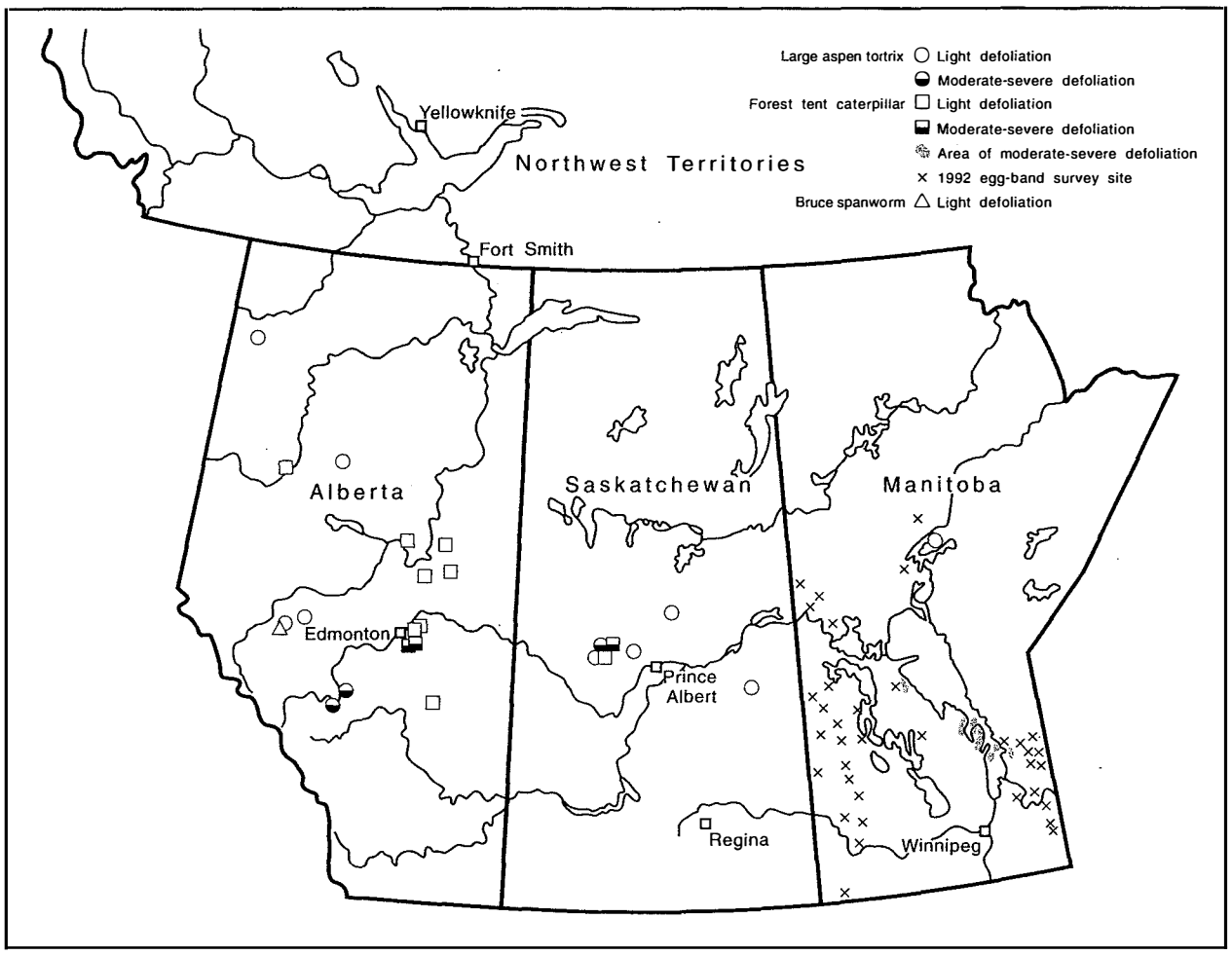

Figure 3. Areas, incidence, and severity of defoliation caused by forest tent caterpillar, large aspen tortrix, and Bruce spanworm in 1992, and locations sampled for forest tent caterpillar egg bands to predict 1993 defoliation.

Table 5. Areas of aspen forests defoliated by forest tent caterpillar in Manitoba in 1992, summarized by Section and Management Unit

Section[a]	Management Unit	Defoliated area (ha)
Lake Winnipeg East	31	311
Interlake	40	11 396
	41	37 374
	46	518
Nelson River	85	1 036
	87	518
Total		51 153

[a] Sections of Manitoba are shown in Figure 1.

BARK BEETLES

Mountain pine beetle, *Dendroctonus ponderosae* Hopk.
Spruce beetle, *Dendroctonus rufipennis* (Kby.)
Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk.

Infestations of mountain pine beetle in the region remained very low in 1992. The presence of the beetle was detected at several locations only by means of semiochemical[2] tree baits. Aerial and ground surveys to detect recent mountain pine beetle-killed trees were conducted by several provincial and federal agencies. Most of the survey effort is now aimed at detection of very low, endemic populations in areas where recent infestations have occurred and in other areas that dispersing beetles are likely to invade. There are several areas of particular concern: southwestern Alberta, including the Porcupine Hills and areas to the west, the Crowsnest Pass corridor, and areas south to Waterton Lakes National Park; Banff National Park, especially the southern end adjacent to the Spray River and Spray Lakes Reservoir, and along the Bow River valley corridor; Kootenay and Yoho national parks; Jasper National Park, especially areas adjacent to the Athabasca River and west to Mount Robson Provincial Park, and areas in the northern end of the park and in adjacent Willmore Wilderness Park; and Cypress Hills Provincial Park in Alberta and Saskatchewan.

In southwestern **Alberta**, no mountain pine beetle-killed trees were observed in areas between the Porcupine Hills and Waterton Lakes National Park. Semiochemical tree baits were again deployed at 19 sites in the southern Bow–Crow Forest. Survey results in 1992 indicated that tree attacks by mountain pine beetle occurred in the same area between Coleman and the British Columbia border as in 1991; however, fewer trees were attacked in 1992.

In the Kananaskis area, 15 semiochemical tree baits were deployed at five locations near Spray Lakes Reservoir and near Upper and Lower Kananaskis lakes. At least 10 of the baited trees were attacked by mountain pine beetle; six of them were heavily attacked and required tree removal or debarking to destroy beetle broods. In addition, two small patches of recently dead lodgepole pine—believed killed by mountain pine beetle—were observed near Mt. Kent during an aerial survey by the Alberta Forest Service.

In 1992, Parks Canada provided an aircraft and assisted in aerial surveys over portions of Banff, Kootenay, and Yoho national parks to sketch-map areas of dead and dying pine. Additional surveys for bark beetle-caused mortality over Kootenay and Yoho national parks were conducted by FIDS staff from the Pacific Forestry Centre, Victoria, British Columbia. No trees recently killed by mountain pine beetle were observed in Banff National Park, and infestations in Kootenay and Yoho national parks remained at levels similar to those of 1991. In Kootenay National Park, over 20 000 newly faded trees were reported in 1992; less than 200 were reported in Yoho National Park. Most of the infestations occurred in the same locations as in 1991. In Kootenay National Park, however, there was an increase in 1992 in the number of new patches of infestation (15–20): over 100 recently killed trees were found between Hector Gorge and the mouth of the Simpson River. The new patches indicated that in 1992 the beetle spread several kilometres eastward from previously established infestations.

No mountain pine beetle infestations were observed in Jasper National Park; however, lodgepole pine beetle (*Dendroctonus murrayanae* Hopk.) was associated with one or more dying trees near Jasper Park Lodge. The Alberta Forest Service placed 24 semiochemical tree baits in eight locations: one at the northern end of Jasper National Park and seven in Willmore Wilderness Park. Mountain pine beetle attacks occurred at two of the sites: Chown Creek in Jasper National Park, and Beaverdam Pass in Willmore Wilderness Park. All attacked trees were treated to destroy broods, either by debarking infested portions of the stems or by felling and debarking.

[2] Semiochemicals are compounds involved in the chemical interaction between organisms. They are message-bearing or behavior-modifying chemicals such as pheromones, allelochemicals, and kairomones and are produced by animals and plants.

In the Alberta portion of the Cypress Hills, 200 tree baits were deployed at 67 sites by Alberta Recreation and Parks staff. Only one adult beetle attack was reported near Graburn Creek, compared to the 18 attacks reported in 1991.

In the Cypress Hills area of **Saskatchewan**, detection surveys for mountain pine beetle were carried out by the Saskatchewan Department of Natural Resources, and included the deployment of 100 semiochemical tree baits at 50 locations. Tree baits were deployed for the ninth consecutive year. No mountain pine beetle attacks have been detected in the area since 1986.

The Alberta Forest Service conducted aerial surveys to map areas of tree mortality caused by **spruce beetle** in the Peace River and Slave Lake forests of **Alberta**. No areas of recent mortality were observed in the Slave Lake Forest. In the Peace River Forest, however, several patches of tree mortality were scattered in the Clear Hills and extended northeastward to the Hawk Hills and to areas along the Kemp River. Patches of recently killed or dying trees (up to 10% within stands) were scattered over an estimated 4000 ha of mature white spruce forests.

The origin of the spruce beetle outbreak was attributed, in part, to a storm that caused extensive damage in late May, 1989. Trees with tops broken by heavy wet snow became infested by the spruce beetle in 1989 and 1990, allowing beetle population build up and spread to present levels. In one of the infestations located about 50 km north of Manning, semiochemical-baited traps have been deployed annually since 1987, and their catch results have reflected an increasing population trend since 1989 (Table 6).

Several small areas were harvested during the winter of 1991–92 to salvage some of the beetle-killed trees, and additional areas are scheduled for harvesting during 1992–93. In addition, the province deployed semiochemical tree baits and felled trap trees as strategies to help suppress spruce beetle populations in one of the infestations in the Hawk Hills.

The infestation of **Douglas-fir beetle** in **Alberta**, which was initially reported to have killed about 50 Douglas-fir trees in 1991 in Jasper National Park, expanded in 1992. Aerial and ground surveys conducted by Parks Canada identified about 31 new infestation patches in 1992 with a total of over 200 recently killed trees. The patches were scattered along the Athabasca River valley, in areas adjacent to the Jasper townsite and Jasper Park Lodge, and at several locations up to 15 km north and south of Jasper.

Several trees recently killed by Douglas-fir beetle were cut and removed to reduce the hazard of falling trees in high-use areas. At two of the infestation sites, traps baited with experimental semiochemicals were deployed in cooperation with Parks Canada to attract and collect adult Douglas-fir beetles. The trapping results were considered successful in providing data on flight duration and relative abundance, and they indicate a potential use in direct control strategies.

Table 6. Summary of spruce beetles captured in Lindgren funnel traps baited with semiochemicals[a] during 1987–92 near Hawk Hills, Alberta

Year	Number of traps	Number of trapping days	Trapping period	Rate of catch (Number of beetles/ trap/trapping day)
1987	7	48	May 31 – July 1	1.22
1988	14	86	May 10 – August 4	0.09
1989	5	55	May 31 – July 25	0.02
1990	12	56	June 5 – July 31	0.66
1991	10	30	May 21 – June 20	1.66
1992	8	47	May 11 – July 6	3.78

[a] All traps were baited with the same semiochemicals each year, had approximately the same release rates, and were within the same mature white spruce stand.

DUTCH ELM DISEASE
Ophiostoma ulmi (Buis.) Nannf.

In **Alberta**, surveys to detect the incidence of Dutch elm disease (DED) were conducted by the staff of Alberta Agriculture. There were no reports of the disease in the province.

In **Saskatchewan**, three new locations were recorded as having DED-infected elms: Brokenshell Creek west of Weyburn, and the towns of Carnduff and Carrot River (Fig. 4). Detection of these new infections was made possible through the cooperation of the provincial Dutch Elm Disease Program staff, the Saskatchewan Dutch Elm Disease Committee, and the public. In 1992, intensive ground surveys were conducted in Estevan's 2-km-wide buffer zone and in the Wascana Creek area known to be infested west of Regina. In total, 70 elms were marked and removed in the Estevan buffer zone, and 60 were marked and removed along Wascana Creek. In addition to ground surveys, one aerial survey was conducted along the South Saskatchewan River from Prince Albert to Diefenbaker Lake, the western portion of the Qu'Appelle River valley, and Moose Jaw Creek and its tributaries. More aerial surveys are planned for 1993.

Staff of the provincial Dutch Elm Disease Program distributed traps baited with elm bark beetle pheromone (an attractant mainly to the smaller European elm bark beetle (*Scolytus multistriatus* [Marsh.])) to 29 communities for deployment,

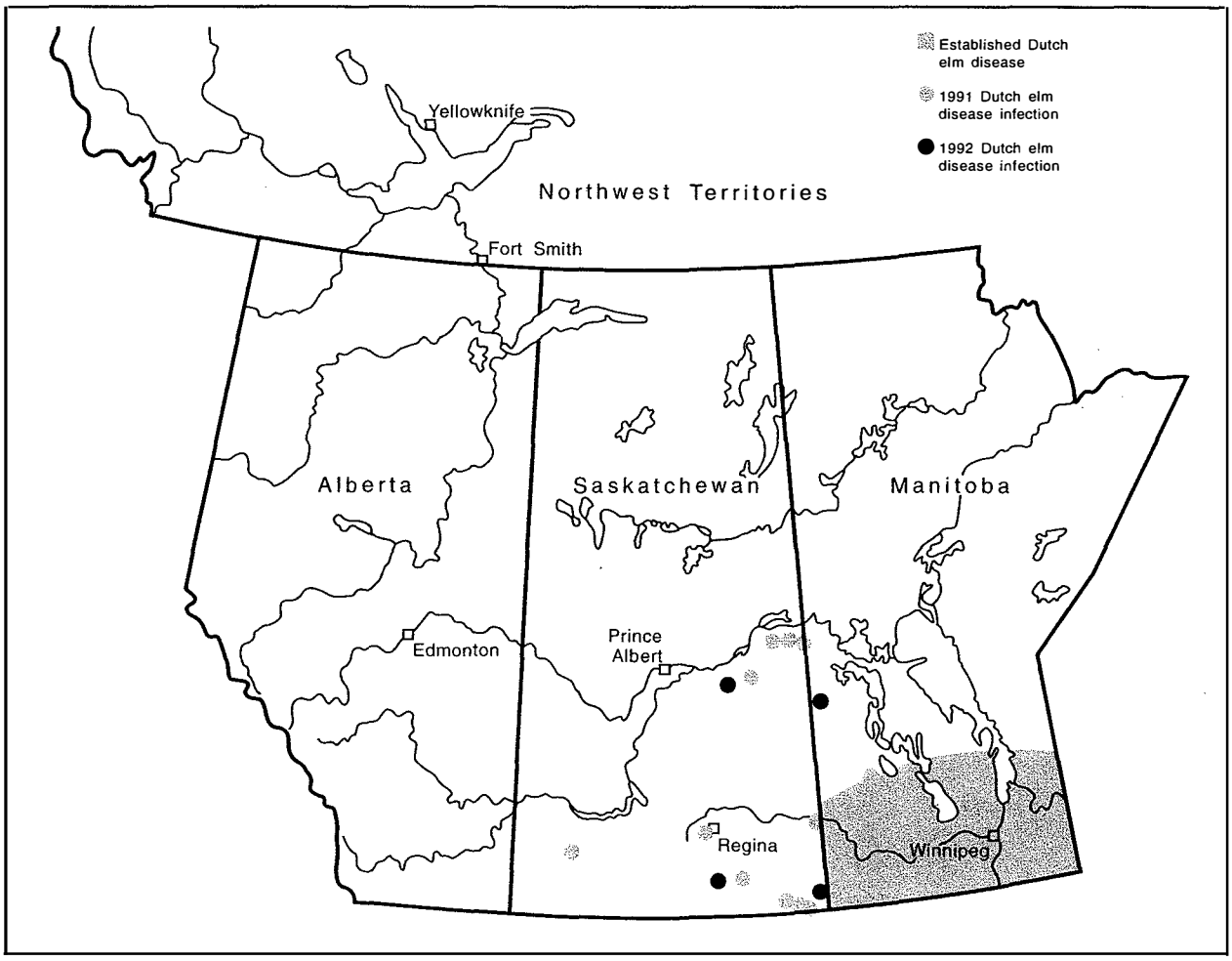

Figure 4. Distribution of Dutch elm disease in the prairie provinces in 1992, and infections identified in Manitoba and Saskatchewan in 1991 and 1992.

which aided in the detection of elm bark beetles around these communities. At least 12 specimens of *S. multistriatus* and over 200 native elm bark beetles (*Hylurgopinus rufipes* [Eichh.]), were trapped in Regina. Both species are important vectors of DED. No *S. multistriatus* was trapped at any other location, but one specimen of *H. rufipes* was collected in each of two locations: near Carrot River and at Outlook.

A bark-feeding weevil (*Magdalis armicollis* [Say]), which was reported to be attacking elms in Saskatoon in 1991, caused similar injury to elms at Waskana Centre in Regina in 1992. This weevil breeds under the bark of an injured or stressed tree and girdles branches in the crown. It is possible that this species is also a vector capable of transmitting the DED fungus.

The public education program on DED was continued in 1992: DED workshops and radio, newspaper, and television advertisements were used to better inform Saskatchewan residents of this disease of elm.

In **Manitoba**, 42 communities participated in the 1992 cost-shared DED program involving Manitoba Natural Resources and individual municipalities. This program included sanitation pruning, basal spraying with insecticide to reduce beetle vector populations, and replacement plantings. The Elm Guard Program was continued with a volunteer group assisting in the detection of DED-infected elms.

The survey by Manitoba Natural Resources detected a new infection on three trees in Swan River. This extends the range of known DED northward by about 90 km. An aerial survey was made by Manitoba Natural Resources of areas between The Pas and the Manitoba–Saskatchewan border to determine if any new infections had advanced into Manitoba from the Carrot River valley in Saskatchewan; no suspect trees were observed.

In 1991–92, 16 000 diseased and hazardous elm trees were removed in Manitoba. In 1992–93, another 13 400 trees will be removed: 5850 in Winnipeg, 247 in Brandon, and the remainder in outlying communities. The reduction in the number of infected elm trees in 1992 may be the result of the cool, moist weather, which reduced the level of stress for elm. Overall, incidence of tree loss from DED remains around 2% in Manitoba.

GYPSY MOTH *Lymantria dispar* (L.)

Gypsy moth trapping surveys were completed in all three prairie provinces in 1992 by Agriculture Canada in conjunction with other agencies. In **Alberta**, 465 pheromone-baited traps were placed at various locations throughout the province: in Banff, Jasper, and Waterton Lakes national parks; in Calgary, Drumheller, Edmonton, and Red Deer; and in 47 provincial parks. No male gypsy moths were captured. Egg-mass surveys in Moose Jaw, Calgary, and Drumheller—locations where male moths were trapped in 1991—were all negative.

In **Saskatchewan**, 101 traps were set out across the province: 15 by Forestry Canada and 86 by Agriculture Canada. No moths were captured this year, in comparison to the single moth trapped in Moose Jaw in 1991, even though the number of traps was doubled in 1992.

In **Manitoba**, 319 traps were placed throughout the province, most south of Trans-Canada Highway 1, and the remainder in Riding Mountain National Park and the beach areas of Lake Manitoba and Lake Winnipeg. Positive trappings occurred only in Birds Hill Provincial Park (one moth) and in Shilo, southeast of Brandon (one moth).

ABIOTIC FACTORS AFFECTING FORESTS

Late spring frost was the most devastating abiotic factor affecting new buds and shoots of spruce, new foliage of aspen, and flower shoots and buds of balsam poplar. Frosts occurred during

mid-to-late May when temperatures dropped to –4 to –6°C. Aspen, white and black spruce, and balsam poplar were severely affected in many areas of **Alberta** and **Saskatchewan**. Aspen foliage turned brown or crown dieback occurred in east-central Alberta, in Delburne, St. Paul, and Vermilion, and in west-central Saskatchewan, in Meadow Lake. These areas were subjected to forest tent caterpillar defoliation during the 1980s as well as late frost in 1986 and 1987, which may have increased the susceptibility of these trees to the late frosts that occurred in 1992. Other areas of Alberta where aspen growth was poor and/or dieback occurred were around the Wapiti River and Grande Prairie, and between Entwistle and Drayton Valley.

Drought has affected forest trees around St. Paul in **Alberta** for eight consecutive growing seasons, and trees in the area show symptoms of stress. In 1992, extensive jack pine mortality was observed southeast of St. Paul in Whitney Lakes Provincial Park and the surrounding forest (about 2500 ha). Drought conditions may also have predisposed the aspen in this area to frost damage.

Storm damage affected areas of Jasper National Park in **Alberta**, and Mt. Robson Provincial Park in **British Columbia**. Storm damage resulting from wind and wet snow was observed between Jasper and Yellowhead Lake along the north-facing slopes of the mountains. Damage included yellowing of needles and dieback on lodgepole pine.

Red belt injury was observed in **Alberta**, on the west-facing mountainsides above Fiddle River in Jasper National Park. The cause of this injury relates to the rapid changes in temperature conditions.

PESTS AND DAMAGE CONDITIONS IN YOUNG STANDS

During 1992, young, high-value, coniferous stands, including seed orchards and genetic improvement plantations, were surveyed for insects, diseases, and other damage agents: in **Alberta**, near or in the Bow–Crow and Rocky–Clearwater forests, Swan Hills, and Grande Prairie; in **Saskatchewan**, in the Hudson Bay, Meadow Lake, and Prince Albert regions; and in **Manitoba**, in the Lake Winnipeg East Section. The information from these surveys is summarized by locality and insect pest in Table 7 and by locality and fungal pest in Table 8.

Natural stands were healthy, with trees within the stands classified as 81–93% healthy, 1–17% declining, and 1–7% dead. Lodgepole pine trees at the Swan Hills genetic plantation were classified as 94% healthy, 0.6% declining, and 5.1% dead, while Siberian larch trees at the Judy Creek genetic plantation were classified as 74% healthy, 4% declining, and 22% dead. The high mortality at the Judy Creek plantation was caused by Armillaria root rot (*Armillaria ostoyae* [Romag.] Herink).

On lodgepole pine, northern pitch twig moth (*Petrova albicapitana* [Bsk.]), pine needle casts (*Lophodermella concolor* [Dearn.] Darker and *Davisomycella ampla* [Davis] Darker), and western gall rust (*Endocronartium harknessii* [J.P. Moore] Y. Hiratsuka) were the most prevalent pests. On white and black spruce, spruce gall adelgid (*Adelges lariciatus* [Patch]) was relatively common, while Venturia leaf and shoot blight (*Venturia macularis* [Fr.] E. Müller & Arx) was the most prevalent pest of aspen. Armillaria root rot was present at all sites examined, with incidence ranging between 2 and 22%.

Table 7. Summary (by percentage of trees affected) of important insect pests[a] and other agents causing injury to young, high-value, coniferous stands in Alberta, Saskatchewan, and Manitoba in 1992

Location	Host species	Frost	J-root deformation	Mechanical/ browse	Northern pitch twig moth	Pine spittlebug	Root collar weevils[b]	Spruce bud midge	Spruce budworm	Spruce gall adelgid	Terminal weevils
Alberta											
Bow–Crow Forest	Lodgepole pine	–[c]	–	–	0.7	–	0.4	–	–	–	3.2
	White spruce	–	–	–	–	–	–	–	–	–	–
	Black spruce	–	–	–	–	–	–	–	–	–	–
	All species	–	–	3.2	–	–	–	–	–	–	–
Rocky–Clearwater Forest	Lodgepole pine	–	–	–	–	–	0.9	–	–	–	0.6
	White spruce	–	–	–	–	–	–	–	–	33.3	–
	Black spruce	–	–	–	–	–	–	–	–	–	–
	Aspen	–	–	–	–	–	–	–	–	–	–
	All species	–	–	0.1	–	–	–	–	–	–	–
Swan Hills genetic plantation	Lodgepole pine	–	24.4	0.2	68.2	–	0.8	–	–	–	2.0
Judy Creek genetic plantation	Siberian larch	–	–	1.3	–	–	–	–	–	–	–
Huallen genetic plantation	Lodgepole pine	–	–	0.6	60.7	–	–	–	–	–	–
Saskatchewan											
Prince Albert Region	Jack pine	–	–	–	41.1	4.2	0.4	–	–	–	10.7
	Scots pine	–	–	–	24.0	12.0	–	–	–	–	4.0
	Siberian larch	–	–	–	–	–	–	–	–	–	–
	White spruce	–	–	–	–	–	–	–	–	–	–
	All species	–	0.9	–	–	–	–	–	–	–	–
Hudson Bay Region	Jack pine	–	8.4	–	15.1	–	–	–	–	–	–
	White spruce	2.4	6.3	–	–	–	–	3.9	–	–	–
	Black spruce	17.9	–	–	–	–	–	–	–	–	–
	All species	–	–	0.6	–	–	–	–	–	–	–
Meadow Lake Region	Jack pine	–	–	1.5	27.7	–	–	–	–	–	10.8
Manitoba											
Lake Winnipeg East Section	Black spruce	4.5	–	–	–	–	–	–	11.6	–	–

[a] Insect pests: northern pitch twig moth (*Petrova albicapitana* [Bsk.]); pine spittlebug (*Aphrophora cribrata* [Wlk.]); root collar weevils (*Hylobius warreni* Wood and *H. radicis* Buch.); spruce bud midge (*Rhabdophaga swainei* Felt); spruce budworm (*Choristoneura fumiferana* [Clem.]); spruce gall adelgid (*Adelges lariciatus* [Patch]); and terminal weevils (*Pissodes terminalis* Hopping and *P. strobi* [Peck]).

[b] Percentage of root collar weevils indicates mortality caused by these pests, not total incidence.

[c] No injury.

Table 8. Summary (by percentage of trees affected) of important fungal pests[a] causing injury to young, high-value, coniferous stands in Alberta, Saskatchewan, and Manitoba in 1992

Location	Host species	Armillaria root rot[b]	Atropellis canker	Large-spored spruce–Labrador tea rust	Comandra blister rust	Melampsora leaf rust	Pine needle casts	Venturia leaf and shoot blight	Western gall rust
Alberta									
Bow–Crow Forest	Lodgepole pine	2.0	3.4	–[c]	–	–	18.8	–	11.1
	White spruce	–	–	–	–	–	–	–	–
	Black spruce	–	–	–	–	–	–	–	–
Rocky–Clearwater Forest	Lodgepole pine	5.9	–	–	–	–	1.0	–	2.7
	White spruce	–	–	–	–	–	–	–	–
	Black spruce	–	–	4.9	–	–	–	–	–
	Aspen	–	–	–	–	4.2	–	94.4	–
Swan Hills genetic plantation	Lodgepole pine	0.6	–	–	–	–	0.6	–	16.1
Judy Creek genetic plantation	Siberian larch	22.5	–	–	–	–	–	–	–
Huallen genetic plantation	Lodgepole pine	–	–	–	1.0	–	–	–	5.3
Saskatchewan									
Prince Albert Region	Jack pine	–	–	–	–	–	–	–	12.1
	Scots pine	–	–	–	–	–	–	–	4.0
	Siberian larch	–	–	–	–	–	–	–	–
	White spruce	–	–	–	–	–	–	–	–
	All species	1.8	–	–	–	–	–	–	–
Hudson Bay Region	Jack pine	–	–	–	–	–	–	–	6.1
	White spruce	–	–	–	–	–	–	–	–
	Black spruce	–	–	–	–	–	–	–	–
	All species	0.7	–	–	–	–	–	–	–
Meadow Lake Region	Jack pine	–	–	–	–	–	–	–	16.9
Manitoba									
Lake Winnipeg East Section	Black spruce	–	–	–	–	–	–	–	–

[a] Fungal pests: Armillaria root rot (*Armillaria ostoyae* [Romag.] Herink); Atropellis canker (*Atropellis piniphila* [Weir] Lohman & Cash; large-spored spruce–Labrador tea rust (*Chrysomyxa ledicola* Lagh.); Comandra blister rust (*Cronartium comandrae* Pk.); Melampsora leaf rust (*Melampsora medusae* Thuem.); pine needle casts (*Lophodermella concolor* [Dearn.] Darker and *Davisomycella ampla* [Davis] Darker); Venturia leaf and shoot blight (*Venturia macularis* [Fr.] E. Müller & Arx); and western gall rust (*Endocronartium harknessii* [J.P. Moore] Y. Hiratsuka).

[b] Percentage of Armillaria root rot indicates mortality caused by this pest, not total incidence.

[c] No injury.

Surveys were initiated in 1992 within trembling aspen forests in the three prairie provinces to monitor the incidence, distribution, and relative abundance of important insect and disease pests and other damage agents, defects, and tree mortality. This survey, to extend over three or more years, utilized the permanent sample plot (PSP) sites selected previously by the provinces for inventory measurement. Data were selected from 11 PSP sites in **Alberta**, 9 PSP sites in **Saskatchewan**, and 17 PSP sites and one ARNEWS (Acid Rain National Early Warning System) plot site in **Manitoba** (Fig. 5; Table 9). All aspen that had been previously tagged, numbered, and measured were included in the survey. Aboveground tree components were examined for insect and disease injury on all living trees, while on recently dead or dying trees the root collar base was examined nondestructively for insect- and fungus-caused injury to identify the likely causal agent (Table 9).

General site characteristics of the PSPs surveyed varied from dry to moist. Ages of the stands also varied widely: from less than 20 years to over 80 years. In this first stage of analysis, trees from all sites were pooled together, regardless of stand age, crown class, stand density, or site class. These factors will be examined in more detail after more data have been accumulated.

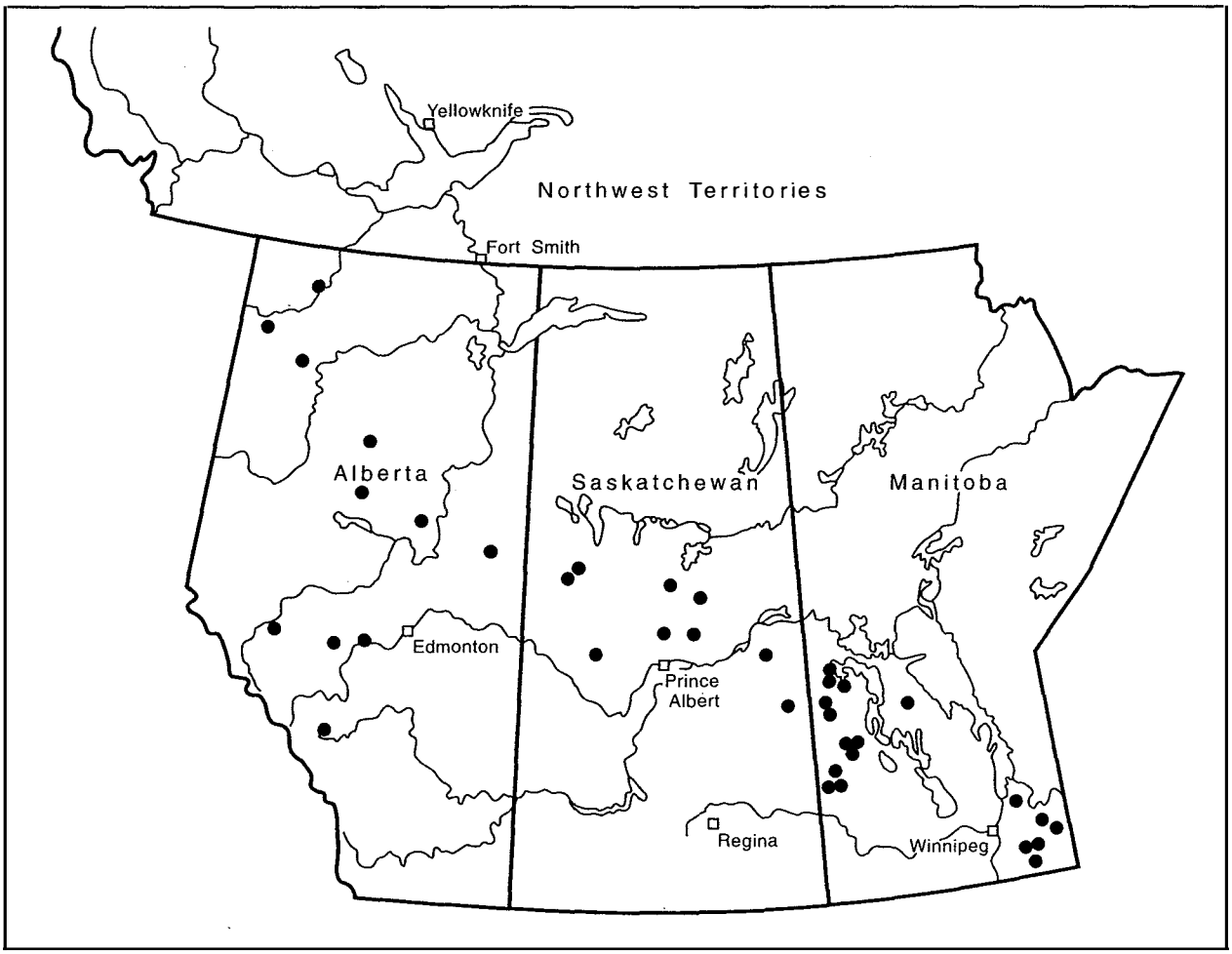

Figure 5. Locations of permanent sample plots used for surveying trembling aspen forests in Alberta, Saskatchewan, and Manitoba in 1992.

Table 9. Summary of incidence (by percentage of trees affected) of important insects and diseases or of condition of trembling aspen surveyed on permanent sample plots in Alberta, Saskatchewan, and Manitoba in 1992

Damage agent or tree condition	Alberta	Saskatchewan	Manitoba
Number of sites sampled	11	9	18
Total trees sampled	1301	684	979
		Affected trees (% of total)	
Aspen defoliators[a] *Choristoneura conflictana* (Wlk.) *Malacosoma disstria* Hbn.	8.2	33.6	11.5
Poplar borer *Saperda calcarata* Say	0.4	4.8	1.1
Armillaria root rot[b] *Armillaria* sp.	<1.0	<1.0	3.6
Hypoxylon canker *Hypoxylon mammatum* (Wahl.) J.H. Miller	<5.0	<5.0	1.0
False tinder conk *Phellinus tremulae* (Bond.) Bond. & Boriss.	6.0	3.4	5.5
Stem-staining fungus *Peniophora polygonia* (Pers.:Fr.) Boud.	20.2	6.4	8.0
Top dieback[c]	7.8	9.9	6.9
Dying and dead trees	15.6[d]	41.4[d]	21.1[d]
Other[e]	39.9	11.5	20.8

[a] Levels of defoliation varied widely from trace to moderate or severe; defoliation was due mostly to large aspen tortrix (*C. conflictana*).

[b] Values are for trees that died from this disease only. Since sampling was nondestructive, incidence of this disease may have been higher.

[c] Top dieback = partial mortality of shoots and branches in the upper crown.

[d] Values for Alberta: 3.5% dying, 3.6% dead 1–2 years, and 8.5% dead 2+ years; values for Saskatchewan: 12.6% dying, 4.5% dead 1–2 years, and 24.3% dead 2+ years; values for Manitoba: 5.6% dying, and 15.5% dead 1+ years.

[e] Other factors include frost cracks, mechanical injury, and partial girdling by hares or other animals, and major defects such as forked stems, severe lean, broken top, and twisted stem.

NURSERY PEST SURVEY

During July 1992, a pest survey was undertaken in **Alberta**, at the Pine Ridge Forest Nursery near Smoky Lake. Nursery stock inspected included bare-root, 2–0, and 3–0 white spruce seedlings and container-grown white spruce, and bare-root lodgepole pine seedlings. Additionally, nursery seed orchards and other trees in the nursery were inspected for pests.

In the seedling beds, up to 70% of the white spruce seedlings had frost tip injury. This was a result of frosts during mid- to late May. Throughout spruce and pine seedling beds there was evidence of a damping-off disease, probably a *Fusarium* species. The only insect observed was a woolly aphid species (probably *Adelges* or *Pineus* sp.), which was abundant on many developing shoots of white

spruce, but resulting damage was negligible. Some seedlings showed evidence of root crown girdling, which may have been caused by strawberry root weevil (*Otiorhynchus ovatus* [L.]), although no adults or larvae were observed.

In the greenhouse where white spruce was being grown in containers, there was low incidence of browsing of terminal shoots (probably caused by mice), and some seedlings succumbed to a damping-off fungus—again, probably a *Fusarium* species.

The white spruce seed orchard located on nursery lands contained several insect pests: spruce spider mite (*Oligonychus ununguis* [Jac.]); yellow-headed spruce sawfly (*Pikonema alaskensis* [Roh.]); white pine weevil (*Pissodes strobi* [Peck]); and a *Dioryctria* species. All these species were present at low population levels and caused insignificant damage. Frost injury to the terminal buds of white spruce was common.

Other tree species located in the nursery were damaged by biotic and abiotic agents: white birch was infested with birch leafminer (*Fenusa pusilla* [Lep.]); green ash sustained light frost injury; and aspen had Cytospora canker (*Leucostoma* sp.), Venturia leaf and shoot blight, and a gall-forming insect (species unidentified) on a branch.

BALSAM FIR MORTALITY SURVEY

Balsam fir mortality has been noted in the Slave Lake, Athabasca, Lac La Biche, Whitecourt, and Grande Prairie forests of **Alberta** for the past several years. Forestry Canada was asked by the Alberta Forest Service to investigate the cause of this mortality.

Balsam fir can be found dying singly or in patches of varying sizes within these Forest districts. In 1992, permanent, fixed-area plots were established in stands in Slave Lake Forest and in Winston Churchill Provincial Park near Lac La Biche. These plots were established to monitor the health of the trees and to determine mortality rates. Dead and dying balsam fir within and outside the plots (a total of 163 trees) were examined for signs and symptoms of insect and disease. There was no evidence of defoliation or disease in the stems of the trees. Armillaria root rot was found in 79% of the dead and dying trees; the species involved were *A. ostoyae* and *A. sinapina* Bérubé & Dessureault. It is unknown at this time whether Armillaria root rot is responsible for the mortality or is secondary in nature. Some recently dead trees had bark beetle (species unidentified) and bark weevil (*Pissodes* sp.) infestations in the lower boles and root collar areas, but these infestations were believed to be secondary. This balsam fir mortality was similar to a condition reported in the Maritimes as Stiilwell's Syndrome, which was associated with spruce budworm defoliation (Moody 1988). Balsam fir mortality in Alberta in 1992 was not associated with spruce budworm defoliation.

ACID RAIN MONITORING

The Acid Rain National Early Warning System (ARNEWS) was established in 1984 to detect symptoms of acid rain injury to forests. Twelve permanent sample plots were established in the Northwest Region at that time: five in **Alberta**, three in **Saskatchewan**, and four in **Manitoba**. In 1991, five new plots were established: one in Saskatchewan, two in Alberta, and two in the Northwest Territories. The four new plots in Alberta and the Northwest Territories included trembling aspen and white spruce as the dominant species components. The 17 ARNEWS plots now in the Northwest Region are part of a permanent, nationwide network of plots where changes in soil, minor vegetation, tree condition, tree growth, and insect and disease incidence are detected and monitored.

During August and September, 1992, the 12 long-established regional plots were visited and assessed for acid rain symptoms and pests; data were completed for Forms 4, 7, 8, 9, and 10 (mixedwoods) or Forms 4, 7, and 8 (conifers) or Forms 4, 9, and 10 (hardwoods) (Magasi 1988). No symptoms associated with acid rain were observed at any of the 12 original sites.

Some of the insects and diseases that caused injury noted at sites in **Alberta** included *A. ostoyae*; Atropellis canker (*Atropellis piniphila* [Weir] Lohman & Cash); northern pitch twig moth; tar spot needle cast (*D. ampla*); and large-spored spruce–Labrador tea rust (*Chrysomyxa ledicola* Lagh). In **Saskatchewan**, pests observed on ARNEWS plots were dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.); large aspen tortrix; and spruce budworm. In **Manitoba**, only one important pest was observed: western gall rust.

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APPENDIX

NOTEWORTHY INSECTS, DISEASES, AND OTHER DAMAGE AGENTS

Insect, disease, or damage agent	Host	Location	Remarks
Ambrosia beetle *Trypodendron retusum* (LeC.)	Aspen	Saskatchewan	Specimens collected from dying aspen near Candle Lake in late April.
Armillaria root rot *Armillaria ostoyae* (Romag.) Herink	Pine species	Alberta Saskatchewan	Infection centers found throughout most of the region.
Aspen serpentine leafminer *Phyllocnistis populiella* (Cham.)	Aspen	NWT	Observed at low population densities throughout Fort Liard, Fort Simpson, and Trout Lake areas.
Atropellis canker *Atropellis piniphila* (Weir) Lohman & Cash	Pine	Alberta	Commonly found on lodgepole pine near Rocky Mountain House.
Birch leafminers *Fenusa pusilla* (Lep.) *Profenusa thomsoni* (Konow) *Heterarthrus nemoratus* (Fall.)	Birch	Alberta	Moderate-to-severe leaf mining, caused mostly by *P. thomsoni*, occurred throughout north-central Alberta, Jasper National Park, and most urban areas. An infestation of *H. nemoratus* occurred near Slave Lake.
Birch skeletonizer *Bucculatrix canadensisella* Cham.	White birch	Alberta	Moderate-to-severe injury noted in Grande Prairie, Whitecourt, and Slave Lake forests for the second consecutive year.
Cottonwood leaf beetle *Chrysomela scripta* F.	Poplar	Alberta	Severe damage to balsam poplar noted at Lesser Slave Lake Provincial Park, Alberta.
Cyclaneusma needle cast *Cyclaneusma minus* (Butin) DiCosmo, Peredo and Minter	Mugho pine	Alberta	Collected from mugho pine in Edmonton. First report in Alberta on hard pines.
Cytospora canker *Leucostoma kunzei* var. *piceae* (Fr.) Munk	Colorado spruce White spruce	Manitoba	Damage observed on spruce shelterbelts.

NOTEWORTHY INSECTS, DISEASES, AND OTHER DAMAGE AGENTS (continued)

Insect, disease, or damage agent	Host	Location	Remarks
Dothiorella wilt *Dothiorella ulmi* Verrall & May	American elm	Alberta	Crown wilt and defoliation occurred on isolated street trees in Edmonton. First report in Alberta.
Dwarf mistletoe *Arceuthobium americanum* Nutt. ex Engelm.	Pine	Alberta Saskatchewan Manitoba	Important cause of degrade and mortality in commercial pine stands in the prairie region.
Fir–fireweed needle rust *Pucciniastrum epilobii* Otth	Balsam fir	Alberta	Observed on fir near Rocky Mountain House.
Gray willow leaf beetle *Tricholochmaea decora* (Say)	Willow	Alberta	Moderate-to-severe defoliation noted between Wandering River and Fort McMurray and from Fort Vermilion to just north of High Level.
Great ash sphinx *Sphinx chersis* (Hbn.)	Green ash	Alberta	Observed in Jasper on newly transplanted green ash from Calgary.
Lace bug *Corythucha* spp.	Poplar	Alberta	Noted on balsam poplar near Lesser Slave Lake Provincial Park.
Large-spored spruce–Labrador tea rust *Chrysomyxa ledicola* Lagh.	Spruce	Alberta	Moderate-to-severe infestations observed from Mariana Lake north along Highway 63 toward Fort McMurray, throughout the Stoney Mountain escarpment, and southwest of Rocky Mountain House.
Lodgepole pine beetle *Dendroctonus murrayanae* Hopk.	Lodgepole pine	Alberta	Several infested trees found in Jasper National Park.
Lodgepole terminal weevil *Pissodes terminalis* Hopping	Jack pine Lodgepole pine	Alberta Saskatchewan	Jack pine regeneration (about 2 m high) infested in central Saskatchewan. Common on lodgepole pine (2–7 m high) near Hinton, Alberta.
Northern pitch twig moth *Petrova albicapitana* (Bsk.)	Pine	Alberta	High population observed attacking lodgepole pine near Rocky Mountain House.

NOTEWORTHY INSECTS, DISEASES, AND OTHER DAMAGE AGENTS (continued)

Insect, disease, or damage agent	Host	Location	Remarks
Pine needle casts *Lophodermella concolor* (Dearn.) Darker *Davisomycella ampla* (Davis) Darker *Elytroderma deformans* (Weir) Darker	Pine	Alberta	Needle cast *L. concolor* found at light-to-severe levels around Lake Louise, Castle Mountain, Banff, and Kananaskis; *D. ampla* observed on lodgepole pine near Rocky Mountain House; and *E. deformans* caused moderate needle casting near Sundre.
Poplar borer *Saperda* sp.	Aspen Poplar	NWT	Borer (probably *S. calcarata*) observed throughout the areas of Fort Liard, Fort Simpson, and Trout Lake, primarily on poplar.
Root collar weevils *Hylobius warreni* Wood *H. radicis* Buch.	Lodgepole pine Scots pine	Alberta Manitoba	Mortality caused by *H. warreni* noted in the Caroline–Sundre area and near Rocky Mountain House in Alberta. Mortality caused by *H. radicis* occurred near Belair, Manitoba.
Saprophytic fungus *Tryblidiopsis pinastri* (Fr.) Karst.	Spruce	Saskatchewan	Fungus, known to be mildly parasitic, found on dead branches and stems near Candle Lake.
Snowshoe hare *Lepus americanus* Erxleben	Jack pine White spruce	Saskatchewan	Tree mortality of 25% noted in a stand of young jack pine and white spruce southeast of Hudson Bay at Woody Lake.
Spotted willow leaf beetle *Chrysomela k. knabi* Brown	Willow	British Columbia	Severe defoliation observed along Tokumm Creek in Kootenay National Park, British Columbia, adjacent to Banff National Park, Alberta.
Spruce budmoth *Zeiraphera canadensis* Mut. & Free.	Spruce	Saskatchewan	Severe defoliation of young spruce occurred north of Hudson Bay.
Spruce gall adelgids *Adelges cooleyi* (Gill.) *A. lariciatus* (Patch) *A. strobilobius* (Kltb.)	Spruce	Alberta Saskatchewan	All three adelgids commonly observed throughout northern and western Alberta and northwestern Saskatchewan.

NOTEWORTHY INSECTS, DISEASES, AND OTHER DAMAGE AGENTS (concluded)

Insect, disease, or damage agent	Host	Location	Remarks
Spruce gall midge *Mayetiola piceae* (Felt)	Spruce	Alberta Saskatchewan	Severe damage observed at Hutch Lake north of High Level, Alberta, and southwest of Hudson Bay, Saskatchewan. In some parts of the infestation areas, some bud and shoot kill possibly incorrectly attributed to frost kill or damage by spruce budworm.
Spruce spider mite *Oligonychus ununguis* (Jac.)	Spruce	Alberta	Severe damage occurred in Edmonton and in shelterbelts in areas near Grande Prairie affected by drought.
Sulphur dioxide damage (SO_2)	Aspen	Alberta	Light damage attributed to SO_2 noted on aspen in the Fort McMurray area.
Verticillium wilt *Verticillium albo-atrum* Reinke & Berth.	Elm	Saskatchewan	One infected tree found in each of four locations: North Battleford, Saskatoon, Shaunavon, and Swift Current.
Wetwood or Slime flux	Elm	Manitoba	Numerous reports of this symptom (caused by a bacterium) received from landowners in Manitoba.
White pine weevil *Pissodes strobi* (Peck)	Spruce	Alberta	Commonly found on roadside trees and plantations throughout the north-central region of Alberta and Saskatchewan.
Willow leaf miner *Micrurapteryx salicifoliella* (Cham.)	Willow	Alberta	Severe damage observed from Alberta/NWT border to just north of High Level. This pest found in association with *Tricholochmaea decora.*
Wood borers *Monochamus scutellatus* (Say) *Tetropium cinnamopterum parvulum* Casey	Spruce	Alberta	Both species continued to cause degrade in lumber at a mill in High Level.