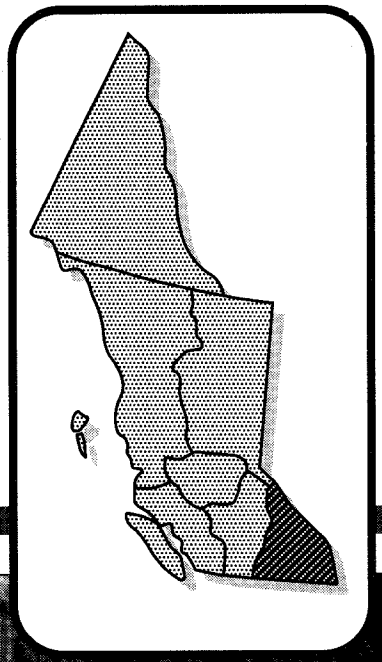
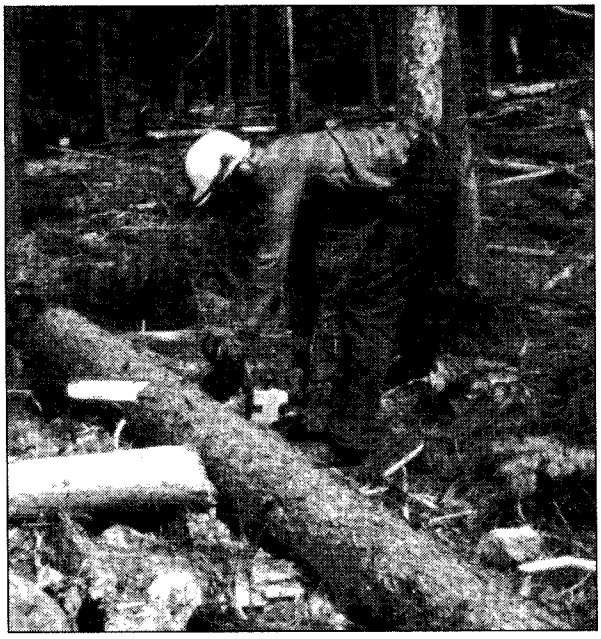
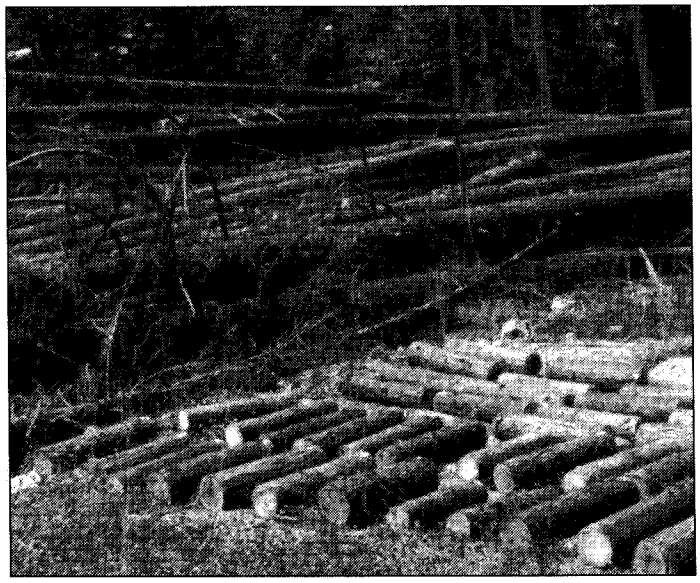


Forest Insect and Disease Conditions

Nelson Forest Region • 1992

Leo Unger and Alan Stewart





Forestry Canada Forêts Canada

Canada

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Foreward

The Forest Insect and Disease Survey (FIDS) is a national unit within Forestry Canada responsible for:

(1) producing an overview of forest pest conditions and their implications, including predictions when possible;

(2) maintaining records and surveys to support quarantines;

(3) supporting forestry research, herbaria and insect collections;

(4) providing advice and extension on forest insects and diseases;

(5) developing and testing survey techniques; and

(6) conducting related biological and impact studies.

The cooperation of federal, provincial and local government agencies, industry, and academic establishments is essential to effectively fulfill these responsibilities and is greatly appreciated.

During the field season, from May to October, correspondence can be directed to:

Forest Insect and Disease Survey
Box 120
Wasa, B.C.
V0B 2K0 Ph. 422-3465

Forest Insect and Disease Survey
Box 7
New Denver, B.C.
V0G 1S0 Ph. 358-2264

or throughout the year to:

Forest Insect and Disease Survey
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5
Ph. 363-0673

Additional copies of this report and copies of related publications such as provincial and national pest survey overviews, forest pest leaflets, and regional forest pest histories can be obtained from FIDS at the above addresses.

Introduction

This report outlines forest insect and disease conditions in the Nelson Forest Region and Kootenay, Yoho, Glacier, and Mt. Revelstoke National parks in 1992, highlighting pests that cause forest management problems and forecasting population trends. Pests are discussed by host, in order of importance, often within the context of a management unit or Timber Supply Area (TSA).

The 1992 field season extended from mid-May to mid-October when about 150 insect and disease collections were submitted to the Pacific Forestry Centre. About 200 contacts and on-site pest examinations were made with a wide range of individuals and groups, including the B.C. Forest Service, industry, parks, media, and private individuals. New slide and video documentation of numerous pest concerns was collected to update existing files. About 46 hours of fixed-wing aerial survey time and assistance in producing preliminary sketch maps was provided by the B.C. Forest Service.

In this report, incidences of trees killed by bark beetles are defined as: **light** - <10% of a stand; **moderate** - 10 to 30%; **severe** - >30%. Defoliation is defined by intensity as: **light** - <25% of foliage gone, usually limited to the upper crown; **moderate** - 25 to 65% defoliation, usually extending down through the mid-crown; **severe** - >66% defoliated, usually throughout the crown.

The following related information is available upon request:

* Maps of major beetle and defoliator outbreaks, Nelson Forest Region, 1992.
* Summary of pest problems in provincial parks, Nelson Forest Region, 1992.
* Summary of pest problems in young stands, Nelson Forest Region, 1992.
* Pest reports mailed out during the year:

- Status of mountain pine beetle in the East Kootenay.
- Pine needle scale in the Pacific and Yukon Region.
- Forest pest outbreaks in the West Kootenay: an early season update.
- Mountain pine beetle outbreak in the West Kootenay: early season update.
- Satin moth outbreak in the Boundary Forest District.
- Western spruce budworm in the Kamloops, Nelson, and Vancouver Forest Regions.
- Summary of forest pest conditions in the East Nelson region.
- Poplar Pathology surveys and research in the Pacific Region.
- Western spruce budworm in British Columbia 1992 and forecast for 1993.
- Outbreak of the western hemlock looper in British Columbia 1992 update and forecast for 1993.
- Susceptibility of western hemlock to pinewood nematode and its wood borer vector.
- Forest pest conditions in Kootenay National Park 1992.
- Forest pest conditions in Yoho National Park 1992.
- Forest pest conditions in Mt. Revelstoke and Glacier National Parks 1992.

Summary

In this regional summary, pests are grouped by host(s), generally in order of importance.

Mountain pine beetle populations declined by 39% overall, killing an estimated 681 900 trees over 8920 ha; increased attack levels in 1992 should lead to greater numbers of discoloring trees in 1993. Secondary attacks by **ambrosia beetles** in mountain pine beetle killed trees were quantified. **Ips beetles** declined in mountain pine beetle outbreak areas, but killed ponderosa pine in spaced stands. **Red turpentine beetle** killed patches of up to 30 ponderosa pine in the Boundary TSA. **White pine blister rust** infected an average of 27% of the white pine in five young stands. Repeated severe infection by **pine needle cast** reduced increment up to 72% over 33 000 ha. **Pine needle miner** populations increased in the southeastern part of the region.

Western hemlock looper outbreaks expanded to over 47 000 ha from the northern boundary south to Upper Arrow Lake; continuing defoliation is expected in 1993. Defoliation

by the **gray spruce looper** declined to trace levels in the Arrow TSA. Defoliation by **western blackheaded budworm** was mapped over 150 ha near Kootenay Lake, and populations increased west of Donald.

The **Douglas-fir beetle** population declined in the Rocky Mountain Trench, killing 900 trees, and rose to kill about 100 trees in the West Kootenay. Defoliation by **western spruce budworm** declined to trace levels in the southwest and is expected to remain minor in 1993. Severe infection by **Douglas-fir needlecast** in young stands reduced growth by almost 30% over 23 000 ha. **Douglas-fir tussock moth** populations declined near Christina Lake following trace defoliation in 1991.

Spruce beetle populations increased in numerous areas north of Golden, although only 39 ha were mapped. **Spruce weevil** attack levels increased two-fold.

Two-year-cycle spruce budworm populations increased in the east with light defoliation over 3500 ha by mature larvae in the Rocky Mountains and over 900 ha by immature larvae in the Purcell Range; defoliation is expected to increase in 1993 but decline in 1994. **Western balsam bark beetle** killed alpine fir over 4250 ha.

Larch casebearer activity slightly increased in the east, with 1260 ha of light defoliation mapped near Creston. **Larch needle blight** declined to trace levels in most of the host range. Damage by a **larch shoot moth** declined in spaced stands near Windermere Lake but still killed 18% of the terminals.

Tomentosus root disease was found on 50% of mature Engelmann spruce in the Skelly Creek, Bush and Flathead river drainages. **Armillaria root disease** killed an average of 4% of the trees in 10 of 30 young stands surveyed. **Black stain root disease** infection centers had 75% tree mortality at Redding creek. Seedling mortality caused by **Rhizina root disease** remained patchy, with fruiting bodies observed in 8 of 24 burned clearcuts examined, causing mortality of up to 20% of planted seedlings. **Bears** and **porcupines** caused significant damage in 7 of 21 young stands surveyed. **Voles** damaged 10% of spruce seedlings in recent plantations along the Palliser River. **Frost damage** was common in young stands in the southeast portion of the region. Low levels of **black army cutworm** are not expected to rise in 1993. No gypsy moth were captured at 32 locations trapped.

Satin moth defoliated trembling aspen over 500 ha in the Anarchist Mountain to Grand Forks area. An **aspen leafroller** severely defoliated trembling aspen over 2300 ha, mainly in the Golden area. Damage by a **birch leafminer** increased to over 800 ha in the northwest part of the region. **Fall webworm** defoliation expanded in the drier southern parts of the region.

Pests of young stands surveys were done in 49 stands established or treated under Canada-B.C. Forest Resource Development Agreements (FRDA); of the total 5042 trees surveyed, 4% had pests leading to tree mortality and a further 4% had pests causing growth loss. In a joint FIDS-Council of Forest Industries (COFI) study, **pinewood nematode** was found in 72% and 4% of the lodgepole pine in study sites at Canal Flats and Deer Park, respectively, and was absent from woodborer-infested western hemlock. Two additional **Acid Rain National Early Warning System (ARNEWS)** plots were established in the region and no damage was recorded at the existing site.

Other noteworthy pests not surveyed annually or currently at low levels are tabulated.

Pine Pests

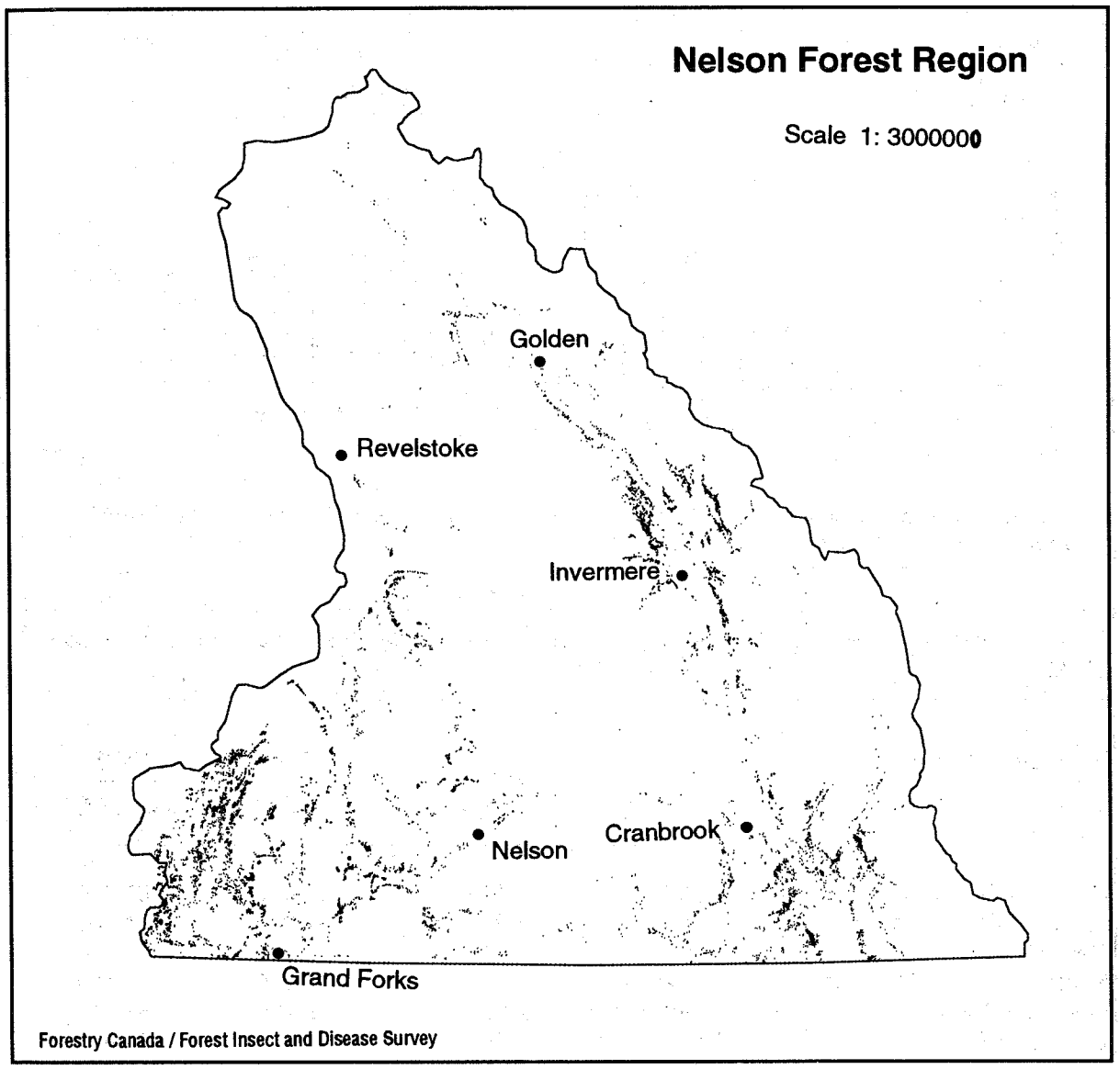
Mountain pine beetle

Dendroctonus ponderosae

Mountain pine beetle killed mainly lodgepole and occasionally western white and ponderosa pines on 8920 ha region-wide (Table 1, Map 1), down overall for the third year and 39% less than 1991. The decline in area was limited to the Cranbrook TSA and Kootenay National Park, other areas were static or increasing.

Boundary TSA

After three years of decline the area of red trees mapped increased by 5% to 3100 ha. However, the number of infestations more than



Map 1. Areas of pine recently killed by mountain pine beetle as determined by ground and aerial surveys, 1992.

tripled from last year due to new spot outbreaks of up to 25 trees each scattered in susceptible stands throughout the TSA. Severe infestations, mainly spot outbreaks, were 32% of the area mapped, 20% was of moderate incidence, and 48% was light. Although spot outbreaks contribute minimally to area figures, 0.25 ha each, impact in terms of trees killed and volume loss increased by 75% over 1991.

Arrow TSA

The area of red trees mapped increased to 1390 ha, 59% more than 1991. Most of the increase was in the southern half of the TSA, though significant numbers of new spot outbreaks occurred in drainages east of Upper Arrow Lake. Severe infestations, mainly spot outbreaks, were 20% of the area mapped, 36% was of moderate incidence, and 45% was light.

Revelstoke TSA

Infestations remained at the low levels of recent years, consisting of 14 spot outbreaks on slopes above the east shore of Upper Arrow Lake and 6 north of the Illecillewaet River. Most of these lingering spot outbreaks are in or near

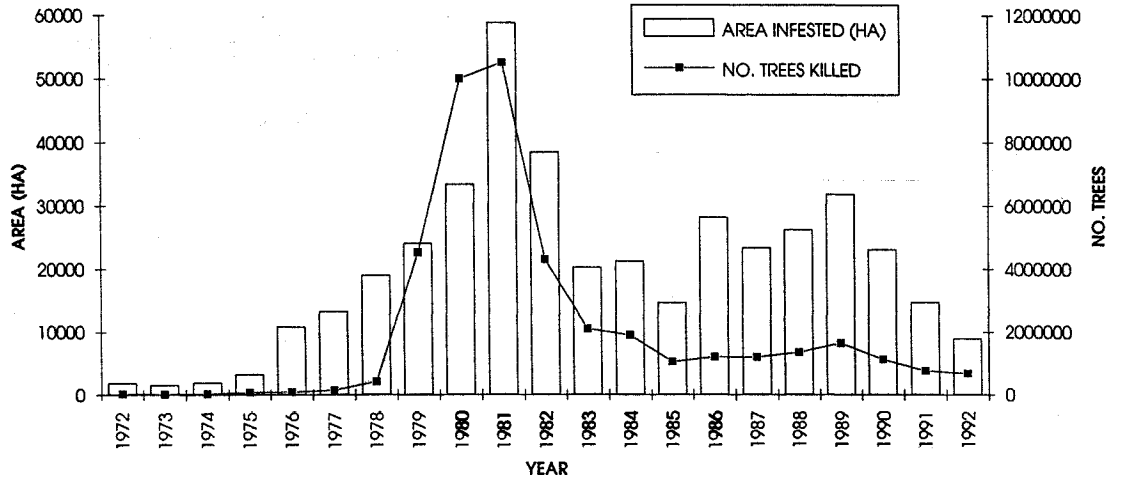


Chart 1. Mountain pine beetle infestations from 1972 to 1992 in the Nelson Forest Region. Forestry Canada, Forest Insect and Disease Survey.

Table 1. Annual occurrence and impact of the mountain pine beetle. FIDS, Nelson Forest Region 1992.

Management unit	Number of infestations	Area (ha)	Trees killed (faders)[1]	
			Number	Vol. (m^3)
Boundary TSA	2 450	3 100	238 000	85 700
Arrow TSA	960	1 390	87 000	34 800
Revelstoke TSA	20	10	300	160
Kootenay Lake TSA	172	90	2 900	1 150
Cranbrook TSA	1 240	2 190	188 200	67 750
Invermere TSA	1 030	1 460	88 300	31 800
Golden TSA	138	35	2 600	940
TSA Total	**6 010**	**8 275**	**607 300**	**222 300**
Kootenay National Park	413	600	72 900	26 290
Glacier National Park	29	36	1 400	1 400
Yoho National Park	30	8	280	100
Mt. Revelstoke Nat. Park	3	1	20	10
National Parks Total	**475**	**645**	**74 600**	**27 800**
Regional Total	**6 485**	**8 920**	**681 900**	**250 100**

[1]Trees attacked in 1991, discolored in 1992.

mixed stands with relatively few lodgepole or white pine to spread to.

Kootenay Lake TSA

The area of red trees mapped doubled from 1991 to 90 ha, with the number of infestations increasing more than threefold due to new spot outbreaks of 5 to 10 trees. Several remained in the Hawkins and Freeman creeks areas and expansion occurred on slopes above the Kitchener, Moyie, and Goat rivers. Severe infestations, mainly point sources, were 44% of the area mapped, 20% was of moderate incidence, and 34% was light.

Cranbrook TSA

The area of infestation decreased dramatically, to 2200 ha from 8580 ha in 1991. There was a general decline in the number of faders mapped throughout the TSA, with the exception of areas south and east of Cranbrook. The main area of decline was in the large infestations in the Rocky Mountain Trench portion of the TSA. The reduction of faders was due to overwintering mortality, close to 90% during the winter of 1990-91, which resulted in a very small flight in 1991. Fewer trees also were mapped along the Bull and Wigwam rivers, the Galton range, and at St. Mary Lake. Infestations remained stable at Gold Mountain and in the Fernie--Morrissey area. There was a slight increase in the number of faders in the Moyie Lake area and along Gold Creek north of Caven Creek.

Invermere TSA

There was a general increase in the number of trees mapped in the TSA. Expanding infestations continued in the drainages between Horsethief and Bugaboo creeks, along Pinnacle Creek, and in the newer infestation areas along Horsethief and Forster creeks. There was a major increase in the number of spot infestations north of Parson to the Golden TSA boundary. Infestations remained stable to declining along, and to the south of Columbia Lake and Toby Creek.

Golden TSA

There was a threefold increase in the number of recently killed lodgepole and white pine in the TSA. Much of the increase was along the Columbia River south of Golden, Waitabit Creek, and the lower portion of Columbia Reach. Infestations also continued along Blackwater Ridge, Glenogle Creek, near Lyell Creek, at Split Creek in the Blaeberry River drainage, and in small groups of white pine north along McNaughton Lake.

National Parks

Beetle activity increased in Kootenay, Glacier, and Yoho National parks while declining in Mount Revelstoke National Park. In **Kootenay National Park**, 72 900 trees were killed, up from 56 000 in 1991. There was a significant expansion to the north and south of the original epicenter of the infestation between Pitts and Daer creeks. Infestations in the Redstreak Creek area declined, while there was an increase in activity east along Sinclair Creek. The decline in area mapped was largely due to the deletion of older portions of the infestation.

In **Glacier National Park** (1400 trees up from 900 in 1991), the chronic infestation in white pine at the junction of Beaver River and Mountain Creek continued with small satellite infestations radiating to nearby white pine pockets.

In **Yoho National Park**, there was little change in the infestation intensity along the Kicking Horse River opposite Field, or in the small groups of two to five faders at the mouth of Amiskwi and Emerald rivers. In **Mount Revelstoke National Park**, only three lingering spot outbreaks of about five trees each were mapped on south-facing slopes above the Illecillewaet River.

Forecasts

Overall, the number of discolored trees should increase in 1993 after a mild winter resulted in high brood production (Table 2) and a large beetle flight in 1992. Brood sampling indicated an increased flight at 22 of 32 sites (69%) examined. Forecasts are grouped according to distinct outbreak areas, with some overlap between TSAs where outbreaks are continuous.

Table 2. Overwintering survival and population status of the mountain pine beetle. FIDS, Nelson Forest Region 1992.

Location	"R" value[1]	Population status[2]	Location	"R" value	Population status
Boundary TSA			**Cranbrook TSA**		
Burrell Creek	6.4	Increasing	Barkshanty Cr.	12.1	Increasing
Boundary Creek	5.5	Increasing	Bull River	8.9	Increasing
McRae Creek	5.2	Increasing	Etna Creek	6.0	Increasing
Beaverdell	4.8	Increasing	Fernie	5.0	Increasing
Grano Creek	3.1	Static	Jaffray	4.4	Increasing
Kettle River	1.3	Decreasing	Plumbob Creek	4.4	Increasing
Cup Lake	0.9	Decreasing	Gold Mtn.	4.1	Static
			Phillipps Cr.	1.9	Decreasing
Arrow TSA			Sparwood	1.0	Decreasing
Big Sheep Creek	6.0	Increasing			
Nancy Greene Lk	4.9	Increasing	**Invermere TSA**		
			Pinnacle Cr.	11.0	Increasing
Kootenay Lake TSA			Cartwright Iks.	10.9	Increasing
Hawkins Creek	5.6	Increasing	Parson	5.8	Increasing
			Hurst Creek	5.5	Increasing
National Parks			Canal Flats	2.6	Static
Field	6.7	Increasing	Brisco	1.8	Decreasing
Mountain Creek	4.0	Static			
Dog Lake	3.9	Static	**Golden TSA**		
			Twelve Mile Cr	12.4	Increasing
			Quartz Cr.	8.6	Increasing
			Blackwater Rdg	4.7	Increasing

1"R" value = an average population trend, derived in spring from the number of insects relative to the number of entrance holes in representative bark samples at DBH.

2Interpretation of "R" values: <2.5 = decreasing population; 2.5-4.0 = static population; >4.0 = increasing population.

Boundary and southern Arrow TSAs

After a mild winter, spring assessments of overwintering survival (Table 2) revealed a population increase at most locations in this outbreak zone. Subsequent fall cruises (Table 3) confirmed that the 1992 beetle flight resulted in an expansion of the outbreak, with ratios of current to red attack averaging 1.4:1, double those of 1991.

Revelstoke, western Kootenay Lake, and northern Arrow TSAs

Spot infestations are expected to remain at relatively low levels, as they have for several years, with expansion probable as fire-regenerated pine stands age to favor successful brood production.

Table 3. Status of lodgepole and white pine in stands infested by mountain pine beetle, from fall prism cruises. FIDS, Nelson Forest Region 1992.

Location	Percent of pine attacked[1]				Percent healthy
	Current (1992)	Partial (1992)[2]	Red (1991)	Grey (pre-1991)	
Boundary TSA					
Boundary Creek	21	8	17	11	43
Mt. Baldy Road	21	5	18	5	51
Conkle Creek	26	1	29	12	32
Beaverdell Creek	30	3	13	8	47
Arrow TSA					
Big Sheep Creek	20	12	9	15	45
North Ridge Road	26	6	14	4	50
Cranbrook TSA					
Barkshanty Creek	48	11	13	3	25
Mause Creek	32	2	29	6	31
Tepee Creek	20	18	25	1	36
Fernie	15	19	18	2	46
Bull River	12	19	20	4	45
Gold Mtn.	10	7	23	5	55
Caven Creek	8	8	15	1	68
Sand Creek	8	15	27	3	47
Invermere TSA					
Pinnacle Creek	52	8	14	1	25
Hurst Creek	35	7	17	5	36
Horsethief Creek	35	8	26	4	27
Cartwright lakes	32	10	12	3	43
Brisco	21	3	15	5	56
Mitchell Creek	17	13	16	0	54
Parson	12	13	10	7	58
Golden TSA					
Waitabit Creek	22	6	15	2	55
12 Mile Creek	20	10	14	0	56
National Parks					
Field	35	8	20	1	36
Settlers Road	30	3	28	0	39
Mt. Daer	28	11	21	1	39
Regional Average	25	9	18	4	44

[1] Totals may not equal 100% due to mortality from other causes.

[2] The partial attacks include pitchouts.

Cranbrook, southern Invermere, and eastern Kootenay Lake TSAs

In the dry southeastern portion of the region, the number of discoloring trees should continue to decline. Although spring brood sampling suggested an increasing population in most areas (Table 2), subsequent brood mortality was high and successful attack was reduced. This was reflected in current to red ratios of 1:1.8 (Table 3). Factors affecting current attack levels included; a high predator--prey ratio following major overwintering beetle mortality in 1991, a late 1991 flight, which combined with weather conditions caused trees to dry out during the critical early stages of larval development preventing beetle maturation, and fewer highly susceptible trees caused beetles to disperse further resulting in increased pitchouts. Of the 1992 flight, 54% was pitched out in the drier trench areas.

The only area where beetle populations continued to increase were in the Moyie Lake area. In a single cruise strip in the Barkshanty Creek drainage, the current to red ratio was 3.7:1 from a spring "R" value of 12.1 (Tables 2 & 3).

Golden and northern Invermere

There was a general increase in current attack in this area. Seven of eight brood samples indicated an increasing population (Table 2), and in cruise data collected after beetle flight, the current to red ratios averaged 1.8:1 (Table 3). Large populations remain in the Horsethief Creek to Cartwright lakes area posing a continual threat to mature pine stands in side drainages and to the north. Numerous new spot infestations can be expected north of Parson, where current attack was often found long distances from recently killed trees. No sampling was done in the Golden portion of the Beaverfoot--Kootenay river drainages, but the large populations in Kootenay National Park are expected to continue a northward movement into the TSA.

National Parks

In Kootenay National Park, variable results from brood samples and cruise data suggest that populations will maintain their current level. Continuing spread can be expected especially to the south of the main concentration in the Mt. Daer area, but also to the north including the Vermilion River drainage. In Glacier National Park, the infestation at Mountain Creek can be expected to decline due to host depletion, but continued activity should continue in small pockets of white pine. The infestation near Field, in Yoho National Park, is expected to increase slightly, with some spread to mature pine at the mouths of Emerald, Amiskwi, and Otterhead rivers. Lingering spot infestations are expected to continue at the same low level in Mt. Revelstoke National Park.

Ambrosia beetles

Trypodendron spp.

Trees recently killed by mountain pine beetle will often attract ambrosia beetles, primarily *Trypodendron lineatum*, the following spring. However, the ambrosia beetle attack is highly dependent upon the circumference area occupied by mountain pine beetle brood (Table 4). Ambrosia beetles avoid areas of the tree bole where mountain pine beetle brood is present. Therefore, in areas in which there was a late mountain pine beetle flight the previous year, ambrosia beetle attack may be more intense. This is the main factor in the large standard deviation. All of the trees sampled were successfully attacked by mountain pine beetle. Of nine trees felled in three of the four areas sampled, 80% of the attack was within two meters of the ground, and no ambrosia beetle attack was noted along the bole above the mountain pine beetle attack.

Only very limited observations were made of ambrosia beetle attack on spruce beetle-killed trees but they suggested that damage is much more significant. Because spruce beetle attack occurs earlier in the season than mountain pine beetle, Ips beetles were attracted to trees shortly after spruce beetle attack. Consequently, ambrosia beetle attack was intermingled with areas occupied by spruce beetle brood and there was little relationship between spruce beetle and ambrosia beetle attack densities.

Table 4. Relationship between mountain pine beetle and ambrosia beetle attack densities. FIDS, Nelson Forest Region 1992.

Mountain pine beetle attack densities[1]	Mean number of ambrosia beetle attacks	Standard deviation	Sample size
0 - 5	80	21	16
6 - 15	37	13	24
16+	5	5	28

[1] bark sample size was 0.5 x 0.5 at one meter above ground.

Ips beetles

Ips pini
Ips mexicanus

Ips beetles remained common in areas of mountain pine beetle infestation, but at greatly decreased levels from 1991, when up to 40% of the trees were killed by Ips beetles. Ips beetles continued to cause tree mortality in older mountain pine beetle infestations where up to 5% of currently attacked trees were killed by Ips beetle.

Ponderosa pine stands are highly susceptible to Ips beetle attack. In a recently spaced 30-year-old Douglas-fir and ponderosa pine stand near Wolf Creek, 21% of the crop trees were killed by Ips beetles. Similarly, in the Wasa Lake area, where snow damage killed young trees in the fall of 1990, scattered tree mortality was evident. Ips beetle populations rapidly increase in recently cut or killed trees, especially in dry ponderosa pine sites. When broods emerge nearby trees become infested.

Red turpentine beetle

Dendroctonus valens

The red turpentine beetle is most commonly associated with attacks on stressed ponderosa pine, though populations can build rapidly in stumps, slash, and recently killed trees to the point where healthy trees are attacked. Trees extensively snow-damaged in the fall of 1990 allowed both turpentine and Ips beetles to increase, leading to scattered tree mortality in the Fort Steele to Canal Flats area. Similarly, spacing where ponderosa pine are designated as the crop tree will often result in considerable tree mortality. In these areas, care must be taken to consider this pest when planning spacing programs. In recently spaced young stands surveyed in the Canal Flats to Wasa Lake area, 31% of the ponderosa pine crop trees had been killed with additional attack present on 7% of the trees.

Approximately 140 patches of up to 30 dying ponderosa pine were scattered throughout the host range in southern areas of the Boundary and Arrow TSAs, most frequently in the Rock Creek to Bridesville, Midway, and Grand Forks areas. Initial mass attacks by the red turpentine beetle were followed by the mountain pine beetle, the western pine beetle, *D. brevicomis*, and an *Ips beetle,* Ips pini. In the larger patches, trees of all sizes were infested. The potential for additional infestation is high considering the scattered and intense nature of these outbreaks and the number of possible hosts remaining. Current attacks were observed near recently killed trees after the 1992 flight.

Infestation by the red turpentine beetle and secondary attack by the mountain pine beetle also killed about 25 mature white pine infected by blister rust in the Slocan Lake area.

White pine blister rust

Cronartium ribicola

This introduced fungus remains the most important pathogen of western white pine throughout its range. The scattered occurrence of infections, discoloration for several years before mortality, and occasional infestation by the mountain pine beetle and red turpentine beetle preclude an accurate determination of annual impact. In surveys of young stands treated under the FRDA programs, usually spaced with diseased trees removed, an average of 27% of the remaining white pine component was infected in 5 of 10 stands assessed.

Research continues on annual genotype variations from several general infection areas in the region: from limber pine, *Pinus flexilis*, near Golden and from whitebark pine, *P. albicaulis*, in the Galton Range and Jumbo Pass.

Pine needle cast

Lophodermella concolor

Infected 1991 lodgepole pine needles were killed at moderate to high intensity through much of the southern portion of the region. Most infections were on understory and sapling regeneration. Drier spring weather in 1992, for instance May precipitation 52% below normal in Grand Forks, should limit new infections.

Most young plantations were severely diseased in drainages south of and including the Spillimacheen River on the eastern side of the Purcell Mountain Range. In pole-size to mature stands, moderate to severe infection was mapped over 33 000 ha. In the Hawkins Creek--Yahk river area to Bloom Creek, moderate to severe infection was mapped over 23 000 ha. Additional patches of disease were mapped on 3500 ha along Kitchener Creek and the lower Goat River to Creston. Near Kimberley, 2700 ha of moderate needle casting was mapped in the Pudding Burn and Lost Dog creek areas, but large areas of additional light discoloration were present from Findlay Creek south.

Needle casting continued at reduced levels in the Bull, White, Elk, and Flathead river drainages, east of the Rocky Mountain Trench.

Overall, an estimated 64 000 m3 of potential growth was not realized due to foliar infection, based on an average mean annual increment (MAI) of 3 m3.

A secondary fungus, *Hendersonia pinicola*, was present in most collections of *L. concolor*. *H. pinicola* may partially control *L. concolor* by invading infected needles and preventing the development of ascomata.

Pine needle miners

Zellaria haimbachi
Coleotechnites starki

There was a general increase in needle miner populations in the southeastern portion of the region. Defoliated lodgepole pine was mapped over 50 ha in an inaccessible area along Diorite Creek. Trace levels of defoliations were noted from Moyie Lake through to the Flathead River drainage with small patches of pine showing feeding damage on 70 to 80% of the terminal foliage. Trace defoliation of Ponderosa pine was also present in the Wasa Lake area.

Feeding is usually concentrated on the terminal and upper branches, resulting in up to 50% terminal mortality following only two successive years of moderate defoliation. Three years of defoliation will often result in multiple leaders until dominance is re-established.

Hemlock Pests

Western hemlock looper

Lambdina fiscellaria lugubrosa

Defoliation of mature to overmature western hemlock-western red cedar stands by the western hemlock looper increased nearly six-fold to 47 212 ha in the third year of an outbreak (Table 5). Feeding intensity also increased with 92% of current defoliation moderate to severe compared to 55% in 1991. Defoliation also continues in portions of the Kamloops, Cariboo, and Prince George Forest Regions, totalling 186 000 ha provincially.

Table 5. Defoliation in the current outbreak of the western hemlock looper. FIDS, Nelson Forest Region, 1992.

Year	Number of Infestations	Area defoliated (ha)			Total (ha)
		Light	Moderate	Severe	
1990	7	915	-	-	915
1991	143	3 701	3 455	1 069	8 225
1992	302	3 989	23 838	19 385	47 212

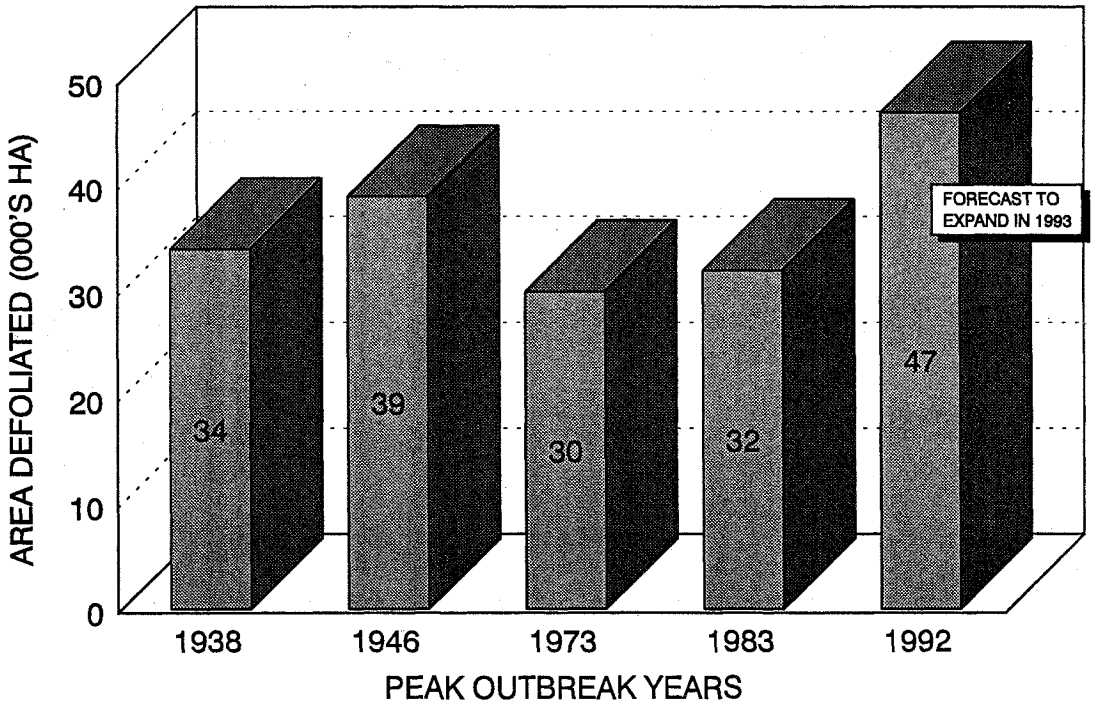
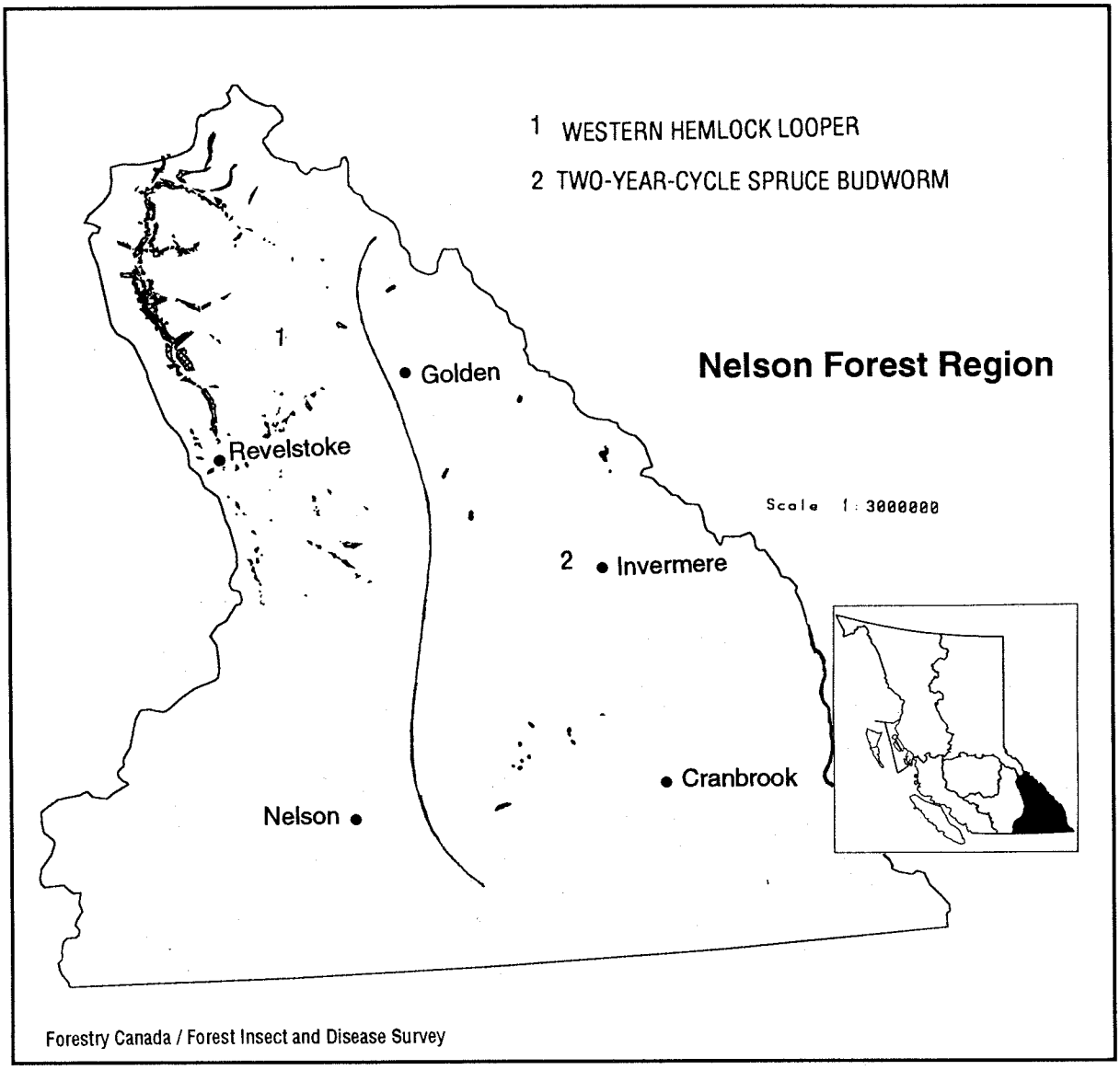


Chart 2. Maximum extent of annual defoliation during recorded outbreaks of the western hemlock looper. FIDS, Nelson Forest Region 1992.

Defoliation continued in remaining stands of old growth in side drainages and along the Revelstoke and McNaughton lakes reservoirs, expanding and intensifying south over Frisby Ridge and in patches to the Beaver River, respectively (Map 2). Spill-over feeding into neighboring young stands was also severe in some areas. Stands of Douglas-fir and spruce were occasionally defoliated along McNaughton Lake and near Mica.

Southerly expansion of the outbreak also occurred in patches near Arrow Lake as far as Pingston Creek, and in the Lardeau Creek, Trout Lake, Incomappleux River, Beaton Creek, Halfway River, and Westfall River areas. New patches of defoliation were also mapped near Jordan River and along the Illecillewaet River from Mt. Revelstoke National Park to Cougar Brook, including along the Tangier River.



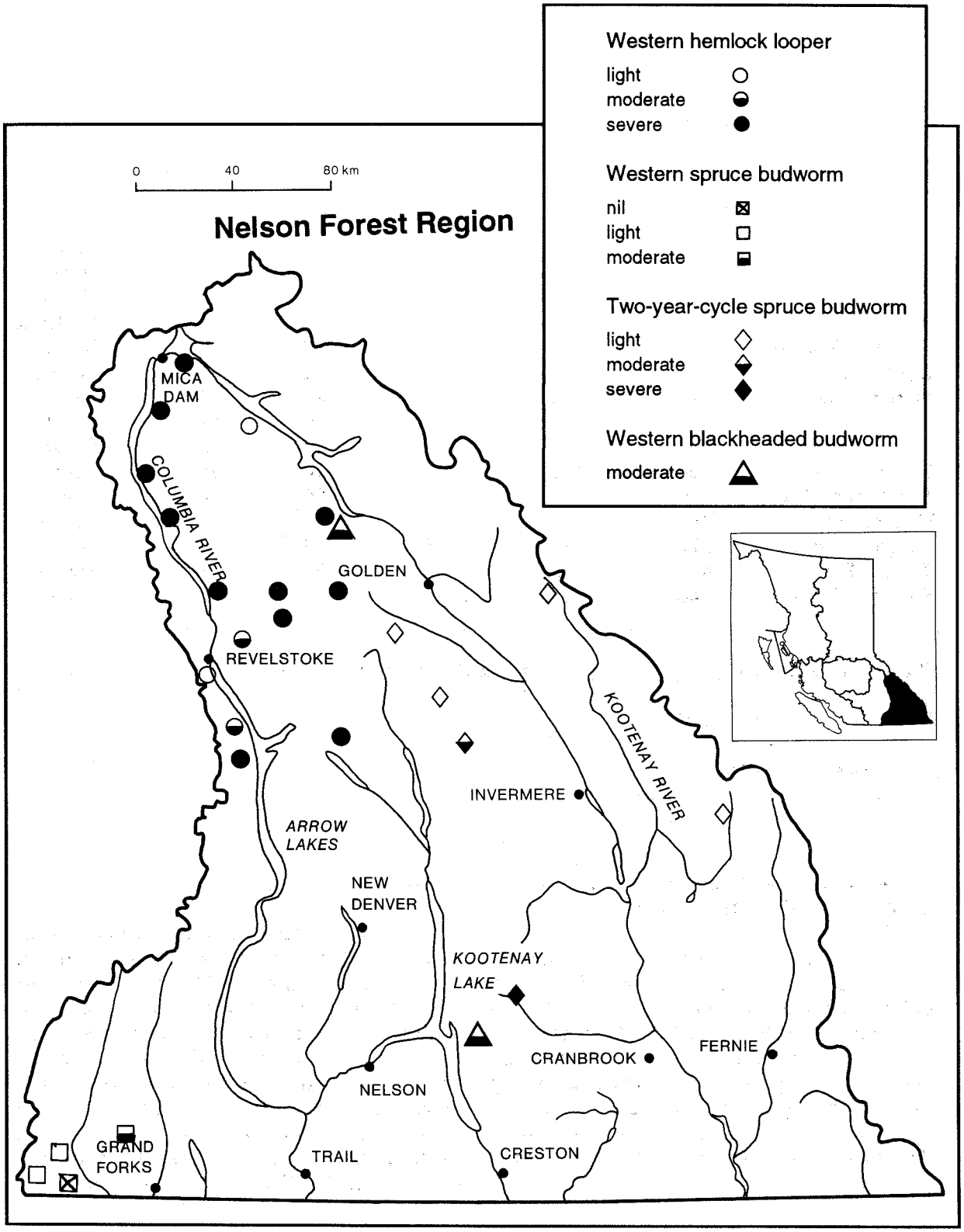
Map 2. Areas where current defoliation was detected during aerial and ground surveys in 1992.

Six outbreaks have been recorded in the Interior at intervals of about 8 to 9 years. These have usually caused defoliation for 2 to 3 years before collapsing, leaving extensive top-kill and scattered mortality. Regionally, the current outbreak is the largest yet (Chart 2) despite habitat lost to flooding the McNaughton and Revelstoke lakes reservoirs.

Forecast

Significant defoliation is expected to continue and expand in 1993 (Table 6, Map 3) based on fall egg sampling. Egg parasitism was only significant in some of the areas defoliated since 1990 and averaged 12% overall, well below the level indicating a population collapse. Previous outbreaks usually collapsed when egg parasitism averaged 30% or more.

Combined larval and pupal parasitism remained low, averaging 3% (Table 7), up slightly from 1% in 1991. Rearing mortality due to disease averaged 19% but varied widely, reaching 86% at Lardeau Creek due mainly to a fungus in the Entomophthoraceae family. Mortality from undetermined causes during the rearings averaged 32%, some probably due to



Forestry Canada / Forest Insect and Disease Survey

Map 3. Forecasts of defoliation expected in 1993 by the western hemlock looper, western spruce budworm, two year-cycle spruce budworm and western blackheaded budworm.

Table 6. Results of fall egg sampling to forecast defoliation by the western hemlock looper in 1993. FIDS, Nelson Forest Region, 1992.

Location	Average number eggs per 100 g lichen				Percent parasitism	Predicted 1993 defol[2]
	Healthy	Parasitized[1]	Infertile	Old		
Begbie Creek	10	0	0	13	0	Light
Double Eddy Creek	20	1	0	4	5	Light
Shelter Bay	27	4	0	11	13	Moderate
Illecillewaet River	41	5	0	14	11	Moderate
Redrock Peninsula	71	19	11	86	19	Severe
Bigmouth Creek	74	52	14	212	37	Severe
Martha Creek	74	3	0	24	4	Severe
Beaver River	75	1	9	40	1	Severe
Lardeau Creek	81	41	17	81	29	Severe
Downie Creek	88	105	13	410	51	Severe
Goldstream River	110	5	14	360	4	Severe
Cougar Brook	141	1	2	19	1	Severe
Tangier R. valley	278	10	16	52	3	Severe
Tangier River	408	9	19	68	2	Severe
Pingston Creek	448	13	25	115	3	Severe

[1]Parasitism based on discoloration during egg extraction by hot water treatment.

[2]Defoliation prediction thresholds:

light:	5-26 healthy eggs
moderate:	27-60 healthy eggs
severe:	>60 healthy eggs

diseases expected to increase during the outbreak and contribute to its collapse.

In a co-operative Simon Fraser University - FIDS study, a pheromone identified in 1991 is being calibrated by relating moth catches to defoliation expected. This should result in an additional monitoring method to predict outbreaks and compliment forecasts based on egg sampling during outbreaks. Tentative predictions based on moth catches in the first year of the study were consistent with egg sampling forecasts.

Impact

Previous infestations have caused extensive top-kill and scattered mortality. In older stands, trees that are 100% defoliated are usually killed directly while those 80% or more defoliated usually die within 3 years from secondary causes. Top-kill and mortality are occurring in most areas currently defoliated and will be assessed at representative locations after the outbreak. Factors influencing the planning of salvage operations include wildlife and watershed considerations in the numerous areas where the leave strips from previous harvesting are defoliated.

Table 7. Results of mass rearings to determine combined larval and pupal mortality of the western hemlock looper by agent. FIDS, Nelson Forest Region, 1992.

Location	No. larvae reared	% Adult emergence	Parasitism (%)	Disease (%)	% Dead, cause undetermined
Lardeau Ck.	44	14	0	86	0
Bigmouth Ck. 1	99	34	2	-	63
2	98	57	3	1	38
Redrock Penin. 1	100	50	6	3	41
2	108	57	3	-	40
Downie Ck. 1	119	55	2	-	44
2	89	57	2	16	26
Goldstream R. 1	152	68	1	-	32
2	84	73	4	1	22
Pingston Ck.	104	78	2	8	13
Regional Average		54	3	19	32

Gray spruce looper
Caripeta divisata

Defoliation of mainly western hemlock declined to trace levels as an outbreak of the gray spruce looper is collapsing. Defoliation of 1370 ha in 1990 and 4060 ha in 1991 (revised total after new area mapped spring 1992) occurred mostly on western slopes above portions of Arrow, Slocan, Box, and Duncan lakes. A decline had been expected when larval mortality due to disease reached an average of 72% in 1991. This was the second known outbreak of this insect in B.C., the first caused light defoliation near Terrace in 1961.

Impact

The impact of two years of varying defoliation of semi-mature to mature western hemlock was assessed in representative stands near Slocan and Arrow lakes (Table 8). There was 78% mortality in a stand severely defoliated for both years. When severe feeding was followed by moderate or light feeding, mortality declined to 46 and 14 percent, respectively. Varying degrees of crown dieback in all defoliated stands will probably lead to considerable additional tree mortality by secondary insects and climate. Salvage logging is underway in the Arrow Lake portion of the outbreak and to a lesser extent near Slocan Lake.

Defoliation of codominant trees, especially Douglas-fir, was usually limited to lower crown feeding by larvae dispersing from infested hemlock. Understory trees of all associated species except western red cedar were occasionally severely defoliated and killed, but the extent was variable and not quantified.

Forecast

Although outbreaks are rare and there are no quantitative forecasting methods, a pheromone is being developed and field tested by researchers from Simon Fraser University. An indication of the population status can be gained by monitoring larval mortality, though some contamination of healthy larvae is likely during mass shipment and rearing. In a mass collection from Saddle Mountain there was only 1% parasitism but all the remaining larvae died from disease or rearing mortality. The continued increase in disease and reduced defoliation in 1992 suggest that the population should continue to decline in 1993.

Table 8. Impact after two years of defoliation by the gray spruce looper on semi-mature to mature western hemlock in representative stands near Arrow and Slocan lakes. FIDS, Nelson Forest Region 1992.

Location	Defoliation 1990/1991	Avg. accumulated defoliation (%) upper crown	mid crown	lower crown	whole tree	Dieback extent (% trees)1 upper crown	mid crown	lower crown	whole tree
Saddle Bay	SEV/SEV	100	98	96	98	96	80	78	78
Saddle Mountain	SEV/MOD	100	96	92	96	98	64	52	46
Wragge Point	SEV/LT	91	80	68	80	64	30	14	14
Nakusp	MOD/MOD	64	47	31	47	36	0	0	0
McDonald Prov. Park	MOD/LT	87	56	39	61	20	0	0	0

1Dieback of entire crown portion and tree mortality.

Western blackheaded budworm
Acleris gloverana

Blackheaded budworm populations increased, defoliating 150 ha of western hemlock in the Gray Creek drainage along Kootenay Lake. Defoliation was light to moderate on the current-year foliage. There was also a general increase throughout much of the western hemlock looper infestation area in the northern part of the region. Between Quartz Creek and Gold River, along the west side of Columbia Reach, there were an average of 98 larvae in three tree beating samples of each species, causing trace to light defoliation. The most recent blackheaded budworm infestation in the region occurred in the mid to late 1980s throughout the wet belt.

Defoliation is predicted to increase to moderate levels in 1993 (Map 3). At Gray Creek and Beaver River there were an average of 47 and 36 eggs per 45-cm branch, respectively. Moderate defoliation frequently follows egg counts between 27 and 59 per 45-cm branch.

Douglas-fir Pests

Douglas-fir beetle
Dendroctonus pseudotsugae

The area covered by Douglas-fir beetle infestations declined in 1992, but populations remained persistent from Wickman Creek in the south to the Prince George regional boundary in the north (Table 9).

In the Golden TSA, there was little change in the number of recently killed trees. Most of the activity continues along the east side of McNaughton Lake north of Bush Arm and near Rice Brook along Bush River. While there were several patches with 50 to 100 trees, most of the recently killed trees were in small groups of 5 to 15. Infestation pockets are localized, initiating around blowdown and logging fringe, and expanding in adjacent root rot-stressed trees for several years, before collapsing.

In the Invermere TSA, there was a significant reduction in the number of beetle-killed trees. Scattered activity continued in the Whiteswan Lake area, and isolated mortality was present along the lower Lussier River, at Columbia Lake and at Fairmont. No recent tree mortality was mapped in the Findlay River drainage.

Table 9. Location, number, and area of Douglas-fir recently killed by Douglas-fir beetle. FIDS, Nelson Forest Region 1992.

TSA	Area	No. infestations	No. trees
Cranbrook	2	5	100
Invermere	9	16	210
Golden	11	30	590
Total	22	51	900

In the Cranbrook TSA, beetle activity decreased in chronic infestations at Wickman and Wildhorse creeks. Only a few groups of recently killed trees were mapped at both locations, with up to 40 trees at Wickman Creek and less than 10 at Wildhorse Creek. In the Kishinena-Sage creeks area, there were several groups of up to 10 recently killed trees.

Populations remained low in the western half of the region. Occasional spot outbreaks, usually less than 10 trees, were mapped on north-facing slopes above the West Arm of Kootenay Lake and Kootenay River, and in the Enterprise Creek area along Slocan Lake. The potential for population expansion is high due to brood production in scattered windthrow and trees killed by root disease, and extensive increasingly-susceptible (aging) host stands largely arising from the huge fires caused by miners, railroads, and settlers a century ago and maintained by fire supression.

Forecasts

Of the three infestations examined in the Golden TSA, fall brood sampling indicates that increased attack can be expected along the upper Bush River in 1993 (Table 10). At both sites examined along McNaughton Lake; brood size, current to red attack ratios and pitchout

Table 10. Douglas-fir beetle population trends. FIDS, Nelson Forest Region 1992.

Location	Fall "R" values[1]	Ratio of current to red attack
Bush River	8.2	1:3
Caribou Creek	1.2	1:5
Game Creek	0.6	1:4
Whiteswan Lake	3.3	1:2
Wildhorse Creek	3.5	5:2
Wickman Creek	1.4	1:5
Kishinena Creek	1.5	2:5

[1]Reproductive ratios, or "R" values, relate the number of surviving brood to entrance holes in the bark samples; values above 1.4 indicate an increasing population. However, Douglas-fir beetle populations will decrease in the absence of severely stressed trees or recent blowdown. Also, brood productivity should be considered in conjunction with the current to red ratio and infestation size.

levels (28%) indicate a decline in attack levels for 1993.

In the Invermere TSA, current attack levels were further reduced from 1991, but large broods in these trees suggest an increase in attack for 1993 at Whiteswan Lake, the only site examined.

In the Cranbrook TSA, increased attack can be expected in 1993 at Wildhorse Creek, in the few small pockets remaining following recent logging. High pitchout levels (80%) at Wickman Creek along with a moderate brood size suggest a declining population. The small infestations, which developed in the Kishinena Creek area following 1989-90 blowdown, are expected to decline as brood size decreases and pitchout increases.

Western spruce budworm

Choristoneura occidentalis

Defoliation of Douglas-fir in the Boundary TSA declined to trace levels, not visible during aerial surveys, in areas similar to 1991. In 1991, patches of defoliation totalling 4036 ha were mapped from the Anarchist Mountain area to northwest of Grand Forks. Current light to moderate understory and lower crown defoliation was observed in the Phoenix Mountain area.

Western spruce budworm in conjunction with the western false hemlock looper, *Nepytia freemani,* lightly defoliated mixed-age Douglas-fir over 300 ha along Premier Ridge. This was the first record of notable defoliation by the budworm in the East Kootenay. With up to 50% of the current-year foliage of understory trees showing feed damage, Christmas tree cutting in the area was impacted.

Moderate to severe defoliation was predicted from counts of infested buds in May (Table 11), which were down 35% from 1991. However, feeding was reduced by larval mortality attributed to disease, parasitism, and predation. Only 20% of larvae were successfully reared from a mass collection at Conkle Lake

Table 11. Current and predicted defoliation of Douglas-fir by the western spruce budworm. FIDS, Nelson Forest Region, 1992.

Location	Buds infested[1] (%)	Current defol.	No. egg masses per 10 m² foliage			Change from 1991 (%)	Predicted 1993 defoliation[1]
			1990	1991	1992		
Johnstone Creek	26	trace	400	83	0	-100	None
Conkle Lake Road	15	trace	288	179	11	-94	Light
McKinney Creek	22	trace	265	653	12	-98	Light
Phoenix Mountain	44	light	45	110	82	-25	Moderate
Average	27		250	256	26	-79	

[1]Thresholds for current (infested buds) and next season (egg masses) forecasts:

% buds infested	No. healthy egg masses/10m² foliage	Predicted defoliation
1 - 15	1 - 50	light
16 - 30	51 -150	moderate
>30	>150	severe

Road; 31% died from disease, 7% were parasitized, and 26% died from unknown causes, possibly rearing-related. Larvae from Phoenix Mountain and McKinney Creek were contributed to a research project to determine if genetic factors are involved in population dynamics.

Forecasts

In the Boundary TSA, numbers of egg masses declined by an average of 79% at 4 sites (Table 11), probably reflecting a reduced flight after high larval mortality. Relatively minor defoliation is expected to continue in 1993 (Map 3). Current moth catches from a pheromone calibration project (Map 4) also indicate that activity should decline in 1993. Moths in MultipherR traps at Conkle Lake Road (avg. 60) and Phoenix Mtn. (avg. 30) were 71 and 58 percent, respectively, of 1991 catches.

Douglas-fir needlecast

Rhabdocline pseudotsugae

Douglas-fir needlecast continued to increase, reaching moderate to severe intensity over an estimated 23 000 ha. In addition to some chronic areas on the western side of the Rocky Mountain Trench, extensive needlecast occurred along drainages on the eastern side of the trench and in the Creston Valley.

Infections in the western half of the region remained endemic over the summer with some discoloration of current foliage starting in the fall through the southern Boundary and Arrow TSAs. Though currently scattered and patchy, the full extent will become apparent in 1993 when discoloration of 1992 foliage intensifies.

Although the mean annual increment in these areas is highly variable, volume loss due to this disease is estimated to average 0.2 m3/ha, totaling 4600 m3 in 1992. Of additional significance was the impact on tree quality in the Christmas tree industry.

Douglas-fir tussock moth

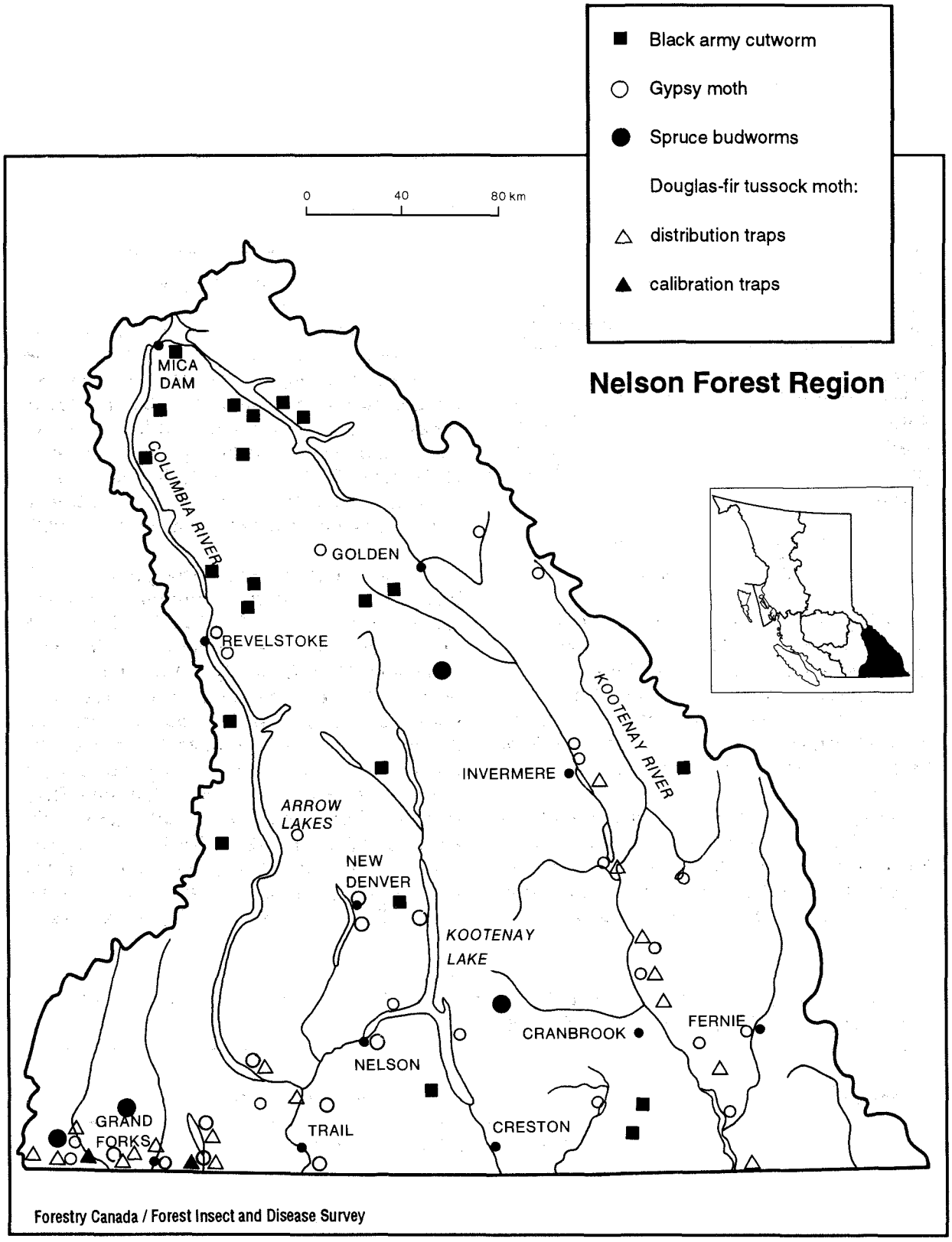
Orgyia pseudotsugata

The tussock moth population declined in 1992 with no defoliation noted near Cascade where trace feeding was recorded in 1991. An isolated case of moderate defoliation of several urban spruce trees continued in Montrose. Numbers of moths caught in pheromone-baited sticky traps (Table 12, Map 4) declined by 92% at Cascade and remained low at Rock Creek. Populations are expected to remain low in 1993.

Twenty additional traps deployed in a distribution study across the southern third of the region were negative for Douglas-fir tussock moth except for one caught at Kettle River Provincial Park (Map 4). Other moths are attracted to the same pheromone. Rusty tussock moth, *Orgyia antiqua badia,* increased threefold at Jaffray (127 moths) and Roosville (74), but were present at only low numbers in most areas with declines of 95% (Kettle River Provincial Park), and 50% (Wasa) where catches were highest in 1991. Catches of the pine tussock moth, *Dasychira grisefacta,* were lower in all areas with declines of 96% (Rock Creek), 94% (Johnstone Creek), 79% (Texas Creek),

Table 12. Catches of the Douglas-fir tussock moth in a calibration study of pheromone-baited sticky traps. FIDS, Nelson Forest Region 1992.

Location	No. traps	Average moth catch per trap				
		1988	1989	1990	1991	1992
Cascade	6	0	2	19	63	5
Rock Creek	6	1	1	8	11	9



Map 4. Locations where one or more pheromone-baited traps were deployed.

86% (Cranbrook), 80% (Skookumchuck), and 26% (Windermere) where catches were highest in 1991.

Historically, neither the rusty or pine tussock moths have caused a severe infestation in British Columbia. The rusty tussock moth caused light to moderate defoliation in the Nelson region over 120 ha at Kingsgate in 1963, in the Kamloops region in 1975, the Cariboo region in 1991, and currently on 12 600 ha in the Prince George region. Large infestations by the pine tussock moth have caused significant defoliation of young ponderosa pine in Montana.

Spruce Pests

Spruce beetle

Dendroctonus rufipennis

Spruce beetle populations continued to increase in the Golden TSA, with 16 infestations mapped over 39 ha in 1992. An estimated 1000, 1991-attacked trees were mapped during aerial surveys, over half of which were in the Bachelor Creek drainage. Smaller infestations were mapped at Sullivan and Bush rivers, and at Cupola, Ensign, and Smith creeks. These are conservative estimates due to the inconsistent timing of discoloration of trees attacked the previous year. Additional discoloration occurred later in the season.

Spruce beetle attack was common in blowdown from the fall of 1991. At Cariboo Creek in the Spillimacheen River drainage, fringe blowdown was heavily infested. At Skelly Creek, extensive fringe blowdown was lightly infested, but instand blowdown had large broods. Large broods were also present in shaded blowdown trees and several partial attacks at Hoodoo Creek in Yoho National Park, and in small groups of spruce blowdown along the Elk River north of Elkford. In each of these areas there is some potential is for very small localized infestations. Along lower Couldrey Creek, discolored spruce, which appeared to be flooding-stressed trees infested by spruce beetle, was mapped.

Broods are generally developing in the normal two year cycle. The brood size, of beetles flying in 1993, indicates a static population at Bachelor Creek ("R" value = 0.7) and increasing at Ensign Creek (1.6), Sullivan River (2.9), and at Cupola Creek (5.9). However, these predictive values must be viewed in conjunction with the beetles' biological habits, especially the gradual decline of populations when brood production primarily occurs on standing trees. Beetle populations are maintained or increased only in the presence of extensive shaded blowdown. In the largest infestation, at Bachelor Creek, this was

Table 13.Status of spruce in stands infested by spruce beetle. FIDS, Nelson Forest Region 1992.

	Percent of spruce attacked					
Location	Current (1992)	Partial (1992)	Pitchout (1992)	Red (1991)	Grey (pre-1991)	Percent healthy
Bachelor Creek	9	3	16	20	11	41
Cupola Creek	38	2	18	4	2	36
Sullivan River	2	5	4	28	0	61
Ensign Creek	7	6	8	24	10	45
Average	**14**	**4**	**11**	**19**	**6**	**46**

Table 14. Spruce weevil damage trends. FIDS, Nelson Forest Region 1992.

Location	Percent of leaders attacked					Remarks
	1988	1989	1990	1991	1992	
Beaverfoot R.	13	6	9	9	14	valley bottom.
Blackwater Cr.	3	4	5	5	12	spaced, valley bottom.
Quartz Cr.	35	32	18	21	26	50% predation; mixed stand
McLeod Meadows	-	-	-	4	9	dense natural stand.
Average	**17**	**14**	**11**	**10**	**15**	

evident with 57% of the 1992 attack having been pitched out (Table 13). However, significant attack can be expected in 1993 at three of the four sites cruised. Much of the attack will be centered on the previous pitchout and partial attacked trees. At Cupola Creek the main flight should be in 1994. In areas where large flights are expected in 1993, an extensive trap tree program should be implemented prior to beetle flight and trees removed shortly after.

In the western half of the region no red stage mortality was mapped. Infestation of windthrown logs in several areas, caused by strong winds in October 1991, was generally limited to a narrow strip along the bottom. Although populations have been low since the last outbreak ended in 1986, additional scattered windthrow in the fall of 1992 could lead to a cummulative population increase, especially if the proportion of current one-year-cycle brood is high. Previous studies have suggested that 1-2 blowdown per hectare will maintain a population, and with five severely infested blowdown per hectare an average of two standing attacks per blowdown can be expected.

Spruce weevil
Pissodes strobi

Spruce weevil damage increased by an average of twofold in young, open-growing, valley-bottom spruce stands (Table 14). In addition to monitoring plots listed below, similar increases where noted at spot checks in the Flathead, Yahk, and White river drainages. The increase in weevil activity appears to have resulted from good overwintering survival and favorable weather conditions for oviposition. The warm temperatures of May and June (10 and 24% above normal, respectively) were critical in successful attack and initial brood establishment. At the Quartz Creek site, 50% of the currently attacked leaders had 95% of the mid-instar larvae destroyed. The predation appeared to have been caused primarily by birds and possibly shrews.

Chronic infestations of sapling-aged young stands continue in the western half of the region. Though not assessed annually, the incidence of current attack is usually less than 10%.

True Fir Pests

Two-year-cycle spruce budworm
Choristoneura biennis

Defoliation of alpine fir and Engelmann spruce by both first- and second-year budworm larvae increased, covering 4400 ha in 1992.

Mature budworm larvae defoliated most of the current-year foliage over 100 ha along Seeta Creek off the White River, 300 ha along Bluewater River, 2800 ha along Vermilion River

Table 15. Forecast of defoliation in 1993 and 1994 by two-year-cycle spruce budworm. FIDS, Nelson Forest Region 1992.

Location	Percent buds infested	No. of egg masses	Predicted defoliation[1]
Bugaboo Cr.	18		light - 1993
McMurdo Cr.	9		light - 1993
Vowell Cr.	32		moderate - 1993
St. Mary R.	48		severe - 1993
White R.	-	5	trace - 1994
Vermilion R.	-	21	light - 1994

[1]Predicted defoliation	Percent buds infested	No. of egg masses/10 m^2
light	1-25	1-100
moderate	26-45	101-300
severe	46+	301+

between Mt. Verendrye and Marble Canyon in Kootenay National Park, and over 300 ha along Ice River in Yoho National Park. During the last year of feeding by mature larvae in 1990, light defoliation was noted over 1800 ha at Marble Canyon and only trace defoliation over 600 ha along the White River.

Immature budworm larvae lightly to moderately defoliated trees over 650 ha along White, Dewar, Lapointe, Sawyer, and Baker creeks in the St. Mary River drainage. Trace defoliation was also noted over 250 ha at Vowell and Bugaboo creeks.

In the western half of the region, populations remained low with no defoliation mapped during aerial surveys. Light defoliation was detected by several co-operators in the upper Barnes Creek area, an extension of an outbreak in adjacent areas of the Kamloops Forest Region.

Forecast

Egg mass counts indicate that budworm populations should decrease in the White and Vermilion river drainages (Table 15, Map 3). In each area, the level of defoliation should be lowered by one category of severity during the next main feeding period in 1994.

Bud counts in the Purcell Mountain Range, where larvae will mature in 1993, indicate an increase in defoliation severity and extent at all areas surveyed (Table 15).

Western balsam bark beetle

Dryocoetes confusus

New alpine fir mortality was mapped over 450 ha, raising the accumulated regional total of chronically infested stands to 4250 ha. Some of the most active beetle areas were along Spillimacheen River, Bobby Burns and Vowell creeks (1400 ha), Lussier and White river systems (800 ha), and in the St. Mary River drainage (900 ha).

Scattered groups of up to 25 recently killed trees were common in most mature alpine fir stands throughout the region. Currently-mapped spot outbreaks were recorded in the Kootenay Lake TSA near Skelly and Summit creeks (83 outbreaks) and Hawkins Creek (1); in the Arrow TSA at Hodder (36), St.Leon (24), Stagleap (10), Enterprise (5), Lemon (5), and Dago (5) creeks; at Gable Creek in the

Boundary TSA (2); and in Stagleap (10) and Kokanee Glacier (10) Provincial Parks. Extensive groups of up to 50 trees were noted at Miller Pass and Albert Creek in the Palliser River area.

Once established, the beetles continue to selectively kill small groups of trees at a fairly constant level, about 1-3% annually. Following blowdown, there will often be a temporary increase in tree mortality as beetle populations increase after emergence from the blowdown. Ground surveys indicate that in most cases, 50 to 65% of the mortality is due to balsam bark beetle, often in association with root rot and/or blowdown.

Current balsam bark beetle attack of standing trees declined by 20% at a monitoring plot in the Spillimacheen River drainage. A significant portion of the 1992 flight was attracted to blowdown, reducing attacks in standing trees. However, beetles emerging from the blowdown may increase attack in standing trees in 1993.

Larch Pests

Larch casebearer
Coleophora laricella

The area defoliated by larch casebearer doubled in the Creston area. Light defoliation was mapped over 1260 ha, mainly along Summit Creek and in a few small patches along Goat River. Increased populations were noted on understory and open regeneration at Whiteswan Lake, near Marysville, Kimberley, Castlegar, and Beaver Falls, and in semi-mature stands at Moyie Lake. At other sampled sites from Cranbrook to Anarchist Mountain, defoliation remained at trace levels.

The incidence of parasitism by both native and introduced parasites doubled at 11 sites, averaging 34% (range 14-72%). Parasitism by an introduced parasite, Chrysocharis laricinellae, averaged 10%, up from 2% in 1991. Parasitism by a second introduced parasite, Agathis pumila, remained relatively unchanged at 9%. Populations of a native diptera parasite, Spilochalis spp. increased, causing up to 38% mortality at five of the sites (average 10%).

Overall, populations are expected to decline in 1993. Adult emergence further declined to 57%, from 66 and 70% in 1991 and 1990, respectively. Fall larval sampling (7 larvae per 100 fascicles) at Summit Creek indicates that only trace defoliation should occur in 1993. When there are fewer than 12 larvae per 100 fascicles, no significant defoliation is expected the following year.

Larch needle blight
Hypodermella laricis

Larch needle blight declined to trace or light intensity in the Boundary, Arrow, and Kootenay Lake TSAs in the following areas where severe intensity occurred in 1991: portions of the July, Hudu, Bowman, Barnes, and Koch creeks and Granby River drainages, and east of Christina Lake particularly along McRae and Texas creeks. No significant needle blight was noted in the East Kootenay, though light to moderate discoloration was common on lower crown foliage in the White and Yahk river systems.

Most current infection is attributed to high spore levels after the 1991 outbreak. Spring weather was drier than in 1991 and newly flushed foliage less prone to infection.

A larch shoot moth
Argyresthia columbiana

Terminal damage by this shoot moth declined in 1992 in western larch in the Columbia--Windermere lakes area. Terminal shoots were killed on 18% of the crop trees in a recently spaced stand. Incidence of terminal mortality in 1991 was 40%. In addition, 56% of the trees had an average of three branches killed in the first whorl. The early indications are that there is an initial surge of attack immediately following spacing, and then tapers down to lower chronic level.

The impact of terminal mortality on larch is uncertain, but in the short term, multiple tops are being formed on 30% of the recently affected trees.

Table 16. Occurrence of *Inonotus tomentosus* in the spruce component of representative stands. FIDS, Nelson Forest Region 1992.

Location	Tree spp.[1]	% spruce healthy	Percent of spruce infected			% of area diseased	No.centers per ha
			no symptoms	symptoms	dead		
Bush River drainage							
Goodfellow Cr.	alF(eS)	86	0	3	11	4	4
Bryce Cr.	eS(alF)	38	31	25	6	15	7
Nemesos Rd.	eS(alF)	17	22	39	22	37	7
Suicide Hill	eS(alF)	4	32	57	7	30	14
Flathead River drainage							
Harvey Cr.	eS(alF)	47	32	12	9	24	7
U. Flathead R.	eS(alF)	26	35	37	2	28	12
Cabin Cr.	eS(alF)	32	32	30	6	26	8
Kishinena Cr.	eS(alF)	11	17	46	26	39	9
Skelly Creek drainage							
N. Basin Rd.	eS(alF)	66	22	10	2	9	4
Skelly Cr.	eS(alF)	64	36	0	0	0	0
Shoe Cr.	eS(alF)	64	31	3	2	3	2
Average		**41**	**26**	**24**	**9**	**20**	**7**

[1]eS=Engelmann spruce, alF=alpine fir; ( ) = lesser stand component

Multiple Host Pests

Tomentosus root rot

Inonotus tomentosus

This root rot was estimated to occur on 50% of the Engelmann spruce in mature to overmature stands surveyed in the Bush and Flathead rivers, and Skelly Creek drainages (Table 16). *I. tomentosus* was the main pathogen, though *Armillaria ostoyae* and *Phaeolus schweinitzii* were also present. *P. schweinitzii* was prominent in the Flathead River drainage, detected in an average of 22% of the trees. In the Bush River sites, *P. schweinitzii* was present at all but the Goodfellow Creek site, with 4 to 11% of the trees infected. *A. ostoyae* occurred on less than 5% of the trees at all areas surveyed.

Root rot incidence was determined in continuous strips 5 m wide for about 1 km. All trees were tallied as with or without root rot symptoms. Groups of recent dead or symptomatic trees were sampled to determine the causal agent. Since *I. tomentosus* must be well established in a tree before visible symptoms are evident, at least two root cross sections were examined on each of 20 randomly selected, apparently healthy trees to determine the percentage of non-symptomatic trees infected. The percentage of area diseased was based on trees with visible symptoms only.

Armillaria root disease

Armillaria ostoyae

Armillaria root disease remains the main detriment to restocking logged areas in southeastern British Columbia, and causes scattered mortality in most existing stands. Infection of

regeneration, mainly by rhizomorphs the first few years after logging and later by root contact, commonly results in unsatisfactory restocking. Partial cutting results in the greatest increase in root disease and is not sustainable in most areas due to mortality of both regeneration and remaining trees.

Due to the chronic, variable, and widespread nature of the disease, and limited resources, no annual surveys of occurrence are conducted beyond specific programs such as surveys of stands established or treated under the FRDA agreements. Ten of 38 sapling-aged stands treated within the last 2 years, usually by spacing, were already sustaining mortality by Armillaria root disease in the remaining trees. An average of 3.9% (range 1-10%) of trees left in the 10 stands had symptoms of root disease.

Black stain root disease

Leptographium wageneri

Small pockets of black stain root disease in semi-mature lodgepole pine are expanding along Redding Creek. In the main root rot center covering 0.25 ha, 75% of the trees had died recently. Diseased live trees occurred up to 50 m beyond the the focal point of dead trees. Once infected, trees usually die within 1 to 8 years. The number of recently killed trees and the extent of infection beyond the focal point suggests that the annual rate of radial spread may be approaching the 4.5 m/year recorded in the United States.

Rhizina root disease

Rhizina undulata

Rhizina root disease remained patchy throughout the region with significant seedling mortality still occurring in some areas. Total growing season precipitation was higher than 1991, and 33% above normal in the main fruiting month of September at Revelstoke, within the main infection zone.

Fruiting bodies were observed at 8 of 24 recently-burned clearcuts assessed in the Revelstoke, upper Arrow, upper Kootenay Lake, Invermere, Cranbrook and Golden TSAs. Seedling mortality was approximately 20% (Tangier River), 10% (Cusson Creek), 2% (Dry Creek), and 1% (km 122 west side of McNaughton Lake). A positive site at the Lardeau River had not been planted. Widely scattered, single fruiting bodies were found at Bachelor Creek, Game Creek, and at Cabin Creek. Ground spore levels are expected to continue to result in scattered infections as new burns provide the necessary environment.

Mammal damage

Bear and porcupine

Tree mortality by these animals is a natural component of all stands, however in areas of high population the impact can be significant. Several of these areas were mapped during aerial surveys along Findlay River, Jumbo Creek--Toby River, and in the Porcupine Creek to Otterhead River area in Yoho National Park.

Damage will often increase after spacing. In 7 of 21 young stands surveyed, an average of 5% (range 2-11%) of the crop trees had been killed within 2 years of spacing. In one case, a lodgepole pine stand was spaced from 2860 stems per hectare to 1200 and the incidence of mortality went from 0.7% to 2.6% in 1 year. Although this rate of mortality will not continue to stand maturity, the incidence is expected to increase to over 15% within 5 years, based on other stands observed.

Hare

Although the hare population remained low throughout the region, local occurrences of mostly ground-level bark feeding did occur. The pine component of a 20 year-old spaced stand near Stewart Creek sustained damage to 71% of the stems, girdling about half the circumference of each. The resulting wounds are likely entrance courts for decay fungi and the pitch exudate was infested by an unidentified pitch moth.

Vole

Vole damage declined in 1992 following a cyclical peak in 1991. Damage was recorded only at one fill-planting site along the Palliser River. Ten percent of the newly planted seedlings were chewed off at ground level. Vole-damaged seedlings will usually form several new shoots from buds below the damage.

Climatic damage

Overall, regional weather during the 1992 growing season was warmer and wetter than normal. In the southwest, total precipitation from April through September was 56% above normal and mean temperatures averaged 6% higher, as recorded at Grand Forks. In Revelstoke, representative of northern areas, temperatures were 9% above normal but precipitation was against the trend at 6% below normal. In the southeast, temperature and precipitation were 5% and 18%, respectively, above normal as recorded at Cranbrook.

Frost damage

Late spring frost caused damage to new growth in numerous areas, especially in the southeastern part of the region. Some of the most extensive damage was mapped over 150 ha in plantations in the upper Bloom Creek drainage. Most buds were killed on spruce, alpine fir, and western larch. In addition, 90% of the early foliage on larch was destroyed. In 5 of 8 young stands surveyed in the Rocky Mountain Range, 79% of the alpine fir had severe frost damage to newly flushed foliage. Other species were only lightly damaged; up to 16% of the Engelmann spruce flush was damaged along the White River.

Black army cutworm
Actebia fennica

Black army cutworm populations remained low in 1992. At 14 sites in the Revelstoke, upper Arrow, Golden, and Invermere TSAs there were too few larvae to damage seedlings.

Follow-up impact surveys were conducted in an area where moderate populations occurred in 1991 at Vowell Creek. Of 200 seedlings monitored, 62% had been stripped of foliage, with the remaining having moderate feeding damage. Overall, 12% of the seedlings died.

Forecast

Numbers of moths caught in pheromone-baited MultipherR traps deployed at 21 sites (Map 4) indicate a continued low potential for defoliation in 1993. Catches at 10 sites in the Revelstoke, upper Arrow, and upper Kootenay Lake TSAs averaged 80 moths per trap (range 5-257), the same as 1991. Similarly, catches at 11 sites in the East Kootenay averaged 94 moths per trap (range 7-344). No significant outbreaks have developed where fewer than 600 moths per trap were caught the previous year.

Gypsy moth
Lymantria dispar

A total of 35 pheromone-baited traps were deployed at 32 forested municipal, provincial, and national park campgrounds in the region, as part of an ongoing co-operative program to detect any introduction of this pest into B.C. (Map 4). No moths were caught in the region; traps placed by Agriculture Canada and the B.C. Forest Service were also negative. However, continued trapping is needed since positive catches have been made near Kelowna, in southern coastal areas of British Columbia, and in northern Washington and Idaho States.

Deciduous Tree Pests

Satin Moth
Leucoma salicis

Patches of mostly severe defoliation of trembling aspen occurred in the Anarchist Mountain to Bridesville area (479 ha, 80% severe intensity) and to a lesser extent northeast of Grand Forks (± 20 ha severe). This defoliator was accidentally introduced to B.C. from Europe in 1920 and first collected in the Nelson Forest Region at Needles in 1963. Of several outbreaks since in the region, defoliation near Bridesville occurred in 1964 and 1984-86.

In previous outbreaks most trees recovered with a second flush of foliage later in the season. However, in this outbreak there was very little refoliation. While the full extent of dieback won't be apparent until after the spring 1993 flush, newly killed and dying trees are already sustaining breakage and windthrow.

Introduced parasites, a native bacterium, and a fungus have helped reduce previous satin

moth outbreaks. Half the larvae from a mass collection at Anarchist Mountain emerged after rearing, while only 2% were parasitized and 48% died from disease or rearing mortality. Mortality and dieback of host trees may also limit populations by starvation in 1993.

An aspen leafroller
Epinotia sp.

This leafroller moderately to severely defoliated trembling aspen and to a lesser degree birch, over 2300 ha in the region in 1992. The most severe defoliation was mapped over 300 ha along the Kicking Horse River just west of Yoho National Park. Light to moderate defoliation was common along the Columbia River from the Golden area to Blaeberry River. Light defoliation was also noted in young aspen stands along the lower Bull River. Following three consecutive years of defoliation, dieback was evident on 30% of the trees along the Kicking Horse River.

A birch leafminer
Lyonetia sp.

Infestation and early browning of birch foliage by a leafminer increased considerably in 1992 in the northwestern quadrant of the region. Moderate to severe discoloration ranged from scattered individual trees to entire stands where birch was the main species. Stands mapped during aerial surveys totalled 810 ha, mainly near the Illecillewaet River (360 ha), Whatshan Lake (285 ha), Frances and Bugaboo creeks (100 ha) and Akolkolex River (65 ha).

Fall Webworm
Hyphantria cunea

Defoliation of mostly willow and black cottonwood by the fall webworm expanded considerably from 1991. Light to moderate defoliation occurred throughout drier areas of the region, most commonly from Christina Lake to Grand Forks, Rock Creek to Anarchist Mountain, Castlegar to the lower Slocan Valley, along Lower Arrow Lake and the Granby River, and in the Cranbrook to Elko area. In addition to unsightly tenting on roadside trees and shrubs, fruit and shade trees were occasionally infested. Natural control by numerous parasitic and predacious insects usually limits outbreak severity.

Special Surveys

Pests of young stands

A total of 49 young stands planted or treated under the Canada-B.C. FRDA agreements were examined for pest problems in 1992 (Table 17). Tree removal during stand treatments affected the occurrence of some pests. Sites were selected from lists stratified by district, biogeoclimatic zone, and treatment. The incidence of some pests, especially root rots, at this early stage after treatment suggests that pre-treatment surveys were inadequate in some areas.

Life-threatening pest problems were recorded in half the stands surveyed. Of 5042 trees examined, 84% were pest-free and 4% had pests that often lead to tree mortality, and 4% had pests that cause growth loss. This level of serious pest incidence, mainly root rot, only one to two years following treatment suggests severe long term impact. Several of the pests in Table 17 are discussed in more detail elsewhere in the report.

Pinewood nematode
Bursaphelenchus xylophilus

By January 1993 most lumber shipped to Europe has to be kiln dried, with a core temperature of 56oC for 30 minutes, to prevent the introduction of this nematode. Meanwhile, all lumber to Europe has to be free of woodborer holes to show that no vectoring of the nematode into the wood occurred. Western red cedar is exempt from the drying since it does not host the *Monochamus* sp. woodborers which vector the nematode in British Columbia.

A joint FIDS-COFI project is underway to gain a similar exemption for western hemlock since it only rarely hosts the Monochamus woodborers and apparently does not sustain the nematode. Fresh 1 m trap logs, 25 each of western hemlock and lodgepole pine, were placed in early summer at 11 locations in British Columbia with a history of high *Monochamus* spp. populations. At all locations, including Deer Park and Canal Flats in the Nelson Forest Region, no pinewood nematodes were isolated

Table 17. Summary of pests in young stands planted or treated under the Canada- B.C. FRDA agreements. FIDS, Nelson Forest Region 1992.

Host/Pest	Severity index[1]	No. stands affected[2]	No. trees affected[2]	% of trees affected[3] avg.	% of trees affected[3] range
Lodgepole pine - 1854 trees in 31 stands, major species in 17 stands					
Warren's root collar weevil	6	4 (18)	13 (1176)	7	2-17
Abiotic	6	1 (31)	6 (1854)	5	
Woody tissue (D. valens)*	5	1 (3)	3 (23)	33	
Mistletoe	5	1 (18)	6 (1176)	7	
Armillaria root disease*	5	4 (18)	20 (1176)	7	2-8
Bear*	5	1 (12)	2 (881)		
Porcupine*	5	2 (12)	6 (881)	21	8-33
Hare*	5	1 (6)	20 (329)	71	
Windthrow	5	1 (3)	2 (23)	2	
Unknown	5	1 (31)	23 (1854)	19	
Western gall rust	4	1 (18)	2 (1176)	6	
Needle diseases*	4	4 (31)	33 (1854)	16	2-33
Squirrel	4	5 (12)	27 (881)	5	2-11
Pithyophthorus	4	2 (18)	4 (1176)	2	1-4
Ice/snow	3	2 (31)	3 (1854)	26	3-50
Zellaria*	2	3 (18)	22 (1176)	25	2-72
Cinara sp.	2	2 (31)	2 (1854)	1	1-1
Pest free	1	31 (31)	1661 (1854)	85	28-100
Engelmann spruce - 1385 trees in 39 stands, major species in 27 stands					
Armillaria root disease*	6	1 (26)	1 (702)	1	
Voles*	6	1 (14)	8 (733)	7	
Abiotic	6	1 (39)	15 (1385)	14	
Inonotus root disease*	5	1 (26)	7 (702)	10	
Bear*	5	2 (7)	4 (90)	6	1-10
Ice/snow	5	1 (39)	1 (1385)	3	
Spruce weevil*	4	5 (15)	11 (482)	4	1-13
Porcupine*	4	1 (7)	2 (90)	3	
Animal ungulate*	4	1 (17)	1 (637)	1	
Frost*	3	2 (39)	27 (1385)	18	15-22
Adelges	2	8 (39)	65 (1385)	53	3-100
Pineus sp.	2	14 (39)	135 (1385)	53	1-100
Pest free	1	34 (39)	1109 (1385)	80	7-100
Douglas-fir - 892 trees in 33 stands, major species in 12 stands					
Armillaria root disease*	6	6 (28)	16 (693)	4	1-10
Root disease*	5	1 (28)	1 (693)	2	
Bear*	5	1 (21)	1 (598)	2	
Ice/snow	5	2 (33)	2 (892)	1	1-1
Cicada sp.	4	1 (33)	2 (892)	9	
Porcupine*	4	2 (21)	6 (598)	14	4-25
Rhabdocline needle disease*	3	5 (33)	83 (892)	28	3-100
Adelges	2	1 (33)	2 (892)	33	
Pest free	1	32 (33)	776 (892)	95	67-100

Host/Pest	Severity index[1]	No. stands affected[2]		No. trees affected[2]		% of trees affected[3] avg.	% of trees affected[3] range
Alpine fir - 255 trees in 20 stands, major species in 6 stands							
Armillaria root disease*	5	1	(15)	4	(221)	19	
Animal ungulate*	4	3	(5)	16	(80)	37	27-45
Frost*	4	5	(20)	49	(255)	82	55-100
Porcupine*	3	1	(8)	1	(144)	6	
Spruce budworm*	2	2	(12)	31	(207)	67	57-76
Needle disease	2	3	(20)	42	(255)	50	24-81
Pest free	1	16	(20)	118	(255)	76	11-100
Western larch - 260 trees in 19 stands, major species in 1 stand							
Armillaria root disease*	6	2	(17)	5	(234)	5	5-5
Abiotic	6	3	(19)	21	(260)	25	5-64
Stem/branch disease	5	1	(17)	3	(234)	9	
Bear*	5	1	(10)	3	(88)	9	
Porcupine*	4	2	(10)	2	(88)	31	11-55
Needle diseases*	3	3	(19)	20	(260)	92	76-100
Pest free	1	17	(19)	207	(260)	86	23-100
Western red cedar - 162 trees in 18 stands, major species in 4 stands							
Armillaria root disease*	5	1	(16)	1	(146)	33	
Pest free	1	18	(18)	161	(162)	98	67-100
Western white pine - 123 trees in 14 stands, major species in 1 stand							
White pine blister rust*	5	5	(10)	7	(26)	42	25-50
Pest free	1	14	(14)	116	(123)	85	50-100
Western hemlock - 77 trees in 16 stands, major species in 2 stands							
Pest free	1	16	(16)	77	(77)	100	
Ponderosa pine - 29 trees in 1 stand, major species in 1 stand							
Mountain pine & Ips beetles*6	1	(1)		13	(29)	45	
Pest free	1	1	(1)	16	(29)	55	
White birch - 3 trees in 1 stand, all pest free							
Western yew - 2 trees in 1 stand, both pest free							

[1]A severity index allows an interpretation of impact, especially pests affecting specific age groups:

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

[2]Figures in brackets indicate number of stands or trees susceptible.

[3]Percent of trees affected only in stands with the pest.

*These pests are discussed in more detail under the appropriate host.

from the hemlock logs in spite of woodborer attack. An average of 18% (range 4-72%) of the pine logs from 6 locations were infected by the pinewood nematode, including those from Canal Flats (72%) and Deer Park (4%).

Another aspect of the study was the examination of 24 log decks throughout the province for the presence of woodborers. No *Monochamus* spp. were found, but other woodborers occurred on 16% of the logs. Pinewood nematode was not found in the 91 insect-infested logs sampled.

Acid rain national early warning system (ARNEWS)

As part of a national network, 10 x 40 m biomonitoring plots have been established to detect and monitor any impact of air- and rainborne pollution on native trees and indicator plants. In addition to the existing plot, established in 1985 along Bulldog Road in the Blueberry-Paulson summit area, new plots were established near Martha Creek and Wasa in June 1992.

Visual assessments of plot vegetation and pest conditions are conducted annually with more detailed measurements, such as foliar analysis, completed every 5 years. In the existing plot, only the same minor pests were found, at low levels, as in previous years. Baseline data were accumulated from the new plots, which also currently sustained only minor pest damage. No symptoms of damage from acidic or toxic rain were found.

Other Noteworthy Pests

Other agents that are currently relatively minor or not surveyed are tabulated, including those capable of causing prominent damage or which to date have caused only minor damage in the region.

Host/Pest	Location	Remarks
Pine		
Arceuthobium americanum lodgepole pine dwarf mistletoe	host range locally severe impact	occasional chronic patches,
Atropellis piniphila Atropellis canker	host range	occasional stem deformation locally severe impact
Cinara sp. giant conifer aphid	Cranbrook TSA	common in young stands
Dioryctria sp. a bud miner	Sand Cr.	lightly infesting buds
Endocronartium harknessii western gall rust	host ranges	widespread, relatively minor impact
Western hemlock		
Echinodontium tinctorium a heart rot	host range	significant decay common in remaining old growth
Nematocampa filamentaria filament bearer	Illecillewaet R.	remaining endemic
Neodiprion sp. a conifer sawfly	Revelstoke TSA	declined to endemic
Douglas-fir		
Antrodia xantha a white pocket rot	Kokanee Ck.	decay at stem fork
Arceuthobium douglasii Douglas-fir dwarf mistletoe	SW quarter of region	occasional chronic patches, locally severe impact
Cicada	Commerce Cr	14% of seedlings top-killed
Cryptoporus volvatus gray-brown saprot	Slewiskin Ck.	prolific fruiting on 10 dead and dying trees

Host/Pest	Location	Remarks
Dichomera gemmicola a bud fungus	Premier Ridge	killing 15% of buds
Erwinia sp. (=Agrobacterium pseudotsugae) a bacteria	Twin Creek	locally common branch galling
Spruce		
Adelges cooleyi Cooley spruce gall adelgid	throughout host range	generally light to moderate intensity
Pikonema alaskensis yellowheaded spruce sawfly	Castlegar	mostly moderate defoliation for + 20 km radius
True fir		
Lirula abietis-concoloris a fir needlecast	host range	trace damage common in higher elevation stands
Pucciniastrum epilobii fir-fireweed rust	host range	light to moderate dieback of current growth common
Western larch		
Arceuthobium laricis larch dwarf mistletoe	host range west of Rocky Mtns.	occasional chronic patches, locally severe impact
Semiothisa sexmaculata green larch looper	host range	remaining endemic after 1990 outbreak
Western red cedar		
Semanotus ligneus cedartree borer	McNaughton Lk.	numerous attacks on log decks left overwinter
Western yew		
Dothiora taxicola a needle and shoot blight	Duncan Lake	light damage common
Juniper		
Gymnosporangium clavariforme clavariform juniper rust	Donald	high incidence of branch swellings
Gymnosporangium nelsonii Nelson's juniper rust	Donald	occasional galls

Host/Pest	Location	Remarks
Seynesiella juniperi a foliage "fly speck"	Donald	low incidence
Multiple hosts		
Gnathotrichus retusus an ambrosia beetle	host ranges	chronic pest degrading softwood lumber
Leptoglossus occidentalis western conifer seed bug	host ranges	common, occasionally numerous overwintering in houses
Mulsantina picta minor ladybird beetle	Castlegar	beneficial, predator of adelgids
Sydowia polyspora Sydowia tip dieback	Lower Arrow Lk. Palliser R.	Douglas-fir tip dieback pine seedlings 40% top-kill
Trypodendron lineatum striped ambrosia beetle	host ranges	chronic pest degrading softwood lumber
Deciduous trees		
Autographa californica Alfalfa looper	Revelstoke, Nakusp,Kaslo, New Denver, Grand Forks	large spring moth flight, minor defoliation later on fruit trees and shrubs
Cryptorhynchus lapathi poplar and willow borer	host range	scattered attacks chronic and widespread
Malacosoma disstria forest tent caterpillar	Golden	collapsed after peaking in 1989 on 9900 ha
Phellinus tremulae a hardwood trunk rot	host range	causing extensive decay
Valsa sp. a saprophyte	Nancy Greene Lake	new host record on Alnus incana