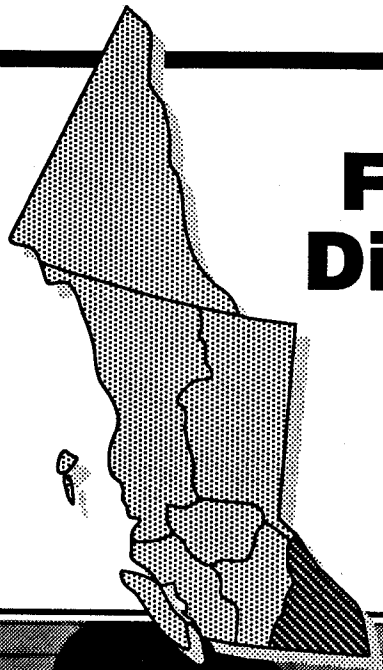
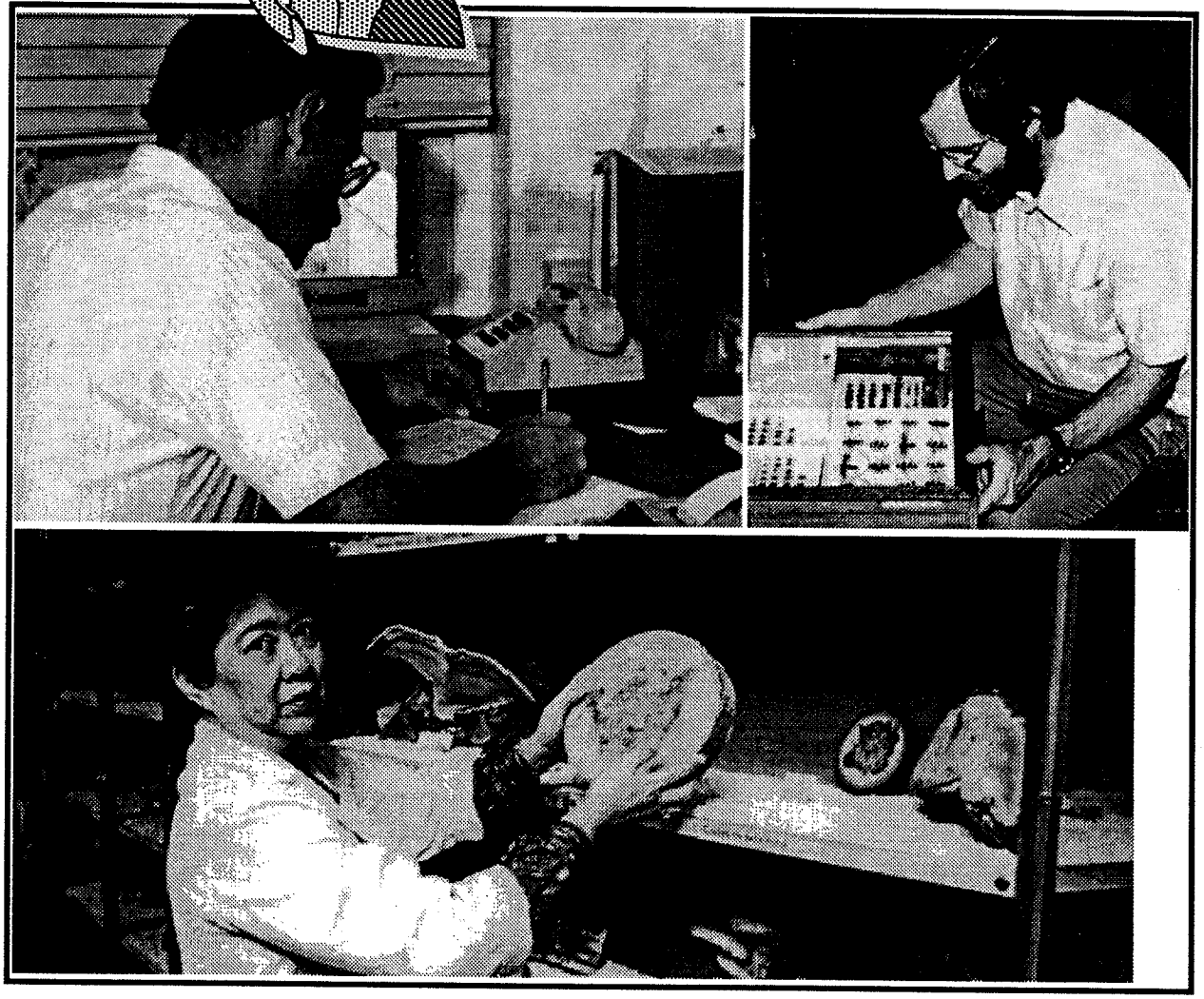


Forest Insect and Disease Conditions

Nelson Forest Region
1991

L. Unger & A.J. Stewart



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APPENDICES

The following appendices are available upon request from the Forest Insect and Disease Survey, Forestry Canada, 506 West Burnside Road, Victoria, B.C. V8Z 1M5.

I Location, area and number of pine trees killed by mountain pine beetle in the Nelson Forest Region, 1991.

II Maps of major beetle and defoliator outbreaks, Nelson Forest Region, 1991.

III Summary of pest problems in provincial parks, Nelson Forest Region, 1991.

IV Details of pheromone trap programs, Nelson Forest Region, 1991.

V Summary of pest problems in young stands, Nelson Forest Region, 1991.

VI Pest reports mailed out during the year:

- Snow damage and blowdown in the East Kootenay.
- Western hemlock looper in the Nelson Forest Region.
- Summary of forest pest conditions Nelson Forest Region (East Kootenay).
- Gray spruce looper in the Nelson Forest Region, 1991.
- Western spruce budworm in British Columbia 1991 and forecast for 1992.
- Pest summary East Kootenay - 1991
- Western hemlock looper in British Columbia 1991 and forecast for 1992.
- Forest pest conditions in Kootenay National Park, 1991
- Forest pest conditions in Yoho National Park, 1991
- Forest pest conditions in Mt. Revelstoke and Glacier National Parks,1991

INTRODUCTION

This report outlines forest insect and disease conditions in the Nelson Forest Region and Kootenay, Yoho, Glacier and Mt. Revelstoke national parks in 1991, 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 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, and records; (4) providing advice and extension on forest insect and disease conditions; (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.

The 1991 field season extended from mid-May to late October during which about 300 insect and disease collections were submitted to the Pacific Forestry Centre (Map 1). Approximately 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. About 59 hours of fixed-wing aerial survey time and assistance in producing preliminary sketch maps was provided by the B.C. Forest Service; two hours of helicopter time to survey portions of Kootenay and Yoho National Parks was provided by the Canadian Parks Service. The area covered by aerial surveys is shown on Map 1.

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.

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

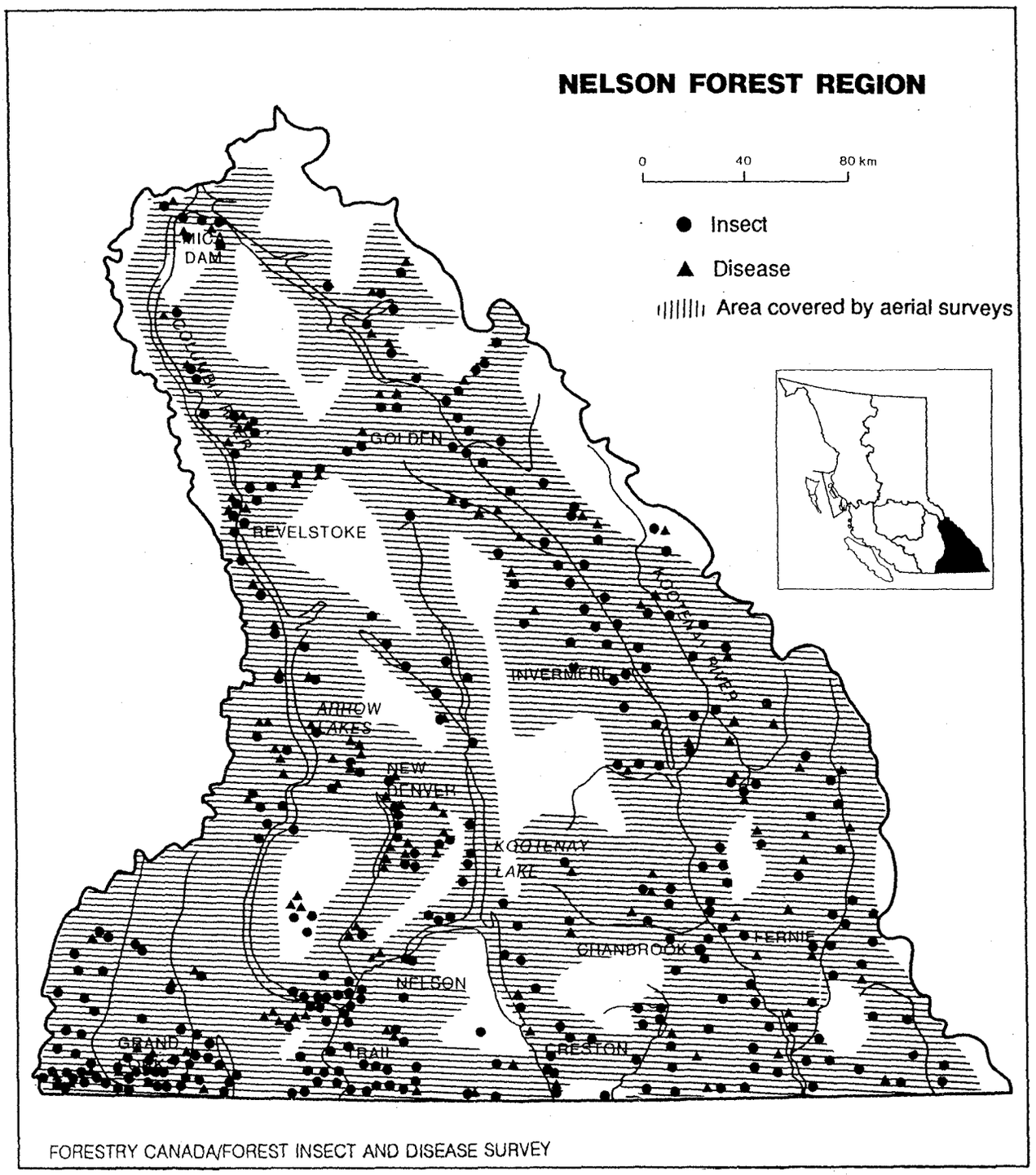
Forest Insect and Disease Survey
Box 120
Wasa, B.C.
V0B 2K0 Ph. 422-3465

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

or throughout the entire year to:

Forest Insect and Disease Survey
Forestry Canada
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 address.



Map 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1991.

SUMMARY

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

Mountain pine beetle populations declined by 36% overall, killing an estimated 762 780 trees over 14 680 ha; overwintering brood mortality resulted in a smaller flight in the south. **Ips beetles** continued to kill pine in the wake of the mountain pine beetle outbreak. **Red turpentine beetle** killed 30% of fire-stressed ponderosa pine near Canal Flats. **White pine blister rust** infections averaged 44% in two young stands. Repeated severe infection by **pine needle diseases** over 22 000 ha in the south reduced increment up to 72%.

Douglas-fir beetle populations declined in the southern Rocky Mountain Trench and increased in the north, killing a total of 3080 trees. Defoliation by **western spruce budworm** increased fourfold to 4036 ha in the southwest, and is expected to continue. Severe infection by **Douglas-fir needlecast** in plantations reduced growth by almost 30% over 5500 ha. Light defoliation by the **Douglas-fir tussock moth** near Christina Lake is expected to increase.

Spruce beetle recently killed 37% of spruce over 20 ha in the Blaeberry River drainage; activity increased generally in blowdown in the Golden TSA. **Spruce weevil** attacks averaged 14% in monitoring plots, unchanged from 1990.

Two year-cycle spruce budworm populations increased in the east with light defoliation over 1500 ha by mature larvae in the Purcell Range and 1300 ha by immature larvae in the Rocky Mountains; defoliation will continue in 1992 and 1993. **Western balsam bark beetle** killed alpine fir over 3850 ha, half in the Spillimacheen River drainage. A **balsam shoot-boring sawfly** declined near Creston. **Balsam tip blight** increased, killing over half the branch tips on 600 ha in the Blaeberry and Bush river systems.

Over 8000 ha was defoliated in a **western hemlock looper** outbreak near Revelstoke and McNaughton lakes; more defoliation but little expansion is expected. Defoliation by the **gray spruce looper** increased three-fold to 3850 ha, most near Arrow Lake, but a decline is expected in 1992. **Conifer sawfly** populations increased in parts of both outbreaks, compounding the impact.

Larch needle diseases again increased in most of the host range, with severe infections over 9900 ha. **Larch casebearer** activity slightly increased in the east with 660 ha of light defoliation mapped near Creston. A **larch shoot moth** increased after stand spacing, killing 40% of terminals in the Windermere Lake area. **Green larch looper** populations collapsed in the southwest.

Tomentosus root disease infected 75% of the mature Engelmann spruce and lodgepole pine in the St. Mary and White river drainages. **Armillaria root disease** killed an average of 7% of the trees in 15 of 20 young stands surveyed. **Blackstain root disease** infected 16% of mature lodgepole pine at Quartz Creek and 21% of Douglas-fir and lodgepole pine in a spaced stand at Donald.

Severe **snow damage** from fall 1990 was mapped over 2100 ha mainly in the southeast. Extensive fringe and scattered stand **windthrow** occurred through much of the region in the fall of 1991.

Bear and **porcupine** damage was mapped over 327 ha, mainly in the Invermere TSA, and caused significant damage in 5 of 17 young stands surveyed. **Voles** severely damaged 24% of spruce seedlings at Ensign Creek. Low levels of **black army cutworm** are not expected to rise in 1992; seedlings were defoliated at one site near Vowell Creek. The occurrence of **rhizina root disease** declined, with high incidence of seedling mortality in only two of 15 sites examined. No **gypsy moths** were captured at 32 locations trapped.

Pests of young stands surveys were done in 46 stands established or treated under the FRDA 1 Agreement; of the total 4293 trees surveyed, 7% had pests leading to tree mortality and 8% had pests causing growth loss.

Venturia foliar blights lightly infected trembling aspen and black cottonwood over 2300 ha in the Golden area. An **aspen leafroller** severely defoliated trembling aspen over 875 ha, mainly in the Golden area.

PINE PESTS

Mountain pine beetle
Dendroctonus ponderosae

Mountain pine beetle killed mainly lodgepole and occasionally western white and ponderosa pines at mostly light incidence over 14 680 ha region-wide (Table 1, Map 2), 36% less than 1990. Most of the decline occurred in the Boundary, Invermere, Kootenay Lake and Arrow TSAs; infestations increased in the Cranbrook and Golden TSAs.

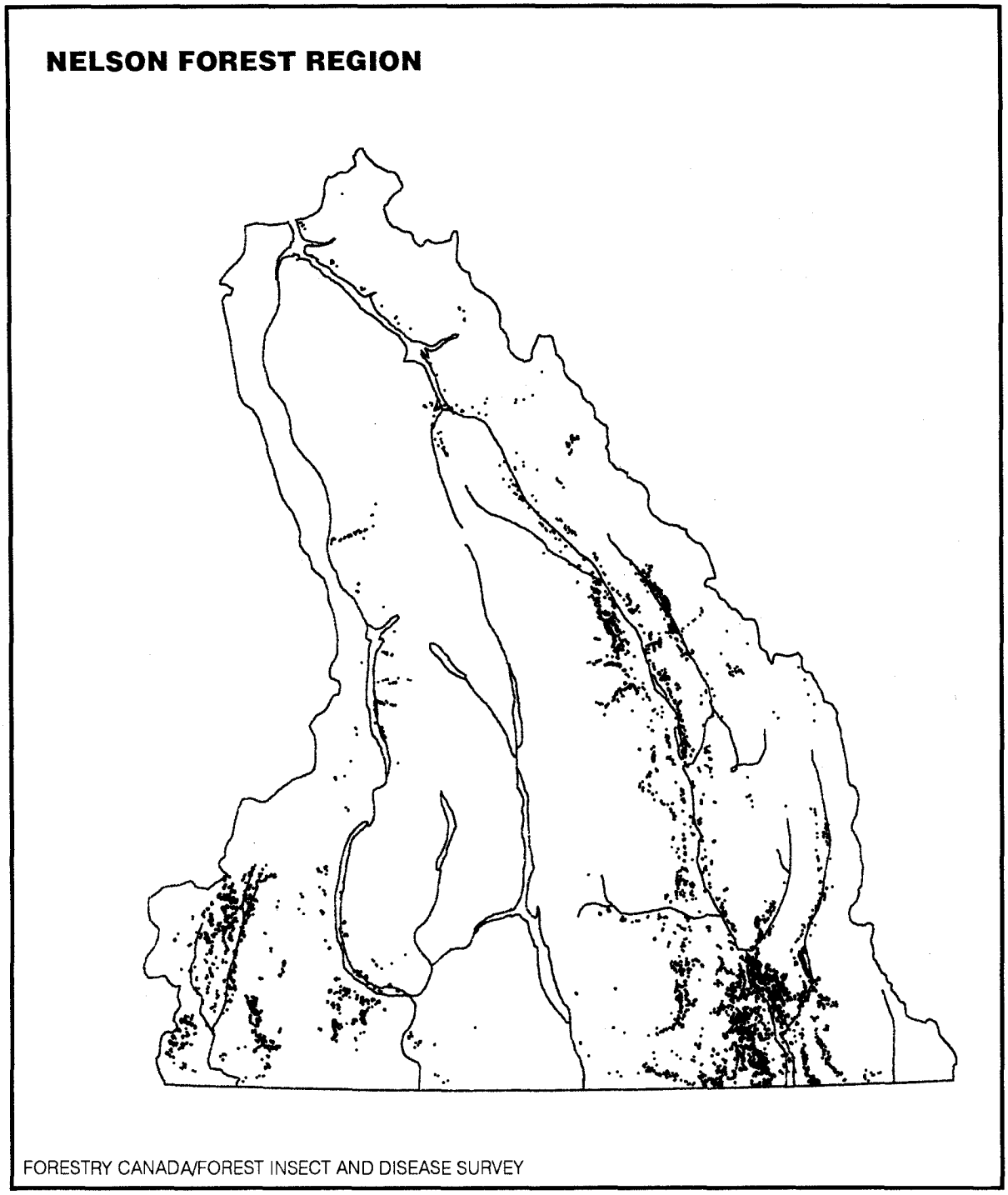
Table 1. Location, number, area and volume of pine recently killed by mountain pine beetle, determined by aerial and ground surveys. FIDS, Nelson Forest Region and National Parks, 1991.

TSA or Park	Number of infestations	Area (ha)	Trees killed (faders)[1] Number	Vol. (m^3)
Boundary TSA	720	2 960	136 000	49 000
Arrow TSA	310	875	37 000	14 800
Revelstoke TSA	18	5	90	40
Kootenay Lake TSA	48	40	1 400	560
Cranbrook TSA	1 917	8 530	480 000	171 000
Invermere TSA	850	1 320	50 300	18 100
Golden TSA	107	40	800	240
TSA Total	**3 970**	**13 770**	**705 590**	**253 740**
Kootenay National Park	248	860	56 000	20 200
Glacier National Park	22	35	900	700
Yoho National Park	29	10	200	80
Mt. Revelstoke Nat. Park	18	5	90	40
National Parks Total	**317**	**910**	**57 190**	**21 020**
Regional Total	**4 287**	**14 680**	**762 780**	**274 760**

[1] Trees attacked in 1990, discolored in 1991.

Boundary TSA

The area of red trees mapped (Map 2) declined for the third year to 2960 ha, 76% less than 1990. The decline was least evident in the Kettle River drainage where lingering patches of moderate to severe incidence were scattered over 1300 ha from the Christian Valley area north to the regional boundary. Other scattered outbreaks, mostly light incidence, were mainly in the Ripperto and Rock Creek drainages, Kettle River drainage from Westbridge to Christian Valley, Boundary Creek and Phoenix Mountain areas, and upper McRae Creek.



Map 2. Areas of pine recently killed by mountain pine beetle as determined by ground and aerial surveys, 1991.

Arrow TSA

The area of red trees mapped declined to 875 ha, 21% less than 1990. Most of the decline was in the southern half of the TSA, though significant patches of light to moderate incidence remain in the Nancy Greene Lake to Gem Hill, upper Big Sheep Creek, and Cayuse to Little Cayuse Creeks areas. Spot outbreaks of 5 to 10 trees and areas of light incidence occurred mainly in the western Robson Ridge to Dog Creek, and Champion Lakes areas, and near upper Rialto, Sunshine, Gladstone and Eagle creeks.

In northern areas of the TSA, spot outbreaks of about five trees increased, mainly on south-facing slopes in the Halfway River, Payne and St. Leon creeks areas, and on west-facing mid-slopes of Sanderson, Abriel, and Kuskanax mountains along Arrow Lake.

Revelstoke TSA

Similar to 1990, 18 small infestations averaging five red trees were mapped mainly in the Illecillewaet River (7), lower Akolkolex River (7), and McNaughton Lake (3) areas of the TSA. Most of these lingering spot outbreaks are in mixed stands with relatively few lodgepole or white pine.

Kootenay Lake TSA

The area of red trees mapped declined to 40 ha, 89% less than 1990. Most remained in the Hawkins and Freeman creeks areas, mainly spot outbreaks of 5 to 10 trees. Small outbreaks of light to moderate incidence occurred near Yahk.

Cranbrook TSA

Infestations increased to 8580 ha, up from 6580 ha in 1990. The main area of increased activity remained in the Rocky Mountain Trench south of Cranbrook and along Gold Creek south of Chipka Creek, though suitable host trees are becoming scarce in some areas. The progression of infestations north along the Elk River continued, with major expansion in the Morrissey to Fernie area and a large increase of spot infestations north of Sparwood to Elkford. Four-year-old infestations in the Bull River and Sand Creek areas continued to expand rapidly. Outbreaks in the Moyie Lake area have become firmly entrenched over approximately 550 ha. Infestations on the west side of the Galton Range continued at reduced levels, while in the Wigwam, Lodgepole and Bighorn creeks some expansion was noted. In the Bloom Creek to Yahk River area, mortality remained in small patches of 5 to 50 trees. The number of spot infestations north of Cranbrook remained relatively stable but with some reduction in area.

Invermere TSA

Infestations continued a downward trend to 1320 ha, from 1845 ha in 1990 and a high of 13 600 ha in 1986. The largest concentrations, where the number of recent faders remained relatively stable, continued along Frances Creek behind Steamboat Mountain, lower Horsethief and Toby creeks, and along the west aspect slopes above Columbia and Windermere lakes. Expansion occurred in the north, with numerous small groups of faders in the Parson and Spillimacheen areas. Infestations continued to grow in the Pinnacle and Kindersley creeks

areas. South of Canal Flats the size and number of outbreaks declined. In the White-Kootenay river drainage east of the Rocky Mountain Trench, the number of faders remained low, however there were a few more spot infestations adjacent to Kootenay National Park.

Golden TSA

There was a five-fold increase in the number of recently killed lodgepole and white pine in the Golden TSA. Most was mapped along the southern end of Columbia Reach; near the mouths of Beaver River and Quartz Creek and along Blackwater Ridge. There were also more small patches of 5 to 20 recently killed trees south of Golden along the Columbia River and east along the Kicking Horse River. Along the upper Kootenay River, a few small pockets were mapped near Kootenay National Park. The number of spot outbreaks remained relatively unchanged along McNaughton Lake.

National Parks

Beetle activity increased in Kootenay, Glacier and Yoho National parks, while remaining unchanged in Mount Revelstoke National Park. In **Kootenay National Park**, 56 000 trees were killed, up from 17 300 in 1990. There was a major intensification in the main area of infestation between Pitts and Daer creeks. Recent tree mortality was also much more widespread to the north and intensified to the south, spreading beyond both park boundaries. Very scattered small groups of recently killed trees were also mapped in the Vermilion River drainage at Simpson River, Mt. Shanks, and Numa Creek. In **Glacier National Park** (900 trees up from 390 in 1990), the chronic infestation in white pine at the junction of Beaver River and Mountain Creek greatly intensified, but most expansion occurred outside of the Park.

In **Yoho National Park**, an increased number of recently killed trees were mapped along the Kicking Horse River opposite Field. Numerous groups of two to five faders were mapped at the mouth of Amiskwi and Emerald rivers. Several beetle-killed trees were also mapped at Wapta Lake. In **Mount Revelstoke National Park**, 18 lingering spot outbreaks of about five trees each were mapped on south-facing slopes above the Illecillewaet River.

Factors influencing population dynamics

Weather conditions greatly influenced beetle populations in 1991, with overwintering brood mortality present in most infested stands (Table 2). Many larvae only reached cold-sensitive egg and early instar stages by fall 1990 and consequently, several weeks of extreme mid-winter cold killed the brood. In southern drier areas surviving larvae dehydrated in the spring and mortality of 90 to 100% was common. Some of the greatest losses were in the Rocky Mountain Trench, south of Columbia Lake, and in parts of the Boundary TSA. In wetter drainages, such as Bull River and Moyie Lake, the northern part of the Rocky Mountain Trench, and Kootenay and Yoho National Parks, brood mortality was not enough to significantly affect population trends.

Cool spring weather delayed the 1991 flight. Consequently, in the warmer valley bottoms the flight was spread out over a longer time period, reducing the

incidence of mass attack and increasing unsuccessful attacks, especially in spot outbreaks. However, in some of the cooler side valleys the delay resulted in a more concentrated flight with a higher level of successful attack. Extended warm fall weather allowed brood development to a winter-hardy, mid-instar larval stage, especially infestations on south and west aspects.

Table 2. Overwintering survival and population status of the mountain pine beetle. FIDS, Nelson Forest Region, 1991.

Location	"R" value[1]	Population status[2]	Remarks
Boundary TSA			
Grano Creek	7.0	Increasing	area of remaining patchy high activity
Volcanic Creek	4.5	Increasing	variable survival, good overall
Kettle Creek	3.2	Static	woodpecker predat. common,spot outbreak
Sand Creek	3.2	Static	variable survival, spot outbreaks
Boundary Creek	2.1	Decreasing	relatively sheltered stand, patchy
McRae Creek	2.0	Decreasing	variable survival, lingering outbreaks
Carmi Creek	1.2	Decreasing	lower survival at DBH, spot outbreaks
Arlington Lakes	0.9	Decreasing	lower survival at DBH, spot outbreaks
Beaverdell	0.2	Decreasing	lower survival at DBH, spot outbreaks
West Boundary Cr.	0.1	Decreasing	relatively open stand, spot outbreaks
Arrow TSA			
Nancy Greene Lake	0.8	Decreasing	higher elevation, lingering outbreaks
Cranbrook TSA			
Barkshanty Cr.	7.3	Increasing	recent major increasing population
Etna Cr.	4.8	Increasing	recent major increasing population
Van Cr.	4.2	Increasing	rapidly expanding pop. for 4 years
Teepee Cr.	2.0	Decreasing	high overwint. mort., old infestation
Bloom Cr.	1.6	Decreasing	high overwintering mortality
Fernie	1.4	Decreasing	high overwintering mort., large trees
Sparwood	0.7	Decreasing	high overwint. mort.,patches 1990 attack
Elko	0.7	Decreasing	high overwintering mortality
l. Yahk R.	0.4	Decreasing	high overwint. mort., scattered patches
Phillipps Cr.	0.3	Decreasing	high overwint. mort., most trees small
Lost Dog Cr.	0.1	Decreasing	high overwint. mortality and logging
Invermere TSA			
Parson	7.9	Increasing	new infestation area
Pinnacle Cr.	5.4	Increasing	expanding populations
Brisco	3.3	Static	new infestation area
Horsethief Cr.	3.2	Static	continuing infestation
Cartwright L.	1.1	Decreasing	numerous small infestations
Canal Flats	0.5	Decreasing	high overwintering mort., old infestn.

(Cont'd)

Table 2. (Cont'd)

Location	"R" value[1]	Population status[2]	Remarks
Golden TSA			
Golden	3.7	Static	small pockets of 1990 attack
Kootenay Lake TSA			
Hawkins Cr.	3.2	Static	small pockets of old trees
National Parks			
Mountain Cr.	8.1	Increasing	infestation in white pine
Redstreak Cr.	2.9	Static	ongoing infestn.,few suscept. trees left
Field	2.1	Decreasing	overwintering mortality, small broods
Hector Gorge	0.7	Decreasing	small pockets, N. fringe of lrg. infest.

[1] "R" value = an average population trend, derived in the spring, from the number of insects relative to the number of parent galleries originating within a representative bark sample at DBH.

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

Forecasts

Overall, the number of discolored trees should decline in 1992, due to the smaller beetle flight in 1991, but the flight is expected to increase in 1992 in most areas. Forecasts are grouped according to distinctly different outbreak areas, with some overlap between TSAs where outbreaks are continuous.

Boundary and southern Arrow TSAs

Spring assessments of overwintering mortality (Table 2) revealed enough brood reduction to predict a population decline at most of the locations in this outbreak zone. Predation by woodpeckers was common. However, brood survival was good below the bole snow line (R-values 8.0, 7.0, and 4.9 at 3 locations checked) and in sheltered trees; enough beetles could have been produced to sustain the outbreak at current levels in some areas.

The results of fall cruises (Table 3) confirm that the 1991 beetle flight resulted in fewer trees being attacked at the locations assessed. Ratios of current to red attack averaged 0.7:1 based on numbers of trees and 0.5:1 in terms of volume. This confirms that the beetles are, on average, attacking fewer and smaller trees, which should result in a further decline in the outbreak for 1992.

Revelstoke, western Kootenay Lake, and northern Arrow TSAs

Spot infestations are expected to continue to linger at low levels, as they have for several years, with some expansion possible in the northern Arrow TSA as fire-regenerated pine stands age to favor successful brood production.

Cranbrook, southern Invermere, and eastern Kootenay Lake TSAs

In the dry southeastern portion of the region, the number of discoloring trees should decline substantially. This was indicated by a sharp drop in both current attack levels (to 6% from 37%) and "R" values (to 0.9 from 7.1) (Tables 2 and 3). However, only slightly reduced current attack was evident in: the southern wetter areas, such as Bull River, Moyie Lake and Hawkins Creek, and in the Rocky Mountain Trench area north of Invermere to Spillimacheen.

In the expansion areas (i.e. upper Elk River) where primarily small groups of less than 30 trees were red in 1991 (killed in 1990), overwintering brood mortality reduced the beetle population to the point where potential for successful attack in 1991 was low. In some of the southern Rocky Mountain Trench areas, there is only a limited amount of suitable host remaining.

Golden and northern Invermere

At Parson and in the Blackwater Ridge--Glacier National Park area, current attack levels on average doubled, but ranged to over fourfold increases in infestations with 30 or more red trees. This was the most active beetle area in the region in 1991, but a strong control program at this early stage of the infestation should limit its impact.

National Parks

In Kootenay National Park, fewer faders are expected in 1992 following a major expansion in 1991, however, concentrated new pockets of attack are expected beyond the current infestation center in the Kootenay River drainage. No significant activity is anticipated in the Vermilion River drainage. In Glacier National Park, expanding beetle populations will continue in the remaining white pine areas, but will also continue to migrate towards Columbia Reach. The infestation near Field, in Yoho National Park, is expected to decline slightly, and no significant activity is expected around the small groups of red trees. Lingering spot infestations are expected to continue at the same low level in Mt. Revelstoke National Park.

Table 3. Status of lodgepole and white pine in stands infested by mountain pine beetle, from fall prism cruises. FIDS, Nelson Forest Region, 1991.

Location	Percent of pine attacked[1]				Percent healthy
	Current (1991)	Partial (1991)[2]	Red (1990)	Grey (pre-1990)	
Boundary TSA					
Cup Lake	5	10	22	4	59
Beaverdell	13	2	19	13	54
McRae Creek	15	12	23	3	48
Arrow TSA					
Big Sheep Creek	13	9	16	6	55
Nancy Greene Lake	17	4	18	6	55
Kootenay Lake TSA					
Hawkins Cr.	10	6	33	10	41
Cranbrook TSA					
Sparwood	2	0	33	2	63
Jaffray	7	10	30	5	48
Plumbob Mtn.	5	3	34	3	55
Gold Mtn.	9	5	30	7	49
Fernie	12	3	22	7	56
Bull R.	48	11	19	3	19
Moyie L.	52	2	15	2	29
Invermere TSA					
Cartwright L.	17	1	19	7	56
Hurst Cr.	22	5	21	8	44
Brisco	25	6	25	7	37
Parson	31	6	9	1	53
Pinnacle Cr.	41	1	21	3	34
Golden TSA					
Blackwater Ridge	28	6	12	1	53
National Parks					
Field	16	16	25	1	42
Daer Mtn.	43	7	11	8	31
Mountain Cr.	46	1	17	1	35
Regional Average	22	6	22	5	46

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

[2] The partial attacks include pitchouts.

Pine needle diseases

Lophodermella concolor

Infection of one year-old lodgepole pine needles by this needle cast increased in intensity through much of the southern portion of the region. Severe infection was aerially mapped over 22 000 ha, however this is a conservative figure due to masking of discoloration by 1991 foliage when mapped. Notable areas of severe infection were in the Flathead River (13 000 ha), Elk River (900 ha), Bull River (5600 ha), Wigwam Creek (500 ha), Bloom Creek (800 ha)and St. Mary River (400 ha) drainages. More scattered and generally less intense infection was common in drainages further north, up to and including the White and Spillimacheen River systems, and to the west in the Boundary TSA. A secondary fungus, Hendersonia pinicola, was present at high levels in the Flathead River drainage, and near Trapping Creek and Matthews Lake. This fungus may act as a biological control of L. concolor by invading infected needles and preventing the development of ascomata.

An assessment to quantify the impact on pole-size lodgepole pine was done in the Lodgepole Creek area. Terminal growth was measured from ten trees which had been severely infected for the past two years and five healthy trees. In trees severely infected, the 1990 and 1991 annual increment was 50% and 28%, respectively, of the average annual height increment of the three preceding non-infected years (Table 4). Annual diameter increment was similarly affected. During the first year of infection diameter increment of infected trees was 47% of the pre-infection years and 29% during the second year.

Table 4. Growth reduction of lodgepole pine due to infection by Lophodermella concolor. FIDS, Nelson Forest Region, 1991.

	Diameter increment[1]		Height increment[1]	
	first year	second year	first year	second year
Infected	-64%	-74%	-43%	-66%
Healthy	-11%	-3%	+7%	+6%
Net impact	-53%	-71%	-50%	-72%

[1] All figures are a percent of the pre-infection increment.

Leptomelanconium pinicola

Generally light infection of ponderosa pine foliage occurred over approximately 500 ha in scattered patches from Roosville north to the Norbury Lake area and including Teepee Creek. Areas of up to four hectares in the Grasmere, Elko and Norbury Lake area were moderately blighted. The most recent,

severe epidemic in the region occurred during the late 1970's when up to 4000 ha were recorded. Severe epidemics often build up over several years; with the moist summer in 1991 further infection can be expected in 1992.

L. pinicola is often found as a saprophytic fungus of older needles, but under favorable conditions it becomes parasitic, capable of infecting all ages of needles and causing growth loss. Limited sampling during previous epidemics indicated that annual radial increment was reduced by 40%.

Lophodermium nitens

White pine foliage on understory and sapling-aged trees was moderately to severely infected by L. nitens in several areas near upper Arrow Lake, particularly near Mosquito Lake and for several kilometers north of Shelter Bay.

Ips beetles
Ips pini
Ips mexicanus

Ips beetles became more evident in 1991 due to the decline of the mountain pine beetle in the southern portion of the region. In the Jaffray, Fernie and Sparwood area an average of 28% of the 1991 attacked trees were killed by Ips beetles. Lower levels were present in other areas where overwintering mountain pine beetle mortality was high. Populations increase with the mountain pine beetle and can cause tree mortality for several years after it declines.

Red turpentine beetle
Dendroctonus valens

Red turpentine beetles caused 30% mortality of ponderosa pine stressed by grass burning in a spaced and pruned 28 year-old stand near Canal Flats. In young stands, burning causes greater stress than in older ponderosa pine stands and some mortality can be expected. Additional stress caused by old stumps smoldering over an extended period of time weakened adjacent roots. This beetle normally attacks only stressed and recently cut trees or stumps.

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 prior to eventual mortality, and occasional infestation by the mountain pine beetle preclude an accurate determination of annual impact. Forty-four percent of susceptible trees were infected in 2 of 4 sapling-aged stands spaced under the FRDA 1 Agreement.

DOUGLAS-FIR PESTS

Douglas-fir beetle
Dendroctonus pseudotsugae

The area covered by Douglas-fir beetle infestations remained relatively unchanged from 1990, while the number of recently killed trees declined by 23% (Table 5). No new infestations were mapped in the West Kootenay.

Table 5. Location, number and area of Douglas-fir recently killed by Douglas-fir beetle. FIDS, Nelson Forest Region, 1991.

TSA	Area (ha)	No. infestations	No. trees
Cranbrook	17	25	500
Invermere	46	112	1950
Golden	8	34	630
Total	71	171	3080

In the **Invermere TSA**, the area with recently killed trees increased overall, mainly in numerous small infestations along the east side of Columbia Lake. Infestations in the Whiteswan Lake area were generally scattered, with small groups of recently killed trees near previously killed stands. Fewer discolored trees were mapped along the Kootenay River east of Canal Flats. In the Whitetail Lake--Findlay Creek area there was little change.

In the **Golden TSA**, there was a five-fold increase in the number of recently killed trees mapped. Most of the activity remains in small pockets north of Bush Arm to the Prince George Regional boundary, but several new infestations were also mapped near Rice Brook in the upper Bush River drainage and along Blackwater Ridge. None of these infestations have been chronic, but rather of two to three year duration, centering around site disturbances such as logging, fire or blowdown. In addition, populations intensified in trees severely infected by root rot, but abated as they attacked healthier trees.

In the **Cranbrook TSA**, beetle activity continues in the Wickman Creek and Wildhorse River areas. Large portions of both infestations have been logged, accounting for most of the reduction in area of beetle-killed trees in the TSA.

Forecasts

In the **Invermere TSA**, fall surveys of current attack levels and brood development (Table 6) generally indicated a further decline in the population. The only exception was in the Findlay Creek drainage where broods were large in currently attacked trees.

In the **Golden TSA**, the current level of attack was high in the new pockets of infestation. However, the brood sizes indicated that attack in 1992 will remain at similar or reduced levels. These infestations appear to follow the short-lived pattern of previous outbreaks in the area.

In the **Cranbrook TSA**, current attack levels appear relatively high, but extensive logging in the infestation areas may be distorting some of the ratios. With smaller infestations and broods, a decline in attack levels is expected in 1992.

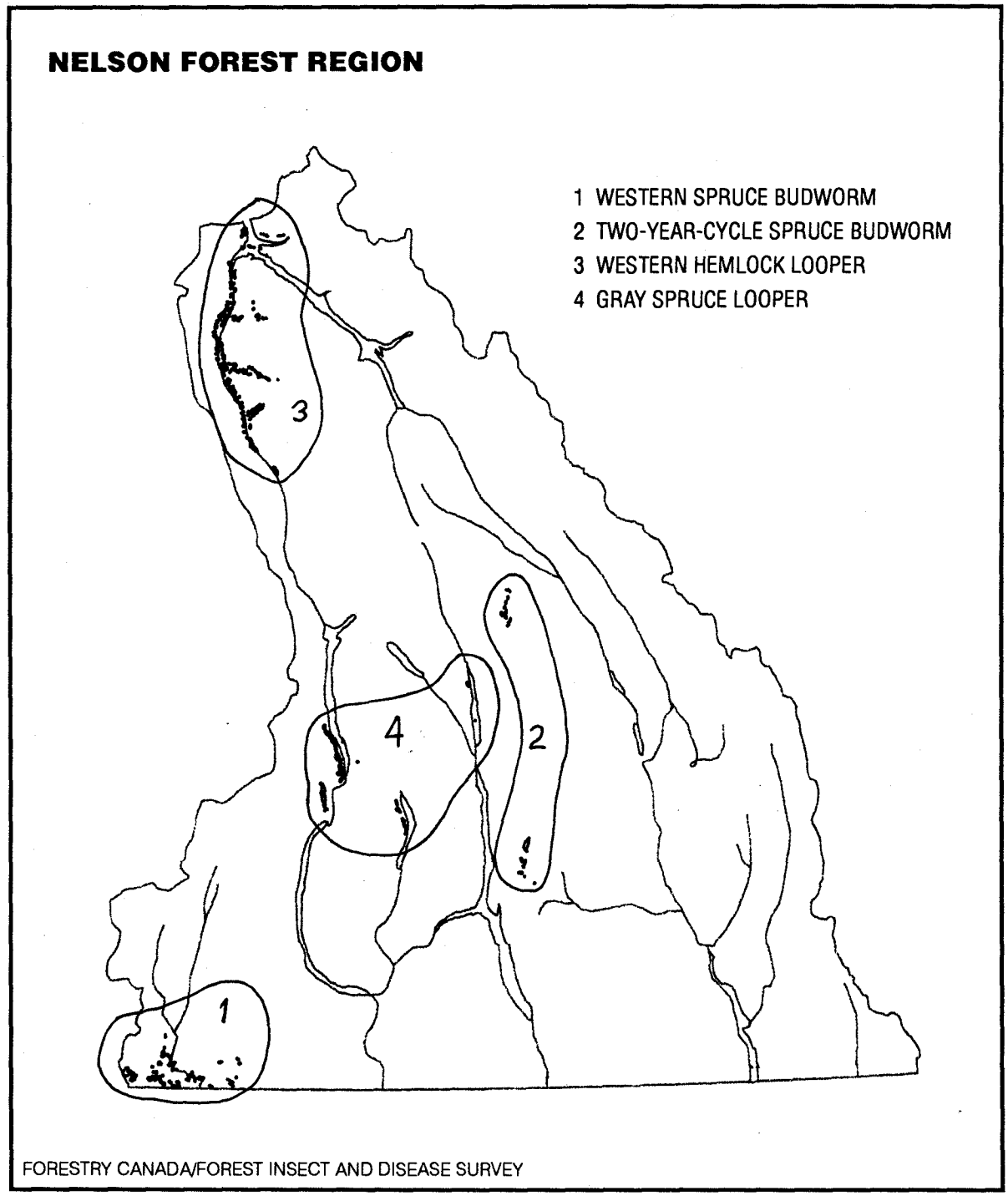
Table 6. Douglas-fir beetle population trends. FIDS, Nelson Forest Region, 1991.

Location	Fall "R" values[1]	Ratio of current to red attack
Cariboo Cr.	0.4	4.5:1
Blackwater Ridge	2.4	2.5:1
Bush R.	2.2	3:1
Findlay Cr.	5.6	1:18
Whiteswan L.	1.0	1:13
Columbia L.	0.1	1:25
Wildhorse R.	0.6	1:1
Wickman Cr.	1.5	1.5:1

[1] Reproductive ratios, or R values, relate the number of surviving brood to entrance holes in 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. Since brood sampling at two meters could suggest a decline, larger broods higher up the bole may be capable of maintaining a stable population. However, lower samples remain sensitive to significant population increases.

Western spruce budworm
Choristoneura occidentalis

Defoliation was mapped in 48 infestations over 4036 ha (Map 3), a four fold increase from 12 infestations over 1160 ha in 1990. Ninety-four percent of the current defoliation was light, the rest moderate. This was less intense than expected from fall 1990 egg counts and spring 1991 bud counts (Table 7) due to larval mortality attributed to: a disease, identification in progress, infecting 85% of larvae in a collection from Conkle Lake Road; parasitism, affecting 21% of a collection from the Bridesville area; and unusually wet weather from May through July, eg. 90% more rain than normal at Grand Forks.



Map 3. Areas where current defoliation was detected during aerial and ground surveys in 1991.

Patches of defoliation occurred from the Anarchist Mountain area east to Baker Ridge and Fisherman Creek near Grand Forks, and north to Cranberry Ridge near Beaverdell. Lower crown and understory foliage can be severely defoliated in stands mapped as lightly defoliated during aerial surveys, due to the larvae dropping down and feeding lower as they age.

Forecasts

In the **Boundary TSA**, numbers of egg masses declined at 8 of 10 sites compared to 1990, by an average of 40% (Table 7). The decline probably reflects a reduced flight after high larval mortality. However, numbers of egg masses were still sufficient to predict moderate to severe defoliation for 1992 in currently infested areas (Map 4). Egg parasitism was significant at some locations (Table 7) but is not expected to alter the course of the outbreak.

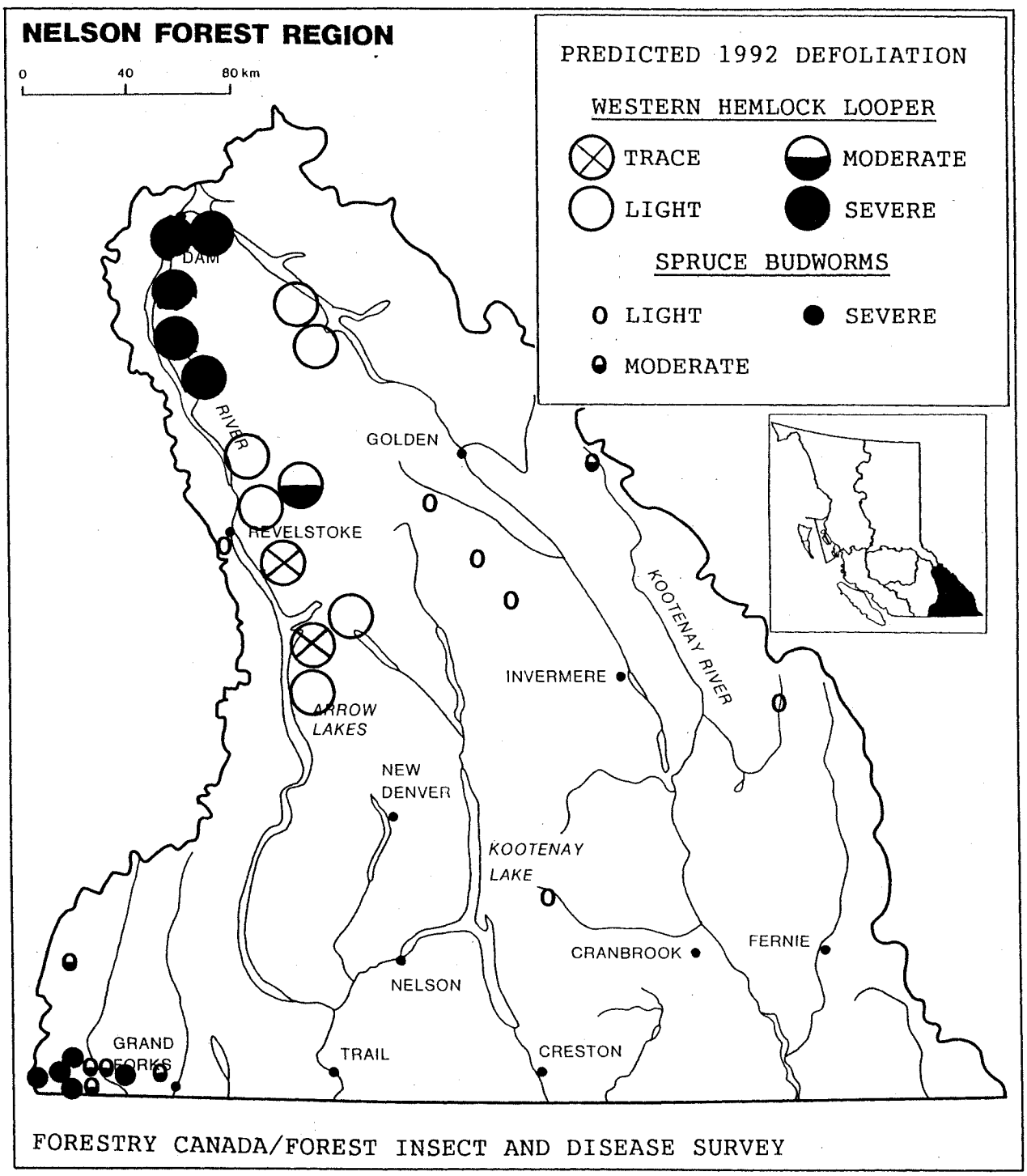
Table 7. Current and predicted defoliation of Douglas-fir by the western spruce budworm. FIDS, Nelson Forest Region, 1991.

Location	% buds infested[1]	1991 defol.	No. egg masses per 10 m² foliage		% change from 1990 (Healthy)	Predicted 1992 defoliation[1]
			Parasit.	Healthy		
Boundary TSA						
Rock Mtn. Rd.	53	light	16	62	-87	moderate
Johnstone Ck.	60	light	0	83	-79	moderate
Phoenix Mtn.	25	light	37	110	+144	moderate
Beaverdell	53	trace	0	116	-64	moderate
Nicholson Ck.	63	light	41	136	-64	moderate
Ingram Ck	48	light	27	163	-66	severe
Conkle Lk. Rd.	30	trace	15	179	-38	severe
Bridesville	44	trace	0	196	-35	severe
Anarchist Mtn.	38	light	0	336	-16	severe
McKinney Ck.	47	moderate	0	653	+176	severe
Revelstoke TSA						
Eagle Pass	-	none	0	17	-	light

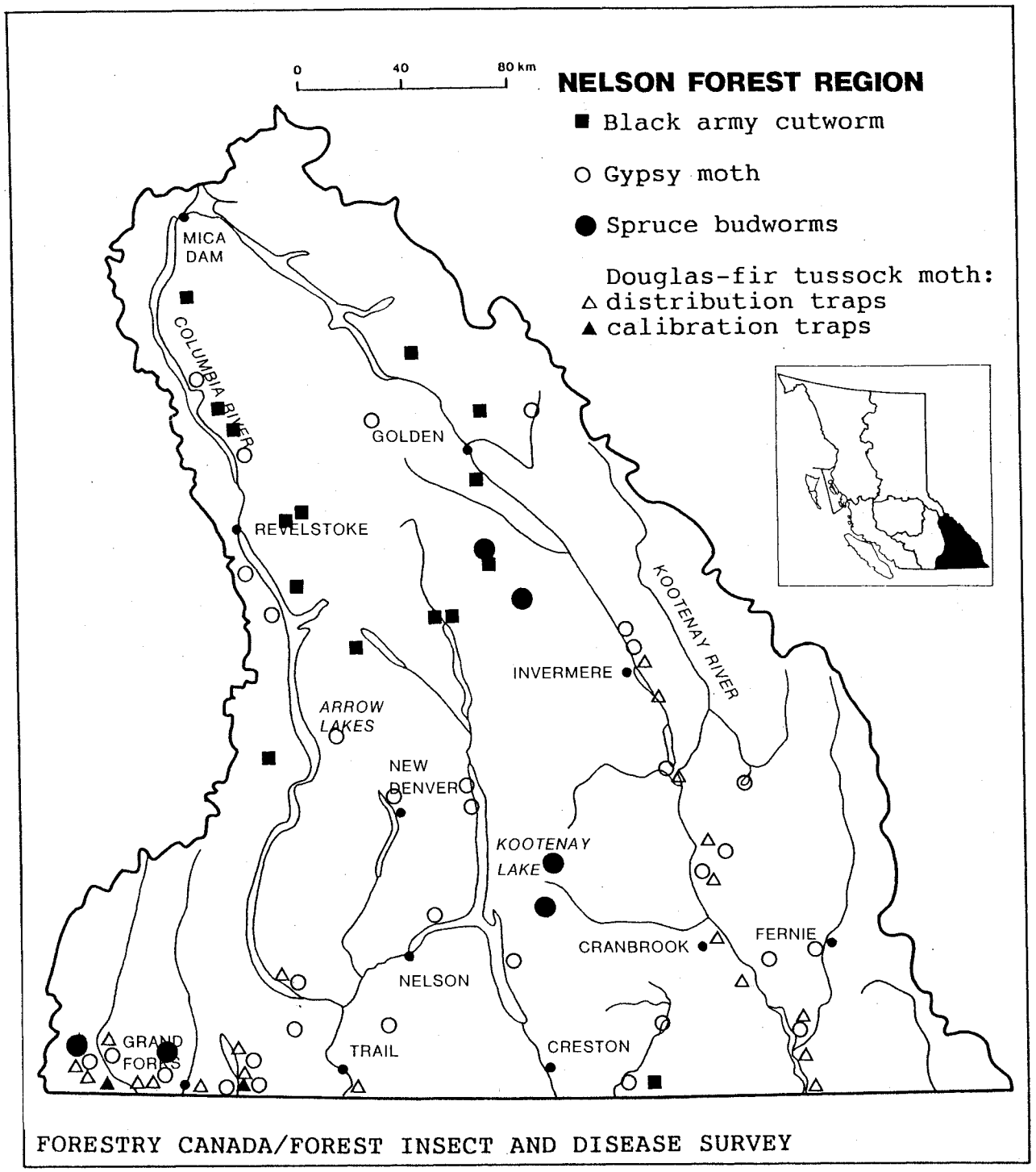
[1] Thresholds for current (infested buds) and next season (egg masses) forecasts:

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

A pheromone calibration project to detect increasing populations and predict infestations continued in 1991 (Map 5). Moth catches in Multipher® traps at Conkle Lake Road (avg. 85) and Phoenix Mtn. (avg. 52) were 50 and 34%, respectively, of 1990 catches which resulted in trace to light defoliation of both areas in 1991.



Map 4. Forecasts of defoliation expected in 1992 by the western hemlock looper, western spruce budworm, and two-year cycle spruce budworm. FIDS, Nelson Forest Region, 1991.



Map 5. Locations where one or more pheromone-baited traps were deployed. FIDS, Nelson Forest Region, 1991.

In the **Revelstoke TSA**, egg sampling at Eagle Pass to detect any dispersal from outbreaks in the Kamloops Forest Region indicated that only minor feeding should occur in 1992.

Douglas-fir needle cast
Rhabdocline pseudotsugae

Foliage infected by Douglas-fir needle cast increased in intensity and incidence over an estimated 5500 ha in 1991. Light to moderate infections continued, especially in the Flathead River drainage and along the western side of the Rocky Mountain Trench. In the Golden TSA, increased incidence was notable in the Blaeberry River drainage, where an average of 11% of the young Douglas-fir in cutblocks were severely infected.

A preliminary impact study was conducted on plantation Douglas-fir along the Blaeberry River by measuring the height increment of 14 severely and 8 non-infected trees. The reduction in height increment was similar for both the first and second years of infection, 24 and 29% respectively, compared to the healthy trees.

Cool and humid weather conditions during the spore release period, concurrent with the bud burst in May and June, highly favor a significant increase in infection levels in 1992.

Douglas-fir tussock moth
Orgyia pseudotsugata

The tussock moth population increased in 1991 with trace to light defoliation near the Christina Lake golf course. No parasites emerged during rearing of a larval mass collection, though an unidentified disease killed 29% of the larvae and 42% died from undetermined causes. Numbers of moths caught in pheromone-baited sticky traps (Map 5, Table 8) increased for the second year, revealing the potential for increased feeding in 1992.

Table 8. Catches of Douglas-fir tussock moth in a calibration study of pheromone-baited sticky traps. FIDS, Nelson Forest Region, 1991.

Location	No. traps	Average no. moths per trap			
		1988	1989	1990	1991
Christina Lk. Golf Course	6	0	2	19	63
Rock Creek	6	1	1	8	11

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 moth caught at Kettle River Provincial Park (Map 5). Other moths attracted to the same pheromone included the rusty tussock moth, Orgyia antiqua badia, which was present in high numbers at Jaffray (35 moths), Wasa (25), Grasmere (20), and Kettle River Provincial Park (19). Dasychira grisefacta tussock moths were present in high numbers at Rock Creek (55), Elko (48), Johnstone Creek Provincial Park (47), Grasmere (44), Cranbrook (43), Skookumchuck (41), Dry Gulch (36), Windermere (34), and Texas Creek (33). Neither of these defoliators have a history of developing to infestation size in British Columbia, but an isolated short-lived outbreak of rusty tussock moth caused light to moderate defoliation in the Kamloops Region in 1975, and large infestations by D. grisefacta have caused significant defoliation in young ponderosa pine in Montana.

SPRUCE PESTS

Spruce beetle
Dendroctonus rufipennis

Spruce beetle populations increased in the Golden TSA in 1991. At Ensign Creek in the upper Blaeberry River drainage, 20% of the mature Engelmann spruce was attacked in 1991 over approximately 20 ha along the creek edges. An additional 17% tree mortality had occurred in 1990. The brood from the 1990 attack was large (42 adults/1000 cm^2) and will cause further tree mortality in 1992, primarily in the leave strip between cut blocks. The brood in the 1991 attacked trees was considerably smaller, only five larvae per 1000 cm^2, suggesting a decline in the local population.

Near Rice Brook in the Bush River drainage, eight, 1991-attacked standing trees were noted in association with fringe blowdown. Most of the large, first-year broods are maturing over two years and will fly in 1993. When beetle populations from logging fringe blowdown expand to the point where standing trees are being killed, additional surveys are recommended.

Strong winds during mid-October caused blowdown in many areas throughout the region, creating favorable conditions for a population build-up. 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 killed an average of 14% of the spruce leaders in four of five young spruce stands surveyed in the East Kootenay (Table 9). This was relatively unchanged from attack levels in 1990. Four of the stands surveyed were population monitoring sites, the only other susceptible spruce stand surveyed along the White River was currently free of weevil damage.

Table 9. Spruce weevil damage trends. FIDS, Nelson Forest Region, 1991.

Location	Percent of leaders attacked 1987	1988	1989	1990	1991	Remarks
Beaverfoot R.	5	13	6	9	9	monitoring site, valley bottom
Blackwater Cr.	0	3	4	5	5	monit. site, spaced valley bott.
Quartz Cr.	30	35	32	18	21	monitoring site
McLeod Meadows (Kootenay Nat. Park)	-	-	17	23	22	monitoring site, natural clumped growth of varying height
White R.	-	-	-	-	0	recently spaced,not incl. in avg
Average	12	17	15	14	14	

TRUE FIR PESTS

Two-year-cycle spruce budworm
Choristoneura biennis

Both first- and second-year budworm larvae lightly defoliated alpine fir and Engelmann spruce in the Nelson Region in 1991.

Mature budworm larvae defoliated 80-100% of the current year's foliage over 1528 ha along Bugaboo Creek and St. Mary River (Map 3). Trace to light feeding was also evident during ground surveys along Vowell and McMurdo creeks. The current defoliation is substantially more than the 40 ha mapped during the last main feeding year in 1989 in the St. Mary River drainage, but remains well below the 10 000 ha reported in 1987.

Immature budworm larvae lightly defoliated trees over approximately 800 ha in the Vermilion River drainage between Floe and Tokumm creeks. Damage to the current year's foliage ranged from 10% at Numa Creek to 80% in parts of the Marble Canyon area. In the White River drainage, only trace to light defoliation of the current foliage was evident over approximately 500 ha.

Impact

The impact upon alpine fir and Engelmann spruce has not been adequately studied, but limited notations of bud mortality and population levels in the upper St. Mary River infestation suggest a greater impact than previously attributed to this budworm. The first impact of continual low levels of feeding is mortality of mid- and lower-crown buds. Bud damage in the lower crowns is more severe as larvae drop down during both years, especially the second year initial concentrated feeding by mature larvae. In this chronic outbreak the lower two-thirds or more of the crown has been killed on 30% of the trees.

Chronic stress caused by foliage loss may also be a factor in the increased incidence of Armillaria root disease in budworm infested spruce-balsam stands relative to non-infested stands. Inonotus tomentosus was the main root rot of spruce in most mature ESSF stands in the St. Mary River drainage (23% dead or dying); only in budworm-infested stands was the incidence of Armillaria ostoyae equal.

Forecast

Egg mass counts indicate that budworm populations should increase slightly in the St. Mary River area while decreasing in the Bugaboo Creek area (Table 10, Map 4). However, defoliation should remain light in both areas in 1993. Trace to light feeding by immature larvae can be expected in these areas in 1992. Bud counts in areas where larvae will mature in 1992 indicate increasing populations in the Vermilion River drainage and decreasing in the White River area.

Table 10. Forecast of defoliation in 1992 and 1993 by two-year-cycle spruce budworm. FIDS, Nelson Forest Region, 1991.

Location	Percent buds infested	No. of egg masses	Predicted defoliation[1]
Vermilion R.	34	-	light/moderate - 1992
White R.	8	-	light - 1992
Bugaboo Cr.	-	12	light - 1993
McMurdo Cr.	-	15	light - 1993
Vowell Cr.	-	10	light - 1993
St. Mary Cr.	-	28	light - 1993

[1] Predicted defoliation — percent buds infested — no. egg of egg masses/10 m^2

light	1-25	1-100
moderate	26-45	101-300
severe	46+	301+

A project to calibrate number of moths caught in pheromone-baited traps to increasing budworm populations was continued at Redding and Bugaboo creeks (Table 11, Map 5). Several more budworm generations have to be monitored at numerous locations before meaningful relatioships can be formulated.

Table 11. Number of larvae, adults and defoliation at two-year-cycle spruce budworm pheromone calibration plots. FIDS, Nelson Forest Region, 1991.

Location	Avg. no. larvae/tree[1]		Avg. no. adults/trap[2]		Defoliation	
	1989	1991	1989	1991	1989	1991
Redding Cr.	<1	<1	56	211	Nil	Nil
Bugaboo Cr.	5	9	179	1320	Trace	Light

[1] sampled by beating three 50cm branches on each of 25 trees over a 60x90cm sheet
[2] five Multipher traps spaced at more than 30 m intervals.

Western balsam bark beetle
Dryocoetes confusus

Recent tree mortality, as detected by aerial surveys, increased to 3846 ha from 1780 ha mapped in 1990, mostly due to increased coverage of the back end of drainages in 1991. Although extensive mortality continues in the Spillimacheen River, Bobby Burns and Vowell creeks drainages (1700 ha), significant mortality was also mapped along the upper Lussier River, Inlet and Thunder creeks (165 ha), East White and Bull rivers (100 ha), Skookumchuck Creek (200 ha),in the Redding and Meachen creeks drainages (100 ha), and in the Sullivan, Kinbasket and Cummins rivers drainages (300 ha).

In addition, scattered groups of 5-10 recently killed trees were common in most mature alpine fir stands throughout the region. Once established in a stand the beetles continue to selectively kill small groups of trees at a fairly constant level, about 1-3% of the alpine fir annually. Following blowdown, there will often be a temporary increase in tree mortality as beetle populations increase due to 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.

A balsam shoot-boring sawfly
Pleuroneura sp.

Damage to new grand fir shoots continued at reduced levels in the Creston area. At East Arrow Creek an average of 34% of the new shoots were infested, down from 60% in 1990. No new damage was evident at Rykerts or Wynndel where shoots had trace to light attack in 1990. Some of the reduction in attack levels may be attributed to extended cool, wet spring weather in 1991, which disrupted synchrony between sawfly and shoot development.

Balsam tip blight
Delphinella abietis

Damage by this shoot blight greatly increased in 1991 with damage recorded over approximately 600 ha along the upper Blaeberry and Bush rivers. Alpine fir in these areas had an average of 50% of the branch tips killed on 20 to 70% of the trees. Although most of the damage occurred on the current year's growth, branch dieback commonly included two to four year-old branches. All age class of trees were affected. Infections generally remained at trace intensity throughout much of the rest of the host range.

Balsam woolly adelgid
Adelges piceae

Surveys to detect the introduction of this insect remained negative in 1991. The nearest infestations are in Idaho and southwestern B.C.. Symptomatic alpine fir, with gouted branch tips, in a residential area of Nelson were infested by a native aphid, Mindarus sp.. Grand fir stands checked at five locations close to the U.S. border, from Waneta to Nelway, were all negative.

HEMLOCK PESTS

Gray spruce looper
Caripeta divisata

Defoliation of mainly western hemlock increased almost three-fold to 3850 ha in 34 infestations, from 1370 ha in 24 outbreaks in 1990, the first year of the outbreak (Map 3). Twenty-nine percent of current defoliation was light and 71% moderate, down from mostly severe defoliation in 1990. This is the second known outbreak of this insect in B.C., the first was near Terrace in 1961.

The increase in area defoliated was in the Arrow Lake portion of the outbreak, adjacent to stands previously defoliated and extending the outbreak south to Graham Creek and north to the Fosthall area. Defoliation was light in previously severely defoliated stands at Slocan, Box, and Duncan lakes. All defoliation in both years of the outbreak was on the western shores of the affected lakes, except for 25 ha just north of Nakusp. Soil samples collected for a study at Simon Fraser University from sites with many overwintering pupae were negative for pathogenic nematodes.

Damage

Mortality of western hemlock averaged 12% in two stands severely defoliated in 1990, while 70% of remaining live trees sustained dieback of the entire top crown and 26% dieback of the entire mid-crown. There were no hemlock killed in a stand moderately defoliated in 1990, but dieback of the entire upper crown occurred in 22% of the trees, and dieback of at least two-thirds of the upper crown in an additional 15%. Other conifers in these stands were less

severely defoliated and recovered well. Assessment of the impact of feeding in 1991 will be possible after the bud flush in 1992.

Forecast

Since outbreaks are rare, no quantitative forecasting methods have been developed, though a pheromone is being researched at Simon Fraser University. However, 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 six collections from the Slocan and Arrow lakes, larval mortality averaged 72% (range 44 to 98%), up from 27% (range 16 to 38%) in 1990. Two genera of pathogenic fungi, Paecilomyces and Entomophaga, were identified in the dead larvae. The increase in disease in 1991 combined with lower intensities of feeding suggest that the population should decline in 1992.

Western hemlock looper
Lambdina fiscellaria lugubrosa

Defoliation of mature to overmature western hemlock-western red cedar stands by the western hemlock looper increased to 8225 ha in 1991, from 915 ha in 1990, the first year of the outbreak. Of the area currently defoliated, 45% was at light intensity, 42% moderate, and 13% severe.

Defoliation was limited to the Revelstoke and northern part of Golden TSAs (Map 3). Patches of moderate to severe defoliation occurred in remaining stands of old growth along the Revelstoke Lake reservoir between the Downie Creek and Mica areas. Light to moderate defoliation occurred along Revelstoke Lake and in some side drainages as far south as Frisby Ridge, and in the Wood Arm, Redrock Peninsula, Encampment, Yellow, and Potlatch creeks areas of McNaughton Lake.

In potential expansion areas along McNaughton Lake, only trace defoliation of understory trees was evident near the mouth of drainages along the west side of the lake. In three tree beatings, there were an average of 57 larvae, with the highest numbers (92) at Gold River and at Km 108. Lower larval populations were also present in the Quartz Creek to Glacier National Park area (avg. 13 larvae) and along Bush River (avg. 1 larva). Previous infestations have developed when larval counts averaged eight or more in a drainage.

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. The last outbreak was 1982-84. In older stands, trees that are 100% defoliated are usually killed, while those 80% or more defoliated frequently die or succumb later to secondary agents.

Forecast

The results of fall egg sampling suggest that defoliation in 1992 will mostly remain in the areas already affected, with any spread to new areas limited to trace to light feeding (Table 12, Map 4). Egg parasitism, though significant, remains below the level indicating a population collapse. In

previous outbreaks, when 30% or more egg parasitism occurred, populations frequently collapsed the next year. Larval and pupal parasitism were insignificant, averaging 0.3% and 0.9%, respectively, at 3 locations each. However, an additional 22% of larvae and 26% of pupae died from undetermined causes during the rearings, some probably due to diseases expected to increase during the outbreak and contribute to its collapse.

Recent identification of a pheromone in a joint Forestry Canada/Simon Fraser University/Pherotech Ltd. study could provide another forecasting tool, after calibration to relate moth catches to defoliation expected.

Table 12. Results of fall egg sampling to forecast defoliation by the western hemlock looper in 1992. FIDS, Nelson Forest Region, 1991.

Location	Average number eggs per 100 g lichen				Percent parasitism	Predicted 1992 defol.[2]
	Healthy	Parasitized[1]	Infertile	Old		
Galena Bay	2	0	0	6	0	trace
Akolkolex R.	4	3	0	0	43	trace
St. Leon Cr.	6	0	0	6	0	light
Illecillewaet R.	8	1	0	6	11	light
Smith Cr.(Km 108)	9	3	0	5	25	light
Trout Lake	10	0	0	4	0	light
Gold River	22	4	1	4	15	light
Martha Creek	26	6	0	1	19	light
Martha Creek	16	4	0	4	20	light
Tangier River	46	11	2	6	19	moderate
Mica	120	42	0	27	26	severe
Goldstream River	160	13	6	13	7	severe
Redrock Harbor	184	29	7	13	13	severe
Bigmouth Creek	297	111	4	36	27	severe
Downie Creek	363	113	3	23	24	severe

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

[2] Defoliation prediction thresholds:
trace: < 5 healthy eggs
light: 5-26 healthy eggs
moderate: 27-60 healthy eggs
severe: >60 healthy eggs

Conifer sawflies
Neodiprion sp.

Conifer sawflies increased on western hemlock, mostly in the same areas as the hemlock looper outbreak. Numbers of sawfly larvae were generally 10 to 20% of the looper in defoliated stands along Revelstoke Lake, though at the

mouth of the Goldstream River they were equal in number and contributed significantly to defoliation in the area. There was no parasitism in sawfly larvae reared from this location, but 17% died from undetermined causes. Sawfly populations remained low while hemlock looper populations rose near the outbreak: McNaughton Lake (west side), Illecillewaet River, and from southern Revelstoke Lake to Upper Arrow Lake.

Beyond the influence of conditions leading to the hemlock looper outbreak, high numbers of sawfly larvae and trace defoliation were recorded at Ferguson, Keen Creek, and concurrent with defoliation by the gray spruce looper at Box Lake.

LARCH PESTS

Larch needle diseases
Hypodermella laricis
Meria laricis

The incidence of needle cast increased to 9900 ha, from 5550 ha mapped in 1990. Infections occurred throughout the host range in the Boundary, Arrow, and Kootenay Lake TSAs. Severe infections were mapped in 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.

In the East Kootenay, 2600 ha of severe discoloration, primarily caused by H. laricis, was mapped along the Yahk and Moyie rivers, and over 100 ha to the west of Windermere Lake. Additional light discoloration of mid and lower crowns was common in most western larch stands.

Calm, cool and moist spring weather favors infection of newly flushed foliage, which discolors and dies within six weeks. Extensive loss of foliage results in reduced growth. With abundant inoculum, infections could increase in 1992 if spring weather is favorable.

Larch casebearer
Coleophora laricella

Larch casebearer activity increased in the East Kootenay with 660 ha of light defoliation recorded in the Summit Creek, Goat River and Rykerts Mountain area, near Creston. This was the first indication of increasing populations since the collapse of the infestation of 1983-85 when approximately 60 000 ha were defoliated in the East Kootenay. Minor increased feeding activity was also evident through most of the lower elevation larch stands east of Creston, and in the Rocky Mountain Trench.

In the west Kootenay, defoliation declined slightly to trace intensity with patches of light near Anarchist Mountain, Blueberry Creek, and Castlegar.

The incidence of parasitism by both native and introduced parasites remained relatively unchanged at 19 sites, averaging 15% (range 0-50%). Parasitism by an introduced parasite, Chrysocharis laricinellae, averaged 2% (range 0-48%), a decline from 5% and 18% in 1990 and 1989, respectively. However, parasitism by another introduced parasite, Agathis pumila, increased to 10% from 8% and 1% in 1990 and 1989, respectively. Mortality due to unknown causes remained unchanged at 17%.

Impact

A small study on the impact of severe larch casebearer feeding on young plantation larch was conducted near Kimberley. Height measurements were taken from ten severely defoliated trees and from the ten nearest non-defoliated trees. In severely defoliated trees the height increment was 6% greater than in 1990, compared to a 79% increase in non-defoliated trees. The average height increment in 1990 was 0.40 m for both groups of trees.

Forecast

Overall, adult emergence decreased slightly to 66% from 70% in 1990, but defoliation levels are expected to remain at similar levels in 1992. Larval sampling in the fall at Summit Creek (30 larvae/100 fascicles) and East Arrow Creek (27/100 fascicles), indicate that light defoliation can again be expected in the spring of 1992. When there are between 12 and 60 larvae per 100 fascicles, light defoliation may follow.

A larch shoot moth
Argyresthia laricella

Terminal damage caused by this shoot moth continues to increase in western larch in the Columbia--Windermere lakes area. In the recently spaced portions of an infestation at Ellenvale Creek, terminal mortality increased from less than 1% prior to spacing in 1990 to 40% in 1991. Of the damaged trees, 62% also had from 1 to 5 of the upper whorl branch tips killed.

With a preference for open-growing terminals, dominant trees in unspaced stands will be continually suppressed while spaced stands favor population expansion. Since usually only portions of the terminals are killed, impact may be restricted to minor reductions in height as laterals below the point of attack assume dominance. Significant impact is only anticipated in chronic infestations in spaced stands.

Green larch looper
Semiothisa sexmaculata

Populations of this looper collapsed in 1991 after causing defoliation over almost 12 000 ha scattered through the host range in the southwestern quarter of the region in 1990. A decline had been anticipated due to high pupal parasitism in the fall of 1990 and the brevity of previous outbreaks; a larch sawfly, Anoplonyx occidentalis, was also collected at endemic levels. A pheromone was identified by researchers from Simon Fraser University in trapping trials along the Sullivan Creek Road.

MULTIPLE HOST PESTS

Root diseases

Tomentosus root rot, Inonotus tomentosus

Root rot organisms infected 75% of the Engelmann spruce and lodgepole pine in mature to overmature stands surveyed in the St. Mary and White river drainages (Table 13). I. tomentosus was the main pathogen, though Armillaria ostoyae was present in 5 to 27% of the trees. In lodgepole pine-spruce stands, A. ostoyae was usually associated with wind damaged stands, while infection was more generally spread throughout alpine fir-spruce stands. Where both root rots were present, I. tomentosus was deemed the main causal agent.

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, with groups of recent dead or symptomatic trees 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 survey was supplementary to a similar survey done in the Spillimacheen, Beaverfoot and Bull rivers in 1989.

Table 13. Occurrence of Inonotus tomentosus. FIDS, Nelson Forest Region, 1991.

Location	Tree spp*	Non-symptom trees (%) healthy	Non-symptom trees (%) infected	Dead/dying (%) trees	Dead/dying (%) area	Dead other causes	No. centers per ha.
St. Mary River drainage							
Redding Cr.	eS(alF)	51	31	18	17	0	8
St. Mary R.	eS(alF)	28	33	32	50	7	19
Meachen Cr.	eS(alF)	75	6	19	4	0	4
Hellroaring Cr.	eS(alF)	37	60	3	4	0	4
Hellroaring Cr.	lP(eS)	28	53	19	22	0	32
Angus Cr.	lP(eS)	3	51	46	72	0	continuous
Dewar Cr.(1989)	lP(eS)	0	60	31	37	9	66
White River drainage							
N. Fork	eS(lP)	0	26	74	78	0	continuous
E. White	eS(alF)	30	40	30	45	0	15
Middle Fork	eS(lP)	1	14	85	94	0	continuous
	(eS)lP	0	4	96	94	0	continuous
Average		23	34	41	42	2	

* Percent figures apply to tree species not bracketed.

Combined data from previous and current surveys indicates that the incidence of I. tomentosus in spruce averaged 87% when the main secondary species was lodgepole pine. In comparison, the infection level declined to 56% in association with alpine fir, and the greater the percentage of alpine fir the lower the incidence of I. tomentosus. This is largely attributed to the lower susceptibility of alpine fir to I. tomentosus. In addition, as lodgepole pine approaches overmaturity the fungus spreads rapidly through the root system and stand, infecting understory spruce at a high incidence and younger than usual.

In several of the mature spruce stands bear scars were associated with tomentosus root disease. All mature trees with recent bear damage had decay, suggesting that bears may be attracted to infected root systems. However, in 40 to 60 year old stands no decay was evident and bears appear to promote root diseases by damaging the root collar and bole.

Armillaria root disease, Armillaria ostoyae

In pests of young stands surveys, 15 of the 20 stands over 10 years old had root rot. Disease incidence by hosts at least 20% of the stand averaged 7% in 14 of 27 occurrences. A. ostoyae was the main root pathogen, with blackstain root disease, Leptographium wageneri, present in one spaced stand near Donald.

The incidence of root disease after spacing may be affected by stand age. Stands spaced when under 25 years old (avg. 19 years) averaged 4% root rot incidence after two years, while stands spaced when over 25 years old (avg. 30) had an average of 16% infection after two years.

Throughout the Pend d'Oreille valley, patchy mortality of 60 to 80 year old grand fir and Douglas-fir regeneration was attributed to A. ostoyae. Attacks by beetles such as Scolytus ventralis, Pissodes sp., and Pseudohylesinus sp. were finishing off some of the dying trees. These sites exemplify the increasing impact of untreated ambient levels of root disease on the next rotation. Higher impacts accrue in second rotations, leading to unsatisfactory stocking in plantations as young as five years old, such as at Skeff Creek.

Black stain root disease, Leptographium wageneri

Black stain root disease recently killed an average of 10% of mature lodgepole pine in surveys at Quartz Creek. An additional 6% of the trees showed typical root rot symptoms. Although this is an area of increasing mountain pine beetle activity, repeated surveys have indicated that blackstain infected trees are not attractive to this beetle, but are commonly attacked by Ips beetles.

Blackstain root disease was also prevalent in a mechanically spaced stand along Donald Creek, infecting 15% of the Douglas-fir and 6% of the lodgepole pine. Increasing tree mortality can be expected due to root contact between the leave trees, and concentrating of weevils, vectoring the disease by transferring inoculum from recently cut stumps to leave strips.

Rhizina root disease, Rhizina undulata

Although the occurrence of Rhizina root disease decreased throughout the region, significant seedling mortality still occurred in some areas. Extended

dry fall weather in the west and north, eg. September precipitation 73% below normal at Revelstoke, may have impeded the virulence and fruiting of the fungus.

In the Revelstoke TSA, seedling mortality at blocks on the Chase and East Twin Creek (km 16) roads was approximately 30% and 20%, respectively. Four other blocks in the TSA had less than 5% seedling mortality. In the upper Arrow and Kootenay Lake TSAs, occurrence of the disease was also patchy. No fruiting bodies were seen in two of four burned blocks assessed (Mosquito Main and Asher Creek). In one of the remaining sites fruiting bodies were sparse and seedling mortality was about 1% (km 58 Duncan Road); they were common at the other site but seedlings had not yet been planted (km 59 Duncan Road).

Rhizina was greatly reduced from 1990 in the eastern portion of the region. Low numbers of fruiting bodies were identified in one of five cutblocks examined, with no seedling mortality recorded. Much of the decline may be attributed to the limited and poor burning conditions during the fall of 1990. A decline in the abundance and size of fruiting bodies in 1991 may indicate that the virulence of the current epidemic is declining, at least in some of the drier biogeoclimatic zones.

Climatic damage

Overall, regional weather during the 1991 field season was warmer and wetter than normal. In the southwest, precipitation from April through September was 32% above normal and mean daily temperatures were 3% higher, as recorded at Grand Forks. In Revelstoke, representative of northern areas, precipitation was 11% and temperatures were 5% above normal. In the southeast, temperatures were 2% above normal but precipitation was against the trend at 16% below normal, as recorded at Cranbrook.

Snow damage

Excessive wet snow in the fall of 1990 caused extensive upheaval and breakage of mostly young to pole-sized stands in mid- to lower-elevation sites. Trees down due to the snow were mapped or observed on approximately 2100 ha, mainly in the Cranbrook TSA, though lighter scattered damage was much more widespread. Some of the more notable areas observed included numerous stands southwest of Cranbrook, from the Jim Smith Lake area along the Moyie River drainage through to the Irishman Creek area, lower Redding Creek, Lost Dog--Meadow Brook area, in southern part of the Green Hills Range near Elkford, along the Bull River, in the Cartwright Lake to Bobbie Burns area, and in the lower Blaeberry River area.

Wind damage

Strong wind storms in mid-October 1991 caused widespread blowdown throughout the region. No total area figures are available, but observations and discussions with BCFS personnel indicate that most of the damage was along opening fringes, generally covering less than 10 ha. Some notable locations with cumulative areas from 30 to 300 ha included Jake Creek, N. Phillipps Creek and the middle fork of White River.

Blowdown areas can become focal points for increasing beetle populations, especially spruce and Douglas-fir beetles. Indications are that the spruce beetle populations are on a natural increasing cycle and the addition of even scattered patches of blowdown could trigger some infestations. Douglas-fir beetle populations are generally declining, but successive years of blowdown could prolong the current infestation in some areas. Ips beetle populations are also attracted to blowdown and populations can multiply rapidly, killing a limited number of adjacent trees over several years.

Root rots also flourish in stands with scattered tree breakage when roots remain intact. In previous surveys, where 25 to 60% of stems were broken above ground by wind, 85 to 100% of remaining trees were infected by Armillaria ostoyae within five to ten years.

Mammal damage

Bear and porcupine

Widespread damage, mainly bear and porcupine, was aerially mapped over 327 ha in 1991. Several key areas of damage included 130 ha in the Findlay River and Dutch and Toby creeks area, 95 ha along the Spillimacheen River, 30 ha in the Kootenay and White River area and 25 ha along Waitabit Creek. Smaller but often more concentrated damage was also mapped in the Beaverfoot River drainage and along Norge, Bugaboo and Vowell creeks.

Tree mortality due to bears and porcupine feeding can also be significant in portions of young stands. Severe tree damage or mortality was present in 5 of 17 young stands, averaging 14% of the lodgepole pine and western larch. Porcupine damage was most common on the lodgepole pine at 6%, bear damage most common on larch at 14% when present. The most severe damage was in fertilized lodgepole pine--western larch stands in the lower St. Mary River drainage. Porcupine damage was present in three of four stands and averaged 7% mortality while bear damage in two of four stands averaged 14%.

Summarizing bear damage in young stands from surveys over the past three years indicates that bear damage can increase more than fivefold following spacing if the stand density varies greatly from the unspaced portion. Simillarly, bear damage increased up to fourfold following fertilization. However, when potential bear damage is recognized and adjusted for in the treatment plan the gains may still exceed the damage inflicted.

Voles

Vole damage increased in 1991, a peak in the four year cycle of vole populations. At Ensign Creek 24% of 1990-planted spruce seedlings were destroyed above ground, with a further 6% of seedlings with feeding damage to the stem. A snow mold fungus, Herpotrichia sp., appeared to be a factor in mortality of 15% of vole-damaged seedlings; of seedlings with partial stem girdling, only those with snow mold infection died. In a FRDA fill-planting site at North Sulphur Creek, 35% seedling mortality was present, but only 18% of the damage could positively be attributed to vole damage, with at least some of the reminder probably due to larger mammal browsing.

In previous studies 20% of lodgepole pine seedlings destroyed above ground died, with the remaining seedlings developing new shoots from below the point of damage. Multi-stemmed trees were common. The adventitious budding capabilities of spruce should allow for similar recovery levels.

Black army cutworm
Actebia fennica

Black army cutworm populations remained low in 1991, with seedling and herbaceous feeding recorded on portions of three cutblocks. The largest population was over 20 ha in a 1991 plantation at Vowell Creek. Moderate population levels stripped all foliage from 50% of the Engelmann spruce seedlings on 10 ha, with only light bud feeding on the remaining 10 ha. Lodgepole pine had only minor feeding damage. Since planting occurred during the infestation some seedling mortality can be expected. In previous follow-up surveys of totally defoliated spruce seedlings, mortality averaged 45% if planted during an infestation but dropped to 10% when planted the spring after a fall burn, largely due to root establishment before defoliation. At Swan Creek only minor feeding occurred on small patches of herbaceous vegetation.

At Vowell Creek, cutworm populations were reduced by disease (36%) and parasitism (17%), based on mass collections of late-instar larvae. Combined with unknown larval and pupal mortality, the adult emergence was reduced to 17%. However, in random duff samples an average of 19 pupae were found per 1000cm^2, which suggests that contamination within the mass collection may have exaggerated the level of disease in the population. Based on both factors, a residual population is expected to remain in the cutblock in 1992.

In the west Kootenay, herbaceous plants were lightly defoliated at 1 of 8 sites examined in the Revelstoke and upper Arrow TSAs, but larvae were too few to damage seedlings.

Impact

The impact of cutworm on western larch, a highly favored host, was examined in 1991. No seedlings completely defoliated in 1990 died, but growth reduction and terminal dieback were substantial. Dieback to near ground level occurred on 46% of the seedlings, with the remaining seedlings not adding any height in 1991. New flush occurred on all seedlings from near ground level, but 70% formed only small bushy growth and were overgrown by thimbleberry. In contrast, non-defoliated larch seedlings had doubled in height and were of equal or greater height than competing vegetation.

Forecast

Pheromone-baited dry Multipher^R traps deployed at fifteen sites (Map 5) indicated a low potential for defoliation in 1992. Catches at 10 sites in the Revelstoke TSA and northern halves of the Arrow and Kootenay Lake TSAs averaged 80 moths per trap (range 24-245). Similarly, catches at five sites in the East Kootenay averaged 82 moths/trap (range 17-125). 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 provincial and national park campgrounds in the region, as part of an ongoing cooperative program to detect any introduction of this pest into B.C. (Map 5). No moths were caught in the region following a single moth caught in Yoho National Park in 1990. Traps placed by Agriculture Canada and the B.C. Forest Service were also negative.

PESTS OF YOUNG STANDS

A total of 46 young stands planted or treated under FRDA 1 were examined for pest problems in 1991 (Table 14). 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 of the stands surveyed. Of 4293 trees examined, 83% were pest-free, 7% had pests that often lead to tree mortality and 8% had pests that cause growth loss. This level of serious pest incidence, mainly root rot, only a few years following treatment, suggests severe long term impact, cumulative until harvest. Several of the pests in Table 14 are discussed in more detail elsewhere in the report.

DECIDUOUS TREE PESTS

Venturia foliar blights
Venturia macularis
Venturia populina

Trembling aspen and black cottonwood foliage was commonly infected by Venturia blights throughout the region. Light to occasional moderate infection of trembling aspen covered approximately 2300 ha in the Golden to Blaeberry River area, along the Kicking Horse River near Yoho National Park, and along the lower Bull River. In most areas, foliage discoloration was accompanied by varying levels of defoliation from Epinotia sp., most prominently along the Kicking Horse River. Infected cottonwood foliage was highly discolored along the Goat River between Kitchener and Creston. Light infection levels were common along the Kootenay River between Canal Flats and Wardner, and from Moyie Lake through to Yahk along the Moyie River. Occasional light infection was also present along the Elk River in the Fernie--Hosmer area and north of Sparwood.

Although damage to foliage can be severe, the impact on mature trees is usually minor. However, regeneration will frequently be killed allowing other species to become dominant. Moist spring weather, as occurred in 1991, can intensify infection of emerging foliage.

Table 14. Summary of pests in young stands planted or treated under FRDA 1. FIDS, Nelson Forest Region, 1991.

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 - 1250 trees in 24 stands assessed, major species in 18 stands					
Armillaria root disease*	6	9 (19)	24 (883)	4	1-14
Blackstain root disease*	6	1 (12)	1 (610)	6	
Ips beetle*	6	1 (9)	3 (691)	6	
Porcupine*	5	5 (14)	10 (826)	6	2-14
Squirrel*	5	3 (14)	85 (826)	28	1-73
Bear*	5	1 (14)	7 (826)	14	
Snow damage*	5	5 (19)	15 (883)	8	1-25
Comandra blister rust	5	1 (19)	1 (883)	1	
Western gall rust	5	1 (19)	2 (883)	4	
Warren's root collar weevil	5	2 (19)	6 (883)	3	3-4
Browse (seedlings)	4	2 (8)	20 (367)	14	14-15
Atropellis canker	4	1 (18)	2 (833)	2	
Lodgepole terminal weevil	3	1 (17)	4 (768)	4	
Pest free	1	7 (24)	1072 (1250)	86	
Douglas-fir - 590 trees in 27 stands assessed, major species in 9 stands					
Armillaria root disease*	6	5 (18)	17 (388)	16	2-33
Blackstain root disease*	6	1 (12)	6 (309)	15	
Browse (seedling)	5	3 (9)	19 (233)	15	9-21
Frost (seedling)	3	1 (9)	1 (233)	100	
Giant conifer aphid	2	1 (27)	1 (590)	100	
Pest free	1	11 (27)	439 (590)	74	
Engelmann spruce - 1789 trees in 33 stands assessed, major species in 21 stands					
Armillaria root disease*	6	1 (10)	1 (214)	33	
Frost (seedling)	5	2 (19)	51 (1221)	20	9-32
Browse (seedling)	4	9 (24)	40 (1589)	6	1-23
Spruce weevil*	3	2 (13)	2 (549)	1	
Small-spored spruce-labrador tea rust	3	1 (33)	13 (1789)	11	
Cooley spruce gall adelgid	3	15 (33)	137 (1031)	31	1-100
Pest free	1	14 (33)	1547 (1789)	86	
Western larch - 272 trees in 15 stands assessed, major species in 6 stands					
Armillaria root disease*	6	1 (12)	6 (245)	7	
Bear*	6	2 (11)	16 (220)	14	14-15
Porcupine*	5	1 (11)	1 (220)	1	
Snow*	5	3 (12)	6 (245)	6	3-9
Phacidiella canker	4	1 (11)	1 (220)	10	
Larch needle blight*	3	2 (15)	54 (272)	75	51-100
Drought - dieback	3	1 (15)	2 (272)	8	
Larch casebearer*	3	1 (15)	1 (272)	100	
Larch sawfly	3	1 (14)	1 (246)	10	
Larch woolly adelgid	2	2 (15)	62 (272)	68	36-100
Pest free	1	7 (15)	191 (272)	70	

(Cont'd)

Table 14. (Cont'd)

Host/Pest	Severity index[1]	No. stands affected[2]	No. trees affected[2]	% of trees affected[3] avg.	range
Alpine fir - 181 trees in 10 stands assessed, major species in 2 stands					
Armillaria root disease*	6	2 (8)	2 (152)	8	2-14
Frost (seedling)	3	1 (2)	5 (29)	18	
Foliar rust*	2	1 (10)	9 (181)	100	
Pest free	1	6 (10)	165 (181)	91	
Western hemlock - 191 trees in 6 stands assessed, major species in none					
Pest free	1	6 (6)	191 (191)	100	
Western red cedar - 80 trees in 12 stands assessed, major species in 2 stands					
Armillaria root disease*	6	1 (4)	5 (37)	19	
Pest free	1	11 (12)	75 (80)	94	
Western white pine - 47 trees in 5 stands assessed, major species in none					
Armillaria root disease*	6	1 (3)	1 (45)	17	
White pine blister rust*	5	2 (4)	17 (46)	44	
Pest free	1	2 (5)	29 (47)	62	
Ponderosa pine - 56 trees in 2 stands assessed, major species in 1 stand					
Turpentine beetle*	6	1 (1)	16 (53)	30	
Pest free	1	1 (2)	40 (56)	71	

[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.

An aspen leafroller
Epinotia sp.

This leafroller moderately to severely defoliated trembling aspen and to a lesser degree birch, over 875 ha in the region in 1991. The most severe defoliation was mapped over 300 ha along the Kicking Horse River just west of the Yoho National Park boundary. Patches of moderate defoliation were common from Golden to Blaeberry River, with light defoliation common throughout aspen stands in this general area. Light defoliation was also noted in young aspen stands along the lower Bull River. Light to moderate foliage infection by

Venturia macularis in all of the insect damaged stands compounded the impact of defoliation.

SPECIAL SURVEYS

Acid rain national early warning system (ARNEWS)

As part of a national network, a 10 x 40 m plot was established in 1985 along Bulldog Road, in the Blueberry-Paulson summit area, to detect and monitor any impact of air and rain borne pollution on native trees and indicator plants. Visual assessments of plot vegetation and pest conditions are conducted annually; in 1991 only the same minor pests were found, at low levels, as in previous years. No symptoms of damage from acidic or toxic rain were found.

Pinewood nematode
Bursaphelenchus xylophilus

The date by which all lumber shipped to Europe has to be kiln dried to prevent the introduction of this nematode has been extended to January 1993. Meanwhile, all lumber to Europe has to be free of woodborer holes to show that no vectoring of the nematode into the wood occurred. Salvage of bark beetle outbreaks and tighter waste standards are resulting in more woodborer-infested wood being shipped to the mills. Collections from mill log yards in 1991 included Monochamus sp. woodborers, main (possibly exclusive) vectors of the nematode in B.C.

Earthworms

Surveys were initiated to compile a record of the species of earthworms throughout the various regions of B.C. In the Nelson Region, collections were made at Reflection Lake near Golden, Gibraltar Rock along the Kootenay River, Wasa Lake, Dodge Creek near Creston, Hawkins Creek and along the Flathead River. No native worms were found; all specimens were of European origin.

OTHER NOTEWORTHY PESTS

Other pests which are currently either 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.

Pest	Host(s)[1]	Location	Remarks
INSECTS			
Acleris gloverana blackheaded budworm	wH,eS alF	Illecillewaet R.	common in low numbers
Adelges cooleyi Cooley spruce gall adelgid	eS, Df	throughout host range	generally light to moderate
Archips rosana a leafroller	elm	Grand Forks	contributing to moderate damage of urban trees
Chionaspis pinifoliae pine needle scale	pP	southern Rocky Mountain Trench	moderate numbers in Teepee Creek
Cinara sp. giant conifer aphids	pP	southern Rocky Mountain Trench	common
	lP	Boundary TSA	patchy in young stands, minor impact
Dioryctria abietivorella fir coneworm	Df	Invermere, Radium Hot Springs	common in Christmas tree plantations
Eriosoma americanum woolly elm aphid	elm	Grand Forks	contributing to moderate damage in urban trees
Hyphantria cunea fall webworm	bCo willow	southern Arrow & Cranbrook TSAs	patchy light defoliation of roadside trees
Leucoma salicis satin moth	tA bCo	Golden Revelstoke	common in low numbers
Lyonetia saliciella birch leaf miner	birch	Illecillewaet R.	light to moderate defoliation
Malacosoma disstria forest tent caterpillar	tA	Golden	collapsed after peaking in 1988 at 9900 ha
Nematocampa filamentaria filament bearer	wH	Illecillewaet R.	low number of larvae

(Cont'd)

Pest	Host(s)[1]	Location	Remarks
Orgyia a. badia rusty tussock moth	wH	Illecillewaet R.	common at moderate numbers with hemlock looper
Pemphigus populitransverus A poplar aphid	Lombardy poplar	Nelson	common in urban trees, causing deformed petioles
Pikonema alaskensis yellowheaded spruce sawfly	eS	Castlegar Pass Ck.	light to moderate defoliation of urban spruce
Pyrrhalta decora carbo Pacific willow lf. btl.	willow	McNaughton L.	moderate skeletonizing common
Xyela sp. pine flower sawfly	pP	southern Rocky Mountain Trench	large numbers present
DISEASES			
Arceuthobium americanum lodgepole pine dwarf mistletoe	lP	host range	occasional chronic patches locally severe impact
Arceuthobium douglasii Douglas-fir dwarf mistletoe	Df	SW quarter of region	occasional chronic patches locally severe impact
Arceuthobium laricis w. larch dwarf mistletoe	wL	host range west of Rocky Mtns.	occasional chronic patches locally severe impact
Atropellis piniphila Atropellis canker	lP	host range	sporadic stem deformation, locally severe impact
Dothiora taxicola a needle and shoot blight	wY	Blueberry Ck.	light infections common
Echinodontium tinctorium a heart rot	wH	host range	significant decay common in remaining old growth
Gymnosporangium tremelloides tremelloid gall rust	Juniper	Castlegar	infections locally common, systemic in galls
Herpotrichia sp. brown felt fungus	eS	Ensign Cr.	severe on young seedlings
Lirula abietis concoloris a fir needlecast	alF	Bulldog Ck. Rd.	trace infections common in higher elev. stands
Melampsora medusae conifer-aspen rust	Df	Kootenay Lk.	patches of light infection

(Cont'd)