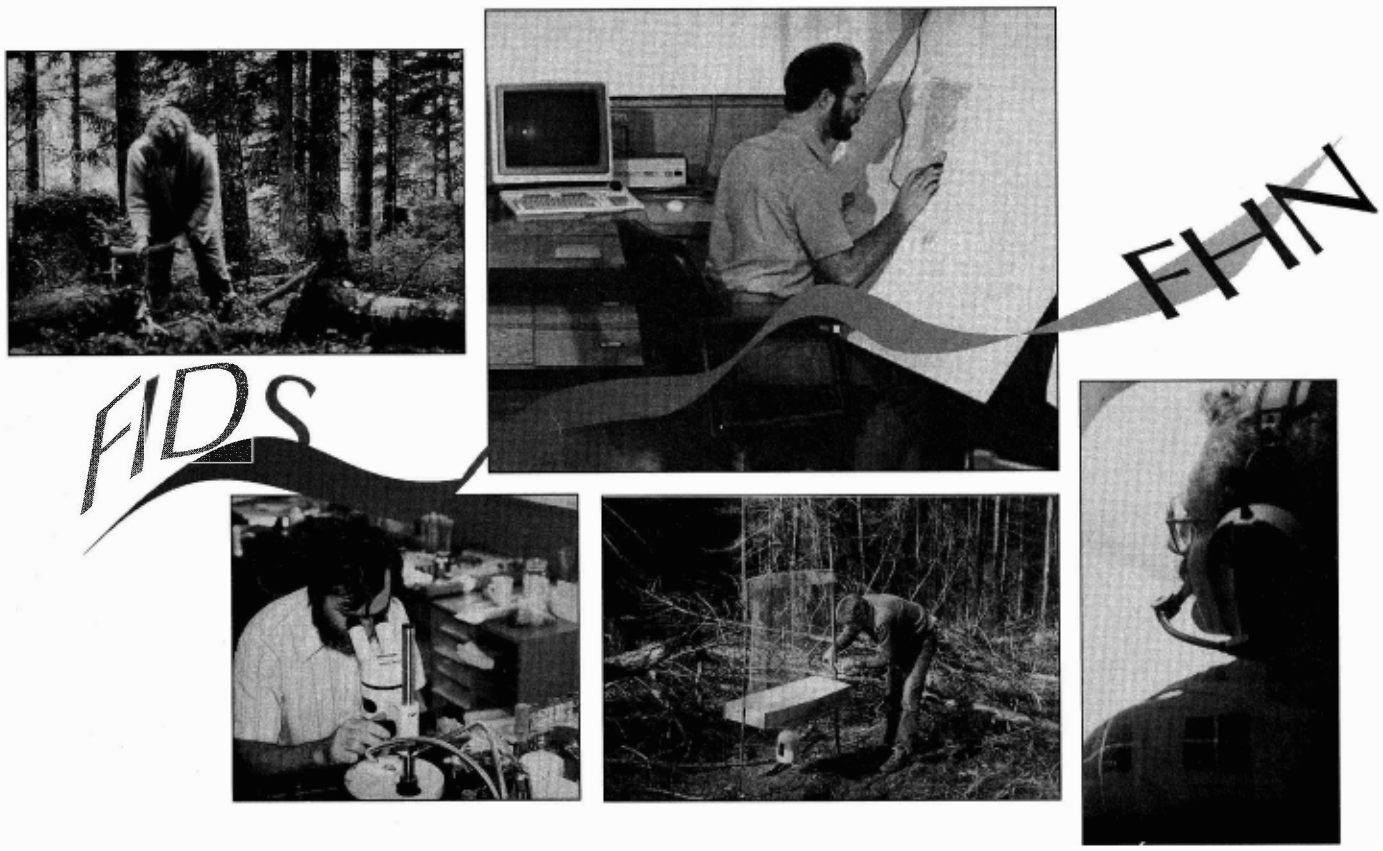
Forest Insect and Disease Conditions Nelson Forest Region – 1995

Leo Unger and Alan Stewart

Pacific Forestry Centre • FIDS Report 96-3



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Transition of FIDS to Forest Health Network

As a result of the CFS program review and reorganization announced in the February 1995 federal budget, the CFS had a substantial reduction in resources (37% fewer staff) and modified its priorities to be more in concert with federal responsibilities in the forestry sector. Overall, the CFS will be reduced to five establishments focusing on science and technology development. Operational forestry activities such as growth and yield, applied silviculture, and the Forest Insect and Disease Survey have been reduced. In the latter case a more nationally-focused Forest Health Network is being developed.

The Forest Health Network is one of 10 CFS Science and Technology networks organized to integrate research among the establishments and seek partnerships with other agencies and stakeholder groups. These networks will promote sustainable forest development and responsible use of Canada's forests, reflecting the two themes of the Science and Technology program: acquisition and aggregation of knowledge related to understanding forest ecosystems, and development of strategies for advancing sustainable forest development. Networks relevant to insects and fungi are Forest Health, Biodiversity, Effects of Forestry Practices, Pest Management Methods, and Landscape Management.

Forest Health Network - National Priorities

1. To monitor and report on changes in national forest health using an expanded and enhanced, ecosystem-based series of plots.

2. To provide, in collaboration with provincial cooperators, national overviews of major forest disturbances due to air pollutants, insects and diseases, using nationally-standardized monitoring systems and a quality assurance program. This will include national-level input required by the Canadian Criteria and Indicators Process for Sustainable Forestry, such as:

   - area and severity of insect and disease attack;
   - occurrence and severity of exotic species detrimental to forests;
   - area of catastrophic forest depletion; and
   - indicators of biodiversity, climate change and forest health.

3. To maintain diagnostic expertise and working reference collections to provide the scientific foundation in support of forest biodiversity policies.

4. To maintain the national forest health database, accessible to all partners, with data analysis and presentation of information in shared electronic formats.

5. To participate in the planning and conduct of surveys, and pest risk analysis for exotic forest pests in cooperation with Agriculture and Agri-Food Canada.

6. To maintain links with other Federal departments (Environment, Heritage-Parks Canada, Agriculture and Agri-Food Canada) as well as collaborative efforts with Provinces, universities, industry and international agencies.

7. To develop, test, and standardize monitoring techniques, indicators and predictive models of forest health.

Forest Health Network - Pacific Forestry Centre

In 1996 the Forest Health Monitoring unit at CFS-Victoria will comprise seven senior Forest Health Technicians. The insect and disease diagnostic capability, permanent reference collections and related databases will be retained, with increased emphasis on forest biodiversity aspects. The geographic information system and associated historical database will continue to support the Forest Health unit and the national database. The long-term plan is to have six forest health technicians in the Forest Health Monitoring Unit.

New Partnerships

At this time of transition, we would like to again recognize the support and cooperation provided by many agencies in helping the CFS deliver the annual forest insect and disease conditions reports in British Columbia and the Yukon Territory for several decades. Without cooperation from employees of federal and provincial parks, Agriculture and Agri-Food Canada, the forest industry, and especially the B.C. Ministry of Forests, the 60 years of insect and disease records affecting the nation's forest would not be as complete.

As the Forest Health Network evolves to fulfill the national aspects of the priorities noted above, we hope that this cooperation and partnership continues. We look forward to continued involvement with our clients in to help develop the Forest Health Network research direction and are pleased that there is already agreement between the CFS and the B.C. Ministry of Forests to undertake a cooperative approach to forest health monitoring.

For further information please contact Dr. Allan Van Sickle, Forest Health Unit Leader, at:

Canadian Forest Service
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C.
V8Z 1M5
(604) 363-0674
avansickle@A1.PFC.forestry.ca

Introduction

This report outlines forest insect and disease conditions in the Nelson Forest Region, including Mt. Revelstoke, Glacier, Yoho and Kootenay National Parks, in 1995. Due to cutbacks, surveys were reduced and several pests were not, or only partially, evaluated. A lack of mention in this report does not imply endemic levels. Contact the authors or Forest Health specialists in the B.C. Forest Service if more information on the status of an insect or disease is required.

The 1995 field season was intermittent from June to September with about 70 insect and disease collections sent to the Pacific Forestry Centre. About 100 contacts and on-site examinations were made with a wide range of groups and individuals, including the B.C. Forest Service, industry, parks, and general public. New slides of pest concerns were collected to update existing files. Aerial survey time (37 hours fixed-wing, 3.5 hours helicopter) and assistance with preliminary sketch maps was provided by the B.C. Forest Service. Six hours of helicopter time were provided by the Canadian Parks Service. The aerial survey of the Boundary District was done by R. Ferris, FIDS Ranger in the southern Kamloops Region.

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 into the mid-crown; or **severe**= >65% defoliation, usually throughout the crown.

The following current information and recent reports are available upon request:

* Maps of insect outbreaks, Nelson Forest Region, 1995.
* Summary of pest problems in provincial parks, Nelson Forest Region, 1995.
* Summary of pest problems in young stands, Nelson Forest Region, 1995.
* Pest reports distributed in 1995:

  - Drought damage in the East Kootenay, 1995. FIDS Pest Report 95-2.
  - Mountain pine beetle population predictions in the East Kootenay, Nelson Forest Region spring 1995. FIDS Pest Report 95-9.
  - Summary of forest pest conditions in the Nelson Forest Region, 1995. FIDS Pest Report 95-21.
  - Forest insect and disease conditions in Kootenay National Park 1995. FIDS Pest Report 95-26.
  - Forest insect and disease conditions in Mt. Revelstoke and Glacier National Parks in 1995. FIDS Pest Report 95-27.
  - Forest insect and disease conditions in Yoho National Park 1995. FIDS Pest Report 95-28.

Summary

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

The area affected by **mountain pine beetle** infestations increased to 6752 ha in the southern two-thirds of the region. **Drought** damage was mapped over 2784 ha, mostly in the Cranbrook District. Discoloration of lodgepole pine foliage by **pine needle cast** declined to endemic levels.

Douglas-fir beetle outbreaks declined to 180 ha, mostly in the Invermere District. High levels of **Douglas-fir needlecast** again reduced growth in young stands in side drainages of the Rocky Mountain Trench and east of Kootenay Lake. Populations of the **western spruce budworm** and **Douglas-fir tussock moth** remained endemic in the southwest.

The **spruce beetle** killed trees on 186 ha, mainly in the Golden District. Current attacks by the **spruce weevil** decreased to average 11% at three monitoring sites.

Defoliation by the **two-year-cycle spruce budworm** increased to cover 761 ha in the Bugaboo River drainage and decreased to 187 ha in the Monashee Mountains. Chronic **western balsam bark beetle** activity continued through the host range.

Populations of the **western hemlock looper** collapsed after a five year outbreak in the northern half of the region; about 6.8 million trees/6.4 million m^3 of mainly western hemlock have been killed to date. Hemlock mortality after a **gray spruce looper** outbreak, which collapsed in 1992, reached about 2.2 million trees/780 000 m^3 in 1995.

Armillaria root disease was present in 85% of managed young stands surveyed. **Vole** populations increased in the northwest, damaging conifers up to about 5 years old. Of two sites checked, the **black army cutworm** defoliated a cutblock north of Golden. No **gypsy moth** were trapped in 41 forested campgrounds.

Defoliation of aspen by the **satin moth** increased to 6620 ha, mostly near Golden. **Leafminers** again discolored birch and black cottonwood, mostly in the northwest. Willow foliage was severely discolored by the **gray willow leaf beetle** in the West Kootenay, and elm foliage by the **elm leaf beetle** in the City of Nelson.

Pests of young stands surveys in 20 managed stands found 4% of trees with pests leading to mortality, and 5% with pests causing growth loss. No symptoms were recorded during assessments at three **Acid Rain National Early Warning System (ARNEWS)** and **biomonitoring** plots.

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

Pine Pests

Mountain pine beetle
Dendroctonus ponderosae

The mountain pine beetle killed lodgepole pine and occasionally western white pine on 6752 ha region-wide (Table 1, Map 1), more than double the 2750 ha in 1994 and following five years of declining populations (Figure 1). Most of the increase was in the East Kootenay where drought stress in 1994 resulted in more successful attack; pitchouts averaged only 1% compared to the normal ±10%. Also, many infestations grew beyond point sources, with corresponding area increases.

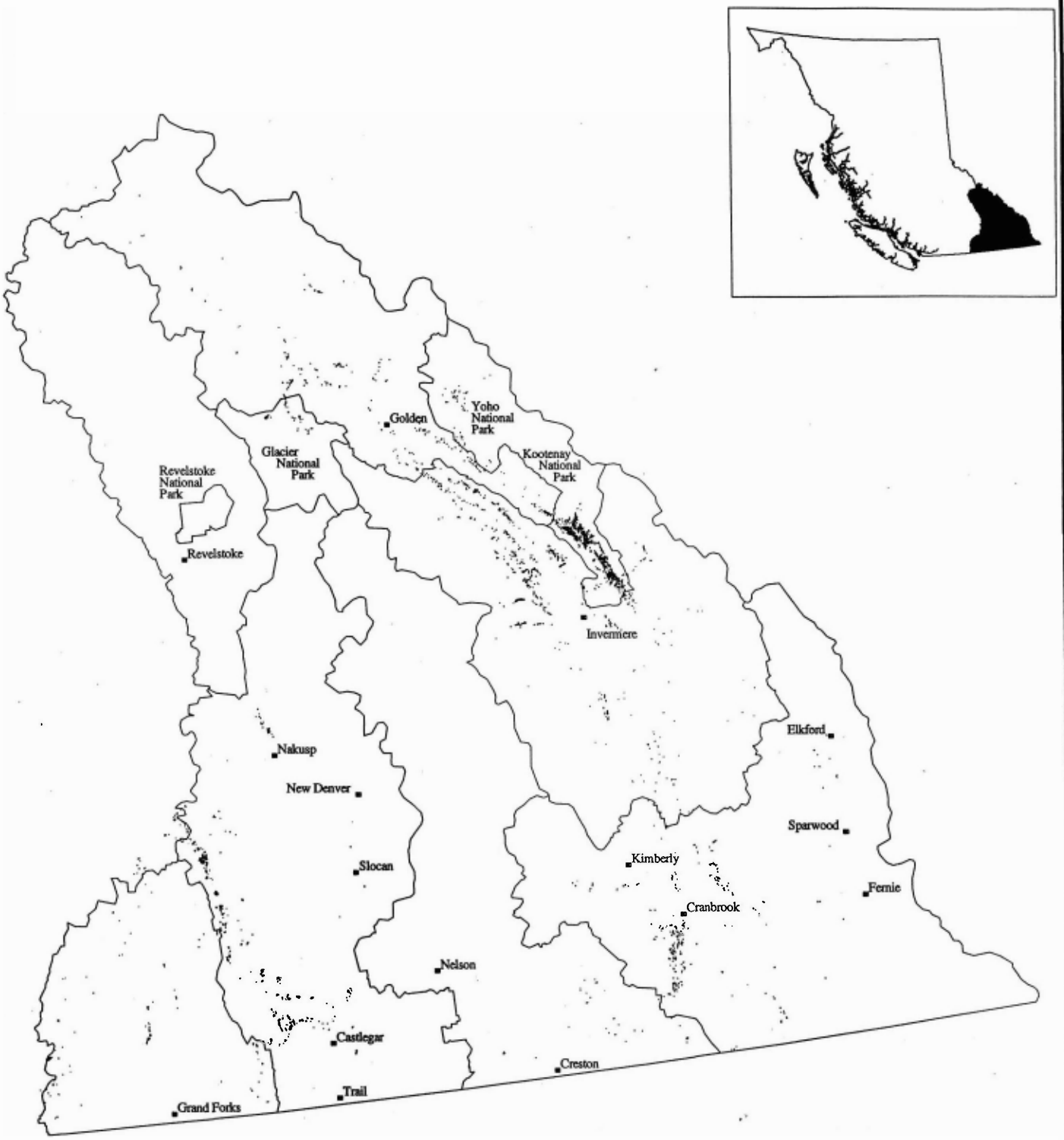
Table 1. Annual occurrence and impact of the mountain pine beetle. FIDS, Nelson Forest Region 1995.

Management unit	Number of infestations	Area (ha)	Trees killed (faders)[1]	
			Number	Vol. (m^3)
Forest Districts				
Arrow	469	2188	not assessed	
Invermere	859	1161	112 200	40 400
Boundary	160	351	not assessed	
Cranbrook	421	361	39 000	14 200
Golden	257	162	13 700	5 800
Kootenay Lake	47	56	not assessed	
National Parks				
Kootenay	591	2403	210 000	75 200
Glacier	60	65	3 700	2 200
Yoho	112	45	1 100	400
Regional Total	**2976**	**6792**		

[1] Trees attacked in 1994, discolored in 1995.

The area of red trees mapped in the **Arrow District** increased to 2188 ha from 637 in 1994. Most of the increase was due to expansion of spot outbreaks from the Blueberry Creek area northwest along side drainages of Arrow Lake to the Inonoaklin River drainage. Scattered spot outbreaks were again mapped at mid-elevations east of upper Arrow Lake, north of Nakusp.

Map 1. Areas with pine recently killed by the mountain pine beetle as determined by ground and aerial surveys in the Nelson Forest Region in 1995.



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Projection: Lambert Conformal Conic

Map Produced by GIS: 30 Jan 96

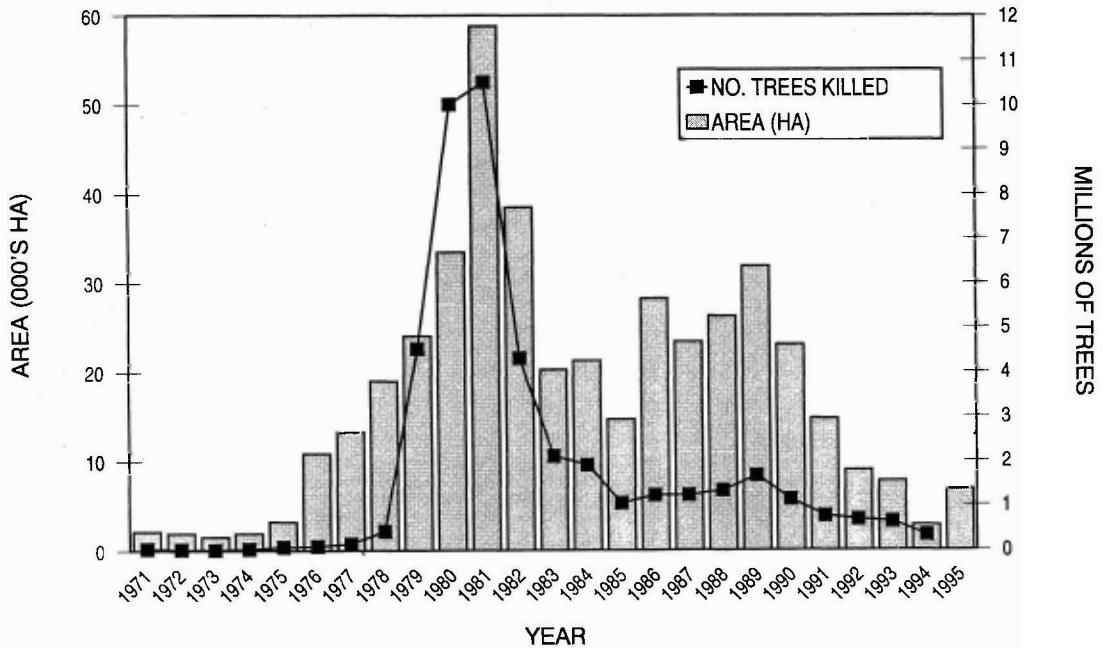


Figure 1. Area and impact of mountain pine beetle infestations over the last 25 years in the Nelson Region. Forest Insect and Disease Survey 1995.

In the **Invermere District,** the area with recent tree mortality increased to 1162 ha from 484 in 1994. The number and size of infestations again grew north of Radium Hot Springs, including both sides of the Columbia River, Pinnacle and Forster creeks, and leave blocks in the Steamboat/Frances Creek area. Also, there were more spot infestations along the Kootenay River south of Kootenay National Park, and along Cross Creek. Populations remained relatively stable in southern areas of the District, and declined in the Whitetail Lake area.

The area of red trees mapped in the **Boundary District** declined for the third year to 351 ha, from 386 ha in 1994, again attributed to host depletion in chronic outbreaks and low brood survival in remaining small trees. Most current infestations were again spot outbreaks, mostly in drainages west of the Kettle River towards the regional boundary, and the Boundary Creek area.

The area mapped in the **Cranbrook District** increased to 361 ha from 157 in 1994, but some areas were uncertain due to drought-induced tree mortality. The main increase occurred in the Peavine Creek/Fasiferne area, while variable static to increasing populations were mapped near Moyie Lake. The number of spot outbreaks increased in the lower St. Mary River area. Populations remained relatively static in the Wildhorse Creek to Norbury Lake area. Only small pockets of beetle activity remained at Morrissey Creek and along the Bull River.

In the **Golden District,** the infested area increased to 162 ha from 57 in 1994. The number of small infestations increased along the Kicking Horse River, the lower Beaver River to near Donald, at Waitabit Creek, and along the Kootenay River adjacent to Kootenay National Park. The number of infestations remained relatively stable, partly due to control programs, along the Columbia River south of Golden, along the lower Blaeberry River, on Blackwater Ridge, and near Lyell Creek. Scattered white pine mortality continued along McNaughton Lake.

The area of red trees mapped in the **Kootenay Lake District** declined for the second year to 47 ha, from 91 ha in 1994. Remaining infestations were mostly spot outbreaks in southeastern areas of the district. Most of the decrease was in scattered spot outbreaks in the West Arm to Kootenay River area.

Infestations in **Kootenay National Park** increased to 2403 ha from 897 in 1994, mainly from Daer Creek to Kootenay Crossing and near the southern park boundary. Only scattered groups of less than five red trees were noted beyond Mount Wardle along the Vermilion River. In **Yoho National Park** the area of beetle activity tripled to 45 ha, mostly in small patches along the Beaverfoot River to the Wapta Falls area with minor increases at the mouth of the Amiskwi River. The infestation at Field remained relatively stable. In **Glacier National Park** much of the increase to 65 ha from 25 was along Mountain Creek. Spot outbreaks in mainly white pine continued along the Beaver River from the north park border to Grizzly Creek. Populations in **Mt. Revelstoke National Park** were not evaluated but are expected to remain at low levels with host trees limited on south-facing slopes above the Illecillewaet River.

Forecasts

In the **East Kootenay** the 1995 beetle flight was generally larger than in 1994, after a mild winter with little brood mortality (Table 2). The 1995 flight was disrupted by cool damp weather, increasing unsuccessful attacks in scattered spot infestations. Brood development was also delayed, with eggs to early instar larvae common at cooler sites examined in mid-September.

Table 2. Overwintering survival and population status of mountain pine beetle. FIDS, Nelson Forest Region 1995.

Location	"R" value[1]	Population status[2]	Location	"R" value	Population status
Cranbrook District			**Invermere District**		
Moyie Lk	5.6	Increasing	Pinnacle Cr.	9.6	Increasing
Teepee Cr.	2.5	Decreasing	Parson	9.3	Increasing
National Parks			**Golden District**		
Kootenay	6.2	Increasing	Waitabit Cr.	6.4	Increasing
Yoho	5.4	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.

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

Fall checks of larger infestations found high levels of current attack in stands with susceptible trees (Table 3). In smaller infestations and where younger trees were attacked there were much fewer successful attacks.

Brood size and cruise data (Table 3) indicate that populations will continue to increase in **Kootenay National Park**. Most suitable host trees have been killed in the Daer Mountain to Kootenay Crossing area, but expansion can be expected north of Kootenay Crossing and south along the Kootenay River to the park border. Spot outbreaks are expected to increase along the Vermilion River as beetles disperse from the main infestation area, but local populations in the drainage remain too small to allow rapid build-up. In **Yoho National Park**, both current attacks near Field and spot outbreaks near the mouth of the Beaverfoot River should continue to increase. In **Glacier National Park** the infestation near the mouth of Mountain Creek should continue in scattered patches of pine along the Beaver River, while the infestation upstream is expected to remain static. Populations are expected to linger at low levels in **Mt. Revelstoke National Park** in limited patches of lodgepole pine and blister rust-infected white pine.

Table 3. Status of lodgepole and white pine in stands infested by mountain pine beetle, from fall prism cruises. FIDS, Nelson Forest Region 1995.

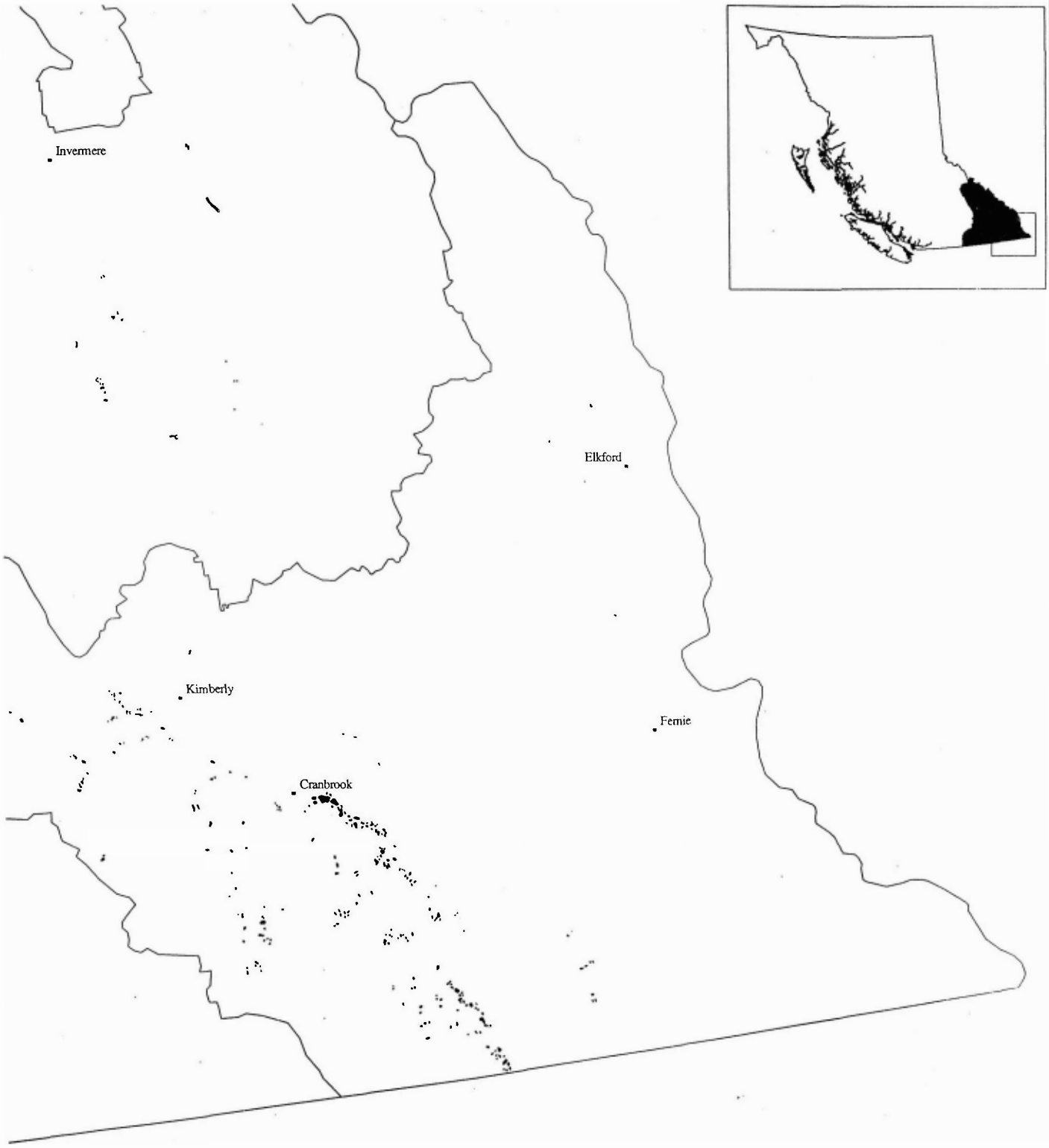
Location	Percent of pine attacked				Percent healthy
	Current (1995)	Partial (1995)[1]	Red (1994)	Grey (pre-1994)	
Cranbrook District					
Moyie Lk.	39	3	6	6	46
Fasiferne	19	7	9	8	57
Invermere District					
Frances Cr.	16	1	13	5	65
National Parks					
Kootenay	52	4	6	0	38
Yoho	22	8	15	4	51
Regional Average	**29**	**5**	**10**	**5**	**51**

[1] The partial attacks include pitchouts.

Drought

Pole-size to semi-mature lodgepole pine killed by drought were mapped over 2784 ha in 1995 (Map 2). Most was on the west side of the Rocky Mountain trench south of Cranbrook, with patches in the Moyie Lake and Matthew Creek to St. Mary Lake areas, along Findlay Creek, and along Columbia and Windermere lakes. The most northern significant area was along the Kootenay River near Pedley Creek where tree death was rare but many mistletoe-infected branches died. Most mortality was on rocky knolls and slopes where trees depend on summer seepage from above.

Map 2. Areas with pine killed by drought in 1995 as determined by ground and aerial surveys in the Nelson Forest Region.



Natural Resources Canada

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Projection: Lambert Conformal Conic

Map Produced by GIS: 30 Jan 96

In the most affected areas, tree mortality averaged 32% and an additional 31% of trees had dead branches. Mountain pine beetle attacked 4% of the trees, mainly those with more than half the branches dead. This will probably not start new outbreaks but may boost current infestations, especially in the Moyie Lake and Fasiferne area, and lower St. Mary, Wasa Lake and Wildhorse Creek areas. Other beetles commonly found in stressed or dying trees were also present: red turpentine beetle, *Dendroctonus valens*, in 4% of trees, most with over 80% of the branches dead; lodgepole pine beetle, *Dendroctonus murrayannae,* in 2% of trees, all with over 90% of the branches dead; and *Ips* spp. in 1% of trees, usually with one of the other beetles.

Pine needle cast
Lophodermella concolor

This fungus declined to endemic levels after four years of killing year-old lodgepole pine needles at moderate to high levels through much of the southern two-thirds of the region. Understory and sapling to pole-sized stands were the most severely affected. After consecutive years of severe needlecast there may be scattered mortality, in addition to the usual impact of 50 to 70 percent annual growth reduction (see 1991 report), though no impact surveys were done in 1995. A secondary fungus, *Hendersonia pinicola*, further blighted infected needles. Trees with chronic needlecasting sustained greater damage by Armillaria root disease (see 1994 report).

Douglas-fir Pests

Douglas-fir beetle
Dendroctonus pseudotsugae

A total of 192 Douglas-fir beetle infestations were mapped over 180 ha in the region, down from 237 ha in 1994 (Table 4). Increased activity occurred along Steamboat Mountain and Premier Lake in the East Kootenay, while scattered spot outbreaks in the West Kootenay collapsed. Many of the infestations in 1994 built up in trees blown down in the fall of 1991. When the beetles had to attack standing, often younger trees the population subsided.

Table 4. Location, number, and area of Douglas-fir recently killed by the Douglas-fir beetle. FIDS, Nelson Forest Region 1995.

District	Area (ha)	No. infestations	No. trees
Invermere	158	157	4200
Cranbrook	17	22	450
Golden	2	6	80
Boundary	1	3	20
Kootenay Lake	1	2	10
Kootenay National Park	1	2	20
Total	**180**	**192**	**4780**

In the **Invermere District,** infestations have increased to 158 ha, from 53 in 1994 and 14 in 1993. Most remain in the Lower Lussier River area, especially in the Premier Lake area, with scattered patches north to Whiteswan Lake, on west aspect slopes along the Columbia River north of Invermere, along Kootenay River to Mary Anne Creek and extending south to Wild Horse Creek in the Cranbrook District. Increasing populations were also recorded along the base of the Purcell Mountains between Forster and Bugaboo creeks.

In the **Cranbrook District,** the area of infestations declined to 22 ha from 67, with the more active populations remaining in the Lewis to Wild Horse creeks area. Small infestations continued in the Palmer Creek area, but had largely subsided in the Moyie Lake and Elk River areas. Beetle activity in the **Golden District,** was reduced to small scattered groups of tree mortality along the Kicking Horse River and McNaughton Lake. The infestation near Rice Brook along the Bush River has largely collapsed. In **Kootenay National Park**, scattered groups of less than five recently killed trees were mapped on south-aspect slopes along Sinclair Creek.

Populations collapsed in most areas of the **West Kootenay**. A few scattered residual attacks were mapped in the Boundary District and north of Kaslo. Sanitation and salvage logging also reduced populations along the West Arm of Kootenay Lake where occasional current attacks were reported by the B.C. Forest Service.

Forecast

Large areas of the Nelson Region are susceptible to outbreaks of this beetle due to aging stands which often contain patches of root disease, are sheltered from successional change by fire protection, and have few harvesting options due to conservation and visual quality objectives.

Populations in the Premier Lake to Wildhorse Creek area are expected to continue to increase in 1996, based on brood sampling in the Premier Lake area. The current attack was similiar to 1994, although pitchout levels increased substantially. The "R" value decreased to 2.0 in 1995 from 4.7 in 1994 but still indicated increased attack for 1996 (1.4+ = increasing population).

Douglas-fir needlecast
Rhabdocline pseudotsugae

Douglas-fir needlecast continued to impact Douglas-fir in side drainages of the Rocky Mountain Trench and east of Kootenay Lake. In Christmas tree growing areas between Canal Flats and Edgewater the incidence decreased to an average of 9% of the trees from 34% in 1994. However, intensity remained unchanged at 40% of foliage on affected trees.

Western spruce budworm
Choristoneura occidentalis

The budworm population remained low in the southwest quadrant of the region with no defoliation mapped for the third year. Moth catches at Phoenix, the only remaining pheromone calibration site, averaged 1 moth per multipher trap for the third year. No defoliation is expected in 1996.

Douglas-fir tussock moth
Orgyia pseudotsugata

The tussock moth population remained low with no significant defoliation recorded since 1983. No moths were caught in each set of 6 pheromone-baited sticky traps at calibration sites (Table 5). Populations are expected to remain low in 1996.

Table 5. Catches of the Douglas-fir tussock moth in a calibration study of pheromone-baited sticky traps. FIDS, Nelson Forest Region 1995.

Location	Average moth catch per trap							
	1988	1989	1990	1991	1992	1993	1994	1995
Cascade	0	2	19	63	5	0	0	0
Rock Creek	1	1	8	11	9	0	0	0

Catches of other moths attracted to the same pheromone were: the pine tussock moth, *Dasychira grisefacta*, remaining low averaging 9 moths per trap at Rock Creek and 1 at Cascade; and the rusty tussock moth, *Orgyia antiqua badia,* not caught for the third year.

Spruce Pests

Spruce beetle
Dendroctonus rufipennis

The area in which recently-killed spruce was mapped declined to 186 ha from 292 in 1994 (Table 6). Most activity remains in the Golden District, with occasional small infestations to the south. Reasons for the decline are: no new spruce mortality mapped in the Kootenay Lake District; the small beetle flight in 1994; and slow fading of attacked trees in the cool, wet summer - some may have been missed during aerial surveys in late July and early August.

Infestations mapped in the **Golden District** increased by almost 25% to 169 ha in 1995. Outbreaks were logged in Bachelor and Cupola creeks and the Bush River and Rice Brook drainages, but active pockets remain in leave strips and riparian reserves. Scattered small infestations were mapped along Ensign, Collie, and Martin creeks in the upper Blaeberry River drainage, the Valenciennes River and Icefall Brook area, at Moose Creek and along the Beaverfoot River. Patches of dead spruce were also noted along Cummins and Wood rivers, and Windy Creek, in areas severely defoliated by western hemlock looper during 1992 and 1993. These were not ground checked but with the general increase in spruce beetle the stressed trees would be highly susceptible to attack.

Table 6. Occurrence and impact of the spruce beetle in 1995. FIDS, Nelson Forest Region.

Management unit	Number of infestations	Area (ha)	Trees killed (faders)[1]	
			Number	Vol. (m^3)
Forest Districts				
Golden	89	169	2400	3600
Cranbrook	8	12	210	300
Invermere	5	3	50	80
District Total	**102**	**184**	**2660**	**3980**
National Parks				
Kootenay	3	1	20	30
Glacier	2	1	30	50
National Parks Total	**5**	**2**	**50**	**80**
Regional Total	**107**	**186**	**2710**	**4060**

[1] Trees attacked in 1994, discolored in 1995.

In the **Invermere District**, small infestations with less than 30 trees were mapped along McMurdo, Bugaboo, and Bobbie Burns creeks. Several new spots were mapped along side drainages of the White River north, of Whiteswan Lake. Small infestations of up to 50 trees were mapped in the **Cranbrook District** along the upper Elk and Bull rivers. The areas checked along the Elk River stemmed from 1991 blowdown with most of the initial standing attack occurring in 1993.

A small infestation was reported by the B.C. Forest Service in the upper Downie Creek area of the **Revelstoke District**. An infestation in the **Kootenay Lake District** mapped by the B.C. Forest Service in the upper Corn Creek area in 1994 could not be located during an aerial survey in 1995.

In **Kootenay National Park** the small infestation near the mouth of Numa Creek subsided, but several small groups of recently killed spruce were mapped near the mouth of the Simpson River. In **Glacier National Park** spot infestations continued along Mountain Creek.

Forecast

The few sites examined prevent a comprehensive forecast, but indicate the main beetle flight was in the spring of 1995 and broods were generally developing in a two year cycle. Control programs in the Golden District significantly reduced beetle numbers, but several restrictions allowed smaller infestations to remain active. A stand surveyed along the Elk River had 9% current attack, half of the last main flight year, and a 44% pitch-out rate.

Spruce weevil
Pissodes strobi

Populations declined at three monitoring sites in the northeastern part of the region (Table 7) but were not assessed elsewhere. Cool wet weather in 1995 may have reduced the rate of successful attack.

Table 7. Spruce weevil damage trends. FIDS, Nelson Forest Region 1995.

Location	Percent of leaders attacked 1990	1991	1992	1993	1994	1995	Remarks
Beaverfoot R.	9	9	14	16	21	-	
Blackwater Cr.	5	5	12	19	18	15	spaced, valley bottom
Quartz Cr.	18	21	26	15	17	13	mixed stand
McLeod Meadows	-	4	9	4	8	6	dense natural stand
Average	**11**	**10**	**15**	**13**	**16**	**11**	

Alpine Fir Pests

Two-year-cycle spruce budworm
Choristoneura biennis

Budworm larvae moderately defoliated 761 ha of alpine fir and spruce stands in the Bugaboo River drainage, up from 30 ha during the last main feeding year in 1993. Fall egg sampling indicated potential moderate defoliation in 1997, based on 256 eggs/unit sample (moderate defoliation can be expected with counts between 200 and 300 eggs).

In the Monashee Range the area defoliated declined to 187 ha at light intensity from 282 ha (light) in 1994 and 4300 ha (mostly severe) in 1993. Current defoliation was mapped on the eastern slopes of Whatshan Peak and in upper Fosthall Creek.

Western balsam bark beetle
Dryocoetes confusus

Recent alpine fir mortality was mapped over 2100 ha, but should not be compared to previous years due to inconsistant coverage of higher elevation stands during aerial surveys. Generally, about 4000 to 5000 ha of higher elevation stands are chronically infested by this beetle, usually at light incidence.

Most of the currently-mapped mortality was in scattered groups of up to 50 trees in mature stands throughout the region. Some of the larger concentrations were mapped in the upper St. Mary River drainage, along Bugaboo and Vowell creeks, and in the Spillimacheen River drainage.

Once established, the beetles continue to selectively kill small groups of trees at a fairly constant level, about 1-3% annually. Windthrow will often lead to a temporary spike in tree mortality after beetle populations increase in the blowdown. Ground surveys indicate that in most cases 50 to 65% of mortality is due to this beetle, often associated with root disease and/or blowdown.

Western Hemlock Pests

Western hemlock looper
Lambdina fiscellaria lugubrosa

No defoliation was detected in 1995 after a five year outbreak in overmature western hemlock-western red cedar stands. Populations also collapsed in the Prince George Forest Region and had collapsed in 1994 in the Kamloops and Cariboo regions.

Five outbreaks have been recorded in the Nelson Region with an average of 11 intervening years (range 5-24). Until this outbreak, recorded defoliation was limited to 2 or 3 successive years. In the Nelson Region and B.C. Interior the extent, duration and impact of the recent outbreak were the greatest recorded.

Impact

Current information is derived from fixed-radius plots in stands representing the range of damage that occurred during the outbreak. Mortality of trees which sustained significant crown dieback is expected to continue for several years from secondary causes such as climatic stress, shading out of affected understory trees, insects, or diseases.

Mortality to date over an accumulated total of about 89 800 ha defoliated in the Nelson Region is about 6.8 million trees/6.4 million m^3, up from 4.7 million trees/6.1 million m^3 in 1994. The small volume increase relative to the number of trees reflects most of the post-outbreak mortality occurring in smaller, understory trees to date. Overall, most of the trees killed (88%) and volume (80%) were western hemlock, with western red cedar most of the remainder.

Stands with severe impact, significant mortality visible from the air, were mapped over 9150 ha (see 1994 report) with mortality of 2.0 million trees/5.4 million m^3 to date, compared to 1.8 million trees/5.3 million m^3 in 1994. Most mortality occurred near the upper Arrow and Revelstoke lakes; Pingston, Jumping, Woolsey, and Lardeau creeks; and the Illecillewaet and Tangier rivers. The remaining 80 650 ha defoliated were lightly impacted with a total of 4.7 million trees/1.0 million m^3 dead compared to 3.0 million trees/0.8 million m^3 in 1994.

The large variation in volume rates between impact classes is due to mortality in all diameter classes of severely-impacted stands and only smaller, understory trees dying in lightly-impacted stands (Figure 2). Although almost all defoliated stands were overmature and of similar stocking, those with severe impact were generally the oldest with an average of 26% more volume compared to areas of light impact. This difference could potentially be used to rate the susceptibility of overmature stands to future outbreaks or damage.

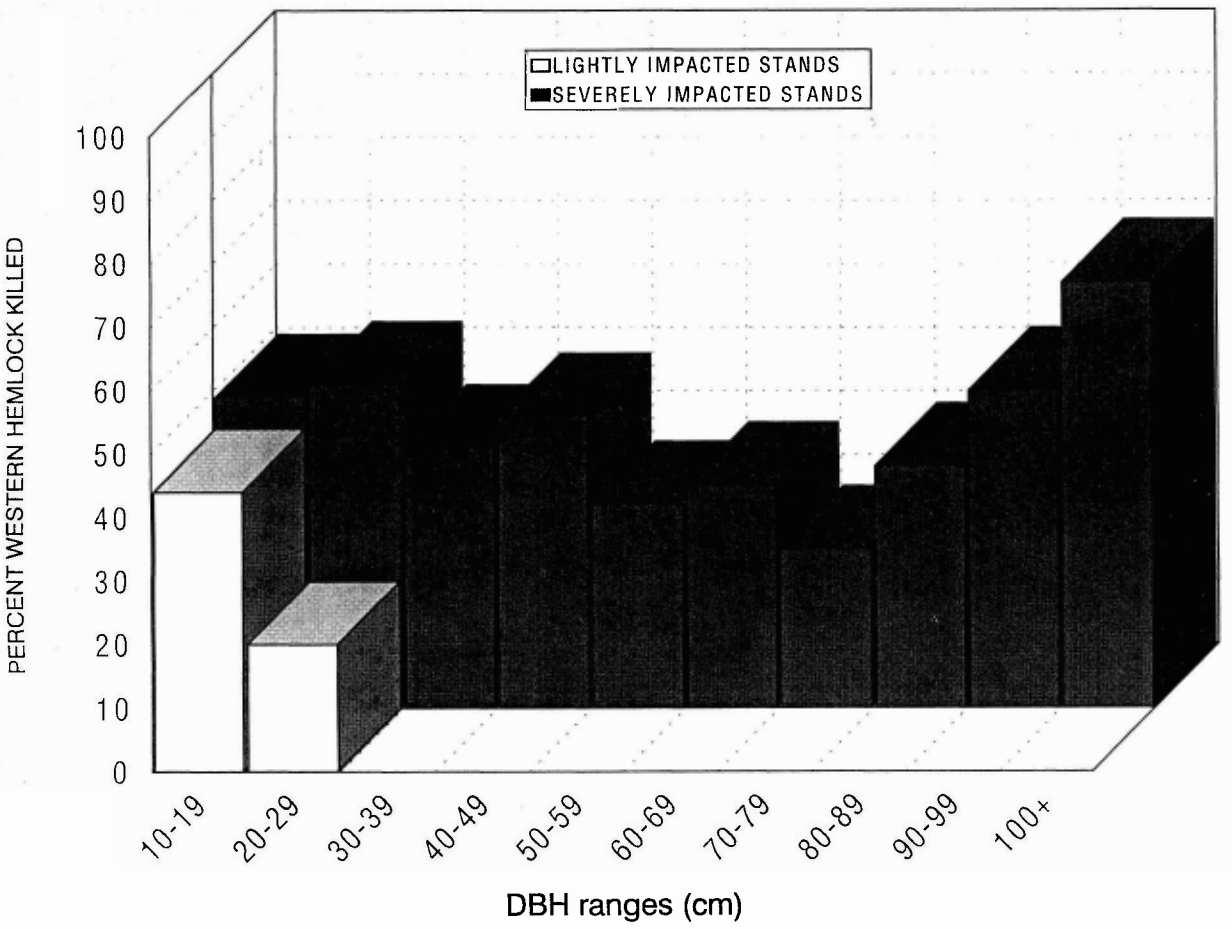

Figure 2. Percent diameter distribution of western hemlock mortality caused by the western hemlock looper in overmature stands. Forest Insect and Disease Survey 1995.

In addition to the impacts quantified above in dead trees, volume losses from reduced growth in surviving trees are expected to be significant. This could be quantified from tree ring analysis in surviving plot trees several years after the outbreak, when the full extent of mortality and recovery is evident.

Forecast

Pheromone trapping was continued at 9 monitoring sites in the Revelstoke District to calibrate a new pheromone by relating moth catches to subsequent defoliation. As expected, moth catches again declined, averaging 19 (range 0-68) moths per multipher trap, compared to 238 in 1994 and 2647 in 1993. Larval sampling and current defoliation were both negative at the monitoring sites. No defoliation is expected in 1996.

Gray spruce looper
Caripeta divisata

Populations of this insect remained endemic after an intense two-year outbreak collapsed in 1992. About 4060 ha of semi-mature to mature western hemlock were severely defoliated, mainly near Arrow, Slocan, Duncan and Box lakes. Trees which sustained significant crown dieback continue to die, mainly from climatic stresses and root disease. Damage has been monitored annually in fixed-radius plots at representative unsalvaged stands near Wragge Point, on Slocan Lake.

The impact of the outbreak grew slightly to about 2.2 million trees/780 000 m^3 in 1995 from about 2.1 million trees/690 000 m^3 in 1994. Western hemlock sustained almost all the mortality, with only 1.9% of the trees and 0.5% of the volume loss in western red cedar. The rate of mortality did not vary significantly with tree size; an average of 48% (range 44-50%) of the trees were killed in each of the 10 cm diameter classes from 10 to 50 cm. Crown dieback averaged 38% (range 0-95%) in remaining live hemlock, compared to 41% in 1994 and 53% in 1993, so additional mortality is possible in some cases.

Multiple Host Pests

Armillaria root disease
Armillaria ostoyae

Armillaria root disease remains the main impediment to fully 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 numerous stand openings. Partial cutting incites the greatest increase in root disease and is probably 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 were conducted beyond specific programs such as surveys of young stands, mostly treated under FRDA agreements. Of 20 stands assessed in 1995 and treated in the last few years, usually by spacing, 17 (85%) already had some of the remaining trees killed by Armillaria root disease. This includes stands where the incidence was low and only recorded between plots. In stands where the disease was detected within plots, an average of 2% (range 1-7%) of trees had symptoms. The incidence is expected to increase considerably within a few years as the root disease flourishes due to the partial cutting.

Vole

Vole populations increased significantly at mid- to higher elevations in the Revelstoke District, adjacent National Parks, and scattered other locations in 1995. In stands older than about 5 years damage was mostly limited to the in-growth of deciduous brush, especially willow, with planted conifers often clipped and removed in younger plantations. Stocking in 3-year old plantations assessed at Tangier River, Spikers Road, and Redfish Creek was 370, 700, and 785 stems per hectare, respectively, about one-quarter to one-half the planted density. About one-third of the deficiency was due to Rhizina root disease, based on surveys the year after planting.

Black army cutworm
Actebia fennica

This insect killed 20% of the spruce seedlings, in scattered patches totalling about 20 ha, in a mixed-species plantation on Blackwater Ridge. A further 55% of the seedlings had all or most of the foliage stripped but viable buds remaining. This infestation followed relatively low (340) moth catches in 1994. No damage was found at a second site re-checked in the Bachelor Creek drainage.

Pheromone trapping was discontinued in 1995 and no ground checks were made over most of the northern half of the region where periodic outbreaks occur.

Gypsy moth
Lymantria dispar

Single pheromone-baited traps were deployed at 41 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 the region. No moths were caught and traps placed by Agriculture Canada and the B.C. Forest Service were also negative. However, the threat of introduction remains with current moth captures in southwestern B.C. and northern Idaho where eradication programs have, to date, prevented establishment.

Deciduous Tree Pests

Satin Moth
Leucoma salicis

Defoliation of mostly trembling aspen by the satin moth continued to increase near Golden, decreased in the Boundary District, and new infestations were mapped in the Arrow and Kootenay Lake districts. Current defoliation was mapped over a regional total of 6620 ha, up from 4660 ha in 1994.

This insect was accidentally introduced to B.C. from Europe in 1920 and first collected in the Nelson Region at Needles in 1963. Six outbreaks have since occurred in the region with host mortality recorded for the first time in the current outbreak. Introduced parasites, a native bacterium, and a fungus have helped reduce satin moth outbreaks.

Golden Forest District

Although the area defoliated increased to 6270 ha from 4580 ha in 1994, the intensity decreased to generally light or moderate in older portions of the infestation. The main infestation remains on bench land west of Golden, but activity increased in the Blaeberry River area and east along the Kicking Horse River. Small patches of defoliation were noted as far south as Jubilee Mountain.

West Kootenay

The three year outbreak in the Anarchist Mountain to Greenwood area collapsed with only two small patches of current defoliation observed west of Bridesville (<10 ha). The outbreak peaked at 500 ha of mostly severe defoliation in 1992 and, for the first time in B.C., there was very little refoliation with mortality mapped over 360 ha in 1994.

Patches of new defoliation, from light to severe, were mapped from Castlegar to Trail (61 ha), along Duncan Lake (236 ha), and at the Westfall River (46 ha).

Leafminers and skeletonizers

Discoloration of birch and black cottonwood foliage by leafminers continued for the fourth year in the West Kootenay, but at lower levels in most areas. Discoloration of birch foliage by *Lyonetia speculella* was again moderate to severe in the Tangier River to Jumping Creek area, the upper Illecillewaet River, lower Kaslo River, and along parts of the West Arm of Kootenay Lake. Previous severe outbreaks of this leafminer have not caused significant tree mortality in the region. Scattered light mining of black cottonwood leaves by *Phyllocnistis populiella* continued.

Mostly severe skeletonization of willow foliage by the gray willow leaf beetle, *Tricholochmaea decora carbo*, was common along Revelstoke and Arrow lakes and along the Slocan and Kootenay river valleys south to the Castlegar area. Moderate to severe discoloration of elm foliage by the elm leaf beetle, *Xanthogaleruca luteola*, occurred throughout the city of Nelson; neither the host nor the insect are native to B.C..

Special Surveys

Pests of young stands

Twenty young, recently-treated stands were surveyed in 1995 (Table 8). Tree removal during treatments such as spacing affected the occurrence of most pests. Sites were selected from lists stratified by district, biogeoclimatic zone, and treatment. The incidence of some pests, especially root disease, at this early stage after treatment suggests that long term impacts may be severe.

Life-threatening pest problems were recorded in 90% of stands surveyed. Root diseases, stem cankers, and mammal damage were the most frequent problems. Of 2820 trees examined, 89% were pest-free, 4% were either dead or had pests that often lead to mortality, and 5% had pests causing significant growth loss. Some of the pests in Table 8 are discussed in more detail elsewhere in this report.

Table 8. Summary of pests when hosts were a significant stand component in 20 young recently-treated stands, usually spaced. FIDS, Nelson Forest Region 1995.

Host/Pest	Most frequent severity index[1]	No. affected stands	No. affected trees	% of trees affected[2] avg.	% of trees affected[2] range
Lodgepole pine - 1188 trees in 15 stands					
Warren's root collar weevil	6	2	3	2	1-3
Ips bark beetle	6	1	1	2	-
Mountain pine beetle	5	1	2	5	-
Armillaria root disease	5	7	11	2	1-4
Comandra blister rust	5	1	1	1	-
Western gall rust	5	8	34	5	1-17
Bear	5	2	2	2	2-3
Porcupine	5	1	1	3	-
Squirrel	5	6	26	5	2-10
Ice/snow/wind	4	4	8	2	1-4
Deer	4	5	6	2	1-3
Lodgepole terminal weevil	4	1	1	1	-
Pine needle cast	2	1	2	2	-
Mechanical	2	4	5	2	1-3
Pitch moth	2	2	5	4	2-7
Dioryctria sp.	2	1	2	3	-
Pest-free	1	15	1044	86	71-98
Douglas-fir - 498 trees in 10 stands					
Armillaria root disease	5	4	7	5	1-10
Drought	5	1	1	3	-
Snow/wind	4	6	9	4	1-8
Mechanical	3	2	2	3	3-3
Pest-free	1	10	479	95	84-100
Alpine fir - 104 trees in 1 stand					
Armillaria root disease	5	1	11	11	-
Drought	4	1	3	3	-
Fork	4	1	7	7	-
Frost	2	1	2	2	-
Pest-free	1	1	81	78	-
Western larch - 190 trees in 5 stands					
Bear	5	3	6	6	2-11
Squirrel	4	1	4	6	-
Snow/Ice	4	2	3	7	2-5
Fork	4	1	1	2	-
Pest-free	1	5	179	94	83-98
Ponderosa pine - 27 trees in 1 stand					
Red turpentine beetle	5	1	3	11	-
Pest free	1	1	24	89	-

[1] **1**=pest free; **2**=minor damage, minimal impact; **3**=significant loss of current growth potential; **4**=loss of significant long-term growth potential; **5**=life-threatening or severely deforming; **6**=recently dead

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

Acid Rain National Early Warning System (ARNEWS)

As part of a national network, 10 x 40 m plots are being biomonitored to detect any impact of air- and rain-borne pollution on native trees and indicator plants. Three plots in the Nelson Region are located near Summs Creek (since 1985), Martha Creek and Wasa (1992). Visual assessments of plot vegetation and pest conditions are done annually with more detailed measurements such as foliar analysis every five years. No damage from acid rain or unusual insect or disease conditions have been found to date.

Other Noteworthy Pests

Agents that are currently relatively minor, or cause significant chronic damage that varies little and is not quantified, are tabulated by host. Some of the entries were collections from research projects or special surveys which contribute to the overall record of biodiversity.

Host/Pest	Location	Remarks
Pine		
Arceuthobium americanum Lodgepole pine dwarf mistletoe	host range	occasional chronic patches, locally severe impact
Ascocalyx abietina Scleroderris canker	Nancy Greene Lake	re-collected after first found in 1970's, not found at eight other West Kootenay locations
Atropellis piniphila Atropellis canker	host range	occasional stem cankering of lodgepole pine, locally severe impact
Cenangium ferruginosum A dieback fungus	Fletcher Creek	trace occurrence of tip dieback on lodgepole pine
Cinara sp. Giant conifer aphid	East Kootenay	common in young stands
Cronartium ribicola White pine blister rust	host ranges	an introduced disease of five-needled pines with chronic high impact
Endocronartium harknessii Western gall rust	host ranges	widespread, occasionally significant impact
Eucosma sonomana Western pineshoot borer	Cascade	low levels on shoots of open growing ponderosa pine
Leptomelanconium cinereum A pine needle blight	S. Rocky Mtn. Trench	decline to endemic after 3120 ha of severe blighting in 1994
Pityophthorus sp. A secondary bark beetle	Wasa Lake	killing branches of ponderosa pine
Trisetacus sp. A mite	Stewart Creek	some damage to lodgepole pine regen. collected by BCFS in a push-over logged block
Whitebark pine decline	host range	root diseases and white pine blister rust the main agents identified so far

Host/Pest	Location	Remarks
Western Hemlock		
Acleris gloverana Western blackheaded budworm	Glacier National Park, Gray Ck.	decline to endemic after 4626 ha light defoliation in 1994
Echinodontium tinctorium Yellow stringy heart rot	host range	significant decay common in old growth stands
Douglas-fir		
Apterona crenulella A bagworm moth	Crescent Valley Krestova	locally numerous on saplings but no apparent impact, introduced to B.C. last few years
Arceuthobium douglasii Douglas-fir dwarf mistletoe	SW quarter of region	occasional chronic patches, locally severe impact
Contarinia pseudotsugae A needle midge	southern Arrow and Boundary districts	scattered conspicuous infestn. of current growth in dry areas for fourth year
Nepytia freemani Western false hemlock looper	Rock Creek	endemic for second year
Spruce		
Adelges cooleyi Cooley spruce gall adelgid	host range	widespread at light to moderate levels
Pikonema alaskensis Yellowheaded spruce sawfly	Castlegar	mostly moderate defoliation for ± 20 km radius, some severe in urban areas
	Slocan Valley	feeding north to Slocan Park for second year
True Firs		
Adelges piceae Balsam woolly adelgid	U.S. border areas	several assessments negative, threat of spread from Idaho
Cinara sp. Giant conifer aphid	Pend'Oreille R.	trace damage on new growth of grand fir, widespread
Dermea pseudotsugae A fungus	Patterson	low level of tip dieback of grand fir
Lirula abietis-concoloris A fir needle blight	host range	chronic light damage common in higher elevation stands

Host/Pest	Location	Remarks
Phyllosticta abietis A fir needle blight	Patterson Pend'Oreille R.	collected at low levels on grand fir
Pleroneura sp. A shoot-boring sawfly	host ranges	chronic low numbers on grand and alpine firs
Potebniamyces balsamicola A fungus	Patterson	low level of tip dieback of grand fir
Pucciniastrum epilobii Fir-fireweed rust	host range	chronic lt. to mod. dieback of current alpine fir needles
Western/Alpine Larch		
Argyresthia columbiana A larch shoot moth	Columbia - Windermere lakes	10% terminal mort. in spaced stands, similar to 12% in 1994
Arceuthobium laricis Larch dwarf mistletoe	host range west of Rocky Mtns.	widespread chronic patches, locally severe impact
Coleophora laricella Larch casebearer	host range	introduced insect at endemic to trace levels for the third year; previous outbreaks controlled by parasite releases
Frost	St.Mary & Albert rivers, Yoho NP	foliage mortality mapped on alpine larch over 164 ha
Hypodermella laricis Larch needle blight	host range	at trace levels for second year
Semiothisa sexmaculata Green larch looper	host range	remaining endemic after 1990 outbreak
Zeiraphera improbana Larch budmoth	southern Rocky Mountains	population collapsed after 678 ha moderate to severe defoliation in 1994
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
Leptographium wageneri Black stain root disease	portions of host ranges	infection centers most often in pine and Douglas-fir

Host/Pest	Location	Remarks
Rhizina undulata Rhizina root disease	northern half of region	infections common in burned sites, up to 45% seedling mortality recorded in 1994, not assessed in 1995
Trypodendron lineatum Striped ambrosia beetle	host ranges	chronic pest degrading softwood lumber
Deciduous Hosts		
Chrysomela scripta Cottonwood leaf beetle	Illecillewaet River	at low levels, for occurrence and distribution information
Cryptorhynchus lapathi Poplar and willow borer	host range	introduced, scattered attacks common and widespread
Fomes fomentarius Birch trunk rot	host range	common stem decay of birch, conspicuous in drier areas
Hyphantria cunea Fall webworm	southern Arrow, Boundary, Cranbrook districts	low levels in roadside trees and shrubs in drier areas
Mamianiella coryli A foliar fungi	Tangier River	at low levels on hazelnut for distribution information
Melampsora occidentalis Conifer-cottonwood rust	host range	chronic light to moderate leaf rusting of black cottonwood
Mycosphaerella populicola Septoria leaf spot	host range	chronic low levels on black cottonwood
Phellinus tremulae White trunk rot of aspen	host range	common, causing extensive decay and wood stain
Phaeocalicium populneum A bark epiphyte	Martha Creek	locally common, no apparent impact
Saperda populnea A twig borer	Fairmont	common at low levels on aspen
Trametes pubescens A decay fungus	Appledale	new record from mountain ash, collected by BCFS