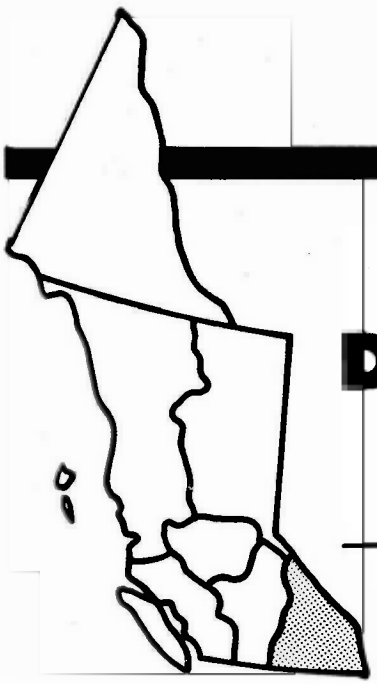
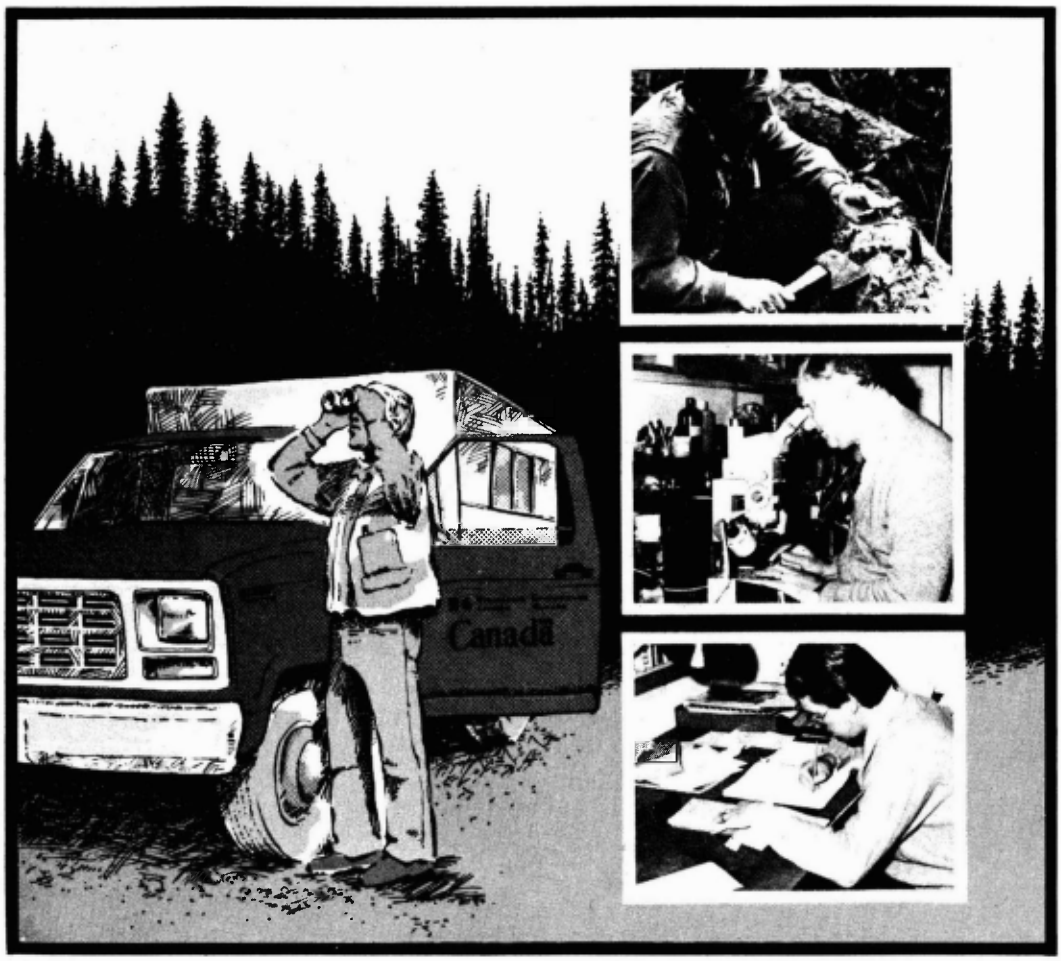


Forest Insect and Disease Conditions

Nelson Forest Region
1983

H.P. Koot and R. Turnquist



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SUMMARY

This report outlines the status of forest insect and disease conditions in the Nelson Forest Region in 1983, and attempts to forecast population trends with emphasis given to pests capable of sudden damaging outbreaks.

Mountain pine beetle, again the most damaging pest in the Region, killed an estimated 2.1 million lodgepole and white pine over 20 000 ha in 1 700 infestations. This is the second successive year of decline from 4.3 million pines killed in 1982 and 10.5 million in 1981. Host depletion and logging of susceptible and infested stands were the key factors which influenced this decline. As in 1982, pine needle diseases such as red band needle disease, pine needle blights and Elytroderma needle disease severely infected lodgepole, ponderosa and white pines in scattered areas throughout the Region. One more year of severe red band needle disease infection on white pine near Summit Lake in the West Kootenay may result in some tree mortality. Squirrel damage to lodgepole pine in a fertilizer trial area near Spillimacheen, declined for the third successive year.

Spruce beetle infestations declined to 2 700 ha from 7 500 ha in 1982. Some of this apparent reduction may be attributed to a reduction in aerial surveys in 1983 because of budgetary restraint.

Larch sawfly defoliation declined to 10 400 ha from 12 000 ha in 1982. Areas of larch defoliation declined between Sparwood and Elkford, and Bull River area, and increased between Elko and Fernie and north of Tie Lake. Larch casebearer defoliated 60 000 ha in the Jaffray, Elko, Koocanusa Lake and Gold Creek areas. Larch budmoth defoliated 6 600 ha in 36 high elevation larch stands in southern portions of the Region. The incidence of the larch needle disease, Hypodermella laricis declined throughout the host range, particularly in the West Kootenay, while Meria laricis lightly infected widespread areas in southern portions of the Region.

Douglas-fir tussock moth caused light to moderate defoliation on more than 2 000 ha of Douglas-fir in the Rock Creek area. However, larval populations collapsed by midsummer. Western false hemlock looper lightly defoliated 110 ha in two areas near Invermere. Western spruce budworm defoliated 60% of new growth of Douglas-fir between Anarchist Mountain and Rock Creek. The number of Douglas-fir beetle killed trees in the East Kootenay increased to small pockets up to 50 trees each. Current year's needles were moderately infected by Rhabdocline needle cast and were widespread in the Region, but less severe than 1982. A Douglas-fir bud blight caused deformity and mortality of buds and disfiguration of shoots of mostly immature Douglas-fir in scattered areas of the East Kootenay.

Western hemlock looper defoliation increased fourfold to more than 32 000 ha in 1983 from 8 000 ha in 1982 in the Revelstoke, Arrow and Golden TSAs and in Mt. Revelstoke and Glacier National parks in

the second year of the outbreak. Western blackheaded budworm lightly defoliated 120 ha of mature western hemlock along Bostock Creek in Glacier National Park.

The western balsam bark beetle complex killed numerous high elevation alpine fir throughout the Region, most notably along the Blaeberry and Spillimacheen rivers. Defoliation of alpine fir and Engelmann spruce by two-year-cycle spruce budworm increased tenfold to 2 000 ha from 200 ha in 1982 in high elevation stands.

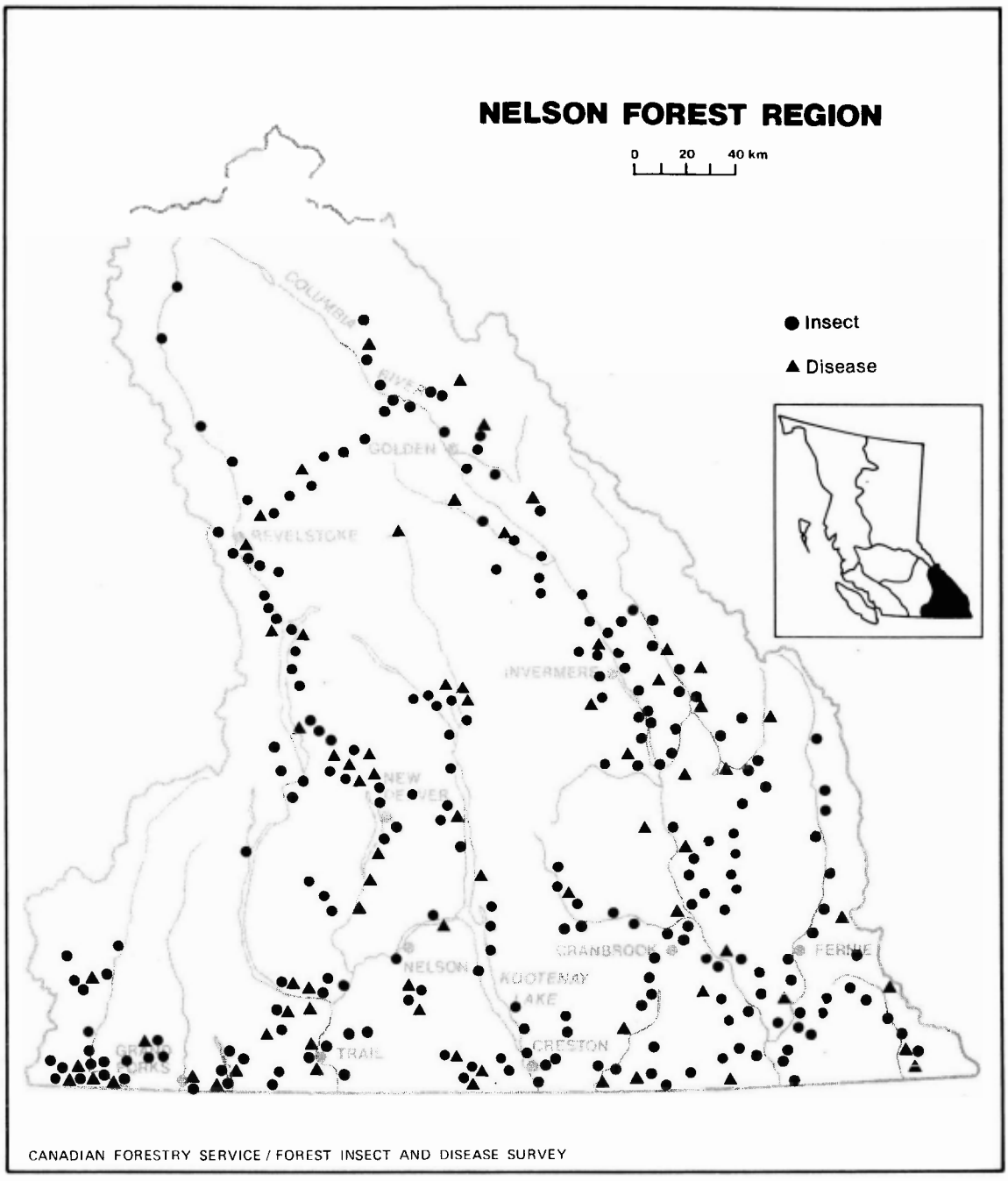
Single pheromone-baited gypsy moth traps were located in 30 provincial parks throughout the Region in 1983; no moths were trapped. Douglas-fir tussock moth pheromone traps located in three areas of the Boundary TSA trapped adult males at all locations. Two-year-cycle spruce budworm pheromone traps (9 sets of 5 each) were located at Silverton Creek, Whiteswan Lake and East Fork White River and adults were trapped in 3 of 9 sets reflecting the strongest pheromone. A pine budmoth pheromone attracted moths in 6 of 15 traps at Sunrise Creek. Fifteen larch casebearer traps were placed at three locations along Slocan Lake but adults were trapped at only one location. Moths were not found in any of five European pine shoot moth pheromone traps placed near Hugh Keenleyside Dam. Traps to test larch budmoth pheromone at Dewar Creek and Skookumchuck provided inconclusive data. This trial may be repeated in 1984.

The 1983 field season was marked by unusually hot, dry weather during spring, followed by cool, moist conditions until the end of July. The cooler, moist weather is thought to have stimulated the incidence of various needle, leaf and shoot diseases.

The 1983 FIDS field season extended from May 24 to October 1 and included special fall surveys to evaluate mountain pine beetle and spruce beetle populations.

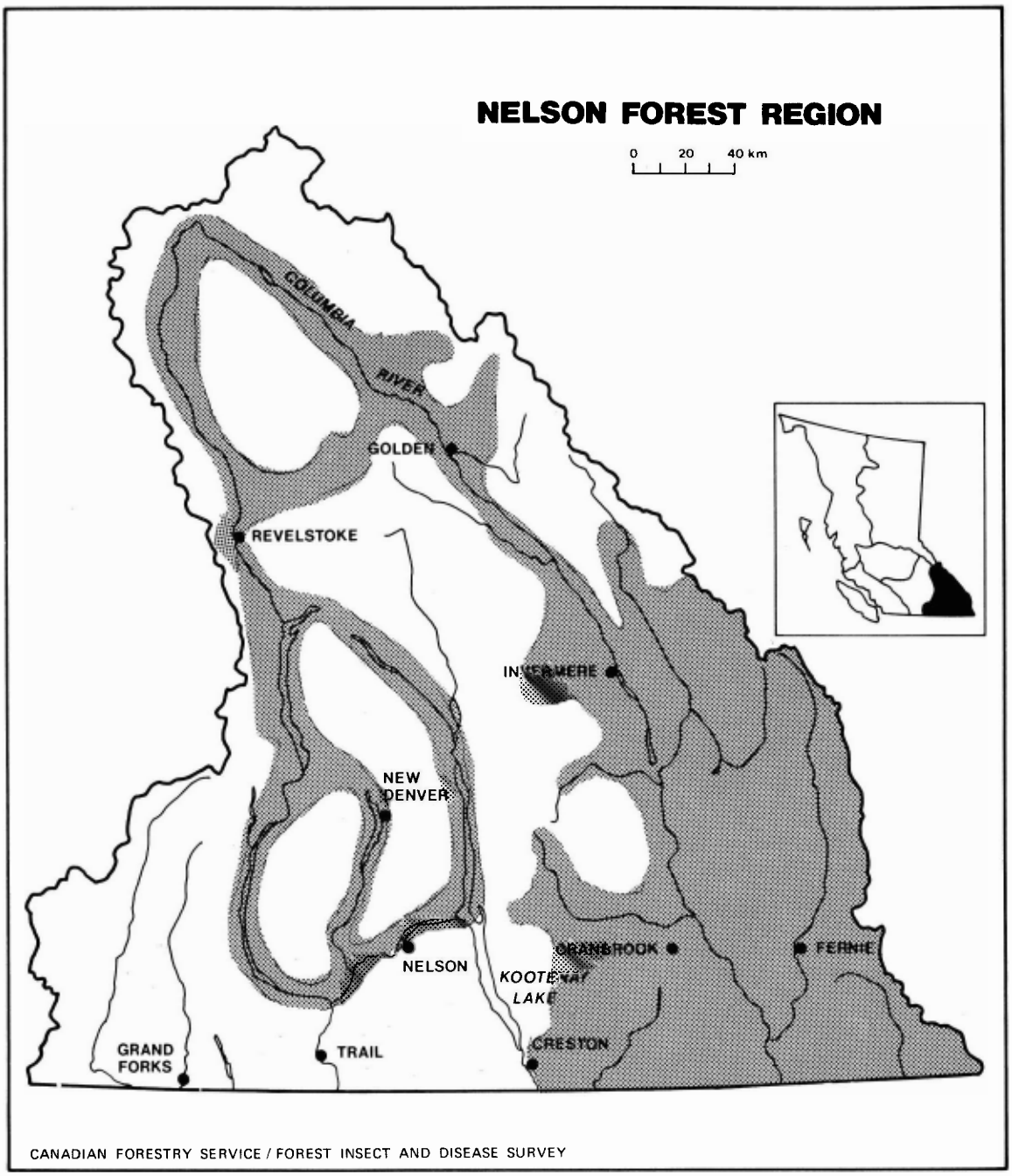
A total of 284 insect and 137 disease collections were submitted for identification to the Pacific Forest Research Centre in 1983 from Nelson Region by FIDS. An additional 48 insect and 74 disease samples were collected by provincial agencies, industry and private sources. Locations where one or more collections were made by FIDS are shown on Map 1.

Approximately 30 hours of fixed-wing flying time, down from 48 hours in 1982, was provided by the Canadian Forestry Service (15 hours) and B.C. Ministry of Forests (15 hours), to observe, map, and photograph currently active forest pests throughout the Nelson Region. An additional 2.5 hours of helicopter time was provided by Crestbrook Forest Industries. Because of budgetary restraints the reduced aerial surveys resulted in some high elevation and other drainages not being surveyed. The area covered by aerial surveys is shown on Map 2.



Map 1

Locations where one or more forest insect or disease samples were collected, 1983



Map 2

Area covered by aerial surveys to map bark beetle and defoliator infestations, 1983

PINE PESTS

Mountain pine beetle, Dendroctonus ponderosae

Mountain pine beetle killed an estimated 2.1 million pine trees over 20 000 ha in 1 700 infestations (Table 1 and Map 3). This is the second successive year of decline; from 4.3 million trees killed over 38 200 ha in 1982, and 10.5 million on 58 000 ha in 1981. These large reductions are mostly attributed to host depletion from both previously killed stands and logging of infested and susceptible types in some of the larger areas such as the Flathead River Valley, the White River drainage and the Bush Arm-Columbia Reach area. The rate of expansion has also declined due to the extended life cycle of the insect at higher elevations where many of the infestations are now concentrated.

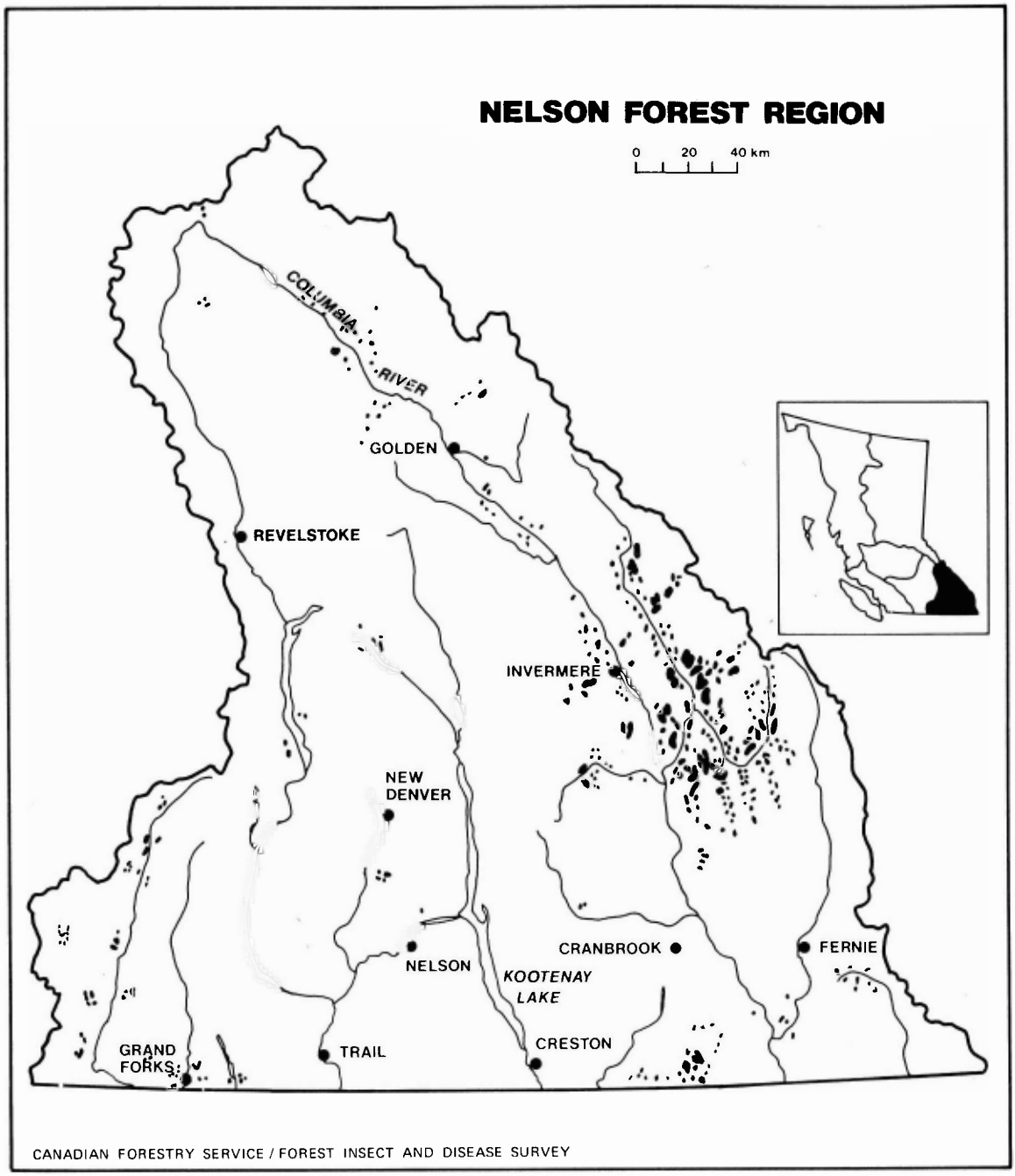
Volume losses of lodgepole and white pine of 731 800 m^3 are less than half of the nearly 1.6 million m^3 recorded in 1982. Over 80% of this loss (614 700 m^3) occurred in the Invermere Timber Supply Area (TSA). The number of infestations also declined to 1 700, from 2 600 in 1982, of which 1 200 were in the Invermere TSA.

TABLE 1. Location, number, area and volume loss of mountain pine beetle infestations by TSA as determined from aerial and ground surveys - Nelson Forest Region and National Parks, 1983.

TSA or Park	Number infest-ations	Area[1] (ha)	Number of trees attacked in 1982	Volume loss (m^3)	
				1982 attack	Grey
Cranbrook	200	810	117 700	42 400	-
Invermere	1 170	16 240	1 707 500	614 700	650 000
Golden	88	1 500	163 500	59 000	290 000
Revelstoke	12	60	400	400	-
Kootenay Lake	27	140	2 600	2 900	6 700
Boundary[2]	80	820	98 000	3 500	-
Arrow	32	160	18 900	7 600	20 000
Glacier Nat. Park	9	50	100	100	-
Kootenay Nat. Park	94	410	3 100	1 200	-
TOTALS	1 712	20 190	2 111 800	731 800	966 700

[1]Areas of "grey" not included.

[2]Aerial survey maps provided by BCMF.



Map 3

Mountain Pine Beetle

Areas of recently killed pine as determined by aerial surveys[1], 1983

[1] West Kootenay District flown by B.C.M.F.

In the Cranbrook TSA epidemics in lodgepole pine stands decreased to 810 ha from 8 620 ha in 1982. This large reduction was primarily due to the complete collapse of infestations in the main Flathead River Valley; only a few small scattered pockets of recently killed pine remained in the headwaters of this drainage and at tree-line elevations in mature stands including white bark pine in Kishinena, Akamina, Sage and Middlepass creeks. Elsewhere in the TSA active infestations in the Ward-Gilnockie creeks area expanded to 368 ha from 256 ha in 1982. Infestations in Bloom and Caven creeks continued to decline through timely harvesting of infested stands. Small localized pockets of infestation continued in the Elko and Morrissey Creek areas.

In the Invermere TSA active infestations decreased to 16 240 ha from 20 000 ha in 1982. The number of previously beetle-killed (grey) trees in old infestations increased to 650,000 in 1983 from 450 000 the previous year. Infestations continued at reduced levels in the White-Upper Kootenay-Lussier river drainages where nearly 8 million trees have been killed since 1971. Much of this reduction is the result of the harvesting of susceptible and attacked stands and also the slower rate of spread at higher elevations, due to an extended life cycle of the beetle. Some notable exceptions are west of Whiteswan Lake, where outbreaks expanded along Mutton Creek, south of Mt. Grainger and along Dry Creek. Near the B.C. - Alberta border a few new spot infestations appeared in the Upper Cross River and along the Palliser River near Joffre Creek. In nearby Kootenay National Park, 94 infestations occurred over 410 ha similar to 84 infestations on 450 ha in 1982. In the Columbia River Valley, major outbreak areas persisted at similar levels to 1982, from Findlay and Dutch creeks west of Columbia Lake, and north to Frances Creek and the Steamboat Mountain area. Scattered small areas of recent beetle-kill continued at reduced levels from Castledale to Golden.

In the Golden TSA, outbreaks in both lodgepole and white pine declined to 88 infestations covering 1 500 ha, from 247 covering 5 500 ha in 1982. This major reduction is mostly the result of host depletion, particularly along Columbia Reach and Bush Arm, where grey stems outnumbered red, five to one. The large infestation opposite Robinson Bay along Bush Arm declined to 380 ha from 600 ha in 1982 with the "grey" volume having increased 20 000 m^3 to nearly 300 000 m^3 in 1983. Elsewhere infestations continued at reduced levels in mixed white pine and lodgepole pine stands along the Kicking Horse, Blaeberry, Beaver, Bush and Valenciennes rivers and along Columbia Reach from Bush Arm to Kinbasket River. Infestations along the Valenciennes and Bush rivers did not expand towards the B.C. - Alberta border.

Only 27 infestations on 140 ha were recorded in the Kootenay Lake TSA down from 35 on 750 ha in 1982. In 1983 aerial surveys were not completed in some areas of the TSA which contributed to the decline in the number and area of pine infested. However, in those areas where

they were completed, the number of recently killed lodgepole pine remained at similar levels to 1982, including Hawkins - Freeman creeks area, Kokanee and Cooper creeks and Trout Lake.

In Glacier National Park infestations in white pine along the Beaver River between Grizzly Creek and the north Park boundary declined to only 50 ha from 200 ha in 1982. Yoho National Park was not surveyed by air this year.

In the Arrow TSA, 32 infestations covered a total of 304 ha and an additional 144 ha of "grey", down from 36 infestations over 910 ha in 1982. Salvage logging and host depletion in the Chapleau-Springer Creek area, and in the Halfway River area north of Nakusp contributed to the large reduction in the area attacked.

Fifteen infestations covering approximately 30 ha of western white pine killed by a combination of white pine blister rust and mountain pine beetle were mapped mostly in scattered pockets along the southwest shore of Slocan Lake, north of, and along the northeast side of Trout Lake, and north of Nakusp on the west side of Upper Arrow Lake.

Fall cruises in the Chapleau Creek area indicated that some of the beetle population was in a 1 1/2 year cycle, and was approaching the overwintering period as eggs or pupae, both vulnerable stages that could result in overwintering mortality.

In the Revelstoke TSA, 12 infestations occurred on 60 ha, with the largest infestation, 48 ha, at Crawford Creek southeast of Revelstoke. Elsewhere recently dead scattered western white pine, probably killed by a combination of white pine blister rust and mountain pine beetle, were observed north to McNaughton Lake.

In the Boundary TSA, 80 infestations covered approximately 820 ha, down from 284 infestations covering 1 400 ha in 1982. This information was provided by the British Columbia Ministry of Forests, who conducted their own aerial surveys and transferred the data to FIDS.

Intensive salvage logging throughout the Boundary TSA, and particularly in TFL 8, contributed to the decline in area attacked. The beetle, however, is still active in many of the areas attacked in 1982, including Collier Lakes, Boomerang Creek, Moody Creek, Beaverdell, and Copperkettle Lake.

Current attack in 6 representative stands in the Nelson Region was 7%, similar to 1982, which indicates continuing, but declining, outbreaks and tree mortality in 1984.

Red band needle disease, Dothistroma (Scirrhia) pini

Red band needle disease, D. pini, the imperfect form of Scirrhia pini, first reported in the Nelson Region in 1982, caused extensive discoloration and premature needle loss of one- and two-year-old western white and lodgepole pine needles throughout the Region. This disease is particularly damaging to young trees because of its ability to attack needles of all ages.

At Galena Bay, 45% of the two-year-old needles on the lower third of white pine were infected over 2-3 ha; in the Summit Lake-Hills area, 100% of the white pine in scattered mixed and 1-2 ha pure stands averaged 70% infection; near Winlaw, 100% of the white pine averaged 35% infection; at Hall Creek, south of Nelson, 30% of the needles on 100% of the white pine were infected.

In a 20 tree, 1-2 ha permanent sample plot near Summit Lake 75% of the needles of the immature western white pine were infected, compared with 56% in 1982. About 10% of the plot trees were 90-100% defoliated in the lower two-thirds of the crown with only new growth and one-year-old needles remaining in the upper third of the crown. If infection of the remaining needles continues at 1983 levels, mortality of some of the young white pine stems could occur in the plot or the Region in 1984.

Lodgepole pine throughout the Region were more severely infected by D. pini in 1983 than in 1982. At Lemon Creek Flats about 40% of the foliage was infected on 96% of the trees over a 5 ha area. At Winlaw, 100% of the trees averaged 45% infection intensity over a similar sized area. Similar infection levels prevailed in other lodgepole pine stands throughout the southern Slocan Valley; at Hall Creek, south of Nelson, 100% of the trees averaged 50% infection intensity; at Sheep Creek, south of Salmo, 45% of the needles were infected on 100% of the trees over 10 ha. From Salmo south to the Canada-U.S. border, infections covered 1 000 ha, the most severe at the junction of Highway 3 and 6, near Nelway, where 100% of the semimature lodgepole pine over a 15-20 ha area lost 50% of its foliage.

Infections in the East Kootenay were less prominent than in 1982. Although incidence of the disease was up to 100% in small areas, usually less than 30% of the needles were infected. Notable locations of infection included Hawkins and Ellenvale creeks, and Golden.

Warren's root collar weevil, Hylobius warreni

In the Beaverfoot River Valley at Marian Lake, weevils killed about 5% of 15-year-old planted lodgepole pine on 5 ha. Along the White River, 1 and 2% of lodgepole pine regeneration were girdled on about 40 ha in each of two areas. Three percent of planted lodgepole pine in a small area near Morrissey had been girdled, but the damage was old, and no recent girdling was observed.

The most severe damage is caused by the larvae girdling the root collar; adults feed principally upon the bark of small roots and twigs and needles of the host. In addition to causing outright mortality, partial girdling by weevils can cause growth loss, and an important avenue of infection for root-rotting and staining fungi.

Current damage, including tree mortality, did not have a significant impact on planted or natural lodgepole pine sites to the extent that spacing densities were significantly altered.

Squirrel Damage

For the third consecutive year, debarking of immature lodgepole pine by squirrels was assessed in a 13-year-old spaced and fertilized trial area west of Spillimacheen. Of 1 350 trees examined in 16 spaced plots, 26% (range 11 to 48%) had patches of bark removed from stems and branches prior to 1983, compared to 7% of about 375 trees in 8 nonspaced plots. In 1983 the incidence of debarking declined to about 6% in the spaced plots and 1.5% in the nonspaced plots. Only 3% of the trees in 24 plots were dead. Of the dead trees 9% had western gall rust stem infections, but none were killed by rodent debarking.

The identifying characteristics of squirrel debarking are the absence of tooth marks on the sapwood and the presence of bark strips (averaging 3 x 8 cm) accumulated on the ground under the injured tree. Similar damage by rabbits is characterized by toothmarks on the sapwood and the lack of bark strips.

Pine needle diseases, Lophodermella concolor and Lophodermium montivaga

Cool moist weather in the early summer of 1983 intensified fungal infections which resulted in significant discoloration of two-year-old pine foliage in many areas of the Region. In the East Kootenay, L. concolor infected from 15-30% of the foliage on up to 80% of the lodgepole pine in areas of up to 100 ha, along Bloom, Findlay and Sage creeks, the Bull River Valley, near Canal Flats and along Settlers Road in Kootenay National Park. Similar infection levels occurred in the West Kootenay at Trapping Creek and between Beaverdell and the Big White Mountain "turn-off". Light infection of lower branches of immature lodgepole and white pines by Lophodermium sp. occurred on 10 ha near Nakusp.

L. montivaga infected up to 75% of foliage of immature lodgepole pine on 30 and 250 ha respectively at Ellenvale and Driftwood creeks, on natural roadside regeneration at Lumberton, and on scattered pines between Castlegar and Nancy Greene Park.

Infection of 1983 pine needles by these fungi in 1984 is likely, if moist conditions prevail in spring and early summer.

A pine needle blight, Leptomelanconium cinereum

Infection of 1982 needles persisted in ponderosa pine stands in the Elko-Baynes Lake and Plumbob Mtn. areas, where up to 60% of the 1982 foliage was infected. The incidence of infection ranged from 50 to 100% of pines in small groups up to 10 ha in size. With the exception of 1980, this blight has been common in ponderosa pine stands in the Elko-Grasmere area since 1977, and has caused significant premature needle loss.

A pilot sample of basal ponderosa pine discs from the Elko-Baynes Lake area indicated growth reduction of about 40% for the period 1978-82.

After a period of severe infection when blighted needles have been cast, the foliage takes on a characteristic "bottle brush" appearance.

Elytroderma needle disease, Elytroderma deformans

Elytroderma disease which causes discoloration of year-old needles and produces brooms, continued to infect ponderosa pine stands between Johnstone Creek Provincial Park and Christina Lake. Severe brooming in the Rock Creek area affected up to 45% of trees which had one or more brooms. To a lesser degree brooming was also evident in Johnstone Creek Provincial Park and the Kettle Valley Recreation Area, and between Grand Forks and Christina Lake, where there was low to moderate incidence of infection.

Up to 40% of the foliage was infected on about 50% of the lodgepole pine in localized areas near Moyie Lake and Ram Creek, but near Plumbob Mountain more than 200 ha were affected.

Atropellis canker, Atropellis piniphila

Severe cankering occurred in nearly 20% of the lodgepole pine in a 1 ha understocked stand north of Riondel, and at least two trees were killed by this pathogen. This is an abnormally high incidence of the disease for such a site, since heavy infection is normally associated with overstocking. Elsewhere, 5% of lodgepole pine were affected in two EBAP[1] spaced stands east of Yahk. The environmental alterations of these stands, through spacing, should reduce the incidence of infection, providing there is no high infection source in immediately adjacent stands.

[1]Employment Bridging Assistance Program

Stalactiform blister rust, Cronartium coleosporioides

This blister rust infected 20% of the stems of young lodgepole pine over 2 ha near Sage Creek in the Flathead River Valley. Several pine up to one metre tall were killed as a result of stem girdling. Potential for spread is great in this predominantly pine area. Removal of infected trees and pruning of infected branches are the only practical means for controlling the spread.

SPRUCE PESTS

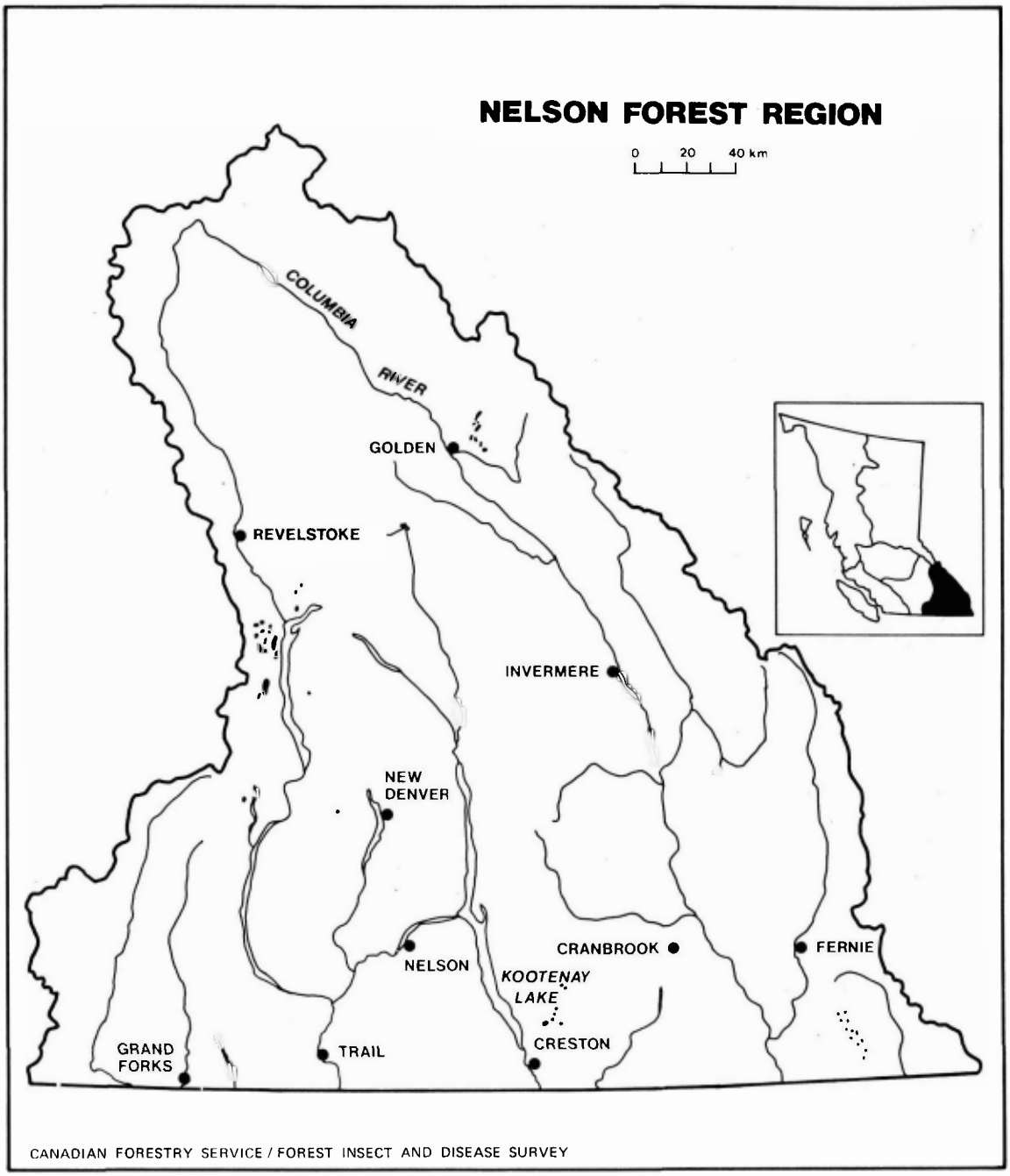
Spruce beetle, Dendroctonus rufipennis

Spruce beetle infestations in mature Engelmann spruce stands covered nearly 2 700 ha, down from 7 500 ha in 1982 (Map 4). Volume losses from the 1982 beetle attack, in 60 infestations mapped by aerial survey in 1983 were about 51 000 m^3, down from 216 000 m^3 in 1982 (Table 2). However, some of the reduction is a result of restricted aerial surveys which excluded an overflight of several high hazard areas recorded in 1982 in portions of the Kootenay Lake and Cranbrook TSAs.

TABLE 2. Timber Sale Area, number of infestations, area and volume of mature Engelmann spruce recently killed by spruce beetle. Nelson Forest Region, 1983.

TSA	No. Infest-	Area (ha)	Volume (m^3)[1] under attack	Red volume (m^3) 1982 attack	Current volume (m^3) 1983 attack
Cranbrook	4	120	23 500	1 200	700
Golden	6	50	12 250	620	400
Revelstoke	23	1 350	331 800	26 100	10 000
Kootenay Lake	22	450	121 800	6 700	3 700
Arrow	5	700	134 400	16 350	4 000
TOTAL	60	2 670	623 750	50 970	18 800

[1] Total spruce volume in infested area



Map 4

Spruce Beetle

Areas of recently killed spruce as determined by aerial surveys, 1983

Spruce mortality in the Revelstoke TSA generally declined, to a total of 1 250 ha, mapped during the limited aerial surveys. In the Pingston Creek drainage, 1 170 ha of mortality was mapped, down from 2 870 ha in 1982; of this total, 832 ha were light (less than 6% mortality), and 336 ha moderate (6-30% stand mortaltiy). Extensive salvage logging and host depletion contributed to the continuing decline of the infected spruce in the Pingston Creek drainage. A small 32 ha area of mortality was mapped near Arrowhead on Upper Arrow Lake, a continuation of a small infestation mapped for the first time in 1982. At Crawford Creek, north of Arrowhead, an additional 48 ha of mortality was mapped, up from 25 ha in 1982.

Infestations were reported to be declining at Frisby Ridge, Iron Bridge, Bench Road, Farm Creek and Tangier River, due mainly to successful lethal trap tree programs and continued salvage logging.

In the Arrow TSA, aerial surveys mapped 575 ha of mortality, up slightly from 553 ha in 1982. Of this total, 100 ha was light near Whatshan Lake, 430 ha moderate and 15 ha light near Vanstone Creek, just north of Fosthall Creek. Two small (15 ha) pockets of light mortality were noted on the east side of Upper Arrow Lake at Cariboo Creek and south of the Halfway River. At Plant Creek, 100 ha of mature spruce was killed prior to 1982.

In the Kootenay Lake TSA, epidemics declined to 450 ha in 22 areas from 830 ha in 1982. Most of the outbreaks north of Creston in Kianuko, Kamma and Skelly creeks appear to have peaked in 1981, with less than 5% 1982 attack observed this year. The north and south side of Summit Creek west of Creston where scattered pockets of infestation occurred in 1982, were not flown this year due to reduced aerial surveys. In the Duncan River infestation, first reported in 1982, ground surveys by BCMF identified nearly 100 ha in six areas requiring management action, four of which were in crown land and two in Glacier National Park, near the headwaters of the Beaver River. A trap tree program initiated in the fall of 1982 on provincial crown land, consisting of 100 non-lethal trap trees, absorbed a large flight of beetles in spring 1983. Between 1 and 17% of surrounding spruce trees were also attacked, thus prompting control measures in the form of sanitation logging of mature spruce to reduce spread potential. In addition, another 90-100 non-lethal trap trees were felled adjacent to the Park, with removal scheduled for 1984. Aerial surveys of the Duncan and Beaver rivers will receive a high priority in 1984 as the large mature spruce components identify these as high spruce beetle hazard areas.

Reflecting restricted aerial surveys in the Cranbrook TSA, only 120 ha of infestation were observed in 1983 as compared to 2 000 ha the previous year. However, no expansions were noted in most areas of previous attack and management action has addressed many of the problem areas, including the Lower Flathead Valley and the St. Mary River drainage system.

In the Golden TSA, the use of lethal and non-lethal trap trees in Glenogle Creek had mixed results in six infestations over 50 ha. The trap trees were generally successful, but some spillover into standing trees occurred, prompting additional logging in timber originally designated to be left standing. Elsewhere in the TSA, spruce beetle populations were light.

In the Invermere TSA, substantial spruce beetle populations in TFL 14 were contained in trap trees and right-of-way log decks in Caribou and McMurdo creeks. No current attack was observed in adjacent standing trees. Infested stems containing beetles and larvae were expected to be removed prior to beetle flight in 1984. As a preventative maintenance measure, additional trap trees were expected to be incorporated into the management plan for these areas. Only occasional low populations were encountered elsewhere in the TSA.

Yellowheaded spruce sawfly, Pikonema alaskensis

Sawflies defoliated 30 to 100% of single and groups of young Engelmann spruce up to four metres tall in a plantation near Morrissey, and roadside spruce near Fernie, Sparwood and Paterson. Two spot infestations at Sparwood and Paterson on private property were controlled with a commercial insecticide. Tree mortality or branch dieback is not expected, unless defoliation recurs in 1984.

Low numbers of sawflies were found elsewhere in the Nelson Region on Engelmann spruce.

Sirococcus shoot blight, Sirococcus strobilinus

A serious pathogen of container grown seedlings, the disease infected less than 1% of container spruce seedlings at the BCMOF nursery at Harrop. A BRAVO-BENLATE mix was applied as a treatment for the disease, and as a preventative against damping off disease, Botrytis cinerea.

The shoot blight was found in the fruiting stage on old spruce cones at Dry Creek, at the headwaters of the Duncan River, and at Monk Creek in the East Kootenay. These collections helped to clarify the disease's life cycle.

Snow moulds, Herpotrichia spp.

Snow moulds infected alpine-growing Engelmann spruce and lodgepole pine regeneration in four locations in the Region. Mortality of a few Engelmann spruce occurred in a localized area near the head of McMurdo Creek, and on 20% of lodgepole pine at Skookumchuck Lookout. In the West Kootenay light infection, confined to the lower branches of Engelmann spruce regeneration, occurred at two high elevation NSR sites. These fungi are of little economic significance, but may have some biological impact in maintaining stability of alpine sites.

WESTERN LARCH PESTS

Larch sawfly, Pristiphora erichsonii

Defoliation of western larch in the East Kootenay declined slightly to 10 400 ha from 12 000 ha in 1982 (Map 5), of which 1 000 ha was classified as severe, 4 100 as moderate, and 5 300 as light defoliation[1]. Defoliation ranged between 20 and 90%, but averaged about 60%, a reduction from the 70% estimated in 1982. In the Cranbrook TSA, the defoliated area declined between Sparwood and Elkford, and in portions of the Bull River, but increased between Elko and Fernie and north of Tie Lake, while remaining the same between Fernie and Sparwood and along Michel Creek.

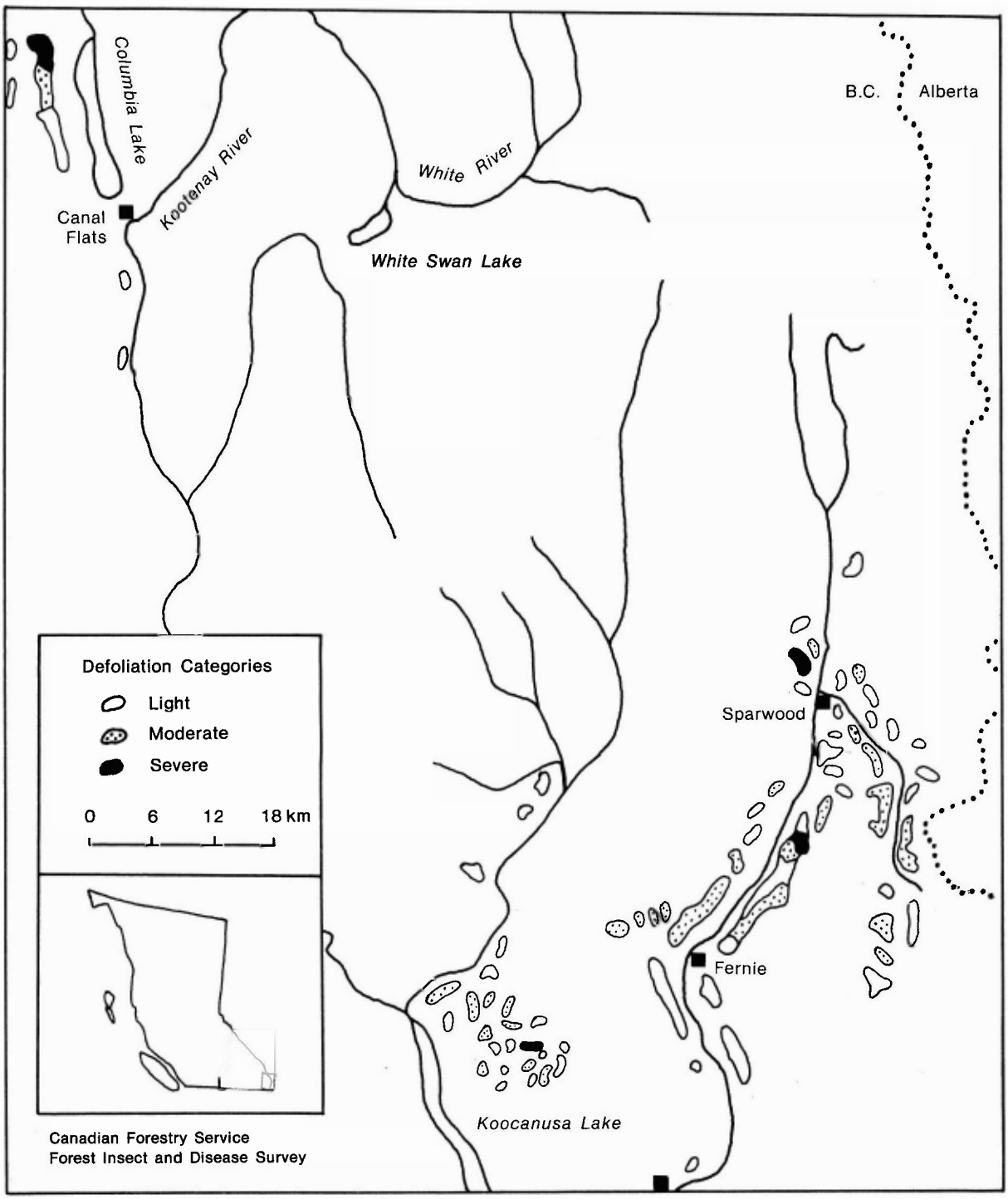
Nearly 2 200 ha were defoliated in the Invermere TSA, a threefold increase from 750 ha in 1982. Most defoliation was concentrated south of Dutch Creek on the west side of Columbia Lake with a few isolated pockets north of Whitetail Lake, and south of Findlay Creek. Defoliation of western larch by sawflies was often difficult to distinguish from that of larch budmoth, Zeiraphera improbana which occurred in the same areas, but defoliation by the budmoth was generally restricted to elevations above 1 200 m.

Overwintering cocoon assessments for parasitism and disease were made in September at five areas to determine population trends for 1984 (Table 3), from 1 000 cm^2 samples of duff, taken from beneath each of 10 defoliated trees in each area. Although rearing of cocoons was not complete at time of writing, preliminary observations, including x-rays of samples, indicate a general reduction of larval populations for 1984 in all areas examined with the exception of Michel Creek, where 95% of cocoons appeared healthy. Rodent predation, evident at Corbin and Hosmer, may also affect the overwintering population, resulting in reduced defoliation in 1984.

Table 3. Location and average percent defoliation of western larch and numbers of overwintering larvae in cocoons per 1 000 cm^2 of duff, Cranbrook and Invermere TSAs, Nelson Forest Region, 1983.

Location	Average defoliation (%)	No. healthy cocoons in 1 000 cm^2 of duff	% healthy cocoons
Corbin (Michel Cr.)	60	245	95
Fernie	60	45	60
Hosmer	70	40	50
Douglas Lake	80	109	50
Dutch Creek	45	32	45

[1] light - occasional branch defoliation
moderate - 1/3 or less of crown defoliated
severe - more than 1/3 of crown defoliated



Map 5

Larch Sawfly

Areas of defoliated western larch as determined by Aerial Surveys, 1983

Previous outbreaks of this western larch pest occurred in the Nelson Forest Region in the 1930's, 1940's, 1960's and most recently from 1976-80, when a maximum of 4 600 ha of larch was defoliated in 1978. Native parasites of larch sawfly, Mesoleius tenthredinus and Tripneptis klugii, and an introduced species Olesicampe benefactor plus weather conditions and predators contributed to the decline of these epidemics. Though repetitive defoliation may result in significant increment loss, no tree mortality has been recorded.

Larch casebearer, Coleophora laricella

After causing only light defoliation of western larch in a few localized pockets near Jaffray and Rykerts in 1982, light to moderate defoliation expanded to approximately 60 000 ha in the Jaffray, Elko, Koocanusa Lake and Gold Creek areas in 1983. Severe defoliation of up to 90% of small scattered groups of western larch occurred near Jaffray, Baynes Lake, on the west side of Koocanusa Lake, at Plumbob Creek and along the Gold Creek-Waldo Road. Elsewhere, light foliage discoloration occurred along Summit Creek, Rykerts and between Cranbrook and Moyie Lake. The most northerly range of larch casebearer in the Nelson Region was extended to Duncan Lake this year with the discovery of pupal cases on roadside regeneration. No appreciable defoliation was noted.

Pupal parasitism caused primarily by the introduced chalcid wasp, Chrysocharis laricinellae, averaged 5% from collection points at Rykerts, Summit Creek, and Baynes Lake; down from 12% in 1982. Due to this low incidence continued defoliation can be anticipated in 1984.

As part of a continuing biological control program, over 1 300 C. laricinellae adults, imported from Austria, were released at Jaffray, Koocanusa Lake and Slocan Lake. The decline of casebearer populations in the West Kootenay over the past two years has been attributed, in part, to this parasite.

Larch budmoth, Zeiraphera improbana

New outbreaks of the budmoth affected 6 600 ha of western larch in 36 widely scattered stands between 1 200 and 1 800 m elevation in the Region, of which 3 600 ha were lightly and 3 000 ha were moderately defoliated. The largest infestations occurred in the West Kootenay on 4 300 ha in 14 areas in the Kettle and Granby River drainages, near Grand Forks, and along the "Rossland Cut-off". Smaller infestations on 2 300 ha in the East Kootenay were observed on the west side of the valley between Invermere and Skookumchuck, along White River, and west of Kimberley along St. Mary River and White and Dewar creeks.

This is the fourth outbreak in the Region since first recorded in 1965 on 71 000 ha and the first in the East Kootenay since that date. The most recent infestation at Caribou and McDonald creeks in the West Kootenay collapsed in 1979, when larval parasitism affected 50% of the population.

Since larval feeding had virtually terminated by mid-May prior to its discovery, a biological assessment of the population was incomplete. Pheromone trapping of adults carried out for the first time near Skookumchuck and Dewar Creek, produced inconclusive results. Historical data indicates, however, that continued defoliation at reduced levels can be expected for at least one more year.

Larch needle diseases, Hypodermella laricis, Meria laricis

The incidence and intensity of H. laricis infections in western larch stands further declined in 1983 while M. laricis, last seen in 1981, reappeared in 1983.

Western larch was discolored by M. laricis for several kilometres south of Bridesville, where 35% of the crowns of 44% of immature stems were infected. West of Castlegar, 70% of young stems averaged less than 20% infection over approximately 5 ha. At Sheep Creek near Salmo, 100% of western larch averaged less than 10% infection over 10-15 ha. The disease also infected young larch at low levels at Memphis Creek and north of Rosebery on the east side of Slocan Lake.

The only stands of western larch infected by H. laricis in 1983 were scattered areas south of Rock Creek on the Canada-U.S. border, and a few isolated locations in the East Kootenay near Cranbrook and along the Kootenay River. Dwarf shoot mortality of young stems was 7.2% on young larch in a permanent sample plot 21 km west of Castlegar, where the disease was severe in 1981. The warm, dry weather during bud burst and early needle development allowed time for the waxy outer cuticle of the needles to thicken, which prevented penetration by the spores which are usually transferred by rain splash from old infected needles to new growth.

A damping-off disease, Fusarium oxysporum

This disease which infected less than 1% of the western larch seedlings at the B.C. Ministry of Forests Nursery at Harrop on the west arm of Kootenay Lake, was collected on western larch for the first time in B.C. This serious pathogen has the capacity to affect large numbers of seedlings in greenhouse and nursery environments.

A leader dieback, Sclerophoma semenospora

This parasitic fungus commonly associated with dieback of drought affected young Douglas-fir was collected for the first time on western larch, south of Rock Creek. Additional surveys will be made of this potentially damaging pathogen in 1984.

A conifer-aspen rust, Melampsora medusae

About 10% of the western larch needles over a 10-15 ha stand at Sheep Creek, near Salmo, were discolored by the rust. No significant effects are expected from this rust unless severe infections continue for several years. This rust, the alternate host of which are poplars, Populus spp., is also known to infect Douglas-fir and various native and exotic pines, and is capable of causing significant damage to conifer seedlings.

European larch canker, Lachnellula willkommii

Recently reported on tamarack in New Brunswick, Nova Scotia and Maine, this disease, if introduced to British Columbia, could have a significant impact on all age classes of western and alpine larches in the Nelson Region; it has to date not been found. A related fungus, probably L. occidentalis, infected single branches of western larch in Jim Smith Lake Provincial Park near Cranbrook, but it is a saprophyte and does not affect tree growth.

DOUGLAS-FIR PESTS

Douglas-fir tussock moth, Orgyia pseudotsugata

Aerial surveys by the British Columbia Ministry of Forests in August, mapped 2 275 ha of light to severe defoliation between Johnstone Creek Provincial Park, Rock Creek and Midway, and north towards Westbridge. Defoliation intensities were light[1] on 1 890 ha and moderate on 385 ha, up eightfold from 270 ha defoliated in 1982. Populations increased in the Rock Creek area before collapsing in late summer, while declining to endemic levels at Christina Lake Golf Course.

Nineteen single-strength pheromone traps (0.1% (z)-6-heneicosen-11-one) were placed at three sites in the Boundary Forest District (Table 4). The average number of male adults trapped at all three locations declined to less than one-half the number trapped in 1982.

[1] Light = 0-25% defoliation
Moderate = 26-65% defoliation
Severe = 66%+ defoliation

TABLE 4. Average number of male Douglas-fir tussock moth adults caught in pheromone traps at three locations, Nelson Forest Region, 1983.

Location	No. Traps	Avg. No. Male Adults Trapped
Christina Lake Golf Course	7	5.2, 0.2[1]
Eholt	5	0.2, 1.6[1]
Rock Creek	7	19

[1]Rusty tussock moth, Orgyia antiqua badia

Populations at Christina Lake Golf Course dropped to endemic levels, no new defoliation was recorded, down from 20 ha of defoliation in 1982.

A small localized infestation reported in the Trail area was identified through pheromone trapping as Orgyia antiqua badia, rusty tussock moth. This localized infestation is not expected to cause significant defoliation in 1984.

At Rock Creek, five standard beating samples within the infested area contained an average of 79 larvae (range 7 to 220) indicative of a high population. A single collection from the area in July was infected by nuclear polyhedrosis virus (N.P.V.). During fall surveys a further collection of dead and dessicated larvae found at the base of many defoliated Douglas-fir confirmed the infection by NPV. Egg mass surveys conducted by FIDS at three locations near Rock Creek were negative, as were surveys by B.C. Ministry of Forests personnel at six other locations in the Rock Creek area.

The absence of 1983 egg masses and low numbers of male adults in pheromone traps indicate that the Douglas-fir tussock moth epidemic in the Rock Creek area is declining, largely due to the naturally occurring nuclear polyhedrosis virus. Larval populations are not expected to be high in the Rock Creek area in 1984, and defoliation, if any, will not be as severe and widespread as in 1983, but confined to scattered pockets of light defoliation.

Western false hemlock looper, Nepytia freemani

After two successive years of increase, larval populations caused light defoliation of Douglas-fir on 110 ha in two areas in the Windermere Valley. Light defoliation, mostly of the upper crown,

occurred in scattered pockets on 30 ha south of Dry Gulch Creek, which included a Christmas tree production area on Indian Reserve Land near Invermere Airport, and on 80 ha along the Westside Road, 8 km north of Invermere. Trace defoliation was observed over an undetermined area near Lillian Lake, and in Invermere.

Nearly 25% of the population was affected by a nuclear polyhedrosis virus but cross contamination may be responsible for the high incidence of infection. The overwintering egg population on Douglas-fir branches was assessed on samples from south of Dry Gulch Creek collected by B.C. Ministry of Forests personnel. The average number of eggs per square metre of foliage, from two-50 cm branches from the mid-crown of each of ten trees per location, was 51, which indicates light[1] defoliation in 1984. When additional samples are processed a better forecast of defoliation intensity in the Invermere area in 1984 will be possible.

Careful monitoring of larval populations is recommended in Christmas tree growing areas, as defoliation can have a significant impact on the marketability of this product. Consideration for control action may be warranted in 1984 in areas identified as having a high defoliation hazard.

Western spruce budworm, Choristoneura occidentalis

Scattered Douglas-fir stands between Rock Creek and Anarchist Mt. were defoliated by the budworm for the sixth consecutive year. Defoliation of the current year's needles averaged 60%, up from 20% in 1982. The most severe defoliation occurred on young growth south of Johnstone Creek Provincial Park where up to 90% of the 1983 foliage was affected. An average of 28 larvae (range 1 to 140) were counted in nine standard beating samples between Rock Creek and Anarchist Mt. The highest number of larvae, 140, occurred at the west entrance to Johnstone Creek Provincial Park, this indicates possibly increased levels of defoliation in the park which will be monitored in 1984. Although defoliation intensity increased from 1982, the area remained about the same and major change is not expected in 1984.

Douglas-fir beetle, Dendroctonus pseudotsugae

The number of recent beetle-killed Douglas-fir increased in the East Kootenay in 1983, where small pockets of up to 50 trees each occurred along Wildhorse, Moyie, Lussier and Wigwam rivers, Bighorn and Lodgepoles creeks and at Harvey Pass. In Wickman Creek, where 20% of the Douglas-fir veteran component was attacked on 100+ ha, and

[1] <300 eggs per m^2 foliage - light defoliation
300-699 eggs per m^2 foliage - moderate defoliation
700+ eggs per m^2 foliage - severe defoliation

lodgepole pine is infested with mountain pine beetle, future management will favour the establishment of western larch.

At Christina Lake Golf Course in the West Kootenay, beetles attacked eight mature Douglas-fir defoliated by Douglas-fir tussock moth in 1981 and 1982. Two applications of Sevin insecticide were not fully successful in preventing the attacks, however, trees are scheduled for removal prior to beetle emergence in spring of 1984.

Rhabdocline needle cast, Rhabdocline pseudotsugae

Although widespread throughout Douglas-fir stands in the Nelson Region, infections were not as severe as in 1982. One notable exception was in a Christmas tree permit area near Skookumchuck, where severe infections rendered many Douglas-fir unsuitable as Christmas trees. Foliage infections averaged 30% of the needles on 75% of the immature Douglas-fir trees on 200+ ha along Ram and Roan creeks and along the Lussier River.

In the West Kootenay low incidence and intensity levels of the disease affected planted stock at Beartrap Creek near Duncan Lake, and at West Trail. North of Nakusp, 17% of the naturally regenerated Douglas-fir were lightly infected on a 10 ha site.

Some slight growth loss may occur as a result of infections, but no permanent damage is expected unless stands experience successive years of severe defoliation.

A Douglas-fir bud blight, Dichomera gemmicola

This bud blight killed and deformed buds and disfigured shoots of Douglas-fir in scattered areas throughout the host range in the East Kootenay (Table 5). There are indications that the disease occurs chiefly in areas where the host is not suited to the site.

TABLE 5. Location, area and degree of infection of Douglas-fir buds in the East Kootenay, Nelson Forest Region, 1983.

Location	Area (ha)	Incidence of Trees Infected (%)	Avg. Foliage Infection (%)
Sanca Creek	40	60	40
Bugaboo Creek	5	40	30
Split Creek	10	30	30
Premier Lake	4	90	30
Dutch Creek	1	100	40
Cedrus Creek	1+	80	50

The effect on the host varies with the degree and location of infection. The production of 'zigzag' or 'looping' branches is the most common kind of deformity. These are produced by the repeated killing of the terminal bud, which results in the dominance of a lateral. If this occurs to the leader, the tree has difficulty forming a conical shape.

Cooley spruce gall aphid, Adelges cooleyi

This native pest of spruce and Douglas-fir was common throughout the Nelson Region, particularly in plantations and on ornamental trees.

Near Howser and Retallack, galls were evident on nearly 100% of Engelmann spruce in two plantations. On Douglas-fir aphids infested 13% and 43% of natural and planted trees near Little Wilson Lake and Nakusp respectively.

Chlorosis of Douglas-fir foliage resulting from light to moderate populations of aphids occurred in Christmas tree production areas in scattered locations on the St. Mary Indian Reserve. After surveys for this pest were completed, a pestfree area was identified, from which trees were obtained for certification and subsequent export to Malaysia and Japan.

A canker disease, Sclerophoma pithyophila and associated environmental problems

Douglas-fir in a plantation at Hamling Creek near Little Wilson Lake were infected by the canker disease associated with moisture stress, which caused lateral and terminal shoot dieback on 68% of the

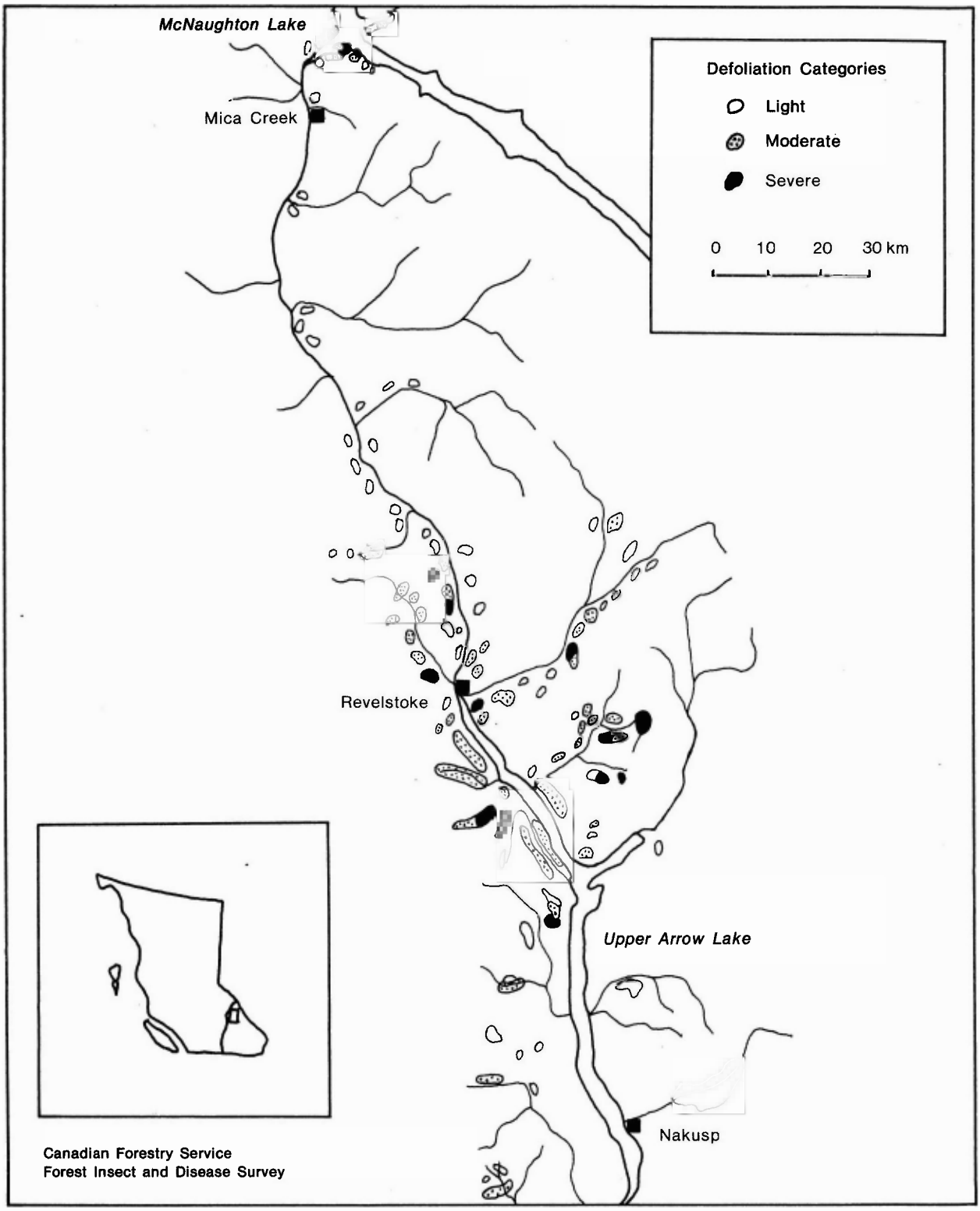
trees. Other problems were dead tops, multiple leaders and generally poor form and vigor. Environmental conditions such as sunscald, moisture stress and snow breakage, appear to be associated with these other problems.

Moisture stress and associated sunscald caused leader dieback on 8% of the planted 15-year-old Douglas-fir on a 15 ha rehabilitated coal mining site at Sparwood. This condition was probably initiated by the combination of intense heat from direct sun rays causing heat lesions, and heat absorption by the black overburden which resulted in moisture stress and subsequent topkill. To fully identify this problem, further assessments will be made in 1984.

WESTERN HEMLOCK PESTS

Western hemlock looper, Lambdina f. lugubrosa

Western hemlock looper infestations expanded for the second year, and the area defoliated increased to 32 000 ha, a fourfold increase from the 8 000 ha defoliated in 1982. Light to severely defoliated stands were mapped in 144 separate infestations from Fife Creek near Whatshan Lake in the southern portions of the outbreak, in the Columbia River Valley and north to Canoe Reach on McNaughton Lake.



Map 6

Western Hemlock Looper

Areas of defoliated Western Hemlock and Western Red Cedar as determined by aerial surveys, 1983

TABLE 6. Location, area, and defoliation intensity of western hemlock and western red cedar by western hemlock looper, Nelson Forest Region, 1983.

TSA/National Park	Area & Defoliation Class[1] Light (ha)	Moderate (ha)	Severe (ha)	Total
REVELSTOKE TSA				
Potlatch Cr.	640	320		960
Mica Dam - Mica Cr.	575			575
Bigmouth Cr. - Goldstream R.	830			830
Liberty-Downie Cr.	640			640
Bourne Cr. - Eighteen Mile Rapids	130			130
Big Eddy-Frisby Cr.	1 025	385		1 410
LaForme-Sale Cr.	190			190
Martha-St. Cyr Cr.	130	385	450	965
Steamboat Rapids	320	65		385
Jordan R.		1 920	700	2 620
Albert-E. Twin Cr.		385	255	640
Tangier R.	130	130		260
Illecillewaet R.	190	190		380
Greely Cr.-Revelstoke	15	1 535	240	1 790
Mulvehill-Begbie Cr.		1 310	365	1 675
Cranberry-Blanket Cr.	370	2 015	100	2 485
Shelter Bay	465	430	270	1 165
Pingston-Ledge Cr.	960			960
Akolkolex-Crawford Cr.	225	1 840	510	2 575
Arrowhead	130	145		275
ARROW TSA				
Thompson Cr.	50			50
Plant-Fosthall Cr.	865	370		1 235
Rioulx-Cusson Cr.	225			225
Whatshan Lk.	255	320		575
Halfway R.	750			750
Kuskanax Cr.	4 250			4 250
GOLDEN TSA				
Canoe Reach-Wood Arm	1 215	830		2 045
Ellow Cr.-Red Rock Hbr.	320	515	130	965
Red Rock Peninsula		320	130	450
MT. REVELSTOKE NATIONAL PARK				
Little Dalles Canyon		320		320

...

TABLE 6 continued..

TSA/National Park	Area & Defoliation Class[1] Light (ha)	Moderate (ha)	Severe (ha)	Total
GLACIER NATIONAL PARK				
Illecillewaet R.	255			255
TOTAL	15 150	13 730	3 150	32 030

[1]Defoliation was defined as follows: light - discolored foliage barely visible from the air, some branch tips and upper crown defoliation; moderate - pronounced discoloration, noticeably thin foliage, top third of many trees severely defoliated, some completely stipped; severe - bare branch tips and completely defoliated tops, most trees more than 50% defoliated.

An average of 96 larvae (range 1 to 300) were collected in 21 standard beating samples from Mosquito Creek near the south end of Upper Arrow Lake to Bigmouth Creek near Mica Dam. In a pupal trapping experiment carried out near Cranberry Creek, south of Revelstoke, about 10 000 pupae were collected from 27 mature western hemlock. Pupal parasitism was found to be 8.6%, with 8.3% being Dipterous parasites and 0.3% Hymenopterous parasites.

Egg samples were collected in late September, to determine the number and viability of overwintering eggs and to forecast larval population trends and subsequent defoliation for 1984. Ten 100 gram samples of 'old mans beard' lichen were collected at each of three areas: Redrock Peninsula, Begbie Creek and Cranberry Creek. Following extraction by a hot water vacuum process, eggs were counted and evaluated (Table 7). The number of healthy eggs indicate moderate defoliation in 1984 at Cranberry Creek and severe defoliation at Begbie Creek and Redrock Peninsula.

TABLE 7. Location, condition, and average number of eggs from ten 100 gram samples per location, Nelson Forest Region, 1983.

Location	Healthy	Parasitized	Infertile	Old	TOTAL	Predicted Defoliation[1]
Redrock Peninsula	219.6	68.3	68.6	201.7	558.2	S
Begbie Creek	92.1	36.6	70.3	105.5	304.5	S
Cranberry Creek	56.2	28.9	22.8	48.9	156.8	M

[1]Light defoliation (L) - 5-26 healthy eggs per 100 g lichen
Moderate defoliation (M) - 27-59 healthy eggs per 100 g lichen
Severe defoliation (S) - 60+ healthy eggs per 100 g lichen

The defoliation estimates could, however, be affected by the increase in the average percent of parasitized eggs, as related to healthy eggs, which increased from 0.6% in 1982 to 29% in 1983, while the average number of healthy eggs per location decreased particularly at Begbie Creek. Previous hemlock looper infestations in the Nelson Region have collapsed after 2-3 years consecutive defoliation (1937-39; 1973-75) and this is the second year of recorded defoliation; also, a larval disease, Entomophthora spp., was found on about 1% of the larvae in the Cranberry Creek area. These factors could contribute to a population decline or collapse.

Western blackheaded budworm, Acleris gloverana

Defoliation of western hemlock by the budworm averaged about 20% on 120 ha along Bostock Creek in Glacier National Park. Larval populations had been increasing in this area for the past three years. A single standard beating sample contained 290 larvae, up from 120 in 1982. Defoliation of old growth foliage caused by conifer sawflies accounted for perhaps one-third of total feeding damage.

Some light defoliation of new growth of alpine fir and Engelmann spruce occurred along Dewar Creek, where similar levels were recorded in 1982.

Since no disease or parasitism was noted in populations from either area, there is potential for increased defoliation in 1984. No lasting adverse effects such as topkill or tree mortality is expected from this year's or next year's defoliation.

Green-striped forest looper, Melanolophia imitata

There was an average of seven larvae (range 0-35) in 17 of 23 standard beating samples in the area of western hemlock looper infestation in the Columbia River Valley, up from an average of one in

1982. A larval disease, Entomophthora spp., infected about 10% of the larvae collected at Wilson Creek but the effect on the overall population is not presently known. Further monitoring of populations will continue in 1984.

Conifer sawflies, Neodiprion spp.

Larvae were most evident in association with high western hemlock looper populations in outbreak areas in the Columbia River Valley near Revelstoke. About 50% of the standard beating samples from western hemlock were positive, and averaged 18 larvae each. Light defoliation (10+%) of year-old foliage occurred at Quartz and Upper Koch creeks where samples contained 138 and 195 larvae respectively. Elsewhere in the Region, populations were low in western hemlock and Douglas-fir stands with only 1 or 2 larvae per sample.

ALPINE FIR PESTS

Western balsam bark beetle complex, Dryocoetes confusus, Ceratocystis dryocoetidis

This beetle pest and its associated blue stain fungus kills significant numbers of mature high elevation alpine fir stands in many areas of the Region. Due to restricted aerial surveys in 1983, however, overflights of many chronic infestation areas were not completed. Only 10 infestations were mapped over about 150 ha, the majority of which were along the Upper Blaeberry River. Elsewhere infestations were small, with between 5 and 20 trees each in widely scattered areas. The beetle rarely attacks more than 10 trees/ha in one year.

Studies have shown that approximately 35% of alpine fir mortality is due to direct attack by the beetle, the remainder being attributed to the beetle-induced, lesion-causing fungus C. dryocoetidis. Little is known, however, about Armillaria root rot, Armillaria mellea, and its possible association with balsam bark beetle attack of alpine fir. Due to the increasing emphasis by the forest industry and B.C. Ministry of Forests on alpine fir, and because of gaps in the knowledge of the insect/disease complex and association with root rot, a ground survey is planned in 1984 of several infested stands, including TFL 14 along the Spillimacheen River.

Two-year-cycle spruce budworm, Choristoneura biennis

Infestations of two-year-cycle spruce budworm expanded to 1 200 ha of light and 800 ha of moderate defoliation in 12 high elevation mature alpine fir-spruce stands in 1983, up from only 200+ ha of light defoliation in 1982.

Up to 100% of the new growth was defoliated on 250 ha along the south fork of Bugaboo Creek in the East Kootenay. Defoliation of new

growth averaged 70% in stands along Redding and Baker creeks west of Kimberley, where noticeable feeding damage was also recorded in 1982. Three localized areas of light defoliation were recorded along Dewar Creek.

Aerial surveys in the West Kootenay identified moderate defoliation on 500 ha of high elevation alpine fir-spruce along Fosthall and South Fosthall creeks and 350 ha of light defoliation along Cusson Creek. This is the first record of budworm damage in this area of the West Kootenay. One area of light defoliation was also observed in adjacent Kamloops Region near the headwaters of Cherry Creek.

Since most of the feeding was confined to 1983 foliage, tree mortality is not expected, but some bud-kill may occur in areas such as Baker and Redding creeks, where there have been two or three consecutive years of budworm feeding.

Fir-fireweed rust, Pucciniastrum epilobii

Fir-fireweed rust infected up to 50% of all alpine fir on two 60 ha high elevation NSR (Not Satisfactorily Restocked) sites examined at Hicks and Baerg creeks in the West Kootenay. No long term damage is expected unless severe infections continue for several years. This rust also infected mature alpine fir at Dry Creek near Shelter Bay. However, the incidence and intensity was low with only a few needles on the lower branches infected.

The rust was common along Cabin Creek Pass in the East Kootenay, where 10% of needles were infected on 90% of all age-classes of alpine fir on 100+ ha.

WESTERN RED CEDAR PESTS

Cedar leaf blight, Didymascella thujina

For the second consecutive year, most of the western red cedar were up to 50% discolored by the leaf blight in the wet belt area between New Denver and Kaslo. Moderate (35%) foliage infection occurred in a mixed cedar stand on about 20 ha in Mt. Fernie Provincial Park, resulting in premature leaf drop.

The black fruiting bodies on the underside of the needles serve to distinguish this disease from 'cedar flagging' which lacks fruiting structures and was also common throughout the wet belt cedar stands. The leaf blight does not cause any permanent damage to trees, but may affect increment growth if severe for several years.

DECIDUOUS TREE PESTS

Birch leaf skeletonizer, Bucculatrix canadensisella

White birch stands in and around Trail, and on the east side of the Columbia River north to Genelle were discolored for the second consecutive year by the skeletonizer. Approximately 500 ha were affected, down from 2 000 ha in 1982. At West Trail the upper third of the crown on 30% of the trees were skeletonized. At Sunningdale, 100% of the foliage was affected, with 50% or more of the leaf area skeletonized.

Fume Damage

Foliar browning of deciduous and conifer species by sulphur dioxide fumes from industrial emissions was almost nonexistent in 1983. A few birch scattered over several hectares above West Trail exhibited light fume damage, with some minor tip scorching of lodgepole and ponderosa pine needles.

Birch leafminer, Lyonetia saliciella

As in previous years this leaf miner discolored up to 80% of the foliage of birches along the Columbia River from Radium to Golden, west into Glacier National Park, along the Blaeberry River and along the Kickinghorse River east to the Beaverfoot River. Foliage discoloration of up to 100% was common on birches in scattered patches along Driftwood, Bugaboo and Bobbie Burns creeks, and the Spillimacheen River Valley. After 10 consecutive years of infestation, however, no lasting adverse affects such as topkill or dieback were noted.

Satin moth, Leucoma salicis

Satin moth larvae totally defoliated 60% of the mature and undergrowth black cottonwood and some ornamental willows on five hectares at Moyie. Although defoliation was severe, most of the trees had refoliated by mid-August. Apart from one larval collection from Invermere in 1982, this is the first record of defoliation in the East Kootenay portion of the Region since first found at Needles in 1963.

A large moth flight was reported from the Rock Creek area but no defoliation was observed.

Aspen leafminer, Phyllocnistis populiella

Foliar discoloration by leafminer affected up to 100% of the trembling aspen stands for approximately five km along Highway 3 near Eholt, and for two km along the Phoenix Mountain road. No long term damage is expected unless severe infestation levels continue for several years. Discolored trembling aspen and black cottonwood was also visible for several km south of Revelstoke towards the Akolkolex River,

and together with a leaf roller Compsolechia niveopulvella, on aspen between Hills and Summit Lake.

Fall webworm, Hyphantria cunea

Tents and light defoliation caused by fall webworm were visible on roadside shrubs, such as chokecherry, willow, elderberry, cottonwood and occasionally fruit trees from Christina Lake to Bridesville, Sanca Creek to Creston and between Bull River and Wardner. No long term damage is expected from defoliation by this common and highly visible pest.

Mourningcloak butterfly, Nymphalis antiopa

Occasional defoliation of roadside willows in and around New Denver initiated several enquiries from local residents. Individual branches were stripped by this colonial feeder on a single black cottonwood in New Denver and a white birch in Revelstoke. Large numbers of Nymphalis j. albun butterflies were seen between New Denver and Summit Lake, and near Howser, but larvae were not collected or reported from these areas.

A poplar shoot blight, Venturia macularis

Discoloration of up to 100% of the trembling aspen was common throughout the Kootenay Region, but was usually confined to single trees or small groves in the following areas: between Parson and Nicholson, Greenwood and Grand Forks, Hills and Summit Lake, Paulson Bridge and Christina Lake, Trail and Nelson, and south of Revelstoke on the east side of Upper Arrow Lake. Despite the severity of infections, less than 10% top dieback occurred in any area.

Shot hole of aspen, Ciborinia whetzelii

Leaf spots were common on 100% of the trembling aspen on 10 ha near Morrissey and on 20 ha along Lodgepole Creek, and affected up to 50% of the foliage. The characteristic 'shot hole' effect, produced when the circular spots of dead tissue fall out leaving holes, is usually not important unless defoliation occurs and is repeated for several successive seasons.

Poplar and willow borer, Cryptorhynchus lapathi

Poplar and willow borers killed approximately 20% of the small willows on 200+ ha in a large burn along the Blackwater Creek Rd. This reduction of the willow component appears silviculturally beneficial in restricting competition for planted and natural conifers.

MULTIPLE HOST PESTS

Cone and Seed Insects

Cone crops on Douglas-fir and Engelmann spruce in the Nelson Region, were generally light to moderate. Insects infected 44% of 650 Douglas-fir cones examined from 13 areas in the Region. The most commonly found insect was the Douglas-fir cone moth, Barbara colfaxiana, which infested 32% of the cones. Other common but less damaging pests were: Douglas-fir cone gall midge, Contarinia oregonensis, infested 20%; Douglas-fir coneworm, Dioryctria abietivorella, 20%; Douglas-fir seed wasp, Megastigmus spermotrophus, 20%, and Douglas-fir cone scale midge, Contarinia washingtonensis, 8%.

A spiral spruce-cone borer, Hylemya anthracina, and a cone worm Dioryctria sp. were the only insects which infested 20% of the Engelmann spruce cones from two locations.

Control of cone insects in most natural stands is not practical even though there is a need for seed from these areas. Preventive measures against damage are possible and practical only in limited areas such as seed orchards and designated seed production areas.

Micro-nutrient Deficiencies

Micro-nutrient deficiences causing elongated, chlorotic and otherwise deformed needles affected a variety of hosts in several areas. Douglas-fir regeneration at Hicks Creek, an NSR area of approximately 60 ha northeast of Rosebery, exhibited limp, droopy leaders and elongated foliage caused by a suspected potassium and/or magnesium deficiency. A dieback condition caused by boron deficiency affected Douglas-fir seedlings at Beartrap Creek, near the north end of Duncan Lake. A suspected magnesium deficiency affected lodgepole and western white pine natural regeneration exhibiting chlorosis in a 10 ha area north of Nakusp.

Herbicide Damage

At Christina Lake Provincial Park, approximately one-half of planted Douglas-fir, lodgepole pine and western larch exhibited chlorotic and red foliage, symptoms that were confirmed as herbicide damage. The parking lot area was sprayed with TORDON in June 1982 to combat the spread of Knapweed, and it appeared that some herbicide drift did occur. It is suspected that mortality of severely affected trees could result from the drift. Environmental conditions such as heat or drought could also affect the chances of survival of lightly damaged trees.

Gypsy moth, Lymantria dispar

Gypsy moth pheromone baited traps have been placed singly in provincial parks in the Region each year since 1975 to monitor gypsy moth populations. No moths were trapped at any of the 30 parks in which traps were located in 1983. Visitors frequenting parks from outside the Region are considered the primary vector responsible for the migration of this insect. Gypsy moth is a major pest of deciduous trees and some conifers in eastern Canada and parts of the USA, including Washington State.

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