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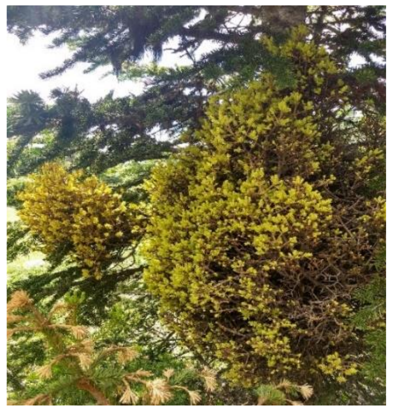

B.C. Southern Interior Conditions Report for 2023

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INTRODUCTION

This report summarizes the results of the 2023 Aerial Overview Surveys, forest health operations, special surveys and research projects conducted in the southern interior of British Columbia, covering the Cariboo, Thompson Okanagan and Kootenay Boundary Regions. The Aerial Overview Survey is performed annually by the B.C. Ministry of Forests and details forest damage due to bark beetles, defoliators, and other visible forest health factors, such as foliar diseases and abiotic damage. Surveys were carried out using the standardized Provincial Aerial Overview Survey protocols (*http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/aerial-overview-surveys/methods*). Polygons are used to record larger areas of continuous damage and are assigned severity ratings as described in Table 1. Spots are used to record small, discrete groups of affected trees.

Table 1. Severity ratings used in the Aerial Overview Surveys.

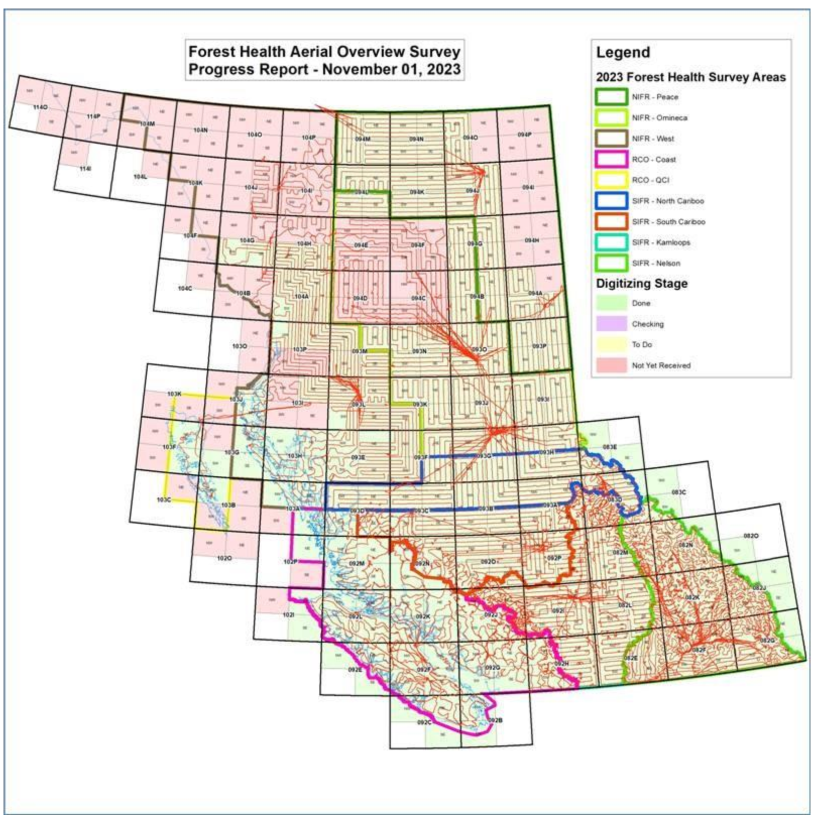
Disturbance Type	**Severity Class**	**Description**
Tree mortality	Trace	<1% of trees in the stand recently killed
(including bark beetles, abiotic factors, and animal damage)	Light	1-10% of trees in the stand recently killed
	Moderate	11-29% of trees in the stand recently killed
	Severe	30-49% of trees in the stand recently killed
	Very Severe	50%+ of trees in the stand recently killed
Defoliation*	Light	Some branch tip and upper crown defoliation, barely visible from the air.
(including defoliating insect and foliar disease damage)	Moderate	Thin foliage, top third of many trees severely defoliated, some completely stripped
	Severe	Bare branch tips and completely defoliated tops, most trees sustaining >50% total defoliation
Decline Syndromes	Light	Decline with no mortality - the first detectable stage, characterized by thin crowns and no individuals without visible foliage
	Moderate	Decline with light to moderate mortality. Thin crowns are accompanied by individuals devoid of foliage. Greater than an estimated 50% of individuals have some foliage.
	Severe	Decline with heavy mortality - crowns are very thin and greater than 50% of standing stems are devoid of foliage.

* Serpentine leafminer defoliation is rated according to the percentage of trees in the stand that are affected, based on tree mortality classes.

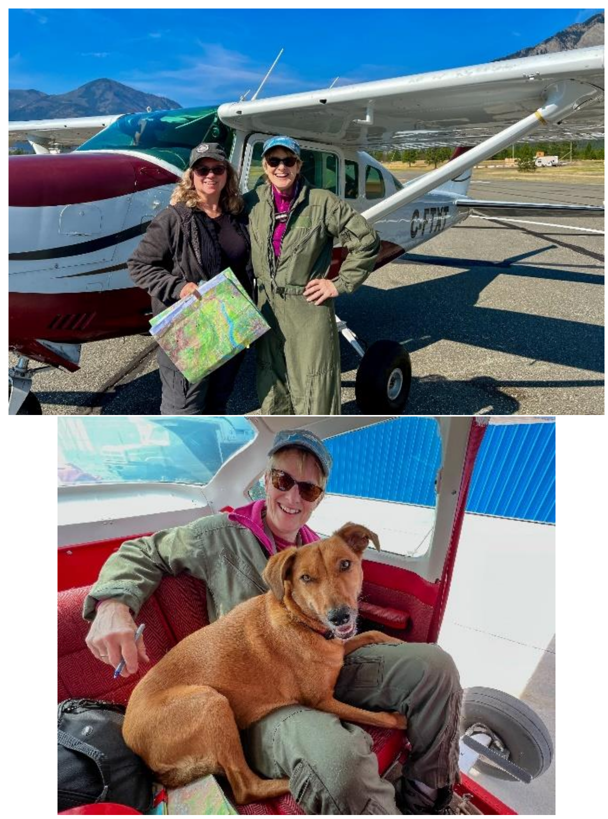
The 2023 surveys were completed between July 5th and October 13th (Table 2). Flying conditions were challenging in 2023 due to many wildfires burning in the south, making for smoky skies and restricted flying zones. A total of 344.9 hours of fixed-wing aircraft flying time over 65 days were required to complete the surveys, covering all areas within the Cariboo (CAR), Thompson Okanagan (TOR), and Kootenay Boundary (KBR) Natural Resource Regions. These three Regions cover more than 25 million hectares, of which over 15 million hectares are forested.

Table 2. Aerial overview mapping was conducted by trained contractors in the three Regions as follows:

Region	Start-end dates flown in 2023	Mappers	Aircraft	# Days	# Hours	Contractor company
CAR - South	July 20 - Oct 13	Barbara Zimonick, Karen Baleshta	Cariboo Air Ltd., Cessna-182	14	45.8	Zimonick Enterprises
CAR - North	July 5 - Oct 6	Nathan Atkinson, Tom Foy, Barry Mills	Guardian Air, Cessna-182	13	104.0	Industrial Forestry Service Ltd.
KBR	July 14 - Sep 16	Neil Emery, Adam O'Grady, Jason Lessard	Babin Air, Cessna 337	24	115.0	Nazca Consulting
TOR	July 20 - Sep 22	Barbara Zimonick, Karen Baleshta	Fort Langley Air Ltd., Cessna U206G	14	80.1	Zimonick Enterprises
Total				**65**	**344.9**	



Flight lines of aerial overview aircraft and mappers (right).



Barbara Zimonick, Karen Baleshta and friend

South Area Summary of Mapped Damage Agents

Twenty-one unique damage agents were mapped during the 2023 surveys, compared to 28 in 2022, affecting approximately 1,167,099 hectares over 15 TSAs (including the Cascadia TSA near Revelstoke). Damage caused by agents such as drought or fire was counted as one unique damage agent, although they were recorded in separate categories (e.g. drought causing mortality; drought causing only foliar symptoms). A new damage code for woodborers (NDW) was added in 2023 to reflect the complex of drought, heat and woodborer damage observed throughout the southern interior. Damage mapped in 2023 increased by 632,105 hectares from 2022, representing a 54% increase (Table 3). A significant proportion of the 2023 increase in damage recorded was due to wildfire activity (303,477 ha burned), drought (261,940 ha affected) and western spruce budworm (285,039 ha defoliated) (Table 3; Figure 1).

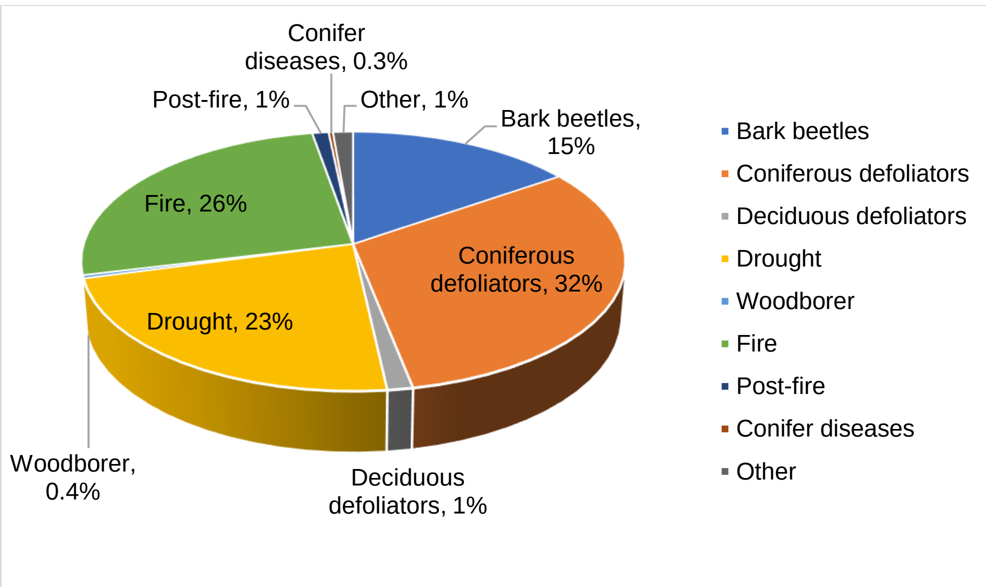


Figure 1. Proportion of hectares damaged in southern B.C. in 2023 by major biotic and abiotic agents.

Drought damage

Wildfire

Total area affected by bark beetles declined by 112,364 ha to 178,986 ha damaged, representing a 39% decrease. All four major bark beetles (Douglas-fir beetle, spruce beetle, mountain pine beetle, and western balsam bark beetle) experienced a decline in hectares affected (Figure 2). Western balsam bark beetle remained the most prevalent bark beetle, affecting 126,330 ha over the three regions; however, the majority of the area affected was mapped as trace (<1% of trees in the stand recently killed). The total area affected by western balsam bark beetle declined by 25% from 2022, with 9 TSAs declining and 5 TSAs increasing in ha affected. All TSAs in the Thompson Okanagan Region saw an increase in western balsam bark beetle activity, increasing from 63,687 ha in 2022 to 74,280 ha in 2023. Kamloops TSA had the highest level of western bark beetle infestation, with 30,714 ha recorded. The Arrow TSA in the Kootenay Boundary Region was the only other TSA recording an increase in infestations. Spruce beetle infestations declined by 90% from 32,773 ha affected in 2022 to 3,259 ha in 2023. Only the Arrow, Golden and Okanagan TSAs saw very small increases in spruce beetle activity. Douglas-fir beetle saw a 69% decline in 2023, with only 16,003 ha affected, compared to 45,092 ha in 2022. Of the 14 TSAs recording Douglas-fir beetle activity, only two TSAs (Quesnel and Revelstoke) did not decline in 2023. Although the total area affected by mountain pine beetle declined in the southern interior, from 44,999 ha in 2022 to 33,394 ha in 2023, areas in the Kootenay Boundary Region saw increased activity in 6 TSAs.

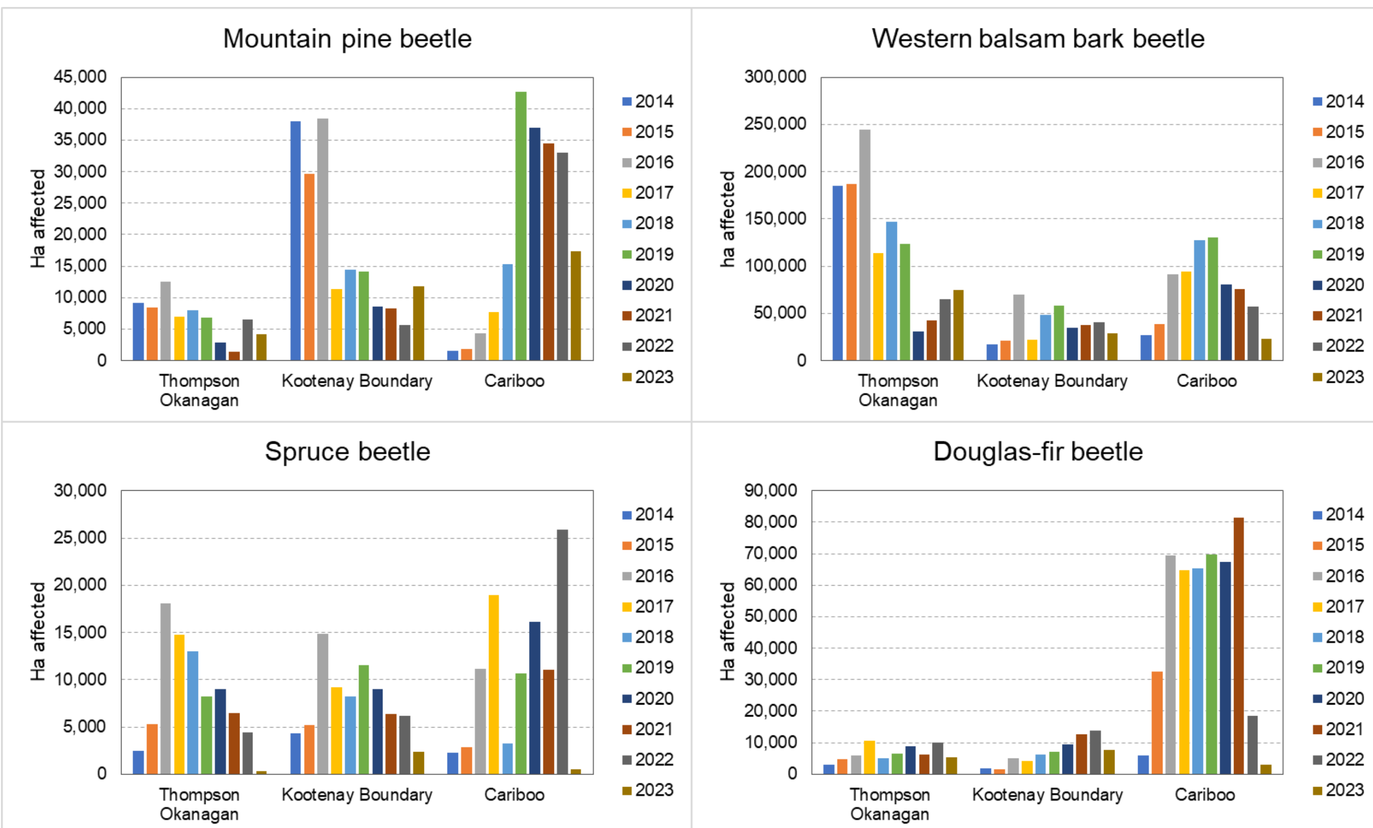


Figure 2. Hectares affected by the four major bark beetles in the south area over the past 10 years.

Damage caused by insect defoliators increased by 159,066 ha in 2023, mainly due to a doubling in the area affected by western spruce budworm and a substantial increase in area defoliated by the western hemlock looper complex. Many hemlock areas with mapped defoliation could not be ground checked, so it is assumed that the damage was caused by a complex of defoliators, including loopers, sawflies and budworm.

Western spruce budworm infestations expanded significantly in Kamloops, Merritt and Lillooet TSAs in 2023 (Table 3). Aspen serpentine leafminer continued to decline, with only 15,607 ha defoliated. The Arrow, Cranbrook and Kootenay Lake TSAs saw very slight increases in area defoliated. Williams Lake and Kamloops TSAs had the most defoliation, with just over 3,000 ha mapped in each TSA. Balsam woolly adelgid damage was mapped on 0.25 ha in the 100 Mile House TSA.

Western balsam bark beetle damage

Western spruce budworm defoliation

Drought and drought related damage comprised 23% of all damage recorded in the southern interior in 2023, affecting multiple species and age classes of trees and stands. Foliar damage was the most prevalent symptom observed, affecting 261,940 ha. Mortality due to drought affected 877 ha. A new phenomenon of woodborer-caused mortality was observed in 2023, affecting mature and immature stands, over 4,631 ha. Several species were infested and killed by woodborer including Douglas-fir, lodgepole and ponderosa pine, and western larch. However, much of the woodborer-caused mortality was not captured by the aerial overview surveys since the affected trees dropped their needles within the year of attack or was not distinguishable from old Douglas-fir beetle mortality. Wildfires dominated southern interior landscapes in 2023, burning over 303,477 ha in 14 TSAs. Okanagan TSA (84,644 ha), Kamloops TSA (66,910 ha), Lillooet TSA (40,234 ha), Williams Lake TSA (37,392 ha) and Quesnel TSA (22,760 ha) suffered the highest losses due to fire. Post-fire mortality was mapped on 12, 912 ha.

Drought damage to lodgepole pine north of Kamloops

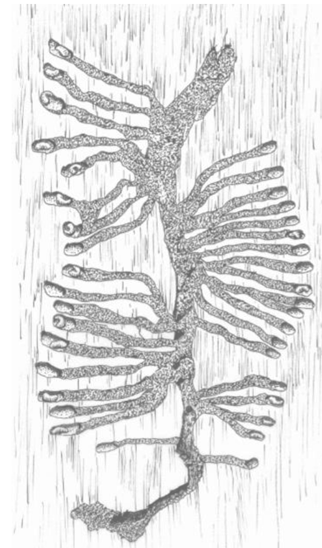
Other miscellaneous damage was mapped, including aspen decline, cedar flagging, flooding, slides, and windthrow (Table 3) over 15,350 ha. Small amounts of bear damage (90 ha) were recorded in 8 TSAs.

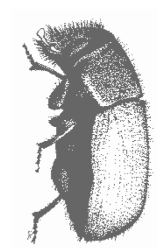
Very little foliar disease damage was observed in 2023, with larch needle blight and white pine blister rust affecting 3,295 ha and 43 ha, respectively.

2023 wildfire – Lillooet area

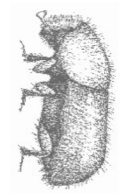
Table 3. Area affected (sum of spots and patches) by damaging agents in the southern interior in 2023. 189 ha of unknown conifer defoliation was recorded in the Lillooet TSA (not included in this table).

Timber Supply Area and Damaging Agent	**Area of infestation (ha)**				
	Trace	**Light**	**Moderate**	**Severe**	**Total**
Douglas-fir beetle					
100 Mile House TSA	901	42		271	1,214
Quesnel TSA				12	12
Williams Lake TSA	437	1,080	15	202	1,733
Arrow TSA	393	558	175	49	1,174
Boundary TSA	150	417		15	583
Cranbrook TSA	206	1,516	1,017	47	2,786
Golden TSA	180	330	383	15	909
Invermere TSA	297	272	544	48	1,160
Kootenay Lake TSA	186	526	105	36	852
Revelstoke TSA		86	218	8	312
Kamloops TSA	1,209	222		140	1,571
Lillooet TSA		10	4	16	30
Merritt TSA	116		3,041	20	3,177
Okanagan TSA	245	91	31	121	489
Total	**4,320**	**5,151**	**5,532**	**999**	**16,003**
Spruce beetle					
Quesnel TSA	311			15	325
Williams Lake TSA	173			12	185
Arrow TSA	17	200		1	218
Cranbrook TSA	72	332	151	5	561
Golden TSA	101	422	218	2	743
Invermere TSA	48	185	521	104	858
Kootenay Lake TSA		17		0	17
Kamloops TSA	46				46
Lillooet TSA	240		15	1	256
Okanagan TSA	24	25		1	49
Total	**1,033**	**1,181**	**905**	**140**	**3,259**
Mountain pine beetle					
Quesnel TSA				1	1
Williams Lake TSA	16,937	357	8	16	17,317
Arrow TSA	140	256	53	5	454
Boundary TSA	16	78	464	8	565
Cranbrook TSA	978	1,408	2,078	453	4,916
Golden TSA		9		2	11
Invermere TSA	935	1,694	1,836	121	4,585
Kootenay Lake TSA	158	544	541	70	1,313
Revelstoke TSA				1	1
Lillooet TSA	3,851	354		27	4,231
Total	**23,015**	**4,699**	**4,979**	**701**	**33,394**





Timber Supply Area	Area of infestation (ha)				
and Damaging Agent	Trace	Light	Moderate	Severe	Total
Western balsam bark beetle					
100 Mile House TSA	135			19	154
Quesnel TSA	5,288	64		63	5,415
Williams Lake TSA	16,229	1,053		79	17,362
Arrow TSA	1,034	1,211		15	2,261
Boundary TSA	149	299		7	455
Cranbrook TSA	3,253	3,733	290	24	7,301
Golden TSA	3,114	2,166	17	4	5,300
Invermere TSA	6,273	3,700	1,121	13	11,108
Kootenay Lake TSA	1,569	850		11	2,430
Revelstoke TSA	235	29		1	265
Kamloops TSA	30,261	267	3	183	30,714
Lillooet TSA	10,923	469	14	109	11,516
Merritt TSA	9,464	117	8	41	9,630
Okanagan TSA	22,237	71		112	22,420
Total	**110,167**	**14,030**	**1,454**	**680**	**126,330**
Red turpentine beetle					
Kamloops TSA				1	1
Total	**0**	**0**	**0**	**1**	**1**
Western spruce budworm					
100 Mile House TSA	2,035	7,842	27,297	1	37,175
Quesnel TSA		1,211			1,211
Williams Lake TSA		34,766			34,766
Kamloops TSA		12,913	35,502	1	48,416
Lillooet TSA		5,269	26,126	351	31,746
Merritt TSA		59,629	70,658	1,150	131,436
Okanagan TSA			289		289
Total	**2,035**	**121,631**	**159,871**	**1,502**	**285,039**
Two-year cycle budworm					
100 Mile House TSA		2,388			2,388
Revelstoke TSA		30			30
Kamloops TSA		310			310
Lillooet TSA		922	2,018	731	3,671
Merritt TSA		457	8,609		9,066
Total	**0**	**4,108**	**10,627**	**731**	**15,466**
Western hemlock looper					
Williams Lake TSA		528			528
Arrow TSA		510	75		585
Kootenay Lake TSA		352	24		376
Kamloops TSA		9,991	19,187	1,992	31,170
Okanagan TSA		3,326	25,565	6,405	35,297
Total	**0**	**14,707**	**44,851**	**8,398**	**67,956**



Timber Supply Area	Area of infestation (ha)				
and Damaging Agent	Trace	Light	Moderate	Severe	Total
Aspen serpentine leafminer					
100 Mile House TSA		1,511			1,511
Quesnel TSA			159		159
Williams Lake TSA		3,059			3,059
Arrow TSA	178	860	1,931		2,969
Boundary TSA		20	86		106
Cranbrook TSA		220	2,614		2,834
Golden TSA		546			546
Kootenay Lake TSA		290	563		853
Revelstoke TSA			529		529
Kamloops TSA		3,042			3,042
Total	**178**	**9,547**	**5,882**	**0**	**15,607**
Drought - general, foliage loss					
100 Mile House TSA	0	341	428	32	801
Quesnel TSA	0	1,473	584	621	2,677
Williams Lake TSA	0	4,728	15,968	1,448	22,144
Arrow TSA	31	6,479	3,855	806	11,144
Boundary TSA	0	1,125	2,797	43	3,965
Cranbrook TSA	0	672	1,647	44	2,303
Golden TSA	30	3,019	2,007	128	5,184
Invermere TSA	0	55	430	0	485
Kootenay Lake TSA	0	3,959	1,821	0	5,644
Revelstoke TSA	0	4,053	6,469	1,641	12,131
Kamloops TSA	0	9,358	30,922	24,395	64,673
Lillooet TSA	0	44	16,945	84	17,069
Merritt TSA	0	1,072	5,161	229	6,463
Okanagan TSA	0	5,978	87,894	13,386	107,258
Total	**61**	**42,357**	**176,928**	**42,857**	**261,940**
Drought - mortality					
Williams Lake TSA				15	15
Kamloops TSA	8		389	42	440
Lillooet TSA				37	37
Merritt TSA			4	22	26
Okanagan TSA	3		52	303	358
Total	**12**	**0**	**445**	**420**	**877**

Timber Supply Area	Area of infestation (ha)				
and Damaging Agent	**Trace**	**Light**	**Moderate**	**Severe**	**Total**
Woodborer damage					
100 Mile House TSA	1,102	71		38	1,211
Quesnel TSA				1	1
Williams Lake TSA	64	118		54	235
Kamloops TSA	785	329	156	81	1,351
Lillooet TSA			28	4	32
Merritt TSA	78	3		15	96
Okanagan TSA	159		1,494	51	1,705
Total	**2,188**	**522**	**1,679**	**242**	**4,631**
Aspen decline					
100 Mile House TSA	31	29		7	67
Williams Lake TSA				10	10
Kamloops TSA			4		4
Okanagan TSA			7		7
Total	**31**	**29**	**11**	**17**	**88**
Fire					
Quesnel TSA				22,760	22,760
Williams Lake TSA			3	37,389	37,392
Arrow TSA				3,117	3,117
Boundary TSA				6	6
Cranbrook TSA				14,341	14,341
Golden TSA				1,560	1,560
Invermere TSA				17,465	17,465
Kootenay Lake TSA				8,253	8,253
Revelstoke TSA				3,080	3,080
Kamloops TSA				66,910	66,910
Lillooet TSA				40,234	40,234
Merritt TSA				3,715	3,715
Okanagan TSA				84,644	84,644
Total	**0**	**0**	**3**	**303,474**	**303,477**
Post fire mortality					
100 Mile House TSA		214	2,378	751	3,343
Quesnel TSA			9		9
Williams Lake TSA		37	140	112	288
Kamloops TSA		516	2,610	979	4,105
Lillooet TSA		626	757	368	1,751
Merritt TSA		25	159	291	475
Okanagan TSA		501	1,347	1,094	2,941
Total	**0**	**1,918**	**7,399**	**3,595**	**12,912**

Timber Supply Area	Area of infestation (ha)				
and Damaging Agent	**Trace**	**Light**	**Moderate**	**Severe**	**Total**
Cedar flagging					
Quesnel TSA		472	519	621	1,612
Williams Lake TSA		2,297	8,474	1,403	12,173
Kamloops TSA			114		114
Total	**0**	**2,769**	**8,993**	**2,023**	**13,785**
Flooding					
100 Mile House TSA			19	58	77
Williams Lake TSA		1	81	1,145	1,227
Quesnel TSA				40	40
Arrow TSA				10	10
Golden TSA				11	11
Invermere TSA				114	114
Kamloops TSA				10	10
Okanagan TSA				2	2
Total	**0**	**1**	**100**	**1,391**	**1,492**
Slide					
Arrow TSA	**0**	**0**	**0**	**18**	**18**
Windthrow					
Arrow TSA				28	28
Kootenay Lake TSA				11	11
Revelstoke TSA				16	16
Total	**0**	**0**	**0**	**55**	**55**
Bear					
100 Mile House TSA			3	1	4
Williams Lake TSA	20			1	21
Cranbrook TSA		40			40
Invermere TSA				1	1
Kamloops TSA				3	3
Lillooet TSA				1	1
Merritt TSA	5			1	6
Okanagan TSA		12		3	15
Total	**25**	**52**	**3**	**10**	**90**
Larch needle blight					
Arrow TSA		237	119		356
Boundary TSA		306	229		535
Cranbrook TSA		631	1,207		1,839
Invermere TSA			17		17
Kootenay Lake TSA		452	96		548
Total	**0**	**1,627**	**1,669**	**0**	**3,295**
White pine blister rust					
Kamloops TSA	**0**	**0**	**41**	**1**	**43**

Drought damage on cedar and heavy cone crop on spruce near Cherry Ridge – Okanagan TSA

Southern Interior Overview

Woodborers, wildfire and drought

Woodborers are an ecologically important guild of insects that include the Buprestidae (flat-headed woodborers), Cerambycidae (roundheaded woodborers), and Siricidae (horntails or wood wasps). They are integral to nutrient cycling, forest succession and forest food webs. Drought, extreme summer heat and wildfire may create defensively compromised trees, which are unable to repel invading insects such as woodborers and bark beetles. These trees are the preferred hosts of woodborers and produce volatiles that are highly attractive to subcortical, woodboring insects. Certain woodborer species are known to locate burned trees by sensing heat or smoke. Woodborers commonly infest areas where fire-damaged trees are located; leading to severe degradation of high value stands slated for post-fire salvage logging. In recent years, we have seen a build-up of these subcortical insects on the landscape and a shift from invading primarily post-wildfire settings to infesting and killing *apparently* healthy, live trees.

During the summer and fall of 2022 and into 2023, there were numerous reports and observations of damage caused by woodborers and other insects infesting fire-damaged and drought-stressed trees. Over 4,600 ha of woodborer damage were mapped within 7 TSAs. Ground checks and aerial surveys revealed that woodborers were killing Douglas-fir, ponderosa pine, western larch, and to a lesser degree lodgepole pine. Primarily mature trees were attacked, but numerous young lodgepole pine (age 10-20 years) were also attacked and killed. Within past wildfires, many large, moderately burned Douglas-fir and ponderosa pines were infested with high numbers of woodborers belonging to the Buprestidae, Cerambycidae and Siricidae families. Woodborer activity within wildfire settings seemed to be competing with Douglas-fir beetles, which also infest fire-damaged trees. This interaction of the two subcortical dwelling insect guilds could help reduce Douglas-fir beetle populations.

Widespread, scattered mortality from this woodborer/fire/drought complex was observed in the 2023 AOS throughout southern B.C., including areas in the Cariboo, Thompson, south and central Okanagan, Similkameen and Kootenays (Table 3). Woodborer damage was not recorded in other parts of B.C. despite significant areas of past damage from wildfire, drought and bark beetles (Table 4). The highest levels of mortality were mapped in the Okanagan (1,705 ha), Kamloops (1,351 ha), and 100 Mile House (1,211 ha) TSAs.

Trees killed by drought and woodborers at Skimikin Lake – Okanagan TSA

Table 4. Hectares affected by fire, drought, woodborers and bark beetles in British Columbia and the southern interior in 2023, showing the percent of this damage recorded in the southern interior.

Damage agent	Ha affected in 2023 B.C.	Ha affected in 2023 Southern interior	% of damage in south
Wildfire	2,845,186	303,477	11%
Post-fire mortality	18,281	12,912	71%
Drought (foliage damage)	296,151	261,940	88%
Drought (mortality)	1,648	877	53%
Woodborer damage	4,631	4,631	100%
Bark beetles (all species)	2,322,575	178,986	8%

Woodborers mine within the phloem and sapwood of highly stressed trees, often causing severe degradation of trees and stands scheduled for post-fire salvage harvest. However, these insects also serve in the natural successional process of habitats altered by fire or bark beetles and serve as prey for several woodpecker species. It was due to the extreme woodpecker action on infested trees in burned areas and on presumably live trees not in burnt areas that the extent of woodborer activity was noticed beginning in 2022.

Woodborer mining and stain

Woodborer damage in Isadore Canyon-Cranbrook TSA

The life cycle of cerambycid and buprestid beetles is dominated by the larval stage, which typically lasts one year, but can extend to several years. Female beetles deposit eggs in bark crevices, under bark scales, or in small niches cut into the bark, and have been observed to avoid oviposition where bark beetle activity is high. Larval stages feed within the cambium layer during early development and later tunnel into the sapwood and heartwood. Tunneling introduces fungi that reduces the economic value of harvested timber, but also facilitates the decomposition of dead wood, recycling nutrients and reducing fuel loads. Adults emerge and fly during the warmer months, seeking out recently dead or weakened trees, and recently cut or decked trees. Woodborers are often attracted to trees infested by bark beetles such as Douglas-fir beetle and western pine beetle, and woodborer larvae may consume bark beetle larvae if they encounter them in the phloem.

Cerambycidae larva

Buprestidae larva

Siricidae larva

Most woodborers are unable to attack healthy trees and are more often attracted to trees releasing chemical stress signals, with a reduced ability to produce defensive chemicals (e.g. pitch, resin). Some woodborers locate burned trees by sensing heat or smoke.

	
Buprestidae	
	
Siricidae	*Cerambycidae*
	
Cerambycidae	
	
Cerambycidae	*Woodborer damage*

INSECT DEFOLIATORS, GENERAL

Methods used to monitor defoliator populations

There are several methods used to monitor or predict defoliator populations. Brief descriptions of the most regularly used methods are described below, while information that is more detailed is provided within separate defoliator sections.

Methods include:

1. Aerial overview and detailed mapping of defoliation - provides the most current information on extent and severity of defoliation. Detailed aerial surveys are conducted when planning control programs.
2. Annual trapping with pheromones at permanent sample sites (PSPs) - provides data that can highlight trends in populations and be used to predict imminent defoliation. Trapping is conducted annually for Douglas-fir tussock moth and western hemlock looper.
3. Three-tree beatings - an assessment of species richness and abundance. This is a technique conducted annually to collect defoliator larvae at permanent sample sites (often coupled with moth trapping). Three-tree beatings are conducted at Douglas-fir tussock moth and western hemlock looper PSPs throughout the southern interior and at an additional thirteen PSPs established in the East Kootenays to monitor western spruce budworm and other defoliating insects.
4. Egg mass surveys - conducted late summer or fall. These surveys provide an estimate of predicted defoliation (defoliator population) in the next season. Egg mass surveys are most often conducted for western spruce budworm and Douglas-fir tussock moth, and occasionally western hemlock looper, as part of the planning process for control programs.

Western spruce budworm egg mass (hatched)

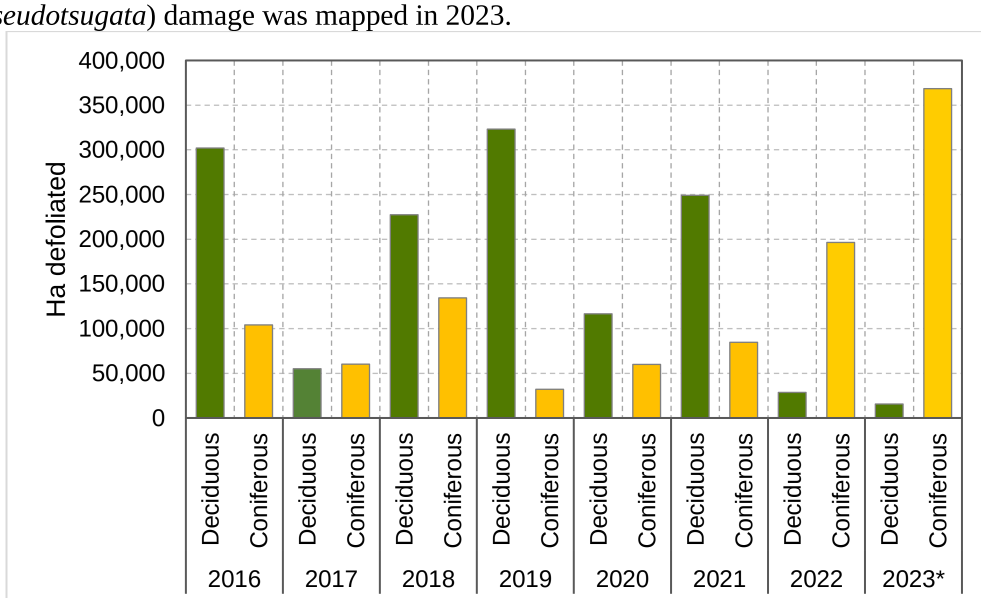
Douglas-fir tussock moth egg mass

In 2023, approximately 384,256 ha of deciduous and coniferous forests (including 189 ha by an unknown defoliator) were impacted by insect defoliators, up from 225,001 ha mapped in 2022 (Figure 3). Conifer defoliation increased almost two-fold over 2022. Deciduous tree defoliation saw a 45% decline from 28,597 ha in 2022 to 15,607 ha in 2023. **Aspen serpentine leafminer** (*Phyllocnistis populiella*) was the only deciduous defoliating insect recorded in 2023 (Table 3).

Three species of coniferous defoliators were recorded, with **western spruce budworm** (*Choristoneura freemani*) affecting the largest area of southern interior forests. Western spruce budworm increased dramatically throughout Kamloops, Merritt and Lillooet TSAs in the Thompson Okanagan Region, with over 285,000 ha infested (Figure 4). This dramatic increase in extent and severity of defoliation marks the start of the next outbreak cycle in the region. Populations declined in the Cariboo Region except for pockets of new infestation mapped in the Quesnel TSA, which covered 1,211 ha. Defoliation in the Quesnel TSA is in an historic area of budworm infestation, just north of Williams Lake TSA on both sides of the Fraser River, near Wayne Creek on the west side and Marguerite on the east.

Active infestations of the **western hemlock looper** (*Lambdina fiscellaria lugubrosa*) increased by 69% in 2023. Western hemlock looper defoliation was mapped over 67,956 ha in 2023 (Figure 4) compared to 36,467 ha in 2022. The increases occurred in Kamloops and Okanagan TSAs, whereas all other infested TSAs recorded declining populations. Infestations in Kamloops TSA occurred in the northern portion throughout Wells Gray Park and along the North Thompson River from White River to Albreda. In Okanagan TSA, new infestations were mapped at the north end of Seymour River, Ratchford Creek and south to Eagle and Shuswap Rivers.

The only other conifer defoliator detected in the 2023 AOS flights (Figure 4) was the **two-year cycle budworm** (*Choristoneura biennis*), which was in its 2nd year in the south (Merritt and Lillooet TSAs), and off-year farther north. The total area affected in the southern interior declined to 15,466 ha. However, Merritt and Lillooet TSAs saw increases in area affected (Table 3). Two-year cycle budworm populations in the Cranbrook TSA were not recorded during the 2023 aerial overview surveys because symptoms were masked by spruce and western balsam bark beetle attack in the same stands. No **Douglas-fir tussock moth** (*Orgyia pseudotsugata*) damage was mapped in 2023.



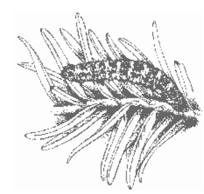


Figure 3. Area affected by deciduous and coniferous insect defoliators 2016-2023. * In 2023, there was an additional 189 ha of defoliation mapped (causal agent not identified or included in this figure).

Western spruce budworm

Aspen serpentine leafminer damage

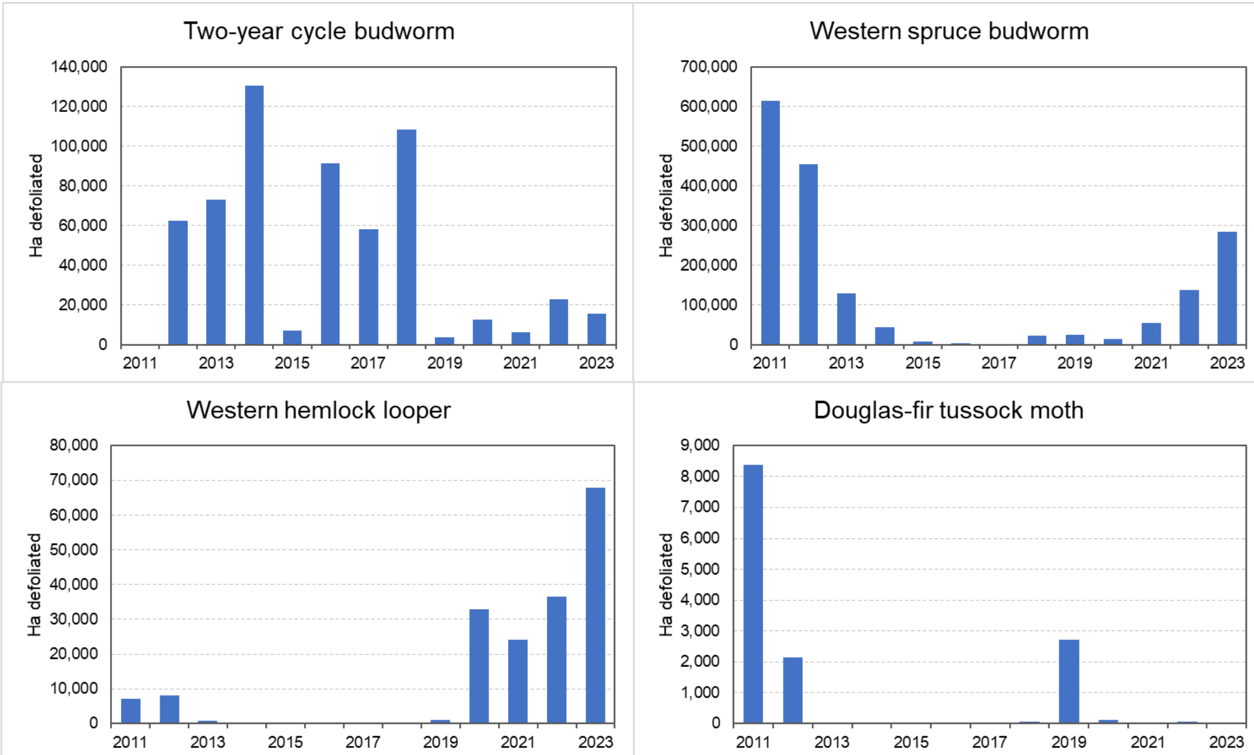


Figure 4. Hectares affected by four major conifer defoliators in the southern interior of B.C. (2011-2023).

Western Spruce Budworm, *Choristoneura freemani*

Western spruce budworm defoliation of Douglas-fir was mapped in seven TSAs in the south area in 2023 (Table 3) compared to 6 TSAs in 2022, for a total of 285,039 ha defoliated. Populations declined significantly in the Cariboo Region, most notably in Williams Lake TSA, where the outbreak is now centred in the McEwen Creek area west of the Fraser River and the Joe's Creek area east of the Fraser River. Total defoliation mapped in 100 Mile House TSA declined, but was still substantial at 37,175 ha affected. Budworm moved into areas from Helena Lake southeast through Exeter Lake and there were expansions in the south near Chasm. Mapped defoliation in the Thompson Okanagan Region increased 11-fold, notably in Kamloops, Merritt and Lillooet TSAs (Table 3). Large infestations were mapped in Kamloops TSA north of Hwy. 99 near Two Spring Creek, in the Trachyte Hills, Gallagher's Lake, south through the Hat Creek area, and from Finney Lake south to Blue Earth Creek. Patches were also noted near Venables Lake. Budworm is building in historic areas within Lillooet TSA, through the Marble range into 100 Mile House TSA, near Mount Cole, Pavilion Lake, and near Kwotlenemo (Fountain) Lake south along the Fraser River. In Merritt TSA, infestations were mapped from Logan Lake south to Merritt, and in numerous Douglas-fir sites south of Merritt. Large areas of defoliation were recorded near Tahla Lake, Boss Lake, Davis Lake, and in the Pothole Creek area near Kentucky-Alleyne Park. Near Princeton, populations expanded south of the Similkameen River. The Coast Region also saw a significant increase in western spruce budworm damage. Defoliation was mapped along the Coast Region-Thompson Okanagan Region boundary from Hope to north of Pemberton.

The Cariboo Region sprayed 40,000 ha of priority Douglas-fir stands with the biological insecticide Foray 48B (*Bacillus thuringiensis var. kurstaki;* P.C.P. No. 24977) in June 2023 to mitigate damage from western spruce budworm defoliation (Table 5; Figure 5). Seven blocks were treated in June 2023 at 2.4 litres per ha. Western Aerial Applications Ltd. conducted the aerial applications using two 315B Lama helicopters and two Hiller UH12ET helicopters, each equipped with four Beecomist 361 ultra-low volume hydraulic sprayers. Spray conditions were optimal.

Table 5. 2023 western spruce budworm spray blocks in the Cariboo Region, showing block location, hectares treated and litres of *B.t.k.* applied.

Block	Hectares	Litres *B.t.k.* applied
1. Jesmond	6,815	16,356.0
2. Big Bar Lake	1,144	2,745.6
3. Tinmusket/Dog Creek	19,321	46,370.4
4. Canoe Creek	6,261	15,026.4
5. Meadow Lake S	983	2,359.2
6. Meadow Lake E	742	1,780.8
7. Meadow Lake N	4,734	11,361.6
Total	**40,000**	**96,000.0**

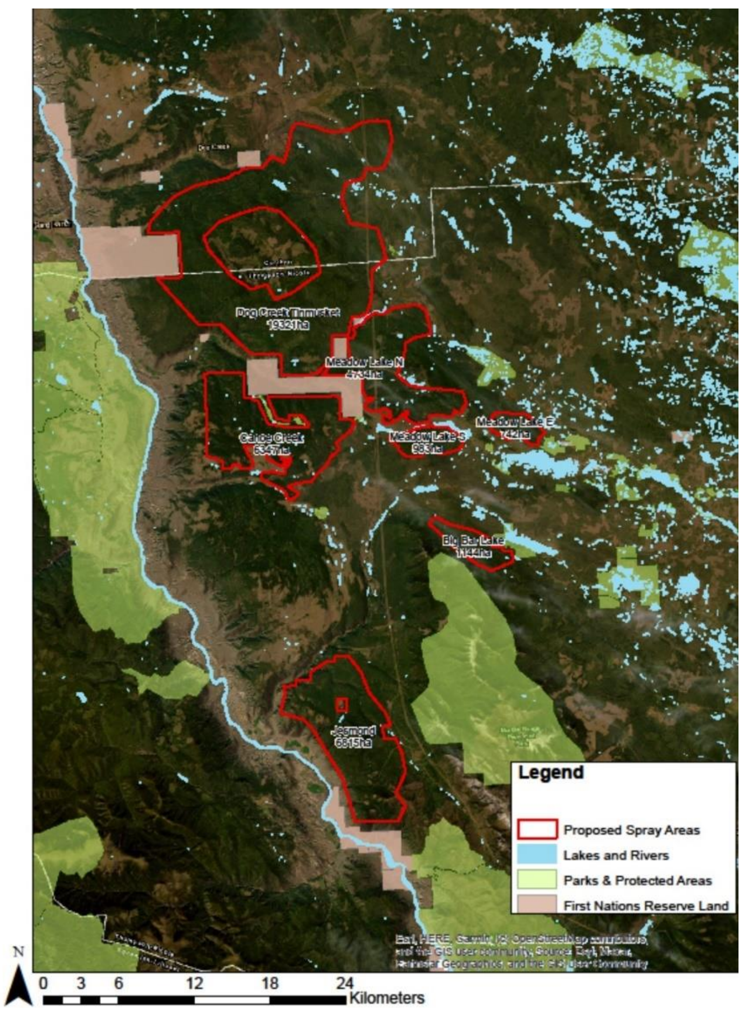


Figure 5. Western spruce budworm 2023 spray blocks in the Cariboo Region.

Efficacy assessment

Pre- and post-spray larval sampling was done near Poison Lake within a treatment area and a comparable unsprayed area, to quantify larval density and treatment efficacy. Pre-spray sampling was done June 13, 2023, the day before *B.t.k.* treatment, and post-spray sampling was done at set intervals after treatment (Table 6).

Budworm larval density at the pre-spray sampling time was just over 5 larvae per m^2 foliage in both the treatment and control sites. By the final post-spray sampling, there were almost no larvae found in the treatment block and on average four larvae per m^2 foliage in the control site (Table 6). The *B.t.k.* treatment achieved very high larval mortality (100%) compared to 69% natural larval mortality in the control site.

Table 6. Pre- and post-spray larval sampling was conducted in one treated and one control (untreated) area where western spruce budworm populations were comparable prior to treatment.

Sampling location	Live larvae per m^2					% Mortality			
	Pre spray (June 13)	1st post (June 19)	2nd post (June 26)	3rd post (July 3)	4th post (July 10)	1st	2nd	3rd	4th
Poison Lake - *B.t.k.*	5.4	5.7	0.3	1.5	0.2	0	94	72	100
Poison Lake - control	5.3	4.6	2.8	4.8	4.0	13	47	9	69

Defoliation predictions for 2024

Fall egg mass sampling is conducted to predict defoliation in the following year and to determine whether stands will require *B.t.k.* treatment. Current, historic, and predicted defoliation are taken into consideration when determining population trends, and which areas are most at risk for ongoing defoliation and damage. In 2023, 233 sites were sampled for western spruce budworm egg masses in the south area, and 12 sites were sampled in the Chilliwack area, totalling 245 sites sampled (Table 7). Defoliation estimates are based on the number and density of egg masses found. Of all the sites sampled, 33% predicted no defoliation in 2024, 58% for light defoliation, 8% for moderate defoliation, and 1% had a prediction of severe defoliation. These predictions were very similar to those in 2023. In 2024, spray treatments are planned for Kamloops and Merritt TSAs within the Thompson Okanagan Region, as well as select sites within the Cariboo Region.

Western spruce budworm egg mass

2023 western spruce budworm defoliation

Of the 110 sites sampled for egg masses in the Cariboo Region, 50% had no egg masses (Table 7). Fifty sites (45%) predicted light defoliation and 5 sites (5%) predicted moderate defoliation in 2024, with the majority of sites predicting any level of defoliation located in 100 Mile House TSA. Only 7% of sites sampled in the Thompson Okanagan Region had no egg masses, while the majority (88%) predicted light defoliation. Due to the physical constraints of sampling, a building population can often be underestimated. Most egg masses are deposited in the mid- to upper crown of overstory trees, often beyond the reach of sampling.

Table 7. Results of the fall 2023 western spruce budworm egg mass sampling in the southern interior and Chilliwack District. The number of sites indicating nil, light or moderate and severe defoliation in 2024 is listed by TSA, with the average number of egg masses per $10m^2$ foliage per tree (10 trees sampled per site) by TSA and the maximum number of egg masses found at a site within a TSA. Nil = 0 egg masses; Light = 1-50 egg masses; Moderate=51-150 egg masses; Severe=>150 egg masses.

	2024 predicted defoliation (No. sites)				Total	No. egg masses	
Region and TSA	Nil	Light	Moderate	Severe	# sites	Avg.	Max.
Cariboo							
100 Mile House	15	31	4	0	50	21.4	117
Williams Lake	40	19	1	0	60	4.9	59
Total	**55**	**50**	**5**	**0**	**110**		
Thompson Okanagan							
Kamloops	6	38	4	0	48	19.6	75
Merritt	1	54	2	0	57	18.6	85
Total	**7**	**92**	**6**	**0**	**105**		
Kootenay Boundary							
Boundary	**18**	**0**	**0**	**0**	**18**	0	0
Coast							
Chilliwack	**2**	**0**	**8**	**2**	**12**	86.0	186
2023 Total	**82**	**142**	**19**	**2**	**245**		

East Kootenay Permanent Sample Sites

In 2007, thirteen permanent sample sites (PSS), formerly monitored by the Forest Insect and Disease Survey Unit of Forestry Canada, were re-established in the East Kootenays to monitor the incidence of western false hemlock looper, *Nepytia freemani*, and western spruce budworm, *Choristoneura freemani* (Figure 6). Historically, the East Kootenays have incurred very little damage from western spruce budworm. However, given climate change and Douglas-fir encroachment throughout the Rocky Mountain Trench, conditions may become more favorable. In 2023, no western spruce budworm larvae were found at any of the plots and no defoliation was observed. Defoliator diversity and incidence was up slightly from 2022, with six other defoliators collected, the most abundant being the greenstriped forest looper, *Melanolophia imitata* and *Eupithecia olivacea*, a rather non-descript solitary defoliator.

Nepytia freemani
false hemlock looper

Nematocampa resistaria
filament bearer

Ectropis crepuscularia
saddleback looper

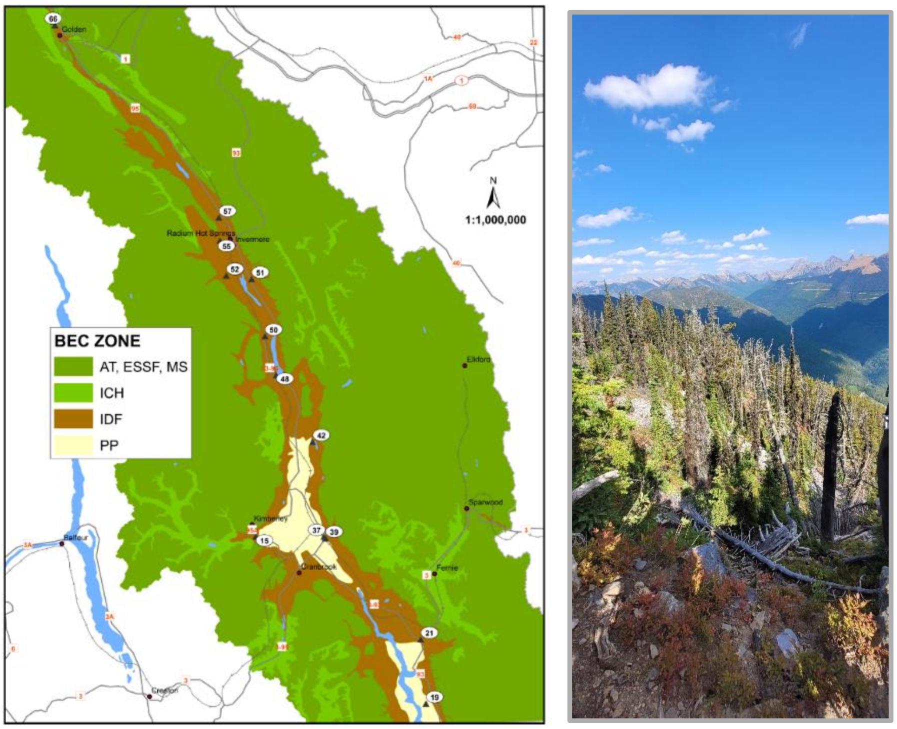


Figure 6. Permanent sampling site distribution in the Rocky Mountain Trench.

WESTERN HEMLOCK LOOPER, *LAMBDINA FISCELLARIA LUGUBROSA*

Western hemlock looper defoliation was mapped on 67,956 ha in 5 TSAs in 2023 compared to 36,467 ha in 9 TSAs in 2022 (Table 3). No defoliation was mapped in Cranbrook, Golden, Revelstoke (and Cascadia) TSAs, indicating the collapse of all outbreaks previously recorded. Only Arrow and Kootenay Lake TSAs in the Kootenay Boundary Region had small patches of defoliation. Williams Lake TSA recorded defoliation on 528 ha; a 1,457 ha decline over 2022. Significant increases in western hemlock looper defoliation were recorded in Kamloops and Okanagan TSAs, 31,170 ha and 35,297 ha respectively, in the Thompson Okanagan Region. Infestations in Kamloops TSA occurred in the northern portion throughout Wells Gray Park and along the North Thompson River from White River to Albreda. In Okanagan TSA, defoliation was recorded near the north end of Seymour River, Ratchford Creek and south to the Eagle and

Shuswap Rivers. Periodically outbreaks of western hemlock looper occur within interior Douglas-fir stands, but no defoliation on Douglas-fir was noticed in 2023.

Trapping and three-tree beating

Western hemlock looper and associated defoliators are monitored annually at permanent sampling sites using a combination of three-tree beating and/or moth trapping (six uni-traps placed per site) (Figure 7). Three-tree beating and moth trapping were done at 16 sites in the Thompson Okanagan Region. In the Kootenay Boundary Region, three-tree beatings were done at 23 sites, while moth trapping was done at 10 sites. In the Cariboo Region, three-tree beatings were done at 10 sites, and moth trapping at 15 sites. The Coast Region did moth trapping at 11 sites in 2023, which were newly established in 2022. Three-tree beatings were undertaken in early to mid-July at all sites and traps were placed at this time. A 60 cm x 90 cm drop cloth and a 2.5-meter pole were used to conduct the tree beatings. All defoliators, both primary and secondary, were recorded in the samples. Traps were collected late September through early October 2023.

The average number of western hemlock looper moths caught per trap declined again in 2023 in the Thompson Okanagan, Kootenay Boundary and Cariboo Regions (Table 8). There was a slight increase in the average number of moths caught per trap at the 11 sites in the Coast Region, from 23 to 30 moths per trap.

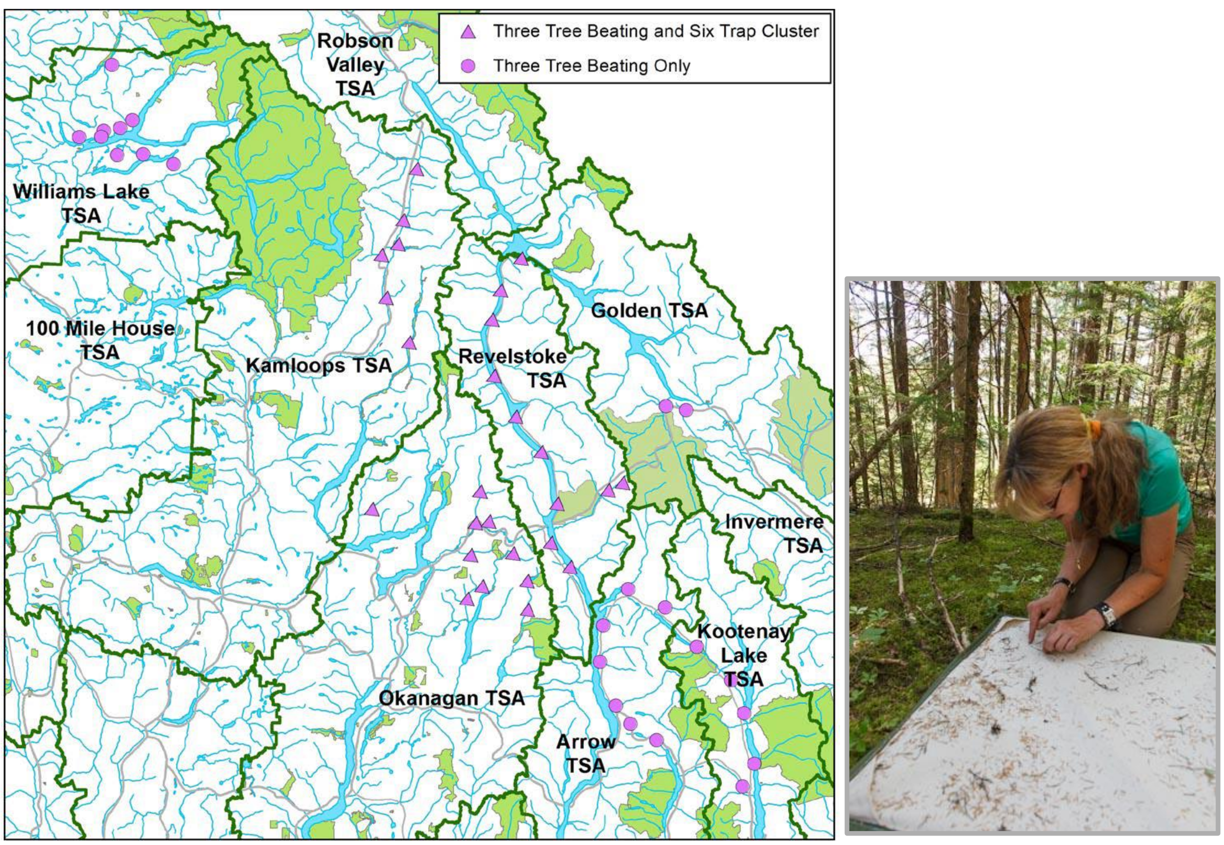


Figure 7. Locations of western hemlock looper permanent sampling sites in the TOR, CAR and KBR.

Table 8. Average number of western hemlock looper moths caught per six-trap cluster in the Thompson Okanagan, Kootenay Boundary, Cariboo and Coast Region Regions, 2016-2023.

		Average moth catch per trap							
Site #	**Location**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Thompson Okanagan Region									
1	Serpentine River	1	9	18	38	448	541	89	8
2	Thunder River	2	34	146	107	489	266	88	321
3	Mud Lake	1	14	294	120	549	442	30	7
4	Murtle Lake	3	51	134	316	533	1,130	15	13
5	Finn Creek	0	14	43	237	356	37	5	5
7	Scotch Creek	4	34	311	222	844	108	15	5
8	Yard Creek	17	72	29	145	121	139	89	88
9	Crazy Creek	2	32	143	146	660	14	6	3
10	Perry River North	10	-	302	197	289	121	32	24
11	Three Valley Gap	8	55	234	291	314	68	27	15
12	Perry River South	8	30	156	233	128	99	5	3
13	Kingfisher Creek	27	50	241	211	260	51	10	6
14	Noisy Creek	12	47	128	178	88	19	21	11
15	Shuswap River	6	49	161	422	848	40	16	14
16	Greenbush Lake	11	81	140	515	724	138	130	45
17	Adams River/Tum Tum	0	39	84	119	716	142	55	24
	Average of sites	**7**	**41**	**160**	**219**	**460**	**209**	**40**	**37**
Kootenay-Boundary Region									
66	Sutherland Falls	1	-	72	235	1,195	1,234	1	4
72	Tangier FSR	1	19	98	56	196	67	5	13
73	Martha Creek	3	23	86	33	439	1,121	24	6
74	Goldstream River	3	42	55	257	1,631	2,213	27	
75	Downie Creek	9	9	35	246	2,387	1,062	50	42
76	Bigmouth Creek	1	26	25	88	375	1,784	52	24
78	Carnes Creek	3	15	8	257	766	1,354	15	41
83	Begbie Creek	0	50	97	658	1,283	2,775	28	4
84	Pitt Creek Rec. Site	2	50	60	342	1,555	2,449	138	12
85	Kinbasket Lake	2	20	145	518	967	703	106	7
87	Jumping Creek	5	41	68	NA	-	-	-	13
	Average of sites	**3**	**29**	**68**	**269**	**1,079**	**1,476**	**45**	**17**



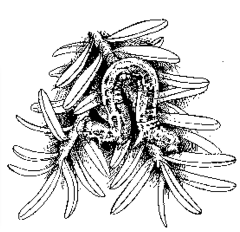


Table 8. Continued…

Site #	Location	Average moth catch per trap							
		2016	2017	2018	2019	2020	2021	2022	2023
Cariboo Region									
N1						302	12	0	0.2
N2						99			
N3						18	47	0	0
N4						828	9	0	0
N5						41	18	1	0
N6						29	9	2	0
N7						183	2	0	0.3
N8						50	43	0	0
S1						105	9	0	0
S2						466	42	0	0.5
S3						5	15	1	0.2
S4						5	5	0	0
S5						46			0
S6						5	23	1	0.8
S7						3	68	5	1.7
S8						7	9	0	0
	Average of sites					**137**	**22**	**1**	**0.2**
Coast Region (3 traps per site)									
1	Chehalis River							17	57
2	Statlu Creek 9km							11	18
3	Statlu Creek 10km							16	45
4	Salsbury							4	7
5	Burke Prov. Park							5	0
6	Belcarra							52	81
7	Seymour Prov. Park							6	0
8	Lynn Creek							125	90
9	Rainy River 3km							3	12
10	Rainy River 4km							7	7
11	Rainy River 5.5km							9	9
	Average of sites							**23**	**30**

Very few defoliating insect larvae were recorded in the 2023 beatings (Table 9), decreasing from 507 individuals in 2022 to 72 in 2023. The richness (diversity of insect species) remained similar at 8 species recorded. The black-headed budworm (*Acleris gloverana*) was the most abundant species, with 35 larvae recorded from samples in the Kootenay Boundary Region (Table 9). This species often increases following the decline of hemlock looper. Very few western hemlock looper larvae were found.

Table 9. Insects collected from the 2023 three-tree beatings at permanent sample sites located in areas of historic western hemlock looper defoliation in the Kootenay Boundary, Thompson Okanagan and Cariboo Regions.

Region	# Sites	Western Hemlock Looper (*Lambdina fiscellaria lugubrosa*)	Black-headed budworm (*Acleris gloverana*)	Sawflies (*Neodiprion, Anoplonyx*)	Green-striped forest looper (*Melanolophia imitata*)	*Cladara limitaria*	*Semiothisa unipunctaria*	*Eupithecia olivacea*	*Macaria unipunctaria*
Kootenay Boundary	24	0	35	0	7	2	4	4	10
Thompson Okanagan	16	5	0	2	0	0	0	0	0
Cariboo	10	3	0	0	0	0	0	0	0

Western hemlock looper defoliation

DOUGLAS-FIR TUSSOCK MOTH, *ORGYIA PSEUDOTSUGATA*

In 2019, the **Douglas-fir tussock moth** began an outbreak cycle in the southern interior, with numerous single-tree epizootics and patches of defoliation recorded for a total of 2,708 ha. From 2020 to 2022, there was a dramatic decline in active tussock moth defoliation and no defoliation was mapped in 2023.

Annual monitoring with six-trap clusters

Outbreak periodicity of Douglas-fir tussock moth varies by Outbreak Area (geographic location) and can range from 5 to over 40-year intervals. Typically, in the southern interior, we experience an outbreak in one or more of the Outbreak Areas every decade. When a consistent upward trend of moths caught in monitoring traps is found in a stand for 2 to 3 years (average over 10 moths per trap), or if an average of 25 moths or more per trap has been caught, ground surveys for egg masses are recommended and defoliation may occur the following summer. The most recent outbreak cycle was centred in the Cariboo, beginning in 2019 and collapsing by 2021.

Douglas-fir tussock moth lures from three chemical companies were deployed in 6-trap clusters at each trapping site between 2016 and 2019, to compare the efficacy of the three lure types in attracting tussock moth and accurately predicting imminent outbreaks: Scotts® (Solida); WestGreen Global Technologies (ChemTica); and, Synergy Semiochemicals® (Figure 7). Scotts® is no longer supplying the same lure, so only two lure types are available. All lures have a loading of 5µg pheromone. Traps are set out in lines of 6 traps at each trapping site in the Thompson Okanagan (33 sites), Kootenay Boundary Region (9 sites) and Cariboo (15 sites) Regions (Figure 8).

Average trap catches remained low at all trap sites in all Outbreak Areas (Table 10), except for the Woods Lake site in the Okanagan Outbreak Area, which had 34.4 moths per trap. Rusty tussock moth and pine tussock moth were present throughout the southern interior at elevated numbers compared to past years. Pine tussock moth was found at 13 sites for a total of 203 moths and 125 rusty tussock moths were trapped at 8 sites.

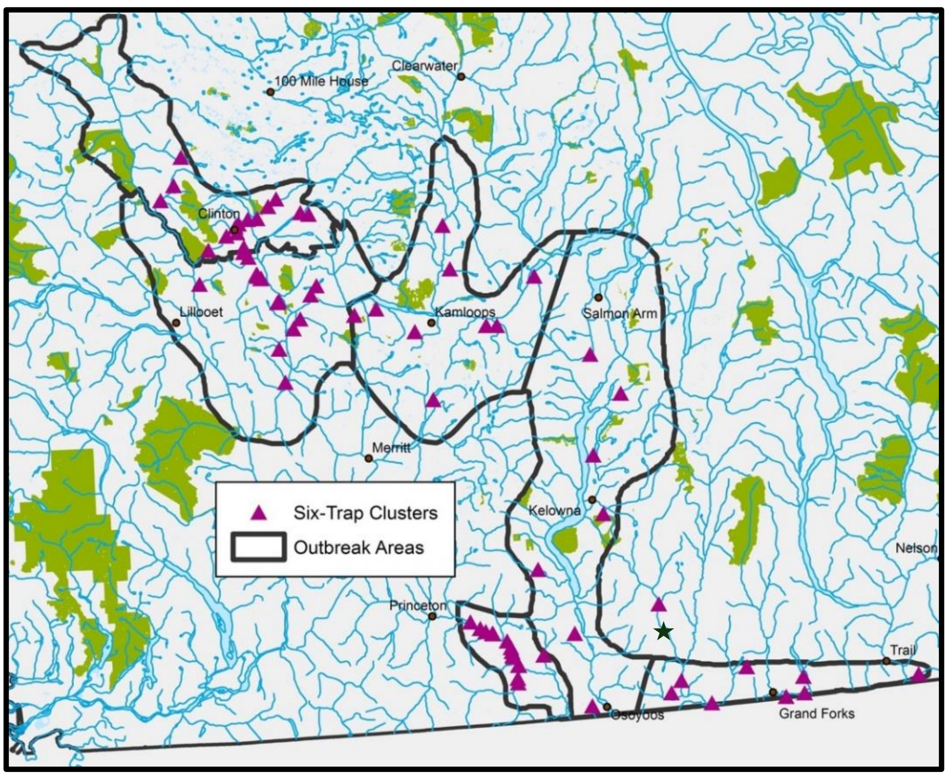


Figure 8. Location of Douglas-fir tussock moth 6-trap clusters throughout the southern interior.

Table 10. Average number of Douglas-fir tussock moths caught per 6-trap cluster in the Thompson Okanagan and Cariboo Regions (2016-2023). In the Thompson Okanagan and Cariboo Regions, lures from three suppliers (Scotts (Solida), ChemTica (WestGreen Global Technologies), and Synergy Semiochemicals) were compared in 2016-2019. Since 2020, either or both of the WestGreen Global Technologies and Synergy Semiochemicals lures have been placed at each site. Other species of tussock moths have been caught at some sites. PTM=pine tussock moth; RTM=rusty tussock moth. *Indicates trapping site discontinued or inaccessible due to wildfire or other issues.

		Average moth catch per site								
Site	**Location**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Comments**
Kamloops (KA)										
1	McLure	5.5	8.9	10.9	21.2	6.5	1.2	3.6	5.8	6 PTM
2	Heffley Creek	26.6	26.8	32.4	18.6	40.4	0.0	1.9	2.0	2 PTM
3	Inks Lake	0.1	0.1	0	0.2	0.0	0.0	0.8	0.8	2 PTM
4	Six Mile	3.4	3.8	9.9	23.1	32.3	0.0	0.4	2.7	
9	Stump Lake	0	0.3	0.1	1.3	0.0	0.1	0.1	0.5	
10	Monte Creek	3.8	6.4	7.8	20.1	30.3	0.0	0.7	5.8	38 RTM; 7 PTM
11	Chase	1.7	0.3	3.4	5.9	2.0	0.3	0.1	0.3	23 RTM; 42 PTM
48	Haywood-Farmer			9.6	20.3	2.6	0.1	1.4	2.0	
49	Buse Lake			5.4	14.1	14.5	0.0	0.6	2.8	
	Average of sites	**5.9**	**6.7**	**8.8**	**13.7**	**14.3**	**0.2**	**1.1**	**2.5**	
Okanagan (OK)										
12	Yankee Flats	3.2	0.5	2.3	1.2	2.4	0.0	1.1	0.5	8 RTM; 2 PTM
13	Vernon		1.4	5.3	0.4	0.1	0.6	2.0	5.6	4 RTM; 14 PTM
14	Wood Lake	7.6	17.0	41.3	17.0	31.2	4.3	8.9	34.4	
15	June Springs	0.5	1.1	2.0	2.7	0.1	0.0	*		
16	Summerland	0.7	0.9	0.3	1.6	0.1	0.1	0.0	1.7	1 RTM
17	Kaleden	4.9	6.2	4.4	7.5	12.1	0.0	1.2	1.2	
18	Blue Lake	11.5	17.3	34.4	18.3	1.7	0.8	6.1	*	wildfire
45	Glenmore	5.3	9.0	25.4	20.1	19.5	0.0	*		
	Average of sites	**4.8**	**7.1**	**14.4**	**8.6**	**8.4**	**0.9**	**3.2**	**8.7**	
Similkameen (SIM)										
19	Stemwinder Park	8.6	8.2	29.8		18.1	1.7	0.3	0.5	
32	Olalla	21.2	21.6	40.4	29.1	23.3	0.1	*		
33	Red Bridge	8.8	7.4	9.3	9.4	10.9	0.0	1.5		
36	Hwy 3 Lawrence Ranch	10.7	11.2	30.4			0.0	*		
38	Hwy 3 Bradshaw Creek	17.7	10.3	29.2	36.8	22.1	0.3	0.7	4.8	
39	Hwy 3 Winters Creek	7.6	7.6	27.7	17.4	13.8	0.2	0.8	2.7	
40	Hwy 3 Nickelplate Road	8.8	9.7	31.3	18.7	21.7	0.1	1.1	3.3	
19a	Doug’s Homestead	16.8	13.8	40.7	36.0	24.3	0.2	0.4	0.5	
41	Stemwinder	11.4		34.2	26.5	13.0	0.5	0.2	0.7	
42	11.8 km Old Hedley Rd	0.3	0.4	2.0	3.8	1.8	0.2	0.5	0.3	
43	Pickard Creek Rec Site	5.5	6.8	31.6	14.5	20.2	0.0	0.8	2.3	
44	5.7 km Old Hedley Rd	3.9	4.3	20.4	7.6	10.8	0.3	0.1	0.8	
	Average of sites	**10.1**	**9.2**	**27.2**	**20**	**16.3**	**0.3**	**0.6**	**1.8**	

Table 10. Continued…

Site	Location	Average moth catch per site 2016	2017	2018	2019	2020	2021	2022	2023	Comments
West Kamloops (WK)										
5	Battle Creek	0.3	0.7	0.9	*					
6	Barnes Lake	2.5	9.9	7.7	25.4	16.2	0.0	*		
7	Carquille/Veasy Lake	10.9	*							
8	Pavilion	1.6	7.7	7.1	20.7	4.4	0.0	0.5	0.0	1 PTM
21	Spences Bridge	2.5	7.3	8.6	14.5	10.1	0.0	0.0	0.0	
22	Veasy Lake	9.7	*	1.7	13.7	16.2	0.0	0.5	1.2	
23	Veasy Lake	5.8	*							
24	Veasy Lake	6.2	*	6.7		18.6	0.0	0.4	0.6	1 PTM
25	Hwy 99	8.7	*							
26	Venables Valley	0.0	1.4	0.2	4.6	5.9	0.0	0.2	0.3	
27	Maiden Creek	0.2	1.0	1.6	6.6	8.1	0.0	0.9	0.5	
28	Hwy. 99	2.2	6.1	9.2	28.6	39.8	0.0	1.3	5.3	1 PTM; 1 RTM
29	Cornwall 79	1.1	*							
30	Cornwall 80	0.7	*							
31	Barnes Lake	0.6	2.1	0.8	9.1	1.3	0.5	0.2	0.0	4 PTM
46	Studhorse Road			2.2	11.2	2.4	0.1	0.7	0.5	
47	Stinking Lake			0.3	6.8	0.5	0.0	0.6	0.0	5 PTM
	Average of sites	**3.5**	**4.5**	**3.8**	**14.6**	**9.6**	**0.1**	**0.5**	**0.8**	
Boundary (KT) (9 sites in 2023)		**0.6**	**1.3**	**2.3**	**5**	**5.7**	**0.3**	**2.8**	**2.3**	116 PTM; 16 RTM
Cariboo (CAR) (16 sites in 2023)		**1.6**	**2.4**	**1.8**	**5**	**0.5**	**0.3**	**1.8**	**3.4**	34 RTM

Milk carton trap for Douglas-fir tussock moth monitoring (left) and uni-trap for western hemlock looper monitoring (right).

Three-Tree Beatings

Three-tree beating is a procedure for sampling defoliating forest insect larvae, which involves beating the foliage of low hanging branches and collecting the fallen insects on a tarpaulin. Three-tree beating provides temporal and spatial information on the richness and diversity of defoliating insects and is conducted annually from mid-June to early July.

In 2023, three-tree beating was conducted at 29 of the 33 monitoring sites in the Thompson Okanagan Region. All defoliators present on the drop cloth were identified and recorded. Defoliator numbers were up slightly from 2022, which had the lowest levels recorded since the establishment of these plots, possibly due to a heat dome in 2021. Douglas-fir tussock moth larvae were not observed at any site in the Thompson Okanagan Region; the most common defoliator recorded being green-striped forest looper (Table 11). Five species of defoliators were recorded in the Thompson Okanagan Region sites, with a total of 24 larvae overall. The only major defoliator species recorded was western spruce budworm, found at 2 sites in the West Kamloops Outbreak area (Table 11).

Very few defoliators were recorded in the West Kootenay sites in 2023, with a total of 13 larvae compared to 7 in 2022, 19 in 2021, and 76 in 2020. Defoliator diversity was up slightly from 2023 with 5 species recorded, up from 4 species in 2022, and down from 7 species in 2021 and 11 in 2020. None of the major defoliator species were noted at any sites.

Table 11. Defoliators recorded in 2023 three-tree beatings in Thompson Okanagan and Kootenay Boundary Regions' interior Douglas-fir forests.

Outbreak Area	Douglas-fir tussock moth (*Orgyia pseudotsugata*)	Western spruce budworm (*Choristoneura freemani*)	Sawflies (*Neodiprion*)	Green striped forest looper (*Melanolophia imitata*)	Eupithecia spp.	*Dioryctria pseudotsugella*	*Semiothisa s. unipunctaria*	Total larvae
West Kootenays	0	0	1	1	5	1	5	13
Kamloops	0	0	1	0	1	0	0	2
Okanagan	0	0	1	0	1	0	0	2
Similkameen	0	0	0	11	2	0	0	13
West Kamloops	0	3	1	4	0	1	0	9
Grand Total	0	3	4	16	9	2	5	39

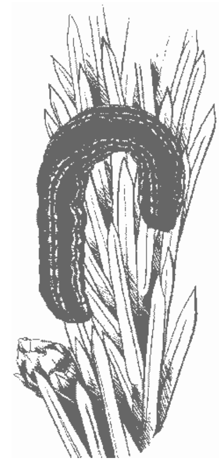
Douglas-fir tussock moth

Western spruce budworm

Sawflies

Green striped forest looper

Black army cutworm, *Actebia fennica*



Black army cutworm (IDA) was a major pest in the 1980s, frequently associated with prescribed burns. With abundant wildlife activity and tight timelines for reforestation, increased monitoring is required to ensure this defoliator does not affect recently planted areas. Larvae feed from April through June on a variety of hosts causing "shot-hole" type defoliation. They prefer a variety of shrubs and herbaceous plants, but will also feed on western larch, Douglas-fir, Engelmann/hybrid spruce and lodgepole pine. When populations are low, black army cutworm feeds on its preferred hosts, as well as larch; however, at moderate and outbreak populations, feeding switches to conifer seedlings such as Douglas-fir, Engelmann/ hybrid spruce and lodgepole pine. Seedling mortality can occur within a single year depending on population density. Most seedlings can sustain moderate defoliation (i.e., less than 60%), with limited impact on their growth or survival. Moister sites recover more quickly than drier sites, which may experience reduced height growth and increased mortality due to moisture stress.

Increases in black army cutworm populations may be noticed the following spring after early season wildfires (April through June). Increase in IDA post late season fires (July through October) will generally occur the following summer. High-risk sites such as burned openings are the preferred egg laying areas. The more severe the burn (i.e. no to little vegetation remaining), the greater the likelihood of high levels of defoliation on natural or planted conifer seedlings the following year. ESSF, MS, SBS, ICH and IDF BEC zones are the highest risk areas, especially drought-prone sites in drier subzones.

Management strategies for black army cutworm include.

1. Conducting spring surveys on the natural vegetation to determine its presence.
2. Conducting adult pheromone monitoring in the summer (July 1st – September 15th) annually one to three years post-fire, using baited multi-pher or unitraps.
3. Depending on population levels, avoid spring planting or delay planting for one to three years following a burn.

Predicted defoliation risk the following year using multi-pher traps can be categorized as low for <350 moths/ trap, moderate >350-1200 moth per trap and high >1200 moths per trap. Traps are placed at least 200 meters apart within the burn area, away from stand edges, with a Vapona® strip placed inside the trap. Traps are placed at 0.5 m to 1 m height, and are checked and emptied periodically throughout the summer.

Kootenay Boundary Region has been monitoring black army cutworm in various locations since 2018, using multi-pher traps (Figure 9). The number of trap sites and locations vary each year depending on the occurrence and severity of wildfires. Three sites were monitored in 2023: two sites in Boundary TSA and one site in Invermere TSA. Trap catch numbers were low, averaging 14 moths per trap.

This year, traps were established in the Thompson Okanagan Region in the Whiterock Lake fire. However, due to new wildfire activity in the area, access was cut-off.

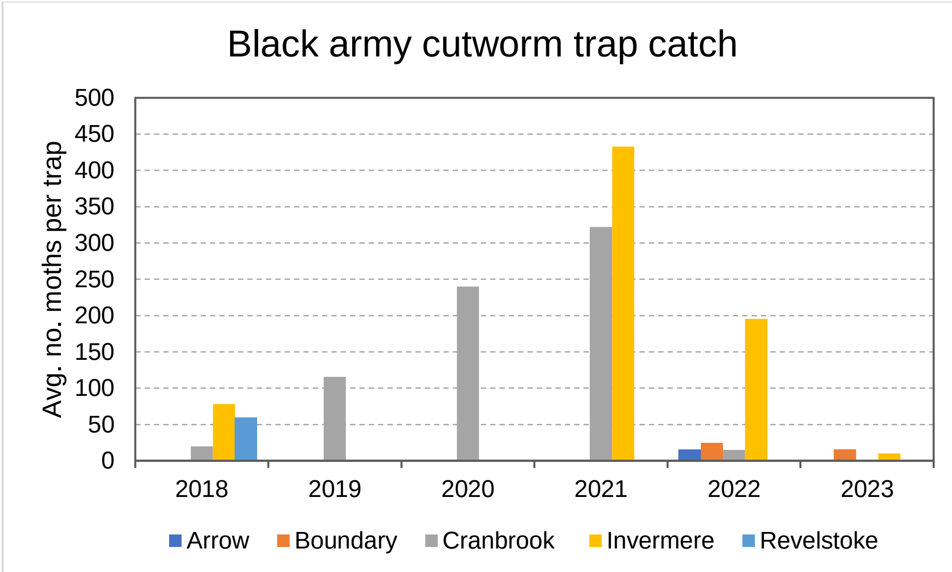


Figure 9. Average number of black army cutworm moths caught in traps in 5 TSAs (2018-2023) in the Kootenay Boundary Region.

Black army cutworm trap

Thompson Okanagan Region Summary

The Thompson Okanagan portion of the Aerial Overview Surveys was carried out between July 20th and September 22nd, 2023. The surveys were completed in 80.1 hours, over 14 flight days. Initially the weather was good, but due to many wildfires, flights were delayed and visibility was often poor due to smoke. There were large cone crops for a second year on several conifer species, particularly Douglas-fir and spruce, making it difficult to discern whether foliar discoloration was insect defoliation or cone crops. All surveys were conducted by Barbara Zimonick (Zimonick Enterprises) and Karen Baleshta, and utilized a Cessna U206G operated by Fort Langley Air Ltd.

Spruce with large cone crops in foreground and western spruce budworm defoliation in background

Kamloops TSA

Douglas-fir beetle was mapped on 1,571 ha, down from 4,867 ha in 2022, mostly as trace infestation (Table 3). Active Douglas-fir beetle infestation was very dispersed throughout the TSA, with many small spots of new attack. There was a significant decline in the northern portion of the TSA near Clearwater and Blue River, while populations in the Knouff Lake, Louis Creek, and Paul Lake areas became more scattered. South and west of Kamloops Lake, infestations were mapped near Fehr Lake, Clemes Creek, Sabiston Lake, Blue Earth Creek and Oregon Jack Creek. Ground checks revealed high levels of woodborers in trees attacked by Douglas-fir beetle and drought stressed trees. It appears that woodborer populations have in part contributed to the decline of Douglas-fir beetle.

Spruce beetle declined to only 46 ha mapped in 2023 and no **mountain pine beetle** was recorded. **Western balsam bark beetle** increased to 30,714 ha affected in 2023. Populations were observed near Chuwhels

Mountain, Mount Lolo, west of Hiuihill Creek, and in the north portion of the TSA near Granite Mountain, Harp Mountain, and from Trophy and Table Mountains north to Battle Mountain.

Western spruce budworm infestation increased significantly in Kamloops TSA affecting 48,416 ha compared to 426 ha observed in 2022. Populations were concentrated in the south portion from Tranquille Creek, west through Stinking Lake, McLean Lake, south through Cornwall Hills along Hat Creek, to Venables Lake and Spatsum. Defoliation was largely mapped as light to moderate from the air, at 12,913 ha and 35,502 ha respectively. Ground checks revealed very heavy feeding on 2023 growth and many moths were observed in late July. Only 7 of 105 egg mass sampling sites had zero egg masses. A targeted treatment with *B.t.k.* is planned for 2024.

Western spruce budworm

Severe defoliation

Western hemlock looper damage increased to 31,170 ha affected, largely in the northern part of the TSA. Defoliation was mapped along the North Thompson River from Blue River to Albreda; near Oliver Creek; and, north of Tum Tum Lake along the Adams River. **Two-year cycle budworm** was in year 1 of its life cycle, with only 310 ha of damage mapped.

Aspen serpentine leafminer activity was recorded affecting 3,042 ha, down from 6,975 ha in 2022. The most notable defoliation was mapped at the south end of Clearwater Lake, near Taweel Lake, west of Lemieux Creek, and between Thuya and Dum Lakes.

The only damage caused by a pathogen was 43 ha of white pine blister rust mortality.

54% of damage in the Kamloops TSA (137,477 ha) was caused by **abiotic factors** including fire (66,910 ha), drought (65,113 ha), post-fire mortality (4,103 ha) and woodborer damage (1,351 ha). Although caused by a biotic agent, woodborer damage is symptomatic of underlying host stress due to drought, extreme heat or fire damage and therefore can be classed as biotic or abiotic damage. Significant post-fire mortality was observed in the 2021 Tremont Creek fire and Sparks Lake fire. Woodborer damage was observed throughout the TSA; however, not much was picked up in the aerial surveys because it was associated with drought, Douglas-fir beetle or fire. Mapped areas included those near Red Lake, Lac Du Bois, McQueen Lake, Jamieson Creek, and Black Pines. Woodborers infested mature and young trees; primarily Douglas-fir and lodgepole pine in Kamloops TSA.

Lillooet TSA

In Lillooet TSA, damage was mapped on 110,761 ha (included 189 ha of unknown conifer defoliation not listed in Table 3) compared to 29,185 ha in 2022. Bark beetles caused 15% of the damage, conifer defoliators (32%), wildfire (36%), and 15% was drought-related damage. The area affected by **western balsam bark beetle** increased slightly to 11,516 ha mapped, primarily as trace infestations (Table 3). Western balsam bark beetle infestations were recorded in most high elevation subalpine fir sites, including Scudamore, Gott, Texas, Cinnamon, Copper, and Ault Creeks.

Mountain pine beetle affected 4,231 ha, down from 6,413 ha in 2022. The most active outbreaks were mapped near Jamie Creek, Leckie Creek, south of Bridge River, and east of Gott Creek. Mountain pine beetle infested white bark pine in high elevation sites and lodgepole pine at mid-elevations. **Spruce beetle** was mapped on 256 ha, a significant decline from 2022, when 4,312 ha of damage were recorded. Small patches of damage were mapped in the Spruce Lake and Lizard Creek areas in the northwest of the TSA.

Only 30 ha of **Douglas-fir beetle** was mapped in 2023. Most active populations were mapped as small spots, primarily south of Seton Lake along Cayoose Creek and the Fraser River.

The area affected by **western spruce budworm** increased 4-fold over 2022, affecting 31,746 ha of interior Douglas-fir. Populations expanded in the Downton, Carpenter and Gun Lakes area, as well as near Kwotlenemo (Fountain) Lake. Infestations continued along the northwest edge of Anderson Lake and in the Twaal Creek and Venables Lake area. Egg mass sampling in the fall of 2022 correctly predicted many of these population increases.

Spruce beetle damage in Lillooet TSA

Foliage response to **drought** was recorded in numerous areas throughout the TSA, affecting 17,069 ha. Drought damage was recorded south of Anderson and Seton Lakes, around Pavilion Lake and Sallus Creek, Yalakom River, Cedarvale and Fall Creeks, and west of Downton Lake along the Bridge River.

MERRITT TSA

A total of 164,091 ha of damage was mapped in Merritt TSA, up significantly from 2022 when 13,619 ha were damaged. Bark beetles accounted for 8% and defoliators were responsible for 86% of the damage observed, with **western spruce budworm** making up 80% (131,436 ha) of all damage recorded in the TSA. Damage caused by **western balsam bark beetle** increased to 9,630 ha, up from 4,337 ha in 2022, most of which was trace severity. Larger infestations were mapped in subalpine fir near Stoyoma Mountain, Zakwaski Mountain, Mount Thyme, July Mountain, and Lodestone Mountain. **Douglas-fir beetle** increased to 3,177 ha, up from 874 ha in 2022. The main area of infestation was the Spius Creek area. No **mountain pine beetle** or **spruce beetle** was mapped in 2023.

Western spruce budworm defoliation persisted near Mamit Lake, and expanded near Princeton, south of the Similkameen River. New infestations were mapped from Logan Lake south to Merritt, while numerous Douglas-fir sites south of Merritt were affected. Large areas of defoliation were recorded near Tahla, Boss, and Davis Lakes, Swakum Mountain and the Pothole Creek area near Kentucky-Alleyne Park. *B.t.k.* treatments are planned for 2024. **Two-year cycle budworm** was mapped west of the Tulameen River in the Coquihalla Mountain area, affecting 9,066 ha.

Western spruce budworm defoliation in Merritt TSA

Drought damage affecting foliage was recorded on 6,463 ha, with the largest areas mapped near Ketchum Road, Conaly Creek and Cook Creek. **Wildfires** damaged 3,715 ha.

Okanagan TSA

Damage was mapped on 255,476 ha in 2023 compared to 40,630 ha in 2022. Most damage was caused by **wildfire** (33%) and **drought** (42%) (Table 3). Bark beetles comprised 9% of damage recorded and defoliators, 14%.

Drought damage in Okanagan TSA

Douglas-fir beetle activity has declined significantly since 2022, affecting just 489 ha, mostly occurring as spots throughout the central and north portion of the TSA. Small infestations were recorded through the Chase Creek corridor, Trinity Valley, in the Lumby area near Camels Hump and Harris Creek, and along Mission Creek. The area affected by **western balsam bark beetle** remained static in 2023 at 22,420 ha of mostly trace attack. Small infestations were mapped in many high elevation subalpine fir sites. The most notably affected areas were near Blurton and Cookie Creeks, and Silver Star Mountain. No **mountain pine beetle** was detected, and **spruce beetle** levels remained very low.

Western hemlock looper remained active in the north and east portion of the TSA, affecting 35,297 ha in 2023. The largest areas of defoliation were mapped along the north Seymour River, Shuswap River and Lindmark Creek, north to Greenbush Lake and Joss Mountain. **Western spruce budworm** levels were very low, with only 289 ha affected.

Large areas of **drought** damage were mapped throughout the TSA, totalling 107,258 ha. Significant **foliar damage** was recorded south of Salmon Arm through to Enderby; on the east and west sides of Okanagan Lake near Sicamous; in the Adams River drainage; near Coldstream and Lumby; and the north end of Rendell Creek. Drought mortality was mapped on 358 ha, with patches southeast of Islaht Lake. **Woodborer** damage was mapped on 1,705 ha, with a large patch near Taft, south of the Eagle River.

Training for the Osoyoos Indian Band

Western pine beetle galleries

CARIBOO REGION SUMMARY

The Cariboo portion of the aerial surveys was completed between July 5th and October 13th. The Region was flown in two sections (divided north and south) by two contractor teams. Barbara Zimonick was the lead surveyor on the south section, with Karen Baleshta as second seat. Surveyors (Nathan Atkinson, Tom Foy and Barry Mills) from Industrial Forest Services Ltd., Prince George B.C. flew the north portion of the Region. A total of 104 hours over 13 days were expended. Cariboo Air and Guardian Air supplied the aircraft. Cessna 182s were the primary aircraft used.

Smoke from local and B.C. wildfires extended the survey into October.

100 MILE HOUSE TSA

The area affected by **Douglas-fir beetle** decreased from 6,953 ha in 2022 to 1,214 ha in 2023. Attack was predominantly mapped as spot data, with a concentration of spots in the French Bar/Big Bar Mountain area and east of Marble Range Provincial Park. Scattered spots were mapped around Lac La Hache, west to Canim Lake. **Western balsam bark beetle** declined slightly from 213 ha to 154 ha. The majority of attack was mapped as spot data, with most spots occurring in the northwestern area of the TSA. Attack was spread north of Timothy Lake, heading northwest to Wells Gray Provincial Park. No **mountain pine beetle** or **spruce beetle** activity was recorded in the TSA.

Western spruce budworm decreased slightly from 44,737 ha to 37,175 ha, with the majority mapped as moderate defoliation. The largest polygon was mapped north and west of Moose Valley Park, from Helena Lake to Hwy 97 at 801 Road. Four polygons were mapped north of Horse Lake to just south of Earl Lake. Polygons were also mapped near and around Green Lake, and north and east of Chasm Park. A *B.t.k.* treatment is planned for the summer of 2024. **Two-year cycle budworm** decreased to 2,388 ha and was mapped near Windy Creek on the far eastern edge of the TSA. **Aspen serpentine leafminer** decreased slightly from 1,622 ha to 1,511 ha. Defoliation was observed on the eastern TSA boundary, with the largest polygon mapped south of Green Lake.

Post-burn mortality (3,343 ha) was observed mainly in and east of Flat Lake Park, south of Moose Valley Park. No **drought mortality** was mapped. **Flooding** decreased from 385 ha to 77 ha.

Quesnel TSA

The area affected by **Douglas-fir beetle** remained low with only 12 ha affected, an increase from 2022 (6 ha). The area affected by **western balsam bark beetle** decreased from 28,434 ha 2022 to 5,415 ha in 2023, with 97% mapped as trace. Most affected stands are located in a north-south swath in the Barkerville Mountain-Wells area and Bowron Lake Park. **Spruce beetle** infestations saw a 59-fold decrease in 2023 (325 ha mapped). Four polygons were mapped across the Nazko area. **Mountain pine beetle** was limited to two spots, for totalling 1 ha in the west, north of Itcha Ilgachuz Park.

Western spruce budworm was mapped on 1,211 ha just over the southern border of the TSA, south of Marguerite, on the east and west sides of the Fraser River. **Aspen serpentine leafminer** damage was mapped on 159 ha in 2023, a decrease of 96% since 2022. One polygon was mapped southwest of Bellos Lake.

Fire mortality was mapped on 22,760 ha.

Williams Lake TSA

Douglas-fir beetle populations continued to decrease, going from 12,334 ha in 2022 to 1,733 ha in 2023. Most attack was mapped as spots scattered south to Churn Creek, and east and west of the Fraser River. Spots were also mapped in the Chilcotin in the northern section of Ts'il ʔos Park, northwest to Patterson Lake Park. **Spruce beetle** attack saw a thirteen-fold decrease in area affected in 2023 (185 ha) primarily mapped as trace, with only 12 ha mapped as severe.

Fire damage and old Douglas-fir beetle damage SE of Hanceville, looking north toward the Chilcotin River

Mountain pine beetle infestations decreased and were mapped on 17,317 ha, almost half the area mapped in 2022. Ninety-eight percent of the infestations were mapped as trace. Polygons were mapped along the southwest portion of the Region in Ts'ilʔos Park, south of Taseko Lake, along the Coast Mountains to Wilderness Mountain. **Western balsam bark beetle** was widespread throughout high elevation sites in the Tatlayoko Lake - Chilko Lake - Taseko Lake, along the Coast Mountains to the Charlotte Lake area in the southeast of the TSA, and from Likely to Quesnel Lake in the northeast. The majority was mapped as trace, for a total area of 17,362 ha.

Western spruce budworm defoliation was mapped on 34,766 ha. All hectares were designated light attack. Much of this mapped defoliation occurred within blocks that were sprayed with *B.t.k.* to control the budworm. Because of high budworm populations in the areas that were sprayed, some feeding occurred prior to treatment and was therefore visible as light defoliation during the Aerial Overview Survey. Populations were located around McLeese Lake, south of Alkali Lake and across the Fraser River, southwest of Junction Sheep Range.

The area affected by **aspen serpentine leafminer** decreased again from 10,385 ha to 3,059 ha with the largest polygon mapped between Rose and Big Lakes.

Post-burn mortality was minimal with only 288 ha affected. **Drought mortality** was low but **drought with foliage loss** affected 22,144 ha, with polygons stretching from Big Lake west to Quesnel Lake and along the west side of the North Arm of Quesnel Lake. **Cedar flagging** occurred along the North Arm of Quesnel Lake and into the Cariboo Mountains Park with 12,173 ha mapped. **Flooding** affected 1,227 ha.

Kootenay Boundary Region Summary

The Kootenay Boundary Region aerial surveys were completed between July 14 and September 16, 2023, requiring 115 hours of flight time over 24 days. Weather conditions were mainly sunny with minor smoke haze throughout July. However, conditions became quite smoky at the beginning of August, so surveys were put on hold until later in the month when conditions improved. All surveys were conducted by Nazca Consulting Ltd., with Neil Emery as the primary surveyor and either Adam O'Grady or Jason Lessard in the second seat. Surveys were conducted using a Cessna 337 Skymaster operated by Babin Air.

Fifteen damage agents were recorded in the Kootenay Boundary Region, affecting 152,441 hectares of forest land in 2023. Table 12 lists these damage agents ranked by hectares affected. Abiotic damage agents affected the greatest area, with fire (47,832 ha) and drought – foliage loss or damage (40,856 ha), first and second in ranking. Western balsam bark beetle affected 29,120 ha (Table 12), the third highest number of hectares affected.

Table 12. Ranking of forest health factors in the Kootenay Boundary Region in 2023.

Ranking of forest health factor (by ha of attack)	Forest Health Factor	Code	Damage (ha)
1	Fire	NB	47,823
2	Drought - foliage loss or damage	NDF	40,856
3	Western balsam bark beetle	IBB	29,120
4	Mountain pine beetle	IBM	11,844
5	Aspen leaf miner	ID6	7,837
6	Douglas-fir beetle	IBD	7,776
7	Larch needle blight	DFH	3,295
8	Spruce beetle	IBS	2,396
9	Western hemlock looper	IDL	960
10	Drought	ND	255
11	Flooding	NF	146
12	Windthrow	NW	44
13	Bear	AB	41
14	Two-year budworm	IDB	30
15	Slide	NS	18
Total			152,441

Table 13 outlines attack by various bark beetles (ha affected) by TSA in the Kootenay Boundary Region in 2022 and 2023, and the difference between the two years.

Table 13. Bark beetle hectares of attack by TSA in Kootenay Boundary in 2022 and 2023, and the difference between the two years.

	Ha of attack											
	IBB			**IBD**			**IBM**			**IBS**		
TSA	**2022**	**2023**	***Diff.***	**2022**	**2023**	***Diff.***	**2022**	**2023**	***Diff.***	**2022**	**2023**	***Diff.***
Arrow	1,520	2,261	*741*	5,460	1,174	*-4,286*	90	454	*364*	0	218	*218*
Boundary	1,328	455	*-873*	2,132	583	*-1,550*	817	565	*-252*	0	0	*0*
Cranbrook	11,050	7,301	*-3,749*	5,157	2,786	*-2,372*	1,117	4,916	*3,799*	7,414	561	*-6,853*
Golden	12,100	5,300	*-6,800*	632	909	*278*	0	11	*11*	350	743	*393*
Invermere	13,427	11,108	*-2,319*	1,693	1,160	*-532*	3,999	4,585	*587*	1,565	858	*-707*
Kootenay Lake	3,304	2,430	*-873*	1,611	852	*-759*	500	1,313	*812*	661	17	*-644*
Revelstoke	660	265	*-395*	306	312	*6*	136	1	*-135*	0	0	*0*
Totals	***43,389***	***29,120***	***-14,269***	***16,992***	***7,776***	***-9,215***	***6,659***	***11,844***	***5,185***	***9,989***	***2,351***	***-7,638***

Mountain pine beetle in the Bull River drainage.

Selkirk South: Arrow, Boundary, and Kootenay Lake TSAs

The total number of hectares affected by forest health factors in Selkirk South in 2023 was 49,009 ha (22,361 ha, 6,215 ha, and 20,432 ha, respectively for Arrow, Boundary and Kootenay Lake TSAs). Thirteen of the 15 mapped forest health factors were mapped in Selkirk South (Table 12).

Douglas-fir beetle populations decreased significantly in Selkirk South, in Arrow, Boundary and Kootenay Lake TSAs. Populations are still active and scattered throughout the area; specifically north of Greenwood and on either side of Arrow Lake. **Mountain pine beetle** populations increased in Arrow and Kootenay Lake TSAs and decreased in Boundary TSA. Mountain pine beetle populations are still active south of Kitchener (east of Creston) towards the US border, south of the Creston-Salmo Pass, southeast of Nakusp near Summit Lake, south of Johnson's Landing on the east shore of Kootenay Lake, and near Baldy Mountain. **Spruce beetle** populations are small in Arrow and Kootenay Lake TSAs, with no recorded incidence in Boundary TSA. Small pockets of infestation were recorded east of Burton. **Western balsam bark beetle** populations increased in Arrow TSA, but decreased in Boundary and Kootenay Lake TSAs, with attacks scattered throughout high elevation subalpine fir stands, specifically on either side of Arrow Lakes, near Granby Provincial Park and west of Slocan Lake.

Larch needle blight was mapped on 1,439 ha, with near equal occurrence in all three TSAs. The largest areas of larch needle blight observed were near Midway Range, Greasybill Creek, Campbell Creek and Fry Creek.

Selkirk North: Golden and Revelstoke TSAs

The total hectares affected by forest health factors in 2023 in Selkirk North was mapped at 30,659 ha (14,264 ha and 16,395 ha, respectively for Golden and Revelstoke TSAs). Ten of the 15 mapped forest health factors were mapped in Selkirk North (Table 12).

Douglas-fir beetle populations were extremely low in Revelstoke TSA. However, populations were recorded along the west side of Arrow Lake just south of Revelstoke, near the town of Revelstoke, as well as some small pockets in the Goldstream drainage, east of Revelstoke Lake. **Mountain pine beetle**

populations have been negligible in the last two years in both Golden and Revelstoke TSAs. **Spruce beetle** populations are high in Golden TSA, specifically on the western edge of Glacier National Park and throughout the Beaver Valley. There was no recorded incidence of spruce beetle in Revelstoke TSA. **Western balsam bark beetle** populations remain high, but are declining in Golden TSA, specifically north of Golden/ east of Donald. Populations are generally low in Revelstoke TSA.

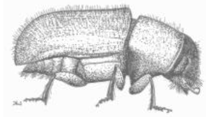
Michael Murray looking at blister rust, Baker Mountain.

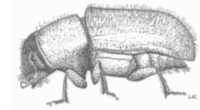
ROCKY MOUNTAIN DISTRICT: CRANBROOK AND INVERMERE TSAS

The total hectares affected by forest health factors in 2023 in Rocky Mountain District was mapped at 72,773 ha (36,980 ha and 35,792 ha, respectively for Cranbrook and Invermere TSAs). Eleven of 15 forest health factors were mapped in Rocky Mountain District (Table 12).

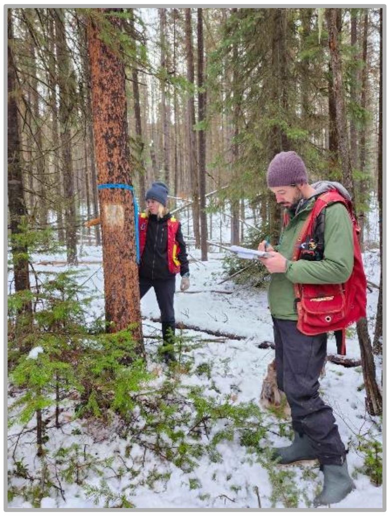
Douglas-fir beetle populations remain high, but are declining, specifically in the Galton's area, east of Grasmere, as well as scattered throughout the area southeast of Cranbrook to Koocanusa (Bloom-Caven and Cranbrook Watershed), Brewer, Kootenay River, Pedley and Fenwick areas. Douglas-fir beetle is also active at lower elevations throughout Kootenay National Park near Kootenay Crossing.

Detailed aerial surveys conducted mid-May, along with ground checks and funnel trapping revealed high levels of woodborers in trees either previously attacked by Douglas-fir beetle or those affected by drought. In the drought-affected trees, woodborers are acting as the primary mortality agent in many trees from the US border north to around Brisco in low elevation Douglas-fir dominated stands. It appears that woodborer feeding has in part contributed to a reduction in the Douglas-fir beetle population. It is possible that some of the attack recorded as Douglas-fir beetle in the aerial surveys may have been miscoded, and is in fact woodborer, due to the rapid color change of woodborer-affected trees.





Mountain pine beetle populations increased in Cranbrook TSA, mainly south of Cranbrook and west of Koocanusa Lake reservoir in the Bloom-Caven and Cranbrook Watershed, and north of Fernie in the Bull River and Galbraith drainages. In Invermere TSA, populations increased in the Toby Creek drainage near Panorama and the back end of the Palliser drainage. **Spruce beetle** continues to be active in the Cranbrook TSA, specifically up the Elk Valley. However, populations have declined significantly this year. Invermere TSA also has declining spruce beetle populations in the Toby Creek drainage near Panorama. **Western balsam bark beetle** populations are extensive, but declining. Areas of significant western balsam bark beetle attacks were noted in Cranbrook TSA east of Canal Flats and Kimberley, throughout the Purcell Wilderness Conservancy, north and east of Fernie and Sparwood, and throughout the Elk Valley.



Two-year cycle budworm was not mapped in 2023. However, populations remain active in Cranbrook TSA at the north end of the Elk Valley. It is difficult to map two-year cycle budworm defoliation because it is often associated with spruce beetle and western balsam bark beetle populations.

Larch needle blight was mapped on 1,839 ha in the northeast portion of Cranbrook TSA near Copper Creek, White Creek, St. Mary Creek and Redding Creek. Very little blight (17 ha) was detected in Invermere TSA.

Yahk mountain pine beetle training session

Detailed aerial survey

Other Contributions and Reports

Establishment of seven permanent sample plots in Kamloops Timber Supply Area to monitor *Pissodes strobi* attack on lodgepole pine

Lorraine Maclauchlan, Forest Entomologist, Thompson Okanagan Region
Rosanna Wijenberg, Blu Mule EcoConsult

As part of a follow-up to a study initiated in 2022 (Maclauchlan et al. 2023), seven permanent sample plots (PSP) in young (average age = 6-27 years) lodgepole pine stands were established during the summer of 2023 in Kamloops Timber Supply Area (TSA). Six 0.04 ha plots were established in the MSdm3 biogeoclimatic zone and one 0.04 ha plot in the IDFdk2 (Table 1). All coniferous L1-L3 (Table 2) trees were tagged. L4 coniferous species and L1-L4 deciduous species were counted and recorded, but were not assessed for pests, nor were they tagged (Table 3). The primary reason for establishing these plots is that the spruce weevil, *Pissodes strobi* Peck has been observed attacking young lodgepole pine in this TSA. Although previously noted on lodgepole pine, it is uncommon and in fact was recorded for the first time in the Kamloops area in 2022. Its mode of attack is different from lodgepole pine terminal weevil, *P. terminalis* Hopping and because it kills two years of growth in one season, it is potentially a much more significant pest. The locations and specific details for each plot are listed in Table 1.

Table 1. Location of permanent sample plots established in Kamloops TSA in 2023.

Plot No.	Mapsheet	Polygon	Plot size (ha)	BEC	Elevation (m)	Northing	Easting
1	92I088	59951225	0.04	IDFdk2	1156	5637938	676479
2	92P009	8116460	0.04	MSdm3	1352	5663342	685810
3	92P009	9706290	0.04	MSdm3	1350	5662982	686153
4	92I100	20816855	0.04	MSdm3	1365	5645963	704777
5	92P009	12666237	0.04	MSdm3	1325	5663119	686722
6	92P009	9136659	0.04	MSdm3	1354	5663575	685963
7	92I100	31125566	0.04	MSdm3	1445	5644525	705863

Low density plantation

Foliar damage

Table 2. Description of tree layers, categorized by diameter at breast height (dbh) and tree height (B.C. Ministry of Forests 1992).

	Description of trees in each layer	
Layer	Diameter at breast height (cm)	Tree height (m)
1	≥ 12.5cm	any, given dbh ≥ 12.5cm
2	7.5 to 12.4 cm	any, given dbh range of 7.5 to 12.4cm
3	0 to 7.4 cm	≥ 1.3m
4	any, given height restriction of < 1.3m	< 1.3m

Table 3. Number of conifer ingress (L4) and deciduous species counted but not tagged during the establishment of seven permanent sample plots in Kamloops TSA.

	N	
Plot no.	Conifer ingress (L4)	Deciduous (L1-L4)
1	6	69
2	61	2
3	62	5
4	170	3
5	36	16
6	454	27
7	196	26

Aside from *P. strobi*, the pest incidence and severity of other insects, diseases, competition from brush and other trees, and abiotic factors were assessed and recorded for each plot tree. Species composition, stand density and tree mortality information were collected for L1-L3 plot trees (Table 4). In the case of tree mortality, cause of death was noted; however, these trees were not tagged and will not form part of the plots going forward. The number of pests found in each plot, the average number of pests per tree and the range of pests per tree were summarized (Table 4). In 2023, the average number of lodgepole pine pests identified per plot was 12.3. The average number of pests per tree recorded ranged from 1.2-2.4, while the range of occurrence of pests per tree was 0-6 (Table 4). Not all pests have an equal impact or severity; however, the sheer variety and abundance recorded is cause for concern. Warmer temperatures and increased rainfall in the spring could lead to shorter life cycles for insects and increased infection capabilities for foliar and stem diseases.

Table 4. Percentage of L1-L3 lodgepole pine and other species that is dead, live, clear or affected by one or more forest health factors, average stem density (sph), and lodgepole pine pest information assessed for the newly established 2023 Kamloops TSA permanent sample plots.

		N			Percent (%) Pl				Density (sph)				
Plot No.	BEC	Live Pl	Dead Pl *	Live other spp.	Live	Clear	Affected	% other spp.	Pl	all live trees	N Pl pests/plot	Avg. N pests/Pl	Range N pests/Pl
1	IDFdk2	58	9	1	98.3	10.5	89.5	1.7	1,450	1,475	12	2.4	0-6
2	MSdm3	96	0	41	57.3	7.3	92.7	42.7	2,400	3,425	10	1.6	0-4
3	MSdm3	77	0	15	80.5	0.0	100.0	19.5	1,925	2,300	8	1.9	1-4
4	MSdm3	315	5	21	93.3	5.1	94.9	6.7	7,875	8,400	15	1.6	0-5
5	MSdm3	175	0	32	81.7	19.6	80.4	18.3	4,375	5,175	15	1.2	0-3
6	MSdm3	233	1	5	97.9	8.8	91.2	2.1	5,825	5,950	13	1.4	0-4
7	MSdm3	133	10	10	92.5	1.6	98.4	7.5	3,325	3,575	13	1.8	0-4

* not included in plot density or % Pl calculation because the trees are not tagged and will not form part of the plot going forward.

Twenty five lodgepole pine were assessed and recorded as dead during plot establishment out of a total of 1,113 trees (all species), equalling 2.2% mortality. This value increased to 2.5% when only lodgepole pine (n=988) were considered. Six of these pines were long dead, while 19 were more recently deceased. Possible mortality agents and their prevalence are listed in Table 5. Many of these trees suffered from more than one mortality agent. Cow damage and both western gall rust and stalactiform blister rust were most prevalent.

Table 5. Possible mortality agents for dead lodgepole pine found in seven permanent sample plots established in Kamloops TSA.

	Possible mortality agents							
Pest	Cow	Deer	Squirrel	Comandra blister rust	Western gall rust (stem)	Western gall rust (branch)	Stalactiform blister rust	Abiotic
N	12	3	1	2	8	2	7	1
% overall mortality	1.2	0.3	0.1	0.2	0.8	0.2	0.7	0.1
% dead Pl	48.0	12.0	4.0	8.0	32.0	8.0	28.0	4.0

Mixed species stand

Pissodes terminalis attack

Diameter at breast height (DBH), tree height and age were recorded on 1,088 (L1-L3) plot trees (Table 6). In general, lodgepole pine comprised the majority of plot trees, other than PSP 2, where there was a more even distribution of pine and other conifer species. PSP 4 was the only plot where the lodgepole pine was similar in size to other species found in the plot. Otherwise, the pine was consistently larger and taller than the other conifers present in the plots.

Table 6. Diameter at breast height (DBH), height and age of lodgepole pine and other species per plot.

	Average for Pl				Average for other species			
Plot	N	DBH (cm)	Height (m)	Age (years)	N	DBH (cm)	Height (m)	Age (years)
1	57	15.1	11.13	27	1	2.1	2.02	
2	55	8.8	5.74	18	41	4.3	3.14	18
3	62	11.6	6.82	19	15	2.3	2.41	17
4	295	4.8	4.95	18	21	4.7	3.61	17
5	143	5.5	4.87	16	32	3.0	3.08	
6	228	4.3	3.92	16	5	1.9	2.92	
7	123	8.5	7.21	18	10	2.1	2.47	
Total	963				125			

Every plot tree was rated for form (good, fair, poor), including coniferous tree species other than lodgepole pine (Table 7). Of 963 lodgepole pine assigned a tree form code, only 27.0% rated a 'good', in contrast to subalpine fir (Bl), Douglas-fir (Fd) and interior spruce (Sx), the majority of which had 'good' form (Table 7).

Table 7. Tree form noted for all assessed trees in seven permanent sample plots in Kamloops TSA.

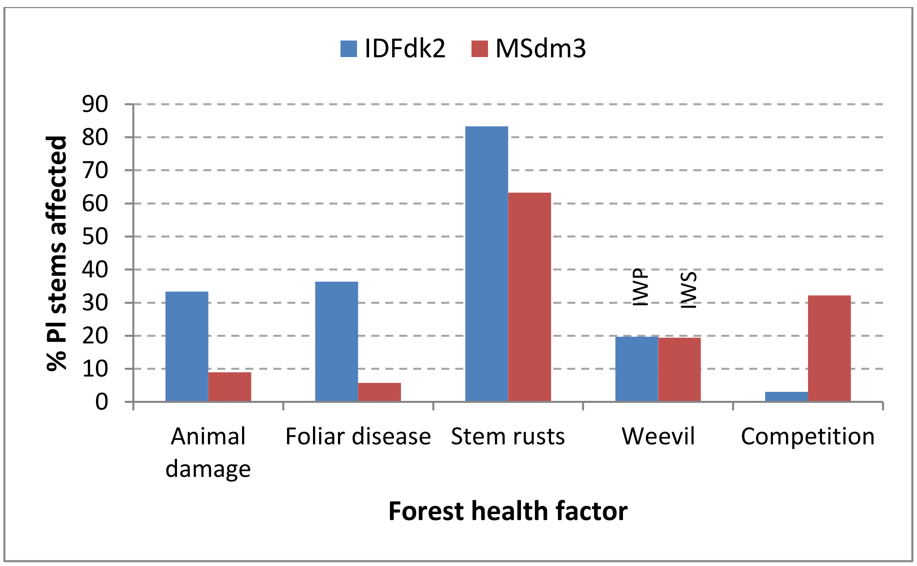
		% Form		
Species	N	Good	Fair	Poor
Bl	32	75.0	15.6	9.4
Fd	32	71.9	28.1	0.0
Pl	963	27.0	49.7	23.3
Sx	61	45.9	24.6	29.5

We calculated the percent of live lodgepole pine affected by common forest health factors and their influence on tree form. The most prevalent pests by far were western gall rust (DSG) and competition effects (VT). The most damaging pests judging from the tree form assigned to affected trees were western gall rust, lodgepole pine terminal weevil (IWP), spruce weevil (IWS) and competition effects (Table 8). Weevil defects, animal damage (A-), damage due to rusts (DSC, DSG, DSS), as well as competition accounted for nearly 24% of the 961 assessed stems that had poor form. Given that the average age of these trees is less than 20 years old, this is cause for concern going forward. Foliar disease (DFL) was present at high levels, but did not affect tree form. The same was true for northern pitch twig moth (ISP). Sequoia pitch moth (ISQ) caused greater damage, which was reflected in tree form (Table 8).

Table 8. Percent live lodgepole pine affected by common forest health factors and influence of these factors on overall tree form.

			% live Pl affected (across all plots)														
Form	N Pl	Defect IWP /IWS	AC	AD	AH	AS	DFE	DFL	DSC	DSG	DSS	ISP	ISQ	IWP	IWS	UA-	VT
Good	259	0.4	0.8	0.0	0.8	0.0	0.0	13.1	1.9	31.7	0.8	15.1	0.0	0.0	0.4	1.2	35.9
Fair	478	15.5	0.6	0.4	2.7	2.9	2.7	6.9	5.2	56.7	2.1	17.2	3.8	2.5	13.0	5.2	37.2
Poor	224	25.4	9.8	1.8	7.6	7.6	3.6	3.6	11.2	65.2	7.1	7.6	10.7	3.6	21.4	10.7	35.3

A comparison of pest incidence between the two biogeoclimatic subzones revealed that the IDFdk2 was more prone to animal damage and foliar diseases than the MSdm3 zone. Stem rusts and weevils were present at similar levels, while trees in the wetter MSdm3 suffered more from vegetation competition (Figure 1). Interestingly, lodgepole pine terminal weevil was more prevalent in the IDFdk2, while spruce weevil occurred more frequently in the MSdm3. Although the average percent weevil incidence is similar (Figure 1), the weevils are distinct, with IWP in the IDFdk2 and IWS in the MSdm3.



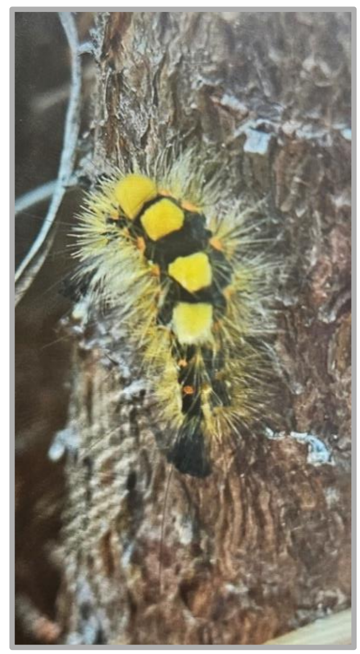


Figure 1. Differences in the average percent incidence of pests in lodgepole pine in two biogeoclimatic subzones. IWP was found primarily in IDFdk2 and IWS in MSdm3.

We compared defect severity by weevil species (Table 9). The most common defects on lodgepole pine due to lodgepole pine terminal weevil were crooks and forks. No lodgepole pine terminal weevil attacks were recorded on interior spruce. Spruce weevil affected lodgepole pine and interior spruce differently, with pine once again having a preponderance of crooks and forks. Spruce had creases, crooks, forks and stags in relatively equal numbers (Table 9). In the plots, spruce weevil attacked fewer spruce than lodgepole pine. It will be interesting to see if this attack trend is ongoing when these plots are next surveyed. Climate, be it temperature or water deficit, may play an integral role in spruce weevil's ability to attack lodgepole pine.

Table 9. A comparison of defect severity by weevil species.

		% defect-IWP attack				
Species	N	Crease	Crook	Fork	Stag	Current
Pl	23	4.3	56.5	39.1	0.0	0.0
		% defect-IWS attack				
Pl	111	2.7	51.4	27.0	11.7	6.3
Sx	32	25.0	28.1	28.1	18.8	0.0

References

B.C. Ministry of Forests. 1992. Correlated guidelines for management of uneven-aged dry belt Douglas-fir stands in British Columbia. First Approximation. Silviculture Branch, Victoria, B.C.

Maclauchlan, L.E., Brooks, J.E., and Zimonick, B. 2023. *Pissodes strobi* attack on lodgepole pine in the Kamloops Timber Supply Area. Journal of the Entomological Society of British Columbia 120. 5 pp.

Trapping forest beetles using semiochemical-baited Synergy Multitrap multiple-funnel traps with and without Fluon applied to the funnels

Lorraine Maclauchlan, Forest Entomologist, Thompson Okanagan Region

Marnie Duthie-Holt, Forest Entomologist, Kootenay Boundary Region

Background

In the late fall of 2022, woodborers were observed attacking apparently healthy, green trees in numerous locations throughout the southern interior of B.C. High levels of bark beetle and woodborer infestation were also noted within areas that had recently been burned by wildfires. The most commonly attacked host trees included mature Douglas-fir, ponderosa pine, western larch and occasionally young lodgepole pine.

Regional Entomologists in the Thompson Okanagan and Kootenay Boundary Regions, and the Stewardship Forester in Rocky Mountain District (Wade Jarvis), in collaboration with Synergy Semiochemicals Corporation (Bob Setter, Nicole Jeans-Williams), organized a small trapping trial to determine:

- woodborer species that were present locally;
- flight times; and,
- the best methodology for trapping woodborers (with or without Fluon).

Lindgren style Multitrap multiple-funnel traps and Synergy Funnel Trap II style funnel traps have been shown to increase numbers of Cerambycidae (longhorned or round headed beetles) caught when Fluon is applied to the funnels (Allison et al. 2016). Fluon seems to reduce friction in traps, which allows increased trap catches. The application of Fluon to traps is challenging and most of it runs off; however, the residual fluid is assumed to make the funnel surfaces slippery (less friction). Fluon coated funnels also adsorb significant amounts of pollen and dust, possibly negating its efficacy in field locations later in the season.

METHODS

Two separate trials were established in 2023. **Trial 1** was located in the Thompson Okanagan Region near Logan Lake; and **Trial 2** in the Kootenay Boundary Region mainly in the East Kootenays. The objectives for both trials were to identify locally active woodborer species and their flight times. Different lure blends were used in each trial.

Trial 1: Synergy Multitrap 5-funnel traps were tested with and without Fluon. Trap catches were compared. Ten traps were established in 5 locations within the 2021 Tremont Creek Fire, near Logan Lake. Each site had two traps spaced 20 meters apart, one coated with Fluon, the other without. This trial is part of a larger collaboration being done in 5 locations in Canada and United States, with 5 different collaborators.

Synergy provided 10 traps and lures to each of the 5 collaborators across North America. Fluon was applied to all funnels on 5 traps, while the other 5 traps were left untreated. All traps were baited with attractive lures appropriate to their location. Traps used wet cups and were checked every second week.

> **Lure:** Trial 1 targeted Cerambycidae in general. The lures included ethanol UHR, Fuscumol acetate, C6 diol (racemic), Fuscumol, 3-hydroxy-2-Hexanone (C6 ketol), and 3-hydroxy-2-Octanone (C8 ketol).

Collected insects were strained from the wet solution and then frozen until being processed for identification. Collections were assessed for total numbers by taxa. All insects were identified to the family level and their abundance and date of capture were noted.

Synergy Multitrap 5-funnel traps

Lure on trap

Trap catch

Trial 2: One Synergy Multitrap 5-funnel trap or one funnel trap II 12-unit funnel trap was established at each of 11 sites located near Cranbrook, Fairmont, and Radium in the Kootenay Boundary Region. No Fluon was applied in this trial. The collection and processing of traps was the same as for Trial 1. Taylor Holt, Forest Health Technician provided support, sorting and counting trap collections, and creating a sample insect collection of representative species caught. She also compiled an identification key for future reference.

> **Lure:** Trial 2 targeted *Monochamus /Xylotrechus* (Sawyer and Zebra beetle combo lure) and included (-) α-pinene, 3-hydroxy-2-hexanone (C6 mixed ketols) ethanol, ipsenol, and monochamol.

Results and Discussion

Thompson Okanagan Region

Traps in the Thompson Okanagan Region were established June 6, 2023, at 5 sites (2 traps per site) within the Tremont Creek Fire. Seven collections were made between June 21 and Nov. 9, 2023. A total of 462 woodborers were caught, with the Cerambycidae comprising 90% of the trap catch. In total, 34 Buprestidae, 418 Cerambycidae and 10 Siricidae were trapped (Table 1). Numerous other insect species were caught, including members of the Curculionidae (bark beetles and weevils). However, the majority of these were tiny, unidentified Scolytinae. One *Dendroctonus ponderosae* and one *D. brevicomis* were collected.

Table 1. Total number of Buprestidae and Cerambycidae caught in traps with or without Fluon between June 21 and Sept. 27, 2023 in TOR.

	Buprestidae (N)		Cerambycidae (N)	
Fluon applied	no	yes	no	yes
June 21	0	0	19	23
July 7	1	9	69	83
July 26	7	3	45	74
August 9	5	2	30	22
September 27	3	4	20	33
Total	**16**	**18**	**183**	**235**

No woodborers were collected after September 27, 2023, even though two further collections were made in October and November. There was no significant difference in the total number of woodborers caught in the traps with or without Fluon ($P>0.05$; t-test). Further analysis showed that only members of the Prioninae were kept in check by the Fluon, with 103 individuals caught in Fluon-coated traps compared to 34 in traps without Fluon. Therefore, there is little advantage to applying Fluon to traps in future trapping trials. One sub-family of Buprestidae (Buprestinae), five sub-families of Cerambycidae and one sub-family of Siricidae were recorded (Figure 1) in trap catches, Fluon and non-Fluon traps combined.

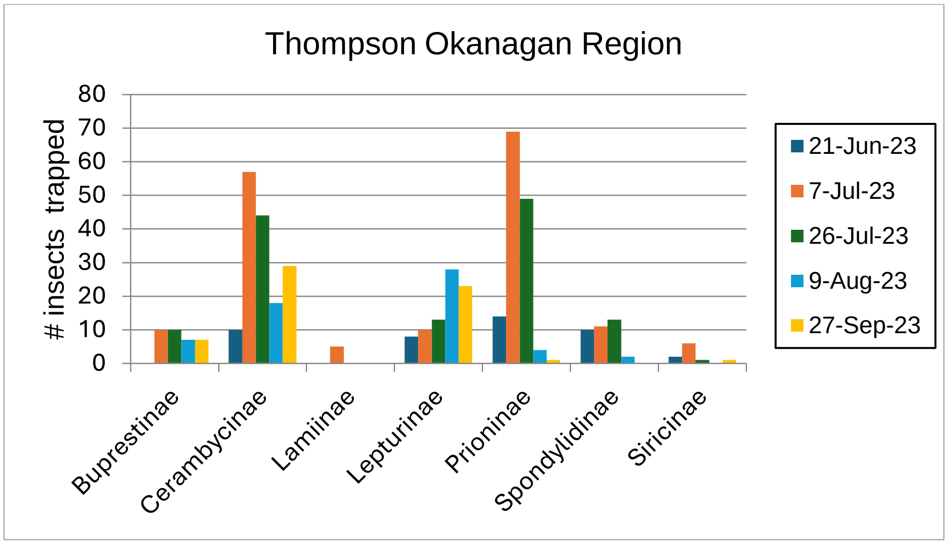


Figure 1. Number of Buprestidae (Buprestinae) and Cerambycidae (by sub-family) and Siricidae (Siricinae) caught in the Thompson Okanagan Region by collection date (Fluon and no Fluon traps combined).

The lure combination used in Trial 1 targeted Cerambycidae, which represented the dominant group captured and a diversity of species (Table 2). Highest captures of Cerambycinae and Prioninae were recorded in July, with low numbers of Buprestidae caught throughout the summer (Figure 1).

		
Cerambycidae: Prioninae	Cerambycidae: Lamiinae	Cerambycidae: Cerambycinae
		
Cerambycidae: Lepturinae	Buprestidae: Buprestinae	Buprestidae: Buprestinae

Table 2. Woodborer species caught in Multitrap 5-funnel traps in the Thompson Okanagan Region, summer 2023.

Family	Subfamily	Species	Common Name	N
Cerambycidae	Unknown			1
	Cerambycinae unk sp.			6
	Cerambycinae	*Opsimus quadrilineatus*	Spruce Limb Borer	1
	Cerambycinae	*Xylotrechus longitarsis*	Spruce Zebra Beetle	150
	Lamiinae	*Acanthocinus princeps*	Ponderosa Pine Bark Borer	1
	Lamiinae	*Monochamus scutellatus*	White-spotted Sawyer	4
	Lepturinae unk sp.			33
	Lepturinae	*Leptura obliterata*		5
	Lepturinae	*Xestoleptura sp.*		4
	Lepturinae	*Stictoleptura canadensis*	Red-shouldered Pine Borer	39
	Lepturinae	*Typocerus zebra*	Zebra Longhorn Beetle	1
	Prioninae unk sp.			7
	Prioninae	*Prionus californicus*	California Root Borer	130
	Spondylidinae unk sp.			30
	Spondylidinae	*Megasemum asperum*	Brown Longhorn	6
Buprestidae	Unknown			7
	Buprestinae	*Buprestis aurulenta*	Golden Buprestid	1
	Buprestinae	*Buprestis lyrata*	Pink-faced Jewel Beetle	26
Siricidae	Siricinae	*Sirex sp.*	Horntail	10

Other insect species collected from the traps over the summer are listed in Table 3. Most of the by-catch was beetles; however, there were also members of the Hymenoptera and other groups of insects. The Elateridae (click beetles) were the most abundant family of beetles caught in the traps, followed by Cleridae (checkered beetles) and Silphidae (carrion beetles) (Table 3).

Elateridae

Cleridae

Silphidae
Photo obtained from:
Silphidae (ubc.ca)

Trogossitidae

Table 3. List of insects other than woodborers caught in the Thompson Okanagan Region traps in 2023.

	N
Coleoptera	
Unknown Coleoptera	95
Cleridae	11
Enoclerus moestus	8
Enoclerus sphegeus	5
Coccinellidae	20
Harmonia axyridis	1
Curculionidae	1
Dermestidae	4
Elateridae	94
Hemicrepidius spp.	3
Nitidolimonius resplendens	1
Silphidae	16
Hymenoptera	
Unknown Hymenoptera	20
Ichneumonidae	58
Formicidae	41
Heteroptera	
Unknown Heteroptera	6
Rhopalidae	20
Coreidae	6
Cicadidae	17
Neuroptera	
Chrysopidae	20
Raphidioptera	13

Kootenay Boundary Region

Eleven sites were selected in the Kootenay Boundary Region (Table 4) in close proximity to observed woodborer damage on green trees. One Multitrap 5-funnel trap or one funnel trap II 12-unit funnel baited with the Sawyer and Zebra beetle combo lure was established per site. Traps were established from mid-June through early July 2023 and collections were conducted periodically from July 10 until October 16.

Table 4. List of woodborer sites in the Kootenay Boundary Region (1 Multitrap 5-funnel trap or 1 funnel trap II 12-unit funnel per site).

Trap #	Location
1	South Star (Gold Creek)
2	Isadore Trails lower
3	Isadore Trails upper
4	Lakit Road
5	Ft Steele 1 - River Valley Ranch
6	Ft Steele 2 - Haven of Hope
7	West Side Road
8	Fairmont 2 - Wilder Loop
9	Fairmont 1
10	Radium 1
11	Kootenay Lake

A total of 613 woodborers were caught, with Cerambycidae comprising 96% of the trap catch (Table 5). The lure was very effective at attracting *Monochamus scutellatus* (573 beetles) but captured lesser numbers of other Cerambycidae.

Table 5. Total number of woodborers collected at 11 locations in the Kootenay Boundary Region, summer 2023 trapping trial. The pheromone lure used was a sawyer beetle (*Monochamus scutellatus*) and spruce zebra beetle (*Xylotrechus longitarsis*) combo lure comprised of: (-) α-pinene, 3-hydroxy-2-hexanone (C6 mixed ketols), ethanol, ipsenol, and monochamol.

		Collection Period (N)				
Family	Species	Mid July	Late July	Late Aug	Early Oct	Total
Cerambycidae	*Monochamus scutellatus*	126	82	190	175	573
	Monochamus notatus	0	0	0	4	4
	Asemum striatum	0	1	0	0	1
	Xylotrechus longitarsis	7	0	0	1	8
Buprestidae	*Chalcophora angulicollis*	10	7	2	0	19
	Buprestis lyrata	0	0	5	0	5
Siricidae	*Sirex sp.*	1	1		1	3

Cerambycidae were caught throughout the collection period, with slightly higher catches later in the summer (Figure 2). Buprestidae were caught until August and predatory beetle catches, specifically *Temnoscheila chlorodia* (Trogossitidae-see above photo), peaked in mid-summer (Figure 2; Table 6). The Trogossitidae (Table 6) seemed very attracted to the Sawyer and Zebra beetle combo lure used in Trial 2, whereas only moderate numbers of this family were caught in Trial 1.

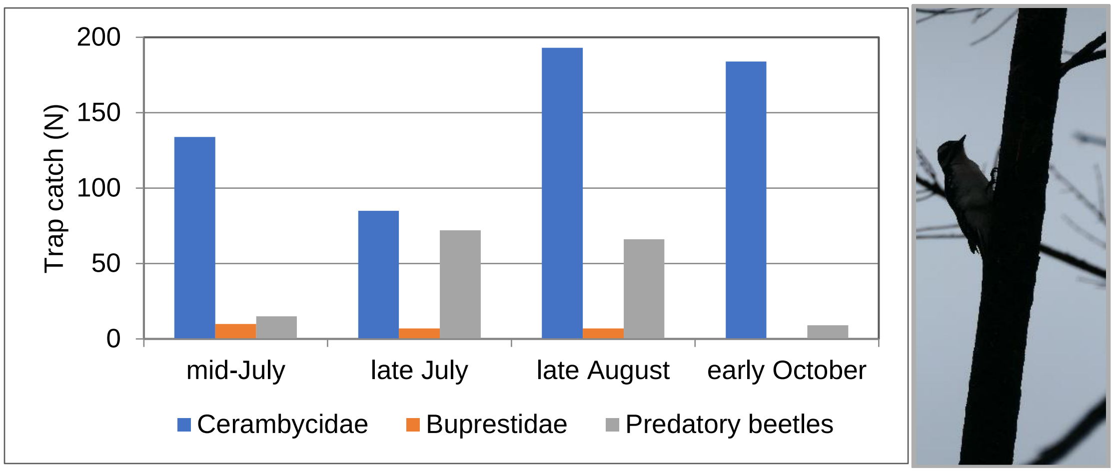


Figure 2. Total trap catch at 4 collection times at 11 trapping sites in the Kootenay Region.

Table 6. Total number of insects other than woodborers collected at 11 locations in the Kootenay Boundary Region, summer 2023 trapping trial.

		Collection Period (N)				
Family	Species	Mid July	Late July	Late Aug	Early Oct	Total
Trogossitidae (predator)	*Temnoscheila chlorodia*	15	72	65	7	159
Cleridae (predator)	*Thanasimus undatulus*			1	1	2
Cucujidae (predator)	*Cucujus clavipes*				1	1
Silphidae (carrion beetles)	*Thanatophilus lapponicus*				15	15
	Nicrophorus sp.			5	31	36
Scarabidae	*Diplotaxis sp.*	1				1

In summary, both trials caught a substantial number of woodborers. A greater diversity of Cerambycids was caught with the generic lure used in Trial 1 compared to mostly *Monochamus scutellatus* being caught in Trial 2. *Monochamus scutellatus* was caught in Trial 1, but at very low numbers. The lure used in Trial 2 was targeted toward attracting *Monochamus*. Therefore, this outcome supports the trapping differences between trials. The generic lure used in Trial 1 caught higher numbers of *Xylotrechus* and *Prionus*, plus smaller numbers of numerous other species. Therefore, to determine the richness and diversity of species in specific settings, the more generic lure for Cerambycidae may be the better option. Additional trapping studies are planned for 2024 using the generic Cerambycidae lure and green panel traps.

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Showcasing Disease Resistance among Canada's Endangered Whitebark Pine

Michael Murray, Forest Pathologist, Kootenay Boundary Region

Whitebark pine (*Pinus albicaulis*) is widely distributed in the higher mountains of southern British Columbia and southwestern Alberta. Due primarily to the introduction of a fungal pathogen (*Cronartium ribicola*), the disease white pine blister rust significantly reduces populations. Whitebark pine provides wildlife with large fatty seeds and a hardy canopy in a harsh environment. Some Indigenous peoples have historically collected its seeds. Other values associated with this species include soil stabilization, snowpack retention, and providing microhabitat for less hardy flora to establish. The decline of whitebark pine led to it being listed as a federally endangered species in 2012.

Mitigating the impacts of blister rust is considered a foundation for the recovery of this species. In 2011, the Ministry of Forests (MOF) began testing wild trees for inherent resistance to blister rust. The process entails collecting cones from healthy trees within heavily impacted stands, growing seeds, inoculating the seedlings, and assessing them for disease signs and survivorship. The process takes about six years per inoculation cohort and is conducted at the Ministry's Kalamalka Research Centre in Vernon (Murray and Strong 2021). This sequence of steps is patterned after the successful western white pine (*P. monticola*) blister rust resistance program that was developed by the US Forest Service, MOF, and Canadian Forest Service decades ago. To help supplement and validate results, several high elevation field trials have been established to examine seedlings from the same parent trees being tested at Kalamalka (see pgs. 54-55, *2014 Summary of Forest Health Conditions in B.C.*). These seedlings were not inoculated at Kalamalka, but rather rely on natural transmission of the disease under environmental conditions typical of whitebark pine habitat.

Inoculation chamber at Kalamalka

Ribes *inoculation at Kalamalka*

White pine blister rust on a seedling

To date, seedlings from more than 300 parent trees have been inoculated. As results accumulate, there is optimism regarding whitebark pine's future. We are detecting individual trees from across the range that are naturally resistant. Resistance is classified on a continuous scale using a susceptibility index and percentile-based grading. The former is a strictly quantitative calculation (Index = avg. no. cankers + avg. severity + % with cankers + % dead from blister rust) that is performed based on seedling results from each parent separately. This susceptibility index is used to compare results within each controlled inoculation run. The index is not used to compare results between different inoculation runs because conditions can vary between runs (e.g. spore load, germination, post-inoculation temperature and humidity). To compare trees among multiple inoculation runs, we introduce a separate percentile-based grading that assigns a letter-grade that is readily understood by stakeholders and allows us to compare trees range-wide (Figure 1).

Our results are helping ensure that the best parent trees are being targeted for seed collections. First Nations, the mining industry, BC Parks, Parks Canada, and The Nature Conservancy of Canada are conducting restorative plantings in affected areas.

Murray, M.P. and Strong, W. 2021. Disease screening for endangered whitebark pine ecosystem recovery in Canada. Journal of Ecosystems and Management 21:1–7.

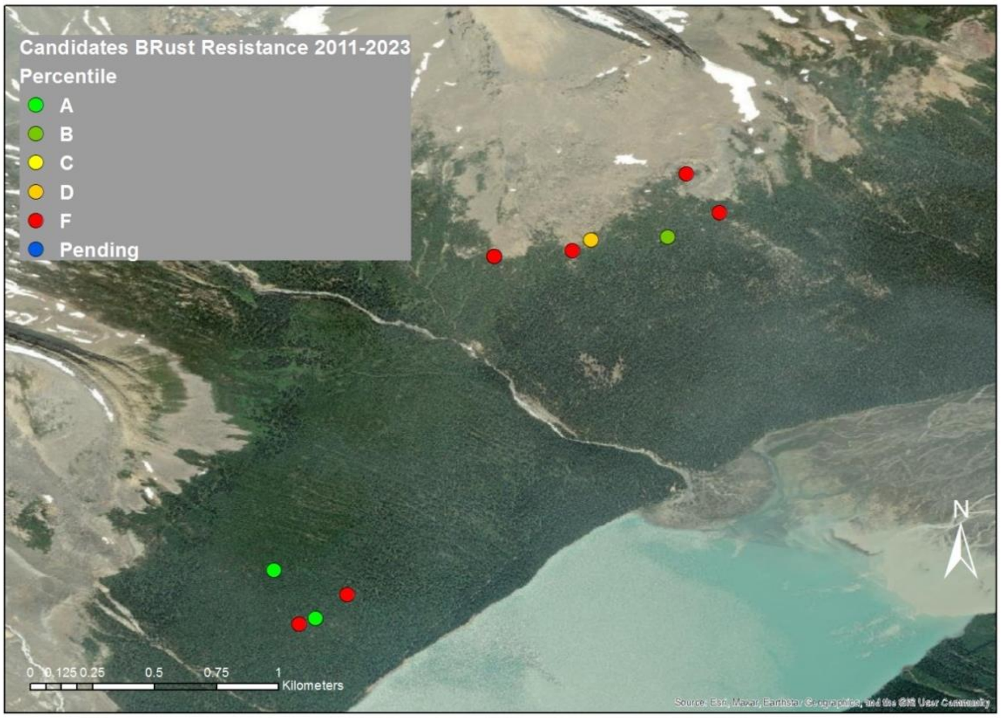

Figure 1. The screening of individual whitebark pine for disease resistance yields results that indicate varying degrees of disease susceptibility. Grading on a scale (A-F) conveys resistance. Ten screened trees at Berg Lake, Mount Robson Provincial Park, BC

Forest Health Extension and Outreach in the Thompson Okanagan Region

Calvin Jensen, Forest Pathologist, Kamloops

Calvin Jensen, working alongside Lorraine Maclauchlan, provided extension and outreach activities in 2023 to inform students, stakeholders, and forest professionals on various forest health issues in the Thompson-Okanagan Region.

Both Lorraine and Calvin gave an in-person presentation to post-secondary students at the Nicola Valley Institute of Technology in Merritt on forest health issues such as white pine blister rust and forest health issues in the region. A *Research Palooza* was held for Okanagan Shuswap District employees with presentations on forest health, soil carbon, and forest hydrology. Calvin also gave a presentation on forest health research and operations to the Qwelmínte Secwépemc Knowledge Builders program in Kamloops.

Field tours were held for post-secondary students from Vancouver Island University to aid in their understanding of forest health issues in the southern interior. The field tour focused on pests of young stands and forest pest management. Field tours and training sessions were also given to licensees, BCTS employees, First Nations forestry workers, and consultants on emerging forest health issues such as drought, Douglas-fir beetle, woodborers, and pest of young stands.

Field tour participants looking for woodborers

Lorraine presenting on Pissodes strobi

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Forest health training, Kamloops

Kathy Bleiker, Canadian Forest Service – gall on lodgepole pine.

Entomologists at Western Forest Insect Work Conference, 2023.

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This report is available in PDF format at: [Aerial overview survey summary reports - Province of British Columbia (gov.bc.ca)]