2022 Forest Health Report

Environment and Natural Resources
Forest Management

Government of
Northwest Territories

Contents

1. Forest Health Program in the Northwest Territories

Background

The Forest Management Division (FMD) of the Department of Environment and Natural Resources (ENR) is responsible for monitoring forest health conditions across the Northwest Territories (NWT) to ensure the forest has the capacity for renewal after a wide range of disturbances, and is able to retain its ecological resiliency while meeting the current and future needs of NWT residents. Historically, the focus of the forest health program has been on monitoring insect and disease impacts in the NWT forests. FMD is also recording abiotic disturbances (disturbances caused by non-living factors) to address the uncertainty of forest ecosystem response to a changing climate. Examples of abiotic disturbances recorded during monitoring surveys include: drought symptoms (reddening of foliage, sun scalding scars, stunted and gnarled foliage), flooding, wind, hail, and snow damage, landslides, and permafrost related disturbance (i.e. "drunken forest" phenomenon or thaw slumps). General decline of some tree species is also tracked. In cases where a biotic agent cannot be identified, it is considered to be of abiotic origin.

Historically, surveys were conducted by the Canadian Forest Service from the 1950's until 1998 when the territorial government took over this function. Since 2009, annual forest health surveys have been conducted by ENR staff, assisted by the Canadian Forest Service (CFS). Beginning of 2022, CFS was no longer able to provide assistance with forest health monitoring due to staff changes. Consequently, GNWT hired a private consultant SKOG Forest Health to assist with surveys. The owner of the SKOG Forest Health is Roger Brett, a former CFS employee who has been working with GNWT for several years in this role. The aerial surveys were conducted by Jakub Olesinski (ENR) and Roger Brett (SKOG).

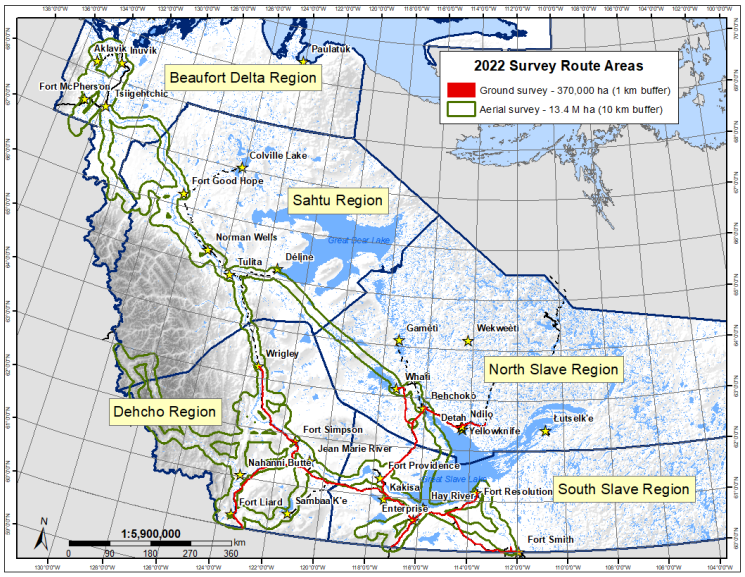


Figure 1: NWT Forest Health aerial and ground survey extent in 2022.

Monitoring scope

Forested land in the NWT encompasses nearly 800,000 km^2, larger than any European country excepting Russia. Due to this immense size, it is necessary to prioritize areas surveyed annually. Traditionally, areas occupied by mature spruce forests have been a priority because of their significance as the preferred host for the most serious insect pest in the NWT – Spruce Budworm (*Choristoneura fumiferana*) (SBW). These areas extend along major rivers and waterways, including the Mackenzie, Liard and Slave Rivers and their main tributaries, as well as the foothills of the Mackenzie Mountains and slopes of the Cameron Hills, Marten Hills and Ebbutt Hills.

In 2022, the ground surveys were conducted along all major highways and the aerial survey followed typical annual routes across the territory (Fig. 1).

Methods

Aerial detection and coverage

Monitoring is mostly conducted through aerial detection mapping using small planes such as a Cessna 206. A helicopter is used when ground verification is required in areas with limited road or water access. Disturbed areas are digitally mapped using a tablet with ESRI Arc Pad 10 software. Insect and disease agents are usually identified on site based on the host and characteristics of the damage. However, in some cases, samples are collected and taxonomic identifications are made at the CFS Northern Forestry Centre lab in Edmonton, Alberta.

The total area that is covered by surveys varies slightly each year due to visibility. Under optimum flying conditions, approx. 12-14 million hectares (ha) are covered which is approx. 15% of the total forest land area in the NWT. In 2022, approximately 12 million ha were surveyed. Aerial surveys were conducted using Cessna 206 (Simpson Air) on July 11-20.

The severity of defoliation and damage is also recorded during aerial surveys as an attribute associated with spatial data. Severity expresses the degree of foliage affected, or amount of mortality present in a stand, caused by the particular pest or damaging agent. In the case of defoliators or abiotic foliar damage, severity class is assessed visually as a percentage of current growth affected (Table 1), whereas with mortality agents such as bark beetles or abiotic factors, severity represents the percent of trees affected within a stand. Mortality can also result from moderate to severe defoliation recurring over several years, which is especially likely with spruce budworm. Other defoliators, like aspen serpentine leafminer or willow blotch leafminer, are rarely the sole cause of tree mortality despite the severe damage they cause each year. The ramifications of severity of defoliation are described below when discussing each particular pest agent.

Table 1: Defoliation severity classes and mortality severity classes used by FMD

Severity class	Defoliation (% of current-year foliage)	Mortality (% of trees killed)
Light (L)	<30	<10
Moderate (M)	30-70	10-70
Severe (S)	>70	>70

Ground surveys

Ground surveys along the major NWT highways are conducted annually. These surveys play an important role as they are often the only opportunity to confirm suspected pest agents on the ground. Ground surveys also provide opportunities for collecting samples and discovering new and emerging factors affecting forest health, often not discernable from the air. The following ground surveys were conducted in 2022:

- Aspen defoliation survey (June 5-12) in accessible areas of the South Slave and Dehcho Regions
- General ground survey (July 21, 24-26, and Jul 29-Aug 5) in accessible areas of the South Slave, Dehcho, and North Slave Regions.

Notes on 2022 survey routes

Aerial survey routes were roughly the same as previous years with a few exceptions:

- The Little Bear – Stewart Lake – Peele River area was not surveyed
- Additional areas on the NW side of the Cameron Hills and north of Fort Providence were surveyed to cover spruce budworm outbreak expansion in these areas.

The newly opened Tlicho All Season Road (Hwy 9) was ground surveyed for the first time.

Pheromone trapping

Pheromones are used to detect both mountain pine beetle and spruce budworm. Mountain pine beetle is detected using a dispersal baiting method. Five baiting locations were established in the southern NWT. Three locations were established along the Highway 1 corridor (Alberta border to Enterprise), and two locations were established between Enterprise and Jean Marie River (Fig. 2).

The spruce budworm pheromone trapping program was active across the territory in 1997-2012, and in the Beaufort Delta Region it has been active again since 2017. The regional forestry staff deploys traps in historical trapping locations along the Arctic Red River, Peel River and the upper Delta. There are currently four active trapping locations with three traps at each site. The Unitrap container type traps are deployed from mid-June to mid-August (Fig 2) using rotary wing. Each trap contains a pheromone lure to attract male moths, and an insecticide strip to kill trapped moths. When traps are collected in August, the SBW moths are separated from other insects that may have been caught, and then counted. Moth count results are sent to the Ecosystem Forester. No SBW pheromone trapping occurred in 2021 due to operational constraints in the Beaufort Delta Region.

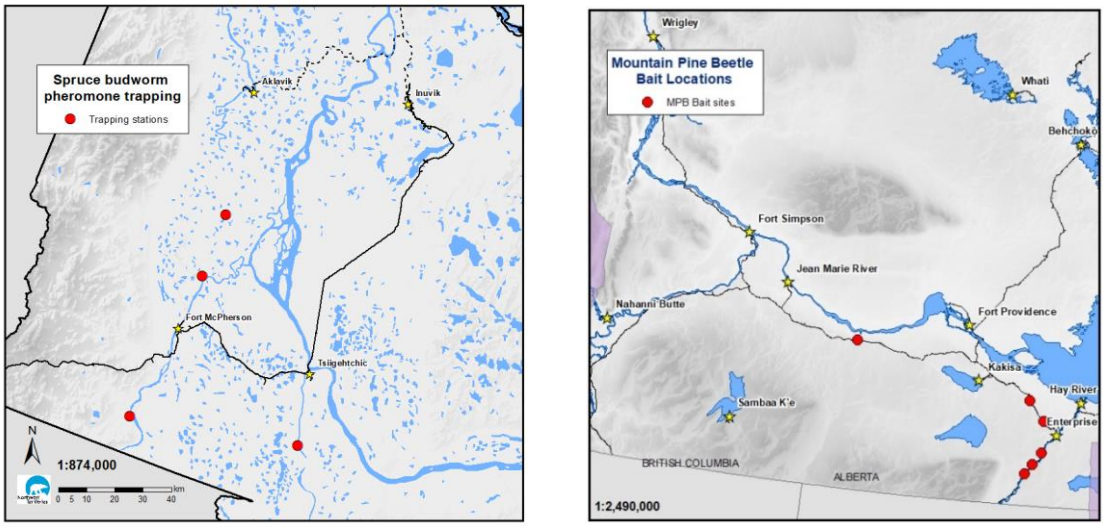


Figure 2: Pheromone trapping locations for spruce budworm in the Inuvik Region (left) and baiting locations for mountain pine beetle in the South Slave and Dehcho Regions (right)

Public reports

Public sightings and regional reports are an important addition to the existing body of knowledge. Renewable Resource Officers, Forest Officers and the general public are encouraged to report any forest health issues that draw their attention. Each year, FMD receives inquiries with photos of various insect and disease disturbances from communities across the NWT. Public reports are important because they not only help corroborate aerial survey observations, but often help direct ground surveys.

2. Climate and wildfire conditions

Climate and weather conditions

The 2022 growing season weather was unusually warm across most of NWT. It resulted with drier than normal conditions throughout most of the territory except for Inuvik. Southern parts of the territory were particularly dry receiving only 50-66% of normal precipitation (Fig. 3). Dry conditions in the south greatly contributed to mitigating areas flooded in previous years by drying many of them up.

Total and Percent of Normal Precipitation: Summer 2022		May	June	July	August	Total Summer Rainfall	% of Normal Summer 2022
Fort Smith A	Actual	49.5	12.1	30.3	24.1	116.0	63
	Average	27.8	48.8	54.5	54.5	185.6	
Hay River Climate	Actual	62.3	4.7	20.5	16.3	103.8	66
	Average	23.3	31.9	43.0	58.7	156.9	
Fort Chipewyan RCS	Actual	67.1	7.7	45.2	31.5	151.5	80
	Average	27.2	44.4	67.4	50.2	189.2	
Yellowknife A	Actual	28.0	6.2	33.4	31.1	98.7	77
	Average	18.4	28.9	40.8	39.3	127.4	
Fort Simpson A	Actual	24.1	32.5	19.2	48.0	123.8	61
	Average	29.4	51.3	61.1	61.4	203.2	
Fort Liard (WJL)	Actual	42.6	21.6	22.3	34.1	120.6	50
	Average	41.4	59.5	83.4	55.3	239.6	
Norman Wells A	Actual	15.1	58.6	22.9	37.5	134.1	92
	Average	19.0	42.7	41.8	41.8	145.3	
Inuvik Climate	Actual	12.7	13.9	50.4	52.5	129.5	119
	Average	17.3	17.3	35.0	39.4	109.0	

Figure 3. Summer (May-Aug) precipitation at major meteorological stations across the NWT in 2021. Source: 2021 Fire Weather Report. True North Weather Consulting Inc.

Precipitation remained well below normal across the bulk of the NWT in September and October increasing the drought conditions developed over the southern NWT. The air temperature was unusually high in September in the South Slave and Dehcho Regions frequently exceeding 25°C and occasionally reaching 30°C. This unusual weather pattern can likely be attributed to a 'heat dome' phenomenon persisting over western North America from mid-August to near the end of October. Some sources suggest that the 2022 conditions resulted from compounded effects of La Nina and climate change.

Fire activity

Compared to the past five years, the 2022 fire season experienced a drastic increase in fire activity across the NWT. There were 262 fires with a total of 708,918 ha burned which was nearly 16% higher than the 30-year average. Fire activity remained unseasonably high throughout the months of September – October with 12 new ignitions, and even in November-December with 5 more new ignitions.

3. Overview of forest health conditions

Over 3 million ha of forested land out of 12 million ha surveyed were affected by forest health related issues. Despite significant wildfire activity, visibility during surveys was favorable with little smoke and only minor rain issues. However, heavy flowering and cone crop on white spruce in the northern parts of the territory impeded accurate aerial assessment of spruce budworm defoliation in those areas. In addition, rain washing may have affected assessment in the South Slave and Dehcho Regions.

The most significant forest health issue observed in 2022 was the ongoing spruce budworm outbreak occurring over much of the southern NWT (1.3 M ha). Another significant pest was aspen serpentine leafminer which affected 1 M ha of aspen forests mainly in the Dehcho and South Slave Regions. Some aspen dominated forests in the Dehcho were also defoliated by the complex of defoliators first observed in 2021, primary agents being either the two-leaf tier or large aspen tortrix (approx. 414,000 ha). Ground surveys revealed several minor and secondary pests affecting aspen, poplar and birch. Overall, 2.8 M ha were affected by insect and disease agents in 2021.

Abiotic disturbance (not related to pests and pathogens) included flooding and high water table issues, observed in the southern NWT despite overall much drier conditions. Changes to permafrost could also play a role in high water tables in these areas as they are located within the discontinued permafrost zone which is particularly sensitive to changes such as rapid thawing. Stress from heat and drought was also noted on various species throughout the South and North Slave, and in the Dehcho. Overall, approx. 185.000 ha were affected by abiotic disturbance.

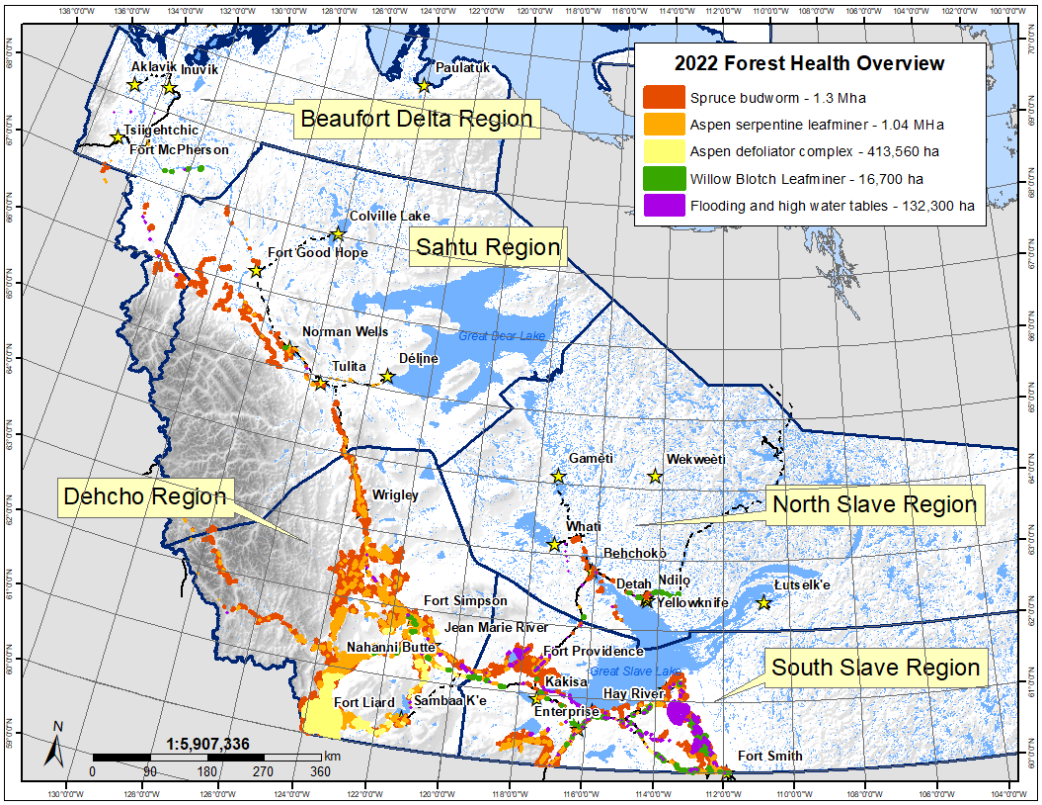


Figure 2. Overview of 2022 forest health conditions in NWT.

Table 2. Summary of areas affected by biotic and abiotic agents across the administrative regions of the NWT based on the area surveyed. The footnotes indicate tree mortality associated with the agent.

Disturbance agent	North Slave (ha)	Sahtu (ha)	South Slave (ha)	Dehcho (ha)	Beaufort Delta (ha)	Total (ha)
Eastern spruce budworm[1]	8,508	54,507	350,558	881,703	14,593	1,309,869
Aspen serpentine leafminer[1]	275	3,626	108,432	933,786	49	1,046,168
Aspen defoliator complex[1]			4,341	409,217		413,558
Willow blotch leafminer[1]	764	42	12,078	1,229	421	14,534
Western gall rust[1,2]	3		137	623		763
Western balsam bark beetle[3]				543		543
Commandra blister rust[1]				440		440
Birch leafminer[1]	182					182
Cottonwood leaf beetle[1]	119					
White-spotted sawyer beetle[2]			51	26		77
Venturia shoot and leaf blight[1]	60			14		74
Ips pini (jack pine)[2]	6		14			20
Yellow-headed spruce sawfly[1]	8			14		22
Total Biotic Disturbance	**9,925**	**58,175**	**475,611**	**2,227,595**	**15,063**	**2,786,369**
High water tables and flood-ing[2]	177	44	125,045	3,682	357	
Black spruce decline[2]		25,348				
Spruce mortality[2]		2,934			17,276	
Drought/Heat stress[1,2]	1,552		1,163	452		
Jack pine shoot/crown dam-age[1,2]	418	8	2,346	93		
Aspen decline[2]	10		14	1,996		
Slumping / Land slides[2]		476		292	726	
Ice flow damage[2]			375		58	
Total Abiotic Disturbance	**2,157**	**28,810**	**128,943**	**6,515**	**18,417**	**184,842**
Total Area Affected	**12,082**	**86,985**	**604,554**	**2,234,110**	**33,480**	**2,971,211**

[1] – Damage to foliage, trees can be affected in the same areas over multiple years. Numbers reported denote area affected in the current year.

[2] – Tree mortality present in a stand of trees. Reported numbers denote new areas affected in the current year.

[3] – Tree mortality present in a stand. Reported numbers denote current status of affected area which had been mapped in previous years (update).

Notes on tree mortality associated with disturbance agents

Insect pests which feed on leaves and needles of trees on an annual basis are called defoliators. These pests usually do not kill trees immediately. A significant loss of leaves or needles results in growth loss, increased susceptibility to attack by other insects and pathogens, and eventually – mortality. For some pests, such as spruce budworm, it takes as long as 5-7 years of consecutive severe defoliation to kill a tree. Other defoliators, such as aspen serpentine leafminer, usually inhibit tree growth and weaken a tree without killing it. Because defoliation can occur over several years in the same areas, reported ha

for defoliators are unique for each year. Some pathogens can also cause defoliation (e.g. spruce needle rust); therefore areas affected by these agents are also unique for each year.

Common defoliators in the NWT: spruce budworm, aspen serpentine leafminer, forest tent caterpillar, large aspen tortrix, aspen two leaf tier, leaf rollers, willow blotch leafminer, birch leafminers.

Damage caused by bark beetles usually results in tree mortality. Numbers reported for these agents represent the current status of areas (tree stands) with % of tree mortality. Often, a complex of pests rather than a single pest is responsible for tree mortality. Most of abiotic disturbance observed in the NWT is associated with tree mortality e.g. flooding mortality or blowdown (wind damage) mortality.

Most common insect pests causing tree mortality in NWT: western balsam bark beetle, spruce beetle, eastern larch beetle, white spotted sawyer beetle (pest complex).

Eastern Spruce Budworm (*Choristoneura fumiferana*) – SBW

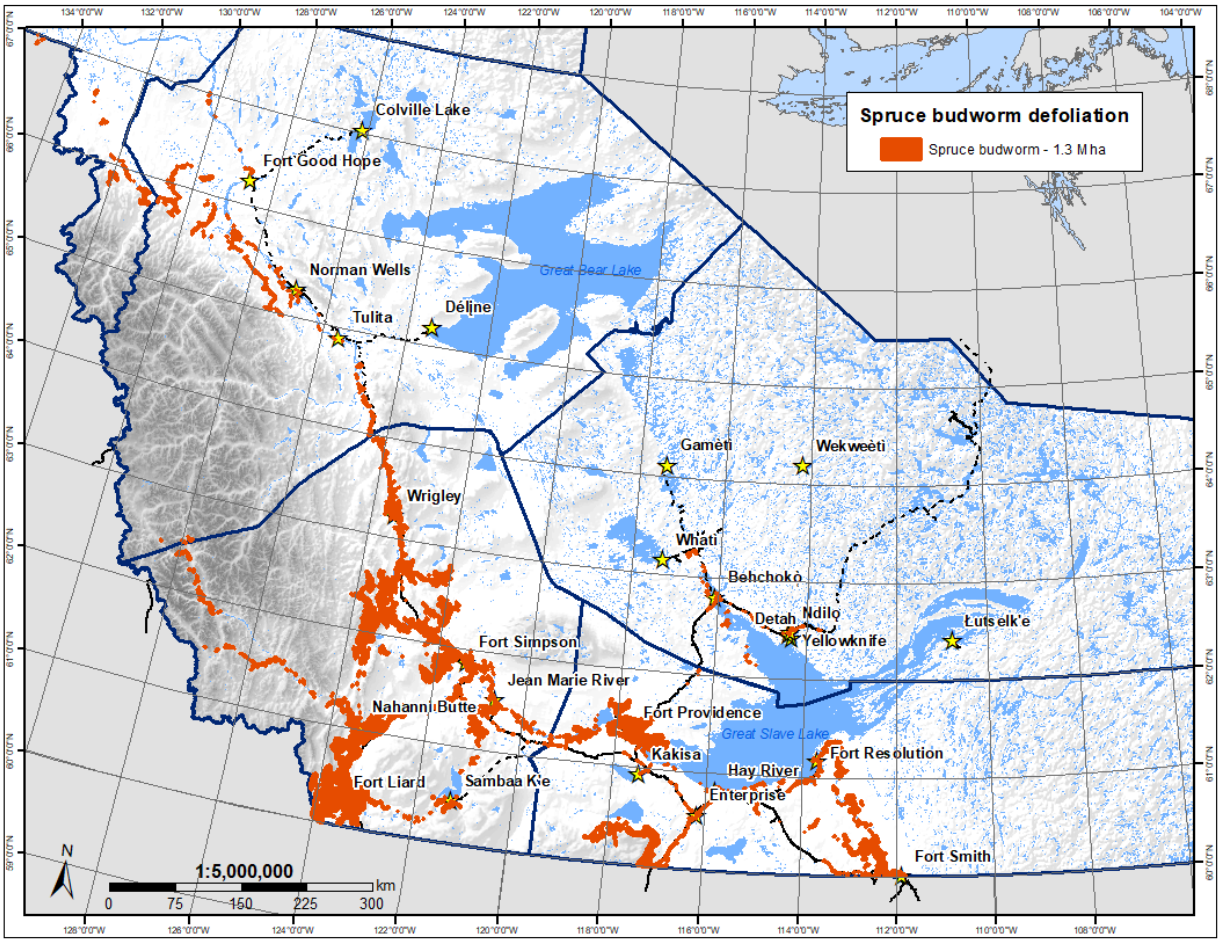
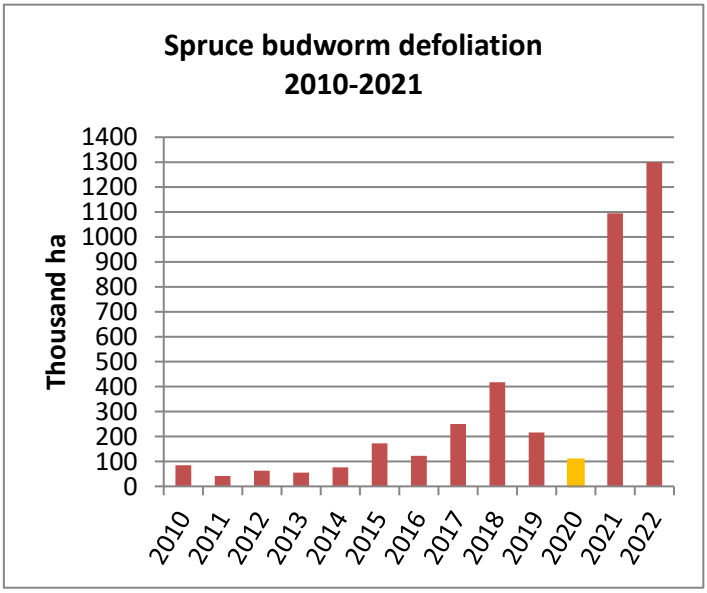


Figure 3. Overview of spruce budworm defoliation in the NWT. Red circled are hotspots of particularly severe defoliation observed in 2021.

Severe and moderate spruce budworm defoliation continued in white spruce dominated stands throughout the South Slave and Dehcho Regions in 2022 (Fig. 5). Over 1.3 million ha were mapped across the territory which is the largest area recorded since the last big outbreak in the early 2000's

when nearly 3 M ha were affected, and expanded from 2021 by 20%.The majority of increases were observed in the Sahtu and Dehcho Regions. Survey routes had to be expanded in many areas to properly record the extent of defoliation (e.g. north of Fort Providence, deeper into North Nahanni and Willowlake Rivers, northeast of Fort Resolution). Budworm populations were extremely high as evidenced by larvae defoliating even black spruce and tamarack.



SBW populations have been gradually increasing, especially in the Dehcho and South Slave Regions starting in 2016. Only the southern part of the territory was surveyed in 2020 but areas that were surveyed showed signs of increased defoliation leading to extreme outbreak levels in 2021 which continued in 2022 (Fig. 4).

Figure 4. Area affected by spruce budworm in the NWT over the last decade. Only the southern part of the territory was surveyed in 2020.

South Slave and North Slave Regions

The majority of white spruce dominated stands in the South Slave Region experienced severe spruce budworm defoliation, as in the previous year (Fig. 7). General declines occurred north of Fort Providence, in the Cameron Hills, and along the Slave River. Despite an overall decrease in defoliated area, a sizeable expansion did occur between Fort Providence and the north shore of the Mackenzie River southeast towards the Big Island. It is possible some of this was present in 2021 but went un-noticed as the area was not covered by the survey route. Much of the defoliation on mature spruce in the Fort Smith area had the pattern of more defoliation on the bottom 2/3 of crowns, while the tops were cleaner. It was also noted that understory white spruce were often severely defoliated. This could indicate heavy rains or frost early in the spring/summer affected the more exposed unprotected larvae.

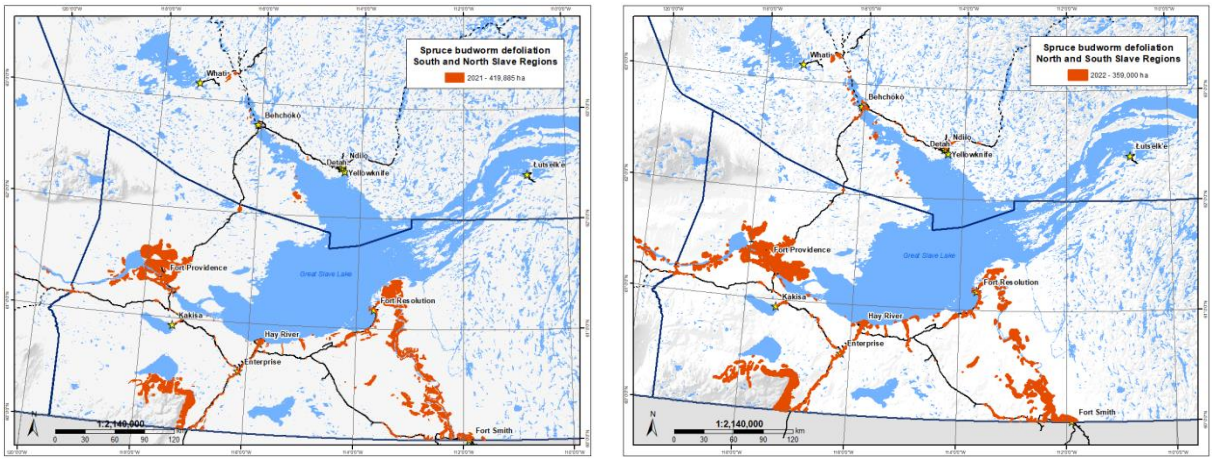


Figure 5. Spruce budworm defoliation extent in 2021(left) and 2022 (right) around the Great Slave Lake.

In the North Slave, small declines were observed on the west shore of the Great Slave Lake near the Shore Point (mainly due to wildfires) and along the Riviere La Martre east of the falls. Aside from the decreases, new areas were also mapped near Behchoko and the North Arm area, on Pointe du Lac, and in the Yellowknife and Ingraham Trail area.

Dehcho Region

In 2021, The Dehcho Region experienced its highest levels of SBW defoliation since the early 2000's. Over 540,000 ha were severely or moderately affected with hotspots around Fort Liard, Nahanni Butte, and along the Mackenzie River up to Wrigley. In 2022, SBW defoliation increased by 38%. Much of new damage was recorded in the Fort Liard / Fisherman Lake areas, Martin Hills, and to a lesser degree north of Wrigley near the Sahtu border (Fig. 6).

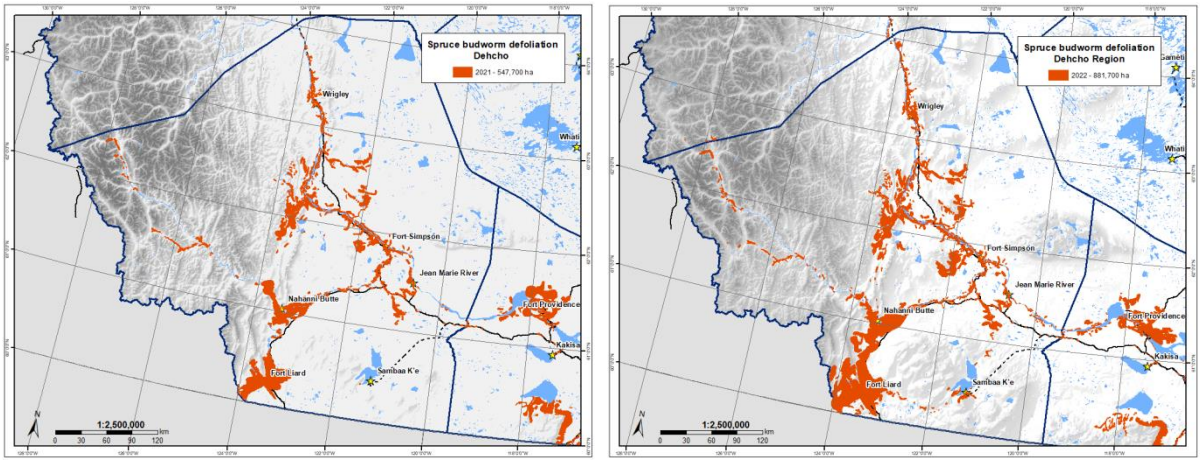


Figure 6. Spruce budworm defoliation extent in the Dehcho Region in 2021 (left) and 2022 (right)

Sahtu and Beaufort Delta

Both Sahtu and Beaufort Delta Regions did not experience as extreme SBW defoliation as the southern regions; however, expansions compared to 2021 levels were noted in several areas. In the Sahtu, increases were observed along the Mackenzie, Carcajou, and Hume Rivers (Fig. 7). Although the Little Bear, Stewart Lake, and Peele River area was not surveyed in 2022, given the current SBW levels it is very likely that these areas were also affected. In the Beaufort Delta Region, general declines occurred along the Arctic Red and Cranswick Rivers.

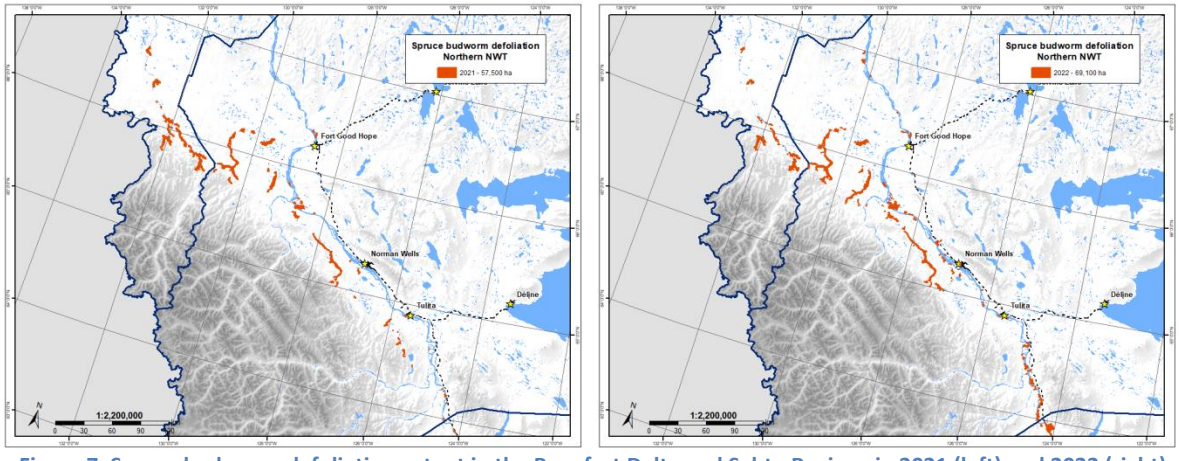


Figure 7. Spruce budworm defoliation extent in the Beaufort Delta and Sahtu Regions in 2021 (left) and 2022 (right).

Pheromone trapping for spruce budworm resumed in the Beaufort Delta Region after a year break. Traps were not deployed in the Peel Channel area due to high water levels at the trapping site. According to trapping results, SBW populations in the Peel, Husky, and Arctic Red River areas appear to be at endemic levels (Table 3). Traps were deployed on June 18 and retrieved on Aug 17. The 5-year trend of SBW population dynamics in the Beaufort Delta has been steadily decreasing (Fig 8).

Trapping location	Trap number	Moth count
Arctic Red	1	22
	2	54
	3	38
Peel River	1	Bear damage
	2	131
	3	111
Husky Channel	1	7
	2	9
	3	1
Peel Channel	Not deployed due to high water levels	

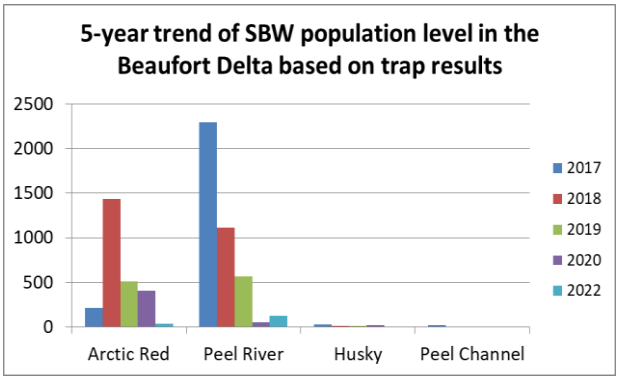


Figure 8. 2022 SBW trap counts (left) and a 5-year trend in population levels in the Beaufort Delta Region based on trapping results (right).

Other pests on white spruce

- Ragged spruce gall adelgid (*Pineus similis*) – observed on a couple small spruce saplings in trace amounts along the Whati Hwy near the Chutes la Martre turnoff.
- Pale spruce gall adelgid (*Adelges strobilobius*) – found along the Ingraham Trail east of the Prosperous Lake Park (Fig 9).
- Suspected – white spruce cone maggot (*Strobilomyia neanthracina*) – damage from this suspected maggot was found on white spruce cones in trace amounts along the Liard River south of the Poplar River.
- Yellow-headed spruce sawfly (*Pikonema alaskensis*)(Fig 9) – damage from this pest was severe enough to warrant mapping in the Dehcho along the Mackenzie Hwy near the Redknife River (14 ha), and in the North Slave just north of Chan Lake Park (3.4 ha), and in Yellowknife (4.2 ha).

Figure 9. Pale spruce gall adelgid (left), yellow-headed spruce sawfly damage (middle) and larvae (right) as observed in 2022

Aspen Serpentine Leafminer (*Phyllocnistis populiella*) – ASL

Aspen serpentine leafminer continues to be one of the most prevalent insect pests in the NWT. The extent of ASL matches the current range of aspen in the NWT, making it one of the most successful pests in the North. In 2022, over 1 M ha were affected by ASL which is a 7% increase compared to 2021. Most of the defoliation was observed in the Dehcho Region (934,000 ha or 86%, Fig 10). The second most affected region was the South Slave (108,000 ha). Undoubtedly, long-term defoliation caused by ASL, along with past droughts, plays a role in the ongoing aspen decline occurring in the Dehcho and South Slave. Many areas affected by the ongoing ASL outbreak are starting to see dieback and even tree mortality among stands. This is especially evident in mature and over-mature aspen forests previously affected by droughts in the Dehcho.

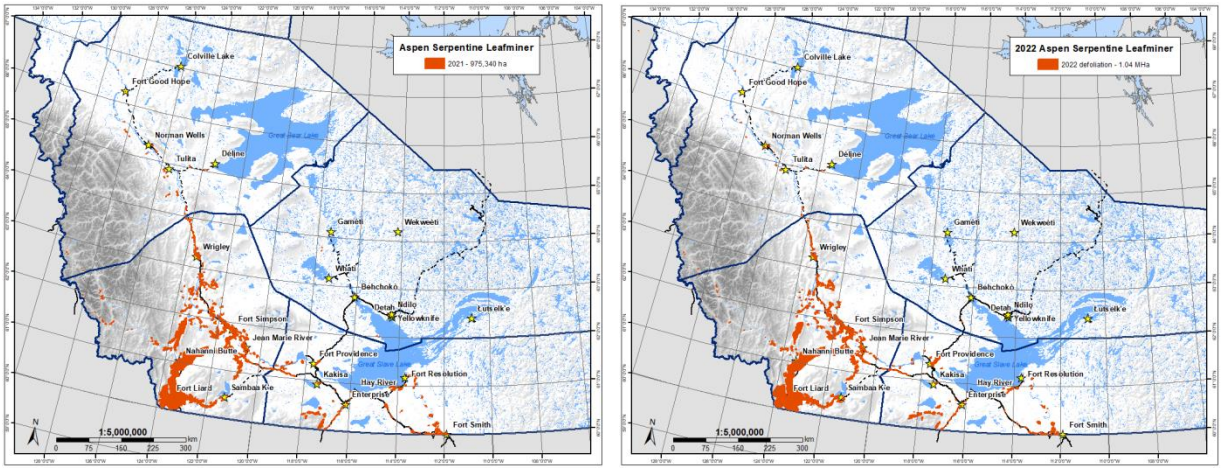


Figure 10. Extent of defoliation caused by aspen serpentine leafminer in the NWT in 2021 (left) and in 2022 (right).

Aspen defoliator complex

The complex of 3-5 defoliators first observed in 2021 continued to be active in 2022.The complex was determined to be comprised of 5 primary agents and many miscellaneous secondary pests. The five primary agents were the aspen serpentine leafminer, aspen two-leaf tier, pale-headed leafroller, large aspen tortrix, and another unidentified leaf tier.

Aspen two-leaf tier larvae feed on the side of the leaves and construct flattened cases made from two leaves bound together with silk webbing. A serious infestation may result in the complete defoliation of the host tree; however, severe damage is rarely caused because outbreaks are usually short-lived (Fig. 11).

Figure 11. Leaf damage caused by aspen two-leaf tier (left) and a pupa of large aspen tortrix (right) as observed in the Dehcho in 2021. ASL damage (serpentine pattern) is also visible in both photos. All three pests were part of a new defoliator complex noted mostly in Dehcho and South Slave Regions.

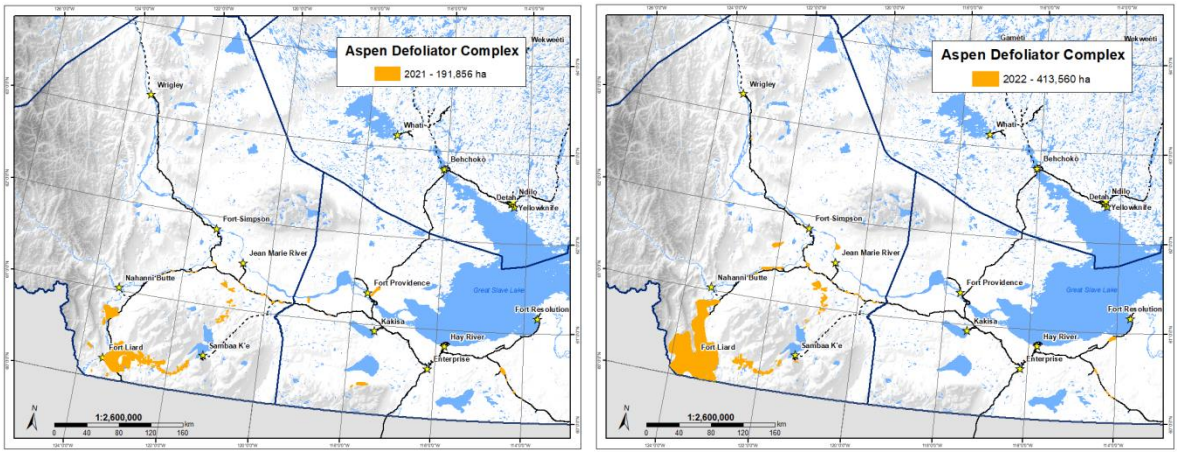


Figure 12. Areas affected by the new aspen defoliator complex in 2021 (left) and in 2022 (right).

Even though aspen serpentine leafminer is part of the observed defoliation complex, it is reported separately due to the ease of recording this pest from the air. Other lesser damaging agents observed causing aspen defoliation were the black-cheeked leaf roller, *Chrysomela spp.* leaf beetles, and various leaf aphids. Large aspen tortrix was only observed south of Fort Simpson and Enterprise; however, it is safe to assume that it is mixed in throughout the bulk of the defoliation in the Fort Liard area. LAT did not appear to dominate in any specific area this summer.

Almost all of the defoliation (98.7%) was observed in the Dehcho Region, specifically in the Fort Liard area, along the Liard River, and north of Trout Lake (Fig 12). The South Slave Region near Fort Resolution (4,300 ha) was the only other area where this disturbance was mapped.

Other aspen and poplar pests

Trembling aspen

- Aspen blotch leafminer (*Phyllonorycter saliciocella*) – observed at trace levels north of Fort Providence south of the Caen Lake
- Aspen leaf beetle (*Chrysomela crotchi*) – observed causing trace defoliation to roadside aspen regene along the Yellowknife Highway
- Bark-mining fly (*Phytobia spp.*) – Common throughout the range of aspen. Found in NWT near the Fort Simpson airport, along the Liard Hwy south of the Birch River, at the Dory Point Day Use area, near Enterprise, and at the Thebacha Campground area near Fort Smith.
- Black galls caused by poplar budgall mite (*Aceria parapopuli*) – observed at the Blackstone River and east of the Jean Marie River turnoff, but common in other areas as well. These types of galls can be common in mature to overmature stands and can also be caused by other factors such as frost damage to epicormic buds, or diseases.
- Flatheaded poplar borer (*Dicerca spp.*) – observed near the Jean Marie River turnoff, and at the Dory Point Day Use area. *Dircera spp.* are quite common throughout the range of aspen, most common being *D.tenebrica* (Fig 13).
- Folding leaf mites (*Eriophyes spp.*) – observed near the Little Buffalo River along Hwy 3, but fairly common elsewhere.
- Large aspen leaf gall aphids (*Pachypappa sacculi*) – observed near Rabbit Creek along the Liard Hwy, and near the Redknife River along the Mackenzie Hwy. They are not as common as other leaf damaging agents (Fig 13).
- Aspen leaf aphids (*Chaitophorus spp.*) – thes leaf sucking aphids are quite common and can be found widespread throughout the NWT. They can at times have Large populations that cause localized damage and premature leaf drop.

- Aspen leaf mites (*Aceria spp.*) – observed on roadside aspen regeneration by Caen Lake north of Fort Providence and east of Jean Marie River turnoff.
- Midge leaf galls (*Harmandiola helena*) – observed along the Mackenzie Hwy near Axe Creek, north of Enterprise, and north of Fort Providence by Chan Lake. This midge damage is fairly common and can often be mistaken for sawfly galls.
- Poplar twig gall fly (*Euhexomyza schineri*) – observed near Skull Creek along the Mackenzie Hwy on a couple roadside aspen trees. Can be confused with other stem gall pests like *Saperda spp.*
- Poplar borer (*Saperda calcarata*) – very common throughout the range of aspen and observed in all three regions during the ground surveys.

Figure 13. Flatheaded poplar borer on aspen near the Jean Marie River turnoff (left), and leaf galls on aspen caused by the Large aspen leaf gall aphids observed along the Liard Hwy (right).

Willow defoliators

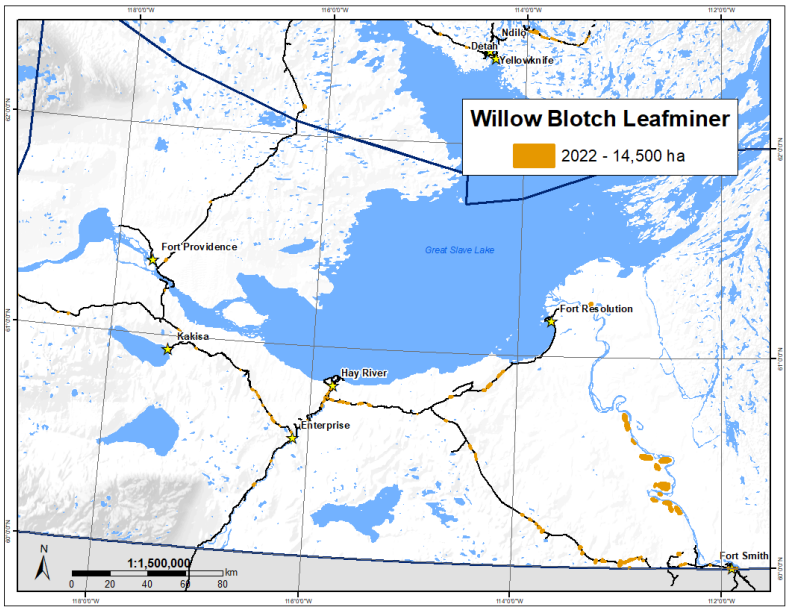


Figure 14. The extent of the Willow blotch leafminer damage in 2022.

Willow blotch leafminer WBL (*Micruapteryx salcifoliella*) remains the main willow defoliator in the NWT.

Approximately 14,500 ha were recorded in 2022, which appeared to be more abundant and severe in the South Slave than in other regions (Fig 14).

Other insect pests affecting willow in 2022 were:

- Eriophyids leaf galls (*Eriophyes salicicola*) – little red mite galls found infesting willow leaves south of Wrigley, at the Mackenzie ferry to Wrigley (south side), and at Madeline Lake along the Ingraham Trail.
- Mourning Cloak (*Nymphalis antiopa*) – these common caterpillars were found defoliating a roadside willow near McNallie Creek along the Mackenzie River.
- Willow cone gall midge (*Rhabdophaga strobiloides*) – damage from this midge was observed near the Blackstone River along the Liard Hwy, and along Hwy 1 to Wrigley near the River Between Two Mountains (Fig 15).
- Willow rosette gall midge (*Rhabdophaga salicisbrassicoides*) – trace levels south of the River Between Two Mountains (Fig 15).
- Spittle bug (*Aphromora spp.*) – observed at the Mackenzie River ferry crossing (north side) to Wrigley.
- Suspected Compton tortoiseshell (*Nymphalis vaualbum)* – observed by Fort Simpson, north of the airport.
- Spotted tussock moth (*Lophocampa maculate*) – observed on willowat the Mackenzie River ferry to Wrigley (north side) and at Madeline Lake along the Ingraham Trail.
- Potato gall midge (*Rabdophaga salicisbatatus*) – observed near the AB border south of Enterprise, at the Fort McPherson airport, and along Hwy 1 north of the Wrigley ferry.
- Willow gall sawfly (*Euura spp.*) – these willow leaf galls are fairly common in the NWT; observations included Norman Wells, south of Wrigley, Liard Hwy, south of Poplar River, Whati, and Tibbitt Lake along the Ingraham Trail.

Figure 15. Damage to shoots and leaves caused by Willow cone gall midge (left) and Willow rosette gall (right) as observed in 2022.

Other insect pests observed in 2022

Birch

- Amber-marked birch leafminer (*Profenusa thomsoni*) – light to moderate defoliation observed at two locations along the Ingraham Trail northeast of Yellowknife. Total affected area was 182 ha.
- Bronze birch borer (*Agrilus anxius*) – observed near Cameron River crossing along the Ingraham Trail.
- Erineum on birch (*Eriophyes spp.*) – observed in Norman Wells and Fort Simpson.
- Suspected Fringed birch sawfly (*Dimorphopteryx melangnathus*) – observed at the Wrigley ferry crossing (south side).

Jack pine

- Pine engraver (*Ips pini*) – observed causing jack pine mortality in two small areas, one in each of the South Slave and North Slave Regions. In total, 41 ha were recorded near Little Buffalo River (Fig 16).
- Northern pitch twig moth (*Petrova albicapitana*) – fairly common on jack pine in NWT, observed along Hwy 9 near the Duport River south of Whati, and along Hwy 6 south of the Lake Buffalo.
- White-spotted sawyer beetle complex (*Monochamus scutellatus*) – observed in three areas causing jack pine mortality together with other secondary agents such as *Ips spp.* and miscellaneous woodborers. A total of 77 ha were recorded in the Dehcho and South Slave. The Dehcho damage occurred north of the Mackenzie River along Hwy 1 to Wrigley (26 ha), while another 51 ha were recorded in the South Slave, 34 km north of Fort Providence.
- *Orthotomicus caelatus* – tiny bark beetle, similar looking to *Ips spp.;* found attacking jack pine regeneration along the Ingraham Trail. Believed to be secondary agent attacking weakened trees. In this case, affected regen may have been previously weakened by drainage flooding.

Figure 16. Pine mortality observed along Hwy 5, caused by the pine engraver (left). Adult *Ips pini* found in sampled trees (right).

5. Pathogen and fungal diseases

Despite drier conditions throughout the southern NWT, pathogen and fungal disease agents were active across the territory. The most serious fungal diseases noted in 2022 were Western gall rust (763 ha) and Commandra blister rust (440 ha), both noted mainly in the Dehcho Region. Below is the list of all pathogen and disease agents observed in the NWT in 2022.

Balsam poplar

- Poplar shoot and leaf blight (*Venturia populina*) – a close cousin to *Venturia macularis* on aspen, these two diseases are often grouped together. Heavier infections of both are mapped as VLB (Venturia Leaf Blight) but hosts are separated in comments. This disease is fairly common throughout the poplar range in NWT.

Jack pine

- Commandra blister rust (*Cronartium comandrae*) – galls from this rust were noted down the Tlicho Hwy, near the Duport River crossing, along the Ingraham Trail near the Cameron River crossing, and in jack pine regeneration east of Hay River near the Birch Creek (Fig 17).
- Western gall rust (*Endocronartium hraknessii*) – branch mortality was recorded in many areas of the Dehcho and South Slave with one light patch observed in the North Slave. This pathogen can reside in pine branches and stems for years and even though it is not believed to cause mortality; in the NWT it has been observed, especially during periods of heat waves and droughts.

White birch

- Hypoxylon canker (*Entoleuca mammata*) – observed affecting white birch along the Ingraham Trail near Cameron River and Tibbitt Lake.

Trembling aspen

- Aspen shoot and leaf blight (*Venturia macularis*) – common in NWT, observed to varying degree on roadside aspen regen near the Fort Simpson airport, the Jean Marie River turnoff, north of the Blackstone River along the Liard Hwy, Kakisa, AB border south of Enterprise, the Fort Smith area, and down the Tlicho Hwy.
- Ceratocystis canker (*Ceratocystis fimbriata*) – observed on mature and overmature aspen along the Liard Hwy, south of Birch River, near the Jean Marie River turnoff, and by the Dory Point Day Use area near Fort Providence.
- Cytospora canker (*Cytospora chrysosperma*) – found throughout the range of aspen. Observed along Hwy 1 east of the Jean Marie River turnoff.
- False Tinder conk (*Phellinus tremulae*) – this decay fungi is common and found throughout the range of aspen. It was observed affecting several trees along the Liard Hwy south of the Birch River, and at the Dory Point Day Use area, near Fort Providence.
- Hypoxylon canker (*Entoleuca mammata*) – observed on aspen south of Wrigley.
- Marssonina leaf blight – (*Marsonnina spp.*) – observed on young aspen near Birch Creek, east of Hay River.
- *Peniophora spp.* – found on mature aspen in trace amounts south of the Willowlake River along the Mackenzie Hwy to Wrigley.

White spruce

- Yellow witches' broom of spruce (*Chrysomyxa arctostaphyli*) – widespread rust throughout the range of spruce (Fig 17).

Willow

- Willow leaf rust (*Melampsora spp.*) – fairly common in the NWT, observed near the Jean Marie River turnoff and down the Tlicho Hwy near Whati.
- Willow tar spot (*Rhytisma salicinum*) – not as common but native to the NWT. Observed on willow at the Wrigley ferry crossing (north side).

Figure 17. Yellow witches' broom on spruce (left) and Commandra blister rust on pine (right) as observed in 2022.

All of these pathogens are endemic in the NWT and as such do not pose serious threat to forests. Their impact is being monitored.

6. Abiotic disturbances

Abiotic disturbances are those caused by non-living factors. They are generally considered a natural and integral part of forest ecosystems and they can have major positive and negative impacts by influencing forest structure, composition, and functioning. They can be important in maintaining biological diversity and facilitate regeneration. When disturbances exceed their natural range of variation, impacts on forest can be extreme, affecting entire landscapes and causing large-scale mortality. Climate change is often thought to exacerbate these impacts by altering existing natural range of variation in frequency, intensity and timing of some events such as extreme winds, storms, landslides, heat waves, droughts, or excessive precipitation. In the NWT, the following abiotic disturbances have been recorded on an annual basis: extensive flooding and high water tables, effects of drought, wind, hail, and snow damage, landslides and slumping, permafrost related issues (drunken trees, thermokarst lakes), and species decline (i.e. aspen, black spruce).

Drought / Heat stress

Foliage wilting and yellowing or browning of leaves/needles manifested on a variety of tree and shrubs species this summer as a result of much drier growing season conditions. From mid-June through August, and later in September until late October, the NWT experienced some above normal temperatures with localized drought. Approximately 3,100 ha of drought / heat stressed foliage was recorded on various species throughout the South and North Slave, and the Dehcho Regions. Tree and shrub species affected included poplar, aspen, birch, larch, willow, alder, and wild rose.

Flooding and high water tables

Despite drier conditions in the southern NWT, approximately 105,800 ha of flooding were mapped in 2022. Although flooding was recorded in all regions surveyed, the majority occurred in the South Slave (101,000 ha), specifically in areas adjacent to the Slave River. The second most affected region was the Dehcho with only 2,740 ha mapped. Although many of the larger areas of flooding in the NWT have been previously recorded, those mapped continue to cause annual mortality (Fig 18).

Figure 18. High water tables and resulting tree mortality north of Fort Providence as observed in 2022.

Ongoing jack pine shoot damage

This issue was described in detail in the 2021 Forest Health Report. The unidentified jack pine shoot damage has been ongoing and was further investigated in 2022. There have been no primary responsible agents identified. Several secondary miscellaneous agents were found that might explain some of the damage, but they were not consistent among sampled trees.

There are two major symptoms occurring, one is branch tip mortality (Fig 19), and the other is the upper inner crown dying (Fig 19). They may not be related. The upper crown damage manifests yellowing and reddening of needles in the inner mid-to-upper crowns of jack pine, radiating outward. While the branch tip mortality is usually confined to last year's growth. In 2022, approx. 3,500 ha were recorded, mainly in the South Slave along Hwy 5 between Hay River and Fort Smith, but also in the Dehcho and North Slave.

The issue was consulted with the CFS forest pathologist, Tod Ramsfield, and entomologist Greg Pohl and they both suggest the damage to be caused by environmental factors, due to the absence of evidence of biotic agents. Unusual summer and early fall heat waves could have been a factor in causing this damage.

Figure 19. Branch tip mortality (left) and mid-crown damage observed on jack pine trees in 2022. The cause of the damage is unknown, likely related to environmental issues.

Mackenzie Delta spruce mortality

This issue was first reported in the 2018 Forest Health Report and was further investigated in 2019. Increasing occurrences of spruce mortality have been noted southwest of Aklavik and between Aklavik and Inuvik. From aerial observations, decline and mortality appears to radiate out from the center of islands, and sometimes there is a distinct line and vegetation change between the mortality and healthier areas. On the shorelines, many areas have trees falling over into the water. The 2019 ground investigations confirmed symptoms such as dead tree tops and branches, as well as foliage discoloration. Tree mortality and evidence of high ground water was increasing towards the center of lowland areas.

In 2022, approx. 17,000 ha of spruce mortality were recorded in the western Delta (Fig 20). Again, mortality occurs on the inside of forests surrounded by delta oxbows and lakes. This pattern of mortality is

similar to thermokarst lake development, which suggests high water tables due to precipitation and thawing of permafrost. It is possible that this is a natural process if how ponds and lakes in the delta develop; however, delta spruce can be very old so given the age of the trees dying, it can be assumed this level and scale of mortality may not be a common event. ENR will continue to monitor forest conditions in the Mackenzie Delta in 2023.

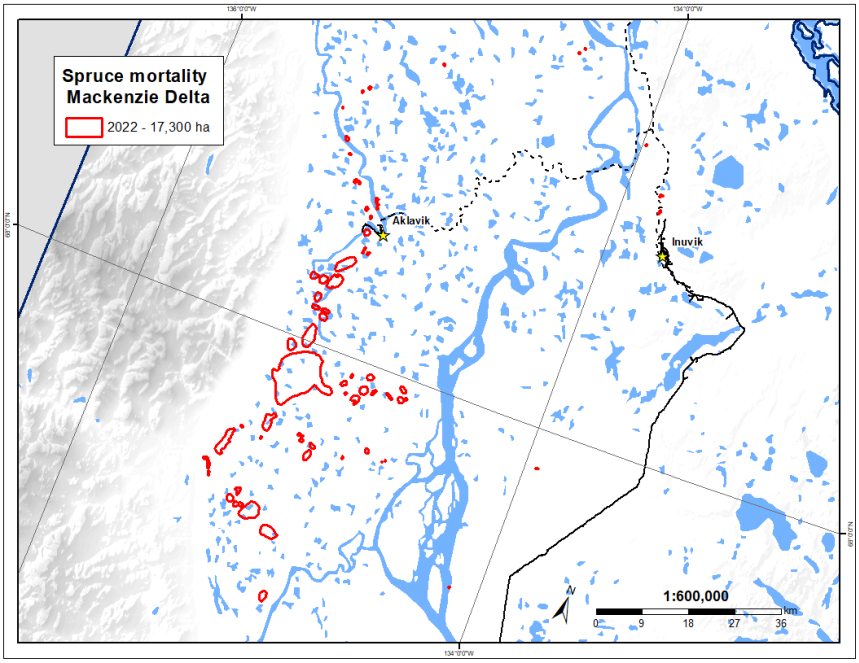


Figure 20. Extent of white spruce decline and mortality in the Mackenzie Delta as observed in 2022.

Other abiotic disturbance

Frost damage – found in the form of frost cracks to aspen stems which are very common throughout the NWT, and broom growth in jack pine cause by the deformed growth over time from frost damaged buds (Fig 21). Frost cracks are widespread, whereas brooms were observed near Fort Smith and at the Prelude Lake along the Ingraham Trail.

Figure 21. Witch's broom on jack pine due to bud damage caused by frost (left) and frost cracks in aspen bark (right)