2021 Forest Health Report

Environment and Natural Resources
Forest Management

Government of
Northwest Territories

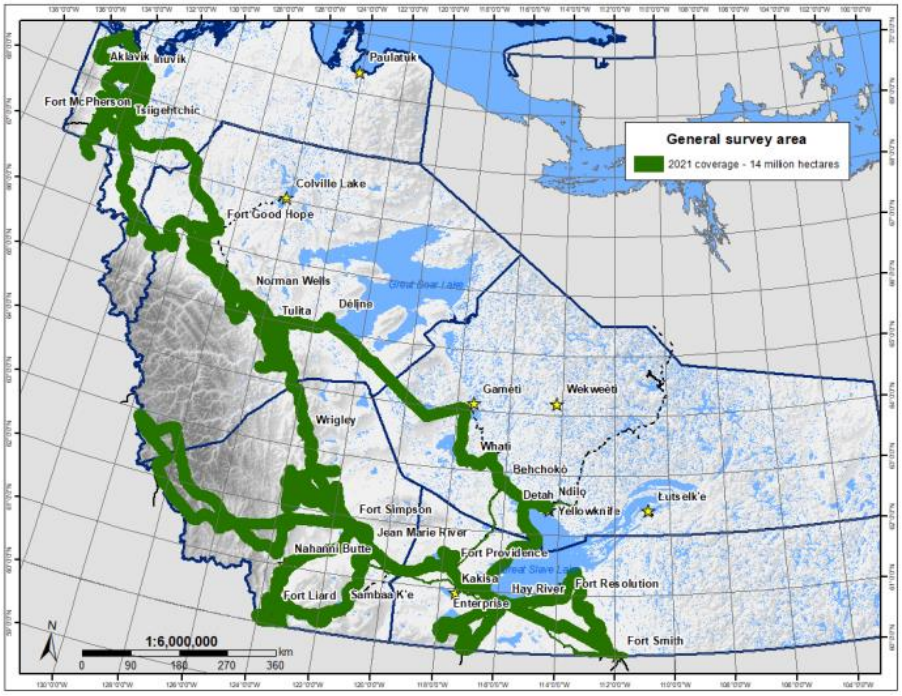
Contents

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. Currently, FMD has also been 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). In 2021, the aerial surveys were conducted by Jakub Olesinski (ENR) and Roger Brett (CFS). Loren Hudson (ENR South Slave) participated in the South Slave aerial survey, Matt Lavoie (ENR Dehcho) participated in the Liard Valley survey, while Shawn Maxwell, the Manager of Forests in the Sahtu Region participated in the Sahtu portion of the survey.



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 2021, 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. 14-20 million hectares (ha) are covered which is approx. 17-25% of the total forest land area in the NWT. In 2021, approximately 14 million ha were surveyed (17.5% of the total forest land area). Aerial surveys were conducted using Cessna 206 (Simpson Air) on July 22-30.

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 reoccurring 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

Defoliation severity class	% of current growth defoliated (conifer)	% of current growth defoliated (broadleaf)
Light (L)	<30	<30
Moderate (M)	30-50	30-70
Severe (S)	>50	>70
Mortality severity class	**% of trees affected within a stand**	
Light (L)	<=10	
Moderate (M)	10-50	
Severe (S)	>50	

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. In 2021, ground surveys were conducted on July 7-11 and July 14-20.

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.

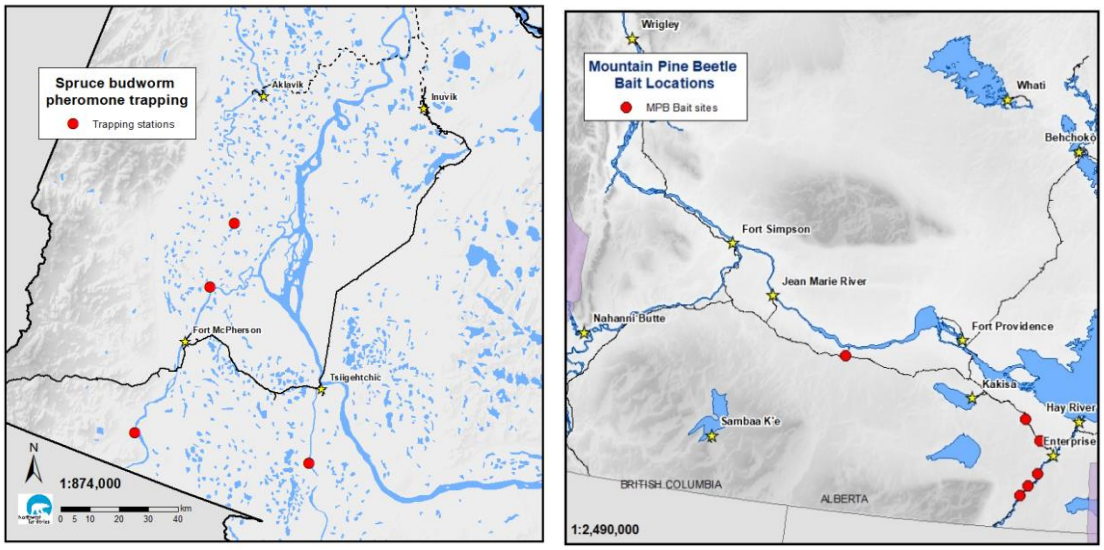


Figure 2: Pheromone trapping locations for spruce budworm in the Inuvik Region (left) and baiting locations for mountain pine beetle in the South Slave and Dehcho Regions (right)

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

Precipitation data from Environment and Climate Change Canada (ECCC) indicted a significant moisture deficit across the southern NWT in the over-winter and early spring periods of 2020-2021 but ENR snow survey results at the end of winter revealed a decent snowpack in these areas. However, in the Beaufort Delta, Sahtu, and Yellowknife, a major moisture deficit was recorded. This is most notable in Inuvik which experienced 5 out of 6 months of below normal precipitation over the winter. The moisture deficit across the region stemmed back to the over-wintering period of 2019.

The 2021 growing season weather was characterized by dry conditions in the northern part of the territory and very wet conditions in the southern part. The driest area was the Beaufort Delta which recorded only 42% of normal precipitation in summer of 2021. In contrast, the South Slave Region experienced 95-177% of normal precipitation. Fort Simpson recorded 108% of normal precipitation throughout the summer (Fig. 3).

Total and Percent of Normal Precipitation: Summer 2021		May	June	July	August	Total Summer Rainfall	% of Normal Summer 2021
Fort Smith A	Actual	27.2	59.1	59.1	30.7	176.1	95
	Average	27.8	48.8	54.5	54.5	185.6	
Hay River A	Actual	16.3	66.9	124.8	69.0	277.0	177
	Average	23.3	31.9	43.0	58.7	156.9	
Fort Chipewyan RCS	Actual	17.9	71.9	38.8	57.2	185.8	98
	Average	27.2	44.4	67.4	50.2	189.2	
Yellowknife A	Actual	2.1	31.8	41.8	25.6	101.3	80
	Average	18.4	28.9	40.8	39.3	127.4	
Fort Simpson Climate	Actual	26.2	68.3	50.0	74.1	218.6	108
	Average	29.4	51.3	61.1	61.4	203.2	
Fort Liard (WJL)	Actual	25.2	89.5	51.9	77.7	244.3	102
	Average	41.4	59.5	83.4	55.3	239.6	
Norman Wells A	Actual	16.6	37.2	13.0	58.5	125.3	86
	Average	19.0	42.7	41.8	41.8	145.3	
Inuvik Climate	Actual	3.6	12.4	4.3	25.2	45.5	42
	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.

The high precipitation in June was followed by a heat dome which developed over western Canada. A heat dome is created when the atmosphere traps hot ocean air, as if bounded by a lid or cap.
It is created when an area of high pressure stays over the same area for days or weeks. This resulted in abnormally high temperatures and extremely high occurrences of lightning strikes and thunderstorms. The last days of June and first days of July were particularly intense with violent storms rolling over the southern NWT causing significant wind damage west of Sambaa K'e (see page 21 for details).

Fire activity

There were 139 fires totaling 144,682 ha burned across the NWT in 2021. Both numbers are well below the 30-year average (237 and 615,965 ha respectively). The North Slave was the most active region in 2021 followed by the drought-driven Beaufort Delta. The Dehcho tallied 29 fires with some them challenging the Region for parts of the summer. The South Slave was the least active Region with just 11 ignitions (16% of normal) due to excessive precipitation throughout much of the season (Fig. 3).

Temperature anomalies and extremes in precipitation patterns (low in the north, high in the south), likely had a significant impact on tree health in 2021.

3. Overview of forest health conditions

Over 2.5 million ha of forested land out of 14 million ha surveyed were affected by forest health related issues. The most significant one was the spruce budworm outbreak occurring over much of the southern NWT (1.09 M ha). Another significant pest was aspen serpentine leafminer which affected 1.04 M ha of aspen forests mainly in the Dehcho and South Slave Regions. Some aspen dominated forests in the Dehcho were also defoliated by a new complex of defoliators, primary agents being either the two-leaf tier or large aspen tortrix. Ground surveys revealed several minor and secondary pests affecting aspen, poplar and birch. Increased activity of rusts was noted in the southern NWT, likely due to a moist summer in these parts of the territory. Overall, 2.2 M ha were affected by insect and disease agents in 2021.

Abiotic disturbance (not related to pests and pathogens) was dominated by flooding and high water table issues, observed in the southern NWT due to excessive precipitation. Changes to permafrost are also thought to 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. Aerial surveys also revealed one of the largest blowdown events ever recorded in the NWT. Over 20,000 ha of aspen dominated forests were flattened south west of Sambaa K'e. Overall, approx. 226,200 ha were mapped as affected by abiotic disturbance in 2021.

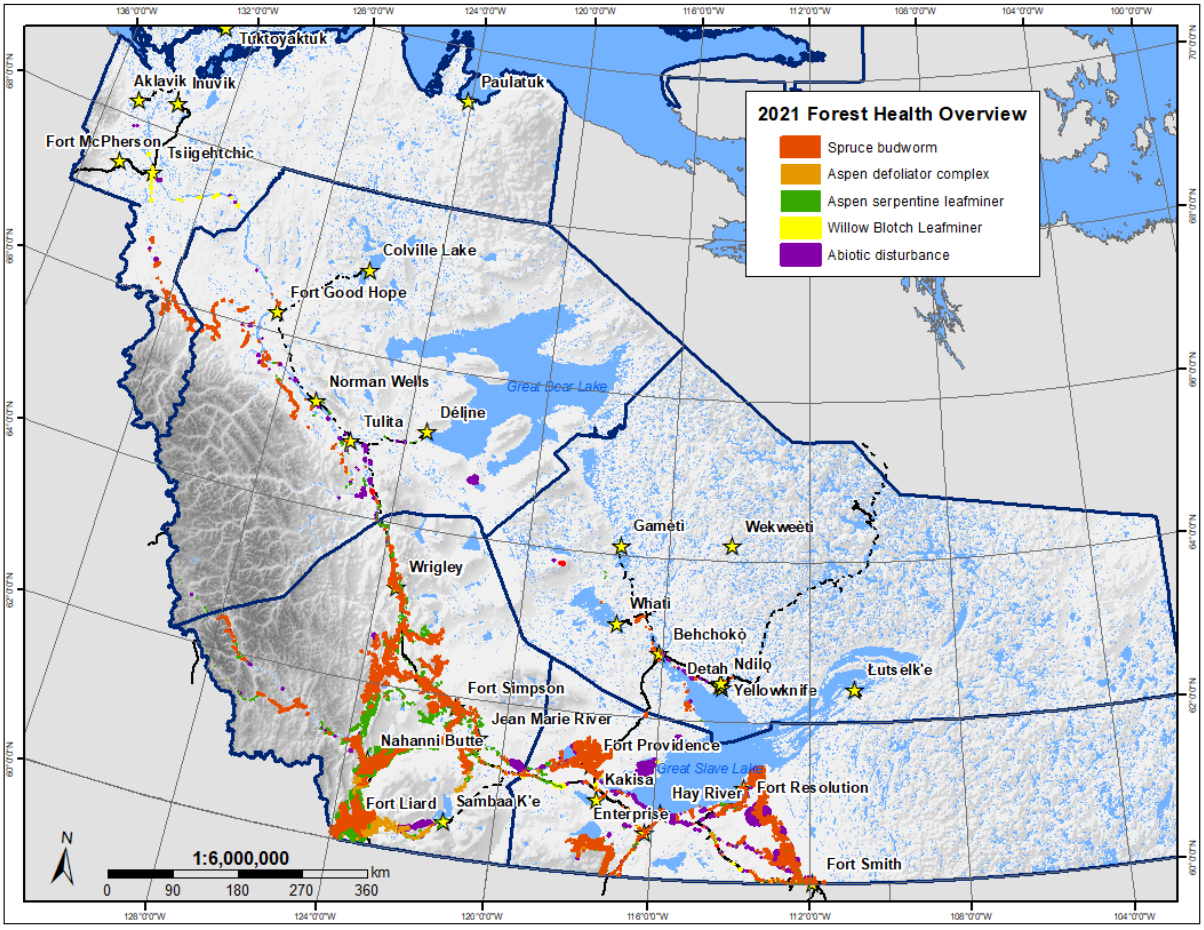


Figure 2. Overview of 2021 forest health conditions in NWT.

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]	9,325	36,646	410,560	547,727	20,894	1,025,152
Aspen serpentine leafminer[1]	825	6,811	109,192	858,512		975,340
Aspen defoliator complex[1]			14,355	177,501		191,856
Willow blotch leafminer[1]		52	8,507	2,472	1,890	12,921
Spruce needle rust[1]	1,922	380	79			2,381
Eastern larch beetle[2]			134	8		142
Western balsam bark beetle[3]				1,011		1,011
White-spotted sawyer beetle[2]	13		43	6		62
Total Biotic Disturbance	**12,085**	**43,889**	**542,870**	**1,587,237**	**22,784**	**2,208,865**
Wildfire	47,810	19,900	7,490	48,430	44,240	167,870
Aspen decline[2]			140	13,481		13,621
Blowdown/Hail[2]				20,304		20,304
Crown and tip damage (pine)	206	2	3,477	109		3,794
High water tables and flooding[2]	2,089	8,177	137,595	11,019	112	158,992
Slumping[2]		855	56	371	157	1,439
Spruce mortality[2]		1,869	889		23,605	26,363
Yellowing stress (suspect high water tables)[1]					1,739	1,739
Total Abiotic Disturbance	**2,295**	**10,903**	**142,157**	**45,284**	**25,613**	**394,122**
Total Area Affected	**14,380**	**54,792**	**685,027**	**1,632,521**	**48,397**	**2,602,987**

[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 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).

Spruce budworm (*Choristoneura fumiferana*) – SBW

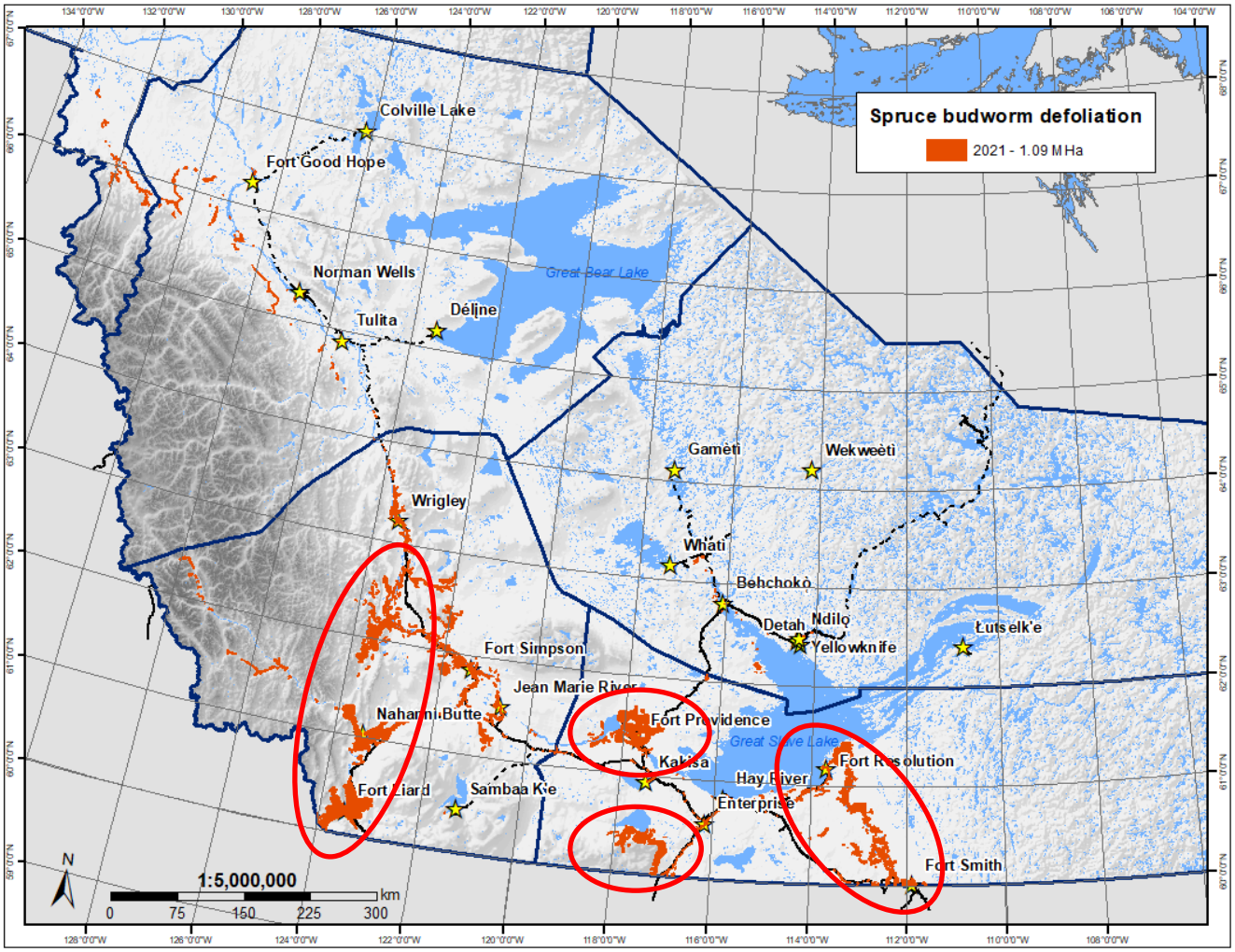


Figure 3. Overview of spruce budworm defoliation in the NWT. Red circled are hotspots of particularly severe defoliation observed in 2021.

Severe and moderate spruce budworm defoliation was noted in white spruce dominated stands throughout the South Slave and Dehcho Regions in 2021 (Fig. 5). Over 1.09 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. The hotspots of the current outbreak, where large severe defoliation occurred are around Fort Liard, Nahanni Butte, North Nahanni River, Mackenzie River from Fort Simpson to Wrigley, Ebbutt Hills, north of Fort Providence, Cameron Hills, and corridors along the

Hay and Slave Rivers. 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.

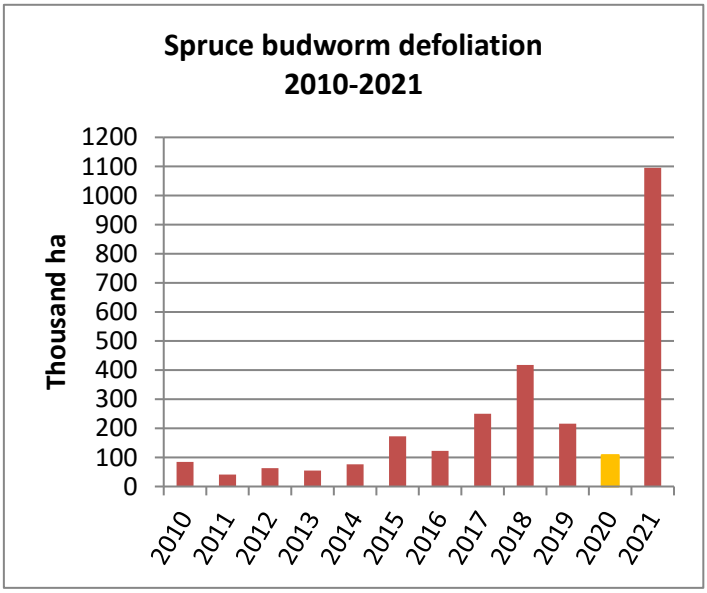


Figure 4. Area affected by spruce budworm in the NWT over the last decade.

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 (Fig. 6).

South Slave and North Slave Regions

The majority of white spruce dominated stands in the South Slave Region experienced severe spruce budworm defoliation. The key areas affected were along the Slave and Hay Rivers, Cameron Hills and north of Fort Providence. SBW activity in the North Slave Region was also higher than in previous years; however, it remained spotty and was pronounced in only a few spruce patches around Whati, Behchoko, and in the East Arm of the Great Slave Lake (Fig. 7).

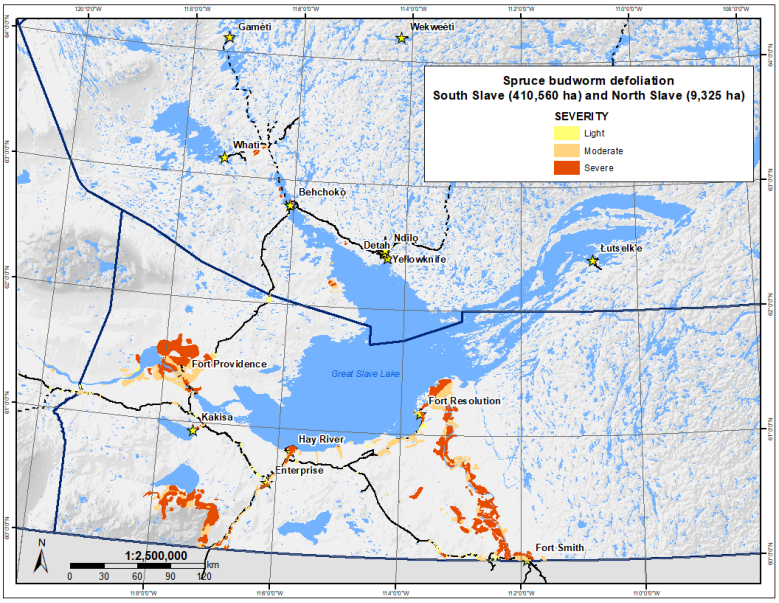


Figure 5. Spruce budworm defoliation extent in 2021 around Great Slave Lake.

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. Many new patches were also mapped along the North Nahanni River (Fig. 8).

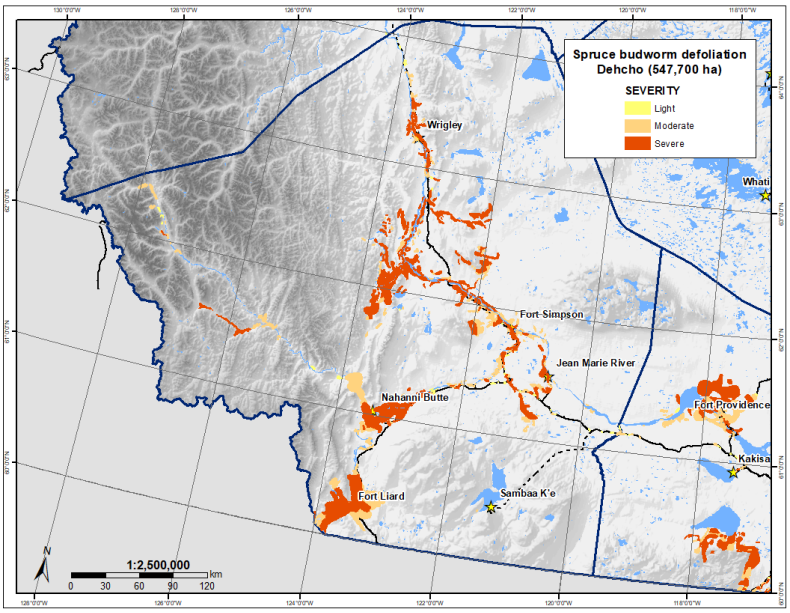


Figure 6. Spruce budworm defoliation extent in the Dehcho Region

Sahtu and Beaufort Delta

Both Sahtu and Beaufort Delta Regions did not experience as extreme SBW defoliation as southern regions. Compared to 2019, population levels along the Arctic Red River declined in the northern parts of the river but remained severe along the southern sections. There was a slight increase in defoliation in the Sahtu, mostly along the Carcajou River, west of Norman Wells (Fig. 9).

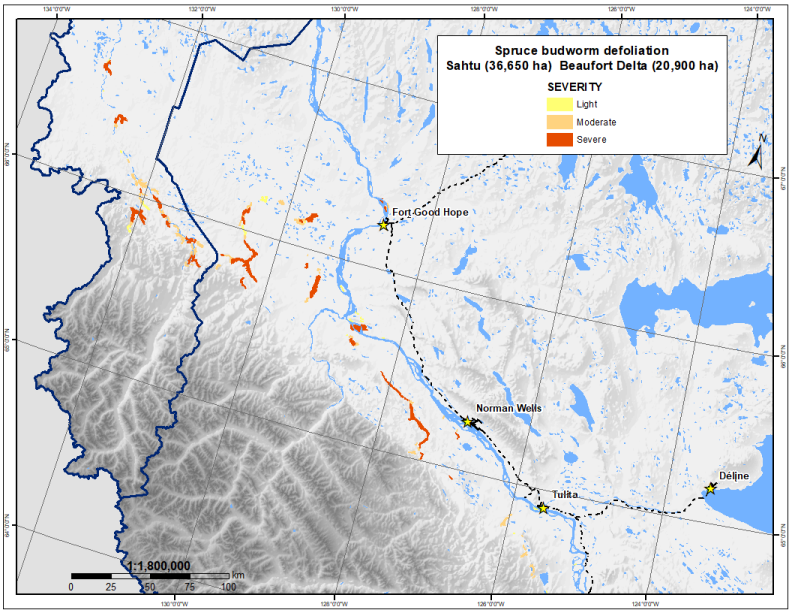


Figure 7. Spruce budworm defoliation extent in the Beaufort Delta and Sahtu Regions.

Pheromone trapping in the Beaufort Delta did not occur in 2021 due to logistical challenges. It is expected to resume 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 2021, over 975,000 ha (almost 50% increase compared to 2019) were affected by ASL. 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 (Fig. 10). There is currently little information available on duration of ASL outbreaks; however, the NWT outbreak seems prolonged, as it has been occurring for approximately 20 years. Normally this pest is considered secondary, causing very minor growth loss and no lasting long-term health effects; however, given the duration and severity of the outbreak, it is likely having a more significant effect on forest health. Given its current spread, it is safe to assume most aspen stands in the NWT suffer some level of damage on an annual basis.

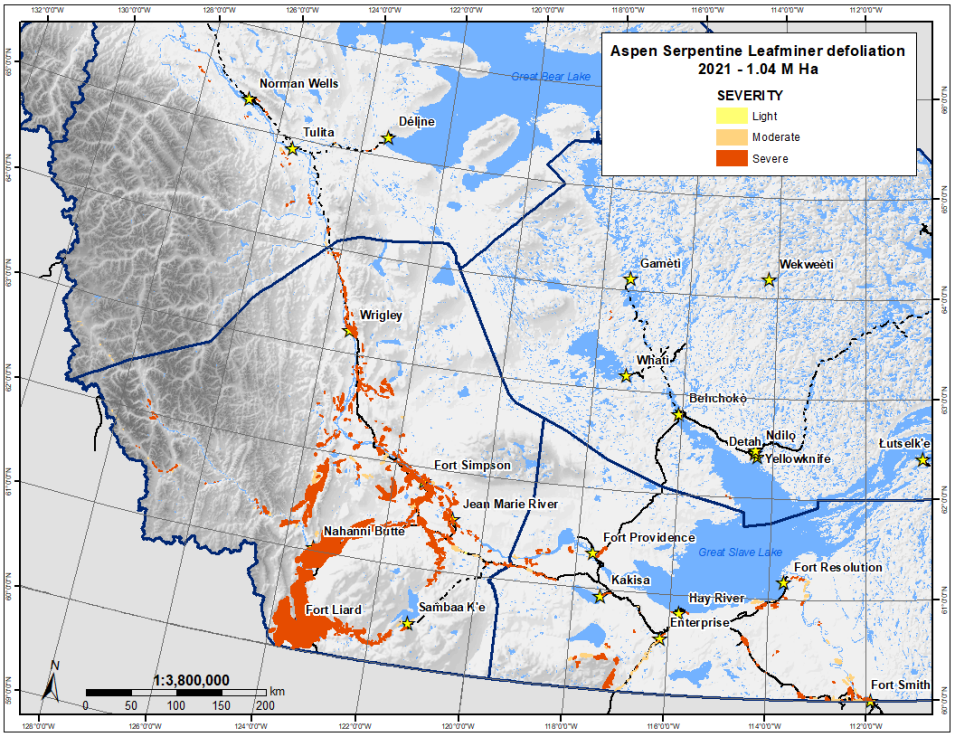


Figure 8. Extent of defoliation caused by aspen serpentine leafminer in the NWT in 2021.

Aspen defoliator complex

Larvae of at least three species of Lepidoptera (moths) were causing additional aspen defoliation recorded in summer 2021: aspen two-leaf tier (*Enargia spp. Poss decolor*), large aspen tortrix (*Choristoneura conflictanta*), and aspen leaf roller (likely *Pseudexentra oregonana*). Although ASL was also present in this newly recorded defoliator complex, it was mapped separately because its detection was easier from the air. Primary agents in the new defoliation complex varied but aspen two-leaf tier was identified as the main agent in 190,357 ha of the mapped area. Large aspen tortrix was the primary agent in only two patches: one along the Hwy 5 in the Wood Buffalo National Park and the other in scattered patches between the Poplar and Blackstone Rivers, totaling 2,313 ha. Defoliation was observed only in the Dehcho and South Slave Regions, the majority being in the Dehcho. The stratification of primary agent is not definitive, as it was determined only from ground surveys along the highways.

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. 11-12).

Figure 9. 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.

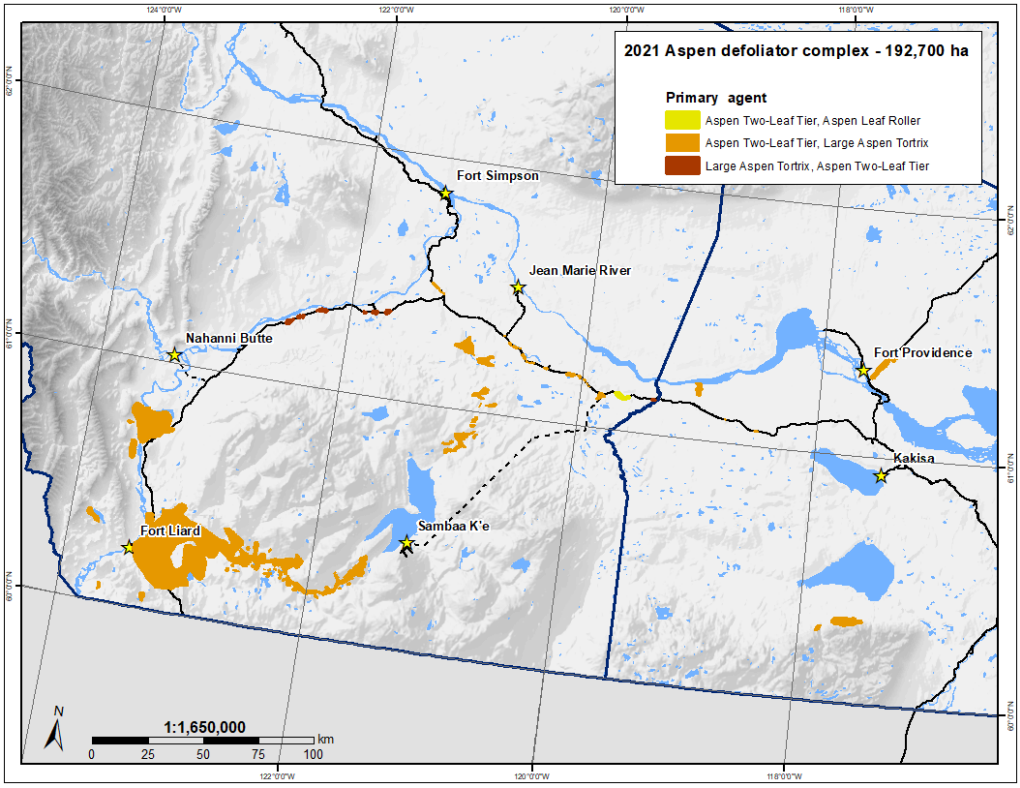


Figure 10. Area affected by the new aspen defoliator complex in 2021.

It is recommended to conduct a dedicated aspen defoliation ground survey in June when active stages of the pests involved in the new defoliator complex can be observed.

Other aspen and poplar pests

A wetter than average growing season in the south of the NWT caused an increased activity of aphids. Other aspen and poplar pests observed in 2021 during the ground surveys included:

- Aspen blotch leafminer (*Phyllonorycter saliciocolella*) – found widespread in the Fort Smith – Wood Buffalo area (Fig. 13).
- Bead-like cottonwood gall aphid (*Parathecabius populimonilis*) – widespread on poplar saplings.
- Cottonwood leaf beetle (*Chrysomela scripta*) – very common and widespread mostly on poplar saplings (Fig. 13).
- Flatheaded poplar borer (*Dicerca tenebrica*) found boring into aspen (along with the more common *Saperda calcarata*) south of Enterprise.
- Aspen leaf beetle (*Chrysomela crotchi*) (Fig. 13)
- Mite bladder galls (*Eriophyes spp.*) – found on aspen leaves, common in the NWT.
- Poplar budgall mite and black galls (*Aceria parapopuli*) – common throughout aspen range.
- Poplar folded leaf aphid (*Thecabius affinis*)
- Poplar folded leaf sawfly (*Phyllocopla spp.*) (Fig. 13)
- Poplar leaf gall midge (*Cecidomyiid spp.*) caused by *Harmandia spp.*
- Poplar leaf petiole gall aphid (*Pemphigus spp.*)

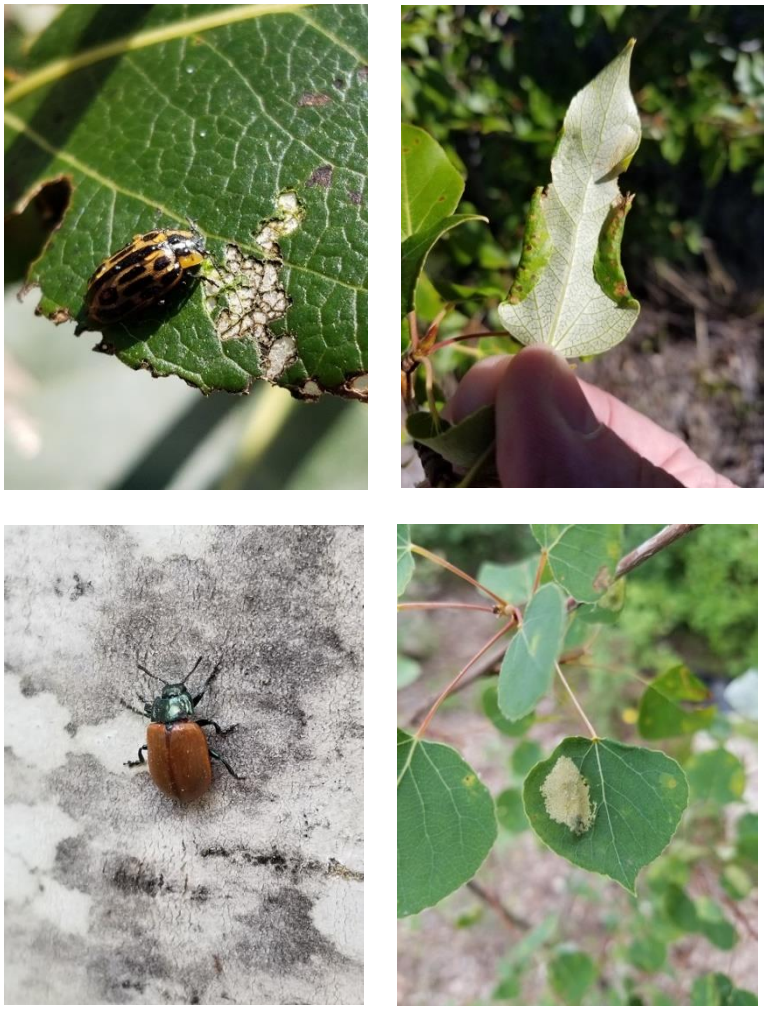


Figure 11. Cottonwood leaf beetle (upper left), the damage caused by the poplar folded leaf sawfly (upper right), aspen leaf beetle (bottom left), and the damage caused by aspen blotch leafminer (bottom right) as observed in the southern NWT in 2021.

Willow defoliators

Willow blotch leafminer WBL (*Micruapteryx salcifoliella*) remains the main willow defoliator in the NWT. In 2021, the affected area recorded was approximately 14,000 ha. As in previous years, heavy rains at the beginning of the season may have slowed development of larvae which were still actively feeding in early July. The WBL activity was noted as far north as the southern part of the Beaufort Delta Region along the Mackenzie and Arctic Red Rivers, although its heaviest occurrence was in the South Slave and Dehcho Regions (Figure 14).

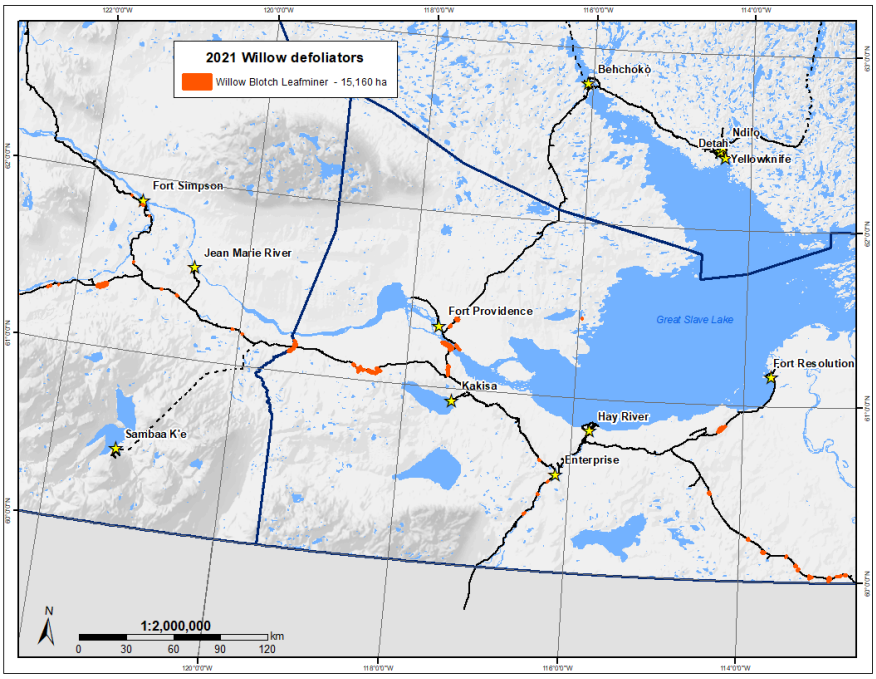


Figure 12. Willow blotch leafminer was the most significant willow defoliator but in 2021 it was less active than in previous years.

Other insect pests affecting willow in 2021 were:

- Willow cone gall midge (*Rhabdophaga strobiloides*) – trace levels, but common
- Willow rosette gall midge (*Rhabdophaga salicisbrassicoides*) – trace levels, but common

Other secondary pests observed in 2021

Birch

- Sapsucker damage – common
- Mites on bog birch (likely *Eriophyes spp.*) – found in South Slave

Jack pine

- Bark beetles (*Ips spp.*) killing a few weakened pine near burns on Ingraham trail and by Fort Smith
- Pitch nodule maker (*Petrova albicapitana*) – noted in South Slave and along the Ingraham Trail. Also found throughout the range of pine, affecting regeneration (Fig. 15).

Tamarack

- Spruce budworm damage noted in the South Slave and Dehcho, especially near Fort Resolution and Fort Liard highway
- Eastern larch beetle (*Dendroctonus simplex*) appears to be down but is still active in some areas along the Liard Highway.
- Thaxter's pinion (*Lithophane thaxteri*) (Fig. 15)

White spruce

- Yellowheaded spruce sawfly – several young trees infested south of Enterprise
- Adelgid galls on spruce (*Adelges lariciatus*) – several trees affected along Hwy 1 south of Enterprise

Figure 13. Damage on young pine caused by the pitch nodule maker (left) and a larvae of Thaxter's pinion on tamarack (right) as observed in 2021.

5. Pathogen and fungal diseases

Wet and humid conditions in the south of the NWT played a role in an increased activity of fungal and bacterial pathogens. The most common agents observed in 2021 included:

- Spruce needle rust (*Chrysomyxa ledicola*)
- Yellow witches broom of spruce (*Chrysomyxa arctosphyli*) – common throughout the NWT, some areas easily seen from the air in 2021 due to wet spring.
- Venturia leaf and shoot blight (*Venturia macularis* – aspen, *Venturia populina* – poplar) – both species found at various locations throughout the NWT but especially evident along the Hwy 5 and 6.
- Rose rust (*Gymnosporangium spp.*) – commonly found throughout the NWT
- Powdery mildew (*Uncinula salicis*) – observed in the Kakisa area on poplar regeneration.
- Sweet fern blister rust (*Cronartium comptoniae*) – found on jack pine along the Ingraham Trail
- Western gall rust (*Endocronartium harknessii*) – common through the range of jack pine. Past droughts and girdling caused by a species of snout moth *Dioryctria banksiella* can occasionally cause premature mortality to some infected trees. (Fig. 16)
- Aster yellows Group (*Candidatus phytoplasma*) – bacteria causing witches brooms on willow. Noted in a few areas along Hwy 1 south of Enterprise.
- Rust on buffalo berry (*Puccinia caricis-sheperdiae*) – moderate levels commonly found in the South Slave and Dehcho.
- Saskatoon-juniper rust (*Gymnosporangium spp.*poss *clavariforme*) – light levels found mostly in the South Slave around the Hwy 5 and 6 Junction.
- Ceratocystis canker (*Ceratocystis fimbriata*) on aspen (Fig. 16).
- False tinder conk (*Phellinus tremulae*)

Figure 14. Western gall rust on jack pine (left) and Ceratocystis canker on aspen (right) as observed in the southern NWT in 2021.

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).

Flooding and high water tables

Southern parts of the territory, especially the South Slave Region experienced the fourth consecutive wet spring and summer with excessive precipitation, leading to local flooding along the shores of Great Slave Lake and countless smaller lakes and rivers. Almost 159,000 ha were mapped in 2021. Despite drier conditions in the north of the territory, yellowing stressed trees and mortality were observed in many areas of the NWT including along the Mackenzie River in the Beaufort Delta or by Mills Lake, east of Hay River, and along the Slave River. Approximately 1,740 ha were mapped in 2021 (Fig. 17).

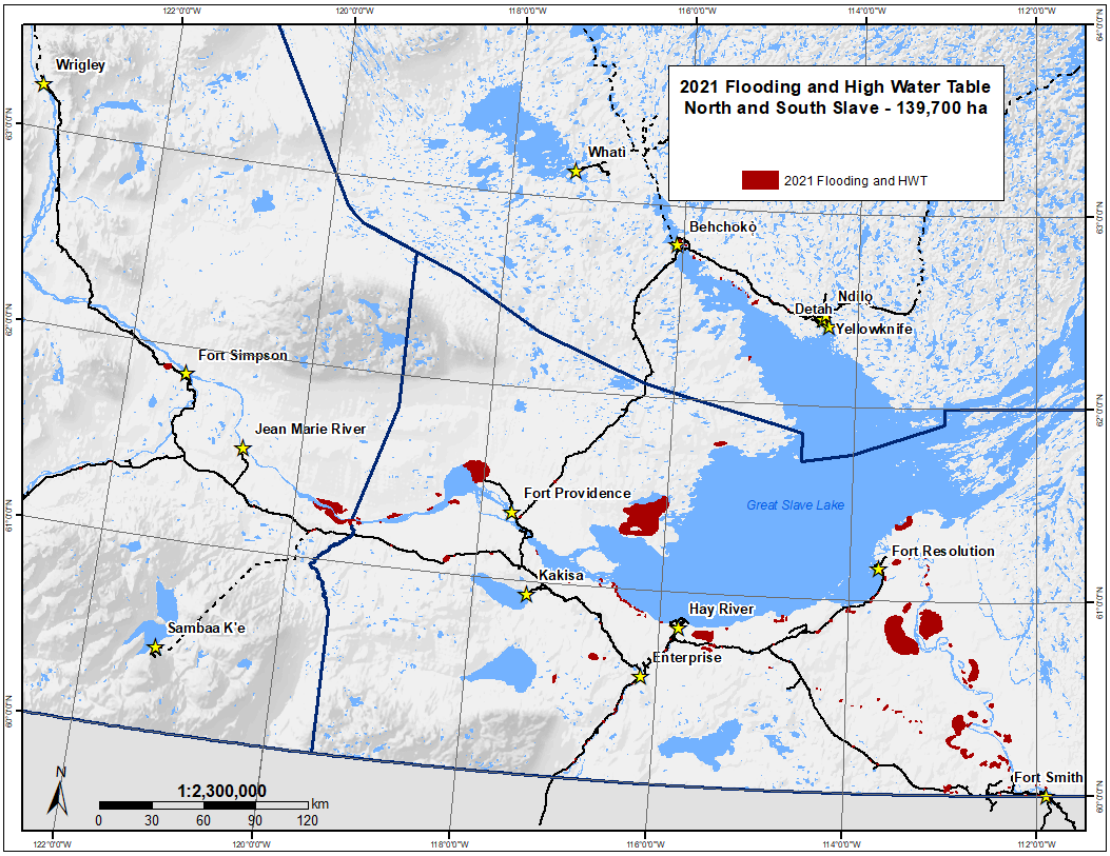


Figure 15. Extent of flooding and high water table disturbances observed in 2021.

Wind and hail damage

One of the largest blowdown events ever recorded in the NWT occurred in the Dehcho on June 29, 2021. The severe damage totalled 20,304 ha and stretched from the south end of Trout Lake almost 70 km towards the Muskeg River (Fig. 18). According to the aerial survey observations, the damage swath was approx. 7 km at its widest point. The majority of forests within mapped polygon areas were dominated by aspen and were completely flattened. In some areas, a few trees were left standing with foliage stripped and broken branches – signs of severe hail accompanying the wind event. A couple of areas on the east slope of the hill on the south end of Trout Lake only had bent tops with little to no foliage or branch damage.

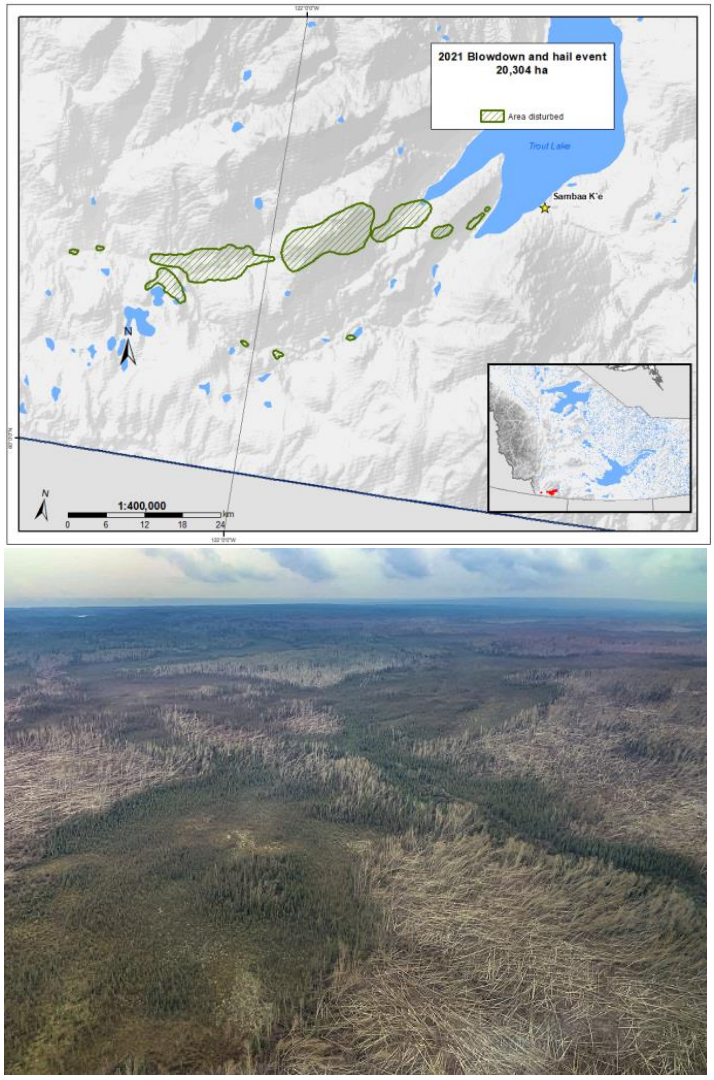


Figure 16 . Extent of the severe damage caused by the downburst that occurred on June 29, 2021 in the southern Dehcho.

The event generated interest in meteorological circles and was further analyzed by the Northern Tornadoes Project (NTP), based at Western University (Ontario). NTP classified the event as a series of downbursts. Downburst is a strong, ground-level wind that originates from a point aloft, most often a thunderstorm. The winds in such events blow radially i.e. in straight lines, in all directions from the point of contact at ground level. Generally, once the downburst core hits the ground, a series of ring vortices would fan out from the centre causing winds to move from the impact point in a chaotic manner and creating a circular pattern in damage (Fig. 19).

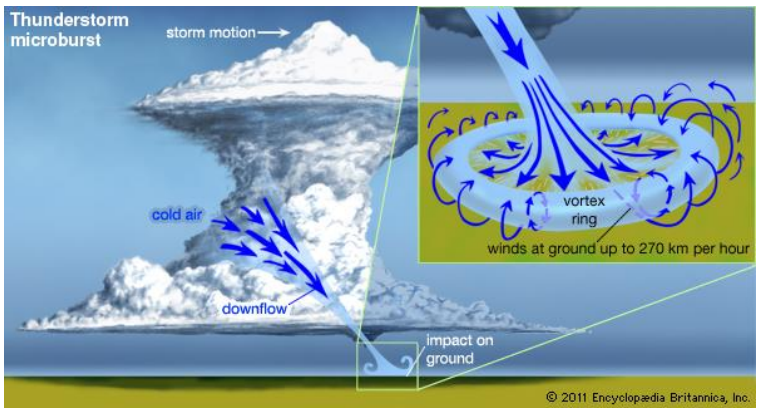


Figure 17. Diagram showing the mechanics of the thunderstorm microburst (downburst) and the circular pattern of damage seen in some areas within the blowdown event in the southern Dehcho.

Severe thunderstorms were a result of the ongoing heat dome which affected western Canada in the last week of June. Based on meteorological evidence, NTP concluded that wind speeds in the affected area reached upwards of 190 km/h. Interestingly, the amount of lightning strikes on the day of the event (136,202) was the second greatest number of strikes ever recorded by the NWT Lightning Detection Network, as reported in the 2021 Fire Weather Report by True North Consulting.

Unknown jack pine shoot damage

First noted in 2015, this shoot damage manifests by yellowing and reddening of needles in the inner mid- to upper crowns, radiating outwards. This issue was first observed in the Dehcho, along the north side of the Mackenzie River in 2015 during the drought period, and was originally thought to be drought damage. The majority of the 2021 damage observed was occurring in the South Slave. The symptoms are similar to drought and ground surveys revealed no obvious evidence of insect or disease damage (Fig. 20). However, the current damage is occurring during a wet period. Drought symptoms can manifest several years after droughts occur because severe droughts can damage roots and water conductive tissues from which some trees try to recover but they are unable to, hence a delay in symptoms and mortality. However, it has now been at least 5 years since the last drought in the areas the damage is observed, so it is unclear if it can be associated with drought or other factors are at play. An important factor might be that the affected stands reside in coarse soils, so it's possible that the last few summer heat waves may have played a role, even after decent spring rains. The stands being affected are mostly young (<20-40 years). Sample collection for detailed lab analysis along with further investigations is planned in 2022.

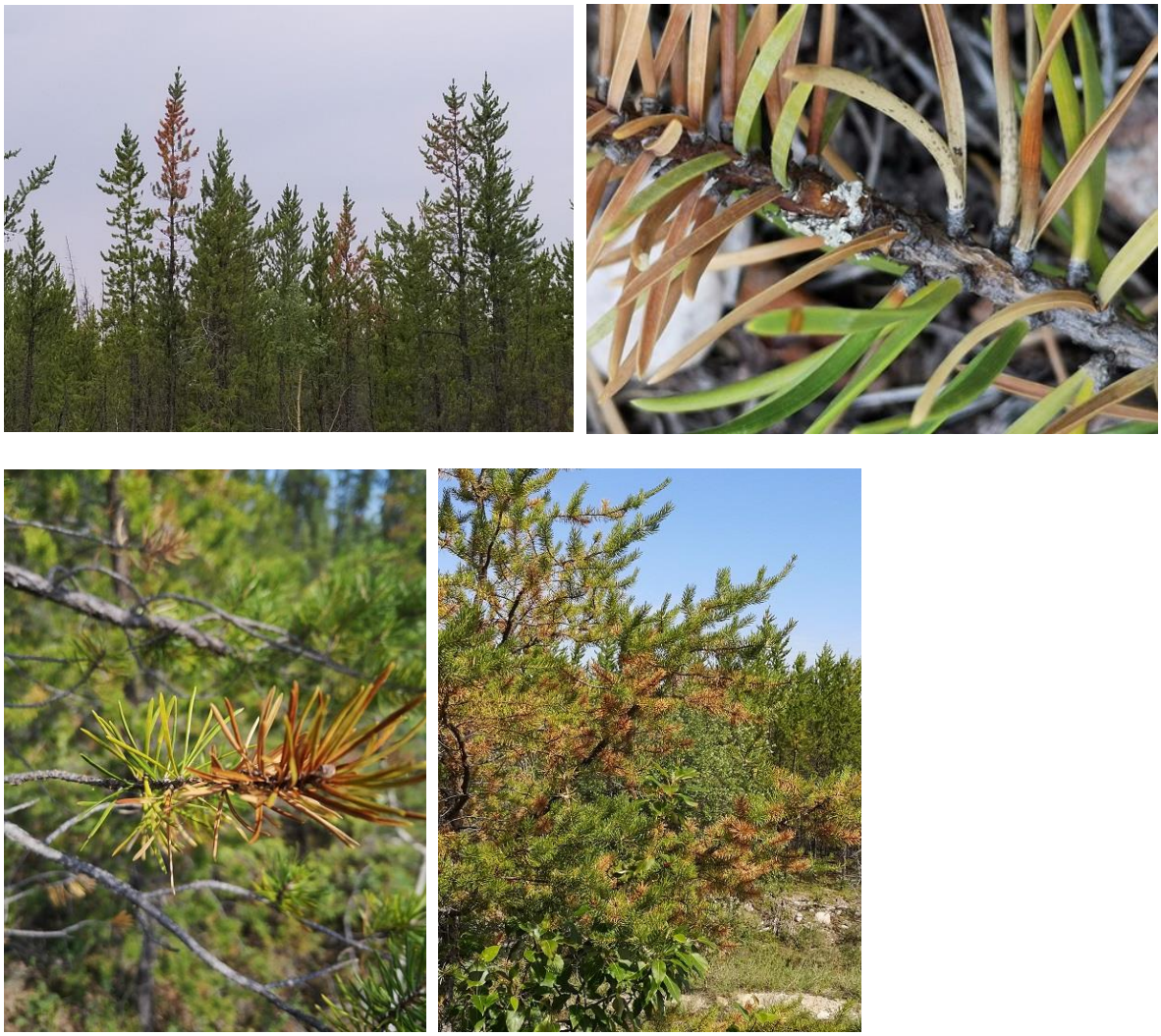


Figure 18. Shoot damage observed on jack pine trees in 2021. The cause of the damage is unknown, likely related to environmental issues.