

Aspen Serpentine Leafminer

Yukon Forest Health —
Forest insect and disease

1



Yukon

Energy, Mines and Resources
Forest Management Branch

Introduction

The aspen serpentine leafminer (*Phyllocnistis populiella*) is a defoliator of trembling aspen (*Populus tremuloides*) and is common throughout the host range in Yukon. The leafminer's activities were first recorded in the early 1950s along the Alaska Highway. At endemic levels, single leaf infestation is common but whole tree infestation occurs during outbreaks. Current outbreaks in Alaska and Yukon have impacted hundreds of thousands of hectares of mature and immature aspen. Ten to twenty years of unprecedentedly severe leafminer defoliation has occurred in stands of aspen along the Silver Trail between Mayo and Stewart Crossing.

While the leafminer rarely causes tree mortality, tell-tale signs of silvery foliage and reduced growth can be seen along most of the highways in Yukon. In general, trees infested by serpentine leafminer will only die if already stressed by factors such as past infestation by large-aspen tortrix (*Choristoneura conflictana*). Interestingly, there has not been an outbreak of large aspen tortrix since the serpentine leafminer outbreak, suggesting that the effects of interspecific competition and/or climate change are less advantageous to the tortrix. In Alaska, the ten-year tortrix cycle ceased in the early 1980s, coinciding with when mean annual temperatures began to increase.

Host Range for Aspen Serpentine Leafminer



(Source data: Yukon Government Forest Inventory Data [2008] and U.S. Geological Survey [1999] Digital representation of "Atlas of United States Trees" by Elbert L. Little, Jr. (<http://esp.cr.usgs.gov/data/little/>)
Disclaimer: The data set for historic incidence is likely incomplete and only extends from 1994–2008. Endemic or outbreak populations may have occurred or may currently exist in non-mapped locations within the host range.

**Forest Health Program
Forest Management Branch
Energy, Mines and Resources
Government of Yukon
P.O. Box 2703 (K-918)
Whitehorse, YT Y1A 2C6**

**867-456-3999
Toll free in Yukon: 1-800-661-0408, ext. 3999
www.forestry.gov.yk.ca**

Life Cycle

STAGE	Winter			Spring			Summer			Fall			W
	J	F	M	A	M	J	J	A	S	O	N	D	
Egg													
Larva													
Pupa													
Adult	Overwinter			Flight Period									

The aspen serpentine leafminer completes its life cycle in one year. Adult moths overwinter in bark crevices and scales of the host trees and surrounding duff layer, then emerge in the early spring before bud break. The tiny (5mm) white moths appear en masse during this flight period, and they can be observed in great numbers on house walls and car doors. They feed on nectar produced by glands near the base of some of the emerging leaves, mate, and lay eggs. Eggs are laid on the upper surface and, less often, the lower surface of the leaves.

Eggs hatch into larvae approximately 10 to 14 days after they are laid. The small, white 1st instar larvae chew through the bottom of the egg and enter the leaf where they mine in the epidermis without damaging the mesophyll or the outer cuticle. The larvae mine in a uniquely snake-like pattern and go through four larval instars in a two week period. Pupation occurs in a fold at the leaf edge. In Yukon, adult moths emerge in late July or early August.

Definitions:

Instar: the stages in the growth of a larva before it pupates.

Frass: a mixture of fecal matter and chewed plant debris.

Host Species Attacked and Damage

Tree species attacked in Yukon: All age classes of aspen and, to a lesser extent, balsam poplar (*Populus balsamifera*) and black cottonwood (*Populus trichocarpa*). Occasionally willow (*Salix spp.*) and ornamental cherry trees (*Prunus spp.*) are infested.

During periods of severe outbreak, entire stands can be defoliated by the leafminer (**photo 7**). During severe outbreaks when the larvae complete their feeding, all that remains are the translucent upper and lower mesophyll and cuticle of the leaves. When viewed from afar, these leaves give infested aspen stands a distinctive silvery appearance (**photo 1**).

Upon closer inspection, the feeding pattern of leafminer larvae is unique. The larvae feed individually on one or both sides of the leaf mid-rib in a sinusoidal, snake-like pattern (**photo 2**). The middle of the mining path contains a conspicuous black line of frass. The feeding damage causes premature desiccation and senescence, or biological aging, of the infested leaf. During periods of severe outbreak, more than 75% of the photosynthetic area of the affected tree can be impacted. This results in an overall decrease in productivity but rarely causes tree mortality. During successive years of defoliation top-kill and branch die-back may occur. Though tree mortality seldom occurs as a result of leafminer activity alone, it can occur when the activity of the leafminer follows a severe outbreak of the large aspen tortrix. Stands repeatedly severely infested can become stunted and deformed.

Wagner (2008) showed that mining of the upper sides of leaves decreases but does not completely stop photosynthetic ability while mining of the lower sides of leaves impacts tree productivity more due to reduced ability for gas exchange and translocation.

While there are no known natural predators of the leafminer, their populations are prone to other natural control mechanisms, e.g. cold, wet weather and intra-specific cannibalism. The current outbreak in Yukon and Alaska is unique in its severity and duration. Natural control agents that normally restore the balance in insect populations have proven ineffective with the leafminer and there is no telling when the infestation will subside.

Key features for identification:

- Eggs are small (0.2–0.3mm), white and semi spherical, and usually laid singly or doubly in folded leaf margins.
- Larvae are flat, small (5 mm long), and white-cream coloured **(photo 3)**.
- Pupae are brown and spindle-shaped (2.5–3.5 mm long) **(photo 4)**.
- Adult is a minute, bluish-white moth with wingspan of 6 mm **(photo 5)**.
- Leaf margins are folded at larval pupation sites
- Mines are silvery-white with black lines of frass in the middle, on the top or underside of the leaf **(photo 6)**.

Photo number:

1. **Silvery appearance of a stand infested by aspen serpentine leaf miner.** Citation: SDA Forest Service — Ogden Archive, USDA Forest Service, Bugwood.org
2. **Leaf damage caused by aspen serpentine leaf miner.** Citation: Rod Garbutt, Canadian Forestry Service.
3. **Aspen serpentine leaf miner larva.** Citation: USDA Forest Service — Ogden Archive, USDA Forest Service, Bugwood.org
4. **Aspen serpentine leaf miner pupa.** Citation: USDA Forest Service — Ogden Archive, USDA Forest Service, Bugwood.org
5. **Aspen serpentine leaf miner adult moth.** Citation: Thérèse Arcand, Natural Resources Canada, Canadian Forest Service.
6. **Folded leaf margin and newly emerged adult moth.** Citation: Thérèse Arcand, Natural Resources Canada, Canadian Forest Service.
7. **Stand level damage.** Citation: Rob Legare, Government of Yukon, Energy, Mines and Resources, Forest Management Branch.







Similar damage

The distinctive mining pattern and host specificity of the aspen leafminer is unique. Only the Agromyzid flies (*Agromyzidae spp.*) mine aspen leaves similarly to the leafminer, although the mining pattern of the agromyzid flies is narrower, shorter and jagged in appearance. Another leafminer, *Phyllonoricter populiella* restricts its feeding to a single area on the underside of the leaf producing characteristic blotches.

Risk Assessment


The following text and table summarizes the likelihood of occurrence and magnitude of impact of an outbreak at the stand level. The table and text are a coarse guide for estimating the risk of an outbreak when populations are at endemic levels.

Likelihood of Occurrence

Defoliator outbreaks tend to be cyclical and, beyond the presence of the host species, are not necessarily linked to specific environmental, climatic or stand conditions that enable an approximation of the likelihood of occurrence. However, physiological stress in host trees influences susceptibility and defoliator populations can be negatively or positively impacted by environmental, climatic or stand conditions. For example, late spring frosts may kill large numbers of larvae and their food source, while warm, dry weather helps improve insect population survival.

Magnitude of Consequence

The magnitude of consequence is a subjective assessment of the potential consequences of an outbreak. This list is not exhaustive and is intended to stimulate thought on potential impacts to consider over time.

Value	Impact							
	-				+			
Traditional Use ¹								
Comment:	Access (-)/sight-lines (+), understory flush (+)							
Visual Quality ²								
Comment:	Red/grey-attack period (-)							
Timber Productivity ³								
Comment:	Not applicable							
Wildfire Hazard ⁴								
Comment:	Increased fuel load (-)							
Public Safety ⁵								
Comment:	Hazard trees (-), increased fuel load (-)							
Hydrology ⁶								
Comment:	No impact anticipated							
Time Scale (years)								
	20+	15	10	0-5	0-5	10	15	20+
Comment:	Impact refers to a predicted, substantial positive (+) or negative (-) impact on a value for an estimated time period							

Notes:

1. In this context, traditional use values considered are hunting, trapping and understory shrub/plant use. Ruffed grouse (*Bonasa umbellus*), an important food supply, depends on aspen buds as a winter food supply. Given that leafminer outbreaks reduce the photosynthetic capacity of the infected trees, aspen buds would have a decreased nutritional value, thus adversely impacting traditional use values.
2. Visual quality is negatively impacted for a brief period during the current year's attack because attacked leaves brown up. In the autumn, the infested aspen stand's normally vibrant yellow hues are muted, therefore, negative impacts are anticipated.
3. There is no commercial harvesting of aspen in Yukon and timber productivity is not considered applicable.
4. Aspen leafminer rarely causes mortality, thus no impact on wildfire hazard is anticipated.
5. Given that serpentine aspen leafminer outbreaks rarely cause mortality, no impact is anticipated.
6. Given that serpentine aspen leafminer outbreaks rarely cause mortality, no impact is anticipated.

Implications of Climate Change

General Circulation Model (GCM) results in the 2007 Intergovernmental Panel on Climate Change (IPCC) report indicate that warming in northern Canada is likely to be largest in winter (up to 10°C) and warmer by 3–5°C in summer. Mean annual precipitation is also predicted to increase (particularly in fall and winter). More rainfall is expected on windward slopes of the mountains in the west, therefore the rain shadow effect of the St. Elias Mountains may mean that southern Yukon will not experience increased rainfall. Higher temperatures will increase levels of evaporation and transpiration, and ultimately lower soil moisture levels. Therefore, even if summer rainfall is maintained at current average levels, higher temperatures would result in limited soil water availability and cause moisture stress in trees. Temperature and precipitation are likely to be the dominant drivers of change in insect populations, pathogen abundance and tree responses as it influences insect/pathogen development, dispersal, survival, distribution and abundance. Defoliator species may benefit from warmer temperatures because of:

- higher rates of overwinter survival
- fewer late spring frost events
- longer summer season for growth and reproduction

Alternatively, if the timing of critical stages in the host (e.g., spring budburst) changes so that it is no longer in sync with key life stages of the defoliator (e.g., spring larval emergence), the defoliator population may be negatively impacted. Elevated carbon dioxide levels would likely reduce the nitrogen content in host needles/leaves, which may have either a positive or negative impact on defoliators depending on their nutritional requirements.

Under a warming scenario, defoliator outbreaks could become more frequent and more severe, which could increase tree mortality, particularly if trees are drought stressed. The current aspen serpentine leafminer outbreak in Yukon is unprecedented in scale and severity. Recent warm winter temperatures have likely improved the overwinter survival of the leafminer population. For example, since the early 1980s aspen serpentine leafminer populations have been on the increase in Alaskan forests.

Management Options

Monitoring

The aspen serpentine leafminer activity can be viewed from both aerial and ground surveys. The best time of year for monitoring is in the mid-summer prior to pupation when the larval mining has reached a maximum. Considering the duration and spatial distribution of the current outbreak, yearly aerial surveys could be effective to monitor the incidence of leafminer activity. For efficiency, survey work should be focused in aspen leading stands. For aerial survey standards, refer to 'BC Aerial Survey Standards' (MoF, 2000). For strategic planning information, refer to the Forest Management Branch risk-based monitoring strategy (Ott, 2009).

Direct Control

There are no known effective means of control for aspen serpentine leafminer outbreaks. While some systemic insecticides may be effective, the use of chemicals should be restricted, as leaf miners are particularly prone to developing resistance.

References

B.C. Ministry of Forests. 2000. *Forest health aerial overview survey standards for British Columbia*.

B.C. Forest Service. 46 pp.

Garbutt, R. 1998–2001. *Yukon Forest Health Reports*.

Unpublished reports prepared for the Department of Indian Affairs and Northern Development.

Garbutt, R. 2002–2009. *Yukon Forest Health Reports*.

www.emr.gov.yk.ca/forestry/foresthealth.html

Jones, J.R.; DeByle, N.V. and Bowers, D.M. 1985. *Aspen: ecology and management in the western United States*. USDA, Forest Service: www.fs.fed.us/rm/pubs_rm/rm_gtr119.pdf

Henigman, J.; Ebata, T.; Allen, E.; Westfall, J., and Pollard, A. *Field Guide to Forest Damage in British Columbia*. Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C. Joint Publication Number 17.

Kruse, J.; Ambourn, A. and Zogas, K. 2007. *Aspen Leaf Miner*. United States Department of Agriculture, Forest Service, Alaskan Region, State and Private Forestry, Forest Health Protection. Leaflet R10-PR-14.

Ott, R.A. 2009. RAO Ecological Consulting Services. *Development of a Risk-Based Forest Health Monitoring Program for the Yukon*. 33 pp.

Snyder, C.; Schultz, M.E. and Lundquist, J. (Compilers). 2007. *Forest Health Conditions in Alaska*. USDA Forest Service, Alaska. Protection Report R10-PR18: www.fs.fed.us/r10/spf/fhp/cond_rept_links.htm

Wagner, D. ; DeFoliart, L.; Doak, P. and Schneiderheinze, J. 2008. *Impact of epidermal leaf mining by the aspen leaf miner (Phyllocnistis populiella) on the growth, physiology, and leaf longevity of quaking aspen*. *Oecologia* 157 : 259–26.

Werner, R. 2007. *Climate warming in Alaska: Effects of climate change on forest insect populations*. In *Climate change impacts on boreal forest disturbance regimes; Conference program & abstracts. Disturbance dynamics in boreal forests*, VI International Conference, Fairbanks, Alaska, 30 May – 2 June.



www.forestry.gov.yk.ca