Birch Defoliator

Yukon Forest Health — Forest insect and disease

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Yukon
Energy, Mines and Resources
Forest Management Branch

Introduction

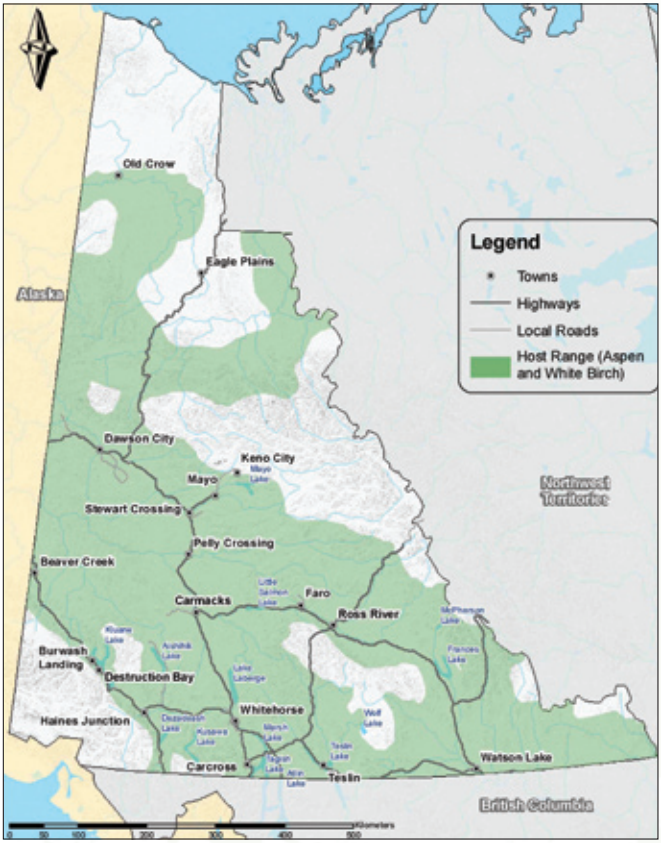
The birch leafminer (*Fenusa pusilla*), amber-marked birch leafminer (*Profenusa thomsoni*), birch leaf skeletonizer (*Bucculatrix canadensisella*) and the birch-aspen leafroller (*Epinotia solandriana*) are defoliators of white birch (*Betula papyrifera*) in North America. Of the four, only the *Bucculatrix* is native to North America, but it is not currently found in Yukon. The other three species, as invasives, pose a far greater threat to native trees because their natural enemies in the form of predators, parasites and diseases are absent here.

The birch leafminer was accidently introduced from Europe in 1923 and is now widely distributed in Canada, Alaska and the northern United States, though it has not yet been found in Yukon. The amber-marked birch leafminer was first described in Quebec in 1959 but is now found throughout Canada, the northern contiguous U.S., and Alaska. The amber-marked birch leafminer has proven to be, by far, the more damaging of the two species. Both species are of the blotch mining type as opposed to the skeletonizing *Bucculatrix* and the leafrolling *Epinotia*.

Amber-marked leafminer damage is typically found along road systems. Infestations along roadsides are often greater in areas of high traffic, or where parked cars are common, suggesting that this pest will hitchhike on vehicles. It was first identified in Anchorage, Alaska in 1996 and has since spread widely to other communities. In areas of Alaska, efforts to control the spread of the amber-marked birch leafminer have been underway since 2003 with the release of parasitic wasps (*Lathrolestes spp.*). In recent years, amber-marked birch leafminer activity has been identified near Dawson City and Watson Lake where native white birch is present. A 2003 survey by Dr. David Langor of the Canadian Forest Service in Edmonton found that this pest was abundant in the Whitehorse region, although mainly associated with ornamental birch (*Betula spp.*).

Both leafminers are species of sawfly wasps that defoliate birch and affect both urban and forest trees. Both species can also be introduced to new areas on nursery stock. The first sign of a leafminer affected tree is leaves which have a centre patch or blotch that is lighter green than the edges. The leaves will eventually turn brown and die. Although repeated years of infestation can induce considerable stress on a tree, death from birch leafminer activity is unlikely.

Host Range for Birch Leafminer, Ambermarked Birch Leafminer, and Birch Aspen Leafroller



(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.

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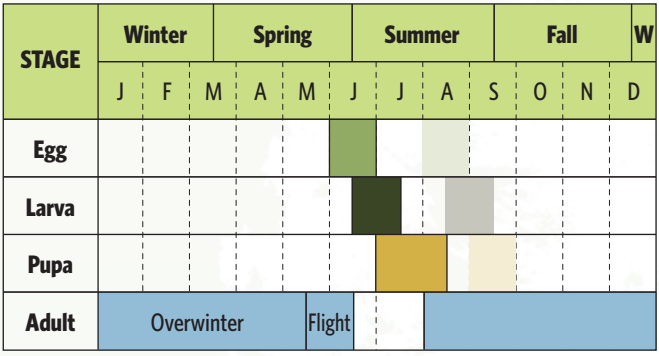
The birch-aspen leafroller is a mainland European pest that has invaded Canada. It was first reported in British Columbia in 1909 but is now found throughout the range of birch in Canada. The birch-aspen leafroller is a suspected cause of severe defoliation of birch on the Alaska Highway, west of the Highway 37 junction.

Neither the birch leafminer nor the birch leaf skeletonizer has yet been identified in Yukon though both have been collected in coastal Alaska. In the future, climate moderation may allow these two pests, to flourish in the more continental Yukon climate.

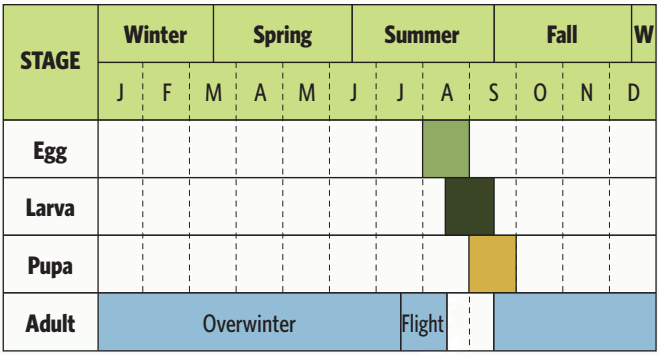
Life Cycle

Birch leafminer



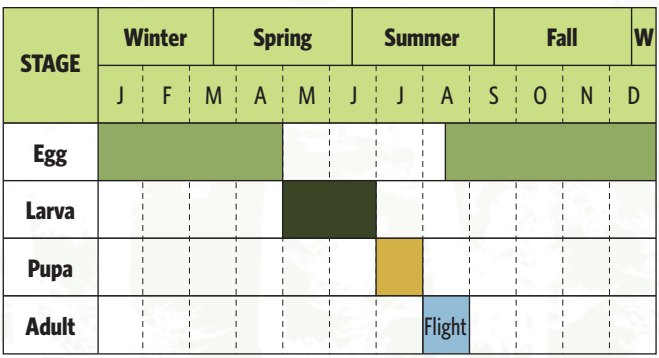
The birch leafminer is the earliest of the birch defoliators to attack in the spring. The adult leafminers emerge from the forest soil as early as mid-May. The females insert about twenty eggs into young leaves. The larvae feed on the leaf material between the upper and lower epidermal layers, causing hollowed and discolored leaves. After ten to fifteen days, the larvae emerge from inside the leaf and drop to the ground where they pupate. The entire life cycle takes about five weeks with the new adults emerging two to three weeks later. The female lays eggs only on developing leaves near the ends of branches and at the top of the tree. A second generation may be produced in a single season, though this is unlikely in the north.

Amber-marked leafminer



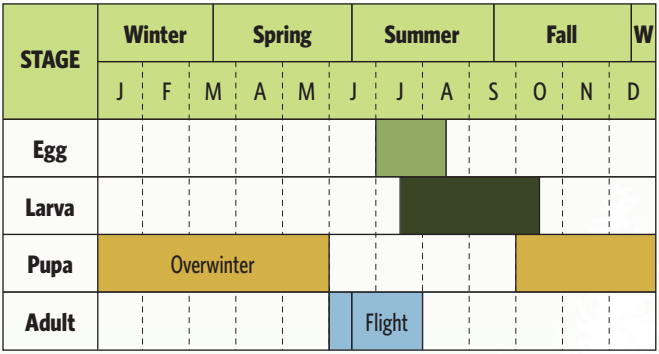
The life cycle of the amber-marked leafminer is similar to that of the birch leafminer; however, amber-marked adults emerge later in the season (mid- to late July). As a result this insect only produces one generation per season. Another distinction is that amber-marked leafminers are parthenogenetic (females can reproduce without being fertilized by males) and males appear to be absent from the North American population. This may explain why they spread so readily and are so successful.

Birch-aspen leafroller



Adult moths of the birch-aspen leafroller emerge from the soil in August. They deposit small eggs on rough branches of birch and aspen, near the point where leaf buds will emerge the following spring. The eggs remain on the branch through the winter and hatch the following May. The caterpillars feed on newly developing leaves until early June and then roll individual leaves into a protective cocoon. Inside the leaf, the caterpillar feeds until full grown in mid-to late June, when it drops to the forest floor to pupate. Three to four weeks later, the adult moth emerges to lay new eggs.

Birch leaf skeletonizer



The birch leaf skeletonizer adult moths emerge from the leaf litter in late June to late July. Eggs are laid singly on either side of the leaf surface, hatching approximately two weeks later. Young larvae mine the leaf material between the upper and lower epidermal layers for three to four weeks, then emerge from the lower leaf surface and spin webs in which they molt. Molting occurs twice over three to four weeks, during which time the larvae feed externally on the underside of the leaves as skeletonizers. When larvae are full grown, they spin cocoons on the dead leaves, which drop to the forest floor, where the larvae pupate over winter.

Host Species Attacked and Damage

Tree species attacked in Yukon:

Birch leafminer: white (paper) birch (*Betula papyrifera*) is the primary potential host in Yukon. It will also affect ornamental grey birch (*Betula populifolia*) and yellow birch (*Betula alleghaniensis*).

Amber-marked birch leafminer: White birch, yellow birch, grey birch.

Birch-aspen leafroller: White birch, trembling aspen (*Populus tremuloides*).

Birch leaf skeletonizer: potentially white birch, yellow birch, grey birch.

Leafminer (both species) damage is caused by the larvae feeding on the mesophyll between the upper and lower epidermis. In general the damage is limited to new leaves and buds or areas near shoot tips later in the season. Initial tree symptoms manifest by leaves turning lighter green towards the centre. Eventually the leaf will exhibit brown blotches that cover the entire leaf **(photo 1)**. When they occur, second generation birch leafminers cause less damage to the tree as there are fewer new leaves for them to feed upon. Severe infestations can result in heavy defoliation, poor tree growth and reduced vigour. Decline in tree health as a result of repeated years of leafminer attack can weaken the tree and make it more susceptible to pathogens or other insects.

Leafrollers actively feed on the entire leaf as it is developing from the bud. As the larvae age they will choose a leaf, roll it up into a protective cocoon, and continue to feed from the inside. It is this rolled leaf that is characteristic of the species, although other insect birch pests such as the native oblique-banded leafroller (*Choristoneura rosaceana*) can also exhibit this behaviour. Like the leafminer, the leafroller can cause heavy defoliation, resulting in poor tree health but rarely causing tree mortality.

The birch leaf skeletonizer first mines the inside of the leaf, resulting in narrow, serpentine mines that may be visible in mid-summer. White, silken molting webs may be visible on the lower leaf surface or on twigs. In late summer and fall, leaves appear brown as they are skeletonized and may drop from the tree. During heavy infestations, leaves may be completely skeletonized but the skeletonizer rarely causes tree mortality.

Key features for identification:

Birch leafminer:

- Eggs are laid in slits cut into the upper surface of developing leaves.
- Whitish larvae are flattened with light coloured heads (full grown = 6–7mm).
- Larvae have 4 midventral black dots on 3 thoracic and 1 abdominal segments.
- First leafminer to attack birch in the spring.
- Adult sawfly is black with yellow brown legs.
- Male adults are common and reproduction is sexual.

Amber-marked birch leafminer:

- Eggs are laid along leaf veins near the centre of developed leaves **(photo 2)**.
- Whitish larvae are flattened with light coloured heads (full grown = 6–7mm).
- Larvae have 1 conspicuous light coloured patch on prothorax and smaller darker patches on other thorax segments.
- Attacks birch later in the season than birch leafminer.
- Adult sawfly is tiny, black and has characteristic white legs **(photo 3)**.
- Female adults are parthenogenetic. Male amber-marked birch leafminers have not been discovered in North America.

Birch-aspen leafroller:

- Egg overwinters on rough bark near the site of an emergent bud.
- Light-green early caterpillar, blue gray late caterpillar **(photo 4)**.
- Roll leaves into a characteristic shelter in the late larval form **(photo 5)**.
- Pupa exists in the forest soil in July and August.
- Adult a small grey brown moth **(photo 6)**.

Birch leaf skeletonizer:

- Eggs are laid singly on either side of the leaf surface.
- White-yellow young larvae.
- Pupa cocoons in the forest litter over winter.
- Adult a small mottled brown and white moth.

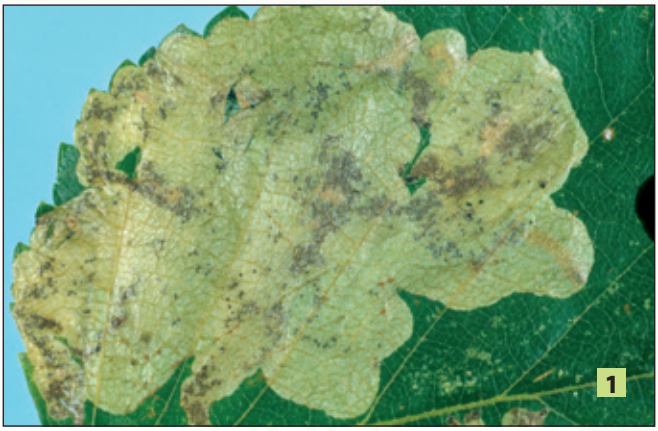
Photo number:

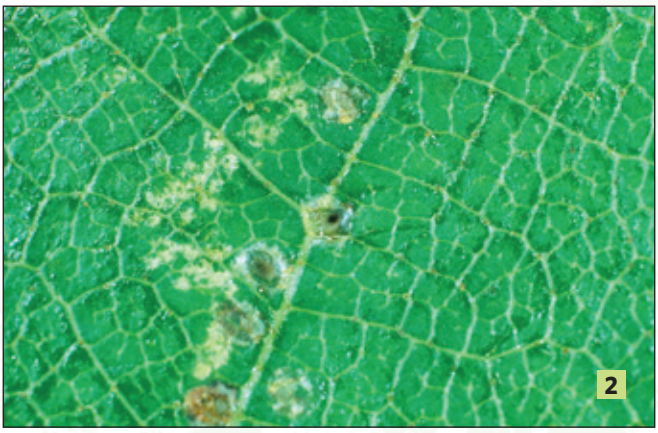
1. **Ambermarked birch leafminer larval feeding tunnel.** Citation: Thérèse Arcand, Natural Resources Canada, Canadian Forest Service.
2. **Ambermarked birch leafminer eggs.** Citation: Thérèse Arcand, Natural Resources Canada, Canadian Forest Service.
3. **Ambermarked birch leafminer adult.** Citation: Thérèse Arcand, Natural Resources Canada, Canadian Forest Service.

4. **Birch leafroller caterpillar.** Citation: Edward H. Holsten, USDA Forest Service, Bugwood.org

5. **Tree with Birch leafroller infestation leaf roll.** Citation: Rob Legare, Yukon Government, Energy, Mines and Resources Department, Forest Management Branch.

6. **Birch leafroller moth.** Citation: Edward H. Holsten, USDA Forest Service, Bugwood.org



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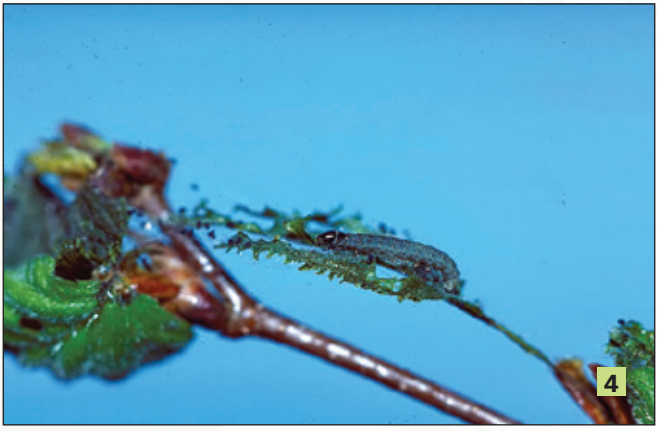
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Similar damage

Leafminer damage is a result of larval feeding within the leaf. Others such as the aspen serpentine leafminer have a more distinctive serpentine feeding pattern compared to the birch leafminer which creates blotches of dead tissue within the leaf. Damage to the tree caused by leafminers, skeletonizers and leafrollers can be similar to other defoliators with crown dieback and the appearance of poor health. Stands and individual trees can exhibit similar damage as a result of drought stress and other factors. Severe spring frost can cause a failure to leaf out, which if not properly identified can be mistakenly attributed to defoliators.

Risk Assessment

The following table and text summarize 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 can 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, defoliator populations can be negatively impacted by inhospitable environmental, climatic or stand conditions. For example, late spring frosts may kill their food source, while warm, dry weather helps improve population survival. The introduced leafminers and leafrollers do not have native predators or diseases that help to regulate their populations, therefore outbreaks of those insects may be more prolonged and severe.

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:	No impact anticipated							
Visual Quality[2]				■				
Comment:	Dead foliage period (-)							
Timber Productivity[3]								
Comment:	Not applicable							
Wildfire Hazard[4]								
Comment:	No impact anticipated							
Public Safety[5]								
Comment:	No impact anticipated							
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. Given that leafminer/leafroller/skeletonizer outbreaks rarely cause mortality, no impact is anticipated.
2. Visual quality is negatively impacted during the current year's attack because of leaf damage and muted autumn leaf colours.
3. There is no commercial harvesting of birch/aspen in Yukon and timber productivity is not considered applicable.
4. Given that mortality is rare, no impact on wildfire hazard is anticipated.
5. Given that leafminer/leafroller/skeletonizer outbreaks rarely cause mortality, no impact is anticipated.
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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 frost events at critical life stages
- 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.

A short life cycle, mobility, reproductive potential and physiological sensitivity to temperature (i.e., insects are cold blooded) will mean that the distribution and diversity of defoliators at higher latitudes could change in a relatively short period of time as they take advantage of new climatically suitable habitats. Under a warmer/drier scenario, defoliator outbreaks could become more frequent and more severe, which could increase tree mortality, particularly if trees are drought stressed. In Alaska, amber-marked birch leafminer populations went into decline during wetter summers, probably as a result of larvae drowning; therefore, a warmer/wetter climate scenario may result in decreased defoliator populations.

Management Options

Monitoring

If in the future, outbreaks of birch leafminer and leaf roller become more widespread and severe, they will be able to be mapped from the air and as well as being assessed from the ground. At current levels, this disturbance agent is best monitored with annual road based surveys as recent outbreaks have been isolated to transportation corridors. The best time of year for monitoring is mid- to late summer when the foliage of the current year's attack is most conspicuous. For efficiency, survey work should be focused in birch leading stands. For aerial survey standards, refer to 'BC Aerial Survey Standards' (MoF, 2000).

Direct Control

There are no effective control measures for large scale outbreaks of birch leaf miner, amber-marked birch leafminer or birch leafroller.

For urban settings there are varieties of ornamental birch that appear to be resistant to the leafminer. These include the Whitebarked Himalayan birch (*Betula jacquemontii*), Dahurian Birch (*Betula davurica*), River Birch (*Betula nigra*), Schmidt Birch (*Betula schmidtii*), Black Birch (*Betula lenta*), Yellow Birch (*Betula alleghaniensis*) and Japanese Cherry Birch (*Betula grossa*).

Keeping trees in good health through fertilizing, watering, proper planting and pruning techniques, can help reduce the impacts of insect pests in urban settings. Pruning may be effective for high value yard trees that are severely infested, as long as infected leaves and branches are removed or destroyed. Contact insecticides are not effective against leaf mining insects during their most damaging stage because they are protected inside the leaf. Some insecticides that are carried systemically through the tree can be effective in controlling leaf mining insects.

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