Western Balsam Bark Beetle

Yukon Forest Health — Forest insect and disease

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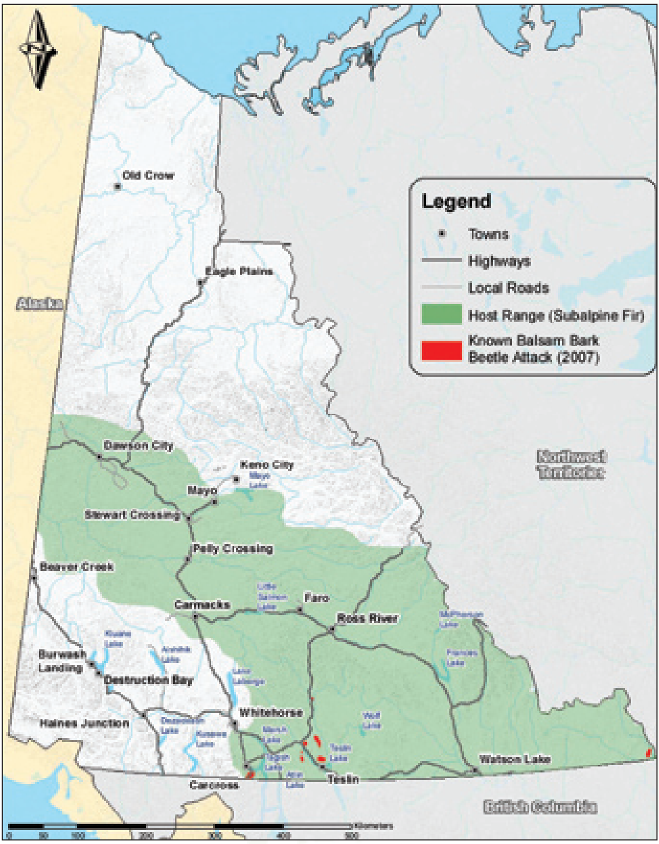
Introduction

The western balsam bark beetle (*Dryocoetes confusus*) is a woody tissue feeder of subalpine fir (*Abies lasiocarpa*). It is found throughout the host range in Yukon and, over the past two decades, light to moderate infestations have been observed in the southern part of the territory. The beetle works in concert with a symbiotic fungal pathogen (*Ceratocystis dryocoetidis*) to overcome tree defence mechanisms. At endemic levels, the beetles prefer trees weakened by age or climatic stress (e.g., drought, wind-damage or snow-damage), but during outbreaks healthy trees are susceptible to attack. Endemic beetle populations can cause single tree mortality; however, outbreak populations can cause extensive group tree or stand-level mortality over successive years of attack.

Over the last 20 years, the western balsam bark beetle has advanced north from British Columbia into southern Yukon. Surveys from the mid-1980s to the early 1990s recorded the beetle's northerly spread across the 60th parallel. With the change in climatic conditions, extensive amounts of mature and semi-mature trees, and successive years of attack, the balsam bark beetle has become an active stand-level disturbance agent in southern Yukon. Surveys indicate that the most affected areas have been high elevation stands with concentrated subalpine fir components. In the mid 1990s, hundreds of hectares of light (<10%), current-year mortality were mapped in the LaBiche River area in southeast Yukon. Years of successive attacks have removed a large proportion of the subalpine fir overstory. In 2007, an extensive area of light, current-year mortality was mapped in the hills south and west of Teslin Lake. Light scattered mortality has also been seen on both sides of Tagish Lake (Windy Arm), south of Carcross.

Host Range for Western Balsam Bark Beetle



(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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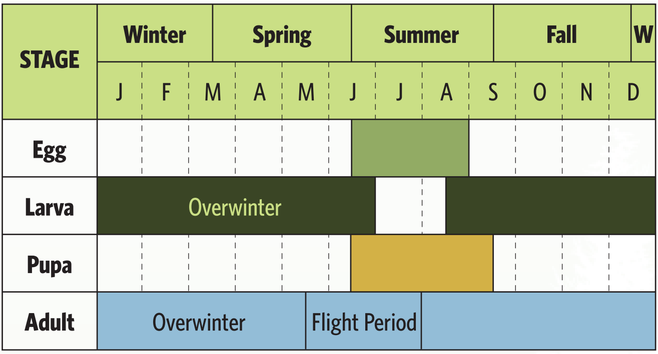
Life Cycle



In Yukon, the western balsam bark beetle normally cycles in two or three years. Males emerge from their host in mid- to late June when the ambient temperature is greater than 15°C. Once the males find fresh host material, they bore through the bark of the host tree, mine a nuptial chamber and release a pheromone to attract females. Anywhere from two to five females will mate with a single male within the nuptial chamber. The female brood galleries radiate from the nuptial gallery in much the same pattern as the pine engraver (*Ips pini*), though they etch less deeply into the sapwood. Eggs are laid singly along the gallery margin. The eggs hatch two weeks later and larvae commence mining the phloem. The larval galleries radiate outward from the main gallery in a random fashion.

Two possible scenarios ensue once the larvae hatch:

1. Adults remain with the larvae in the same tree, overwinter and establish a second brood the following summer; or,
2. Adults re-emerge from the tree to attack a new host and establish a second brood.

Under favourable climatic conditions, the western balsam bark beetle can establish a third brood. The multiple brood behaviour of the balsam bark beetle makes it an effective disturbance agent of fir stands in Yukon.

Host Species Attacked and Damage

Tree species attacked in Yukon: Subalpine fir is highly susceptible throughout its range in Yukon. While there have been no recorded attacks in Yukon, white spruce (*Picea glauca*) has very low susceptibility in other jurisdictions. Younger trees are less susceptible than large-diameter, mature and over mature trees.

During the first year of attack (prior to tree mortality), infestation signs are inconspicuous. Attacks occur above the 2 m mark on the bole, or trunk, of the tree making them difficult to detect from the ground. Pitch tubes are usually absent, but large amounts of diffuse pitch flows will be present if the attack is unsuccessful. The most prominent sign of recent beetle attack is the presence of boring dust and frass in the bark fissures on the bole and around the base of the tree. After the first year of successful attack the foliage turns a bright “brick red” colour **(photo 1)**. Unlike other conifers that shed their needles the following year, subalpine fir retains its discoloured needles for up to five years after the initial attack. Mortality is usually confined to single trees or small groups of trees in any given year. In successive years these groups can coalesce and, over a period of 10 to 20 years of infestation, the whole mature subalpine fir component of a stand can be killed **(photo 2)**. Under these conditions many younger understory trees can also undergo attack.

Under outbreak population levels, scattered mortality occurs throughout a stand though mortality in any single year rarely exceeds 5%. Attacks on subalpine fir are assisted by the fungal pathogen carried by the beetle. It is estimated that 65% of mortality results from the lesions created by the fungus. These lesions, like the larval phloem mining, act to girdle the conductive tissues of the tree. The fungus can be introduced to the tree even when beetle attack is unsuccessful. The fungus will then proliferate in the phloem weakening the tree and attracting subsequent beetle attacks.

Definitions:

Phloem: *the tissue in trees that transports nutrients found just below the bark.*

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

Key features for identification:

- The egg is small, white and oval.
- Larvae (3–4 mm long) are yellow-white and very wrinkly with a strong body curve. The head is pale tan colour **(photo 3)**.
- Pupae (3–4 mm long) are coloured the same as the larvae. Pupae are more developed than other bark beetle pupae (*Dendroctonus* and *Ips spp*) with more of the mature adult body parts visible.
- Adults are small (3–4 mm long) **(photo 4)**, shiny-brown, cylindrical beetles. The distinguishing feature of the balsam bark beetle is the presence of a brush of erect red-brown hairs on the front of the head (frons) of the female adult. The male has fewer red-yellow hairs **(photo 5)**.
- Larval galleries extend from the nuptial and brood chambers in a random fashion **(photo 6)**.

Photo number:

1. **Brick red foliage of attacked tree.** Citation: Ladd Livingston, Idaho Department of Lands, Bugwood.org
2. **Stand level damage caused by western balsam bark beetle.** Citation: William M. Ciesla, Forest Health Management International, Bugwood.org
3. **Western balsam bark beetle larvae.** Citation: USDA Forest Service — Ogden Archive, USDA Forest Service, Bugwood.org
4. **Adult western balsam bark beetle size.** Citation: USDA Forest Service — Ogden Archive, USDA Forest Service, Bugwood.org
5. **Adult western balsam bark beetle.** Citation: USDA Forest Service — Rocky Mountain Region Archive, USDA Forest Service, Bugwood.org
6. **Beetle gallery pattern.** Citation: Scott Tunnock, USDA Forest Service, Bugwood.org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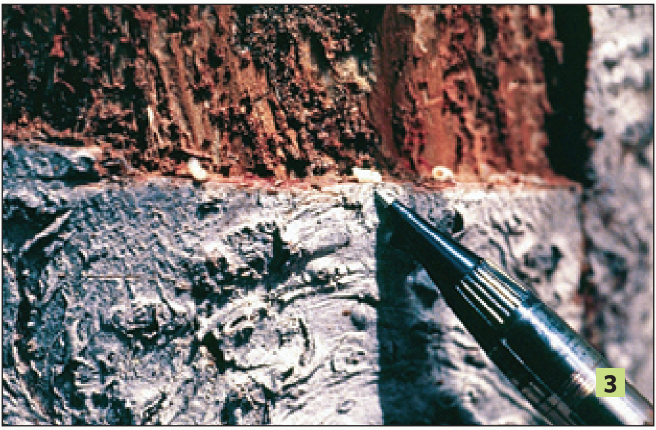

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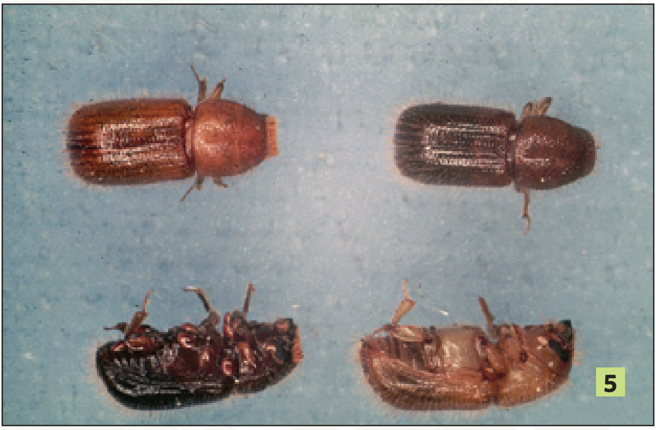

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Similar damage

In areas other than Yukon, the fire engraver (*Scotylus ventralis*) beetle damage causes similar foliage discolouration. Some abiotic factors such as winter-kill, flooding or drought may cause subalpine fir to exhibit brick red crowns.

Risk Assessment

The following tables summarize the likelihood of occurrence and magnitude of impact of an outbreak at the stand level.

These tables are a coarse guide for estimating the risk of an outbreak when populations are at endemic levels.

Likelihood of Occurrence

Stand Susceptibility Factor:	High ⟶ Low	
DBH[1] (Diameter Breast Height)	Large	Small
Stand Health[2]	Stressed/Decadent	Vigorous
Subalpine fir distribution[3]	Continuous	Discontinous with gaps
Stand Age[4]	Older	Younger
Crown Size[5]	Small	Large

Notes:

1. Large diameter subalpine fir are more attractive habitat for balsam bark beetles.
2. Balsam bark beetles are attracted to recently killed and stressed subalpine fir; therefore stands under stress increase the likelihood of attack.
3. A continuous distribution of subalpine fir increases the likelihood that an outbreak can build and spread.
4. Older stands tend to be more attractive habitat for balsam bark beetles due to decreased tree vigour.
5. Trees with a smaller crown size tend to be more attractive habitat for balsam bark beetles.

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. It is assumed that access for hunting will be more difficult due to fallen trees in the long-term. Sight lines through the stand for hunting will be improved in the short term. The understory flush (short-term, vigorous understory growth due to decreased competition for light and nutrients) is assumed to lead to increased berry production and greater diversity in the understory in the short term.

2. Visual quality is negatively impacted initially during the red-attack period and then during the grey-attack period until the trees begin to fall and the green understory takes over.

3. There is no commercial harvesting of subalpine fir in Yukon and, given the general lack of access and timber value associated with subalpine fir stands, timber productivity is not considered applicable.

4. Wildfire hazard increases in the short term while the dead needles are retained on the subalpine fir. It then decreases in the medium term when the needles have dropped. Hazard increases again in the long term when the dead trees fall to the forest floor and contribute large diameter fuels to the regenerating fuel complex.

5. Public safety is negatively impacted in the long term by the increase in hazard trees and wildfire hazard.

6. Given that balsam bark beetle tends to cause large scale tree mortality over successive years of attack, overstory removal will be gradual and no impact on hydrology 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 they influence insect/pathogen development, dispersal, survival, distribution and abundance. Bark beetle species may benefit from warmer temperatures because of:

- higher rates of overwinter survival
- fewer early and late winter frost events
- longer summer season for growth and reproduction (shorter life-cycles)
- moisture stressed trees with less resistance to attack

These factors, coupled with a short life cycle, mobility, reproductive potential and physiological sensitivity to temperature (i.e., insects are cold blooded) have enabled the balsam bark beetle to expand its range north from BC into Yukon in recent years. In addition, balsam bark beetle incidence may increase as new, climatically suitable habitats become available.

Management Options

Monitoring

Balsam bark beetle activity can be viewed from both aerial and ground surveys. Given access issues and the potential difficulty of detecting balsam bark beetle attack from the ground, aerial surveys are likely to be most effective. The best time of year for monitoring is summer when the foliage of the previous year's attack turns brick red. However, unless working with successive years of aerial survey data, it may be important to conduct a ground-truthing exercise after an aerial survey to determine the age of the infestation as trees retain red coloured needles for five years. For efficiency, aerial monitoring should focus on subalpine fir 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 for direct control of balsam bark beetle. Because of the poor access to the alpine and remote location of most subalpine fir stands, sanitation clear cutting of infested stands is not usually an option. Studies have been conducted with pheromone trails using anti-aggregating and aggregating pheromones specific to the balsam bark beetle. The use of these pheromones may prove an effective means of control for protecting high-value individual trees or small groups of trees.

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