Northern Spruce Engraver Beetle

Yukon Forest Health — Forest insect and disease

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Yukon
Energy, Mines and Resources
Forest Management Branch

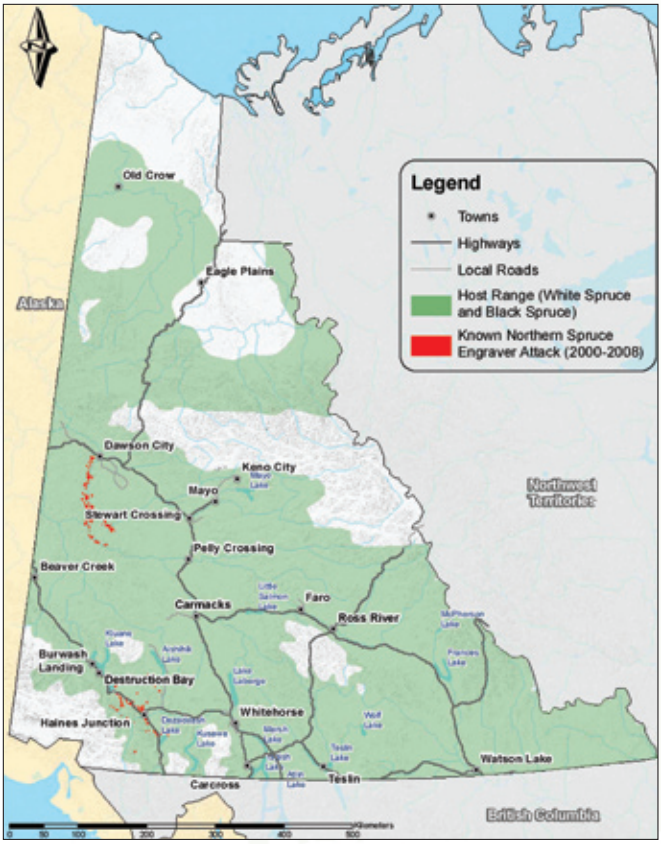
Introduction

The northern spruce engraver beetle (*Ips perturbatus*) is a natural disturbance agent of white spruce (*Picea glauca*) and in rare instances black spruce (*Picea mariana*) in Yukon. The spruce engraver beetle's range extends throughout transcontinental Canada and the northern United States, including Alaska. Engraver beetles are a group of species in the genus Ips (often referred to as ips beetles) that commonly infest logging slash, damaged trees, stressed or recently felled trees and trees attacked by spruce beetle. At outbreak population levels, engraver beetles generally attack and kill smaller healthy trees and the tops of larger trees.

In Yukon, northern spruce engraver beetle is often a secondary bark beetle that attacks trees already infested with spruce beetle (*Dendroctonus rufipennis*). However, when populations are high or host conditions are suitable, it can also be a primary bark beetle. This tends to occur when trees have been stressed by human activities during land clearing. Improper treatment of slash and downed timber during these activities can lead to localized outbreaks. Immature, over-stocked spruce stands containing trees ranging from 10 to 20 cm in diameter are commonly attacked.

The population of northern spruce engraver beetle in Yukon has increased with the surge in available host material created by the spruce beetle outbreak. Historically, *Ips perturbatus* outbreaks in Yukon have been limited to single tree or small group tree mortality although, in Alaska, a large-scale outbreak was recorded in saw-log sized trees during the 1950s. In 2007–2008 an outbreak of Ips occurred along the Yukon River south of Dawson City as a result of severe drought in the spruce.

Host Range for Northern Spruce Engraver 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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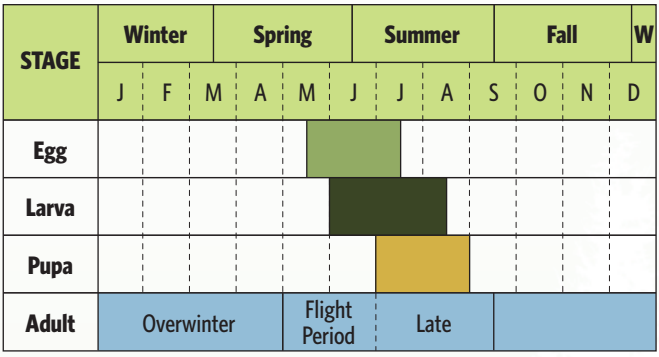
Life Cycle



In most areas of the spruce engraver beetle's range, two to three (and sometimes as many as five) generations are produced each year. However, in Yukon, spruce engraver beetles typically produce one or two generations per year. In early spring, adults that have overwintered in the duff emerge to attack new host material (May–June). Males burrow into the host tree and create a nuptial chamber. Females are attracted to the tree by an aggregating pheromone and one to five beetles will enter the nuptial chamber for reproduction. The female adult produces a single, vertical gallery, laying single eggs on opposite sides of the chamber as she goes. Gallery length typically ranges from 8 to 15 cm. Both the egg galleries and nuptial chambers are kept free from frass and boring dust by the adults.

Larvae hatch and feed (perpendicular to the grain) **(photo 7)** both on the cambium and sapwood for approximately two to four weeks then pupate at the end of their galleries. Larval galleries will be packed with frass. After two more weeks, pupae mature into adults. These adults remain in the host tree and feed before emerging to either: a) drop to the duff, burrow underground and overwinter; or, b) disperse and attack new host material without producing brood. These adult beetles take part in a "feeding" attack where no broods are produced. During late summer and early fall, adults drop from the tree and overwinter in the duff. Dispersal distances range from 10 to 120 m.

Definitions:

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

Cambium: *the actively dividing layer of cells which produces the conducting tissues in a tree, therefore increasing the girth of a tree.*

Bole: *the main stem of a tree.*

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

Host Species Attacked and Damage

Tree species attacked in Yukon: Immature and mature stands of white spruce (*Picea glauca*) with average diameter at breast height, greater than 10 cm and in rare cases, black spruce (*P. mariana*).

Nuptial chambers and egg galleries of spruce engraver beetles can be distinguished from other bark beetles because they are free from frass and boring dust **(photo 6)**. Small larval galleries radiate at right angles outward from the main gallery. Engraver beetles score the sapwood more deeply than *Dendroctonus spp.* galleries. Main galleries are normally vertical like *Dendroctonus spp.* galleries but tend to be narrow and shorter ranging from 6 to 20 cm in length. Fine, yellow-red boring dust and frass are present within the bark crevices and around the root collar during the first year of attack. Pitch tubes are usually absent.

Stands of ips-attacked spruce will exhibit foliage discolouration **(photo 1a, b)**. As early as one month after attack, the needles will change from green to yellow-orange. Most of these needles are shed by the end of the first summer following attack and spruce then appear silver-gray. The ips beetle will not always cause tree mortality. Crown die-back with live lower branches is common in larger trees **(photo 4)**; however in southwest Yukon trees are smaller so the lower bole is normally attacked. Trees killed by ips will exhibit the blue-stain fungus in their sapwood.

Key features for identification:

- The oblong egg is pearly white (1.5 mm).
- All four larval instars are stout, cylindrical and legless (3.2 mm at maturity) **(photo 5)**.
- Pupae are opaque white, inactive and similar in size and shape to the adults.
- The adult beetle is 3–6 mm long and reddish-brown to black. Ips is distinguished from the spruce beetle by wing covers with concave margins and tooth like projections. Also, when viewed from above the head of ips is not visible **(photo 2a, b)**.
- Main egg galleries extend into the sapwood and are free from frass and boring dust **(photo 3)**.

Photo number:

1. **a) Stand damage red and grey attack (Dawson area).** Citation: Rod Garbutt, Canadian Forest Service, and **b) Stand level damage, red and grey attack (Dawson area).** Citation: Rod Garbutt, Canadian Forest Service.

2. **a) Adult.** Citation: Edward H. Holsten, USDA Forest Service, Bugwood.org, and **b) Adult beetle with Clerid larva.** Citation: Rod Garbutt, Canadian Forest Service.

3. **Galleries.** Citation: Edward H. Holsten, USDA Forest Service, Bugwood.org

4. **Upper bole attack showing crown die-back.** Citation: Rod Garbutt, Canadian Forest Service.

5. **Larval galleries with adults.** Citation: Rod Garbutt, Canadian Forest Service.

6. **Main galleries (free from frass).** Citation: Rod Garbutt, Canadian Forest Service.

7. **Larval feeding galleries.** Citation: Rod Garbutt, Canadian Forest Service.


1a


1b


2a


2b


3


4


5


6


7

Similar damage

Damage caused by other bark beetles (*Dendroctonus* and *Ips spp.*) can be confused with that of the engraver beetle. The galleries of the spruce beetle are different in that they do not extend as far into the sapwood. In addition, spruce beetle attacked trees do not usually fade as rapidly, taking up to two years after attack for foliage to change colour. *Ips tridens* and *I. borealis* occur in Alaska and may occur in Yukon.

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 Hazard:	**High** →	**Low**
Recent stand level disturbance causing spruce mortality/debris[1]	Present (within 120 m)	Absent
Spruce bark beetle[2]	Present	Absent
Spruce composition[3]	>65%	<20%
Stand health[4]	Stressed/Decadent	Vigorous

Notes:

1. Ips beetles are attracted to recently killed and stressed spruce or slash therefore nearby disturbance in spruce stands increases the likelihood of attack in adjacent spruce stands.
2. Attack by spruce bark beetle weakens trees and increases the likelihood of attack by ips beetles.
3. A higher proportion of spruce increases the likelihood of attack in a stand.
4. Ips beetles are attracted to recently killed and stressed spruce therefore stands under stress increase the likelihood of attack.

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:	Red/grey-attack period (-)							
Timber Productivity[3]			■	■				
Comment:	Young plantation mortality (-)							
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. Given that outbreaks tend to affect scattered or small groups of small-diameter trees, no significant impact is anticipated.
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. Given that small diameter trees are generally killed, timber productivity may be reduced in the medium-term until young forest regenerates if the stand has an adequate seed bed. Also, top-kill of larger diameter spruce will decrease timber productivity.
4. Wildfire hazard increases in the short term while the dead needles are retained on the spruce. 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 spruce fuel complex.
5. Public safety is negatively impacted by the increase in hazard trees and wildfire hazard.
6. Given that outbreaks tend to affect scattered or small groups of small-diameter trees, no significant 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 greatest 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. Bark beetle species may benefit from warmer temperatures because of:

- higher rates of overwinter survival
- fewer frost events especially in early winter before larvae harden off (produce anti-freeze)
- longer summer season for growth and reproduction (shorter life-cycles)
- moisture stressed trees with less resistance to attack

Ips beetles are likely to benefit from changes that result in increased primary bark beetle activity. A warmer/drier climate scenario is also likely to benefit the northern spruce engraver beetle if it causes drought stress in spruce. *Ips spp.* have been found to be more tolerant of dry host tissue than *Dendroctonus spp.* A warmer/drier climate in Yukon may result in decreased activity by the spruce beetle, and increased activity by the Ips beetle as the primary bark beetle. However, Ips beetle outbreaks may be confined to river floodplains because the upland spruce may be too dry even for Ips to develop outbreak populations.

Management Options

Monitoring

Ips perturbatus activity can be viewed from both aerial and ground surveys. The best time of year for monitoring is late summer or early fall when the foliage colour change is most conspicuous. For efficiency, aerial monitoring should focus on white spruce 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

Direct control for spruce engraver beetle is not generally recommended except when the population is at endemic levels or when attempting to stop an outbreak in its early stages. Options for direct control include:

- Sanitation logging is the most commonly used means of direct control. Complete timber removal of infested stands combined with prompt processing can greatly reduce the beetle population. Stumps can be either peeled or burned.
- In stands with low to moderate beetle populations, a two stage approach can be used. First a sanitation cut is implemented to remove infested trees. Remnant beetle populations are removed using pheromone-baited funnel traps.
- Conventional and lethal trap trees. Conventional trap trees are healthy trees that are felled in the early spring prior to adult flight and, once infested, are removed and milled or debarked or burned. Lethal trap trees are felled, sprayed with aggregating pheromone and then treated with an insecticide.

Harvesting Considerations

Harvesting of spruce may occur either as a by-product of private/industrial land clearing or if a commercial forestry operation is undertaken. The following considerations can apply to both small and large-scale tree harvesting and to either green-tree or salvage harvesting:

- Time harvesting operations to occur outside the beetle flight period and remove or dispose of logs/debris prior to the next beetle flight period.
- Minimize amount and size of green debris left on site through pile-and-burn, broadcast burn or chipping. All debris with a dbh >10 cm should be treated.
- Minimize windthrow hazard when designing the harvest area. Following harvest, survey windthrow in mid- to late June to determine if it is being attacked. Salvage of green windthrow in the years following harvesting will minimize host material.
- Minimize stump height.
- If possible, completely debark or score the bark in strips on logs to be decked, used for access control or other on-site purposes so that it does not provide habitat for beetles.
- Minimize site disturbance to ensure hydrology is not impacted and that residual trees are not mechanically damaged or under stress.
- Partially burned trees in the fringe area of a wildfire should be harvested immediately after the fire if the fire occurs in the early spring. Otherwise, trees can be harvested before the next beetle flight.
- Do not stack infested or uninfested, green fire wood next to healthy trees.
- When broadcast burning or burning slash piles avoid damaging the roots and boles of leave trees. This will minimize the amount of stressed trees on site and decrease the amount of suitable host material.

Silvicultural Considerations

Silvicultural considerations are relevant post-harvest if a stand is being managed for commercial forestry or if an area is being replanted:

- Increase stand biodiversity by utilizing a range of preferred and acceptable species for planting. In southwest Yukon, this may require consideration of off-site species such as lodgepole pine (*Pinus contorta*) if ecologically appropriate.

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