



Canadian Forest Service

Atlantic Forestry Centre – Making a Difference

Early intervention strategy – Efficacy and the non-target impact of insecticides

The spruce budworm (SBW) (*Choristoneura fumiferana*) is the most serious pest affecting the forests of eastern North America. Records indicate that SBW outbreaks are cyclic – occurring every 30 to 40 years. The last extensive outbreak in eastern Canada reached its peak in the 1970s, damaging more than 50 million hectares. An outbreak is currently occurring in Quebec, and populations are increasing in northern New Brunswick.

The SBW completes its life cycle in a single year. After emerging from its pupa, the female moth mates and lays eggs on the underside of needles. The eggs hatch in about 10 days, and the larvae begin to grow, going through six instars or larval phases. During the second instar (L2), the tiny larva crawls into a bark crevice, under a bud scale or into another sheltered area and overwinters in a small cocoon (*hibernaculum*). During spring, the larva emerges, begins feeding and eventually transforms into an adult – thus completing the one-year cycle.

Researchers have found that SBW densities can be determined by sampling the L2 phase. Branches are cut from the mid-crown and processed to determine the number of L2 larvae per section of branch. Knowing this number is the key to understanding how SBW populations are changing. Forest managers use this information to assess the risk the SBW poses to the forest.

Efficacy trial of insecticides

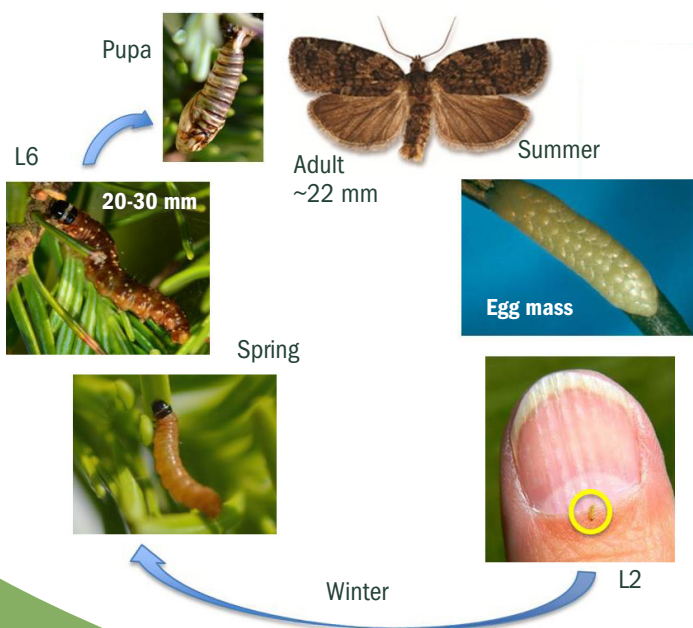
Natural Resources Canada (NRCAN) researchers Dr. Rob Johns and Dr. Veronique Martel are leading a project to examine whether small outlying populations at the leading edge of an outbreak (epicenters or hot spots) can be treated to slow or halt the spread of the outbreak. This goal is the essence of the early intervention strategy (EIS) for the SBW.

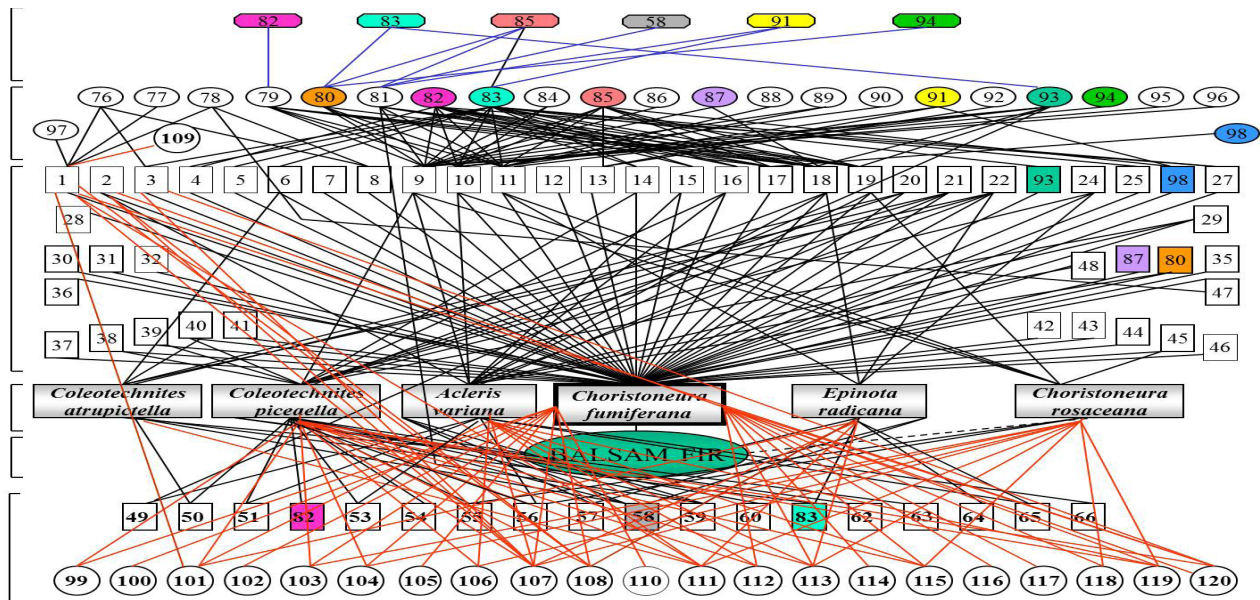
In the past, insecticides have been applied to high density SBW populations in vulnerable stands with the objective of keeping the trees alive. The EIS approach differs because it treats low density populations before they begin to grow exponentially, ideally halting the local outbreak before it gains momentum.

A bacterial insecticide, Btk (*Bacillus thuringiensis kurstaki*) and the hormonal disruptor, Mimic (tebufenozide), are being tested to determine their effectiveness on low density spruce budworm populations as well as the possible impacts on other moth species and natural enemies. Enemies of the SBW include predators (birds, beetles), parasitoids (parasitic wasps and flies), and pathogens such as bacteria, protozoans, viruses and fungi.

Mimic and Btk were chosen because they only target the feeding larvae (caterpillars) of moths and butterflies and because they break down relatively quickly in the environment as compared to traditional chemical insecticides. Their targeted impact and short persistence make these insecticides ideal for managing the spread of the outbreak in New Brunswick. In 2014 and 2015, Btk and Mimic were applied on several large blocks, and nearby untreated sites were used as comparison for natural population growth.

Spruce budworm life cycle





Structure of the balsam fir food web

The size of the SBW populations in the treated and untreated blocks were determined by sampling L2 larvae before and after treatment. The density in the untreated blocks increased while the density in the treated blocks decreased noticeably. These results are very encouraging and provide a proof of concept that the EIS approach to maintaining SBW densities below critical levels may be a viable option in the control of this forest pest.

Impact on other organisms

A very complex food web exists between the SBW and its primary food source: balsam fir. Many organisms (predators, parasites and pathogens) provide a natural population control that keeps the SBW numbers low.

The interaction between these organisms and the SBW is very dynamic and becomes most complex when the SBW numbers are at their highest. Most of the key parasitoids thought to control the SBW are generalists that attack other herbivores when SBW densities are low. Consequently, these herbivores could be adversely affected if a low density SBW population is treated.

Understanding how control products impact this complex community of organisms is critical to the success of the EIS.

Identifying these organisms is often challenging because they can be present in various life stages, be dead or be inside the SBW. Traditionally, identifying these organisms relied on rearing them to maturity and identifying the adults as they emerged. The process was costly, time consuming, could not be used if the sample was

dead and identification of closely related species was sometimes difficult.

An innovative method that involves DNA (barcoding) is being developed by Dr. Eldon Eveleigh (NRCan) and Dr. Alex Smith (University of Guelph) and will be tested to validate its use as a taxonomic tool. DNA barcoding is a new technology that can quickly identify organisms (dead or alive) without having to go through the long and costly process of rearing.

Research project activities

- Assess the efficacy of Btk and Mimic on areas of low density SBW populations.
- Validate a barcoding chip that will provide rapid and precise identification of SBW natural enemies.
- Determine the impacts of the EIS on parasitoid populations and the impacts on the local herbivore community.

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