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Branching Out
from the Canadian Forest Service - Laurentian Forestry Centre

Prompt Action Required to Control Spruce Budworm

Spruce budworm holds the title of the most destructive insect affecting coniferous forests in North America. Canadian Forest Service (CFS) researchers are interested in learning more about this pest and finding ways to limit the damage it causes. Their latest solution for controlling spruce budworm is an early intervention strategy.

The current strategy for controlling spruce budworm (SBW) is to protect some of the tree foliage in order to ensure the survival of trees during an outbreak. Since the mid 1980s, aerial spraying has been carried out with a biological insecticide called *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*), but because spraying has been limited to vulnerable stands (dominated by balsam fir and white spruce) with high commercial value, this approach has no effect on regional budworm populations.

An early intervention strategy is based on the idea that SBW outbreaks are similar in nature to forest fires; they begin in one stand and spread to neighbouring stands until an entire region is affected. An obvious strategy would be to eliminate epicentres by applying insecticides, thereby slowing the progression of the outbreak and reducing its severity. The objective of this early


Photo: SOPFIM

intervention strategy is therefore to alter the course of new outbreaks (i.e., to stop or slow the spread of outbreaks) in their early stages by taking action to control insect populations. To achieve this objective, it is essential to


Photo: SOPFIM

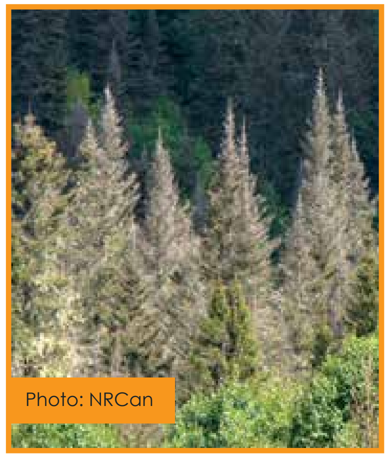
Photo: NRCan

have a good understanding of the processes that lead to the triggering of new outbreaks.

Two visions of why SBW outbreaks occur

There are two schools of thought as to how budworm outbreaks are triggered. The first, called the "double equilibrium" theory, is based on the premise that SBW populations are kept at low densities because of a high mortality rate. Consequently, outbreaks are triggered either by a lower mortality rate caused, for example, by highly favourable weather conditions or by the immigration of moths.

The second theory, commonly known as the "oscillating" theory, is based on the assumption that an outbreak cycle is caused by a slow fluctuation in the mortality rate resulting from the combined impact of natural enemies (predators, parasitoids and disease). A new outbreak begins when the impact of these enemies is at its lowest point. After a few years, the number of natural enemies starts to increase again as the numbers of insects that they prey upon increases. The outbreak comes to an end when the natural enemies regain the upper hand over the SBW population. According to this theory, migration, climate and foliage supply do not trigger new outbreaks, but they can exert some influence on the spread of outbreaks.

Population dynamics: A vitally important research area

Neither of these theories is based on data showing the dynamics of populations at the start of outbreaks, the reason being that there is no such data. However, the findings of studies on population dynamics conducted in New Brunswick, Quebec and Ontario since the 1980s have helped to increase our understanding of the outbreak process.

First, the gradual nature of changing mortality rates caused by natural enemies at the end of outbreaks—a core component of the oscillating theory—can be called into question. Observations suggest that the mortality rate increases only after a decrease in SBW populations. The decrease may be caused, for example, by a low survival rate during the dispersal of larvae in severely damaged stands, as well as by adverse weather conditions, a shortage of food, disease, mass emigration of moths or even by the application of an insecticide.


Photo: SOPFIM

Second, studies of endemic populations currently under way in Quebec have demonstrated that the rate of SBW mortality caused by natural enemies has remained very high over a long period (at least 28 years) despite changes occurring among their natural enemies.

Third, it has recently been demonstrated that there is a relationship between population density and mating success. In low density populations, females have a very low probability of attracting a male


Photo: SOPFIM

and mating. This low mating success rate, combined with a high mortality rate caused by natural enemies, results in a "demographic Allee effect", whereby the rate of population growth becomes negative when the population is at a low density. Therefore, the SBW outbreak process does not seem to be a simple, synchronized predator/prey type of interaction.

What this means in concrete terms

These findings militate in favour of the early intervention strategy. In the context of a simple predator/prey type oscillation pattern, population growth during the upward phase of the cycle would be due to the low impact of natural enemies. It would then become very difficult to halt the population increase. In fact, even after a very effective control operation, the SBW population would quickly recover because of its high growth rate. Consequently, it would become even more difficult (if not futile) if all of the populations are synchronized on a regional scale. However, populations at the start of the upward phase that are subject to the Allee effect may be very localized and scattered. An effective treatment may bring the density of these populations down to a lower level, such that their growth rate becomes too low to allow a sudden increase.

Since 2011, a research project studying these issues has been under way in the Lower St. Lawrence region and in two endemic populations near Quebec City. The objective of this project is to observe the dynamics of SBW populations during the upward phase of a new outbreak over the broadest possible density range. Other projects in which the populations are still very small were launched in New Brunswick in the spring of 2014.

CFS researchers have several partners who are contributing to the advancement of these projects, including Forest Protection Limited, members of Spray Efficacy Research Group International, the Economic Development Agency of Canada, SOPFIM, the ministère des Forêts, de la Faune et des Parcs du Québec, owners of private woodlots and several university research scientists. In their research activities, they seek a better understanding of when and how intervention should be carried out in order to mitigate the effects of SBW outbreaks.

Useful links

http://cfs.nrcan.gc.ca/entrepotpubl/pdfs/33589.pdf

http://cfs.nrcan.gc.ca/entrepotpubl/pdfs/35367.pdf

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