



Ten Years of Advances in Our Understanding of the Spruce Budworm Outbreak

In 2006, when the current spruce budworm (SBW) outbreak began in the boreal forest of the Côte-Nord region, Louis De Grandpré, a research scientist in plant ecology and forest dynamics with the Canadian Forest Service, was already studying the area with his team. Together, they set up a large experimental site consisting of 10 permanent plots ranging between 0.4 and 1 ha and located in stands of fir, spruce, and mixed fir and spruce. De Grandpré wanted to carry out a long-term follow-up study of the effects of the SBW outbreak on the forest ecosystem.

He asked himself the following six questions, which led to the discovery of some exciting new knowledge!

1 Who benefits from the outbreak?

The answer may be surprising: as it feeds, the budworm generates a great deal of waste composed of needle residue and its own excrement. Here a particular cycle begins: a defoliated tree enriches the soil → the soil's nutrients are quickly taken up by the tree → the needles are high in nutrient value → the next generation of SBW is well nourished. However, cumulative cases of severe defoliation eventually deplete trees' reserves, causing significant mortality within four or five years..

2 How can we better understand the effect of leaf area reduction on the vitality of trees?

The analysis of two indicators—the concentration of carbohydrates stored in the tree and the width of the rings—shows that losses of soluble sugars and starch prevent the trees from growing properly. Although the accumulation of environmental stressors must be taken into account, the decline in



Photo: NRCan

starch reserves, results in reduced growth and subsequent softwood mortality.

3 How do salvage cuts following an SBW outbreak disrupt spruce stand regeneration?

Stands affected by SBW which had been subjected to salvage cutting were compared to stands that had not. Results show that harvested sites experienced an increase of about 25% in the defoliation of regenerated black spruce. As a precautionary measure, changes in salvage cutting practices could

be implemented to avoid potential issues, such as the reduction of black spruce and its increasing vulnerability to the SBW.

4 How do large-scale disturbances affect overall forest carbon stocks?

Louis De Grandpré's team along with another from Université du Québec à Montréal conducted the first quantitative analysis of the effect of an SBW outbreak on forest carbon dynamics in the three stand types studied. The results showed that from 2007 to 2017, an area of



Photo: NRCan



Litter trap to monitor the effect of the outbreak on the ecosystem.

more than 20,000 km² of forest was converted from a carbon sink to a carbon emitter. The results suggest that during the same period, young fir forests lost less carbon than fir/spruce or spruce forests during SBW attacks in Quebec. This highlights the importance of considering species composition when assessing vulnerability.



5 What if the SBW was not acting alone?

In the forests of the Côte-Nord region, during SBW outbreaks, tree mortality is mainly attributed to the defoliation caused by the larvae. Thus, throughout the twentieth century, two adverse climatic events preceded SBW infestations and contributed to tree mortality: cold springs and warmer-than-average summers. It seems that these climatic stresses reduce the robustness of trees and that the budworm finishes the job. The SBW should be reconsidered as the main mortality factor.

6 Does climate change alter tree phenology?

In the boreal forest of the Côte-Nord region, analyses have shown that for each degree the temperature increases, bud burst occurs earlier for balsam fir (by nearly 5 days) and black spruce (by nearly 3 days). Balsam fir becomes more defoliated due to the improved phenological synchronicity between the emergence of SBW larvae and the buds opening in the spring. Black spruce, although preferred by the SBW, is currently less accessible as a host. However, coinciding phenologies between SBW and black spruce could occur with global warming, thereby increasing the severity of black spruce stand infestations.



“Louis De Grandpré: Any further questions?”

As a result of the significant mortality of stands attacked by the SBW, the entire forest environment of the Côte-Nord has been profoundly altered. The researcher now wants to answer the following question: «With all these upheavals, what are the current impacts on this forest ecosystem?» More to follow...

Useful links

<https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/39413.pdf>

https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/wildland-fires-insects-disturban/top-forest-insects-diseases-cana/spruce-budworm/13383?_ga=2.8730866.637950555.1596476347-2135249238.1562070469

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