



# InBrief

from the Canadian Forest Service – Laurentian Forestry Centre



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## The mountain pine beetle does not operate alone

The mountain pine beetle is a tiny insect that has taken a heavy toll on the pine forests of British Columbia. The current outbreak in western Canada has destroyed more than 630 million m<sup>3</sup> of pine. Thanks to a number of factors, including climate change, the insect has crossed the natural barrier formed by the Rocky Mountains and is now threatening to devastate Canada's boreal pine forests.

Whereas the mountain pine beetle cannot kill trees on its own, its fungal accomplice, *Grosmanella clavigera*, can have a lethal impact if inoculated at high enough densities. The pine beetle and the fungus have a symbiotic relationship in which the insect transports the fungus to new host trees and bores holes through the bark that give the fungus access to the living tissues. And what does the insect receive in return?

In recent studies, researchers at the Canadian Forest Service and the University of British Columbia, the British Columbia Cancer Agency Genome Science Centre, INRA-France and CRNC-France identified an important effect that the fungus has on the defence mechanisms of pines. They discovered that when a pine tree is attacked by the beetle-fungus pair, it produces toxic resins in an attempt to repel the invaders. The fungus has the ability to tolerate and detoxify these chemicals, enabling the two associates (beetle and fungus) to overcome the host tree's defences and eventually kill it.

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## Reforestation of boreal forested peatlands

In the Clay Belt region of northwestern Quebec, which is part of the black spruce–feathermoss bioclimatic domain, disturbing the organic layer in forested peatlands prior to planting has very positive effects on seedling growth and vigour and on seedling foliar nitrogen and phosphorus

concentrations. This finding comes from a study undertaken by researchers at the Canadian Forest Service and the Université du Québec en Abitibi-Témiscamingue.

The research focused on two surface substrates, specifically feathermoss and sphagnum moss carpets. The organic layer was disturbed and mixed to a depth of about 25 cm. This included severing tree and shrub root systems. The mineral soil was not exposed nor was it mixed with the organic layer. Black spruce seedlings were measured after two growing seasons. The treatment reduced competition significantly throughout the experiment, and soil temperatures were higher in the disturbed plots. In addition, seedlings planted on feathermoss sites exhibited better growth and vigour than those planted on sphagnum moss sites.



Photo: B. Lafleur

Management of black spruce stands with a thick organic horizon poses a challenge. The site preparation typically recommended after harvesting involves exposing the mineral soil, which is often difficult to do when the organic layer is too thick. The goal of the study was to disturb only the organic layer, without mixing it with the mineral soil and without exposing the latter. The results show that this treatment is sufficient to bring about significant improvement in growing conditions.

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## Characterization of post-fire residual habitats

In the boreal forest, fires play a major role in stand renewal and landscape diversity. The presence of unburned areas (residual habitats) within large burns contributes to this diversity. Researchers at the Canadian Forest Service, the Université du Québec à Montréal and the Université du Québec en Abitibi-Témiscamingue used satellite imagery to characterize the residual habitats from 33 fires in the black spruce–feathermoss bioclimatic domain of western Quebec.



Photo: CFS

A strong correlation was found between fire size and the total area of residual habitats. On average, residual habitats accounted for 10% of the total fire area. Owing to the extreme weather conditions in which they occur, fires on the clayey lowlands located in the western portion of this bioclimatic domain produce fewer residual habitats compared with fires occurring farther to the east on thinner deposits and on the hills of the Canadian Shield. In the case of several fires, the presence of residual habitats was linked to the proximity of water bodies. However, no such association was found with wetlands, which suggests that this type of environment serves as a fuel source.

In general, all cover types were represented in residual habitats. However, mossy woodlands were over-represented relative to their pre-fire proportion, suggesting that they are less likely to burn. Local conditions influence the quantity of residual habitats and their distribution; it is therefore important to take this into account in ecosystem-based management planning.

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## Climate change: lichen woodlands to the rescue

Based on a recent study conducted by researchers at the Canadian Forest Service, Agriculture and Agri-Food Canada and Environment Canada, the conversion from closed-canopy boreal forests to lichen woodlands contributes to climatic cooling.

In the boreal forest, a number of tree species, including black spruce, regenerate quickly after fire. However, black spruce is a slow-growing species that can take up to 25 years to reach sexual maturity. In closed-canopy black spruce stands, a first burn or harvest followed by a second burn that occurs before the new cohort has reached sexual maturity may cause a shift to lichen woodland, particularly on well-drained sites.

Canopy opening in the boreal forest usually causes an increase in the albedo, that is, the ability of the surface to reflect solar radiation back into space, largely because of the snow-covered ground that is exposed. The researchers observed that the high albedo of lichen woodlands generates a cooling effect that outweighs the warming effect of CO<sub>2</sub> emissions resulting from the burning of the original forest. The fact that it is the snow and not the lichen cover that causes this increase in albedo suggests that this finding also applies to ericaceous woodlands.

The increased fire frequency predicted in climate change scenarios could lead to the creation of lichen woodlands, which would help mitigate global warming. Conversely, reforestation of lichen woodlands could have a warming effect. These results underscore the need to incorporate changes in albedo in the evaluation of boreal forest management approaches in relation to climate change rather than focusing solely on carbon dioxide effects.

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## Good news for native poplars

Past research has shown that exotic poplars in plantations hybridize with balsam poplars and eastern cottonwoods growing in adjacent areas and that balsam poplars show a greater propensity to hybridize with exotic poplars than do eastern cottonwoods. To what extent are the resulting hybrids viable and able to reproduce in the natural environment? Are exotic traits incorporated into the genome of native species or not?

This phenomenon of introgression was the object of research carried out by Canadian Forest Service researchers in collaboration with colleagues at the California State University, the Université de Lausanne and the ministère des Ressources naturelles et de la Faune du Québec.



Photo: R. Gal

Using dozens of genetic markers, they characterized 635 trees of different age classes, sampled from 15 different populations located on sites with various degrees of anthropogenic disturbance. The study focused on a natural contact zone comprising the two native poplar species and ornamental plantations of exotic poplars (*P. nigra* or *P. canadensis*, a hybrid introduced more than 100 years ago).

The researchers observed a greater amount of introgression on disturbed sites. They also noted that reproduction had occurred between introgressed poplars and balsam poplars and that the genetic traits of the latter were dominant in the new generation of poplars. This indicates that balsam poplar traits may gradually regain their integrity with passing generations. However, other aspects, such as the selective value of exotic characters, must be considered in assessing the impacts on native populations.

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## The pre-industrial forest landscape of Anticosti Island

The pre-industrial forest landscape of Anticosti Island was characterized by a forest matrix of overmature softwood stands with some younger softwood stands. In the moist maritime balsam fir stands of eastern Canada, forest fires and insect outbreaks have a much less pronounced impact on forest dynamics than in continental balsam fir forests. Since the classic cyclic model, which includes stands of different age classes, is not suitable for representing this forest landscape, Canadian Forest Service and Université Laval researchers suggest replacing it with one that includes overmature forests.

Owing to intensive browsing by white-tailed deer and past harvesting activities, there are few remaining primeval forests on the island. The researchers therefore used forest maps and inventory data from the 1950s obtained from the forest industry in order to reconstruct the pre-industrial landscape. Dendrochronological analyses were carried out to study the historical impact of fires and insect outbreaks from which the younger stands originate.

In keeping with sustainable forest management and biodiversity conservation criteria, the researchers recommend maintaining 22% of the forest area in sufficiently large patches of overmature stands. These stands must be fenced in to prevent intensive browsing and to reproduce all the characteristics of overmature stands, particularly in the understory.

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