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In Brief

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Defoliating insects and soil nutrients: a close link?

Defoliating insect epidemics increase the transfer of nutrients to the soil through droppings and damaged foliage falling to the ground. In addition, tree mortality creates favorable environmental conditions for increased microbial activity and nutrient mineralization. These changes can lead to a positive feedback loop as improved soil fertility may enhance the nutritional quality of the host's foliage, potentially intensifying the severity of the epidemic.

Aerial view of defoliation caused by the spruce budworm (Photo: NRCan)

A research team from Université du Québec à Montréal, Université Laval, Edgewood College, and the Canadian Forest Service has tested hypotheses concerning the effect of a spruce budworm epidemic on nutrient dynamics in the boreal forest of eastern Canada. The team measured litter nutrient fluxes, soil nitrogen availability, and leaf nutrient status in fir and black spruce forests. As the spruce budworm epidemic progressed, increases in litter nutrient fluxes and soil nitrogen availability were observed. These changes enhanced the nutritional quality of the foliage in surviving host trees, supporting greater insect reproductive success. This, in turn, contributed to rising population densities and intensified defoliation through the course of the epidemic.

These results suggest that defoliation caused by a spruce budworm epidemic creates the conditions for large-scale epidemics in a self-amplifying dynamic.

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Clearcutting: a threat to soil carbon?

Canada's northern forests store large quantities of carbon and are largely managed on a clearcutting basis. Previous meta-analyses of the effects of this approach on soil carbon have shown short- and long-term decreases after clearcutting. However, the effects of clearcutting on soil carbon stocks specifically for forests in the Nordic countries and Canada remain poorly understood. Research teams from the Norwegian Institute for Nature Research, the Natural Resources Institute Finland, the Norwegian Institute of Bioeconomy Research, the University of Copenhagen, the Swedish University of Agricultural Sciences, and the Canadian Forest Service investigated this issue using national forest inventory data.

The results show that clearcutting has substantial effects on soil carbon stocks in boreal and northern temperate forests. Stocks in the organic horizons of coniferous forest soils decline for around 30 years after clearcutting, while no change in carbon stocks is detected in the upper mineral soil layers. At their lowest levels, carbon stocks in the organic horizons of spruce and pine forests have fallen by 23% and 14% respectively, compared with initial stock levels. Carbon stocks in the organic horizons of spruce stands remain close to their lowest levels up to 53 years after clearcutting, whereas in pine forests they are fully restored after 48 years.

Combining data from national forest soil inventories in several countries provides a better understanding of the effects of forest management on soil carbon stocks.

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Effect of spruce budworm insecticide treatments on non-target insects

Bacillus thuringiensis subspecies *kurstaki* (Btk) and tebufenozid are insecticides used to control spruce budworm in eastern Canada. However, these insecticides could have effects on non-target caterpillars and parasitoids.

A photo showing aerial spraying (Photo: NRCan)

Research teams from Université Laval, Forest Protection Limited, and the Canadian Forest Service studied the impact of Btk and tebufenozid treatments on caterpillar communities and associated parasitism rates. Species richness and abundance, as well as parasitism rates, were assessed using molecular analyses carried out on the caterpillars collected.

The results show that insecticide treatments had no significant impact on the abundance, species richness, or parasitism rate of non-target caterpillars compared with untreated sites. Nevertheless, higher caterpillar abundance and lower parasitism rates were observed in Btk-treated sites, compared with those treated with tebufenozid.

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Cette publication fait partie d'une série qui présente des résumés vulgarisés d'articles scientifiques auxquels ont contribué des chercheurs du Centre de foresterie des Laurentides.

Canada

The effect of climate change on boreal caribou range

Shifting species ranges is one of the most significant consequences of global biodiversity loss. While human activities and their effects on habitat are major threats for many species, climate change must also be taken into account. For species at risk, it is important to distinguish between the effects of human activities and those of climate change on the past and present changes in their range so that effective conservation strategies can be developed.

A research team from the Université du Québec network, Quebec's Ministère de l'Environnement, de la Lutte contre les Changements Climatiques, de la Faune et des Parcs, and the Canadian Forest Service has studied this issue. The team assessed the potential effects of climate change on the northward shift of the southern limit of the boreal caribou's range in Quebec since 1850. To achieve this, historical maps of caribou ranges were combined with climate models from 1850 to the present day to illustrate the geographical progression of climatic conditions favorable to this species.

The results show that, had climate change been the only factor, the southern limit of the caribou's range would have moved about 105 km northwards since 1850, instead of the 620 km observed today. This suggests that the shift due to climate change should have been only 17% of what has been observed since 1850. This relatively limited impact of climate reinforces the idea that the reduction in caribou range in Quebec is mainly due to anthropogenic factors.

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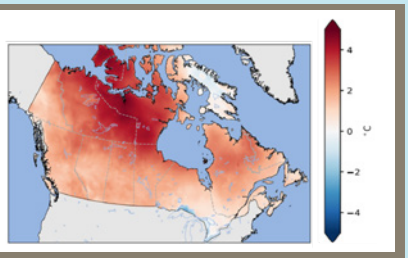
Canada's forest fires of 2023: a record-breaking season

The 2023 forest fire season in Canada was unprecedented in its scale and intensity. The fires spread over a large part of the country's forested areas for seven months between mid-April and the end of October.

A research team from the University of Alberta, Thompson Rivers University, Environment and Climate Change Canada and the Canadian Forest Service investigated the main causes and impacts of this exceptional season.

Anthropogenic climate change has resulted in extreme and persistent weather conditions for fires to occur. The average temperature from May to October in Canada in 2023 was 2.2 °C higher than the average from 1991 to 2020. The all-time record 15 M ha of burned area is attributable to several environmental factors that marked the start of the season: an early snowmelt, several years of drought in western Canada, and a rapid shift to drought in eastern Canada.



Temperature anomalies of the 2023 fire season (May–October) relative to the reference period (1991–2020)

Many fires spread rapidly during the fire season, with extreme fire intensity and towering convection columns. On September 22, the fires devastated 440,000 ha, the largest area burned in a single day in Canada since the first satellite recordings began in 1972. The consequences for people and buildings were disastrous. More than 200 communities were evacuated, and millions of people in several major cities in Canada and the USA were exposed to dangerous air quality due to smoke. The 2023 season highlighted the growing challenges posed by forest fires in the context of climate change.

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Moss transplantation: impact on soil microbial communities

Boreal forests can transition from productive closed-canopy moss forests to low-productivity open lichen forests. Little is known about the effects of this transition on soil microbial communities and their influence on the productivity of these two contrasting forest types. Research teams aimed to evaluate how different vegetation covers affect the composition and structure of soil bacterial and fungal communities.

An experimental design involving the transplantation of moss mats into an open lichen forest was set up in 2011, and the effects on soil microbial communities were measured ten years later.

Teams from the Université du Québec à Montréal, the Université du Québec en Abitibi-Témiscamingue and the Canadian Forest Service have concluded that changes in vegetation cover influence the diversity, composition, and function of soil microbial communities. Fungal communities were more affected than bacterial ones. Moss transplantation favored ectomycorrhizal fungi, particularly those of the *Piloderma* genus involved in nitrogen mineralization, while reducing the relative abundance of ericoid mycorrhizal fungi.

This study highlights the impact of soil cover type on the composition of microbial communities in boreal forests, with potentially significant ecological implications for woodland ecosystems. Moss-friendly silvicultural treatments may help maintain or enhance ecosystem function through positive regulation of soil microbial communities.

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