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Branching Out

from the Canadian Forest Service - Laurentian Forestry Centre

Forest vulnerability to climate change: An integrated regional analysis for Quebec

Major disruptions to global temperature and precipitation patterns are set to become widespread between now and the end of the century. In Quebec, these changes could drastically disrupt forest ecosystems, either directly through their impact on biological systems, or indirectly via an increase in the frequency and intensity of disturbances such as forest fires, droughts and insect epidemics. In this environment, assessing the vulnerability of forest ecosystems to these disturbances is crucial to identifying effective adaptation measures. To this end, the Canadian Forest Service has conducted an integrated regional analysis on the impact of climate change on Quebec's commercial forests, ecosystem services and the forestry sector.

Forest productivity vulnerability

Global warming, coupled with more frequent droughts, is significantly impacting tree physiology, drastically affecting the regeneration, growth and productivity of forest stands. The projected rise in average temperatures could significantly reduce the growth of softwood species. This decline will affect the entire study area but will be more significant in the province's southern forests. By contrast, the growth and productivity of thermophilic species (red maple, red oak, eastern hemlock and American beech) should increase, although this will not compensate for the decline in softwood productivity.

Changes in natural disturbance regimes

For the past few decades, global warming has led to conditions conducive to more severe and extensive forest fires. This trend is most significant in the boreal part of the study area, where fire return intervals are expected to be shorter as early as 2040, according to climate projections, particularly in the northwest region of the province. Climate change may increase the severity of spruce budworm (SBW) outbreaks, driving this pest northwards into previously unaffected forest areas. As a result, black spruce could become a major host of spruce budworm, along with balsam fir. Moreover, SBW epidemics combined with drought episodes could have devastating effects on these host species.

▲ *Adult and larval stages of the spruce budworm,* Choristoneura fumiferana *(Clemens).*

Impact on forest landscape

The effect of multiple environmental constraints due to climate change and their interactions could transform Quebec's forest landscapes in the decades ahead. In simulations, the combined effect of these multiple variables on the study area showed a significant decline in the competitiveness of softwood species in

Background photo:
Aerial view of a forest fire.

Canada

favour of hardwood species, particularly in the southern part of the province. However, the northward migration of hardwood species could be limited by trophic interactions and increased disturbance frequency, which could make it difficult to compensate for the loss of productivity due to the decline of softwoods. At the same time, shorter fire cycles are likely to favour pioneer species such as trembling aspen.

...And what about ecosystem services?

The cumulative effects of climate change will lead to a decline in the productivity of Quebec's forests, which could adversely affect their capacity to meet the demand for wood. The northern region of Quebec's commercial forest is dominated by black spruce and jack pine, species well-adapted to fairly frequent fires in this area. However, with shorter fire cycles, these species may not have time to regenerate. Simulations predict that the areas to the north and central part of the study area could experience these regeneration failures over more than 30% of their surface area by 2100. In the long term, boreal forest landscapes in some areas could be transformed into low-productivity open forests.

The decline in net forest productivity due to changes in natural disturbance regimes will considerably reduce their capacity to sequester carbon. In addition, more severe and widespread forest fires could increase carbon emissions from the combustion of organic matter.

▲ *Aerial view of a forest fire and smoke.*

Effects on wildlife habitats and biodiversity

The combined effects of timber harvesting and forest fires will reduce the surface area of old-growth stands in the boreal forest, which represent a prime habitat for wildlife. In Quebec, the southern boundary of woodland caribou distribution has shifted northwards over the past century, mainly due to anthropogenic pressure. According to our integrated regional analysis, forest fires will significantly reduce the quality of woodland caribou habitats. For birds, projections indicate that the abundance of both generalist and young hardwood species will increase, particularly in temperate forests.

In summary, the results of this integrated regional analysis show that all aspects of forest management and planning will face the challenges of climate change. As a result, forest managers must factor in this new dynamic and prepare today's forests for tomorrow's climate, adapting their practices accordingly. Some adaptive solutions may come directly from current management practices and be applicable without any changes, while others may require adjustments to their application methods to meet specific objectives.

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