SILVA21

TAKE HOME MESSAGE

- At latitudes of 50-51°N, where mean annual temperature is 0°C, is the likely limit at which black spruce shifts from being moisture- to temperature-limited.
- Below 50-51°N, higher summer temperatures reduce annual radial tree growth.
- Above 50-51°N, warmer summers increase annual radial tree growth.
- Forest managers should aim to implement adaptive silviculture to mitigate future growth declines caused by drought stress, particularly in regions below 50°N.

CLIMATE-GROWTH RESPONSE OF BOREAL BLACK SPRUCE SHIFTS FROM POSITIVE TO NEGATIVE AT 50˚N

Boreal forests are experiencing climate change more rapidly than other biomes, which is likely to impact their future management. Understanding how tree growth responds to regional and seasonal variation in climate is essential to anticipate future management of boreal forests. By relating growth-climate relationships to temperature and precipitation, our meta-analysis allows readers to grasp the current growth response of black spruce to climate variation. When combined with climate projections, our results show forest managers the variation in growth response to climate at a given location or region of interest which can help implement adaptive silviculture measures in southern latitudes.

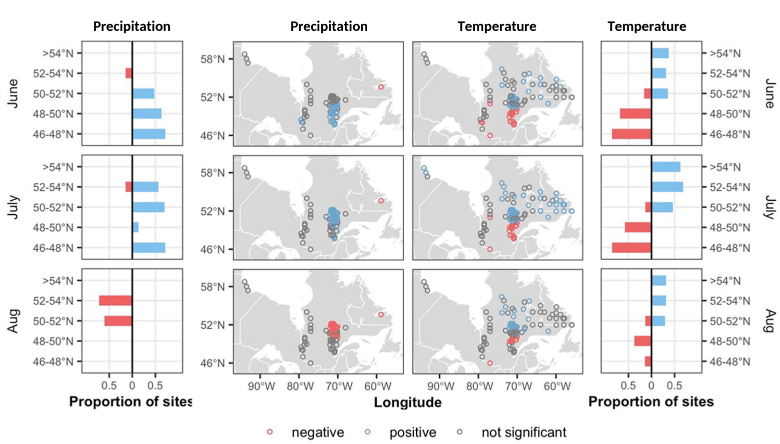

Figure 1: Black spruce growth response to precipitation and temperature can be seen switching from positive (blue) to negative (red) at approximately 50°N latitude.

Black spruce had greater radial annual growth with greater precipitation, except during the month of April

Trees experienced greater radial growth with higher amounts of precipitation in previous years' summer (specifically June - August) and current summer (specifically May - July). On the contrary, precipitation in April was linked to reduced growth. Tree growth in response to previous and current temperature is much more variable (**Figure 2**).

Climate-growth response showed a clear response to latitudinal trends (**Figure 1**). In southern sites (below 50°N), high temperatures in previous summers (June - August) are linked with lower radial tree growth. By comparison, in northern sites (50-54°N), temperature has a positive effect on growth. This effect switches back to negative above 54°N. Warmer springs also increased tree growth as you move from north to south.

Greater precipitation in previous summer improved tree growth consistently across all latitudes. Between 48 and 54°N, greater April precipitation reduced tree growth, but at the start of the growing season (May-June), trees grew in response to more precipitation. This growth decreased as you move from south to north.

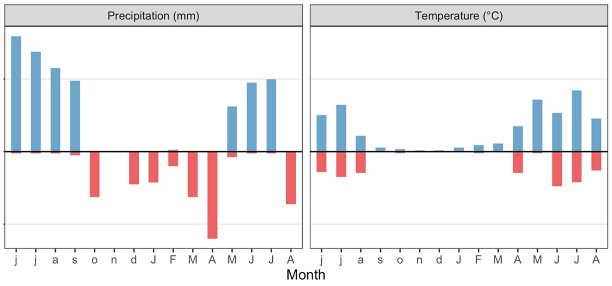

Figure 2: Black spruce growth response varies from positive (blue) and negative (red) depending on previous and current year precipitation and temperature. (Months of previous years are in lowercase letters.)

Adaptive silviculture mitigating drought stress should be prioritized in southern boreal forests

This study helps forest managers understand the variation in growth response to climate at a given location or across a region of interest. In southern regions, where further warming is likely to increase moisture limitation faster, there is accelerated risk of reduced boreal forest productivity. In these regions, managers could prioritize the implementation of adaptive silviculture measures such as stand density management and/or assisted migration in sites experiencing reduced growth reductions associated with, or likely to become at risk of, drought stress. This may be less of a priority in regions where annual precipitation is expected to increase, though the projected increase in frequency and severity of drought events may prevent such phenomenon

METHODOLOGY: 11 dendroclimatology studies, which included 113 sites and 2,995 black spruce trees were used for climate-growth relationships between annual tree rings and precipitation (n=80 sites) and temperature (n=190 sites). A meta-analysis was used to investigate the effects of site conditions on climate-growth response with monthly temperature and precipitation.

Summary based on scientific article:

Chagnon, C., Wotherspoon, A.R., Achim, A. 2022. Deciphering the black spruce response to climate variation across eastern Canada using a meta-analysis approach. Forest Ecology and Management 520:120375. DOI: 10.1016/j.foreco.2022.120375.

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