Is There a Trade-off Between White Spruce Fast Growth and Drought Tolerance at the Genotype Level?

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Problem Statement: Tree improvement improves forest productivity by selecting genotypes for fast growth. However, increased drought events due to climate change could have a negative impact on forestry productivity. Will fast growing genotypes be more impacted by droughts?

Objective: Assess the trade-off between white spruce growth rate and its resistance and resilience to drought to see if there is a genetic relationship between growth rate and drought tolerance.

Prediction: Faster growing genotypes (varieties) will display lower resistance to drought but higher resilience.

Dataset: Somatic embryogenesis (SE) propagated white spruce variety test series established in 2000. 3 Sites across New Brunswick (northern, central, and southern sites)

Method: 1) Identify drought years 2) select fast, moderate, and slow growing SE varieties for sampling based on predictive breeding values for stem volume 3) core trees 4) cross date/measure ring-widths

Analysis: Calculate drought tolerance indexes for resistance, resilience, recovery, and relative resilience (Lloret et al., 2011). Use general linear mixed model to determine if there is a significant relationship between growth and drought tolerance

Sampling Scheme: 4 families with growth rates from slow to fast. 4 varieties/family. 6 trees/variety/site. 3 sites. Total samples = 288

Drought Event: 2012 drought. July precipitation was 31-75% lower than the 1999-2018 average. July chosen because it is during the active growing season. 2020 drought impact will also be quantified.

Progress/Results To Date: Core samples taken, cross dated, ring widths measured and converted to basal area increment. Drought in 2012 had a small impact on growth across all varieties (Figure. 1). There was no drop in growth in 2020 however there was a substantial drop in 2019 (Figure 1). The next steps will be to explore what environmental factors caused the 2019 drop in growth. The 2019 reduction in growth could be effects of the 2017-2019 climatic conditions. There was on average lower rainfall in 2017 and 2018 compared to the lifespan of the test (2000-2020) and 2018 and 2019 saw some of the hottest temperatures in July. However, there was precipitation and temperature variability between sites. Climate moisture index values will be used to equally compare monthly moisture stress by year and by site. If 2019 growth reduction is due to moisture stress, it will be included in drought tolerance calculations along with 2012 for hypothesis testing. Expected completion date: October 2021.

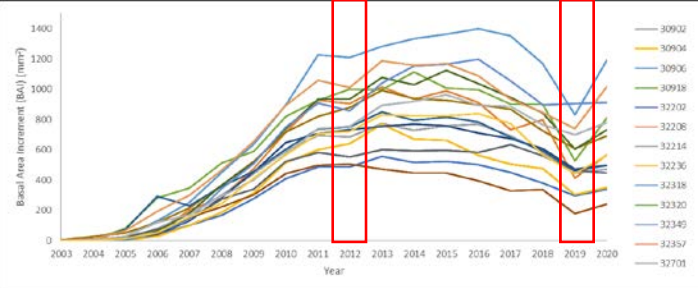

Figure 1: Annual average basal area increment (mm^2) by variety across three sites. 2012 and 2019 decreases in growth highlighted with red boxes.

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Lloret, F., Keeling, E. G., & Sala, A. (2011). Components of tree resilience: Effects of successive low-growth episodes in old ponderosa pine forests. Oikos. https://doi.org/10.1111/j.1600-0706.2011.19372.x