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Tree rings and genetic control of drought resilience

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Severe drought events are affecting forests around the world, even in temperate climates. A viable climate change adaptation strategy may involve planting forests with trees more resilient to drought. The majority of the 300 million seedlings planted annually in western Canada are genetically-selected trees derived from tree breeding programs. Since tree breeding populations supply the seed that is deployed on the landscape, it is important to closely examine the degree of genetic control of drought resilience in these populations – yet methods for evaluating drought responses in mature experimental trials are limited. We evaluated the potential to use tree rings to infer genetic adaptation to drought. Specifically, we used annual growth increments to evaluate the genetic component behind variation in drought resilience. We also quantified potential genetic trade-offs between drought resilience and growth in long-term progeny trials. We worked with two economically and ecologically valuable sympatric conifers, coastal Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) and western redcedar (*Thuja plicata*). Annual growth increment and tree height data were obtained from 1980 coastal Douglas-fir trees (93 polycross families on two well-replicated sites at age 19) and 1520 western redcedar trees (26 polycross families on three well-replicated sites at age 18). All trees showed substantial reduction in growth under drought, but there was clear variability in the longer-term response of families within each breeding population. The heritability (h^2) of such drought resilience, or proportion of this variation explained by genetics, was high for Douglas-fir (h^2 = 0.26, SE = 0.07) and moderate for redcedar (h^2 = 0.13, SE = 0.04). Preliminary genetic correlations between tree height and drought resilience were also positive for both species (Douglas-fir: r_g = 0.77, SE = 0.18; redcedar: r_g = 0.62, SE = 0.17). Families that were both high-yielding and drought resilient could also be identified. Since growth response to drought is a variable and heritable trait, these traits are therefore under the control of the tree breeder. Moreover, the positive genetic correlations between tree height and an adaptive growth response to drought suggest that historic selection for tree height did not compromise

drought resilience of planted seedlings. Tree rings appear to be an effective tool to screen these populations for drought resilience, which will help ensure that planted trees will remain healthy and productive under climate change.