

# COMPETITION ALTERS TREE GROWTH RESPONSES TO CLIMATE AT INDIVIDUAL AND STAND SCALES

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**Abstract**—Understanding how climate affects tree growth is essential for assessing climate change impacts on forests, but is complicated by the effects of competition, which strongly influences growth and could alter how forests respond to climate change. We characterized the joint effects of climate and competition on diameter growth in the mountain forests of Mount Rainier National Park, Washington State, USA using long-term (32-year) forest monitoring data from permanent sample plots in mature and old-growth stands. To analyze the data, we adapted the diameter growth function from ORGANON (a proven forest simulation model), to explicitly include climate, and fit the model using hierarchical Bayesian methods to facilitate error propagation for projections of climate change impacts on individual- and stand-level growth. Individual growth was sensitive to climate under low but not high competition, likely because tree ability to increase growth under more favorable climate (in this case, greater energy availability) is constrained by competition. We found this pattern for all focal species (*Abies amabilis*, *Tsuga heterophylla*, *Pseudotsuga menziesii* and *Thuja plicata*), but with some important variations. Therefore, warming will likely increase individual growth most in low-density stands where there is little competition. However, higher density stands have more and/or larger trees, conferring greater capacity for stand-level growth increases. Our results imply that stand-level growth responses to climate change will be greater at medium density than low density, due to greater capacity for increases, but similar at high and medium densities, due to greater competition counteracting greater growth increase capacity. Thus, competition will likely mediate the impacts of climate change on tree growth in important but complex ways at the individual and stand scales. This work highlights the value of combining long-term forest monitoring data with advanced statistical modeling to assess the impacts of climate change on forests.

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