

Growth responses of pedunculate oak (*Quercus robur* L.) to extreme droughts in southern Sweden

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Climate change has increased the frequency and intensity of droughts in the past decades, affecting the growth and productivity of pedunculate oak (*Quercus robur* L.), an economically and ecologically important species in southern Sweden. Predictions of future oak distribution show northward expansion of its range under climate change. Thus, understanding how oak growing close to the northern edge of its distribution responds to climatic stress is crucial for predicting its role in the future.

In this study, I quantified oak volume growth responses to drought at five sites in southern Sweden. First, I identified the month when water availability has the strongest effect on oak growth. Specifically, I related tree ring widths measured at breast height to Standardized Precipitation Evapotranspiration Index (SPEI). Drought years, which were years with the lowest SPEI in that month, were selected for subsequent analysis. Then, I reconstructed annual volume increment chronologies using the stem analysis method, projected growth based on predrought growth chronologies, and quantified growth responses to drought. Although not all of the 10 driest years were actually drought years, using growth responses in those years allowed me to precisely identify the drought intensity at which oak growth starts to decline. I also estimated the length of the recovery period across a drought severity gradient.

The most significant effects of SPEI calculated over a three-month period (SPEI3) on growth were observed in June. The analysis of volume growth responses to drought revealed that oak growth declined mostly under extreme drought conditions (SPEI3 < -2.0). However, many trees did not show negative growth responses to those events, which highlighted the resistance of oak to droughts. In most cases when the reduction occurred, oak growth returned to predrought levels within three years after the drought event, indicating the high resilience of the species.