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Douglas Fir (*Pseudotsuga menziesii*) as an alternative species for the declining Norway spruce (*Picea abies*) in central Europe: Dendrochronological and xylogenetic insights from Slovenia

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Climate change is reshaping the species composition, distribution and extent of forests worldwide. Across vast areas in Central Europe widespread Norway spruce (*Picea abies*) has exhibited large-scale decline, primarily due to its vulnerability to drought events. Forest management is thus facing important questions related to the replacement of Norway spruce, especially in areas where it was introduced due to its high economic value.

This study investigates the potential of Douglas fir (*Pseudotsuga menziesii*), a drought- and pest-tolerant non-native species, as a more resilient alternative for use in production forests. At the experimental plot in Jable, central Slovenia where both species coexist, we monitored the xylogenesis of five Douglas firs and five Norway Spruces from March to October 2024 by sampling phloem, cambium and xylem tissue every two weeks using the Trephor tool. Additionally, we collected tree cores from 20 trees of each species to perform dendrochronological analyses. These analyses aim to assess climate-growth correlations and growth-based resilience indicators (resilience, resistance, recovery and recovery period).

The main objective of this study is to determine whether Douglas fir is to compare 1) interannual growth dynamics, 2) intra-annual growth dynamics of xylem and phloem, 3) climate-growth relationships, and 4) resilience components of both species. We hypothesize that non-native Douglas fir will exhibit greater growth rates and better resilience indicators and could thus be considered as a replacement for Norway Spruce at similar forest sites in central Slovenia and beyond. By addressing critical knowledge gaps regarding the responses of these species to climate variability, this research can provide important insights to support the strategic adaptation of forestry practices and improve the resilience of ecosystems in the face of environmental change.

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