Does demographic performance predict species distribution? A trait-based analysis on European tree species.

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Abstract

In the face of climate change, there are increasing concerns about the future redistribution of species ranges. Species ranges are thought to reflect demographic trends, which are governed by vital rates (e.g. survival, growth, reproduction). However, we have a poor understanding of how demography drives species distributions. This issue is particularly complex for large and long-lived organisms such as trees, for which populations' dynamics are strongly dependent on their size structure. Integral projection models (IPMs) have been proposed as a powerful tool to predict the fate of such size-structured populations due to their flexibility, robustness to low sample size, and ability to explicitly include a/biotic factors such as density dependence and climate. Here, we used forest inventory data from over 90,000 plots and 27 tree species, containing over one million adult trees across Spain, France, Germany, Sweden, and Finland to parameterise IPMs. These models include the effect of both climate and local competition. To describe each species' niche, we estimated species probability of presence with ensemble species distribution models (SDMs) fitted on 250,000 plots across Europe. Next, we compared key demographic metrics of the population dynamics derived with these IPMs such as life expectancy or passage time against the species probability of presence to test whether climatic-dependent IPMs capture the demographic signature of the species ranges. Specifically, we evaluated whether the level of local competition modifies the links between demography and species ranges. Finally, we explored whether species' functional traits such as wood density or specific leaf area help to explain why for some species there is a strong match between demographic performance and range, whereas for other species demography seems disconnected from their distribution.

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