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Disentangling Biodiversity and Climatic Determinants of Wood Production

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Abstract

Background: Despite empirical support for an increase in ecosystem productivity with species diversity in synthetic systems, there is ample evidence that this relationship is dependent on environmental characteristics, especially in structurally more complex natural systems. Empirical support for this relationship in forests is urgently needed, as these ecosystems play an important role in carbon sequestration.

Methodology/Principal Findings: We tested whether tree wood production is positively related to tree species richness while controlling for climatic factors, by analyzing 55265 forest inventory plots in 11 forest types across five European countries. On average, wood production was 24% higher in mixed than in monospecific forests. Taken alone, wood production was enhanced with increasing tree species richness in almost all forest types. In some forests, wood production was also greater with increasing numbers of tree types. Structural Equation Modeling indicated that the increase in wood production with tree species richness was largely mediated by a positive association between stand basal area and tree species richness. Mean annual temperature and mean annual precipitation affected wood production and species richness directly. However, the direction and magnitude of the influence of climatic variables on wood production and species richness was not consistent, and vary dependent on forest type.

Conclusions: Our analysis is the first to find a local scale positive relationship between tree species richness and tree wood production occurring across a continent. Our results strongly support incorporating the role of biodiversity in management and policy plans for forest carbon sequestration.

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Introduction

The rapid loss of biodiversity in the last century has opened a debate on the consequences for ecosystem functioning. Therefore, understanding whether there is a relationship between species diversity and ecosystem processes is a key priority in the face of major global changes [1,2,3]. One of the most explored relationships has been between plant species richness and productivity, a process determining ecosystem carbon (C) pools and fluxes, and closely linked to ecosystem C sequestration [4,5]. Most studies conducting manipulative experiments have found a positive effect of species richness on productivity [2,6]. However, as these experiments are conducted in simplistic settings (e.g. even-aged species with short life cycles), there is controversy whether this effect holds in structurally more complex natural systems.

Forest ecosystems are major terrestrial C sinks, with a larger capacity to remove atmospheric C than previously thought [7]. Wood production is one of the main components of atmospheric C sequestration in the biosphere, with a high spatial variation depending on biotic, environmental and management factors [8]. Given the global interest in mitigating the consequences of greenhouse gases in the atmosphere, and the need for biodiversity conservation, it is necessary to determine to what extent wood production is reduced by the loss of tree species diversity, and to pinpoint differences among forest types [4,9,10].

The tree species richness-productivity relationship has been investigated in forests by analyzing forest inventory data