Climate change determines the sign of productivity trends in US forests

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Science Question

Forest carbon sinks are hypothesized to result from forest maturation and increased productivity due to CO_2 fertilization (the positive response of photosynthesis to rising concentrations of atmospheric CO_2). However, drought and other environmental changes can lead to reduced forest productivity and thus weaker carbon sinks. How has forest productivity changed over recent decades in different regions of the US?

Analysis

We fit non-linear models to US forest inventory data (113,806 plot remeasurements in non-plantation forests from ~1999 to 2020) to quantify productivity trends while accounting for stand age, tree mortality, and harvest.

Results

From ~1999 to 2020, forest productivity increased in much of the eastern US, where mild warming was accompanied by mild increases in precipitation. In contrast, forest productivity decreased in much of the western US, where warming was more severe and precipitation declined.

Significance

Changes in ecosystem carbon storage are determined by the balance between positive drivers (e.g., CO_2 fertilization) and negative drivers (e.g., increasing frequency and intensity of drought and wildfire). Our results highlight the vulnerability of forest carbon sinks to climate change. The future land carbon balance will likely depend on the geographic extent of drought and heat stress.

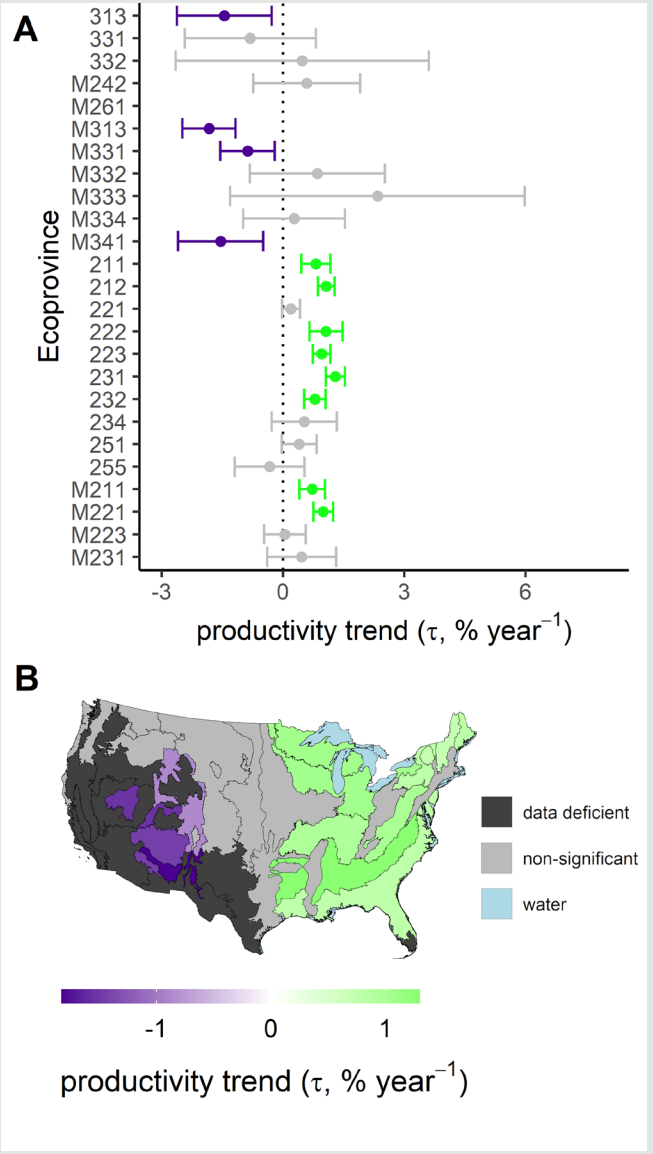

Fig. 1. Productivity trends (~1999-2020) in US ecoprovinces estimated from biomass vs. stand age models. **A**) Productivity trend estimates and 95% confidence intervals from nonlinear model fits. **B)** Mapped productivity trends across US ecoprovinces. Ecoprovinces are shaded as green (positive trend), purple (negative trend), light gray (non-significant), or dark gray (insufficient data). Results from growth vs. stand age and growth vs. biomass models were qualitatively similar.

This study was funded by USDA Forest Service grant 21-JV-11242305-097.