40-Year Record of Tree Growth and Succession Clarifies Climate Sensitivity of Eastern Forests

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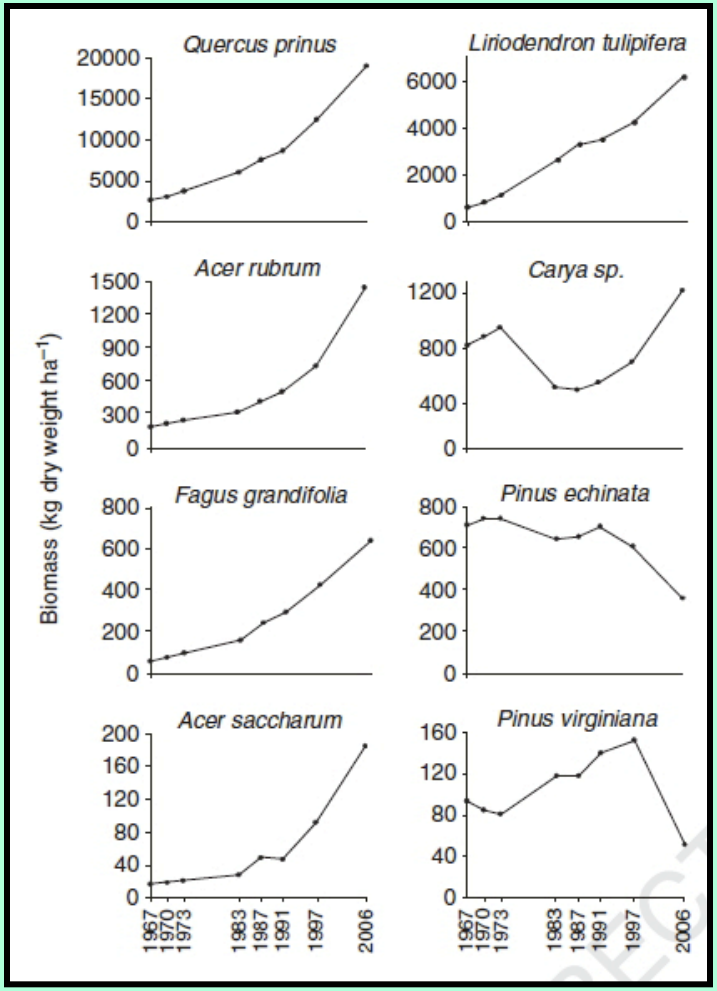
- Long-term data sets of tree diameter growth and survival (1967 through 2006) were used to evaluate the importance of species, succession, and climate on forest composition and biomass accumulation.
- Annual variation in summer temperatures and drought impacted biomass accumulation of some species.
- All forest stands accumulated biomass throughout the 40-year observation period, but drought years reduced the rate of accumulation during some measurement intervals.
- These data show that direct effects of current climate variability on eastern hardwood forests biomass accumulation and composition were small in comparison to changes resulting from natural succession or insect outbreaks.



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Question: Are trees sensitive to climatic variability, and do tree species differ in their responses to climatic variability? Does sensitivity of forest communities to climatic variability depend on stand composition?
Location: Mixed young forest at Walker Branch Watershed near Oak Ridge, East Tennessee, USA.
Methods: Using a long-term dataset (1967–2006), we analyzed temporal forest dynamics at the tree and species level, and community dynamics for forest stands that differed in initial species composition (i.e., chestnut oak, oak–hickory, pine, and yellow poplar stands). Using summer drought and growing season temperature as defined climate drivers, we evaluated relationships between forest dynamics and climate across levels of organization.
Results: Over the four-decade study period, forest communities underwent successional change and substantially increased in biomass. Variation in summer drought and growing season temperature contributed to temporal biomass dynamics for some tree species, but not for others. Stand-level responses to climatic variability were related to the responses of component species, except in pine stands. *Pinus echinata*, the dominant species in pine stands, decreased over time due to periodic outbreaks of pine bark beetle (*Dendroctonus frontalis*). These outbreaks at Walker Branch could not be directly related to climatic conditions.
Conclusions: The results indicate that sensitivity of developing forests to climatic variability is stand type-dependent, and hence is a function of species composition. However, in the long term, direct effects of climatic variability on forest dynamics may be small relative to autogenic successional processes or climate-related insect outbreaks. Empirical studies testing for interactions between forest succession and climatic variability are needed.

Citation:

Kardol P, Todd DE Jr., Hanson PJ, Mulholland PJ (2010) Long-term successional forest dynamics: species and community responses to climatic variability. *Journal of Vegetation Science* (in press)