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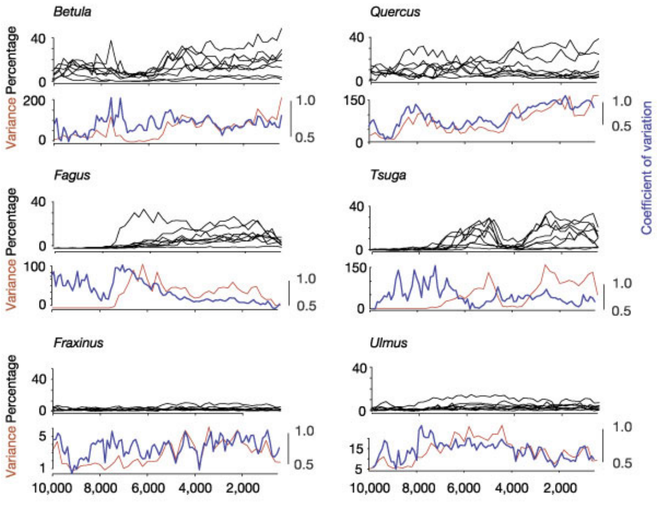
Testing and Building on a Dispersal-Assembly Theory of Ecological Communities



Testing…

Can dispersal-assembly explain the large-scale spatial synchrony observed in forests over the Holocene? Or is such spatial synchrony the result of species' niches stabilizing the community, as previously argued? The figure above shows the percent pollen of six tree families at each of 8 distant lake sites (upper panels) in Southern Ontario, over time (or sediment depth), as well as the variance and coefficient of variation across the eight distant sites (lower panels). The coefficient of variation does not increase over time. Using spatially-explicit simulations I have shown that this can arise from dispersal alone if it has a fat-tailed (slower than exponential) decay with distance. Hence we must look harder for the signature of potential stabilizing mechanisms.

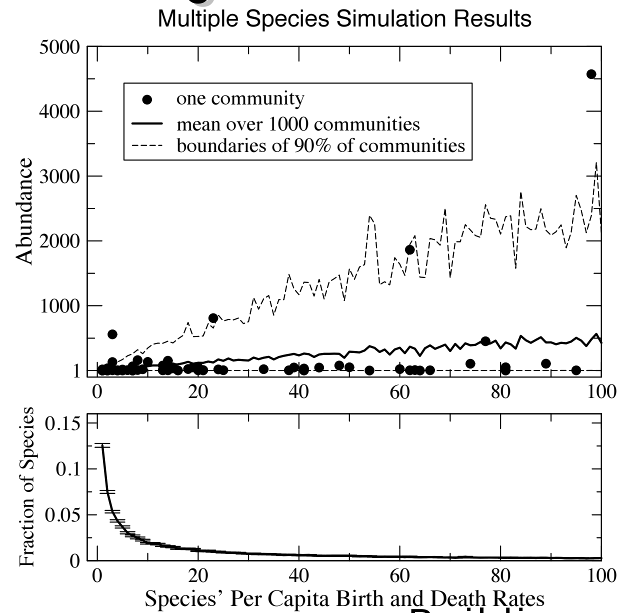
The Issue

Worldwide, unprecedented rates of extinction and changes to the distribution and abundance of species are occurring, due to habitat fragmentation, climate change, invasive species, and other human-derived influences. Biological diversity has direct social and economic value. In addition, the number and relative abundance of species impacts ecosystem functions humans rely on, such as clean water, clean air, and a stable climate.

In order to forestall this trend, we need tools for assessing and managing whole ecological communities. Ecological communities are incredibly complex systems. Hence an understanding of the processes shaping them has been difficult to obtain, leading biologists to take species-level approaches to biological conservation. But ultimately the fates of species are intertwined. Hence we must understand biological systems at the community-level.

The Approach

Use dispersal-assembly as a starting point. One way to approach complex systems is to begin with a "null theory" which knowingly makes simplifications in order to 1) get at fundamental principles inherent to the most basic characteristics of the system, and 2) derive quantitative null hypotheses which when tested on data can reveal which of the ignored processes matter, and when they matter. A "null theory" for ecological communities is that they arise primarily by the dispersal of different species to the same location.



Building…

How does a recruitment-survival tradeoff affect species' relative abundances? Dispersal-assembly theory provides a simple framework into which we can add the tradeoffs between species one-by-one to assess their potential effects. One way in which species differ is that some species are better reproducers and others are better survivors. As shown in the figure this tradeoff causes the better reproducer/poorer survivor species to achieve higher abundances, but also to go extinct more quickly. This result challenges traditional theory in which communities assemble through stabilizing mechanisms and the opposite trends result.

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