Ecologists identify critical life stages for rainforest diversity

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LSU ecologist Kyle Harms co-authors first study to quantify the process of diversification in forests and likely all other sessile ecosystems. Credit: Louisiana State University

The largest trees in a forest may command the most attention, but the smallest seedlings and youngest saplings are the ones that are most

critical to the composition and diversity of the forest overall.

While many people gaze up into the forest canopy, renowned scientist Joseph Connell has spent much of his career looking down quite closely at the forest understory. Connell, who is a professor emeritus in the Department of Ecology, Evolution and Marine Biology at the University of California at Santa Barbara, established one of the world's longest, in-depth ecological research studies on the planet. The Connell Plots Rainforest Network has thus far produced a 50-year collection of data on individual trees in Australia's protected rainforests.

"Having such a long-term, detailed dataset is highly unusual. It's the kind of temporal depth we need to answer some of the big questions such as, what are the ecological processes that maintain diversity?" said Kyle Harms, professor in the LSU Department of Biological Sciences and a collaborator with Connell.

Early in his career, Harms was a post-doctoral researcher in Connell's lab at U.C. Santa Barbara. There, he met former fellow post-doctoral researcher and current collaborator Peter Green, who is a senior lecturer at La Trobe University in Melbourne, Australia.

Harms and Green were inspired to use their mentor's dataset; therefore, they devised an analysis to test the long-standing hypothesis that the patterns of composition and diversity among a forest's mature trees are largely set by processes that occur in trees' earliest life stages. Harms ran statistical analyses on 7,977 individual trees across 186 species that were censused in one of Connell's tropical Australian forest plots from 1971-2013.

He repeatedly ran simulation analyses on six tiers of trees based on size in order to predict the expected outcome of diversity at each tier. Then he compared the expected levels of diversity in each tier with the true

collected data.

"What we found was that the seedlings are more diverse than the statistical expectations predicted them to be, but the larger trees' levels of diversity were about the same as the predictions" he said.

These results are the first quantitative evidence that the earliest life cycle stages of individual trees are more critical than later stages to the overall relative abundances of mature trees in a forest. Their findings will be published online in the *Proceedings of the National Academy of Sciences* this week.

The stronger influence of ecological sorting processes operating at the earliest life cycle stages compared to later life stages, which they quantified, also likely occurs in other highly diverse ecosystems with rooted, or sessile, organisms including grasslands, herbaceous plant communities and marine communities of coral.

"I think this is something that is happening broadly in ecosystems across the planet," Harms said.

He and his collaborators' results underscore the importance of support for long-term, in-depth datasets, as well as the need to investigate the early life stages - for example, the smallest, newly germinated seedlings - where the most critical processes are occurring.

"I think it helps us understand where to focus in order to really understand the biased sorting processes that create the composition and diversity patterns in the forest overall," he said.

More information: Nonrandom, diversifying processes are disproportionately strong in the smallest size classes of a tropical forest , *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1321892112