Light limitation as a factor in ecological conditions

July 27 2017

Credit: Santa Fe Institute

There's a 50-hectare forested plot in Panama where researchers with the Smithsonian Institution have gathered highly detailed information about the species, distribution, and size of trees there. In a 2016 study, researchers proposed that those particular characteristics, and the forest's total metabolic rate, was limited by light. But a recent paper published in *Global Ecology and Biogeography* by SFI External Professor John Harte,

SFI Omidyar Fellow Andy Rominger, and Erica Newman, a postdoctoral fellow at the University of Arizona, suggests that a far simpler model, independent of mechanistic drivers, can also accurately describe that forest, as well as other natural systems and communities.

For roughly 10 years, Harte has been developing a maximum entropy theory of ecology (METE). Drawing on principles from thermodynamics, information theory, and the maximum information entropy (MaxEnt) inference procedure, Harte says very coarse information about an ecosystem can be used to derive detailed distributions. In a dozen papers and one text book, Harte has shown how METE can accurately describe ecological patterns.

In this recent paper, Harte, Newman, and Rominger apply METE to the data from the Panama plot and derive nearly identical patterns as the 2016 study, but without the multiple light-limitation parameters. In addition, they used the same model to accurately describe the metabolic rate distribution of insects in Hawaii and plants in an alpine meadow in Colorado, neither of which are limited by sunlight.

"You don't need a light-limitation model," says Harte. "You can derive the same behavior from a much more well-grounded theory which also describes non-light-limited scenarios."

But their paper isn't simply meant to counter the 2016 study. Rather, the researchers hope it opens a broader discussion about how ecologists approach their work.

Light limitation is a real factor affecting ecosystems, but we may not need such complicated models when looking at more universal patterns, says Rominger. "When we see general patterns in a complex system, the simplest explanations based on statistical mechanisms are likely the best. It seems most fruitful to start simple with minimal assumptions, and only

add those unique life histories in when necessary."

"In some ways, modern ecology has been a pursuit of measuring known environmental drivers of ecological patterns at finer and finer scales and adding variables that could affect these patterns into increasingly complicated models," Newman says. "The beauty of MaxEnt is that there is only one optimization function for each pattern, which requires very few pieces of information to provide realistic descriptions of nature. This method could represent a real paradigm shift in ecology."

More information: John Harte et al. Metabolic partitioning across individuals in ecological communities, *Global Ecology and Biogeography* (2017). DOI: 10.1111/geb.12621

Provided by Santa Fe Institute