Using islands to understand the dynamics of ecological networks: 1st lessons from Hawaii

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Abstract

Interactions among species remain elusive in efforts to understand and forecast biodiversity dynamics. Towards this end, network-based approaches have the potential to simplify species interactions within a common formal mathematical framework. However, testing the utility of such approaches for understanding how environments are changing, requires simple systems. Islands, especially remote oceanic archipelagos, due to their discrete nature and isolation, coupled with the resulting accumulation of locally endemic species and high turnover in diversity, offer a microcosm for examining biodiversity dynamics with network modeling. Here, we examine ecological interactions of arthropods in the Hawaiian Islands. We use the age structure of the islands as snapshots in time to assess how these interactions change over time. We used quantitative NGS metabarcoding to provide molecular identifiers for diversity estimates (richness, abundance, turnover) in communities of different ages in Hawaii. We couple these data with historical information on species interactions that we are assembling of all known trophic interactions among organisms in Hawaii. Data included information from peer reviewed and grey literature, as well as information from the Hawaii Department of Agriculture and U.S. Geological Survey. We connected historical data with metabarcoding data by building a DNA-barcode reference library that allows each barcode to be connected to a known species. We then analyze the heterogeneity of various bipartite networks by studying their degree distribution and related network properties such as vulnerability (e.g. number of predators or parasitoids) and generality (e.g. number of resources). We find network structure changes according to substrate age and relative to composition of taxa at trophic levels, particularly as to how that composition reflects the number of non-natives. With the model we can make predictions for how interactions change over geological time, and how interactions are likely to change with the onslaught of non-native arrivals, focusing in particular on ecological tipping points.

Keywords: biotic interactions, networks, biodiversity, conservation, metabarcoding

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