Characterizing meta-ecosystems: feeding data into the theory

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Abstract

Field data show that the dynamics of many ecological communities rely on spatial subsidies. From this observation emerged the meta-ecosystem concept, which aims to integrate such spatial flows of resources or detritus into meta-community dynamics. Recent theoretical developments identified spatial mechanisms that improved our understanding of species coexistence and ecosystem functioning, such as source-sink shifts induced by subsidy flows. However, the extent to which these concepts can be applied to natural ecosystems remains an open question because of the level of abstraction inherent in general theory.

Here for the first time we assembled empirical estimates from the literature to parameterize a simple meta-ecosystem model consisting of two ecosystems linked by spatial flows of subsidies. We collected data on ecosystem pools (detritus, resource, biomass), local flows (production, decomposition rates), and spatial flows (living organisms or detritus) across nine ecosystem (e.g. stream, forest, grassland) and five climate types (e.g. arctic, temperate, tropical). Based on these estimates, we characterized average empirical meta-ecosystems and compared their general features among types of connected ecosystems and across biomes. We then assessed the sensitivity to perturbations of these empirical meta-ecosystems by simulating different scenarios of changes with the model parameterized with field estimates.

We thus provide a first global assessment of existing meta-ecosystems, their general features, and their dynamics under perturbation. We conclude that parameterizing theoretical concepts with realistic empirical estimates is a crucial step towards building a predictive theory and further improve our understanding of natural ecosystems.

Keywords: meta, ecosystem, subsidy, perturbations, spatial flow, model, empirical data

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