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Modeling Spatial Information Transfer Across Trophic Levels

Differences in spatial and temporal scale are inherent to many cross-species interactions. Spatial patterns formed by such interactions depend both on population processes at each species' own scale, and on the distribution of the other species. For example, predation affects the distribution of predators and prey, but the prey distribution is simultaneously affected by differences in resource availability over space.

From a signal processing standpoint, populations transform spatial environmental information by populating favorable patches, and cross-species interactions propagate information across trophic levels. We expect that disparities in perceptual grain affect the way that trophic interactions transform spatial information.

To address this question, we describe a novel variation on the lattice model. Our model consists of two interacting lattices with different resolutions, and an underlying layer of spatially explicit environmental variation. Prey populations inhabit the fine-grained lattice at the same resolution as environmental variation, while predator populations inhabit the coarse-grained lattice. Cells of the fine-scale lattice nest exactly into coarse-scale lattice cells. Predators respond to the total number of prey within each coarse cell, but cannot perceive prey populations' spatial structure on the fine-grained level.

By simulating a general predator-prey interaction at a range of scales, we explore how perceptual grain disparity distorts spatial environmental pattern as it propagates through trophic levels. We also consider implications for predator-prey coexistence, and for the ability of each species to track necessary resources as they vary across space.