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The effect of foraging patterns on population dynamics for central place foragers

Central place foragers are individuals living in a larger population at a central place from which they emerge to forage and to which they return to reproduce. Examples include ants, bats, colonial seabirds, and cave crickets. Foraging area and foraging behavior may influence population dynamics at the central place where reproduction occurs.

Typically, deterministic models for population dynamics consider either a nonspatial setting (e.g. ODEs or difference equations), or a spatial setting in which the species in question can reproduce anywhere in the domain (e.g. PDEs and integrodifference equations). Since neither of these two frameworks is suited for a central place forager population, we introduce a system of two equations in discrete time, one for the spatial distribution of resources and one for the (nonspatial) density of consumers at the central place. The two equations are connected via a 'foraging kernel' that captures the foraging behavior of individuals.

We study the resulting dynamics in two different cases.

(1) We assume a fixed foraging behavior in time and consider the minimal patch size required to sustain a population. We show how different foraging behaviors give qualitatively different population dynamics.

(2) We assume that individuals forage in such a way that the population-level food intake is maximized at each time step, i.e., the foraging kernel depends on the resource distribution. Several new dynamical behaviors arise with this simplistic implementation of optimal foraging: the minimal patch size becomes zero, and different bifurcations occur.

Typically, optimal foraging has a stabilizing effect on the population dynamics.