SPACE/TIME EVOLUTIONARY STOICHIOMETRIC MODEL FOR THE ALGAE-*DAPHNIA* ECOSYSTEM

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ABSTRACT

The development of ecological models that incorporate food quantity, as well as food quality has deepened our understandings of ecological dynamics. Models developed under the theory of Ecological Stoichiometry integrate Lotka-Volterra type models with stoichiometric constraints by considering chemical heterogeneity of the species. While current models track both energy (light) and nutrients across trophic levels, most neglect spatial dynamics.

Harmful algal blooms block light from getting far beneath the surface and can result in severe ecological consequences. In order to begin investigation of these consequences mathematically requires a complex model that explicitly models the spatial dynamics of light, nutrients, and aquatic population densities. In this work we develop and analyze a stoichiometric model of the algae-*Daphnia* aquatic ecosystem using both time and spatial dynamics.

I. Loladze, Y. Kuang and J. J. Elser constructed a two-dimensional Lotka-Volterra type model using stoichiometric principles (the LKE model), which includes chemical heterogeneity of the first two trophic levels of a food chain, by assuming that both producer and grazer are composed of carbon and phosphorus. This model, however neglects spatial dynamics. Recently, C. Dissanayake spatially expanded the LKE model using lambert-beers law for light absorption to vary the light level with water depth.

In this work, we extend the model further to include more realistic spatial light dynamics that depends on depth, as well as the population densities, for example algal self-shielding. In addition to the spatial distribution of light, the model incorporates spatial dynamics of dissolved phosphorus levels, which also depends on population densities. Model simulations and analysis lead to insights on algae and *Daphnia* population dynamics and how they are integrated with the spatial dynamics of nutrients and light.