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POPULATION DYNAMICS AND FORAGING BEHAVIOR IN A PREDATOR-PREY SYSTEM WITH FAST BEHAVIORAL DYNAMICS

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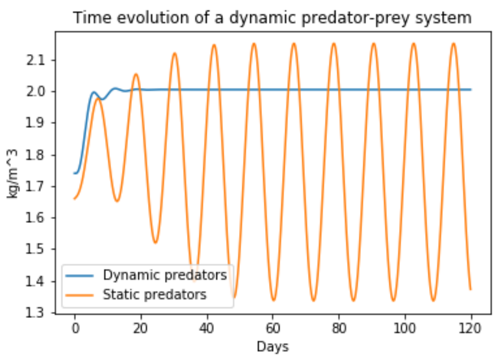
Classical biological models, [3], [1], consider the bifurcations occuring in a natural system with increasing nutrient concentration. These models assume constant behavior for animal individuals, to simplify the models as discussed in [3]. In recent years there has been considerable interest in expanding the modelling to encompass the effect of dynamic behavior on foraging behavior and risk aversion, [4].

We model the interaction of predator and prey populations with adaptive behavior. The interactions and growth terms are given by type II functional responses. We model a situation where the predators and prey can choose how much time to spend foraging, eg. time spent in the upper layers of the ocean as in [7] or [6]. The adaptive behavior is added by finding the instantaneous inner Nash equilibrium of this game. This builds on the work for type I responses in [5].



(a) *Population dynamics with adaptive vs. static behavior*

Adaptive behavior changes the biological system in a fundamental fashion, heavily dampening, and often even removing, oscillations in a Rosenzweig-MacArthur system and making the system more resilient to nutrient shocks. As a result of this, the topological nature of a seasonally driven system is altered, with

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seasonality only forcing a moving steady-state. In addition, a system with adaptive behavior has the ability to sustain a greater population of both prey and predators in comparison to one with static behavior. This is illustrated in the figure above for predators.

Summarizing, we find that a predator prey-system with adaptive behavior have largely non-oscillatory population dynamics with changing resource availability in contrast to a system with static behavior, expanding on the classical results of [1].

Using our model we can also reproduce the results of [2] on the effect of nutrient concentration on the activity of planktonic grazers: In a model with only grazers and resources, we find that on short time-scales the activity level falls drastically when increasing the nutrient concentration.

Building on this, we analyze the inter-trophic flux in the tri-trophic model we have developed on long and short time-scales.

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