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Early signs of regime shift and population outbreak in a two-timescale predator-prey model.

Abstract

A two-trophic ecosystem consisting of two species of predators competing for their common prey with explicit interference competition is considered. With proper rescaling, the model is written as a singularly perturbed system with fast prey dynamics and slow dynamics of the predators. In a parameter regime near singular Hopf bifurcation, chaotic mixed-mode oscillations (MMOs), featuring concatenation of small and large-amplitude oscillations, are observed as long transients before the system approaches its asymptotic state to a Hopf limit cycle. To analyze the dynamical cause that initiates a large amplitude oscillation, the model is reduced to a suitable normal form near the singular-Hopf point. The analysis is then used to (i) determine whether the system exhibits a major population outbreak and (ii) predict the transition to the asymptotic state.