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A Decay-Consistent Model of Population Growth and Competition with Delay

We derive an alternative expression for a delayed logistic equation in which the rate of change in the population involves a growth rate that depends on the population density during an earlier time period. In our formulation, the delay in the growth term is consistent with the rate of instantaneous decline in the population given by the model. Our formulation is a modification of [Arino et al., J. Theoret. Biol. 241(1):109–119, 2006] by taking the intraspecific competition between the adults and juveniles into account. We provide a complete global analysis showing that no sustained oscillations are possible. A threshold giving the interface between extinction and survival is determined in terms of parameters in the model. Our approach for analyzing the global dynamics incorporates the theory of chain transitive sets and the comparison theorem for cooperative delay differential equations. We extend our delayed logistic equation to a system modeling the competition of two species. For the competition model we provide results on local stability, bifurcation diagrams, and adaptive dynamics. Assuming that the species with shorter delay produces fewer newborns than the species with longer delay, we show that there is a critical value τ^* such that the evolutionary trend is to take the delay as close to τ^* as possible.

This is joint work with Chiu-Ju Lin and Ting-Hao Hsu