

Deterministic sudden changes and stochastic fluctuation effects on stability and persistence dynamics of two-predator one-prey Model

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Abstract

In this paper, we present new results on deterministic sudden changes and stochastic fluctuations effects on the dynamics of a two-predator one-prey model. We purpose to study the dynamics of the model with some impacting factors as problem statement. The methodology depends on investigating the seasonality and stochastic terms that which makes the predator-prey interactions more realistic. A theoretical analysis is introduced for studying the effects of sudden deterministic changes, using three different cases of sudden changes. We show that the system in a good situation presents persistence dynamics only as a stable dynamical behavior. However, the system in a bad situation leads to three main outcomes, as follows: first, constancy at the initial conditions of the prey and predators; second, extinction of the whole system; and third, extinction of both predators, resulting in the growth of the prey population until it reaches a peak carrying capacity. We perform numerical simulations to study effects of stochastic fluctuations, which show that, noise strength leads to an increase in the oscillations in the dynamical behavior and became more complex, finally, leads to extinction when the strength of the noise is high. The random noises transfer the dynamical behavior from the equilibrium case to the oscillation case, which describes some unstable environments

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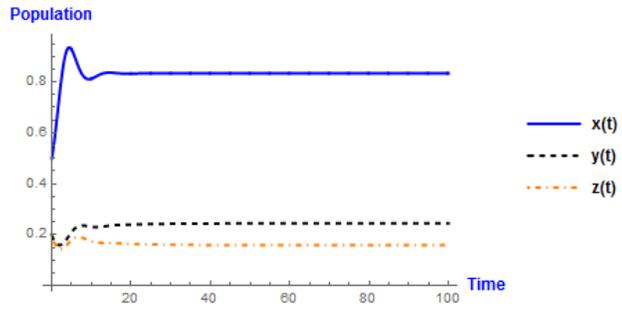


Figure 1. Time series of system (50) without noise ($\sigma = 0.0$).

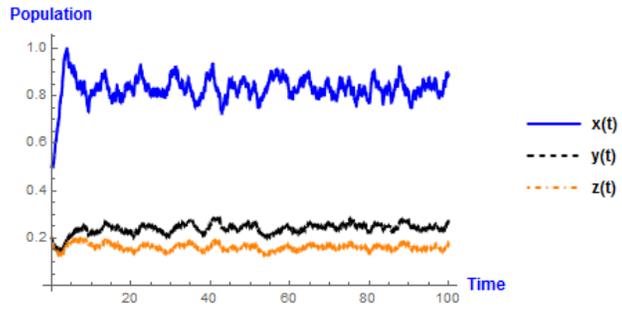


Figure 2. Time series of system (50) with low noise strength ($\sigma = 0.05$).

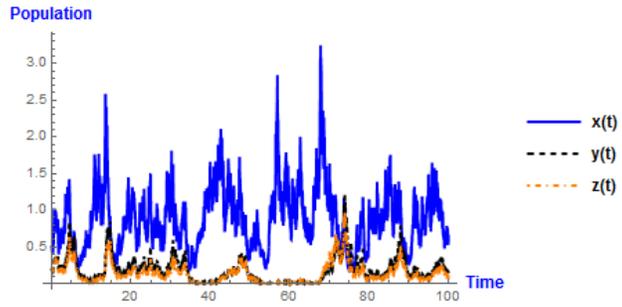


Figure 3. Time series of system (50) with strength medium noise strength ($\sigma=0.5$).

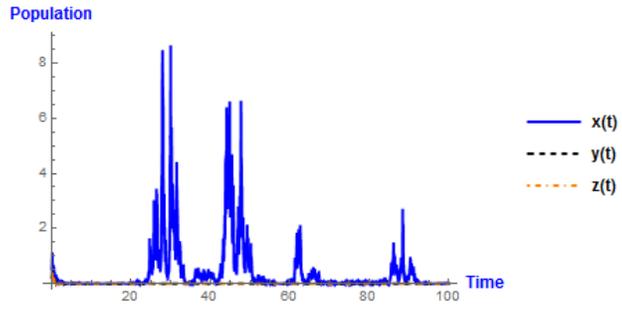


Figure 4. Time series of system (50) with strength high noise strength ($\sigma = 1.4$).