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Extinction Time of a Stochastic Predator-Prey Model by the Generalized Cell Mapping Method

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Abstract

The stochastic response and extinction time of a predator-prey model with Gaussian white noise excitations are studied by the generalized cell mapping (GCM) method based on the short-time Gaussian approximation (STGA). The methods for stochastic response probability density functions (PDFs) and extinction time statistics are developed. The Taylor expansion is used to deal with non-polynomial nonlinear terms of the model for deriving the moment equations with Gaussian closure, which are needed for the STGA in order to compute the one-step transition probabilities. The work is validated with direct Monte Carlo simulations. We have presented the transient responses showing the evolution from a Gaussian initial distribution to a non-Gaussian steady-state one. The effects of the model parameter and noise intensities on the steady-state PDFs are discussed. It is also found that the effects of noise intensities on the extinction time statistics are opposite to the effects on the limit probability distributions of the survival species.

Key words: Extinction time statistics; Stochastic response PDF; Predator-prey model; Generalized cell mapping method; Short-time Gaussian approximation.

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