

Stochastic Bistability: A Logistic Model with Mating Limitation and Stochastic Immigration

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Abstract

We propose a stochastic logistic model with mating limitation and stochastic immigration. Incorporating stochastic immigration into a continuous time Markov chain model, we derive and analyze the associated master equation. By a standard result, there exists a uniquely ergodic stationary distribution. It turns out that for finite population size, such stationary distribution admits a bimodal profile reflecting the bistability in the stochastic model. However, such bistability disappears and threshold phenomenon emerges as the total population size goes to infinity. Stochasticity vanishes and the deterministic model is recovered, as the total population size goes to infinity. Such limiting result interprets differently from the classical strong Allee effect: The species either dies out or survives eventually regardless of the initial population density but depending on a critical inherent constant determined by model itself via birth, death and mating limitation.

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