Effect of Harvesting on Extinction Time in a Stochastic Population Model

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Deterministic population models have limited predictive power since they do not take into account the random characteristics of environmental impacts. Therefore, we use stochastic approaches for a realistic description of a population. There are two commonly used methods to consider stochastic effects. One is to focus on Fokker Planck solutions by identifying statistical properties of noise and writing a Langevin equation. Another approach is to solve the Master equation with the transition rates representing the transition of the population from n individuals to n+r individuals. Thus, it is possible to calculate Mean Time to Extinction (MTE) for single-step or multiple-step processes using WKB (Wentzel-Kramers-Brillouin) approximation. In this study, we first expand a population model under weak or strong Allee effect, according to the value of the parameters to include a harvesting function. Since the effect of harvesting function on MTE can only be analyzed based on multiple-step processes, we propose a way to use WKB approximation for multiple-step processes. Thus, we examine the effect of stochastic effects on extinction time on the basis of multiple-step processes.