Using a Multivariate Diffusion Model to Perform Inference in Ecology

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Abstract

Environmental dynamics have gathered increasing interest in recent times with the widening scope of climate change. Consequently techniques used in modelling are evolving to capture the behaviour of ever more complicated natural phenomena. Diffusion models are used extensively in financial and scientific applications, for the valuation of complicated risk positions and physical dynamical behaviour. We advocate the use of multivariate diffusion processes in the modelling of an ecological time series. Though the nature of ecological data present hurdles not typically present in finance, we demonstrate how to set up a computationally efficient parameter estimation algorithm and subsequently combine the estimation output with the mechanics of diffusion processes in order to gain insight into the population dynamics of *Emiliania huxleyi*, an important unicellular species in the study of marine ecology. We develop quantities that may be useful in quantifying the nature of population dynamics under a given diffusion model. Specifically, we use a temporal measure of the bloom potential of *E. huxleyi* in order to forecast the risk of bloom events. Such an analysis may aid in understanding, developing and ultimately quantifying theories around ecological phenomena.

Keywords: Diffusion Process; Stochastic Differential Equation; Ecological Time Series; Markov Chain Monte-Carlo; *Emiliania huxleyi* .