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The Interplay of Demographic Stochasticity and Environmental noise in Population Dynamics

Multiple factors determine a population's viability. For a population that can persist indefinitely under deterministic forces (i.e., a reasonably low intrinsic rate of increase to avert deterministic chaos), its fate can still become uncertain when facing environmental noise. Environmental stochasticity affects not only the survival of individuals but also their fecundity and thus population recruitment. Demographic processes, such as survival and fecundity, are inherently stochastic, reflecting the ensemble of individual events (survival, death, birth, etc.). Such three destabilising forces (deterministic chaos, environmental noise, and demographic stochasticity), thus, jointly moderate a population's viability and extinction probability. In the early attempts to formulate population viability, scientists have largely focused on the conditions leading to deterministic chaos and the role of demographic stochasticity in combination with random (white) environmental noise. In this work, we model the population dynamics of species with non-overlapping generations using the logistic difference equation, implementing both demographic stochasticity using negative binomial distribution for individual demographic events (survival and fecundity) and 1/f colour environmental stochasticity. We show that the population viability differs under white versus red and pink noise. The risk of extinction tends to decrease as the environmental stochasticity shifts from colour noise to white noise; that is, the persistence and viability of a population can be uplifted when environmental noise loses its colour. Furthermore, the risk of extinction increases intuitively as the probability of survival decreases. We, therefore, add to the ongoing debate in the population viability analysis that colour noise and demographic stochasticity jointly contribute to the moderation of population persistence and extinction risks.