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Repopulation of Ambystoma tigrinum in the West Texas playas in the period following Antevs Altithermal: a mathematical model

We consider a population of amphibians in transient wetlands. The effect of predation, migration and finite resources is examined through a series of models based on differential equations. Logistic growth coupled with predation with satiation can, depending on parameters, produce an Allee effect in an isolated habitat. In particular, a population that might thrive in isolation may go extinct if migration becomes an option and an equilibrium of populations in a coupled system does not necessarily lead to stable nonzero populations when migration stops. We show that under some circumstances periods of migration followed by periods of isolation is a faster way to repopulate a system than a single long period of migration. We apply this model to the Ambystoma tigrinum population of the highland playas of west Texas to show that in a given rainy period it is unlikely that migration will occur except to nearest adjacent ponds. Coupling this result with rainfall data gives a rough probability for migration in a given rainy season. Field data give an indication of extinction rates for individual playas. Coupling these two probabilities in a percolation process on a finite grid gives an indication of how many years are required to restock a whole system of playas from a single populated pond. We show under what assumptions it is possible for the system of about 20,000 playas to be restocked from a single source by Ambystoma tigrinum in the interval since the intense dry period known as Antevs Altithermal.