

Dynamics of Prey-Predator Populations in Multi-Patch Arrangements

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Abstract

We studied the dynamics of prey and predator populations in homogeneous two-patch, then four-patch arrangements. The different four-patch arrangements include a chain, hub, ring, modified ring, and fully-connected graph. We used the classic Lotka-Volterra model, where prey grow exponentially and predation occurs through a mass-action term. Through linear difference terms, both prey and predator migrate to patches with lower populations of their own species. We found that in the listed arrangements, the four-patch systems had the same equilibria as a one-patch system. This fact, in addition to simulations, suggests that changing arrangements does not affect the stability of the prey and predator populations in our model. With this conclusion, one would connect patches in the most cost-efficient way. However, this conclusion is not realistic; we move on to a non-homogeneous two-patch model, allowing different birth, predation, and death coefficients for each patch. In this system we found positive, real equilibria that did not match the one-patch model. Furthermore, simulations suggest that in many cases, these equilibria are attracting. We extended these findings to analyze non-homogeneous four-patch systems in the aforementioned arrangements.