
Metapopulation persistence in a dynamically changing landscape

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Résumé

In natural ecosystems, many species live in habitats that have been fragmented due to natural phenomena or changes in human land use, resulting in the restructuring of the habitat. Habitat fragmentation (destruction, alteration) has intensified in recent years and is a major cause of biodiversity loss. Metapopulation models are used to understand how a species facing local extinction can persist through colonization and extinction processes in a network of patches. Research has focused on examining the impact of habitat properties on species survival, both empirically and theoretically. Specifically, researchers have used a metric called metapopulation capacity, which is derived from network properties, to characterize species persistence.

However, metapopulation models primarily focus on understanding the impact of habitat fragmentation, represented as a network of patches at a fixed snapshot. The temporal dimension is not considered, or is considered through the study of different snapshots over time, without considering the dynamics of the network.

Ecologists have recently begun using multilayer networks as mathematical tools for representing temporal networks. In particular, multilayer networks are well suited for the study of temporal networks in the case of metapopulation dynamics. Using methods borrowed from the physics of Markov processes and epidemiology, we recover the criteria of metapopulation capacity in the case of multilayer networks.

From a sequence of habitat snapshots, we can derive the metapopulation capacity and determine whether a species can survive in a changing habitat. The survival of a species in practical settings can be determined by examining a series of snapshots of its habitat. Ways to mitigate habitat fragmentation can be searched for to ensure the survival of a species based on its properties, such as colonization and extinction.

This new metric, which is similar to metapopulation capacity and considers network structure from a temporal perspective, may be a turning point in the analysis of species persistence in a changing habitat. It provides a single framework that ecologists can use and aligns with recent literature on multilayer networks with a strong theoretical focus.

Mots-Clés: Metapopulation, Markov process, Multilayer network, Metapopulation capacity

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