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Short communication

An R package for simulating metapopulation dynamics and range expansion under environmental change

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A B S T R A C T

The metapopulation paradigm is central in ecology and conservation biology to understand the dynamics of spatially-structured populations in fragmented landscapes. Metapopulations are often studied using simulation modelling, and there is an increasing demand of user-friendly software tools to simulate metapopulation responses to environmental change. Here we describe the MetaLandSim R package, which integrates ideas from metapopulation and graph theories to simulate the dynamics of real and virtual metapopulations. The package offers tools to (i) estimate metapopulation parameters from empirical data, (ii) to predict variation in patch occupancy over time in static and dynamic landscapes, either real or virtual, and (iii) to quantify the patterns and speed of metapopulation expansion into empty landscapes. MetaLandSim thus provides detailed information on metapopulation processes, which can be easily combined with land use and climate change scenarios to predict metapopulation dynamics and range expansion for a variety of taxa and ecological systems.

Software availability

Name of software: MetaLandSim.
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Availability: https://cran.r-project.org/web/packages/MetaLandSim/index.html
Installation: Select the repositories CRAN and Bioconductor (BioC software), then type: install.packages ("MetaLandSim", dependencies = TRUE).

1. Introduction

The populations of many species are spatially-structured, with subpopulations occupying local habitat patches and interacting via dispersal (Hanski, 1999). Much effort has been devoted to understand and predict the dynamics of such populations, leading to the development of a metapopulation paradigm whereby local subpopulations are subject to chance extinction and the proportion of patches occupied depends on extinction and colonization rates (Armstrong, 2005). Building on this paradigm, a wealth of theoretical and empirical studies have explored how metapopulation dynamics (i.e., temporal variation in patch occupancy) is affected by, for instance, species-specific dispersal and colonization abilities, and landscape-level properties such as the size, number and spatial distribution of patches, as well as matrix permeability (Etienne et al., 2004; Hanski, 1999; MacPherson and Bright, 2011). More recently, studies have addressed the consequences of landscape dynamism (i.e., temporal variation in landscape features), resulting from the destruction and recovery of patches due for instance to land use changes and vegetation succession (Wahlberg et al., 2002; Verheyen et al., 2004; DeWoody et al., 2005). Also, a few studies

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