

rangr: An R package for simulating range dynamics of virtual species

Data originating from citizen science and wildlife monitoring programmes pose a great analytical challenge. They usually have complicated, multivariate and hierarchical structure which is a result of spatial and temporal replication, hundreds of recorded species and many observers involved. Despite a relatively low signal-to-noise ratio and considerable observational error, these kinds of data are an extremely useful, and sometimes the only, source of ecological information. Therefore, they are widely used in scientific research and conservation.

In this study, we present rangr, an open-source R package designed to simulate species range dynamics. This tool mimics the essential processes that shape population numbers and spatial distributions: local dynamics, dispersal and habitat selection. Simulations may be conducted in a spatially-explicit and dynamic environment, which facilitates population projections as they respond to climate or land-use changes. By using different sampling schemes and observational error distributions, the structure of the original survey data can be reproduced or a purely random sampling can be mimicked.

Some of the key features of rangr are its high flexibility and customisability, which guarantees that the simulation can be tailored to meet specific research needs. For instance, the user can choose between different types of dynamics (including Allee effects), modes of dispersal and dispersal kernels, detectability functions, or levels of stochasticity. To improve scalability, the R code is optimised to support parallelization and efficient memory management.