Metapopulation dynamics of complex life-cycles in heavily-disturbed landscapes: Insights from exploited species in oceanic archipelagos

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1 Abstract

The dynamics of sparse populations are of utmost importance in ecology. Structured metapopulation models have been extensively used to determine extinction thresholds and populations persistence in future environmental scenarios. We herein developed a metapopulation dynamics model for semisessile highly-exploited species. Four models were developed considering different the habitat fragmentation, isolation and distance of populations in two oceanic archipelagos. We used as empirical example, the populations of two harvested intertidal limpets (*Patella candei* and *P. crenata*) in Madeira, and Tenerife (Canary Islands), two Atlantic volcanic islands distant to the continent.

2 Keywords

Metacommunities, patch dynamics, dispersal dynamics, individual-based model, Approximate Bayesian Computing

3 Introduction

Metapopulation models predict the survival of highly-disperse populations regardless local depletion of species (Hanski, 1999; Akakaya et al. 2007). However, habitat loss and fragmentation may be so extensive that result in a massive species extinction (Montoya, 2008; Rybicki Hanksi, 2013; Haddad et al. 2015). Model predictions have shown that a decrease in connectivity among assemblages, from continuous to sparsely-distributed populations is accompanied by species loss (Metzger et al. 2009; Niebuhr et al. 2015). The role of natural (e.g. stochastic events) and human-induced (e.g. pollution, harvesting) perturbations have been extensively studied in the last decades (Dornelas, 2010 and references therein) and it has been frequently studied in ecological theory (e.g. Volkov et al. 2007; Gardner Engelhardt, 2008). The degree of anthropogenic pressure may be a capital factor for landscape connectivity, since directly affects the persistence or decrease of assemblages (Supp Ernest, 2014). Besides perturbations, dispersal rates in disturbed landscapes need to be high in order to maintain viable populations (Provan et al. 2009). However, individual-based models (IBM) are needed to predic dispersal rates in species where small specimens, i.e. juveniles, are not reproductively active and even larger-sizwed adults harbour the highest reproductive potential (e.g. Hendricks Mulder, 2008; Werner Griebeler, 2011). IBM simulate populations as being composed of discrete individual organisms (De Angelis Grimm, 2014; Van der Vart et al. 2016). in IBMs the actions of single individuals are simulated and they interact with other and the landscape they live in (De Angelis Mooij, 2005). They incorporate attributes vary among the individuals and can change through time such as, growth, foraging, dispersal and reproduction, among others (Martin et al. 2013; De Angelis Grimm, 2014). These models have been used as size-structured methods to integrate a high variety of data which output are pivotal for management purposes (Punt et al. 2013) and conservation strategies (Nabe-Nielsen et al. 2014). We herein develop metacommunity models based on individuals of two intertidal species, namely the limpets *Patella aspera* and *P. candei*. The first model assumes that dispersal rates between patches are distance-dependent, with low rates between highly-separated assemblages. The second model assumes that dispersal rates are positively correlated to individual density. The third model assumes that larger individuals have higher reproductive potential. The fourth model considers a low probability of dispersal to peripheral assemblages relative to central ones. We confront the model with

long-time series data (1994-2014) of two commercial limpet species (*Patella candei* and *P. aspera*) in two overpopulated oceanic islands (¿ 500 inhab km^{-2})$with a high harvesting pressure (see Rieraetal.2016; Sousaetal.2018 for details). Formerstu$

4 Material and Methods

Material and methods where you have to include all methodology and procedures

5 Results

6 Discussion

7 Acknowledgements

8 References

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