Spatial dynamics of anthropogenically altered dispersal patterns

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Abstract

The thesis put forward in this study is that anthropogenic disruption of natural dispersal is of central importance for the conservation of biodiversity. The main rationale being that dispersal, as a fundamental life history trait, is directly linked to, and affected by three of the main threats to biodiversity: Invasive species, habitat fragmentation and climate change.

In terms of biological invasions, the introduction of exotic taxa into a foreign habitat is performed by people, and the spread of these species within the invasion range is often a result of human aided dispersal. Surprisingly though, not much emphasis is put on anthropogenic dispersal when modelling biological invasions.

Habitat fragmentation is the direct consequence of habitat destruction. In a fragmented landscape, remnant natural patches host populations with varying degrees of inter-connectivity. Dispersal through degraded habitat is the key to maintaining viable meta-populations in a fragmented landscape. To facilitate dispersal in highly fragmented landscapes such as cities, a clear knowledge of the roles played by different land cover features (e.g. density of trees or traffic) is the starting point to make informed urban planning decisions.

The main issue with climate change is not that climate conditions are disappearing, but that they are moving. As a consequence of this, organisms also need to move along with the climatic conditions they are adapted to. This process, named range shift, is being observed worldwide on several taxa. Researchers, however, put very little attention to the problems arising when "climate migrants" encounter dispersal barriers (e.g. anthropogenic land cover) on their path.

The main body of work presented here consists in both the practical analysis of specific systems and the development of conceptual and methodological frameworks to address general issues. Among the former, I used population and landscape genetics approaches to analyse the case of Copper skinks (*Oligosoma aeneum*) in Auckland (New Zealand) as a recent and intensive habitat fragmentation scenario, with the goal of detecting the land cover types that allow the highest dispersal in urban settings. I also analysed the case of the Australian *Litoria* frogs (*L. aurea*, *L. raniformis* and *L. ewingii*) in New Zealand with the intent of quantifying the anthropogenic dispersal component of their invasion. As per the latter, I developed a novel method for estimating the anthropogenic component of biological invasions, infer their natural dispersal parameters, and forecast future developments of biological invasions. I also developed the novel concept of C-trap, whereby the shape and spatial orientation of the interface between natural and anthropogenic land cover types may originate traps for climate migrants, and used it to determine where, on a global scale, their high densities can further threaten endangered, endemic animal species.

My results identified an early stage fragmentation scenario for urban Copper skinks in Auckland. Relatively high population genetic structure formed as a result of segregation by a motorway. However, the roles of other land cover types in controlling population connectivity could not be determined. Of all *Litoria* frog populations recorded in New Zealand, about 30% were found to be of anthropogenic origin. Even though the borders of the distribution range occupied so far are unlikely to expand, the density of populations within the range is expected to rise with new, suitable patches being found. Tests on virtual species with the novel methodology for the modelling of biological invasions showed good performance (accuracy in estimating natural dispersal kernel and anthropogenic contribution), also in the presence of challenging limitations in the input

dataset. Finally, the global scale application of the C-traps concept to endangered, terrestrial species highlighted the high potential for conservation issues among climate migrants in Eastern Europe and Southern Asia.

Although it is challenging to quantify the consequences for biodiversity conservation of anthropogenic alterations to natural dispersal, results from the applied studies confirm the initial thesis on their critical role as biodiversity threats; while the novel concepts and methodologies provide a valuable tool for better incorporating these aspects in ecological studies and conservation management.

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