What is the ecological value of fragmented landscapes?

Population dynamics in highly fragmented landscapes

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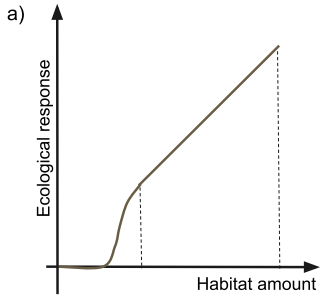
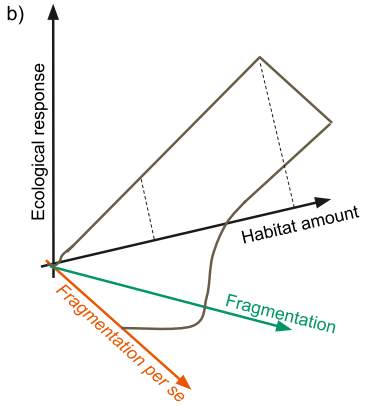




In figure (a), it is possible to observe the ecological response of a population (abundance) or community (biodiversity) to **habitat loss: negative feedback**, with carrying capacity models predicting linear behaviour for medium and large habitat amounts (HA). Then, there is the **extinction threshold**: the minimum HA in which populations persist, about 30%. Nowadays, **the posed challenge is understanding the same feedback relations while controlling fragmentation** parameters as in figure (b).

Modelling

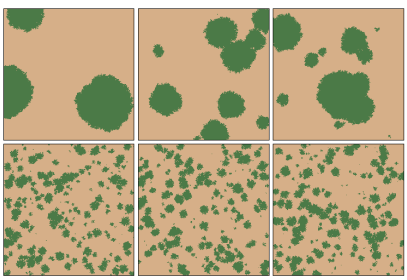
We use numerical methods to simulate reaction-diffusion equations in artificial landscapes generated with different structural distributions of habitat while keeping its total area constant. This guarantees we are observing phenomena caused by ***fragmentation per se***. We discuss the net effects of fragmentation into the steady total population in these landscapes.

$$\partial_t u = ru(1-u) + D_P \nabla^2 u$$
$$\partial_t u = -\mu u + D_M \nabla^2 u$$

The first equation holds in habitat regions while the second holds in matrix. Here, r and D_P is the intrinsic growth rate and diffusivity in patch, and μ and D_M is mortality rate and diffusivity in matrix. Boundary conditions follow the work of Maciel & Lutscher, *The American Naturalist* (2013).

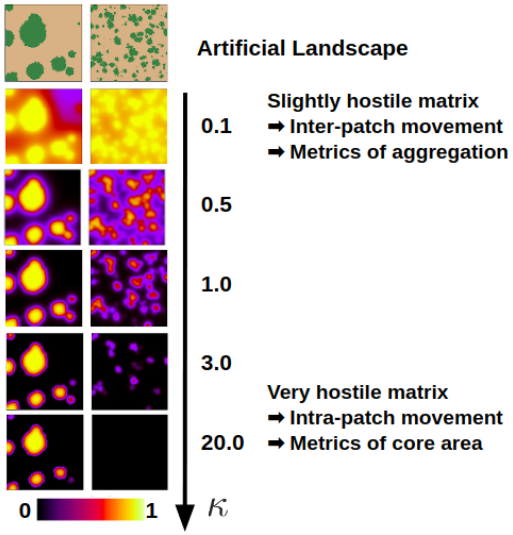
The model is parameterized by the non-dimensional number κ**, measuring the relative quality of matrix (hostility)**. It is the ratio between the patch typical length compared with a typical length in matrix

$$\kappa = \sqrt{\mu D_P / r D_M}$$

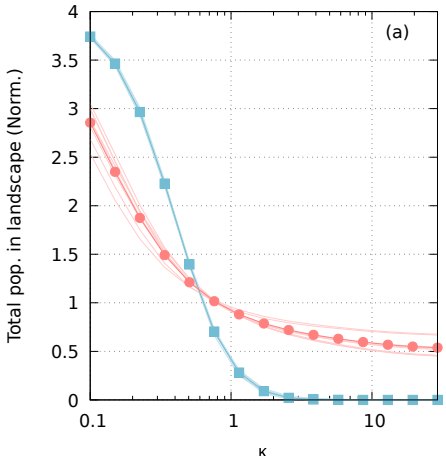


Two groups of landscapes with 25% HA studied: the **slightly fragmented** on top and the **highly fragmented** on bottom.

Results



Effects of fragmentation can be either good or bad - and with different magnitudes - depending on the quality of matrix (κ); Highly fragmented landscapes eventually lead to extinction for a matrix hostile enough and lower HA lead to larger extinction ranges of κ; **Lower HA makes fragmentation effects more significant**, including non-linear behaviour for HA under 25%. **Ecologically relevant features of landscapes vary from aggregation/clustering to core area metrics**, depending on κ.



Red line indicates average over slightly fragmented landscapes and blue line indicates average over highly fragmented landscapes. All landscapes have 25% of HA, as examples in the left.

Click and read more about this project at ***bit.ly/33qgOsp***

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