# What is the ecological value of fragmented landscapes?

## Population dynamics in highly fragmented landscapes

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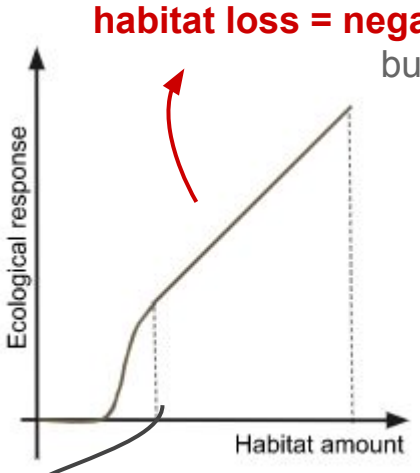
## Landscape ecology

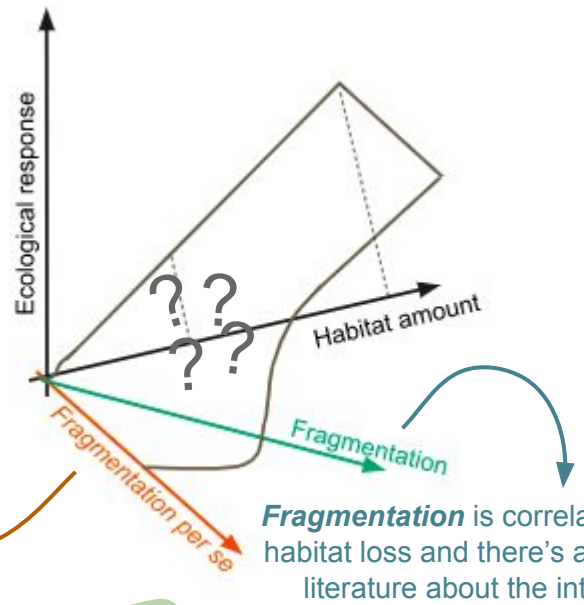
*ecological response* of a population (**abundance**) or community (**biodiversity**)




*Constant carrying capacity density predicts **linear behaviour** for medium and large habitat amounts (HA). Then, there is the **extinction threshold:** the minimum HA in which populations persist, about 30%.*

**habitat loss = negative effects** on the ecological value of landscapes, but **what about the effects of fragmentation?**

Currently a heated debate in the overall direction of these effects (see Fahrig, 2017; Fletcher *et.al.*, 2018; Fahrig *et.al.*, 2019), humorously referred as *FragWars*.



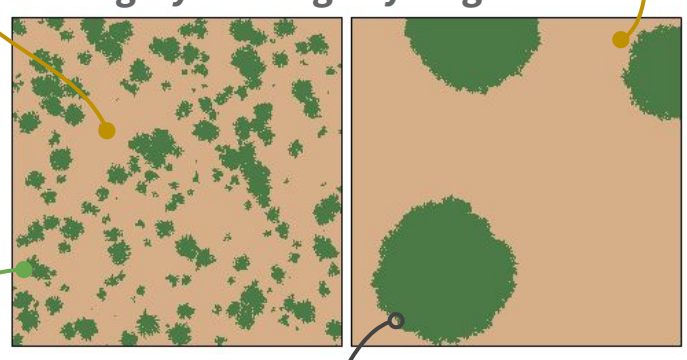

***Fragmentation per se*** represents different spatial distributions of a fixed habitat amount (see Fahrig, 2003).

***Fragmentation*** is correlated to habitat loss and there's a huge literature about the inter-dependencies and covariances of these effects (see Didham, Kapos & Ewers, 2012; Palmeirim *et al.*, 2019)

**Can we use synthetic data help to elucidate and quantify the effects of *fragmentation per se*?**

## Modelling

Two groups of artificial landscapes with fixed HA: **highly** and **slightly fragmented**



$\kappa$ is the only parameter of the model, it can be seen as the **hostility of matrix**

On matrix, species **dies and diffuses**:

$$\partial_t u = \nabla^2 u - \kappa u$$

On habitat, species **grows logistically and diffuses**:

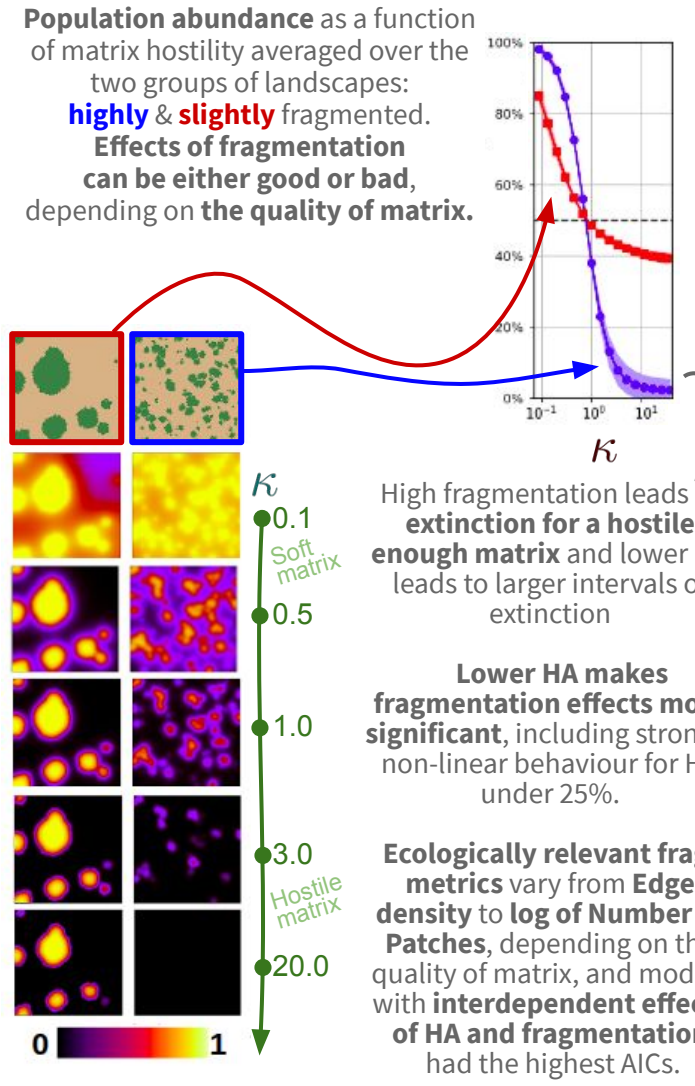
$$\partial_t u = \nabla^2 u + u(1-u)$$

**Interface conditions** with discontinuities following the work of Maciel & Lutscher (2013). Zero flux in the utmost boundary.

In order to **quantify the effects of fragmentation,** we tested **3 statistical models** with **7 different fragmentation metrics** using total pop. in the stationary state as response variable

## Single species abundance

**Population abundance** as a function of matrix hostility averaged over the two groups of landscapes: **highly** & **slightly** fragmented. **Effects of fragmentation can be either good or bad,** depending on **the quality of matrix.**




High fragmentation leads to **extinction for a hostile enough matrix** and lower HA leads to larger intervals of extinction

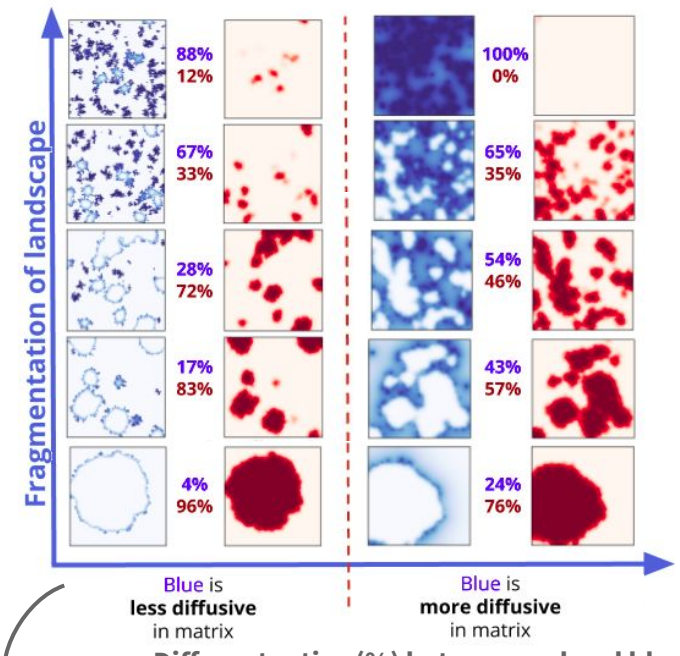
**Lower HA makes fragmentation effects more significant**, including strongly non-linear behaviour for HA under 25%.

**Ecologically relevant frag. metrics** vary from **Edge density** to **log of Number of Patches**, depending on the quality of matrix, and models with **interdependent effects of HA and fragmentation** had the highest AICs.

## Two-species competition

The model can be easily adapted to multi-species models. In the case of in-habitat competition, we observe that considering different patch and matrix mobilities, the **degree of fragmentation is a key factor for coexistence**, both locally as well as in landscape.

We quantify the **mixing measures** of species spatial distributions in different landscapes and observe complex and non-negligible effects of fragmentation in the dynamics depending on a balance between **effects on competition and on mobility**.




**Different ratios (%) between red and blue species in fragmented landscapes**: in an homogenous landscape the blue species would've been excluded by the red species.

**Read more about this project at https://vsudbrack.github.io/projects/frag**

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