How does area loss affect species richness?

Deriving species-area relationships based on spatial simulations

Level: Master
Start: Any time
Project form: Spatial analysis using R
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Background

Understanding large-scale gradients in biodiversity is a long-standing aim in macroecology and biogeography. Area is a key factor in explaining geographic differences in biodiversity, as larger areas typically host more species. Species-area relationships (SARs) quantify this positive relationship between species richness and area of habitat and are commonly approximated by a power law (Eq. 1), where the number of species (S) is related to area of habitat (A) based on the number of species per unit of area (c) and the species accumulation rate (z) (Arrhenius, 1921).

$$\log(S) = \log(c) + \log(A) \cdot z \quad (1)$$

SARs can be derived systematically by overlaying the world with a grid and to count the total number of species across all grids in a sequential grid cell removal process of grid cells (Gerstner et al., 2014; Kehoe et al., 2017; Storch et al., 2012). Geboers (2023) has applied this approach by randomly removing grid cells to derive SARs for amphibians, reptiles, and mammals across the world's biogeographical realms and biomes in this MSc thesis at the department of Environmental Science of Radboud University. Keil et al. (2015) showed that SARs derived from random grid cell removal can differ from SARs derived from outward or inward grid cell removal (Fig. 1). However, SARs have not systematically been derived based on these different grid cell removal processes.

Aim and approach

In the internship, you will derive SARs for one or more species groups. Using the R programming language, you will be analysing species occurrence data in order to find geographical patterns of species richness in relation to area based on different grid cell removal strategies (most-right panel in Fig. 1). The results of this analysis can be used to explore how different spatial configurations of habitat loss can affect biodiversity.

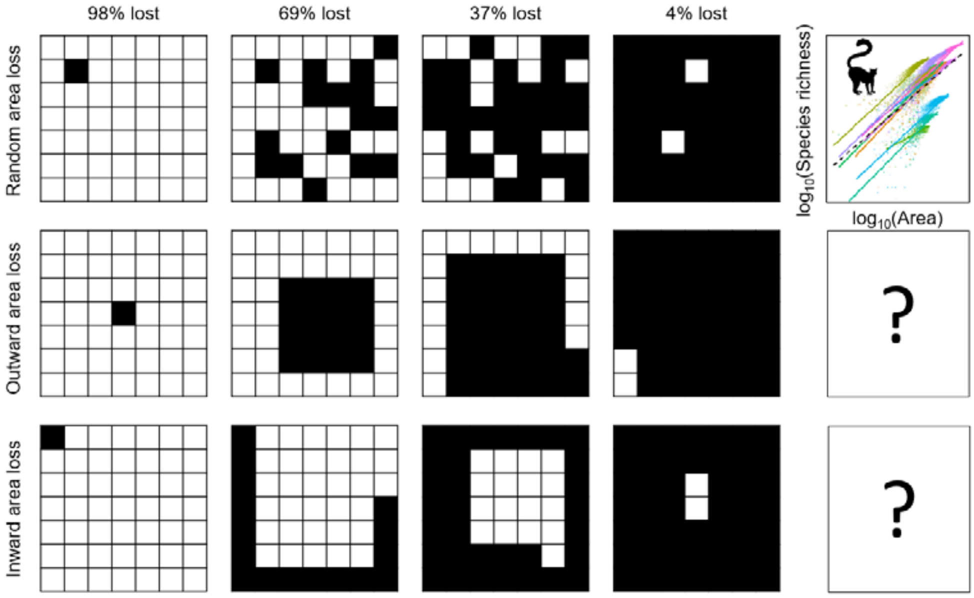

Figure 1. Three simulations of area loss (white grid cells) from 98% (left) to 4% (right): random (top), outward (middle), and inward area loss (bottom). Geboers (2023) derived species-area relationships (SARs) all of the worlds biomes (colours) based on random area loss. However, the effect of non-random (e.g., outward or inward) area loss on SAR slopes is yet unknown.

Literature

Arrhenius, O. (1921). Species and area. *Journal of Ecology*, *9*(1), 95–99. https://doi.org/10.2307/2255763

Geboers, J. (2023). How does species richness change acrcoss spatial scales and geographic regions? Master Internship Report, Department of Environmental Science, Radboud University.

Gerstner, K., Dormann, C. F., Václavík, T., Kreft, H., & Seppelt, R. (2014). Accounting for geographical variation in species-area relationships improves the prediction of plant species richness at the global scale. *Journal of Biogeography*, *41*(2), 261–273. https://doi.org/10.1111/jbi.12213

Kehoe, L., Senf, C., Meyer, C., Gerstner, K., Kreft, H., & Kuemmerle, T. (2017). Agriculture rivals biomes in predicting global species richness. *Ecography*, *40*(9), 1118–1128. https://doi.org/10.1111/ecog.02508

Keil, P., Storch, D., & Jetz, W. (2015). On the decline of biodiversity due to area loss. *Nature Communications*, *6*, 8837. https://doi.org/10.1038/ncomms9837

Storch, D., Keil, P., & Jetz, W. (2012). Universal species–area and endemics–area relationships at continental scales. *Nature*, *488*(7409), 78–81. https://doi.org/10.1038/nature11226