

The Stability of Multitrophic Communities under Habitat Loss

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ARTICLE

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The stability of multitrophic communities under habitat loss

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Introduction: stability and interaction

Habitat loss on diversity and structure

Paradigm of stability

Interaction network

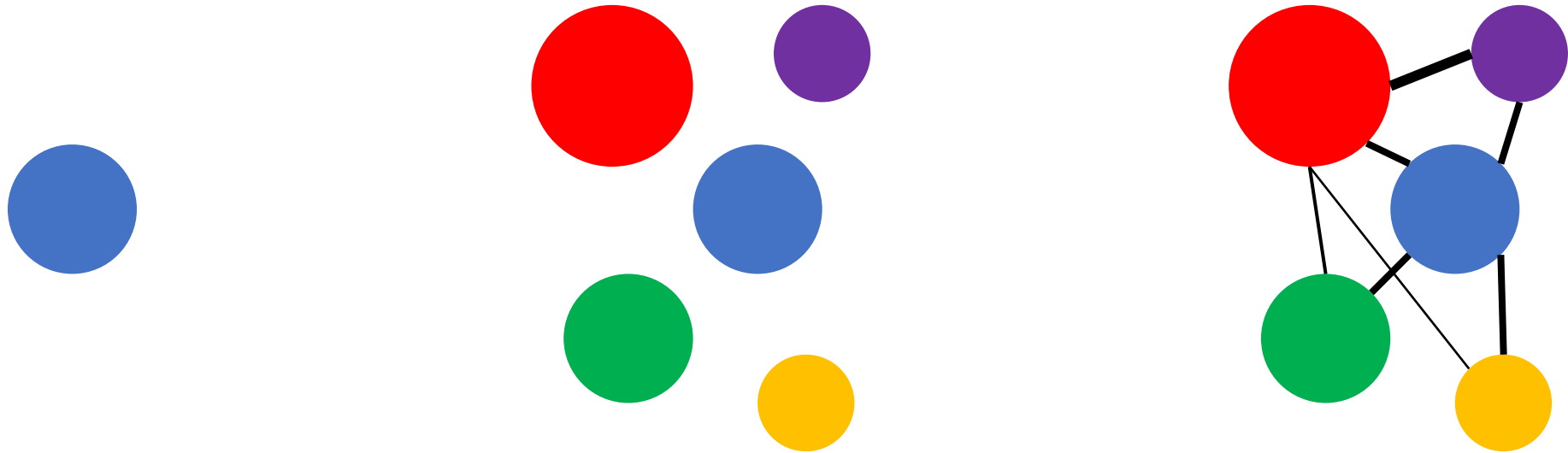
Habitat loss on communities

- Habitat loss (hereafter, HL) is one of the main threats to biodiversity, driving both local and global extinctions of species

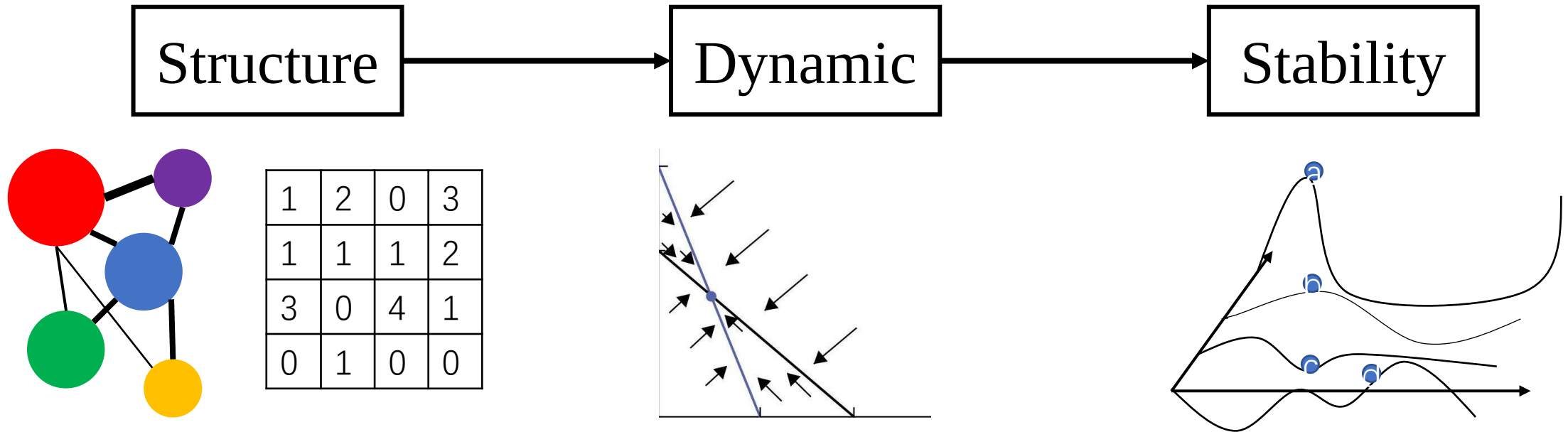
“What escapes the eye, however, is a much more insidious kind of extinction: the extinction of ecological interactions”

-----Daniel Janzen

Interaction: from population to community



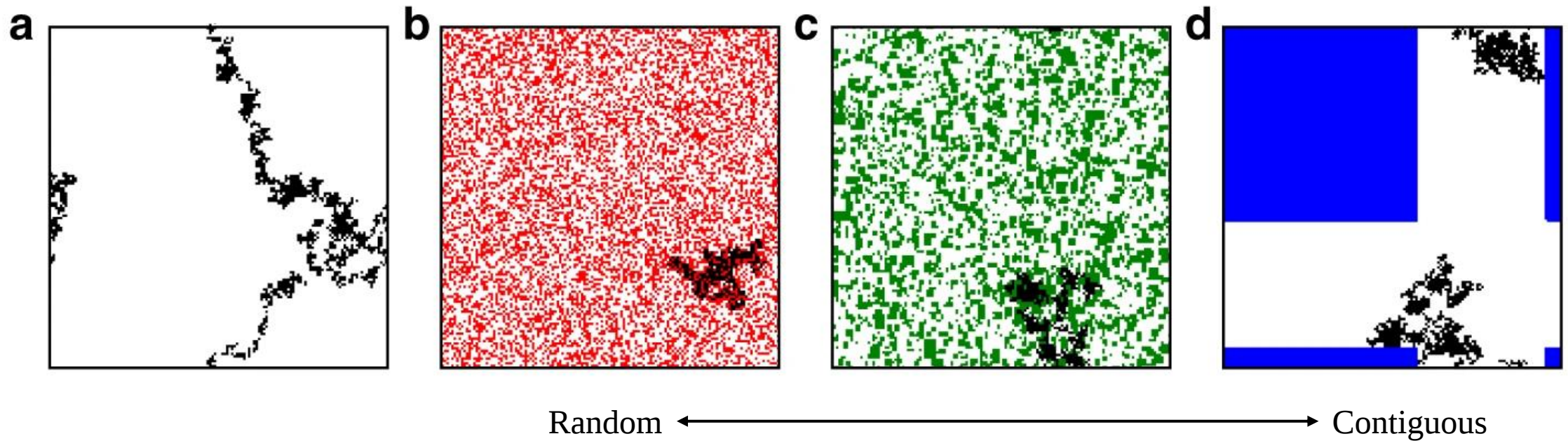
Paradigm of stability



$$N, \vec{r}, \alpha$$

$$\frac{dN_i}{dt} = r_i N_i + \sum \alpha_{ij} N_i N_j$$

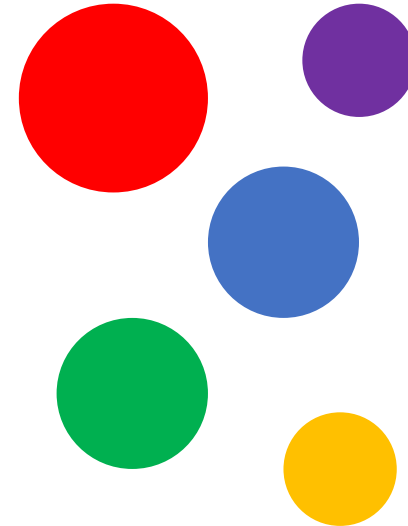
Types of Habitat Loss



Community metrics

Diversity

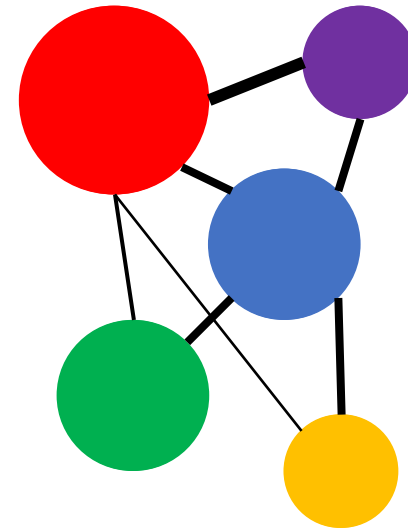
- Number of species
- Number of individuals
- Shannon index
- Shannon equitability
- RATP: relative abundance of top predator species



Community metrics

Network Structure

- Number of links
- Compartmentalisation
- Nestedness
- Generality
- Vulnerability
- Mean interaction strength (IS)



Community metrics: Stability

- CV population
- mean coefficient of temporal variation in species population abundances.

$$\frac{1}{S} \sum_{i=1}^S \frac{\sigma}{\mu}$$

- CV range
- mean coefficient of temporal variation in species range area.

Results: from habitat loss to stability

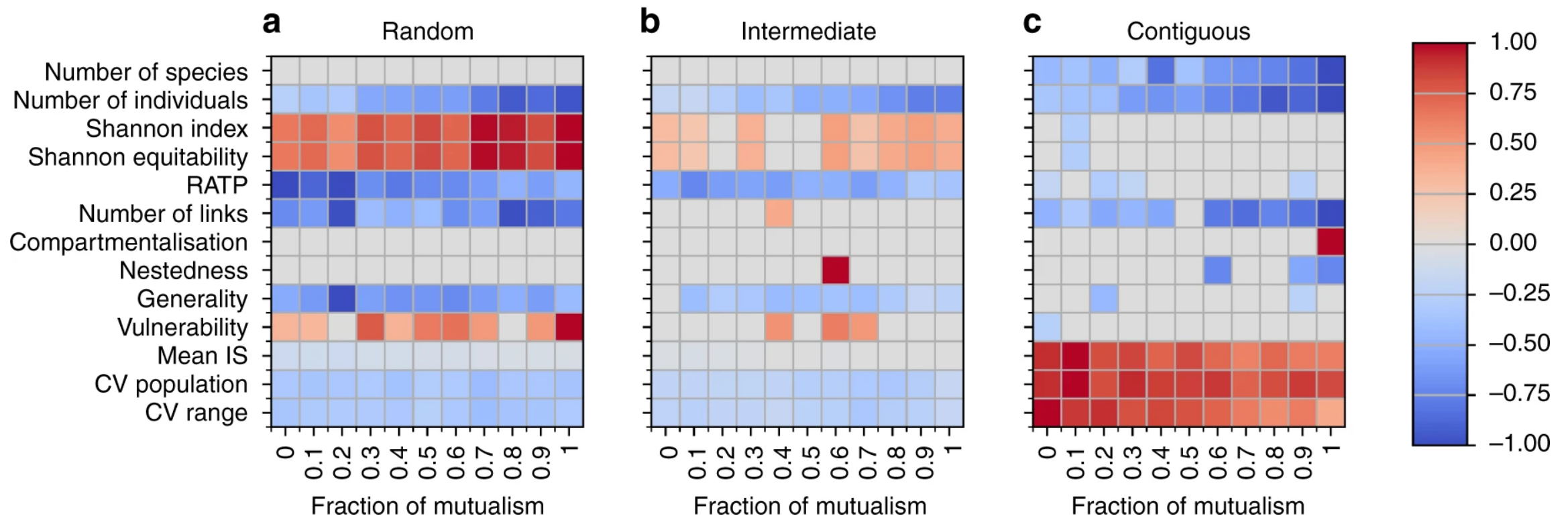
Community response to HL types

Effect on stability vis interaction

Routes to instability

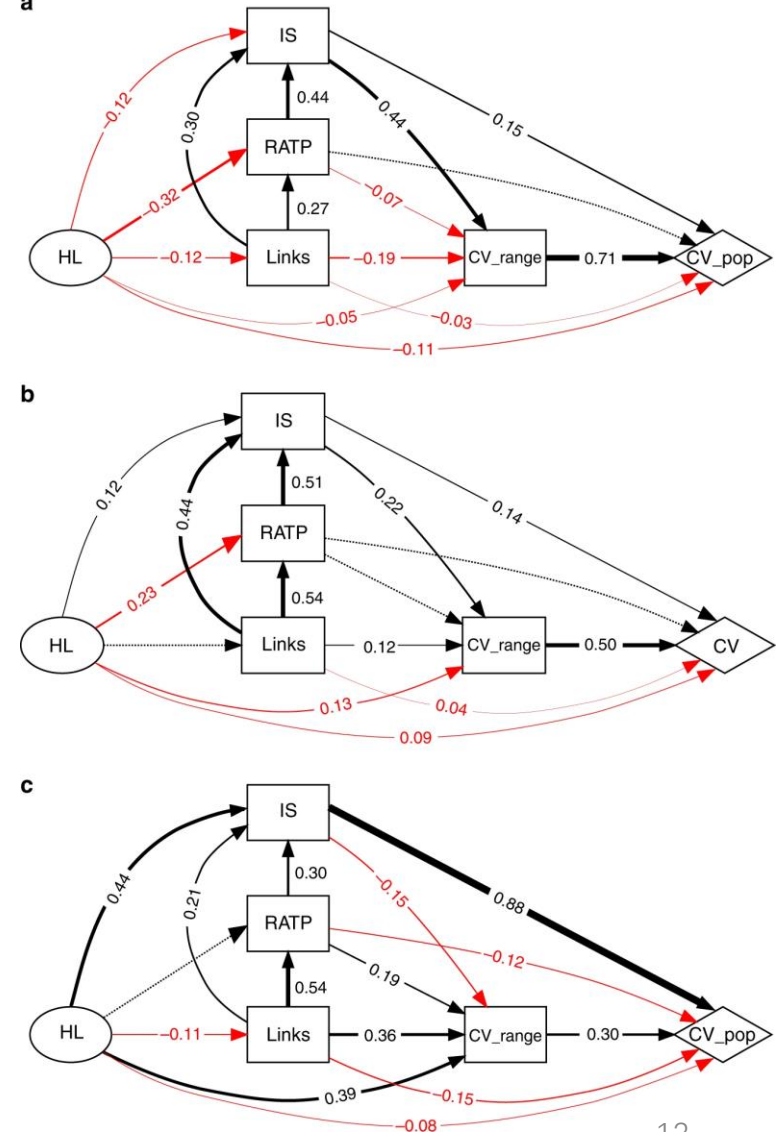
Response of community to habitat loss

- F-test: relation between community metrices and habitat loss

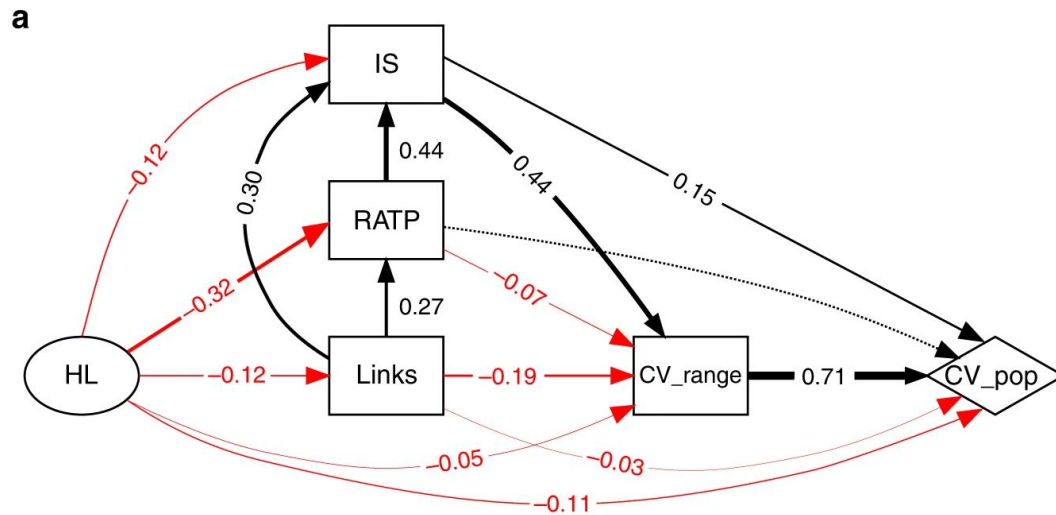


Routes to stability or instability ^a

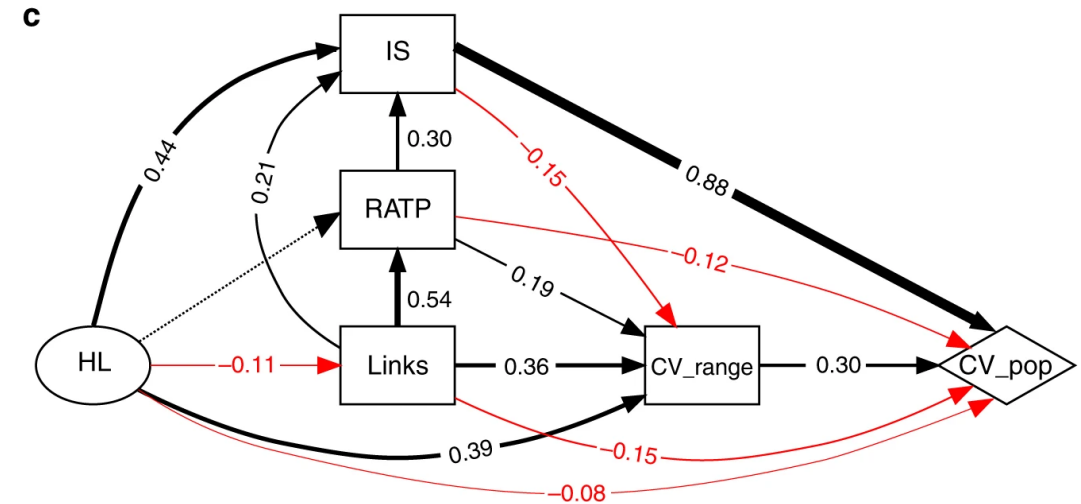
- Structural equation model (SEMs)
- Habitat loss
- Structure
- Dynamics
- stability



Routes to stability or instability



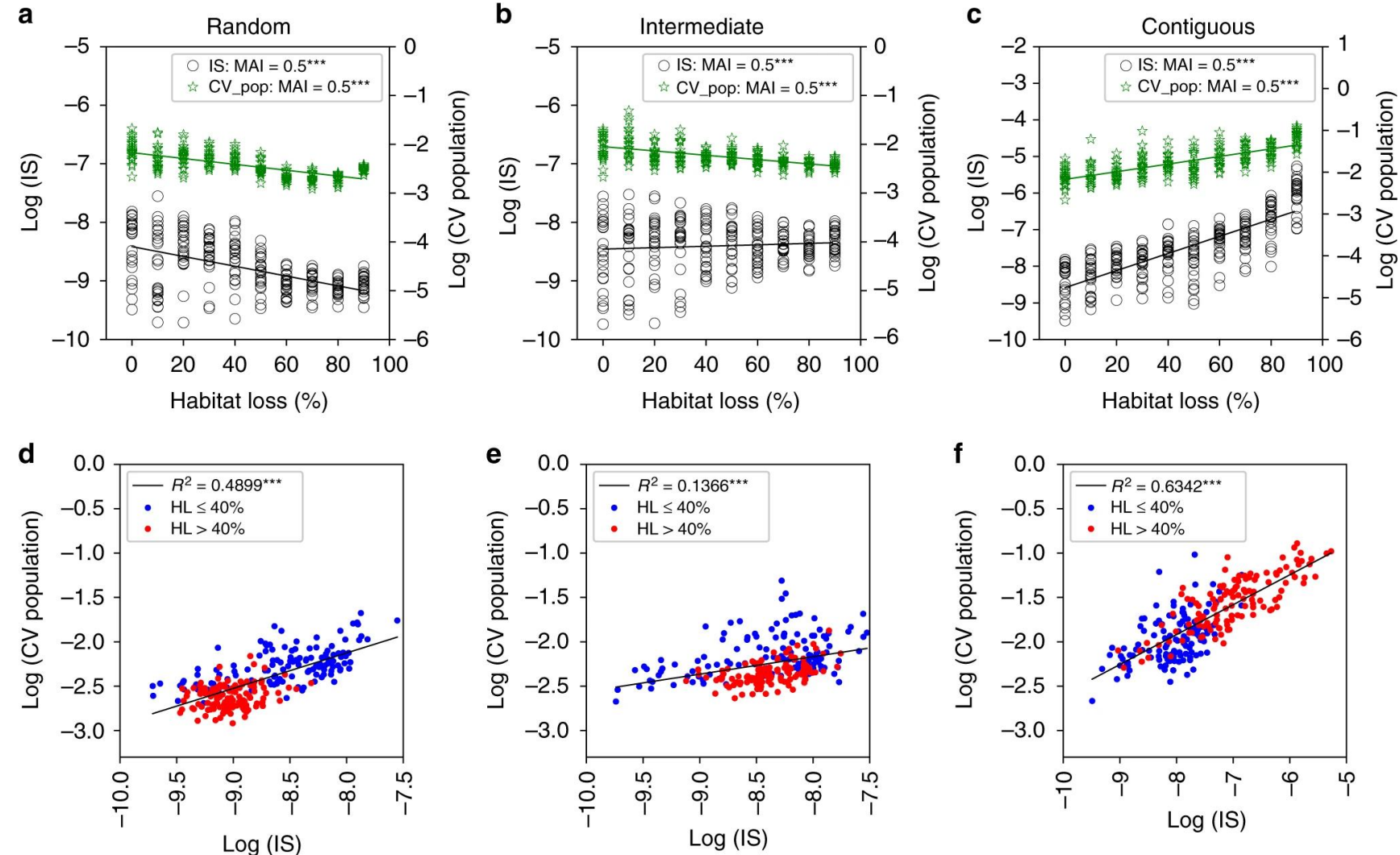
Random



Contiguous

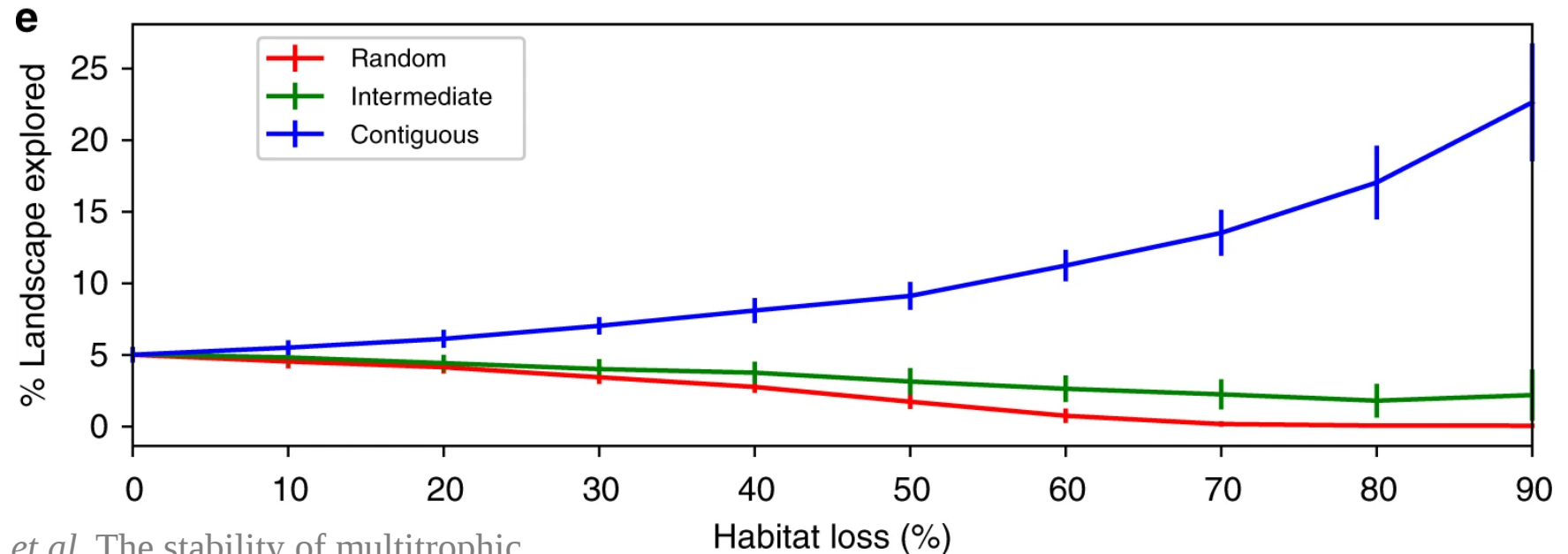
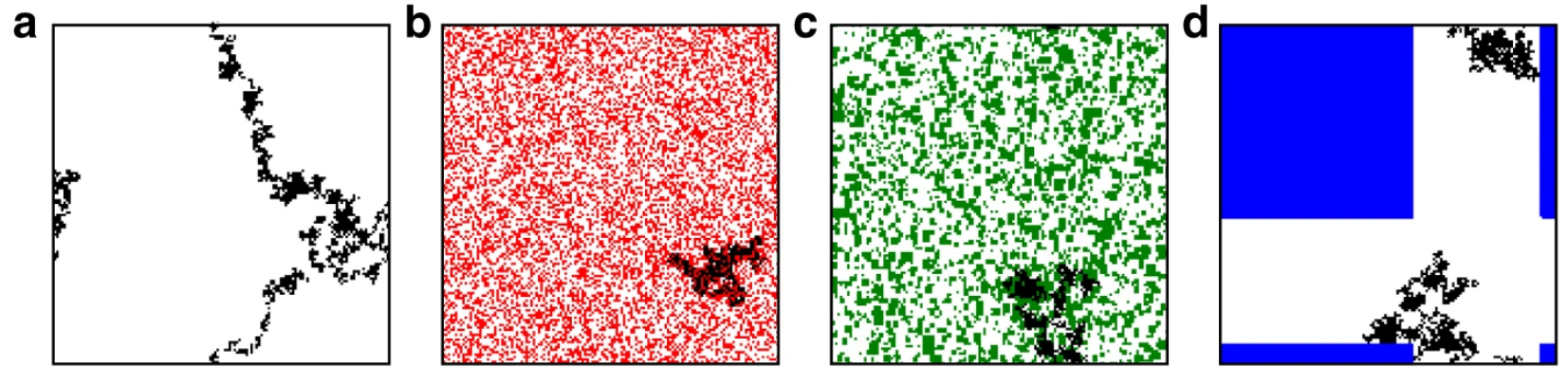
Interaction strength in contiguous loss

- In contiguous model:
- Habitat loss
- Interaction strength
- CV population



Mobility patterns under habitat loss

- Types of habitat loss:
- The mobility



Discussion

Contiguous loss

- the spatial-compression mechanism

Janzen, D. H. The deflowering of Central America. *La deforestación de Cent. Nat. Hist.* **83**, 48–53 (1974).

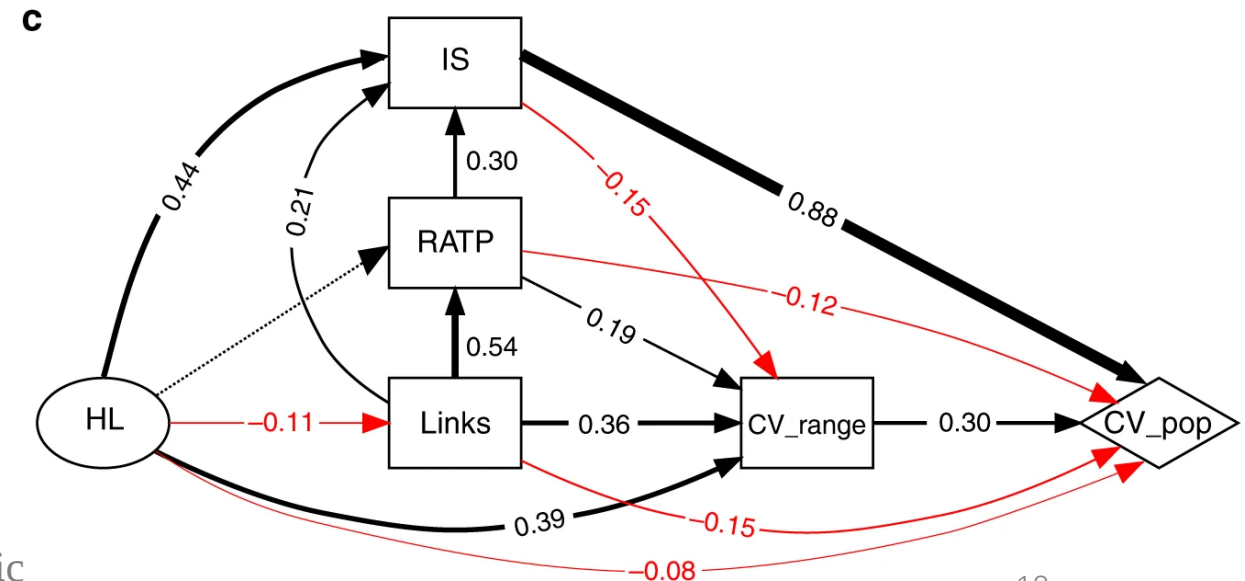
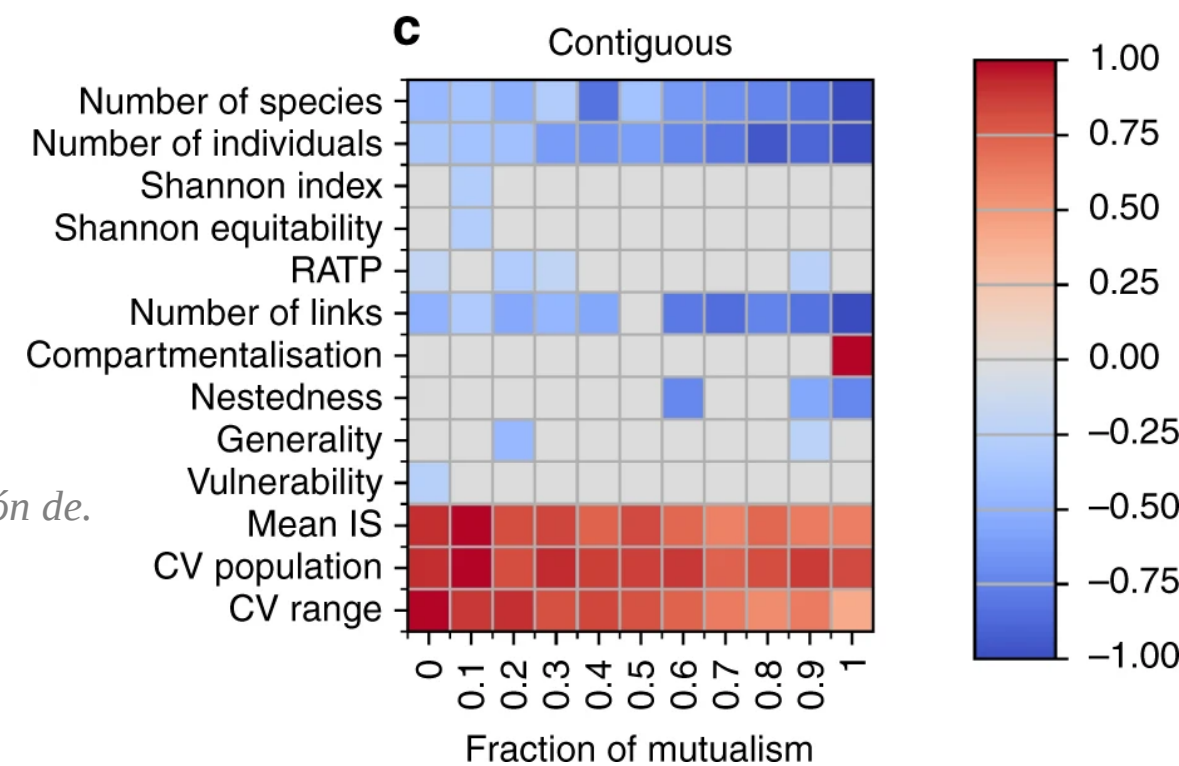
- area-stability relation

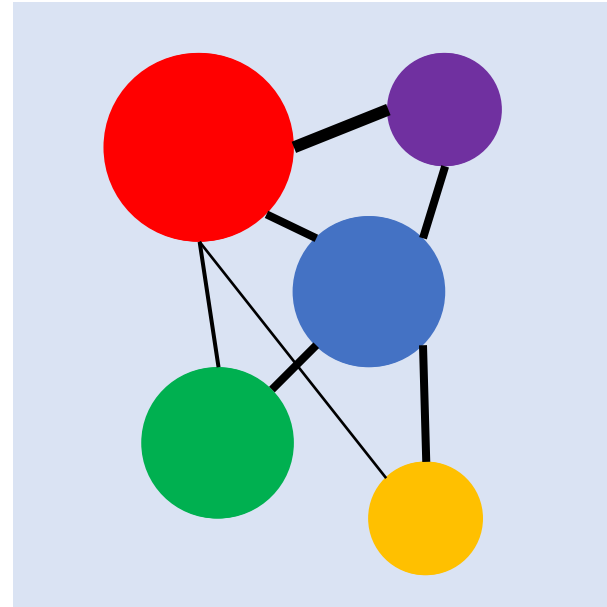
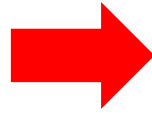
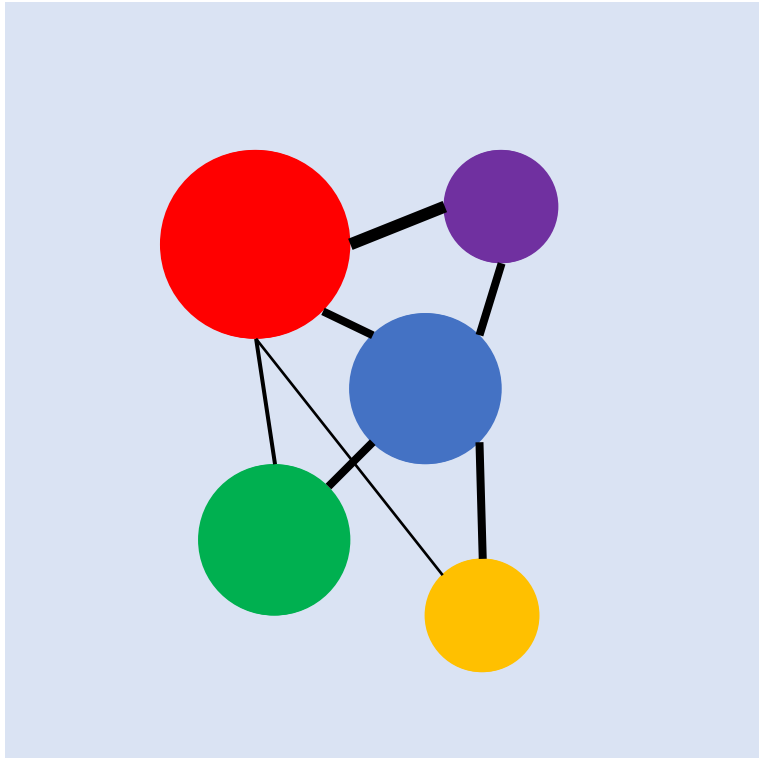
encounter probability

interaction strength

stability

- predation pressure



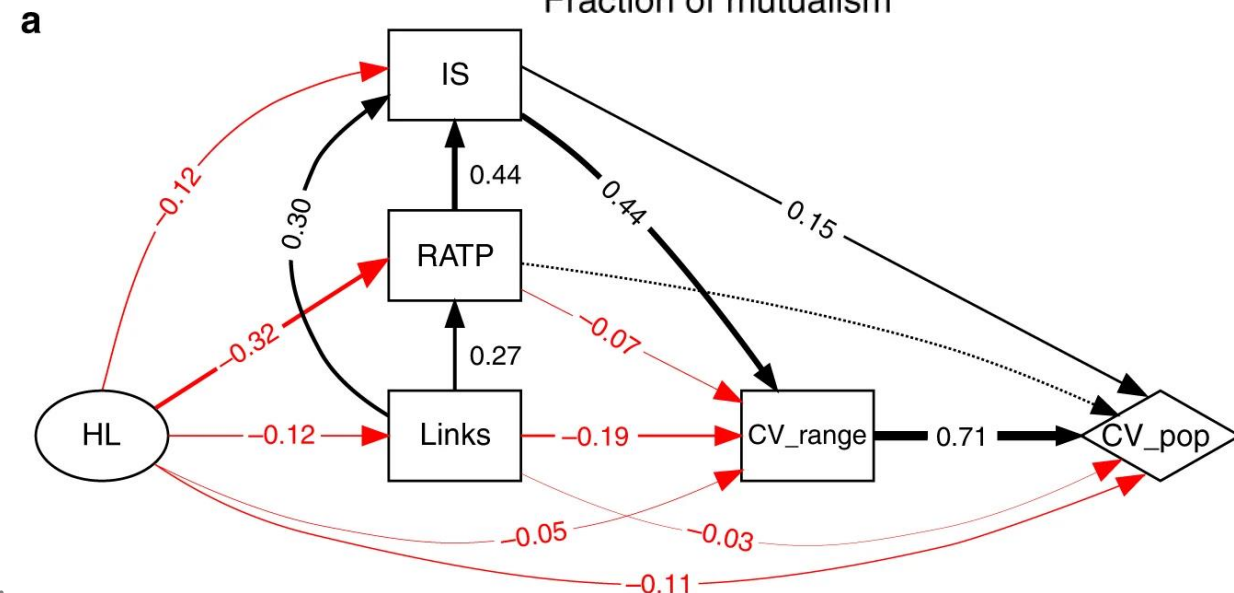
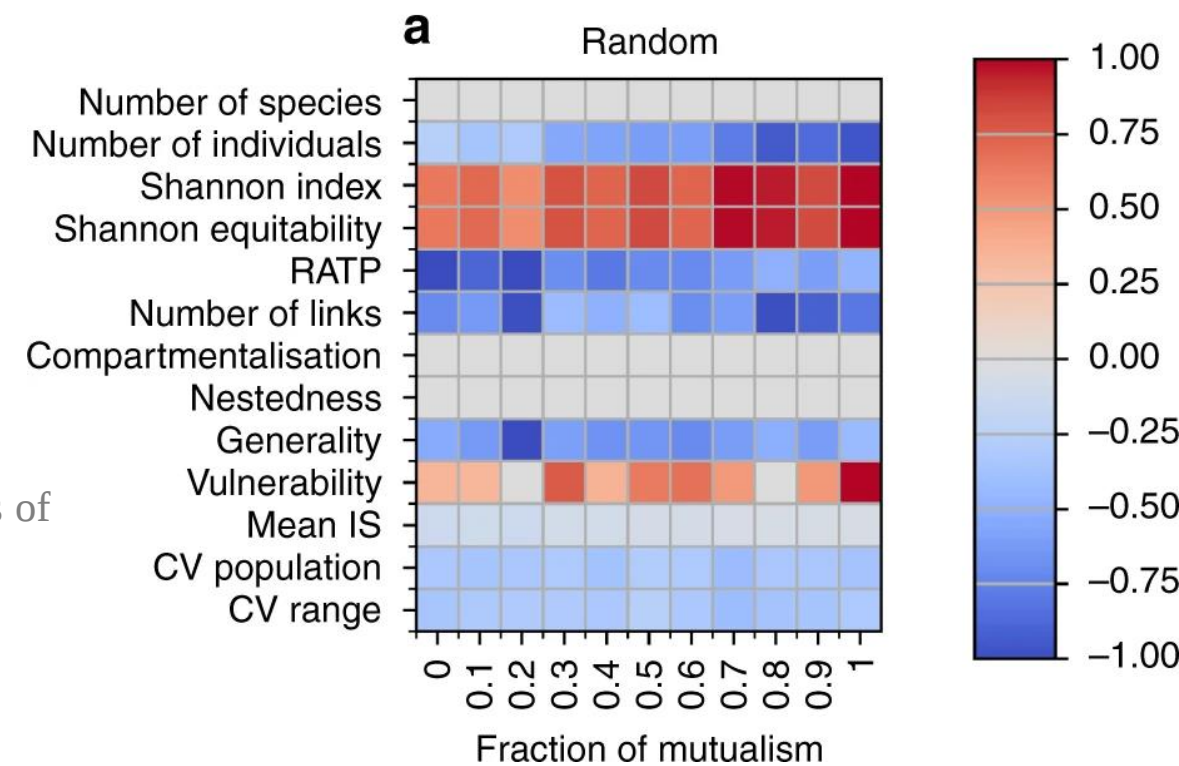


Random loss

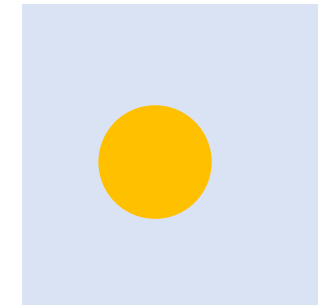
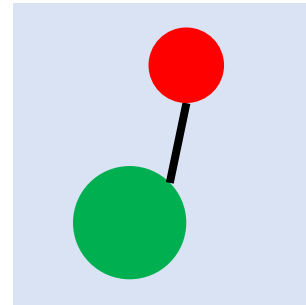
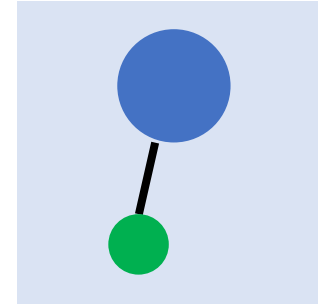
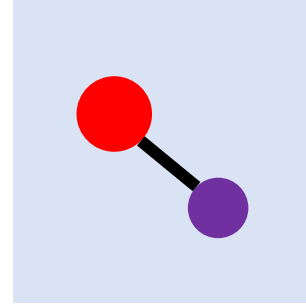
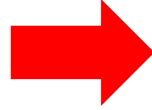
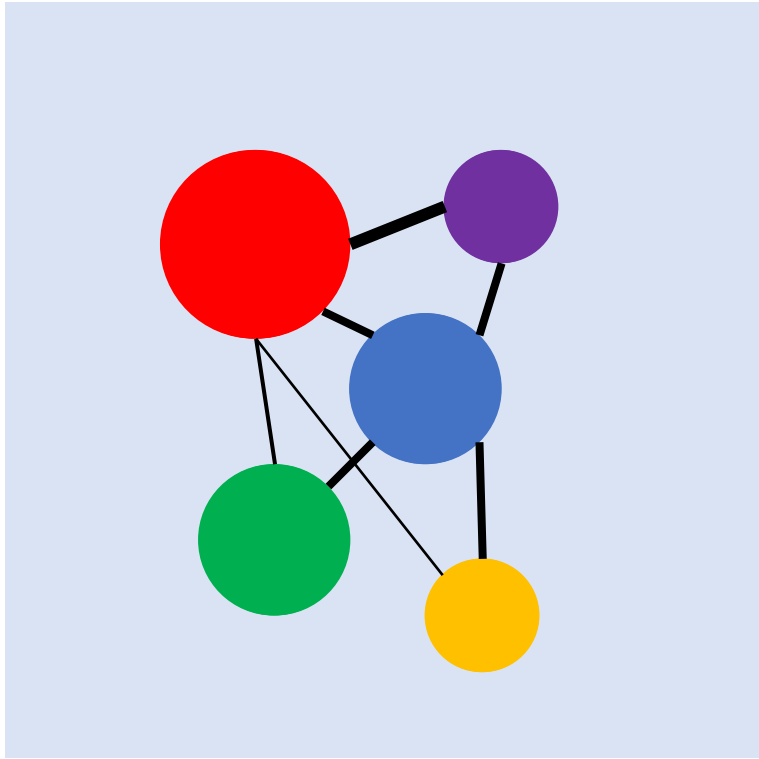
- the ‘empty forest’ hypothesis

McCann, K. S., Rasmussen, J. B. & Umbanhowar, J. The dynamics of spatially coupled food-webs. *Ecol. Lett.* **8**, 513–523 (2005)

- encounter probability
- vulnerable local community
- Decrease CV population
- High stability?

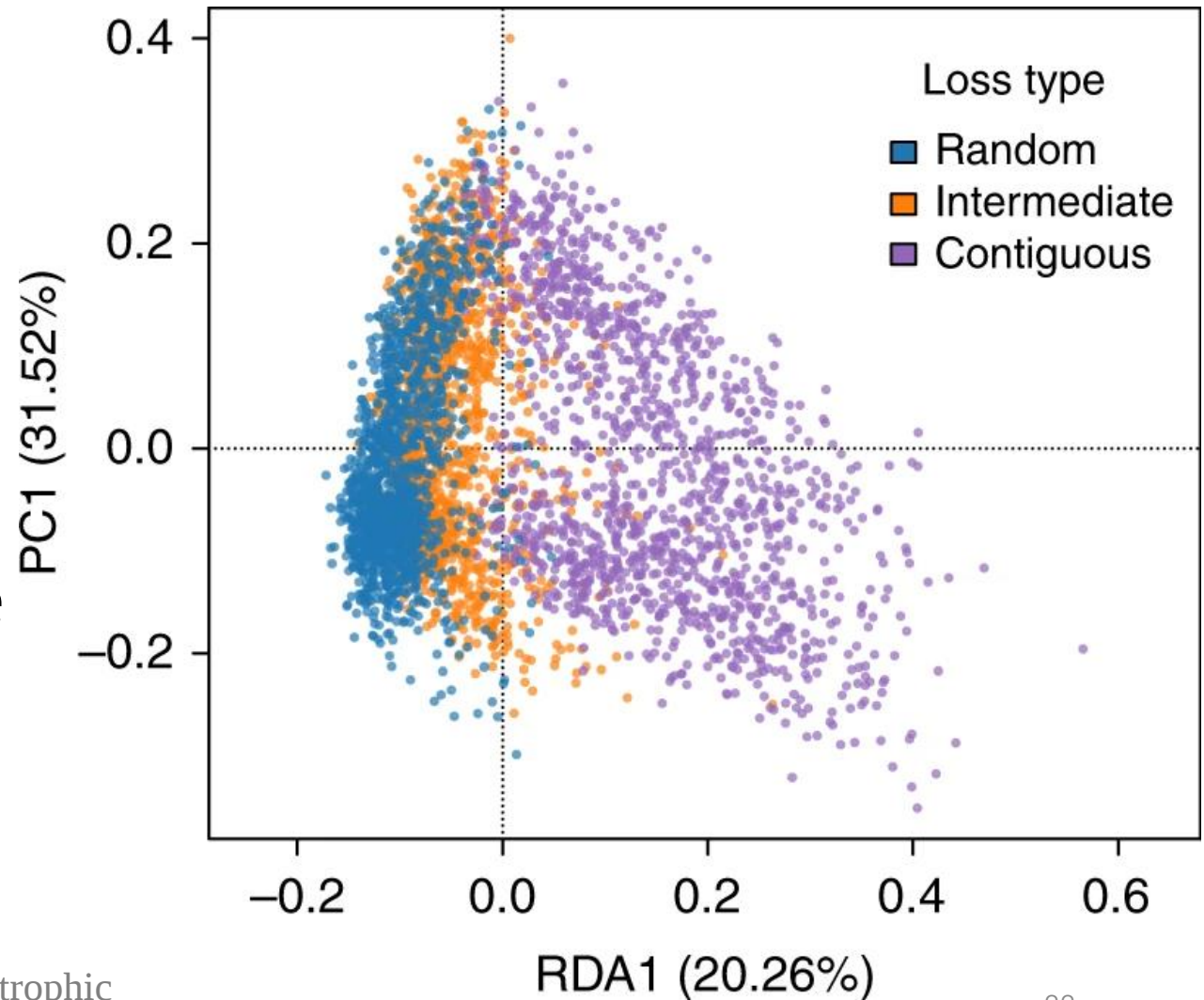


McWilliams, C., Lurgi, M., Montoya, J.M. *et al.* The stability of multitrophic communities under habitat loss. *Nat Commun* **10**, 2322 (2019).



On the Habitat Loss Scenarios

- Redundancy analysis (RDA)
- The RDA axis: constraint
Explanatory variables
- Community responses across the
three HL scenarios were gradual



Take home message

- The type of habitat loss changes the way to affect community dynamics
- Habitat loss alters community stability by affecting interaction strength and limiting species movement
- There is a gradual change from contiguous habitat loss to random loss

At the Edge of Chaos

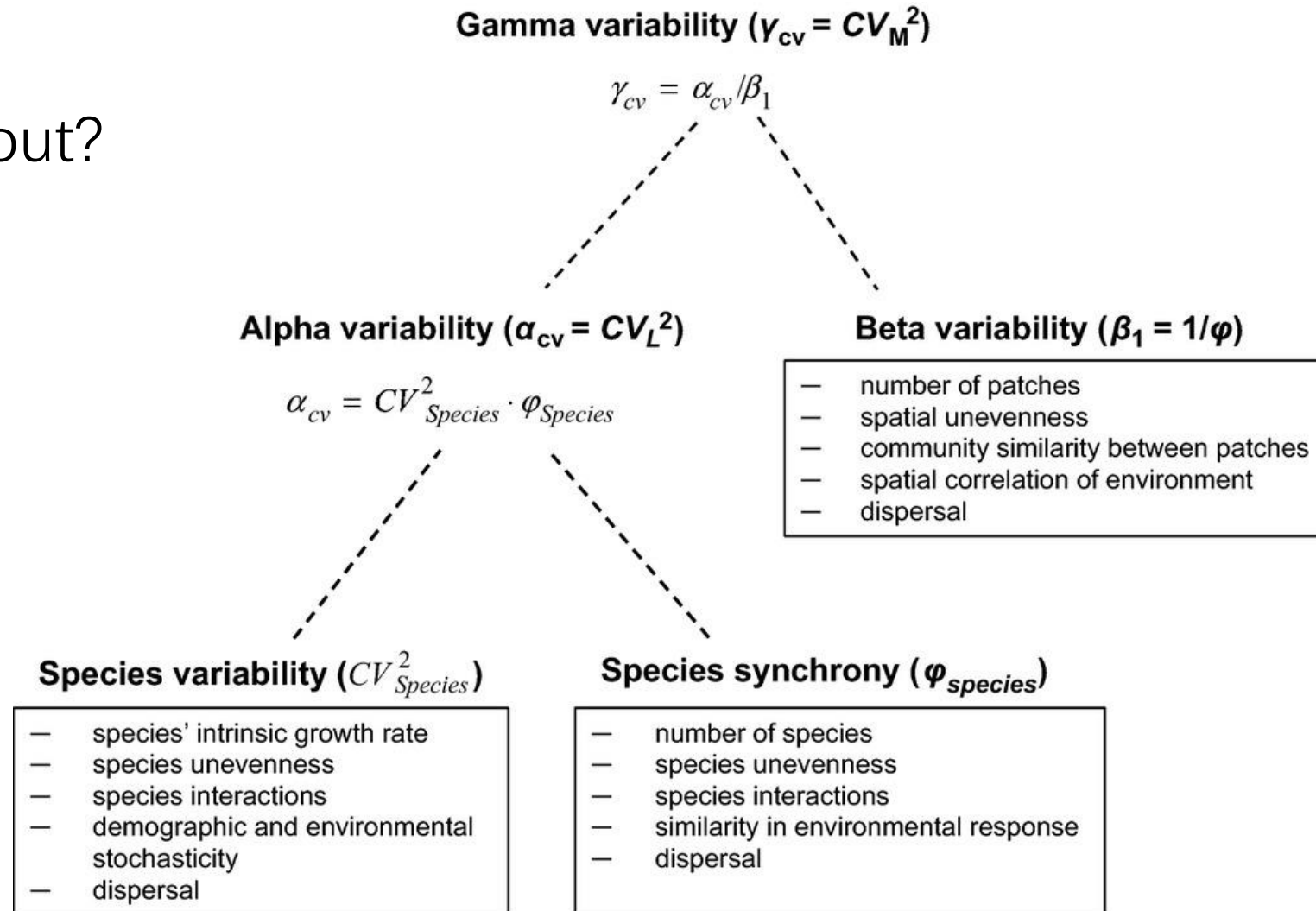
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Questions and Discussion

- The model
individual-based model (IBM) or ordinary differential equations (ODEs)
- Easy to understand?
- Continuous or discrete?
- Time and individual

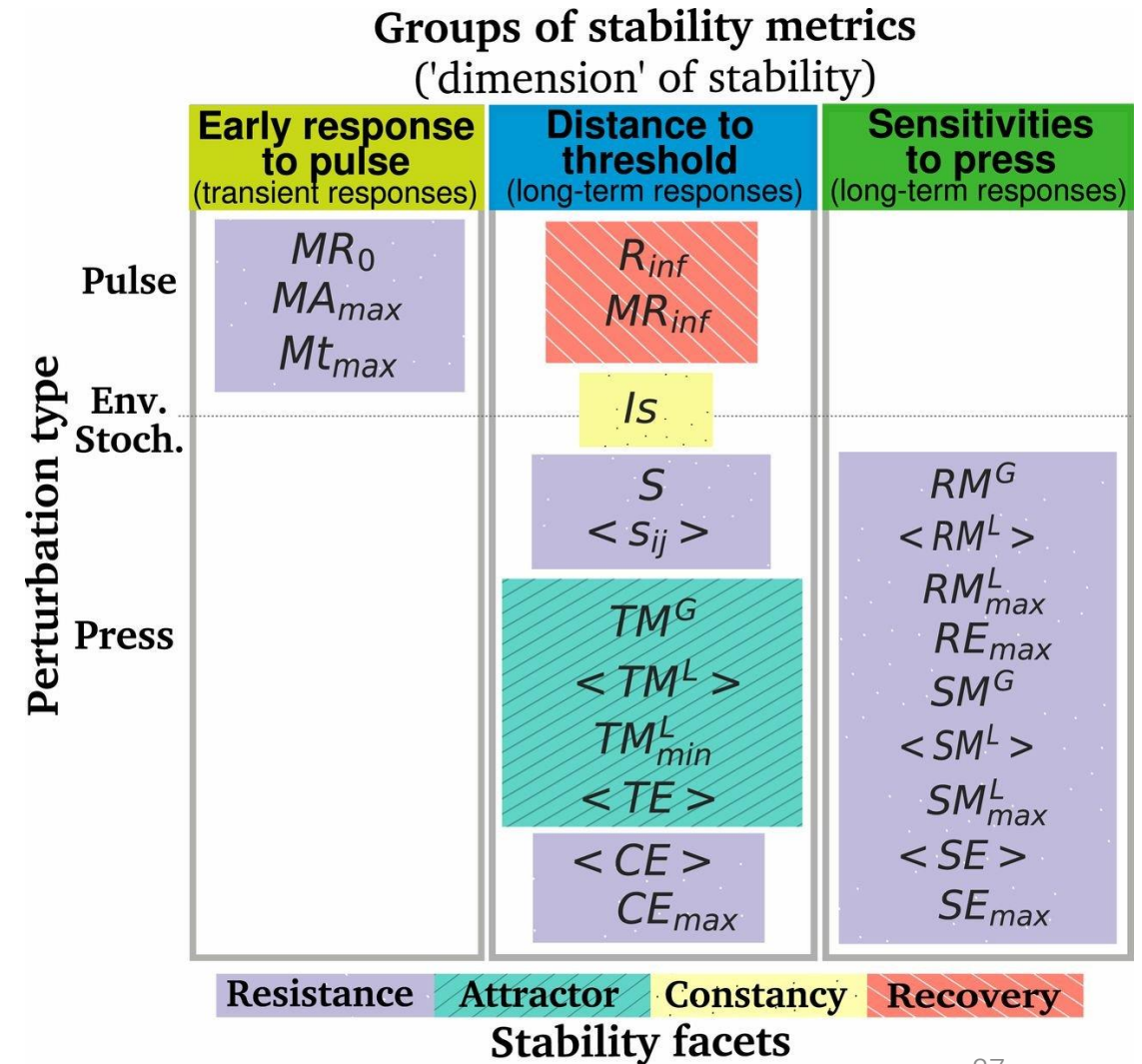
“Stability”

- What are we talking about?



Questions and Discussion

- Stability
- Which one?
- What do you want to focus on?
- What conclusion do you want to get?



Domínguez-García, V., V. Dakos, and S. Kéfi, Unveiling dimensions of stability in complex ecological networks. *Proceedings of the National Academy of Sciences*. **116**:25714–25720 (2019).

Questions and Discussion

- Agenda setting:
- Are we talking about the science in an unscientific way?

At the Edge of Chaos

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