

# The diversity – stability relationship: from theory to natural communities

Théophile Olivier

Elisa Thébault

Benoit Fontaine

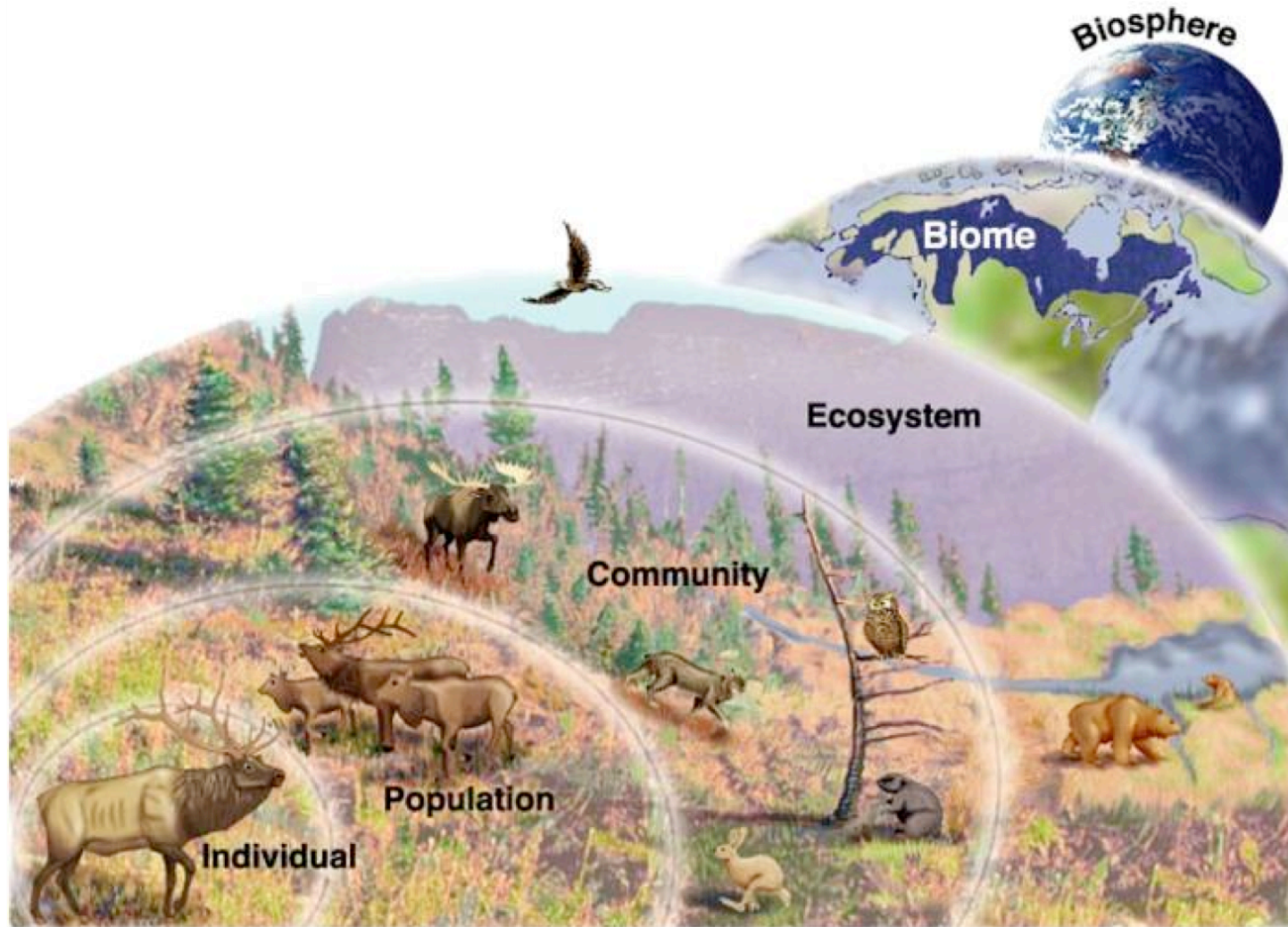
Marianne Elias

Colin Fontaine



# Several organisation levels in ecology

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# Population

---

- Individuals of a same species that interbreed and live a the same place at a same time.

# Population

---

- Individuals of a same species that interbreed and live a the same place at a same time.



*Aptenodytes forsteri*



# Population

---

- Individuals of a species that interbreed and live at the same place at the same time.



*Aptenodytes forsteri*



*Felis silvestris* « loly » *catus*

# Community

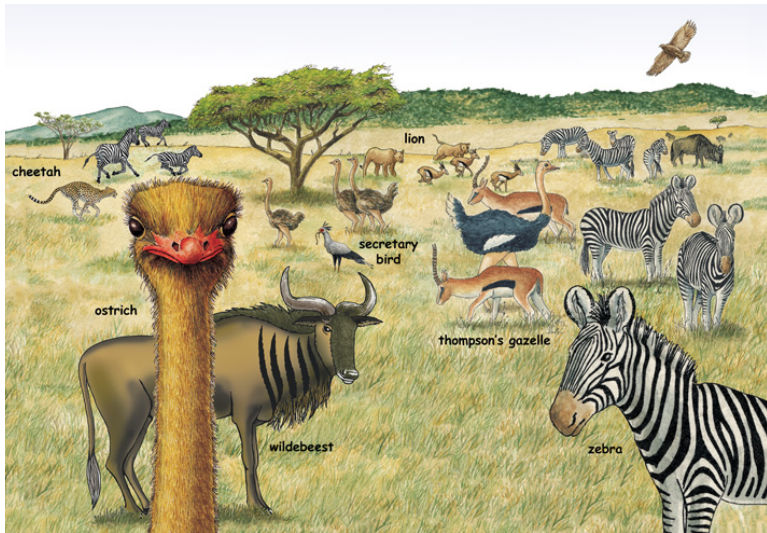
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- Populations of different species coexisting in a habitat over a particular time, with interactions affecting each other's abundance, distribution, adaptation and existence.

# Community

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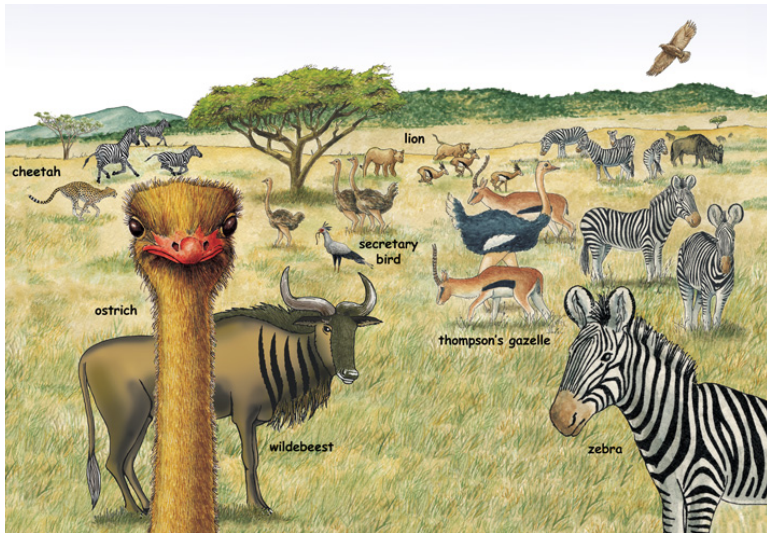
- Populations of different species coexisting in a habitat over a particular time, with interactions affecting each other's abundance, distribution, adaptation and existence.



# Community

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- Populations of different species coexisting in a habitat over a particular time, with interactions affecting each other's abundance, distribution, adaptation and existence.



# Diversity

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## → Species richness

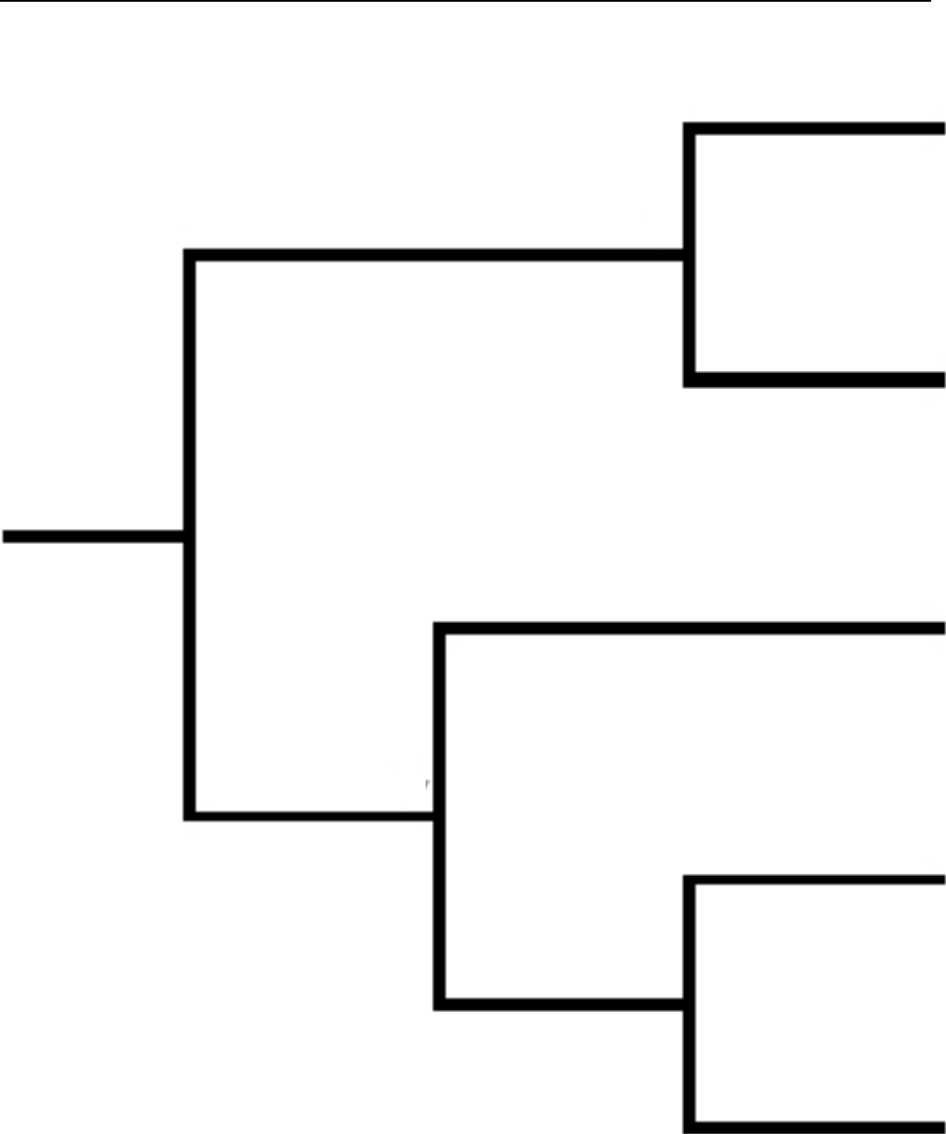
- Number of species in a community

## → Phylogenetic diversity

- Phylogenetic differences between species of a community due to the evolutionary history of species



# Phylogenetic diversity





# Stability

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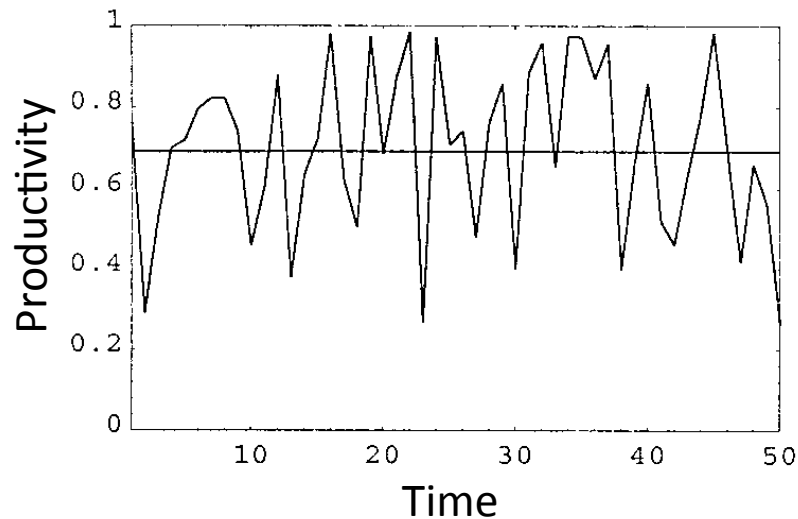
- Temporal invariability of a component
  - Abundance
  - Biomass

# Stability

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- Temporal invariability of a component
  - Abundance
  - Biomass

*Low stability*

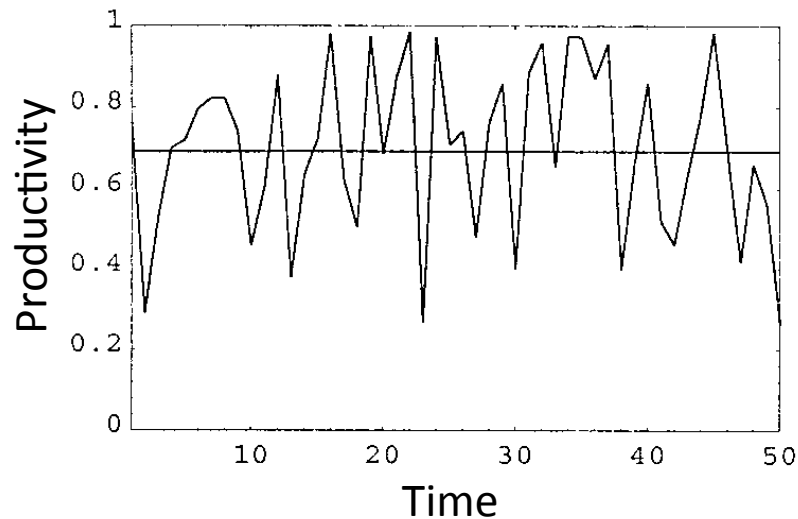


# Stability

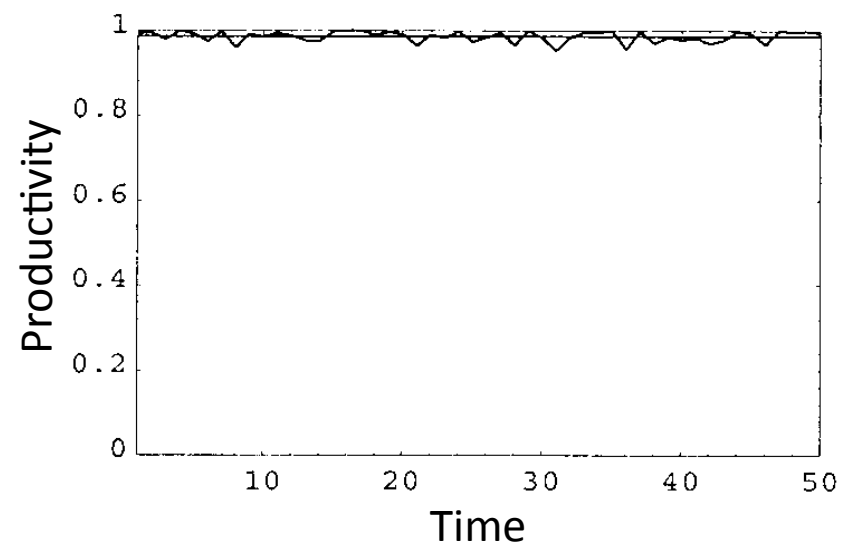
---

- Temporal invariability of a component
  - Abundance
  - Biomass

*Low stability*



*High stability*



# Relationship

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- Dependence between two variables (or two human beings), with a significance and an estimated strength

# Relationship

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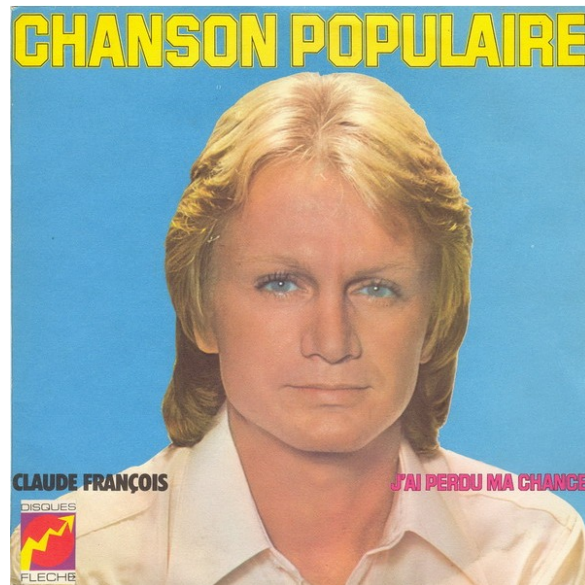
- Dependence between two variables (or two human beings), with a significance and an estimated strength



# Relationship

---

- Dependence between two variables (or two human beings), with a significance and an estimated strength



« Ça s'en va et ça revient, c'est fait d'un tout petit rien »

*Claude François, 1973*



# The diversity – stability relationship: from theory to natural communities

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# The diversity – stability relationship in natural communities of butterflies, birds and bats

Théophile Olivier

Elisa Thébault

Benoit Fontaine

Marianne Elias

Colin Fontaine



# Diversity – stability relationship

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Fluctuations of Animal Populations and a Measure of Community Stability

Author(s): Robert MacArthur

Source: *Ecology*, Vol. 36, No. 3 (Jul., 1955), pp. 533–536

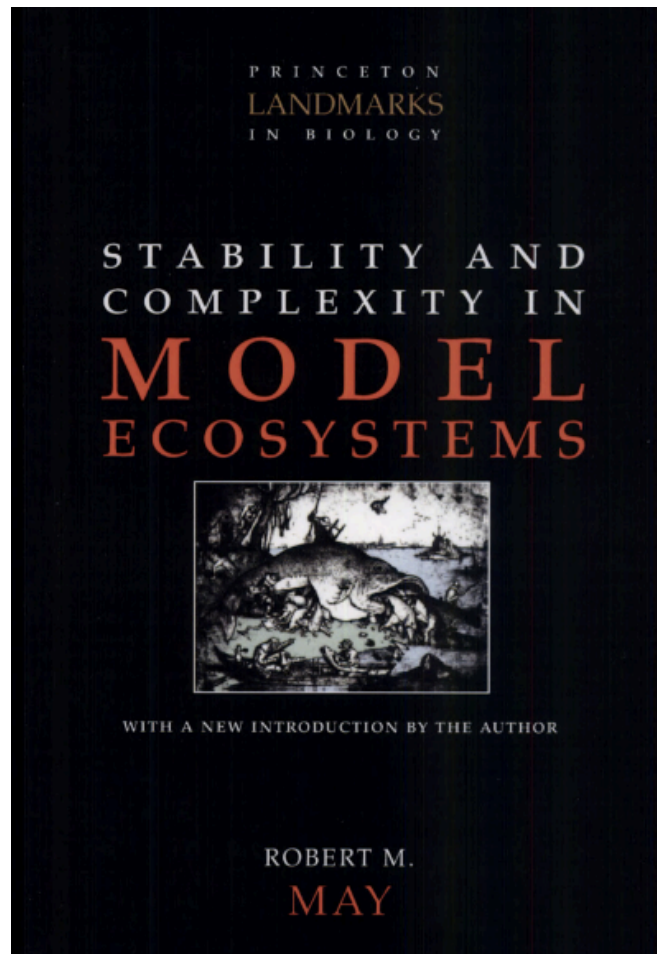
# Diversity – stability relationship

---

Fluctuations of Animal Populations and a Measure of Community Stability

Author(s): Robert MacArthur

Source: *Ecology*, Vol. 36, No. 3 (Jul., 1955), pp. 533–536



# Diversity – stability relationship

Fluctuation Measure of Community Stability  
 Author(s): Emily Grman,<sup>1,2\*</sup> Jennifer A. Lau,<sup>1,2</sup> Donald R. Schoolmaster, Jr.,<sup>2</sup> and Katherine L. Gross<sup>1,2</sup>  
 Source: Ecology Letters, (2010) 13: 1400–1410  
 doi: 10.1111/j.1461-0248.2010.01533.x

**LETTER**  
**ECOLOGY LETTERS**  
 Biodiversity and ecosystem stability: A Comment on  
 Mechanisms contributing to stability in ecosystem  
 function depend on the environmental context  
 Diversity and Stability  
 Ecology  
 Author(s): S. J. McNaughton  
 Source: *The American Naturalist*, Vol. 111, no. 1/9 (May - Jun., 1978), pp. 515-525

**Biodiversity and the productivity and stability of ecosystems**  
 1999  
 Kris H. Johnson, Kristiina A. Vogt, Heidi J. Clark, Oswald J. Schmitz and Daniel J. Vogt  
 TREE vol. 11, no. 9 September 1996  
 Stability and Diversity  
 pp. 515-525

**Biodiversity and stability in grasslands**  
 David Tilman & John A. Downing  
 NATURE · VOL 367 · 27 JANUARY 1994

**Functional Ecology**  
 British Ecological Society  
 Functional Ecology 2015, 29, 615–626  
 doi: 10.1111/1365-2435.12432

Species richness, but not phylogenetic diversity, influences community biomass production and temporal stability in a re-examination of 16 grassland biodiversity studies  
 Patrick Venall<sup>1,1,2</sup>, Kevin Gross<sup>3</sup>, Todd H. Oakley<sup>4</sup>, Anita Narwani<sup>1,5</sup>, Eric Allan<sup>6</sup>, Pedro Flombaum<sup>7</sup>, Forest Isbell<sup>8</sup>, Jasmin Joshi<sup>9,10</sup>, Peter B. Reich<sup>11,12</sup>, David Tilman<sup>13,14</sup>, Jasper van Ruijven<sup>15</sup> and Bradley J. Cardinale<sup>1</sup>

**ECOLOGY LETTERS**  
 Ecology Letters, (2013) 16: 106–115  
 doi: 10.1111/ele.12073

**Biodiversity and ecosystem stability: a synthesis of underlying mechanisms**  
 Michel Loreau<sup>1\*</sup> and Claire de Mazancourt  
 Ecology (Sep., 10)

**IDEA AND PERSP**  
 Understanding diversity–stability relationships: towards a synthesis of portfolio effects  
 Multiple diversity–stability mechanisms enhance population and community stability in aquatic food webs  
 Loïc Ferrière<sup>1,2</sup>, Amy L. Downing,<sup>1,4</sup> Bryan L. Brown,<sup>2</sup> and Mathew A. Leibold<sup>3</sup>  
 Ecology, 95(1), 2014, pp. 173–184  
 © 2014 by the Ecological Society of America

# Diversity – stability relationship

An Empirical Evaluation of the Insurance Hypothesis in Diversity-Stability Models

Author(s): Thomas J. Valone and Nicholas A. Barber

Source: *Ecology*, Vol. 89, No. 2 (Feb., 2008), pp. 522–531

LETTERS Ecology Letters, (2007) 10: 970–976

*Ecology Letters*, (2007) 10: 970–976

doi: 10.1111/j.1461-0248.2007.01092.x

Diversity and stability of

On the stability of populations of mammals, birds, fish and insects

LOIC M. THIBAUT,<sup>1,3</sup> SEAN R. HAYNE

*Ecology*, 93(4), 2012, pp. 891–901  
© 2012 by the Ecological Society of America

Author(s): S. J. McNamara, Richard M. Sibly,<sup>1,2\*</sup> Daniel Barker<sup>3</sup>, Jim Hone<sup>4</sup> and Mark Pagel<sup>1</sup>

Phylogenetic diversity predicts

community stability

TREE vol. 11  
pp. 515–520  
Author(s): R. Bagchi, J. J. C. Caldeira, P. G. D. Palmiotto, J. S. Pereira and M. Loreau

MARC W. CADOTTE,<sup>1,2,4</sup> RUSSELL D. HAYES

*Ecology*, 93(8) Supplement, 2012, pp. S223–S233  
© 2012 by the Ecological Society of America

Biodiversity and ecosystem stability in a decade-long grassland experiment

Stability and ecosystem functioning: a synthesis of mechanisms

David Tilman<sup>1</sup>, Peter B. Reich<sup>2</sup> & Johannes M. H. Knops<sup>3</sup>

NATURE | Vol 441 | 1 June 2006

stabilizing on diversity and overyielding  
A. Hector, Y. Xiao, E. Bazely-Weil, L. A. Jumppon, J. C. Terry, A. J. Van & JOHN A. DOWNING  
VOL 367 - 27 JANUARY 1994

*Ecology Letters*, (2005) 8: 819–828

doi: 10.1111/j.1461-0248.2005.00785.x

IDEA AND PERSP

Understanding diversity–stability relationships: a synthesis of portfolio effects

Species Richness–Variability Relationship  
Author(s): Richard J. Vogt, Tamara L. Brown,<sup>2</sup> and Peter J. Morin  
Source: *Oikos*, Vol. 113, No. 1 (Apr., 2012), pp. 1–10

Temporal stability of aquatic food webs: partitioning the effects of species diversity, species composition and enrichment

Christopher F. Steiner,<sup>\*</sup> Zachary T. Long, Jennifer A. Krumins and Peter J. Morin

Patrick Venail<sup>1,2,3</sup>, Kevin Gross<sup>4</sup>, Todd H. Oakley<sup>5</sup>, Anita Narwani<sup>6</sup>, Eric Allan<sup>6</sup>, Pedro Flombaum<sup>7</sup>, Forest Isbell<sup>8</sup>, Jasmin Joshi<sup>9,10</sup>, Peter B. Reich<sup>11,12</sup>, David Tilman<sup>13,14</sup>, Jasper van Ruijven<sup>15</sup> and Bradley J. Cardinale<sup>1</sup>





# Diversity – stability relationship

An Empirical Evaluation of the Insurance Hypothesis in Diversity-Stability Models

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No. 2 (Feb., 2008), pp. 522-531

Species richness, temporal variability and resistance of biomass production in a Mediterranean grassland

5, (2007) 10: 970-976

doi: 10.1111

M. OIKOS 110: 115-123, 2005 and J. S. Pereira

On the stability of

LOIC M. THIBAUT,<sup>1,3</sup> SEAN R.

fish and insects: A mechanistic examination of diversity-stability relationships in annual plant communities

OIKOS 103: 519-527, 2003

Flu

Ecology, 93(4), 2012, pp. 891-901

© 2012 by the Ecological Society of America

Author(s): S. J. McN Richard M. Sibly,<sup>1,2\*</sup> D.

The diversity-stability debate

Kevin Shear McCann

Ecology, 93(4), 2012, pp. S223-S233

NATURE | VOL 405 | 11 MAY 2000 | www.nature.com

Productivity and ecosystem stability: a synthesis

mechanisms

Michel Loreau<sup>1\*</sup> and Claire de

Mazancourt

Biodiversity, Stability, and Productivity

Author(s): Clarence L. Lehman and Da

Source: *The American Naturalist*, Vol.

IDEA AND PERSP

Multiple diversity-stability relationships: understanding diversity-stability relationships and the role of portfolio effects

Species Richness-Variability Relationship

Author(s): Richa

Source: *Oikos*, V

Diversity-Stability Relationships: Statistical Inevitability or Ecological Consequence?

Author(s): David Tilman, Clarence L. Lehman, and Charles E. Bristow

Source: *The American Naturalist*, Vol. 151, No. 3 (March 1998), pp. 277-282

Temporal stability of aquatic food webs: partitioning the effects of species composition and enrichment

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Diversity and ecosystem stability in a decade-long grassland experiment

David Tilman<sup>1</sup>, Peter B. Reich<sup>2</sup> & Johannes M. H. Knops<sup>3</sup>

Productivity and sustainability influenced by biodiversity in grassland ecosystems

David Tilman<sup>\*</sup>, David Wedin<sup>†</sup> & Johannes Knops<sup>\*</sup>

Productivity and sustainability influenced by biodiversity in grassland ecosystems  
VOL 367 - 27 JANUARY 1994

doi: 10.1111/j.1461-0248.2005.00785.x



1/1365-2435.12432

NATURE • VOL 379 • 22 FEBRUARY 1996

Species composition and enrichment

grassland

# Diversity – stability relationship

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TERRESTRIAL SPECIES  
DECLINED BY 39 PER  
CENT BETWEEN 1970  
AND 2010

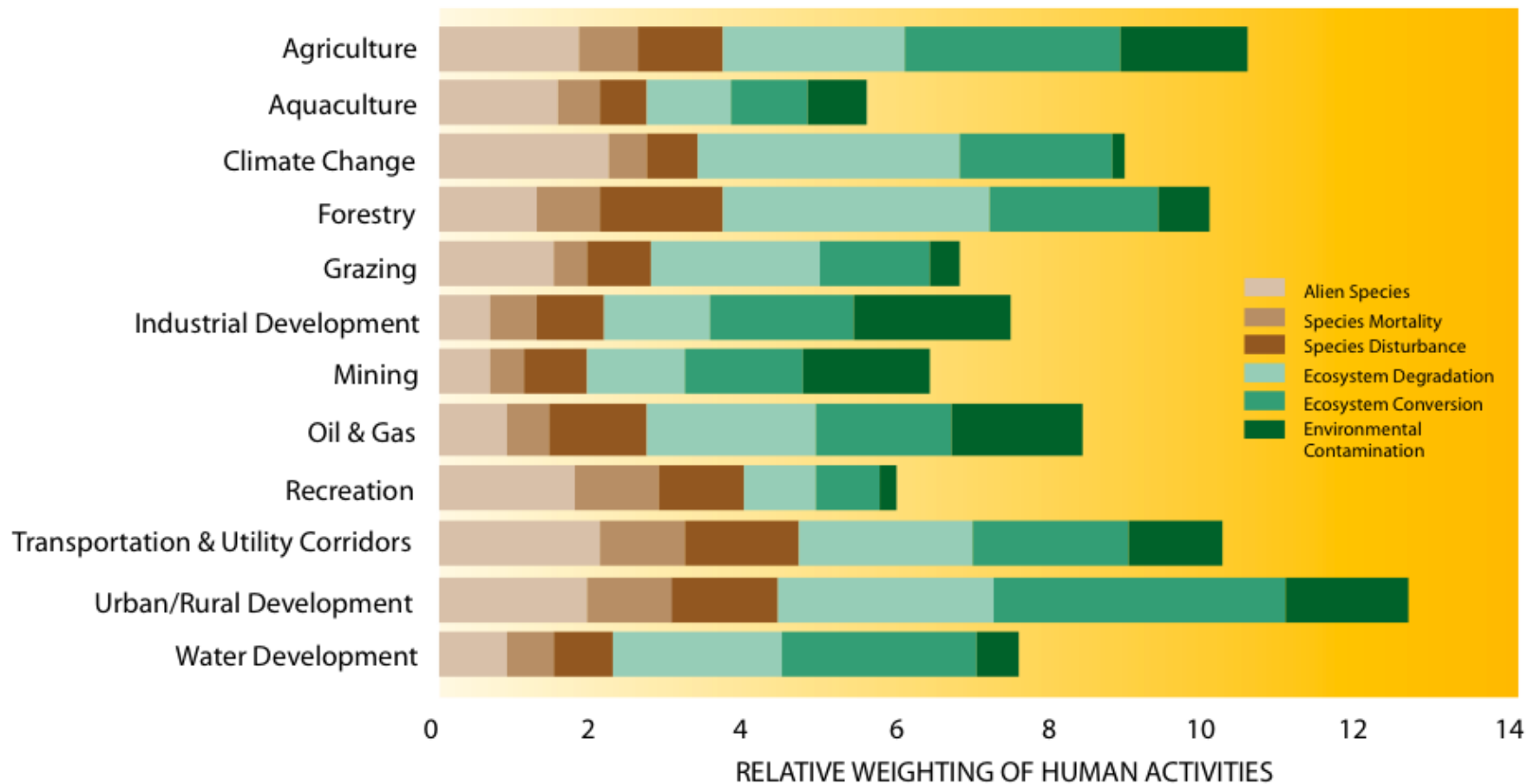


THE LPI FRESHWATER  
SPECIES SHOWS AN  
AVERAGE DECLINE OF  
76 PER CENT

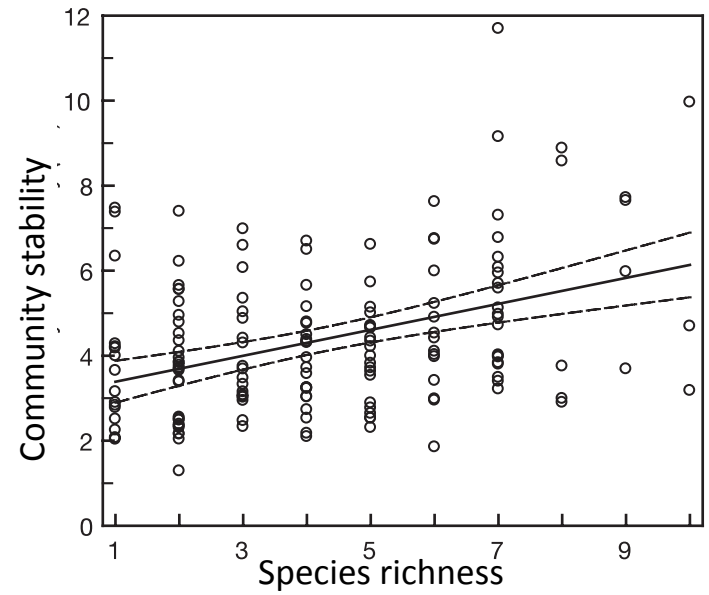


MARINE SPECIES  
DECLINED 39 PER CENT  
BETWEEN 1970 AND  
2010

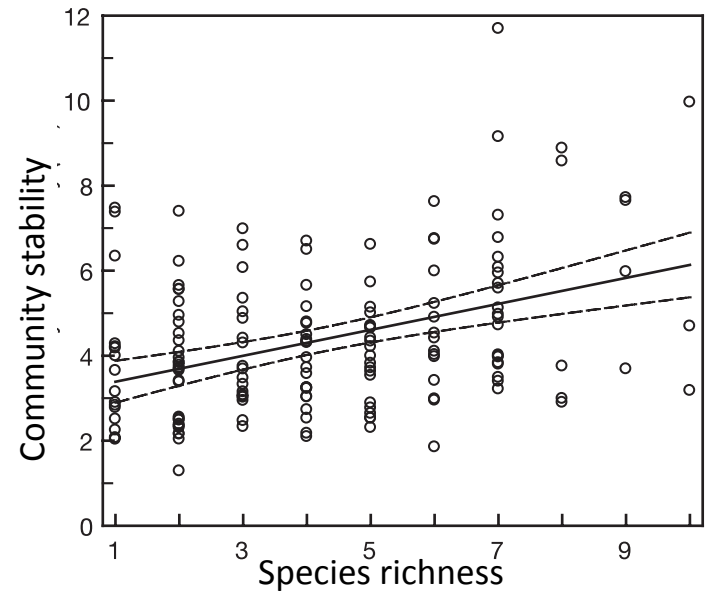
# Diversity – stability relationship



# Experimental studies

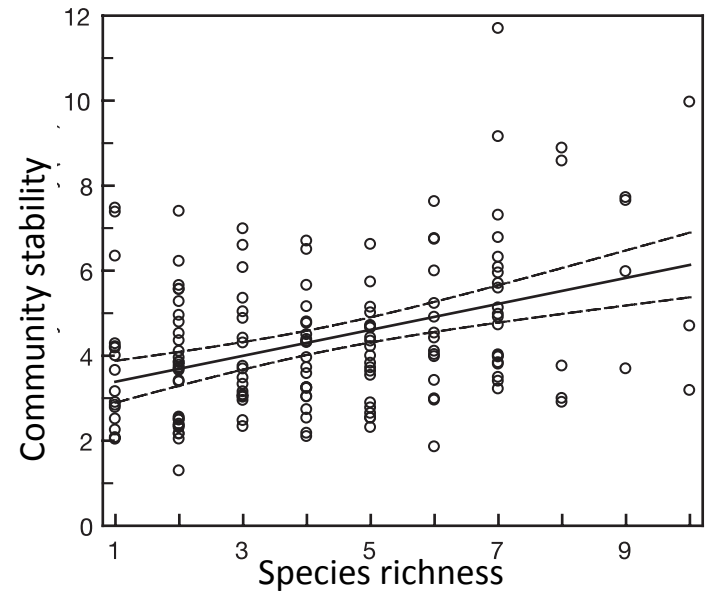


# Experimental studies



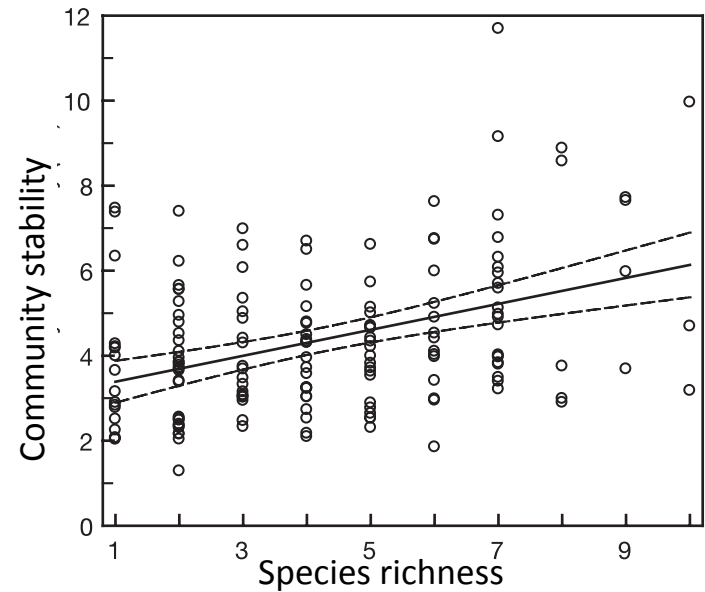


# Experimental studies





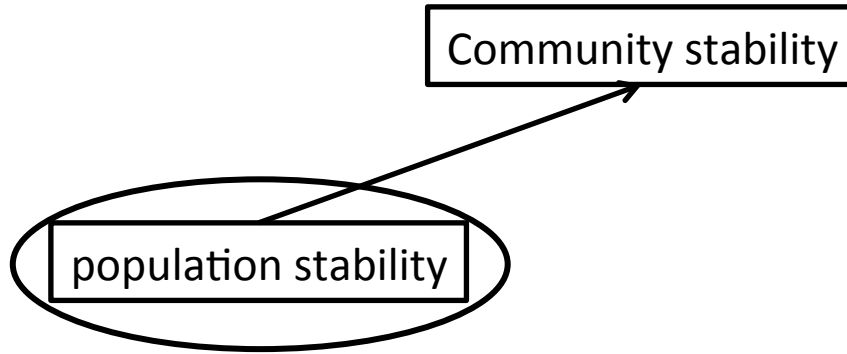
# Experimental studies



Which mechanisms ?

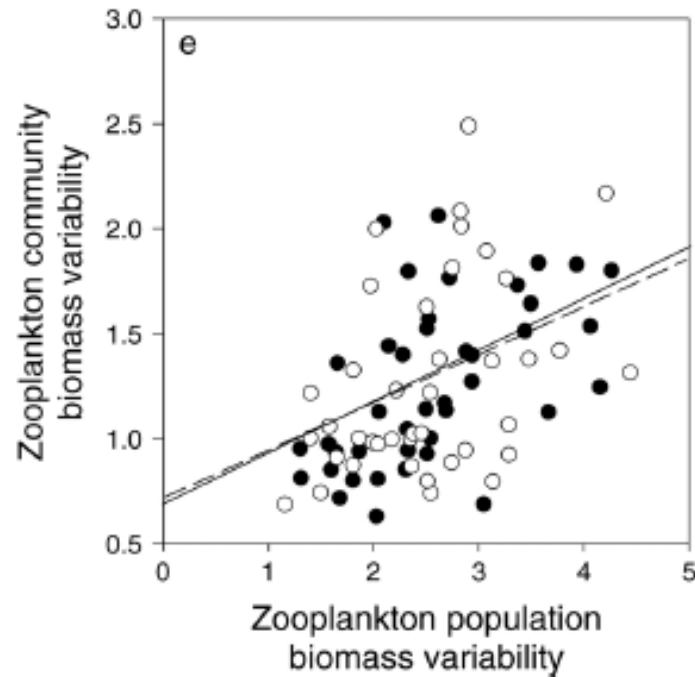
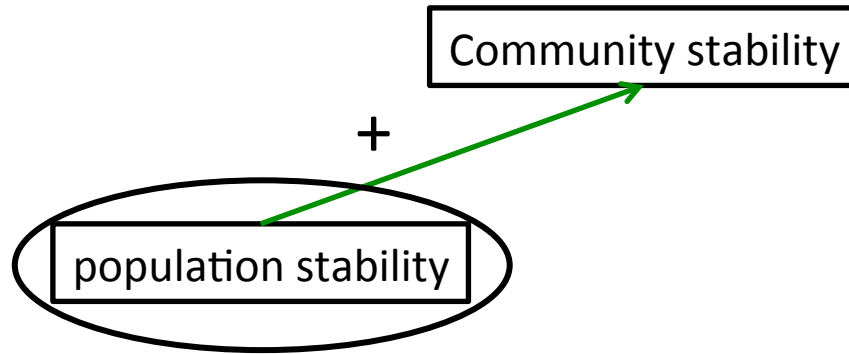
# Population stability

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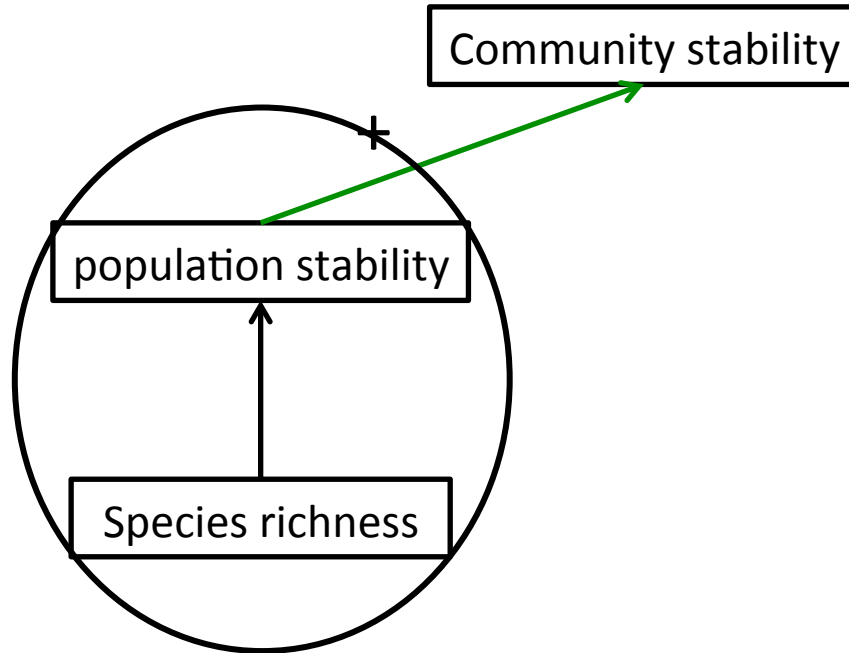
# Population stability

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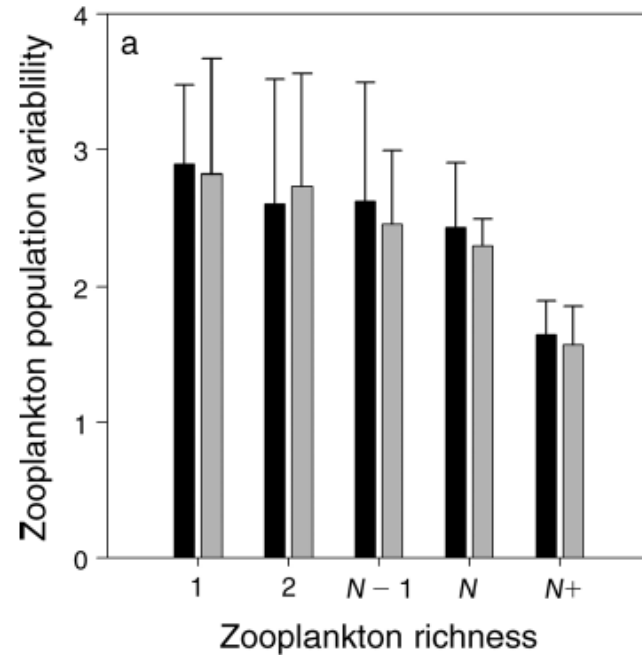
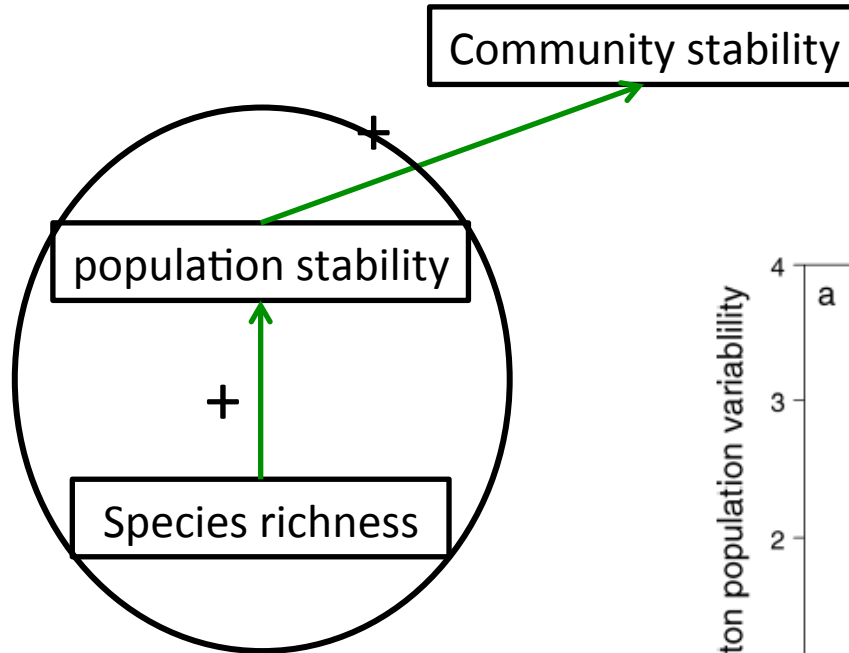


# Population stability

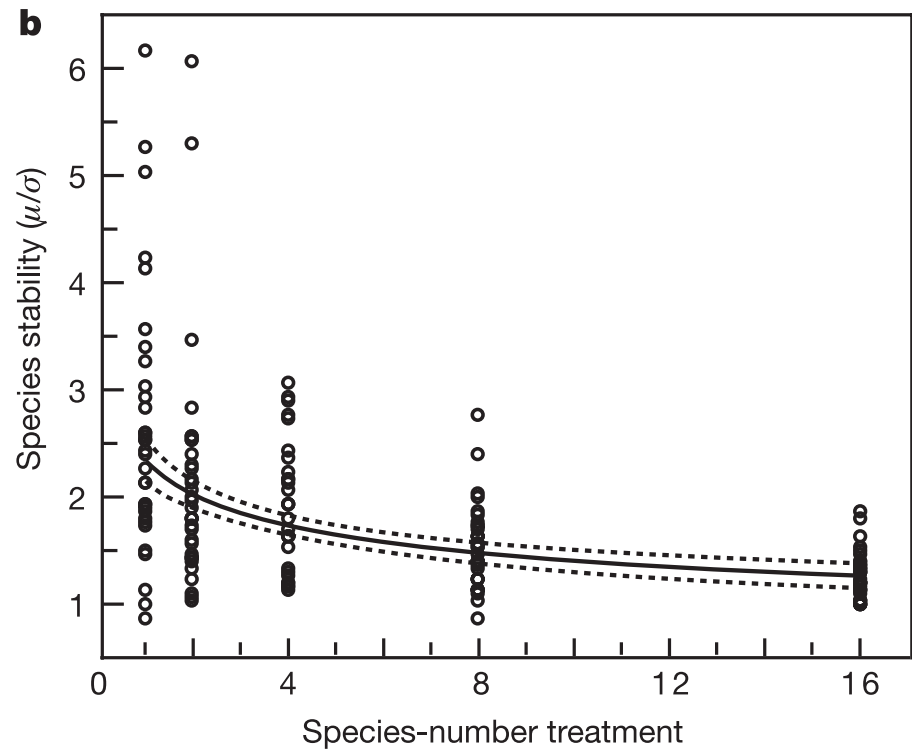
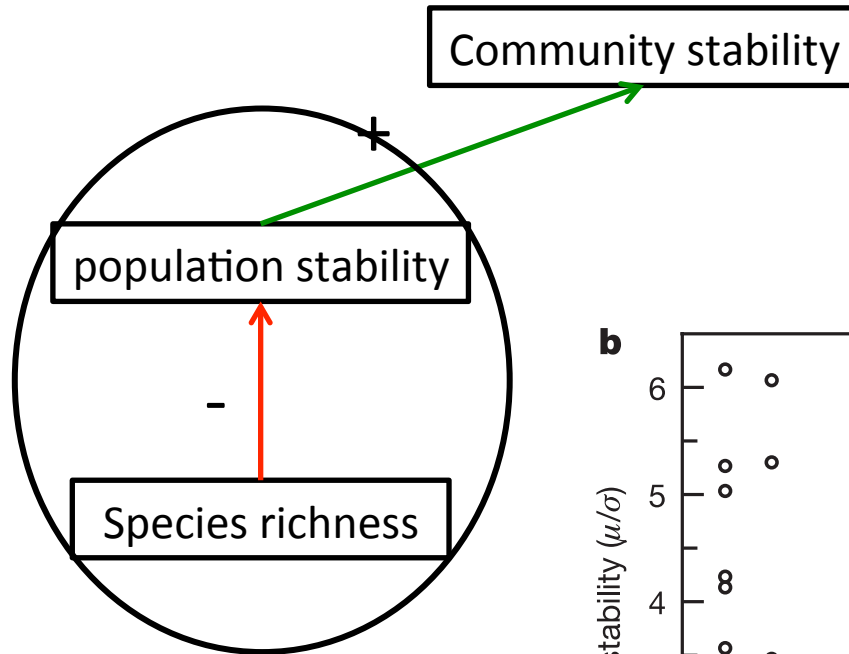
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# Population stability

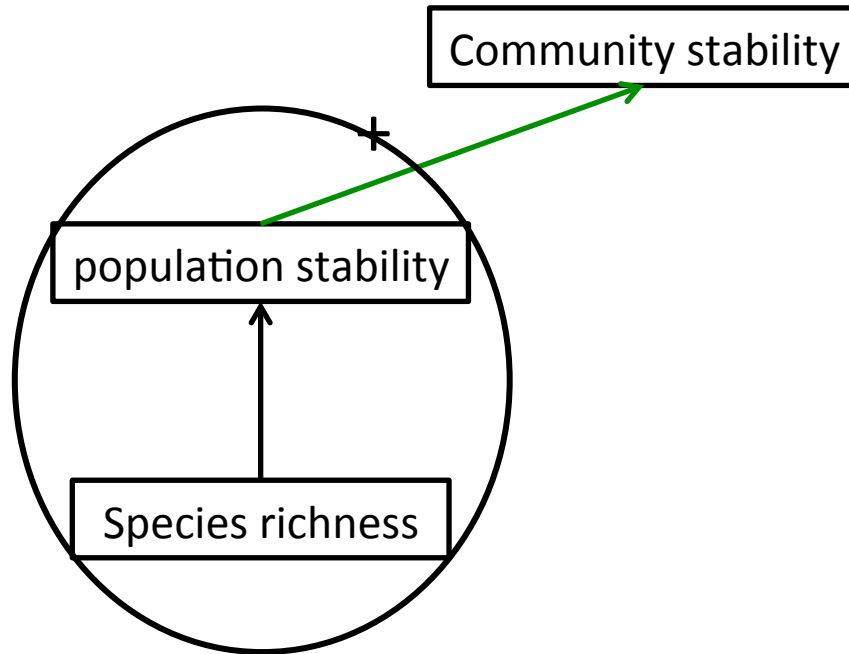


# Population stability



# Population stability

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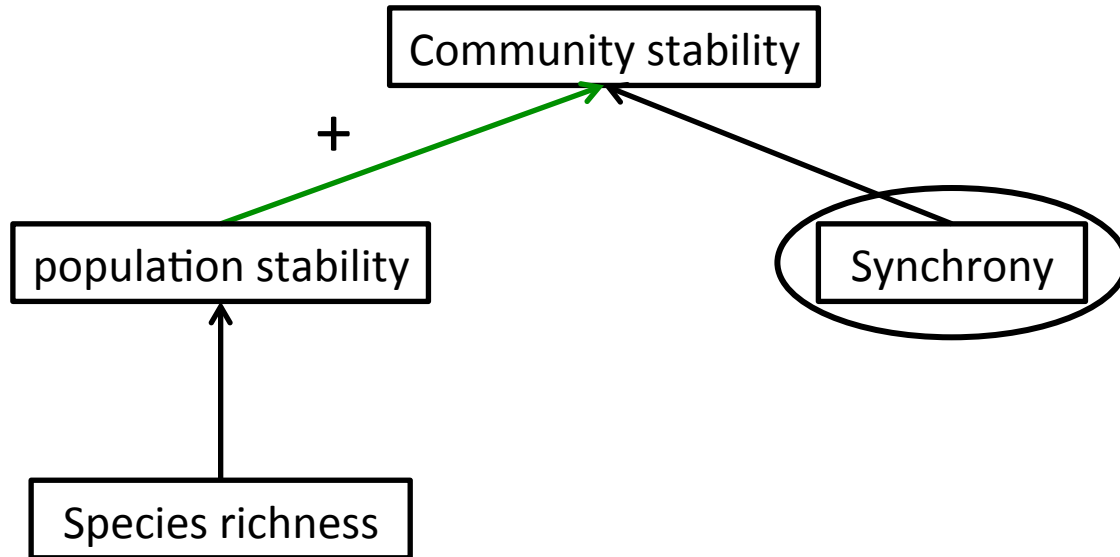


Abundance VS biomass  
Animals VS plants



# Population synchrony

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# Population synchrony

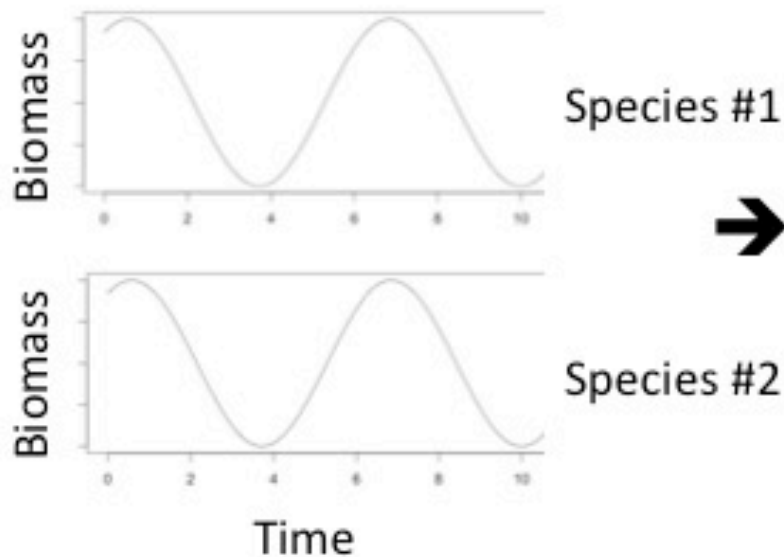
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- Correlation between temporal population's fluctuations

# Population synchrony

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- Correlation between temporal population's fluctuations

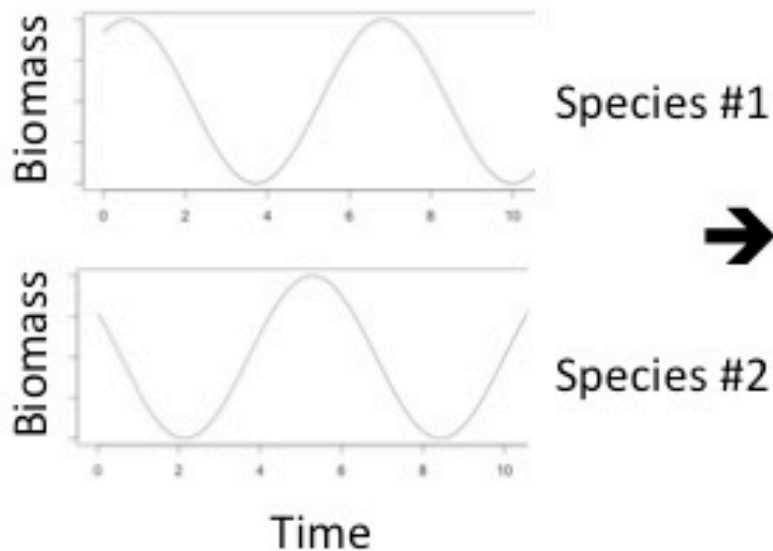


Synchronous populations

# Population synchrony

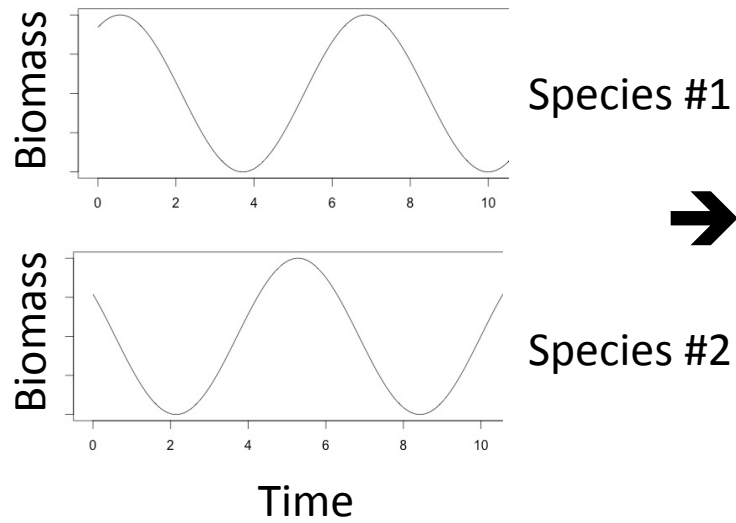
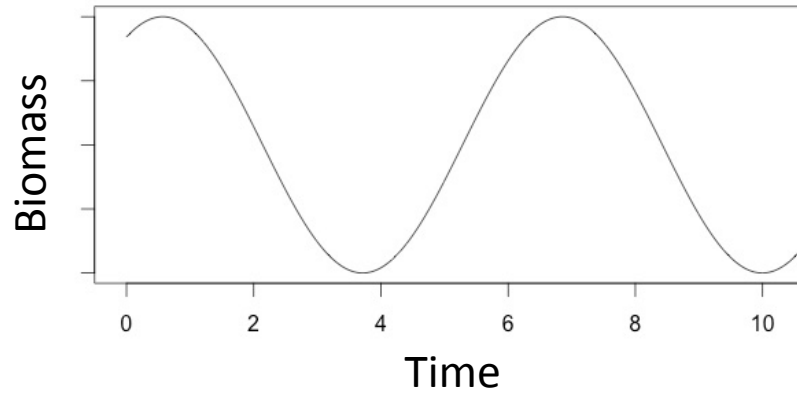
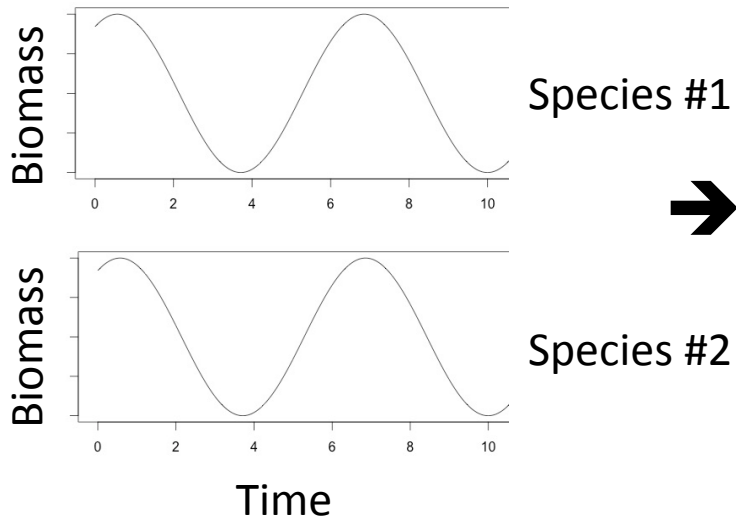
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- Correlation between temporal population's fluctuations



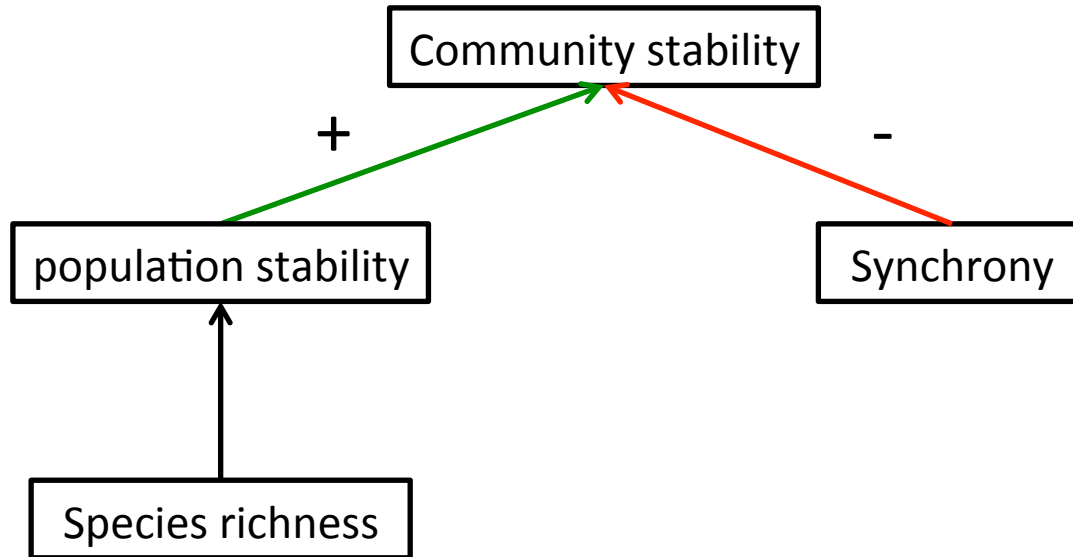
Asynchronous populations

# Population synchrony



# Population synchrony

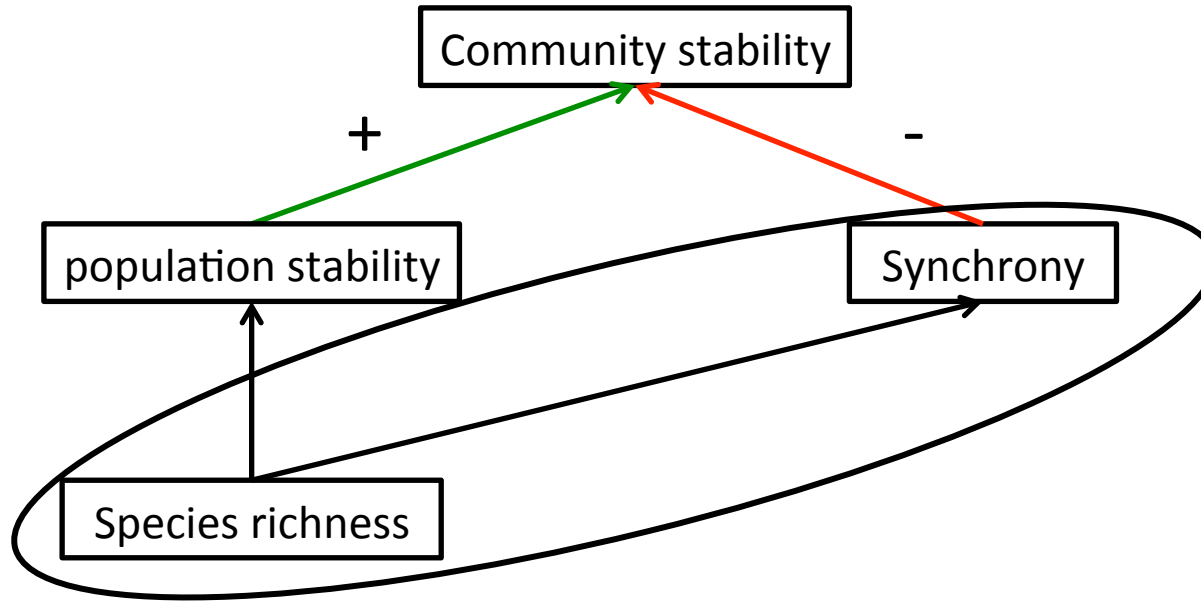
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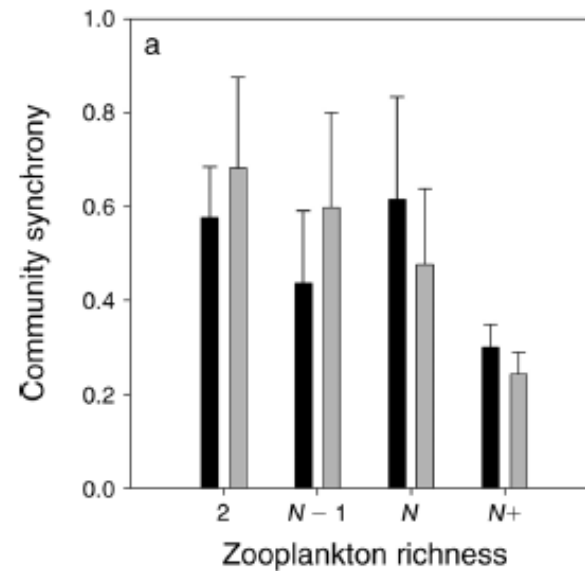
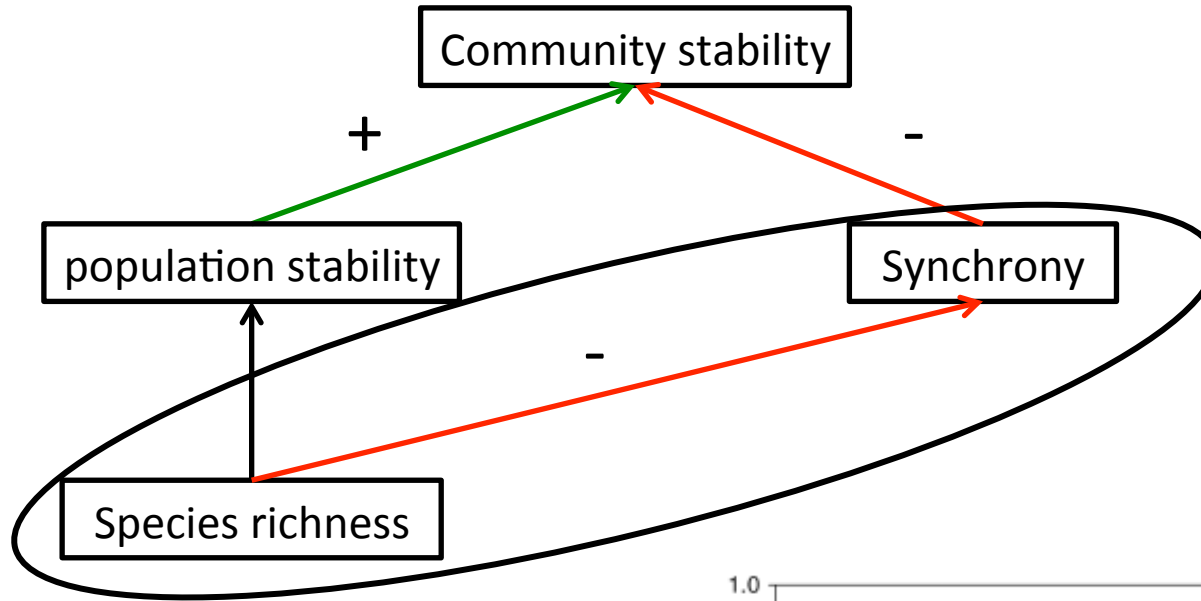


# Population synchrony

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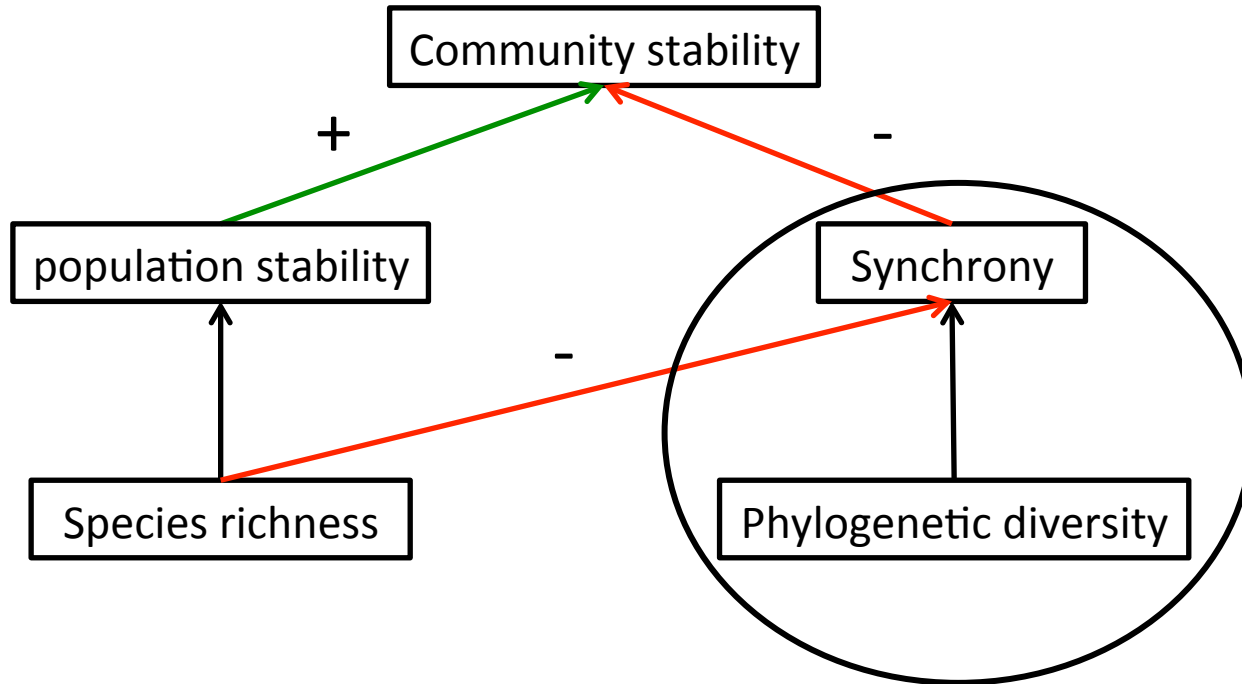


# Population synchrony

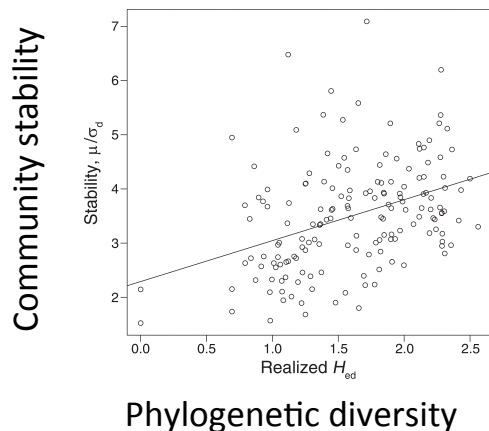
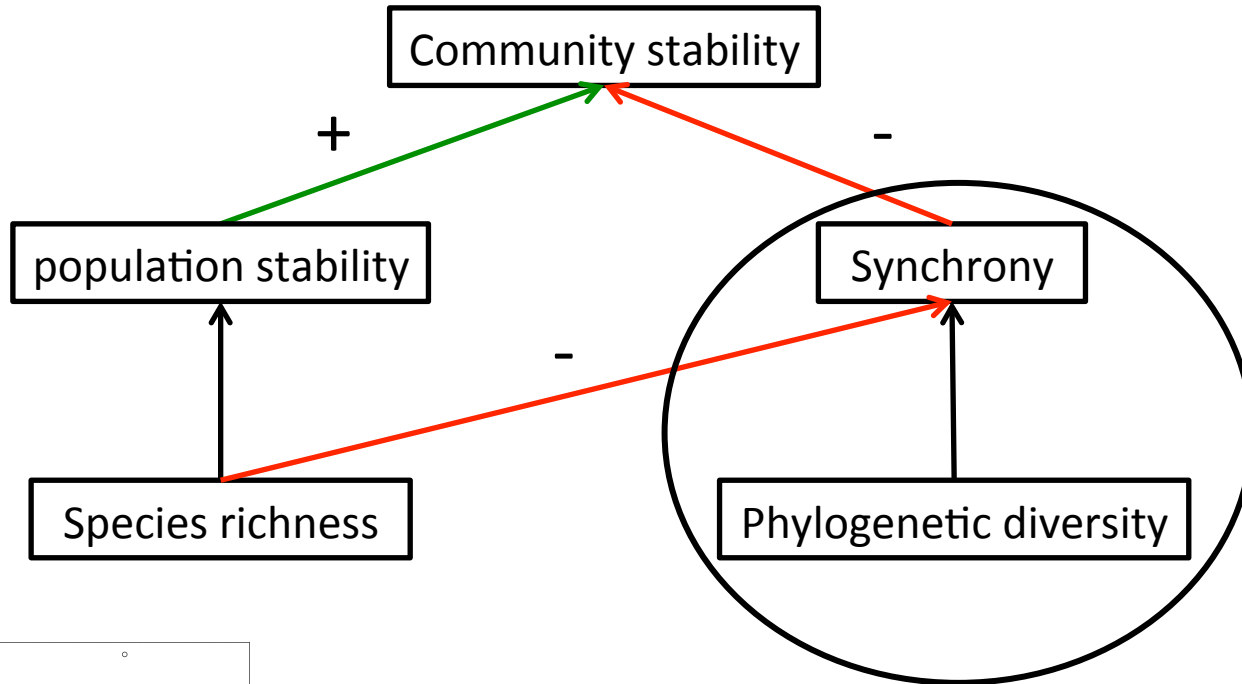


# Phylogenetic diversity

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# Phylogenetic diversity



But

## Functional Ecology



*Functional Ecology* 2015, 29, 615-626

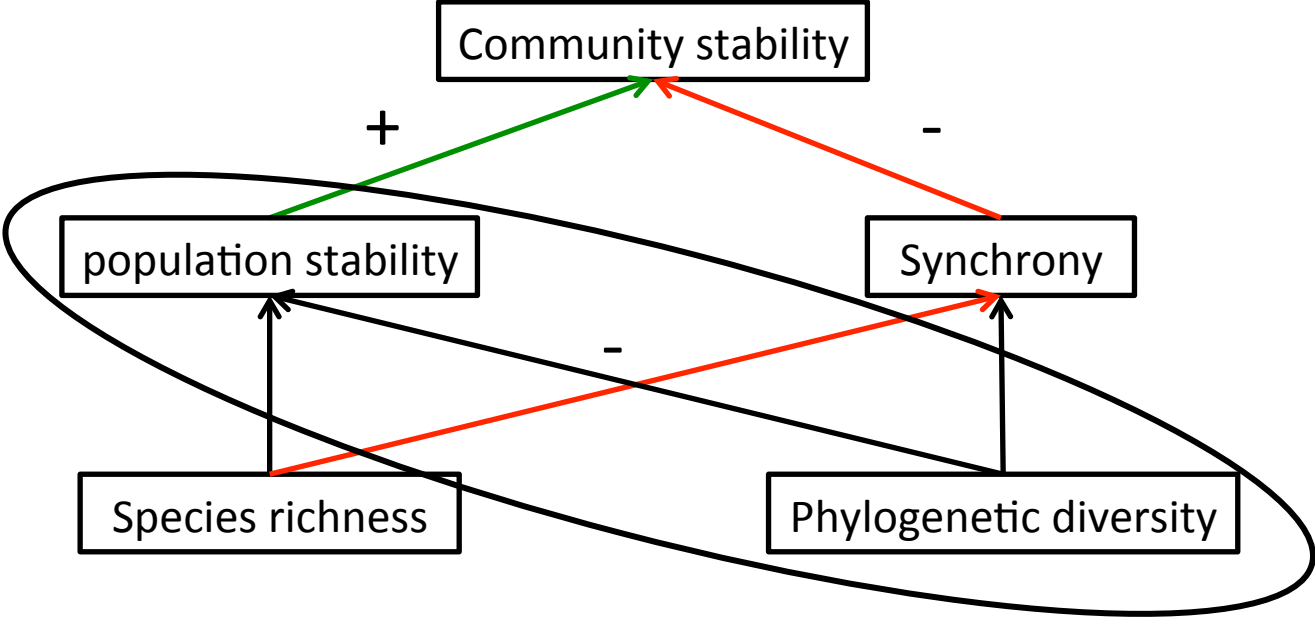
doi: 10.1111/1365-2435.12432

**Species richness, but not phylogenetic diversity, influences community biomass production and temporal stability in a re-examination of 16 grassland biodiversity studies**

Patrick Venail<sup>\*,1,2</sup>, Kevin Gross<sup>3</sup>, Todd H. Oakley<sup>4</sup>, Anita Narwani<sup>1,5</sup>, Eric Allan<sup>6</sup>, Pedro Flombaum<sup>7</sup>, Forest Isbell<sup>8</sup>, Jasmin Joshi<sup>9,10</sup>, Peter B. Reich<sup>11,12</sup>, David Tilman<sup>13,14</sup>, Jasper van Ruijven<sup>15</sup> and Bradley J. Cardinale<sup>1</sup>

# Phylogenetic diversity

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Once upon a time...



# Experimental communities

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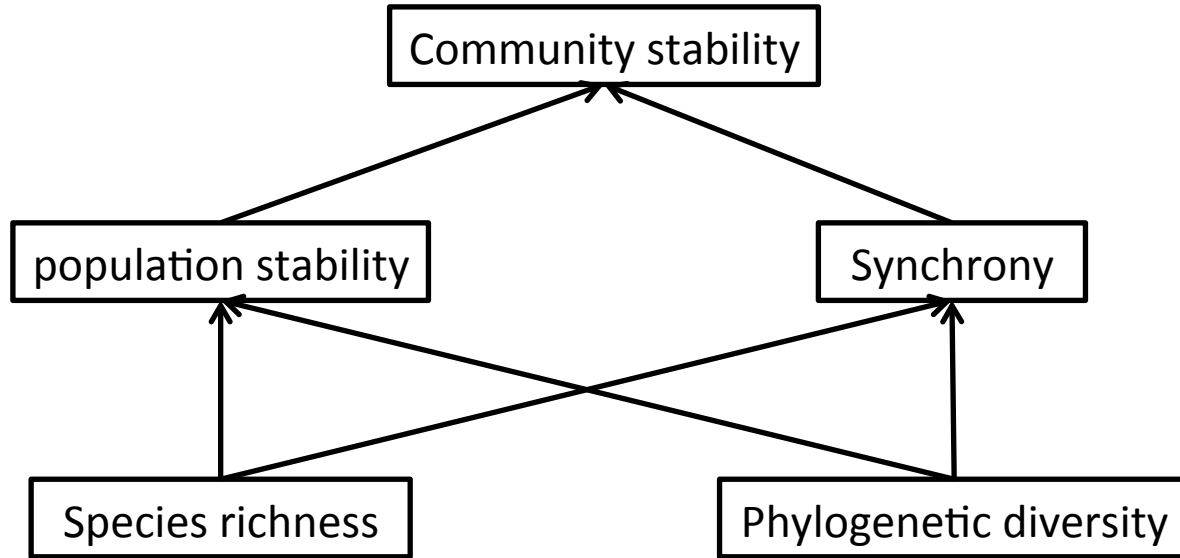
# Experimental communities

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Controlled species richness  
and  
Random species assemblages

# What happens in natural communities ?

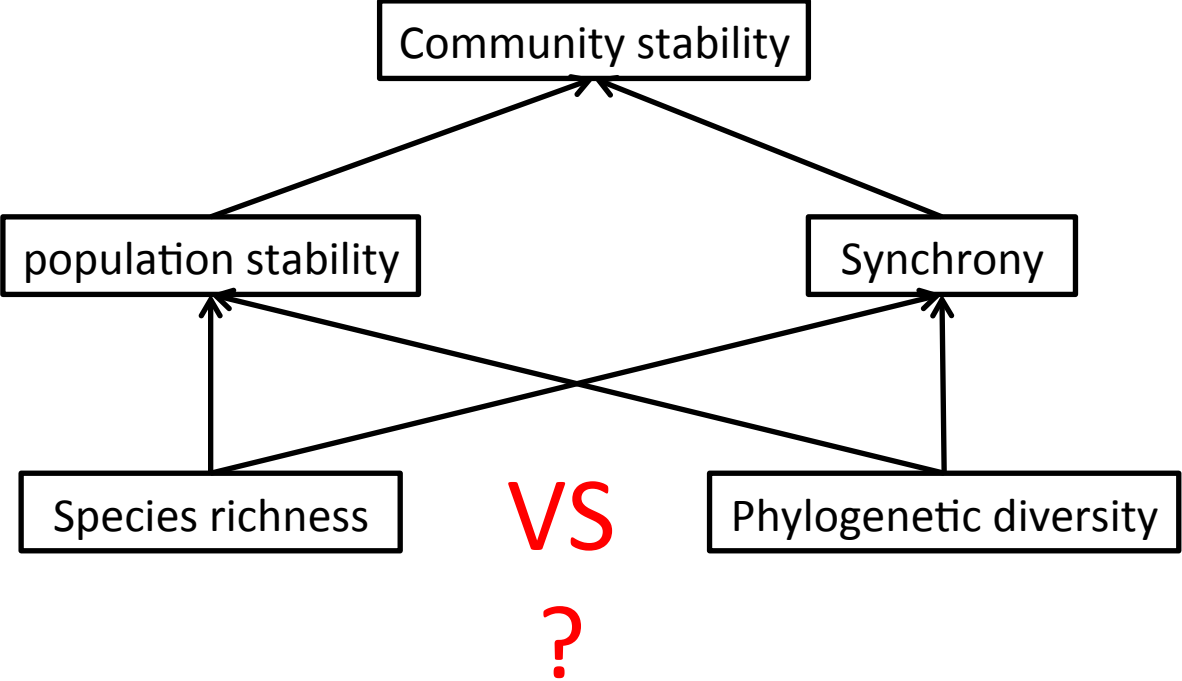
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?

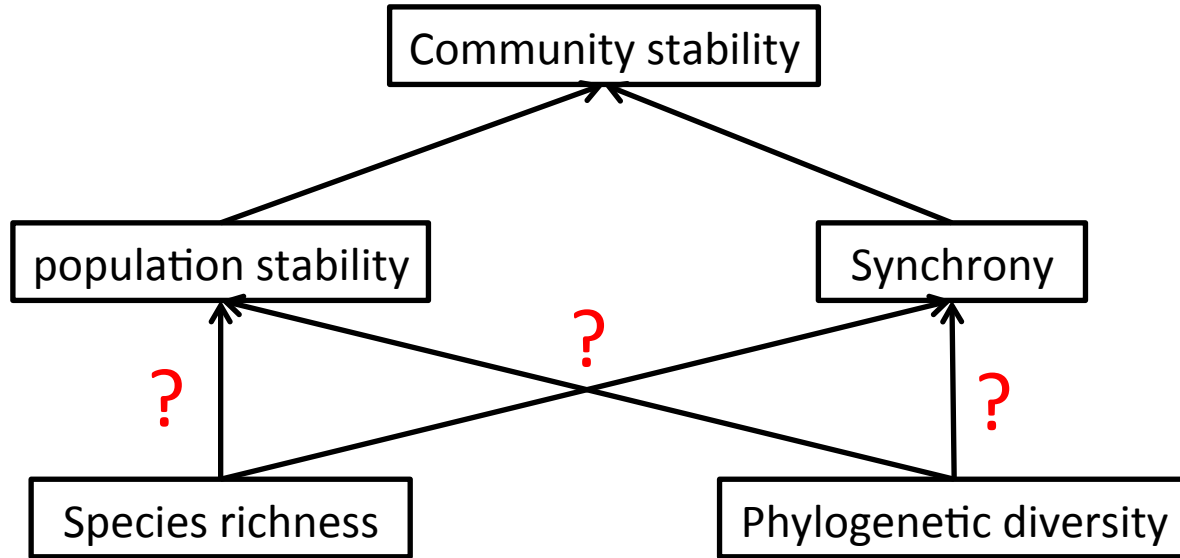
# What drives this relationship ?

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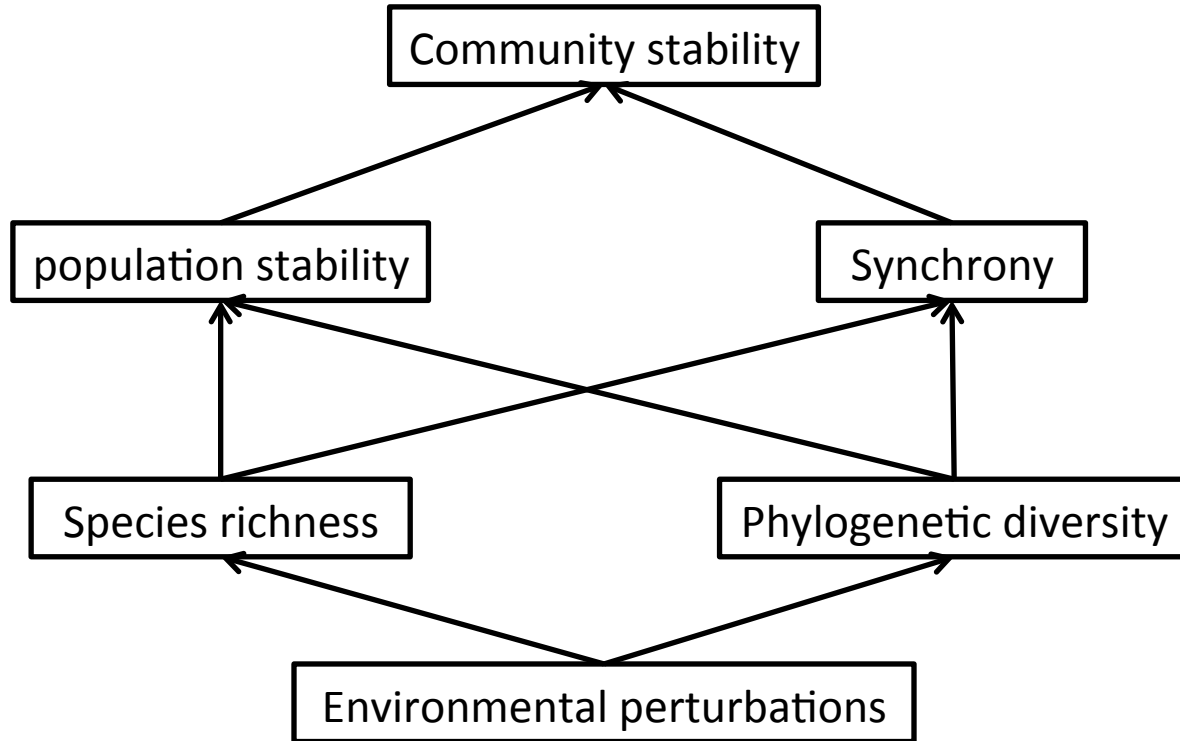
# Through which mechanisms ?

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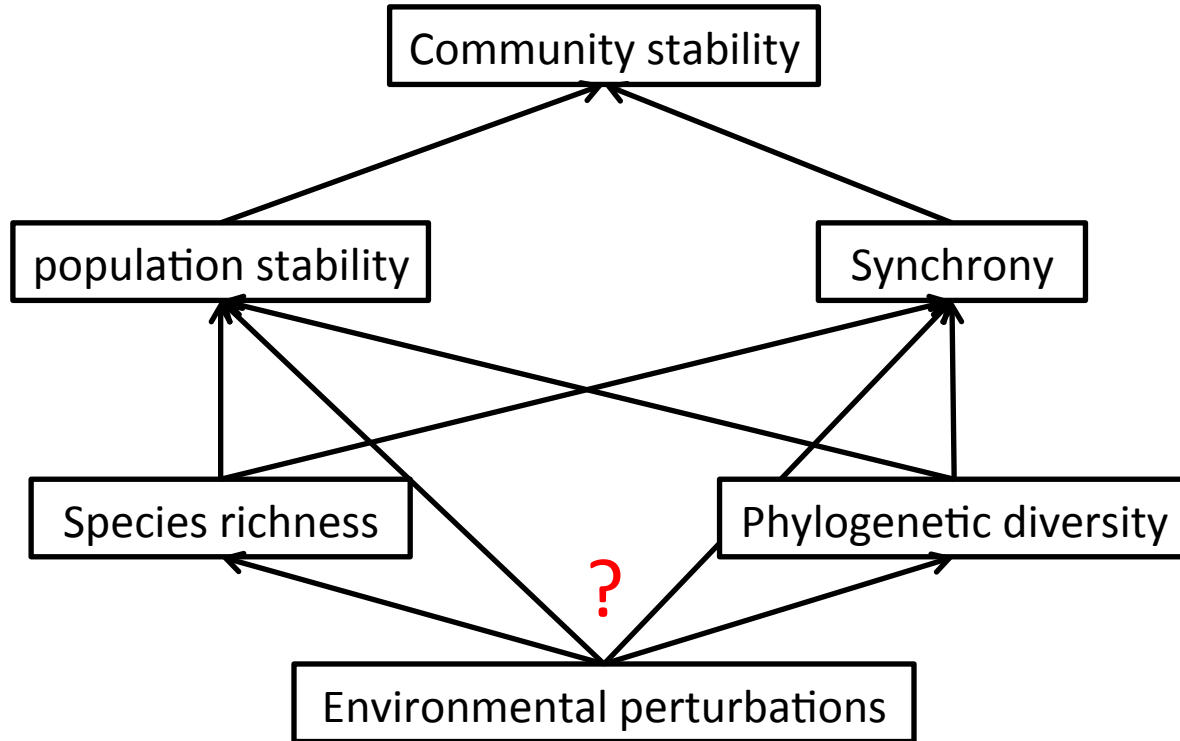
# What is the effect of environmental perturbations ?

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# What is the effect of environmental perturbations ?

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# Datasets

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Highly replicated time series

- ➔ Lot of diversity levels
- ➔ Wide environmental range



# Datasets

---

Highly replicated time series

- ➔ Lot of diversity levels
- ➔ Wide environmental range

**VIGIENATURE**

Un réseau de citoyens qui fait avancer la science

Citizen science programs

# Datasets

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Highly replicated time series

- Lot of diversity levels
- Wide environmental range

**VIGIENATURE**

Un réseau de citoyens qui fait avancer la science

Citizen science programs



# Datasets

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Highly replicated time series

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**VIGIENATURE**

Un réseau de citoyens qui fait avancer la science

Citizen science programs



Observatoire  
de la Biodiversité  
des Jardins

**OPÉRATION PAPILLONS**

# Datasets

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Highly replicated time series

- Lot of diversity levels
- Wide environmental range

**VIGIENATURE**

Un réseau de citoyens qui fait avancer la science

Citizen science programs



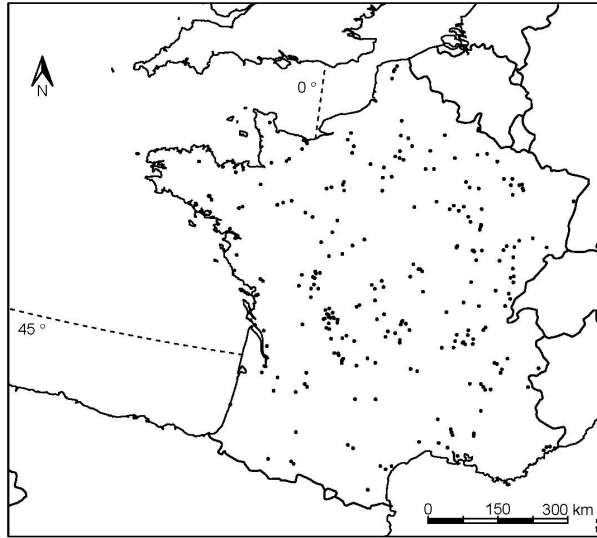
Observatoire  
de la Biodiversité  
des Jardins

**OPÉRATION PAPILLONS**



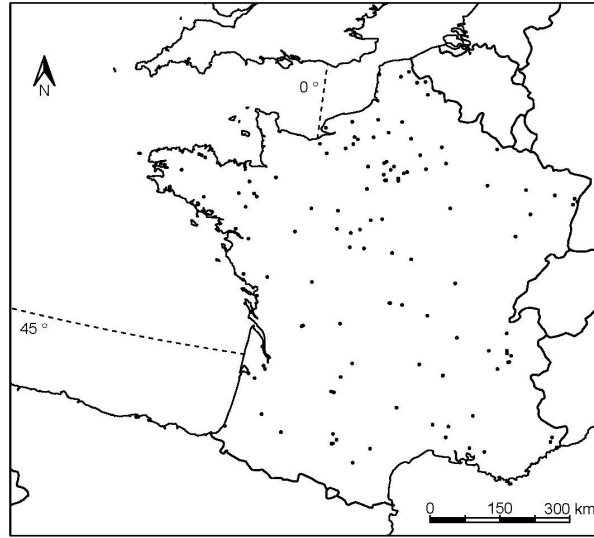
**Vigie-Chiro**  
Suivi des  
chauves-souris

# Datasets



## **Birds**

- 269 communities
- 75 species
- 8 years



## **Butterflies**

- 131 communities
- 14 species
- 7 years

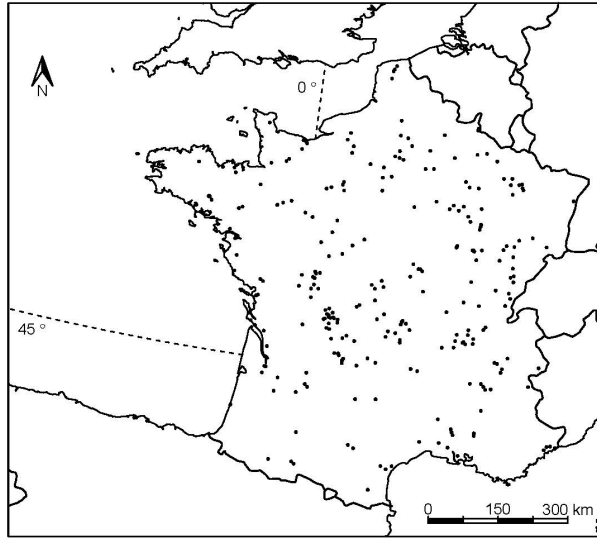


## **Bats**

- 162 communities
- 7 species
- 4 years

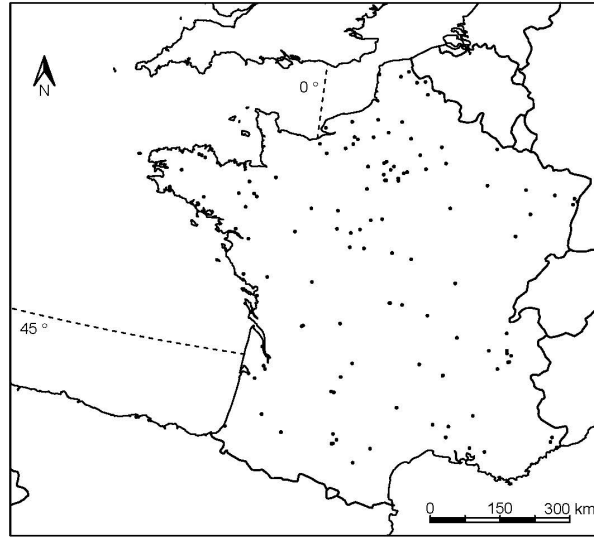
Annual survey  
Same volunteer  
Standardized protocol  
Common species

# Datasets



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- 75 species
- 8 years



## ***Butterflies***

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- 14 species
- 7 years

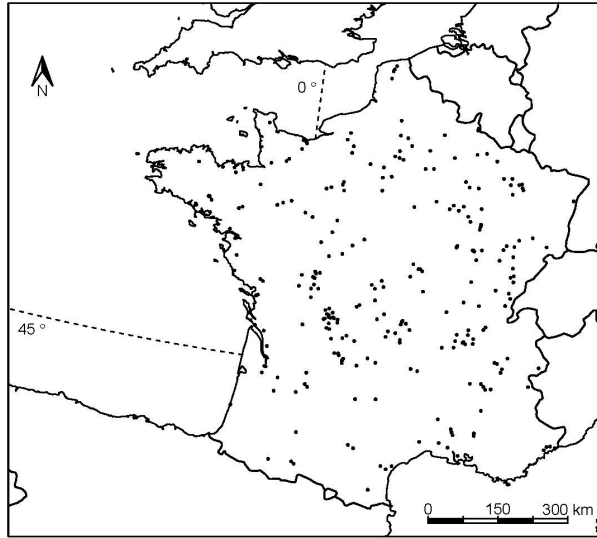


## ***Bats***

- 162 communities
- 7 species
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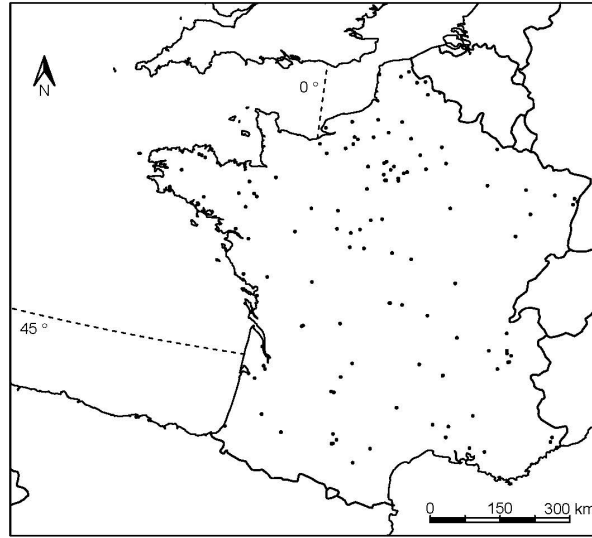
1 abundance value / species / community / year

# Datasets



## ***Birds***

- 269 communities
- 75 species
- 8 years



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- 14 species
- 7 years



## ***Bats***

- 162 communities
- 7 species
- 4 years

Stability of community's abundance

# Stability measure

---

Community stability

$$\frac{1}{CV} = \frac{\mu}{\sigma}$$



# Stability measure

---

Community stability

$$\frac{1}{\text{CV}_{\text{community}}} = \frac{1}{\overline{\text{CV}}_{\text{populations}}} \times \frac{1}{\sqrt{\varphi}}$$

# Weighted mean population stability

---

Community stability

$$\frac{1}{CV_{\text{community}}} = \frac{1}{CV_{\text{populations}}} \times \frac{1}{\sqrt{\phi}}$$

Weighted  
population stability

$$CV_i^w = \frac{\mu_i}{\mu_{\text{community}}} \times CV_i$$

# Synchrony index

---

Community stability

$$\frac{1}{CV_{\text{community}}} = \frac{1}{CV_{\text{populations}}} \times \frac{1}{\sqrt{\varphi}}$$

Weighted  
population stability

Synchrony

$$\varphi = \frac{\sigma_{\text{community}}^2}{(\sum_i \sigma_i)^2}$$

# Community composition

---

Community stability

Weighted  
population stability

Synchrony

Total species  
richness

# Community composition

---

Community stability

Weighted  
population stability

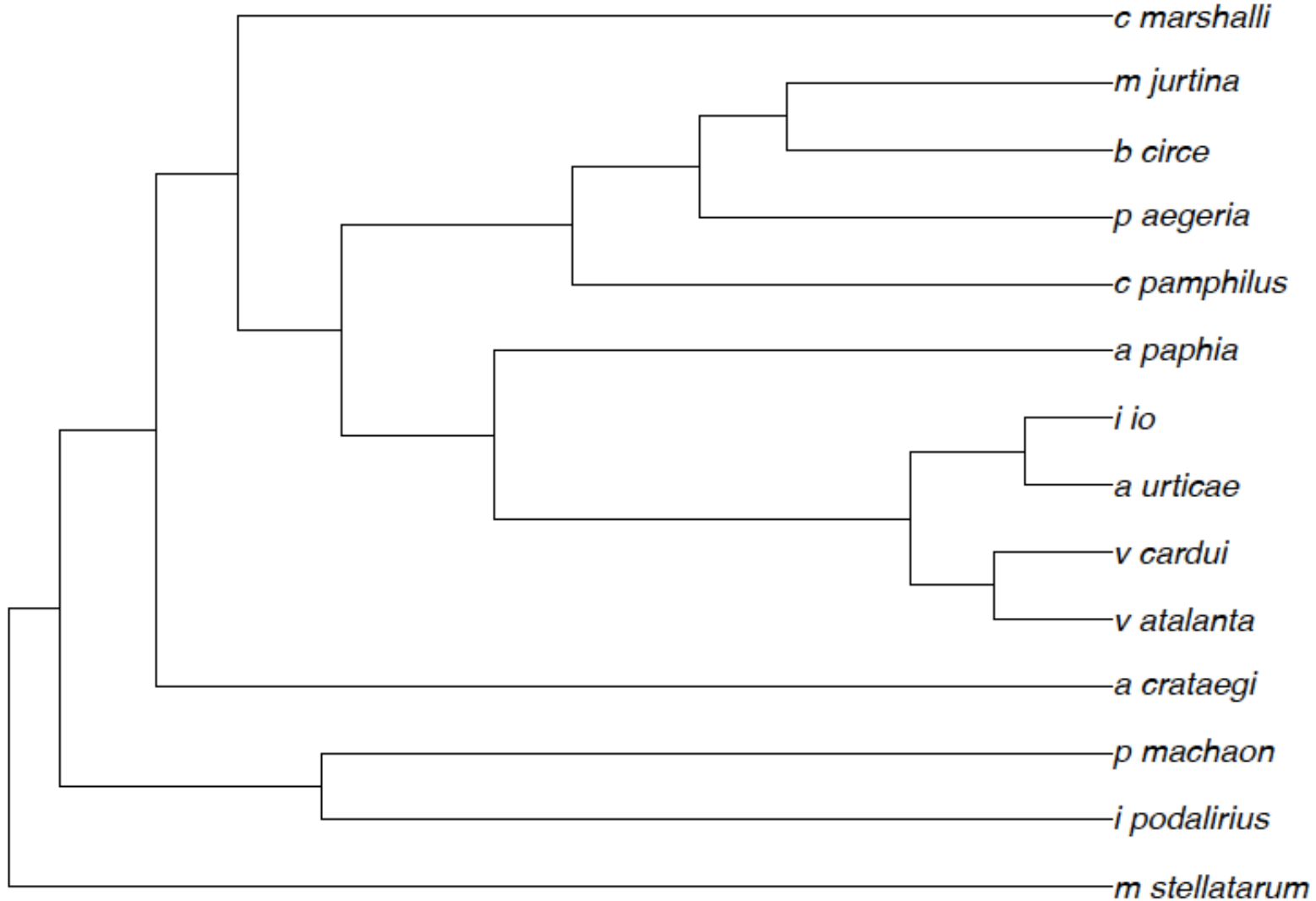
Synchrony

Total species  
richness

Weighted mean  
phylogenetic distance

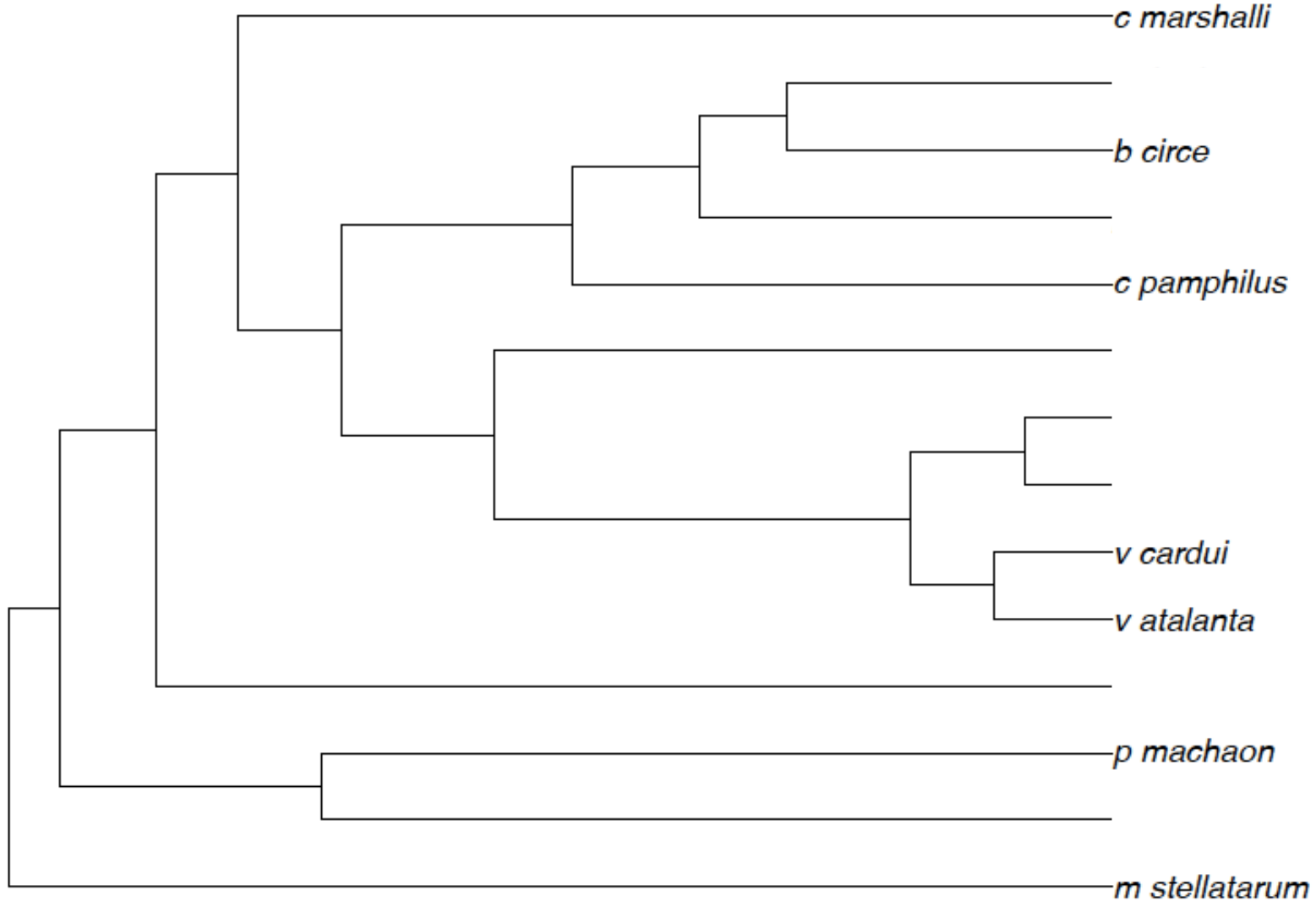
# Weighted mean phylogenetic distance

---



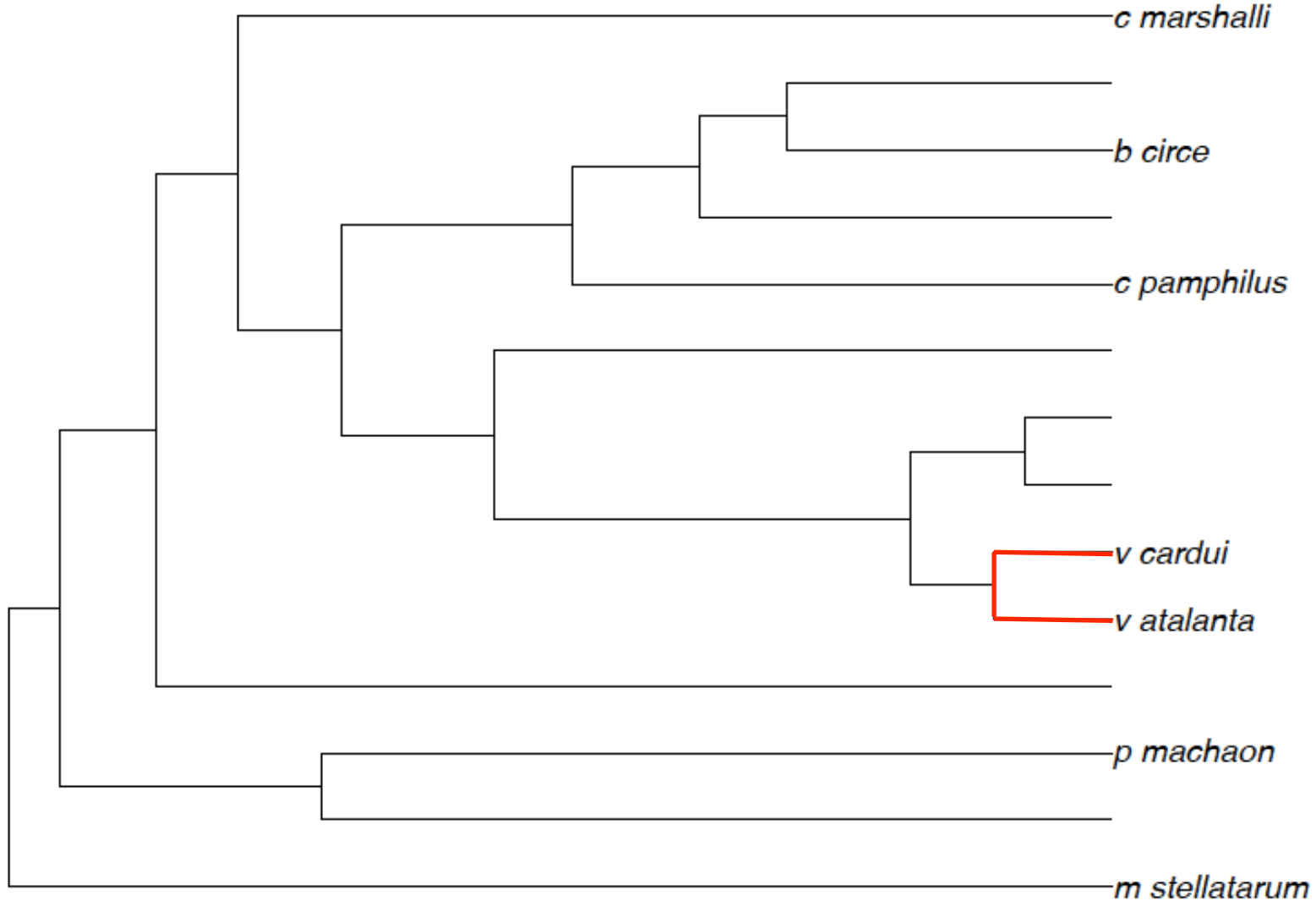
# Weighted mean phylogenetic distance

---



# Weighted mean phylogenetic distance

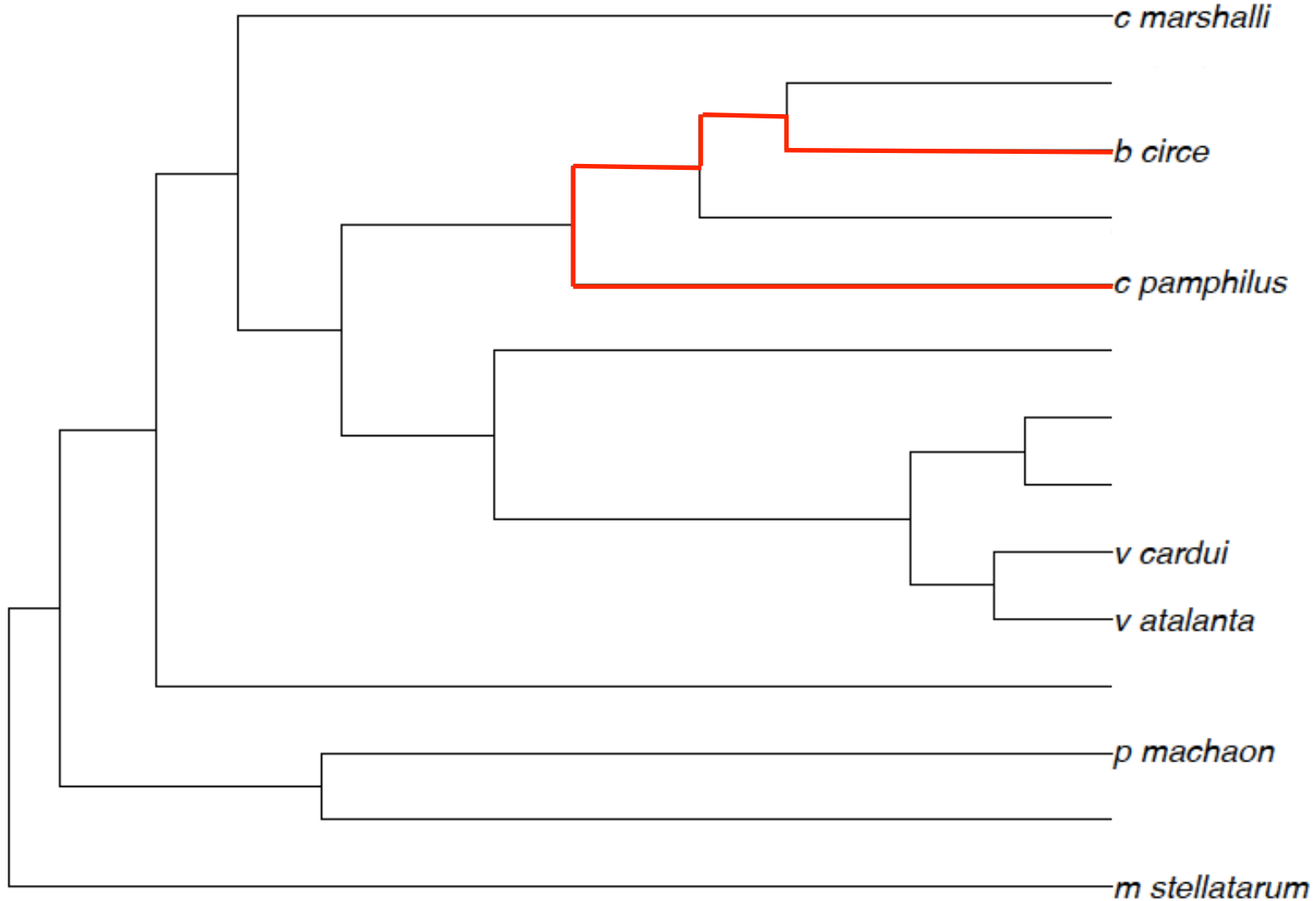
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# Weighted mean phylogenetic distance

---



# Community composition

---

Community stability

Weighted  
population stability

Synchrony

Total species  
richness

Weighted mean  
phylogenetic distance

# Landscape perturbations

---



Urban area



Arable lands



Grasslands



Woodlands

# Landscape perturbations

---



Urban area



Arable lands

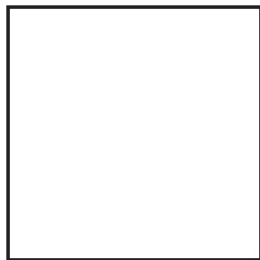


Grasslands



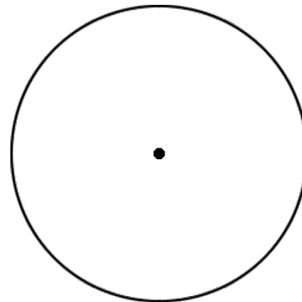
Woodlands

**Birds**



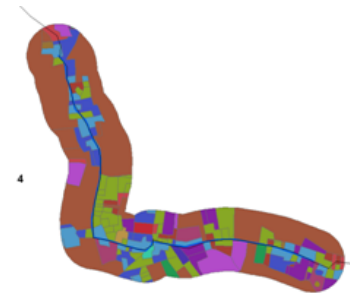
*2km squares*

**Butterflies**



*1000m buffers*

**Bats**



*250m buffers*

# Landscape perturbations



Urban area



Arable lands

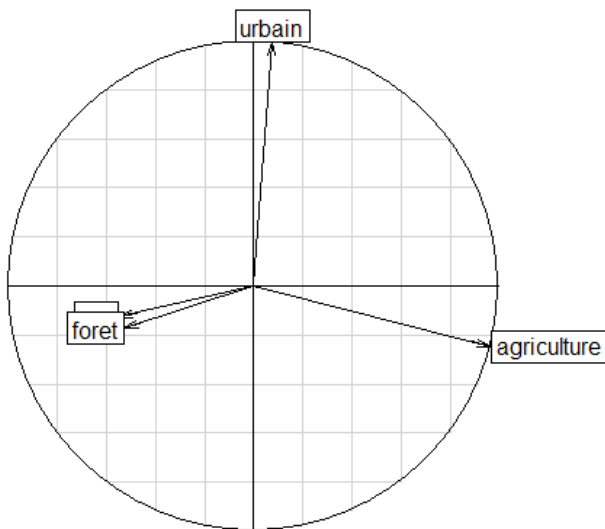


Grasslands

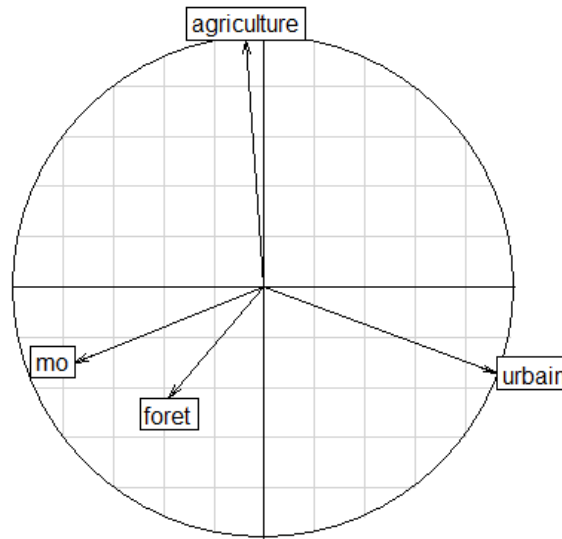


Woodlands

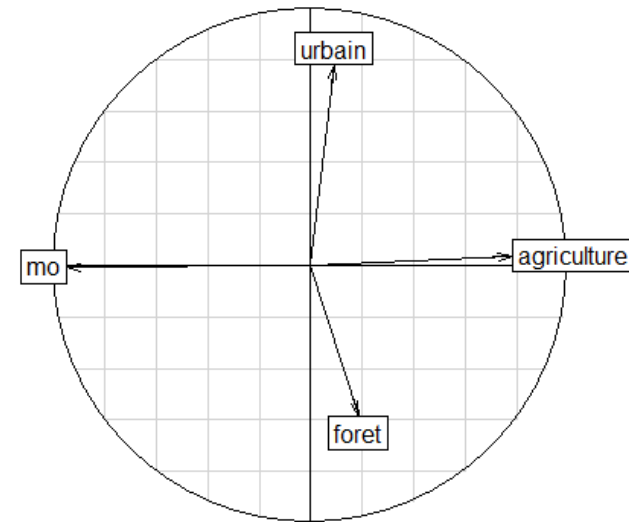
**birds**



**butterflies**



**bats**



# Landscape perturbations

---

Community stability

Weighted  
population stability

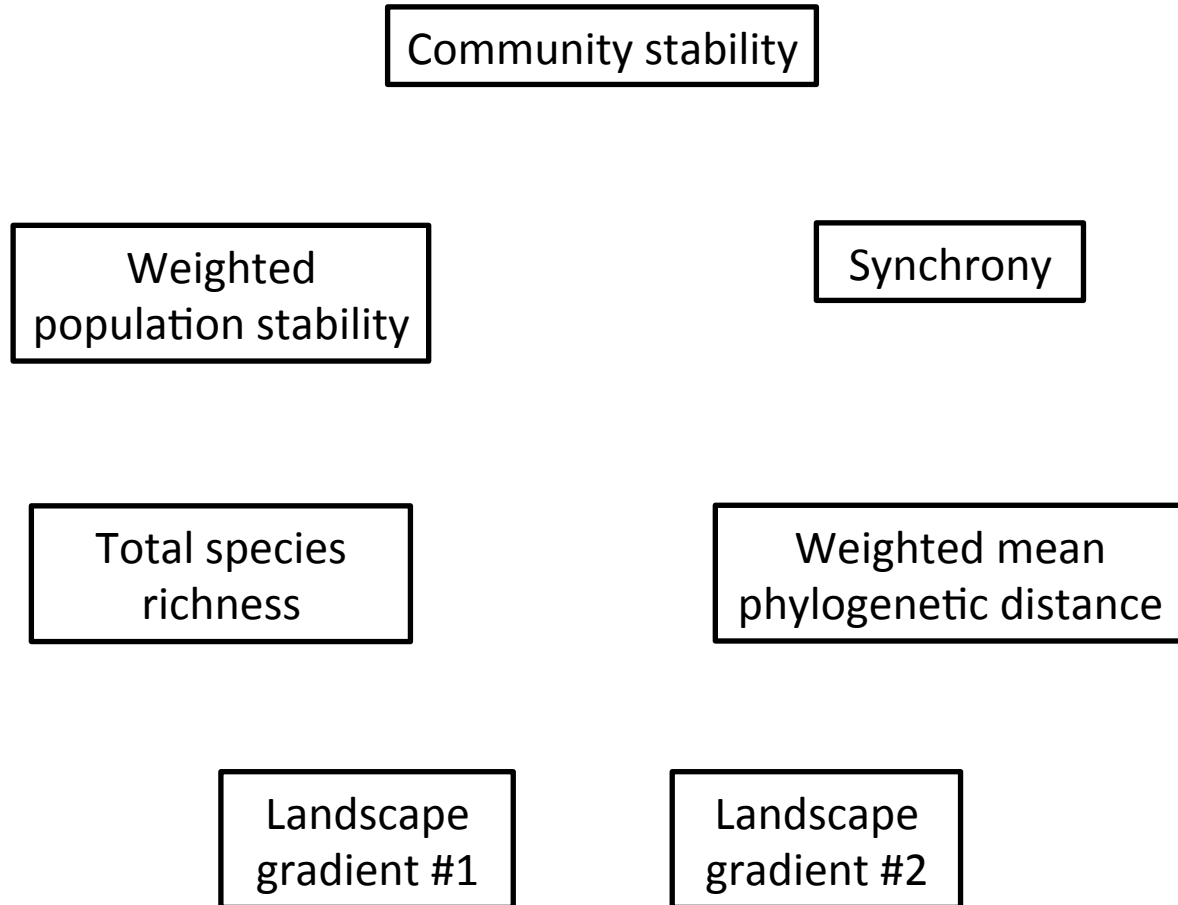
Synchrony

Total species  
richness

Weighted mean  
phylogenetic distance

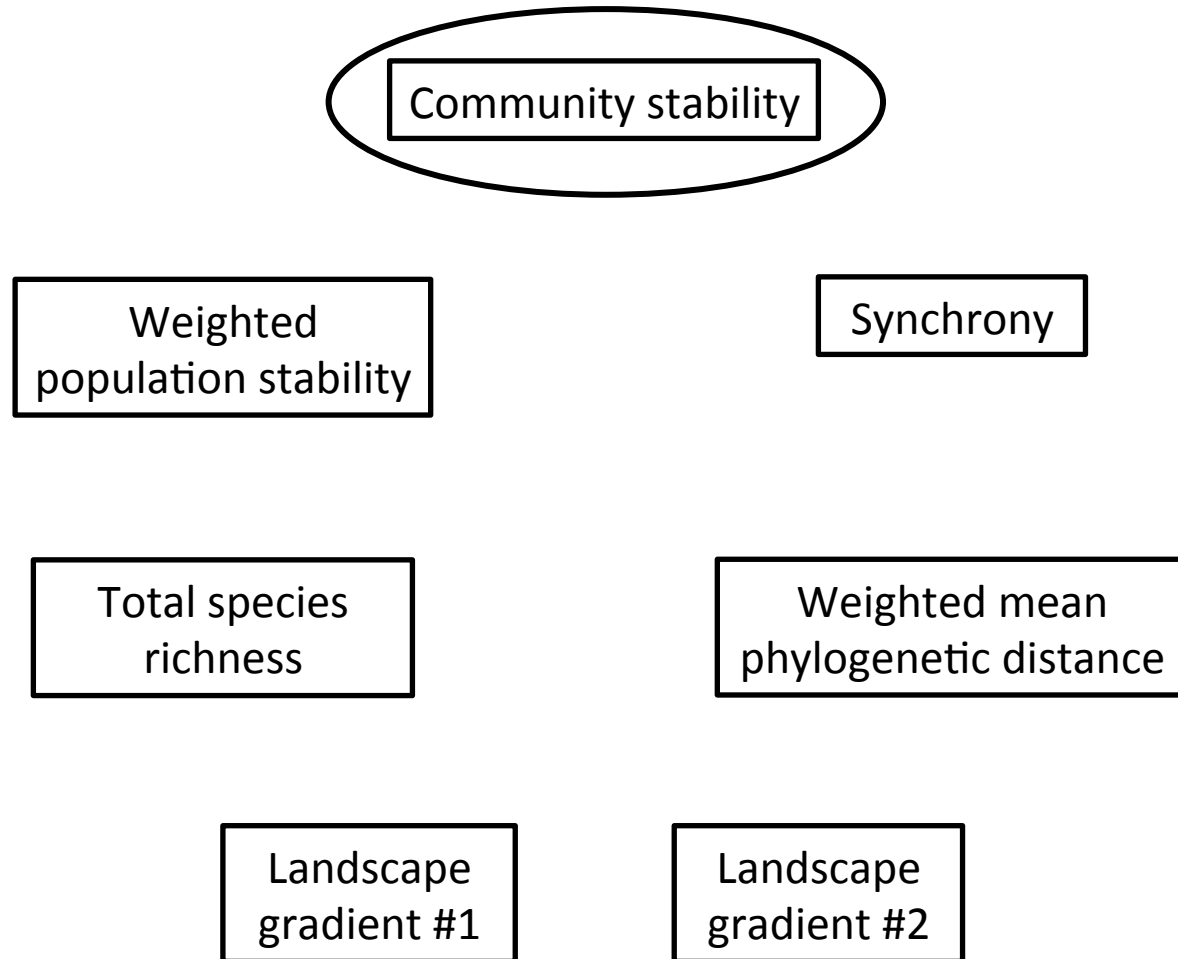
# Landscape perturbations

---



# Community stability

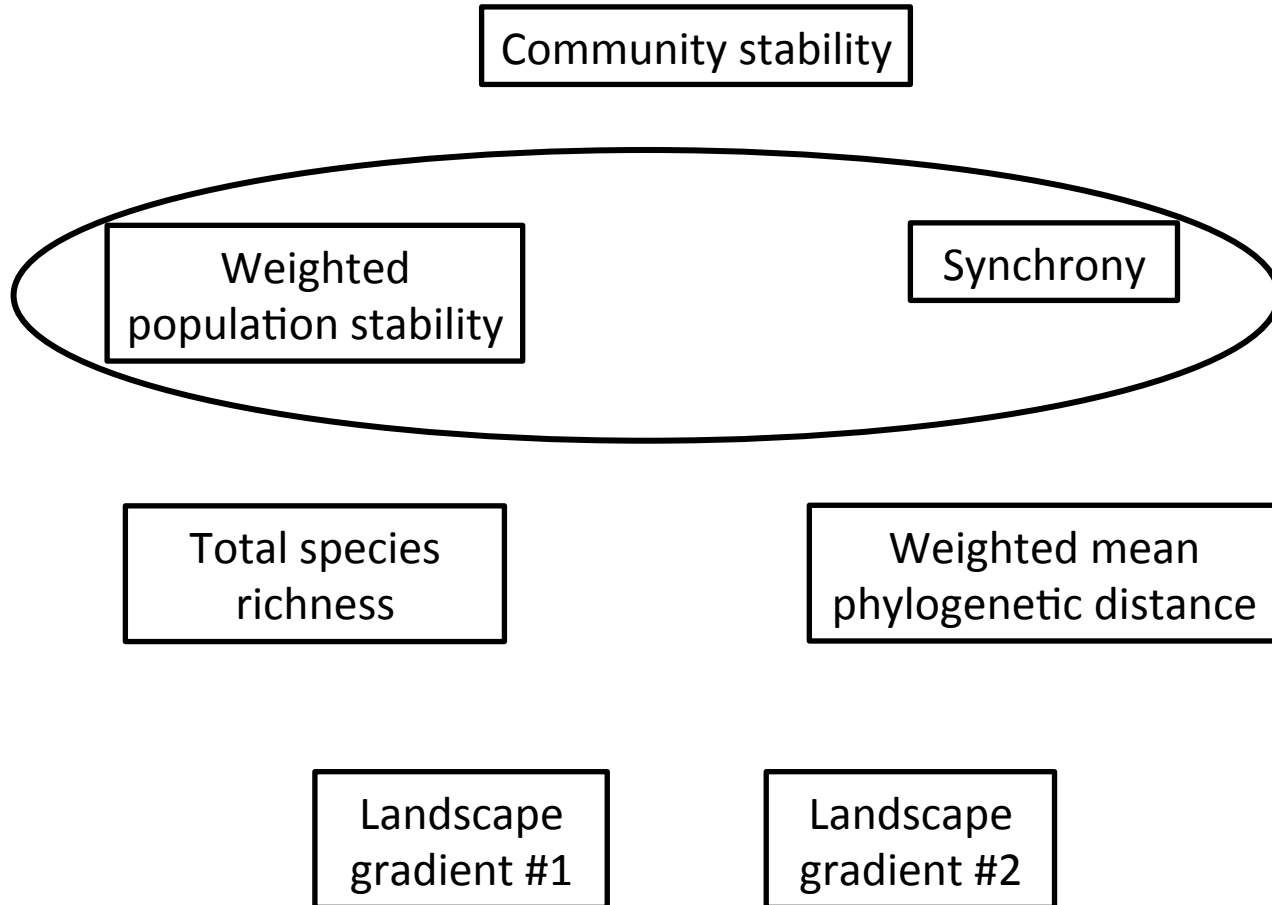
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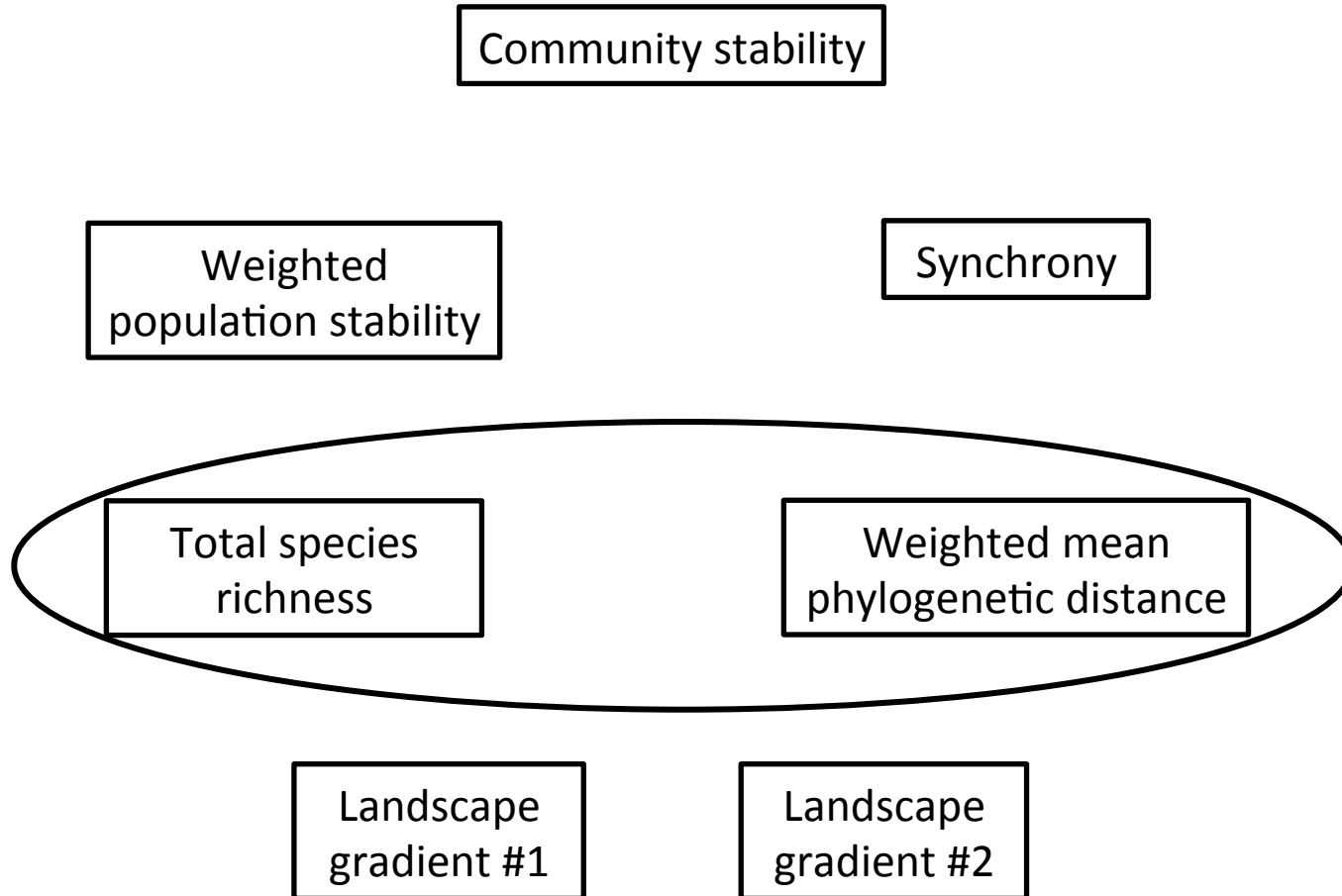
# Community dynamics level

---



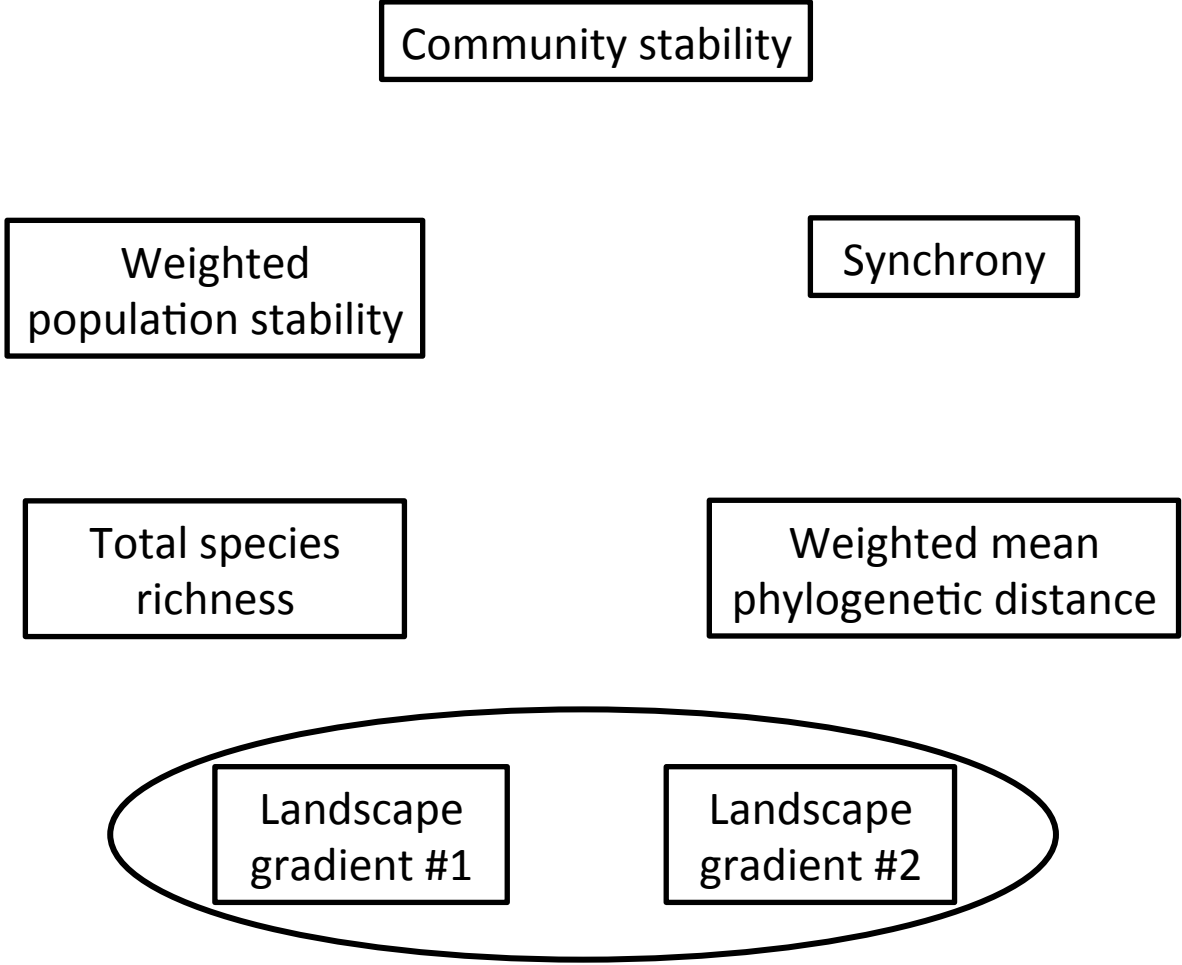
# Community composition level

---



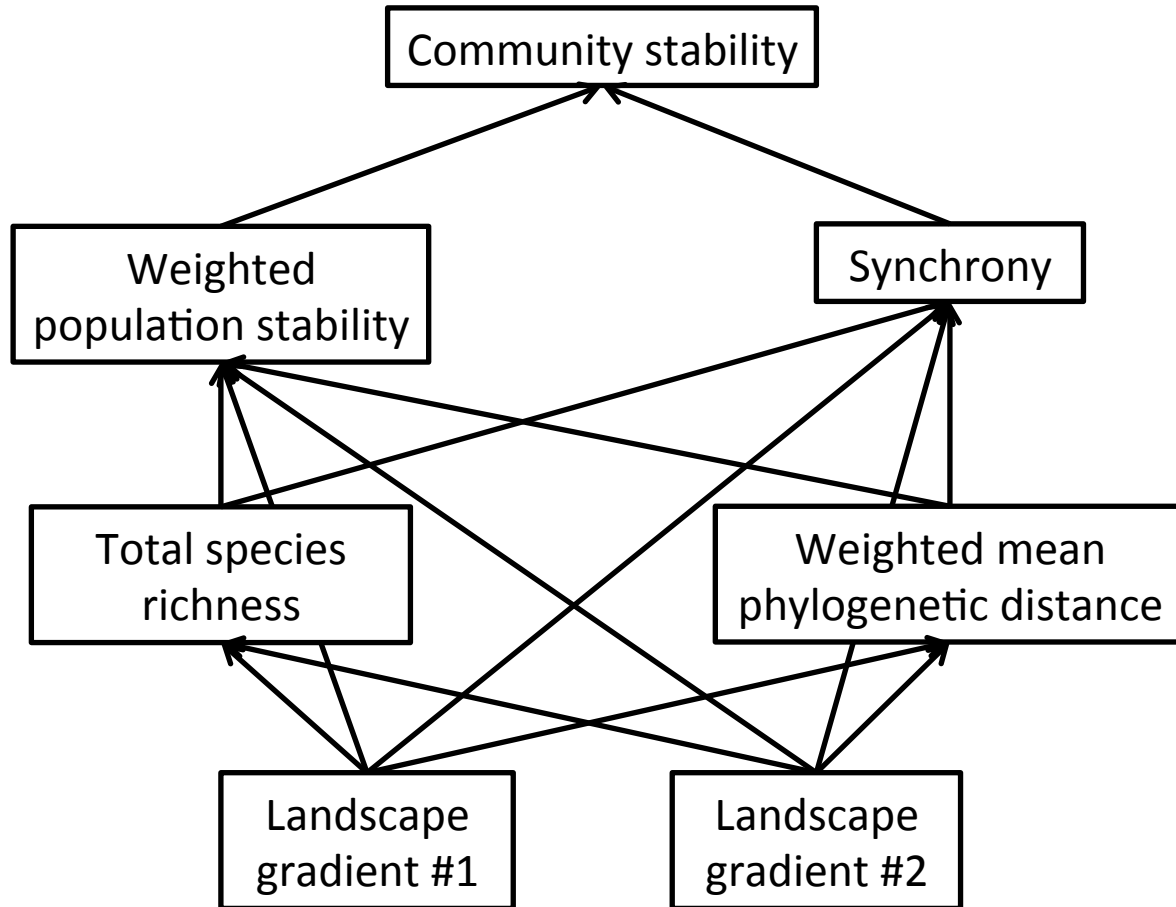
# Environmental perturbations level

---



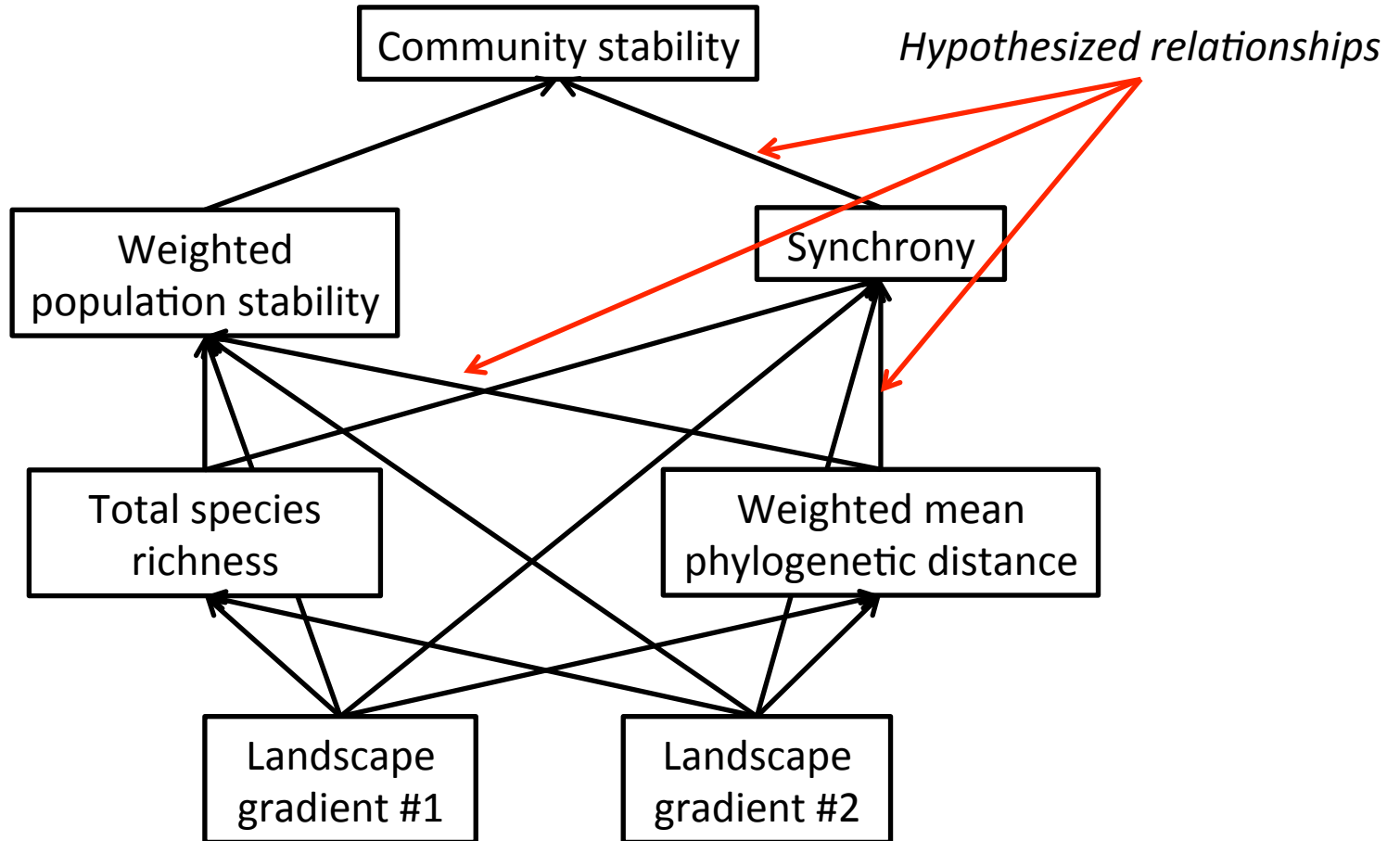
# Path analysis

---



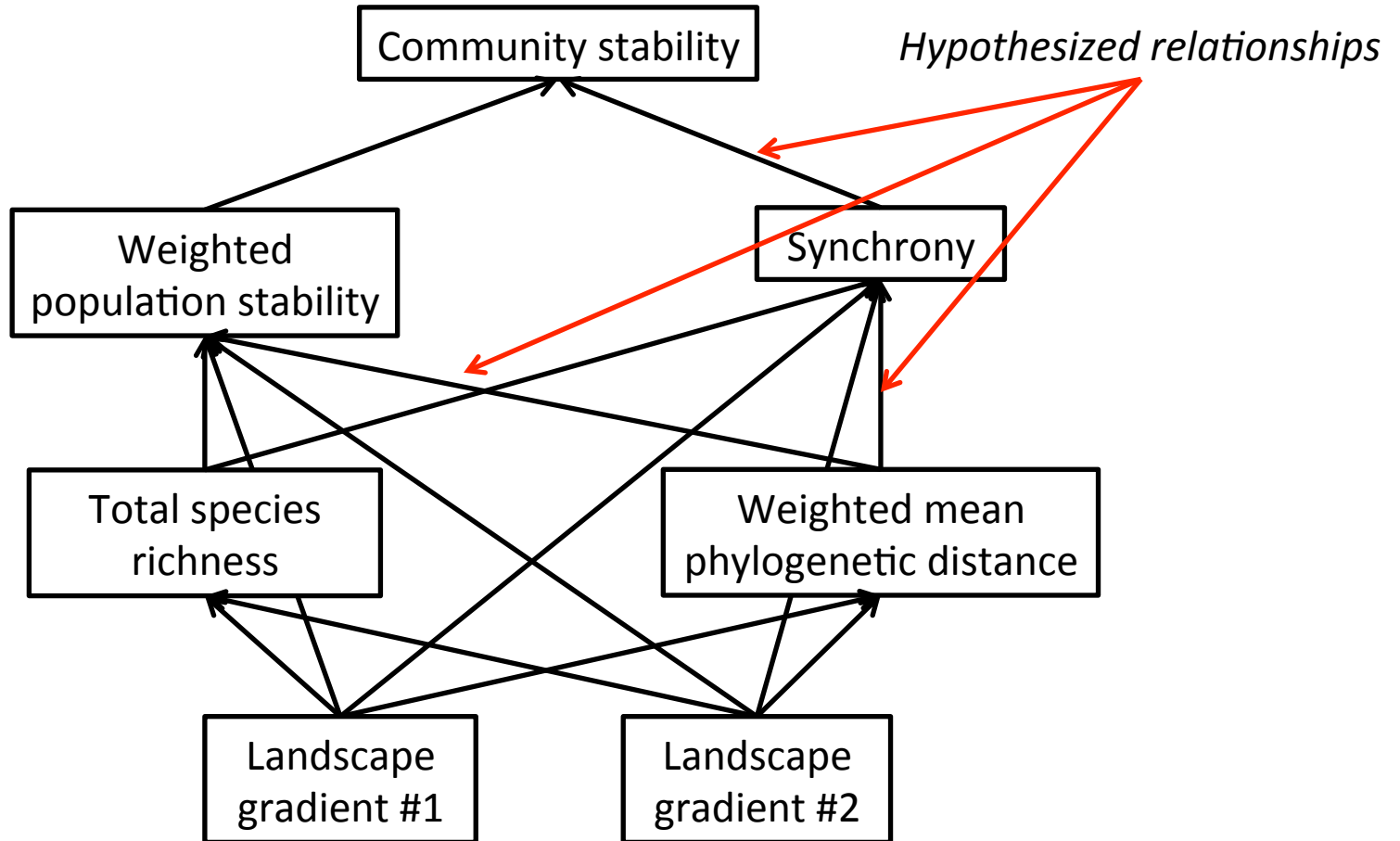
# Path analysis

---



# Path analysis

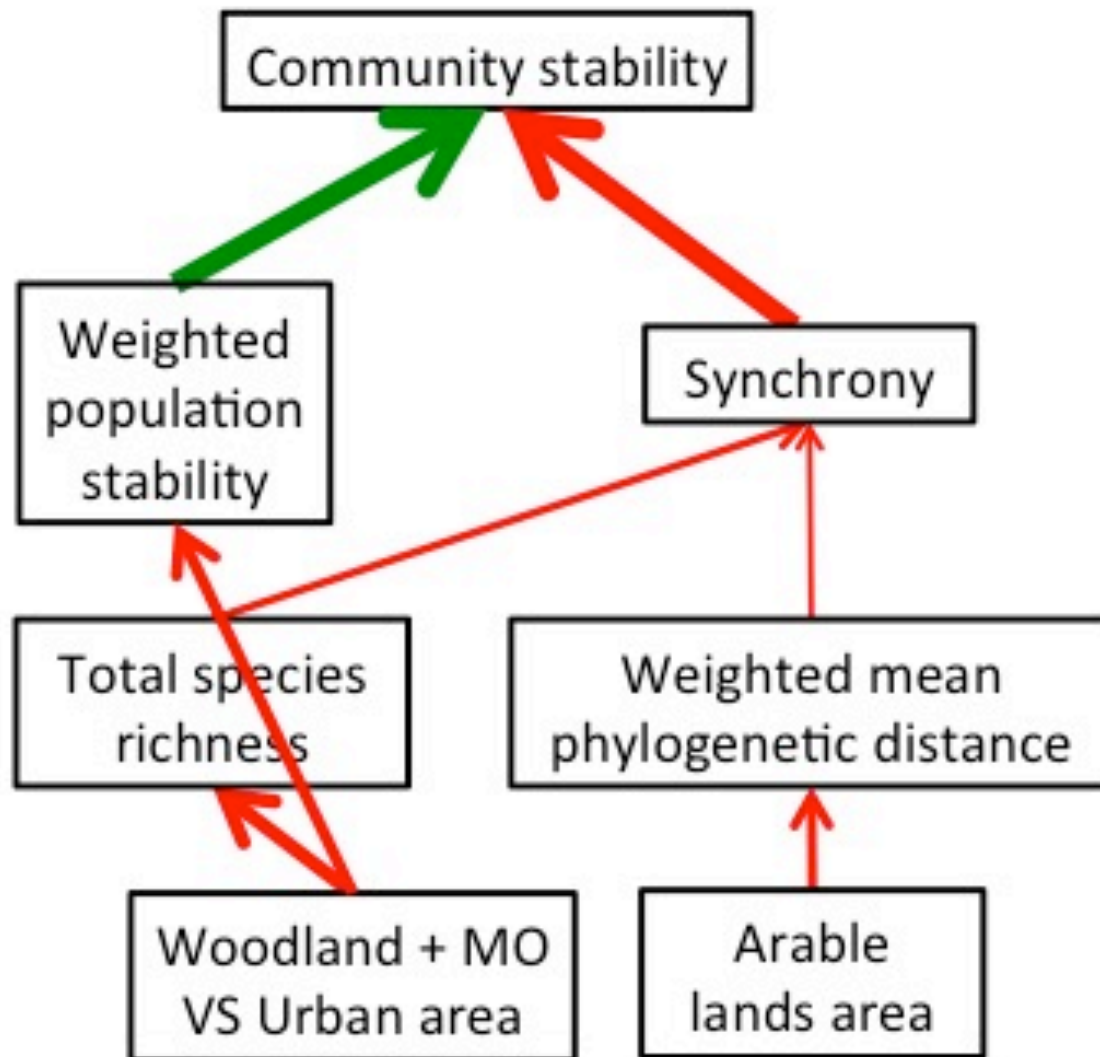
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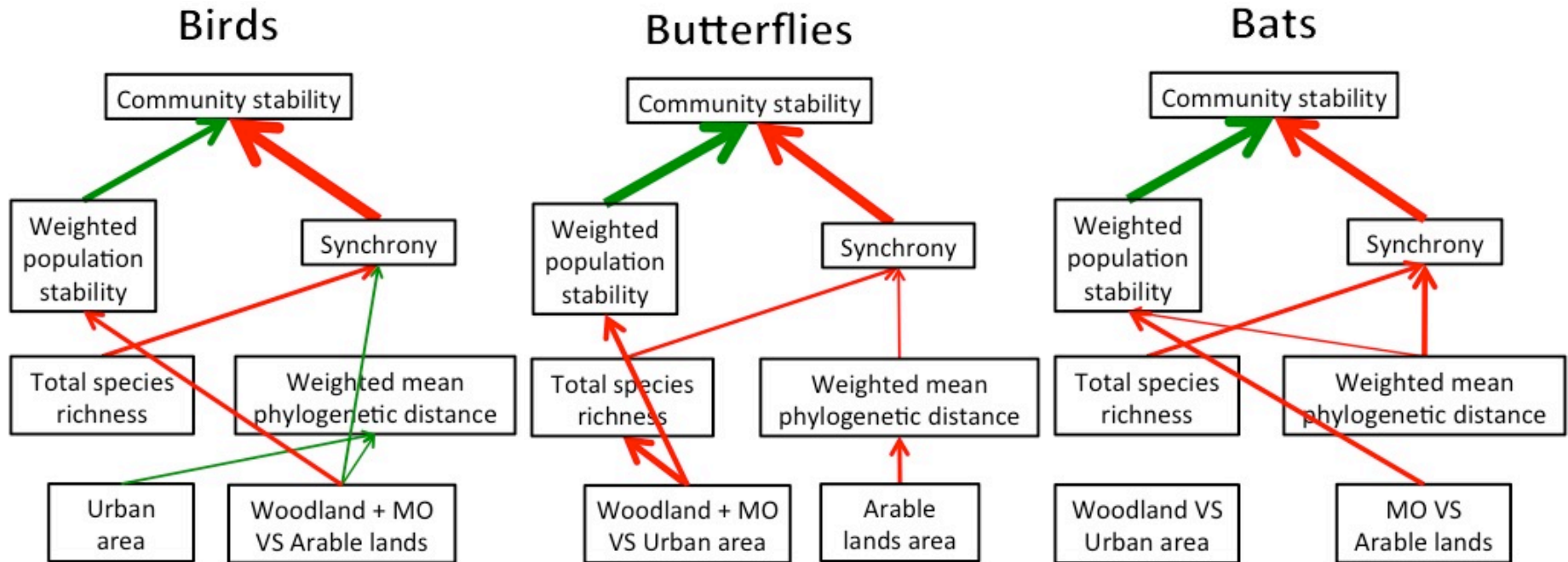
Standardized estimates

# Results

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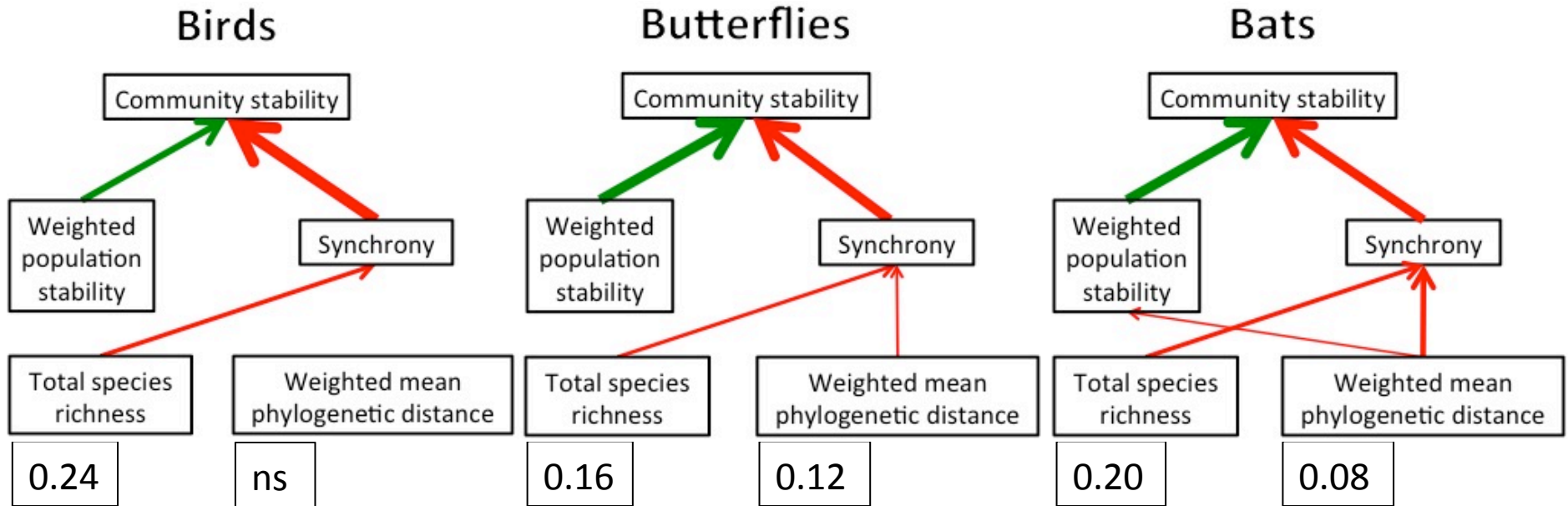


# Results



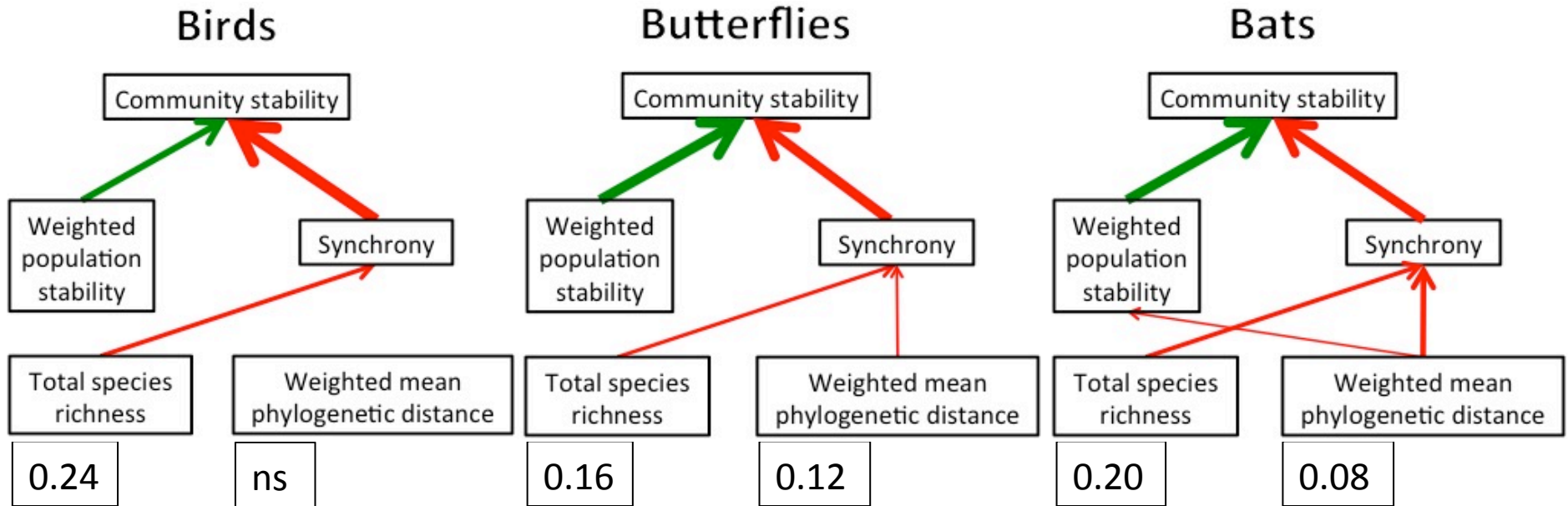


# Community composition level



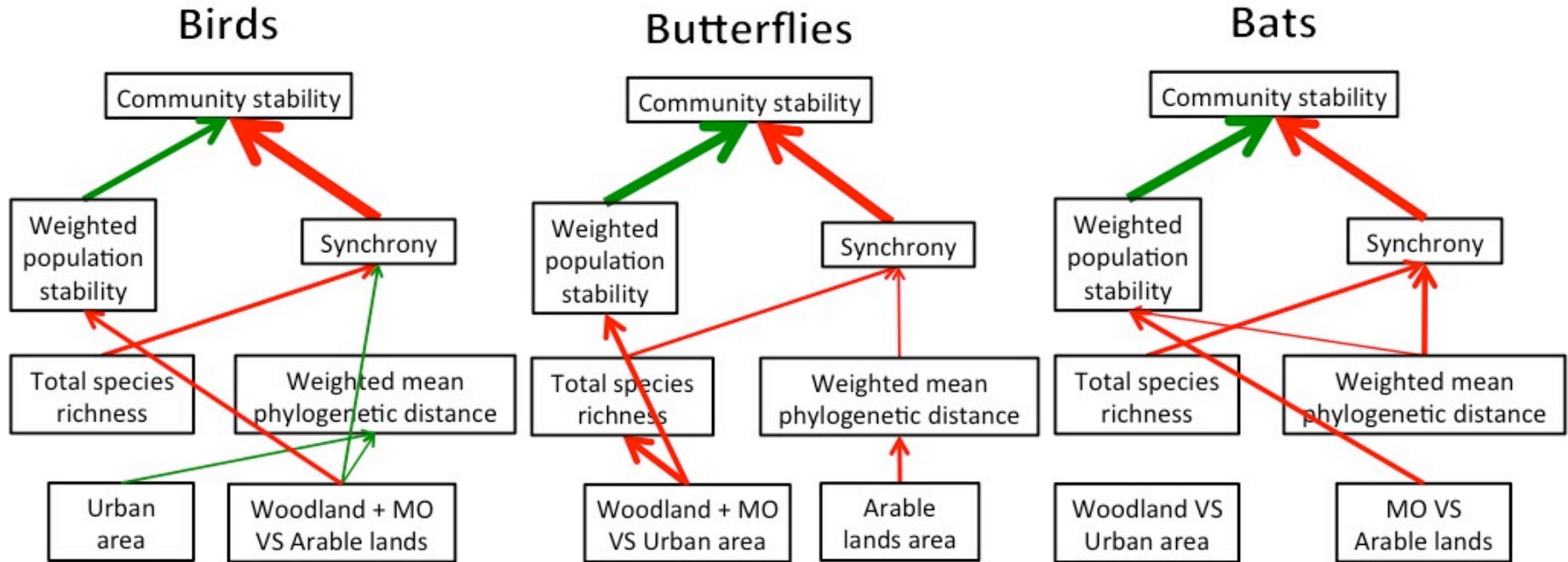
- ➔ Positive effect of Species richness and phylogenetic distance on community stability
- ➔ Species richness effect > phylogenetic distance effect

# Community composition level



- Positive effect of Species richness and phylogenetic distance on community stability
- Species richness effect > phylogenetic distance effect
- Effects mostly mediated by changes in population synchrony

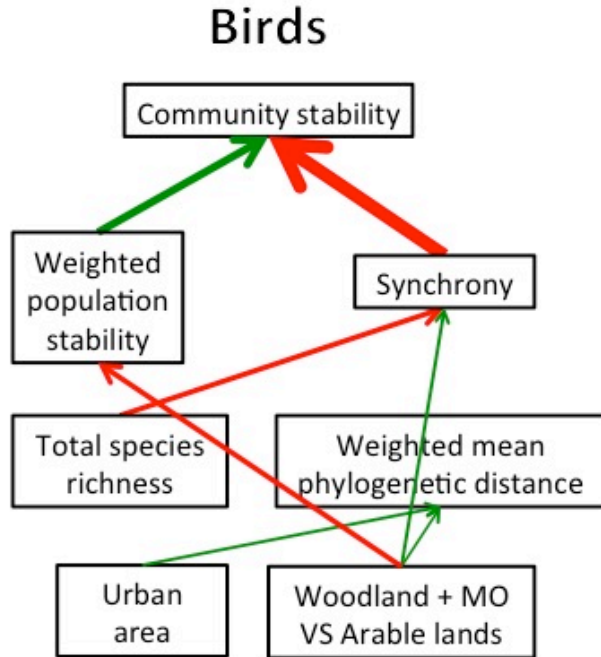
# Landscape perturbations level



→ Effects of landscape perturbations are variable among taxa

# Landscape perturbations level

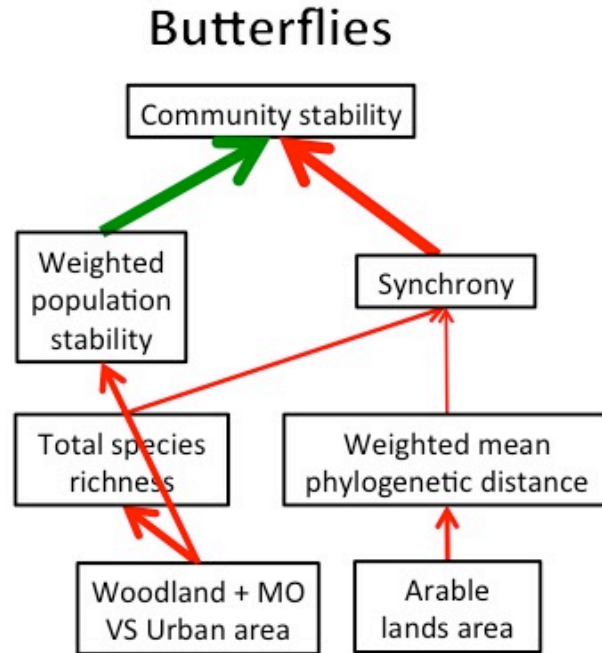
---



- ➔ The increase of urban area and arable lands increases the weighted mean phylogenetic distance
- ➔ The increase of arable lands increases the population's synchrony
- ➔ The increase of arable lands decreases the weighted mean population's stability

# Landscape perturbations level

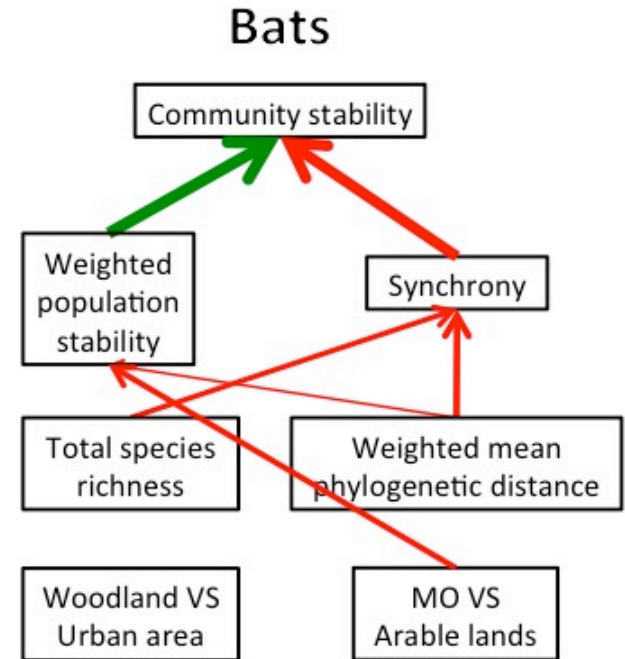
---



- ➔ The increase of urban area decreases the species richness and the weighted mean population's stability
- ➔ The increase of arable lands decreases the weighted mean phylogenetic distance

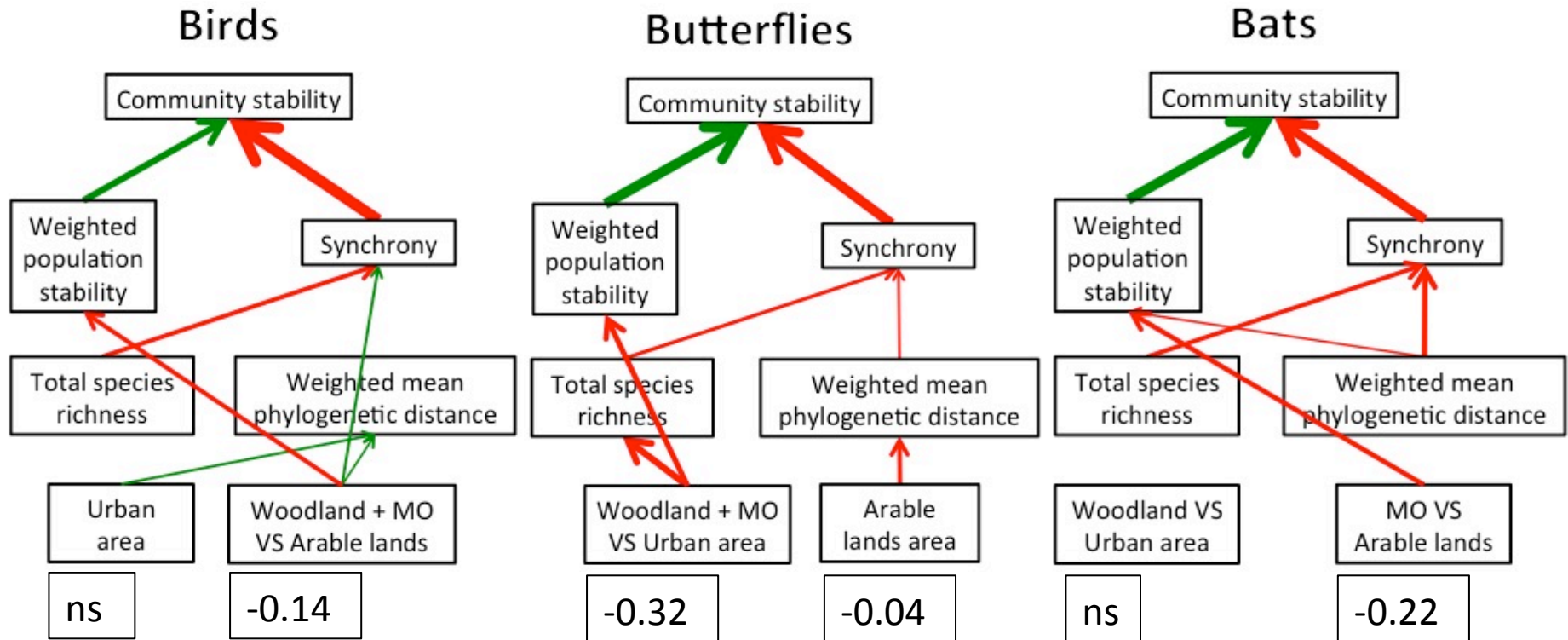
# Landscape perturbations level

---



➔ The increase of arable lands decreases the weighted mean population's stability

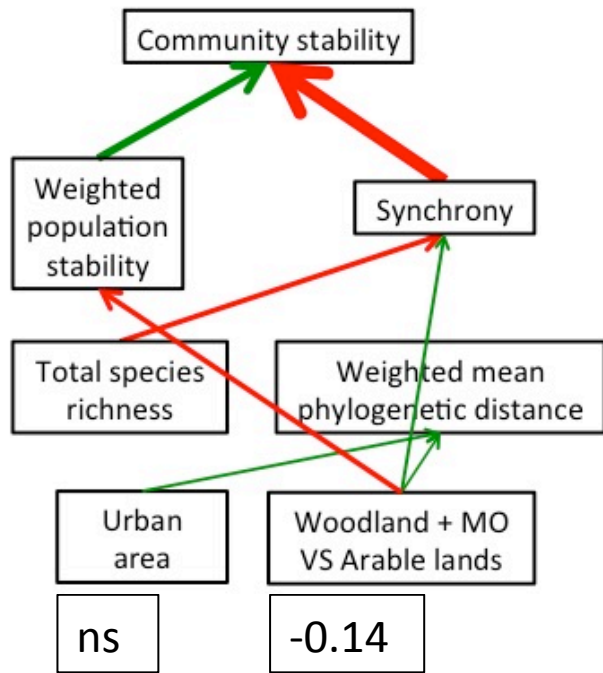
# Landscape perturbations level



➔ Negative effects of landscape perturbations

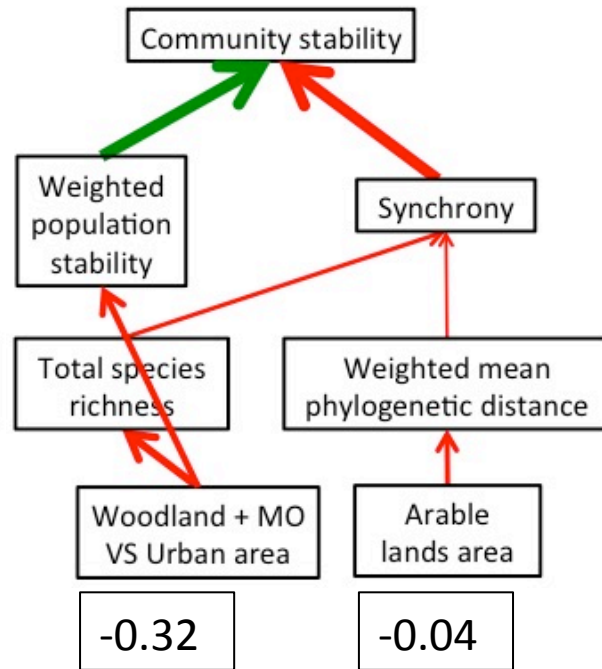
# Landscape perturbations level

## Birds



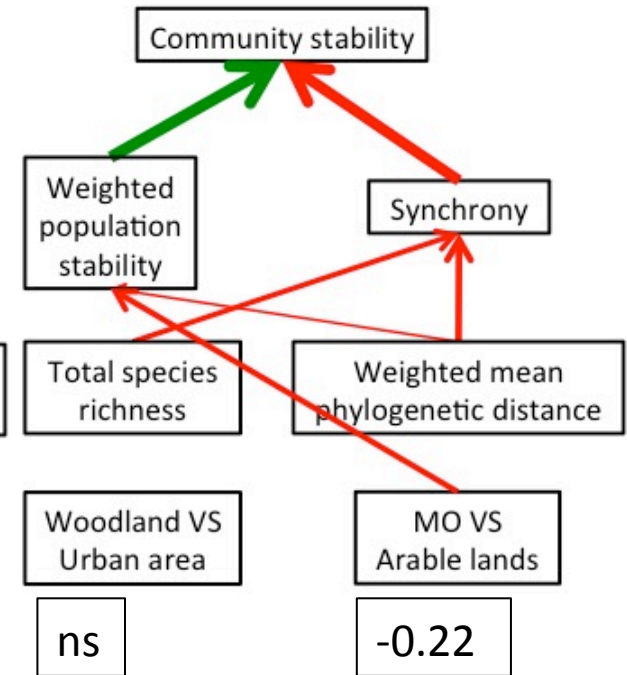
Composition effect = 0  
Dynamic effect = -0.14

## Butterflies



Composition effect = -0.11  
Dynamic effect = -0.25

## Bats



Composition effect = 0  
Dynamic effect = -0.22

- ➔ Negative effects of landscape perturbations
- ➔ Perturbation affect community stability by impacting community composition and community dynamic



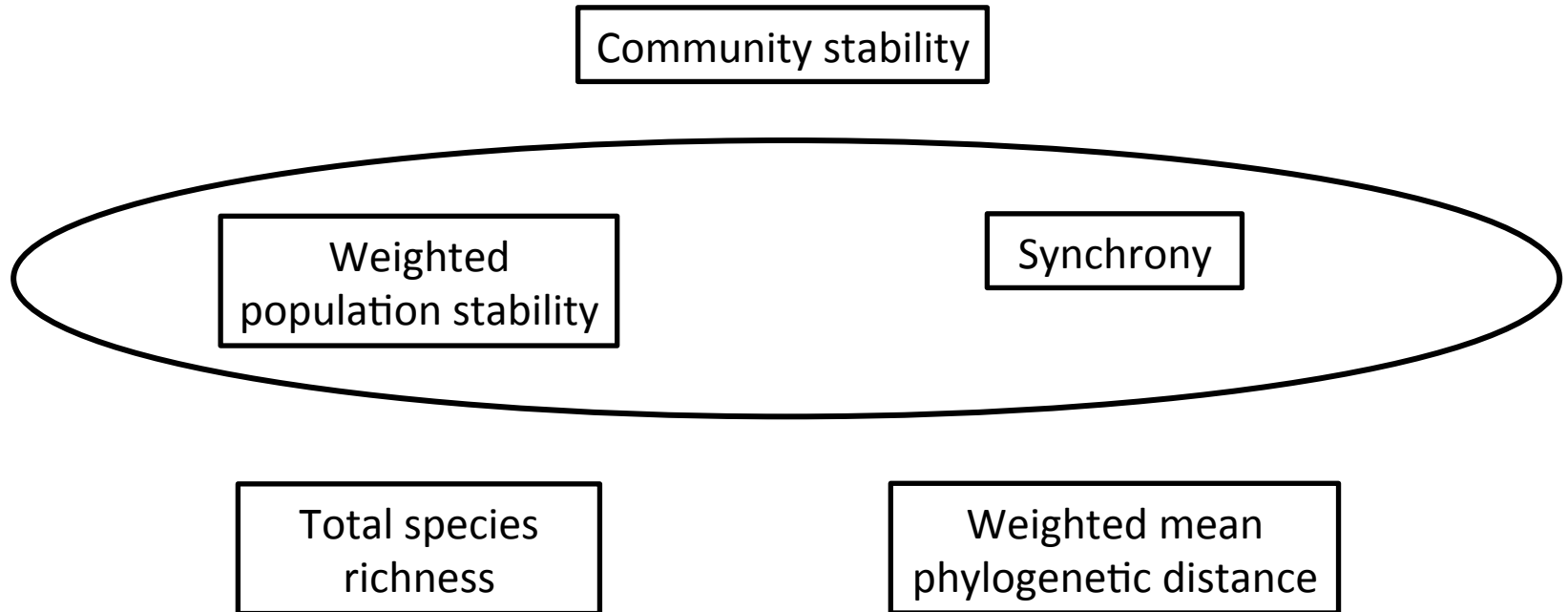
# Take home message

---

- There is a positive diversity – stability relationship in natural communities
- The population synchrony appears to be the main mechanism of the diversity-stability relationship in natural communities
  - Why is there no stronger effect of phylogenetic distance among species?
- Environmental perturbations have a direct impact on community dynamic, and in particular population stability
  - Need for a better understanding of the determinants of the mean – variance scaling of natural population densities

# Perspectives

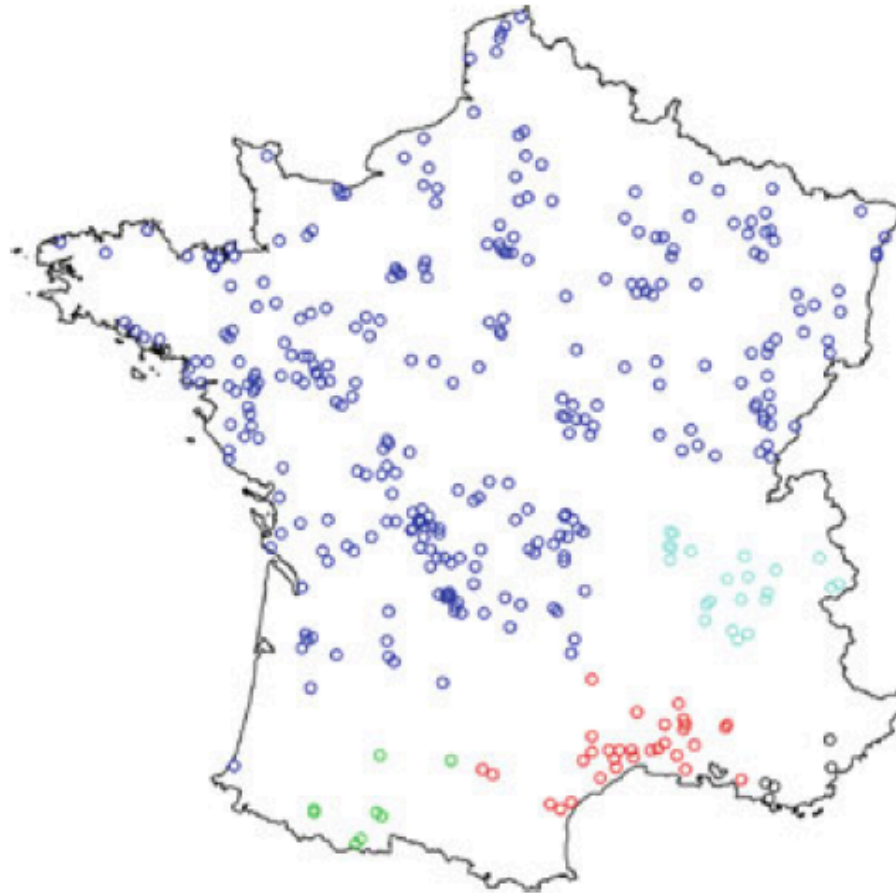
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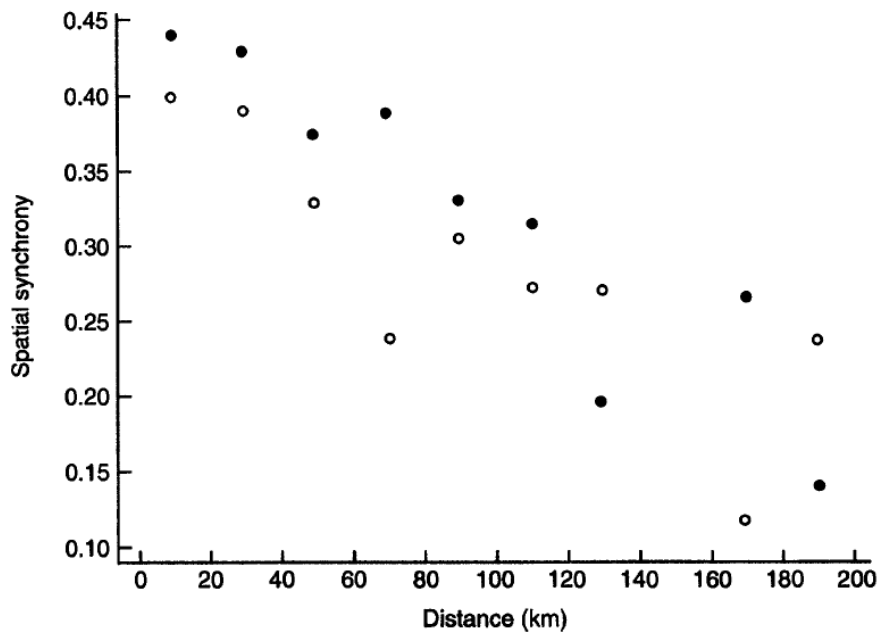
# Perspectives

---

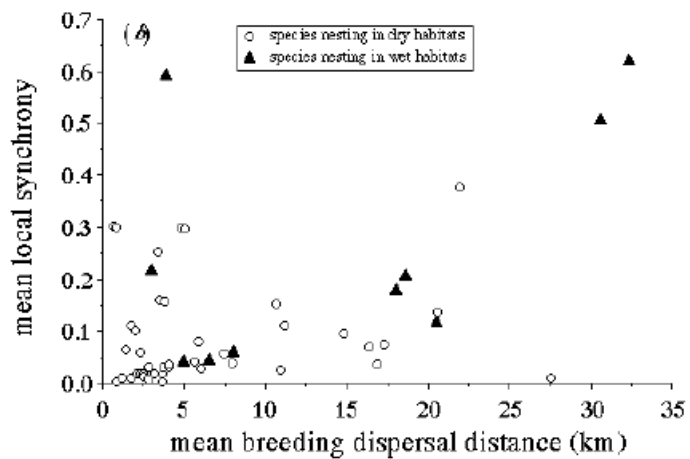
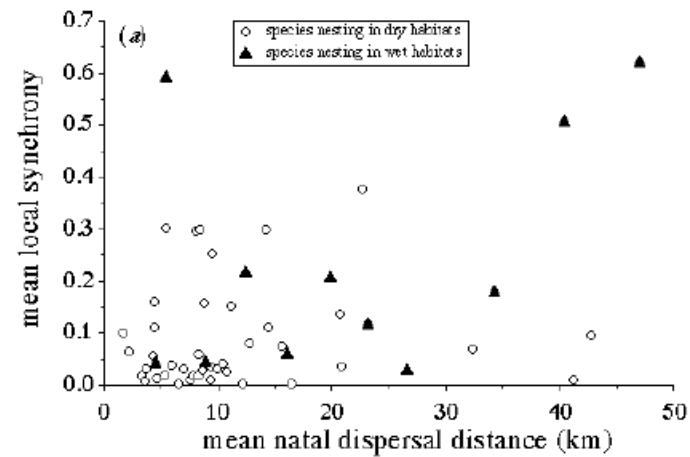
Synchrony



# Perspectives



## Synchrony



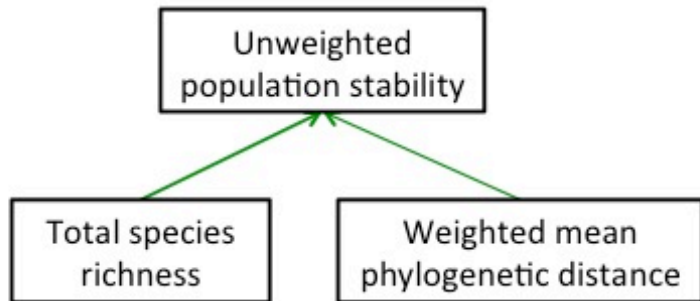
- Are groups of species showing synchrony locally consistent across region?
- Can we identify bio-geographical regions where groups of species are synchronous ?

# Perspectives

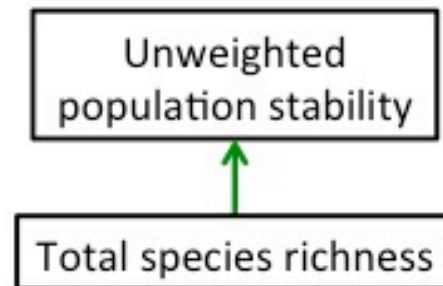
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Population stability

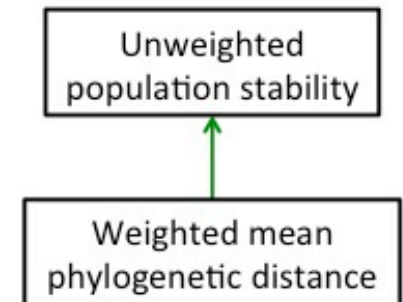
## Birds



## Butterflies

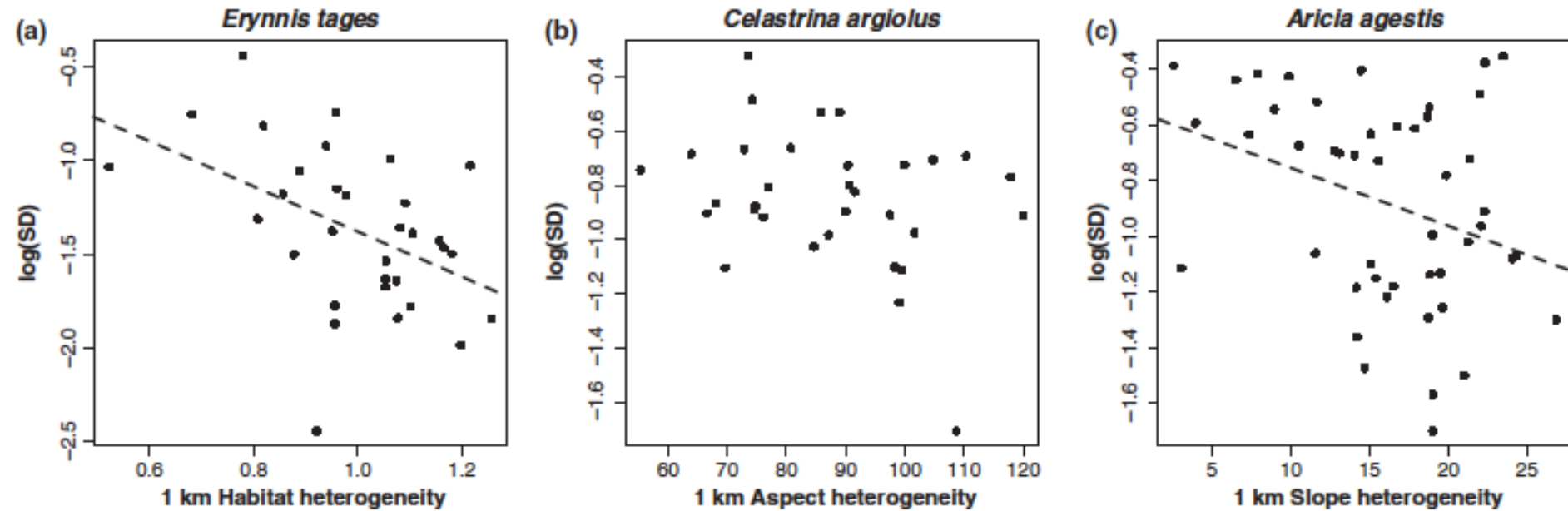


## Bats



# Perspectives

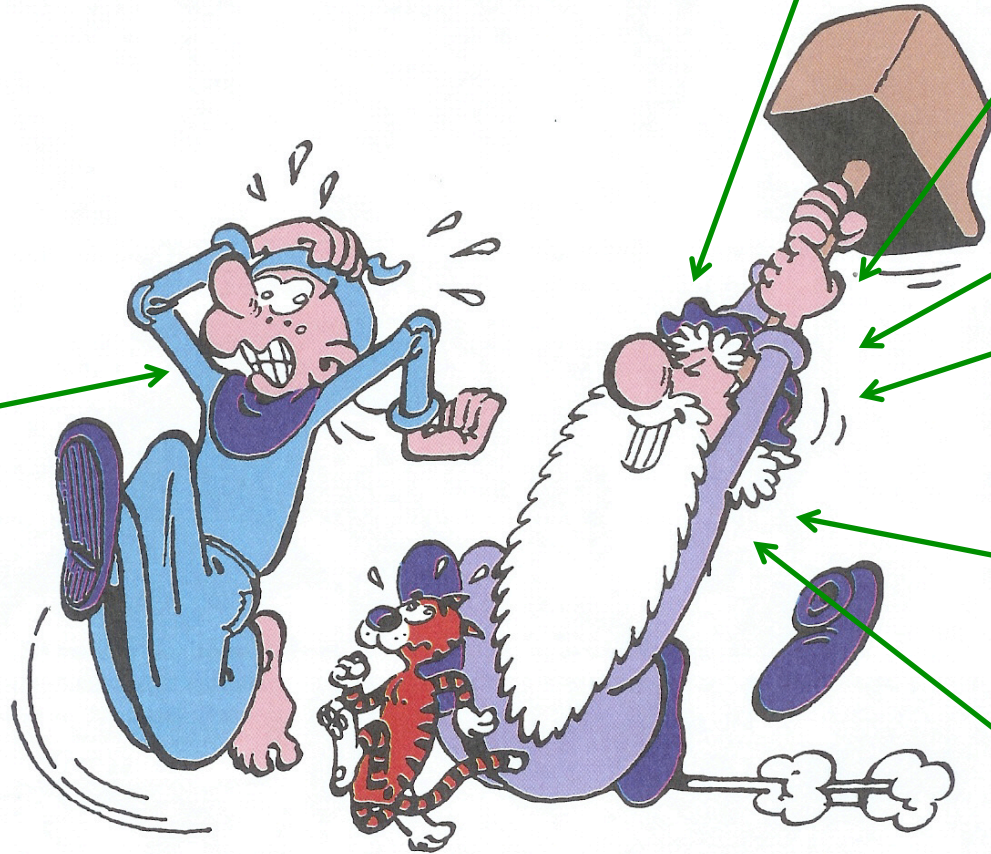
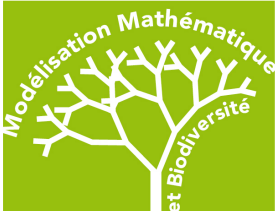
Population stability



- Which kind of species have their population stability impacted by the species richness of the community ?
- Is the impact of landscape perturbations on population stability related to species' relative abundance or functional traits?



# Thank you for your attention



« Je sers la science et c'est ma joie »

*Basile Landouye, disciple de Léonard le Génie*

# Butterfly data



Observatoire  
de la Biodiversité  
des Jardins

OPÉRATION PAPILLONS

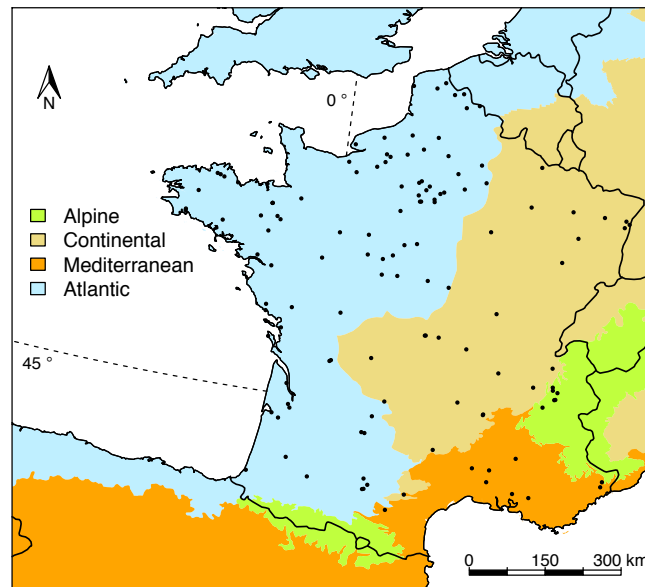
	<b>Lycènes bleus</b> <i>ici, Polyommatus icarus</i> Taille: 30-35 mm. Dessus des ailes bleus chez le mâle, et brun foncé chez la femelle. Dessus bleu clair chez les deux, avec des points noirs encadrés de blanc, et bordé de points noirs et orange. Chenille : tortue, lustrée, etc.		<b>Machaons</b> <i>ici, Papilio machaon</i> Taille: 80-90 mm. Ailes jaunes avec des dessous noirs réguliers. Ailes antérieures postérieures par une queue et bordées de plusieurs taches bleues et d'une tache rouge orange. Chenille : carotte, fennel.
	<b>Aturores</b> <i>ici, Anthocheilus carolinensis</i> Taille: 40-50 mm. Ailes blanches crème avec deux grosses taches orange vif au bout des ailes avant. Femelle ressemblant aux Pierides mais avec le dessous des ailes blanc marbré de vert. Chenille : crucifères sauvages (choux, carottes).		<b>Cuvrées</b> <i>Lycaena phlaeas</i> Taille: 23 mm. Ailes avant orange vif, avec des taches noires et une bordure brune, et ailes arrière marron, bordées d'orange vif. Dessus identique mais en beaucoup plus pâle. Chenille : oseille, romarin.
	<b>Demi-dentés</b> <i>ici, Melanargia galathea</i> Taille: 50-60 mm (femelle un peu plus grande). Les ailes ont le même aspect sur les deux faces : un fond blanc marqué de taches noires en aspect de damier.		<b>Héspérides orangées</b> <i>ici, Thymelicus sylvestris</i> Taille: 25-30 mm. Petit papillon au corps trapu et aux ailes orange, avec une fine bordure noire sur le bord. Chenille : graminées.
	<b>Gazé</b> <i>Aporia crataegi</i> Taille: 60 mm. Les deux faces des ailes sont identiques : blanc presque monochrome, avec des nervures noires très visibles. Chenille : subépineux, punnelier.		<b>Procris</b> <i>Coenonympha pamphilus</i> Taille: 28-30 mm. Ailes orangées marquées d'un petit ocellus noir sur l'aile avant. Dessus orange sur les ailes avant, avec un ocellus noir, et gris sur les ailes arrières. Chenille : graminées.
	<b>Pierides blanches</b> <i>ici, Pieris rapae</i> Taille: 50-60 mm. Ailes blanches avec un ou deux points noirs et une bordure sombre plus ou moins marquée au bout de l'aile avant. Dessus blanc jaunâtre avec des nervures plus ou moins marquées. Chenille : crucifères sauvages et cultivés (choux, cèleri).		<b>Amaryllis</b> <i>ici, Pararge aegeria</i> Taille: 33-45 mm (femelle plus grande). Dessus des ailes orange avec une large bordure brune régulière sur le bord, se poursuivant parfois le long du corps, et un ocellus noir avec deux points blancs sur l'aile avant. Chenille : graminées.
	<b>Citron</b> <i>ici, Gnompteryx rhamni</i> Taille: 50-60 mm. Uniformément jaune vif chez le mâle et blanc verdâtre chez la femelle, les ailes se terminant en pointe. Dans le sud, le mâle du Canton de Provence porte une large tache orange sur les ailes avant. Chenille : sorgho et bordure.		<b>Belle-dame</b> <i>Vanessa cardui</i> Taille: 60-65 mm. Dessus des ailes orange avec des taches noires. Bordure des ailes avant noire avec des taches blanches. Dessus des ailes arrière brun clair, avec des marbrures brunes et blanches. Ailes avant orange ponctuées de noir et de blanc, comme sur le dessus. Chenille : chardon, ortie, etc.
	<b>Flambés</b> <i>ici, Iphiclides podalirius</i> Taille: 70-90 mm. Ailes jaunes pâles, avec zébrures noires. Ailes arrière portant une longue queue noire terminée de blanc et des marques blanches en forme de demi-lune. Chenille : punnelier.		<b>Peuples tortues</b> <i>ici, Iphigonia albanus</i> Taille: 42-45 mm. Dessus des ailes orange avec des taches noires et jaunes caractéristiques sur l'aile avant, et une bordure noire ornée de taches blanches. Dessus des ailes très foncé. Chenille : ortie.

- Abundance of 28 butterfly species and species groups in private gardens
- Between March and October
- 1 data per month of observation
- Max number of individuals seen simultaneously
- Frequency of visits

# Butterfly data

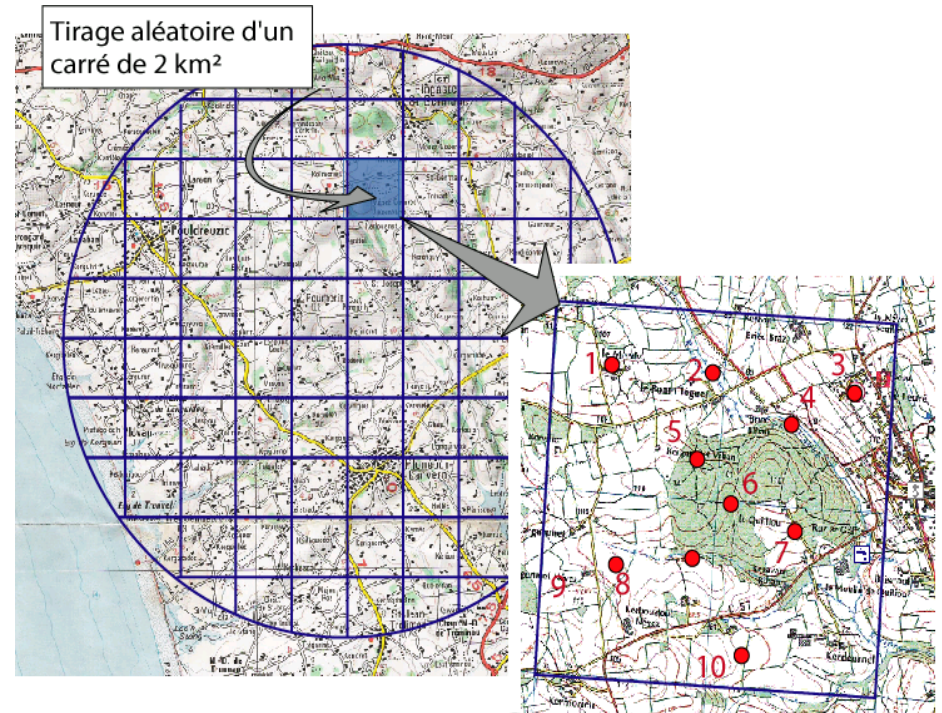
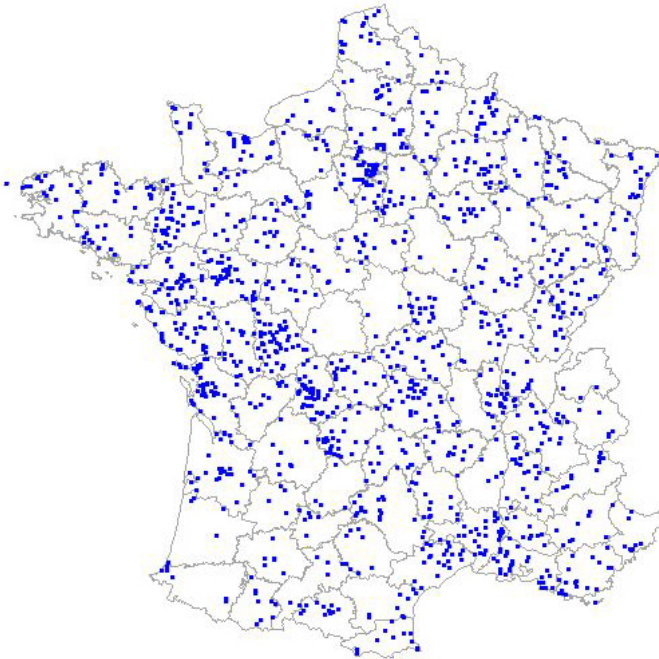
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- 131 residential gardens across France
- Butterfly abundance in July
- 8 continuous years of observations
- 14 species





# Bird data

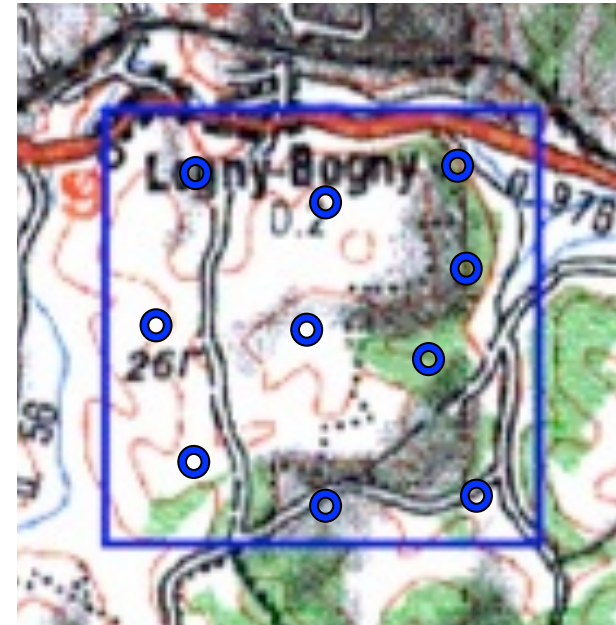


Squares of 2km / 2km  
Randomly selected

# Bird data

---

- 10 points / square
- Standardized habitat description
- Two observation events / year (spring)
- 5 minutes (1h after the sunrise)
- Same place
- Same date
- Same volunteer



# Bird data

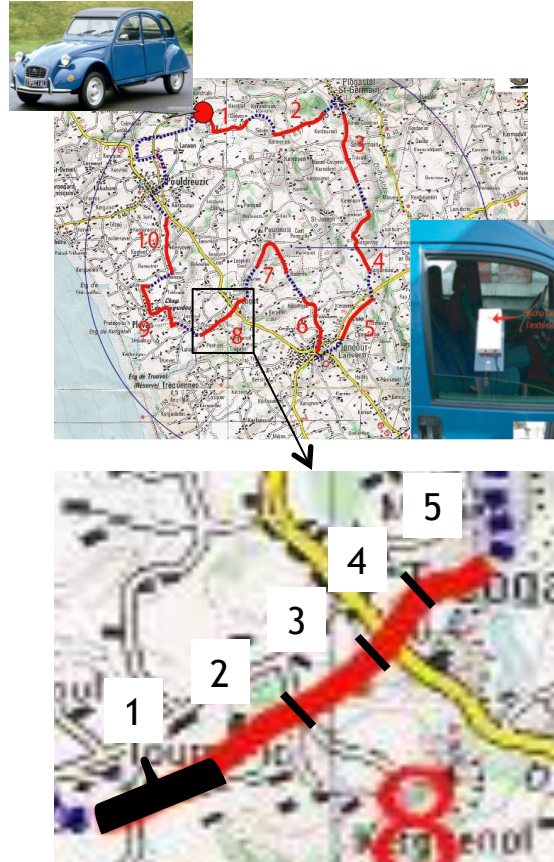
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- 269 squares
- Mean abundance / year / square
- 8 continuous years of observations
- 75 common species

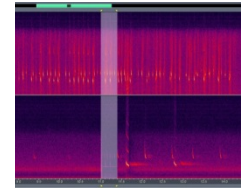


# Bat data

- Since 2006
- Survey by car
- Acoustic signals
- 2 times / year
- 10 tracks of 2km
- 5 transects of 400m / track



**Vigie-Chiro**  
Suivi des chauves-souris





# Bat data

---

- 162 transects
- Mean abundance / year / transect
- 4 continuous years of observations
- 7 species

