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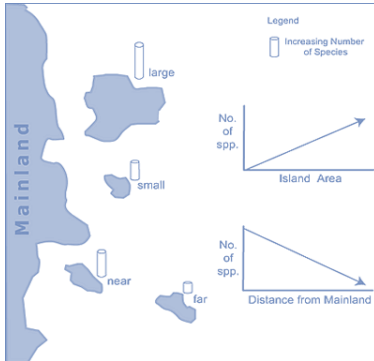
Managing landscape spatio-temporal heterogeneity for biodiversity conservation



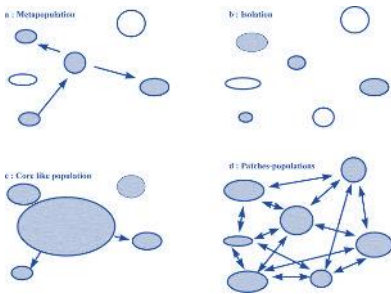
Clélia Sirami
DYNAFOR-INRA Toulouse France



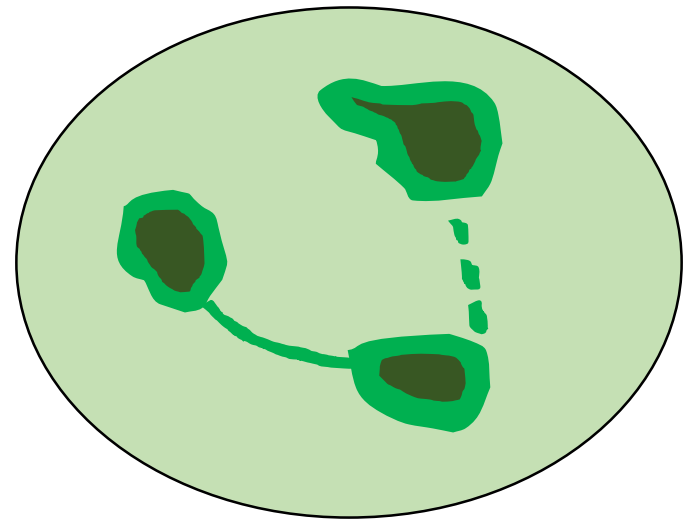
Landscape ecology: A dominant paradigm



Island biogeography theory
(MacArthur and Wilson 1967)



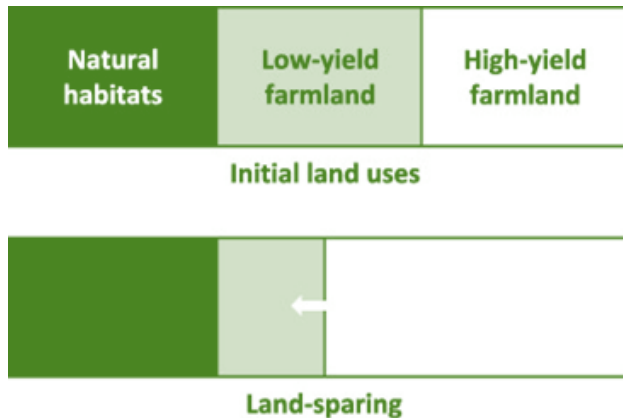
Metapopulation theory
(Hanski & Gilpin 1991)



Habitat-matrix paradigm
(Forman & Godron 1986)

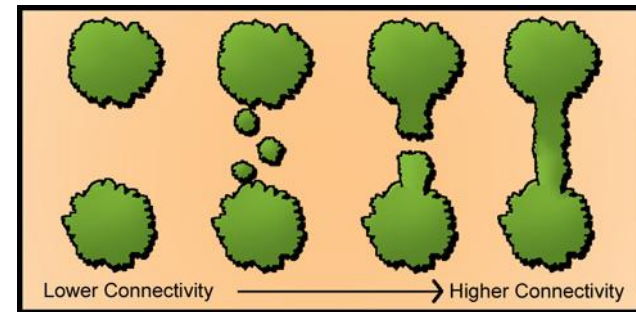
Biodiversity conservation main strategies

Land sparing at multiple scales



From Green et al. (2006)
... to Ekroos et al. (2016)

Increasing habitat connectivity (species traits, invasion, adaptive potential)

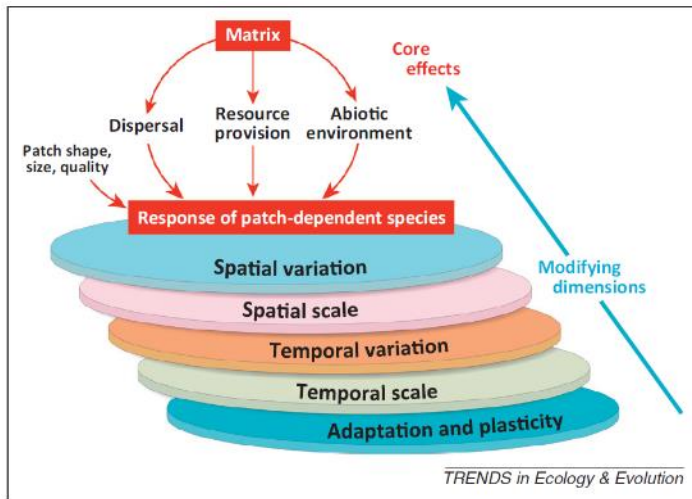


From Fahrig (2003)
... to Caplat et al. (2016)

The role of the matrix?

Conceptual domain of the matrix in fragmented landscapes (Driscoll et al. 2013)

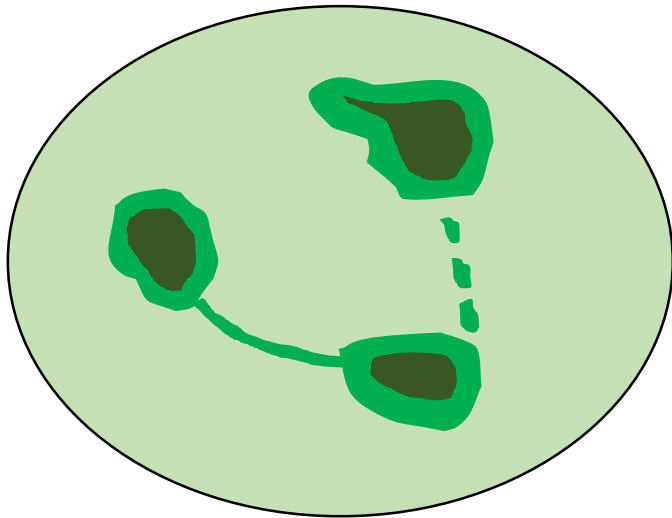
- Not homogeneous/static
- Spatial/temporal scale
- Species adaptation



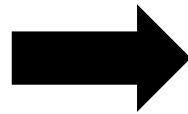
<https://www.youtube.com/watch?v=JZwTZ-d1ZRE>

=> A matrix focus is now both important and possible!!!

Landscape ecology: A paradigm shift



Habitat-matrix paradigm
(Forman & Godron 1986)

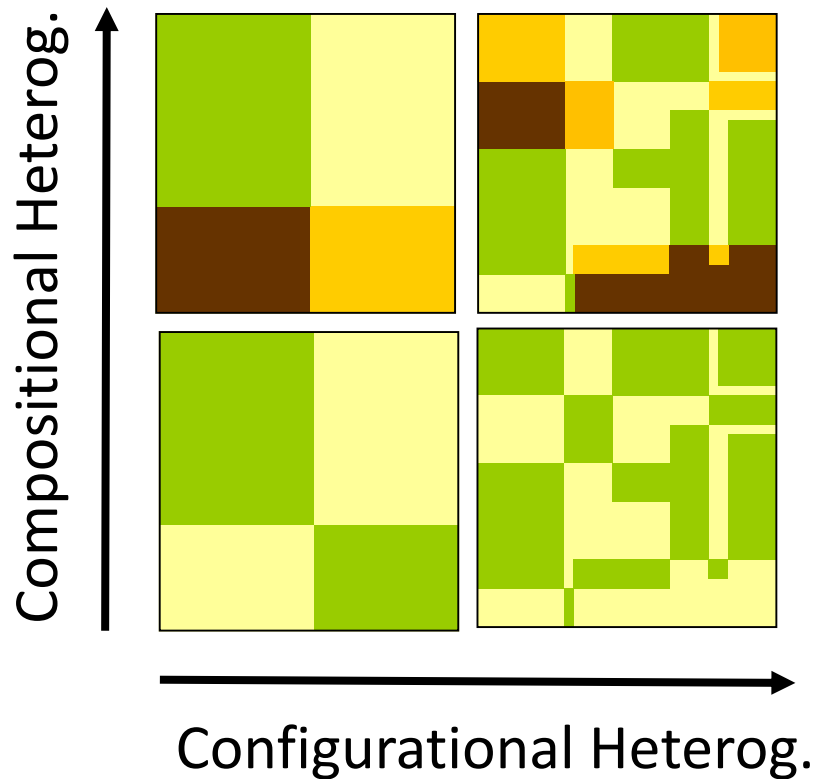


Mosaic paradigm
(McGarigal & Cushman 2002)

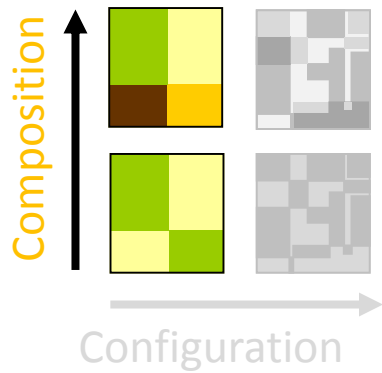
Biodiversity conservation through landscape heterogeneity

Functional landscape heterogeneity and animal biodiversity in agricultural landscapes (Fahrig et al. 2011)

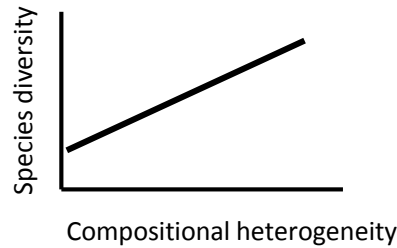
Two separate components



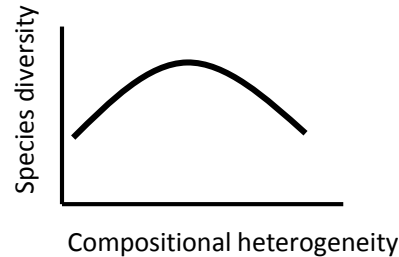
Biodiversity conservation through landscape heterogeneity



Species in ≠ habitats
Landscape complementation

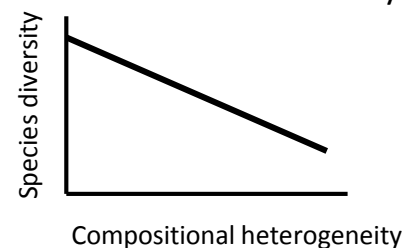


Dunning et al. (1992)

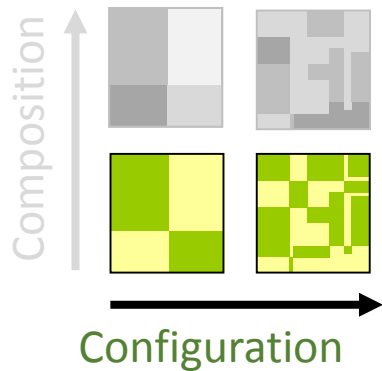


Allouche et al. (2012)

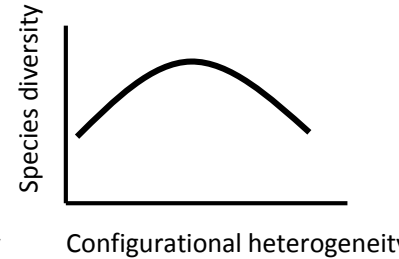
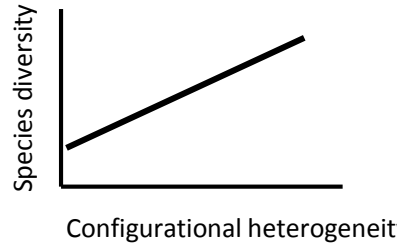
Total habitat area requirement
Habitats with >>> diversity



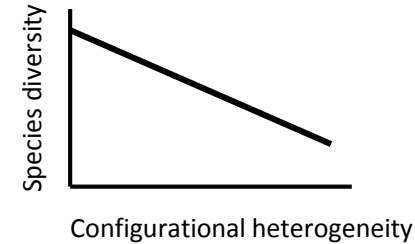
Tscharntke et al. (2012)



Patch permeability/connectivity
Landscape complementation



Negative edge effect
Minimum patch size requirement



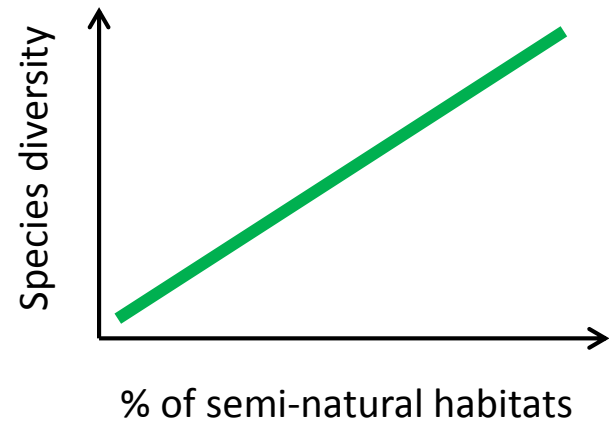
Dunning et al. (1992)

Allouche et al. (2012)

Tscharntke et al. (2012)

Landscape heterogeneity in agricultural landscapes...

Proportion of semi-natural habitats



Role studied/known

Implementation not always feasible

... A paradox?

**Proportion of
few semi-natural habitats**



Role studied/known

Implementation not always feasible

**Heterogeneity of the
large « farmland matrix »**

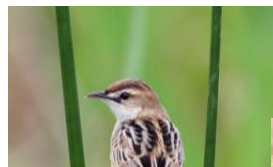


Role ?

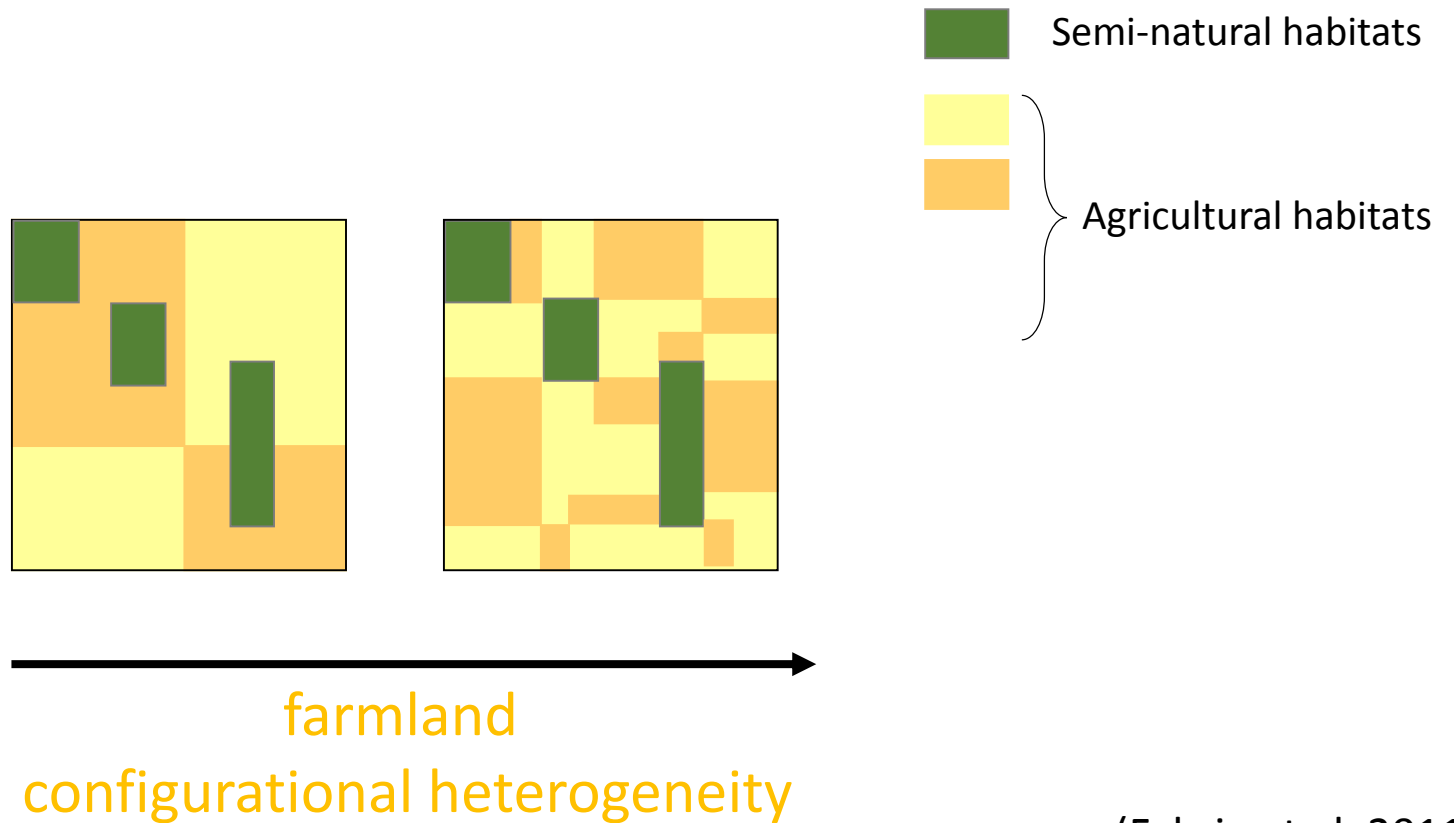
Implementation ?



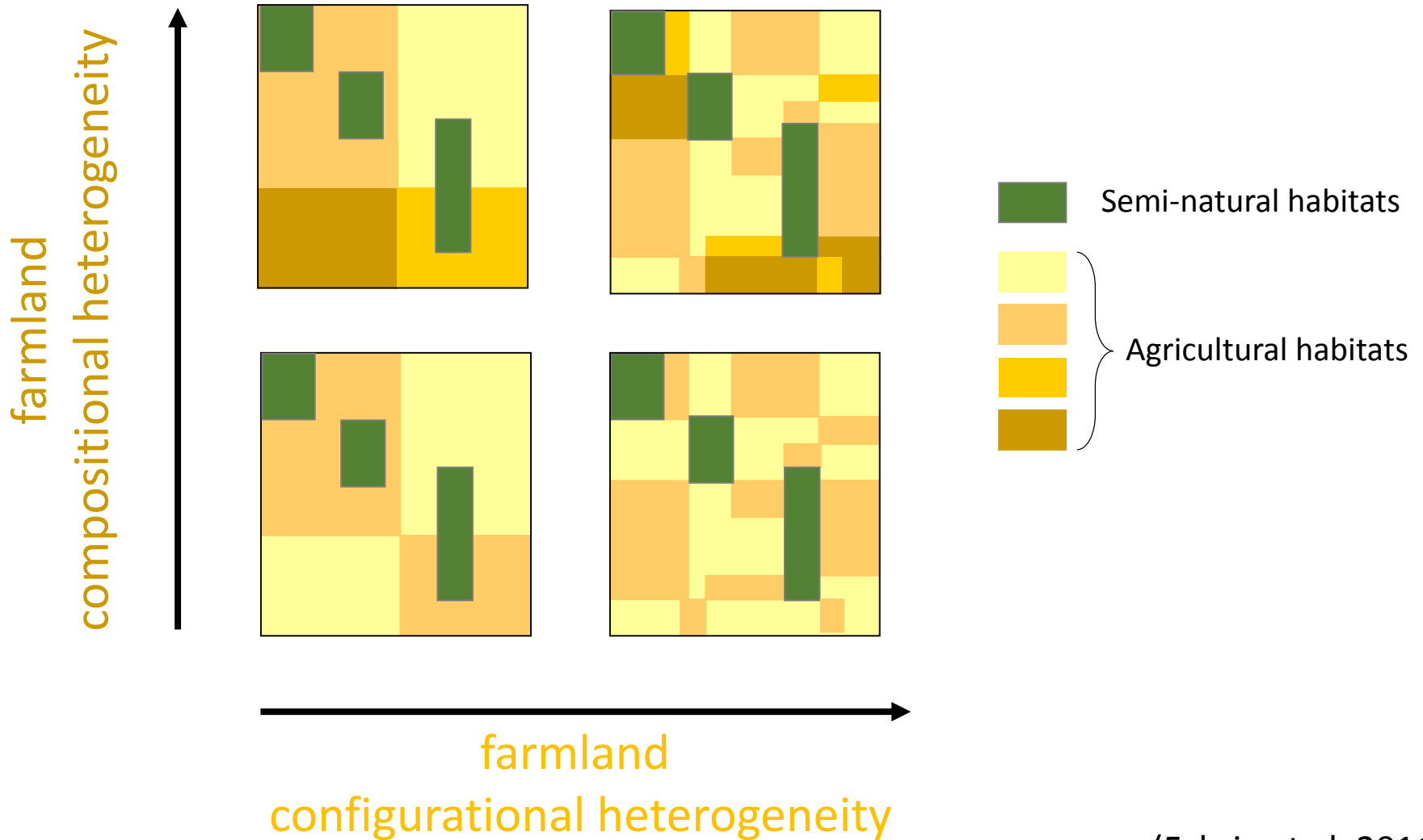
FarmLand



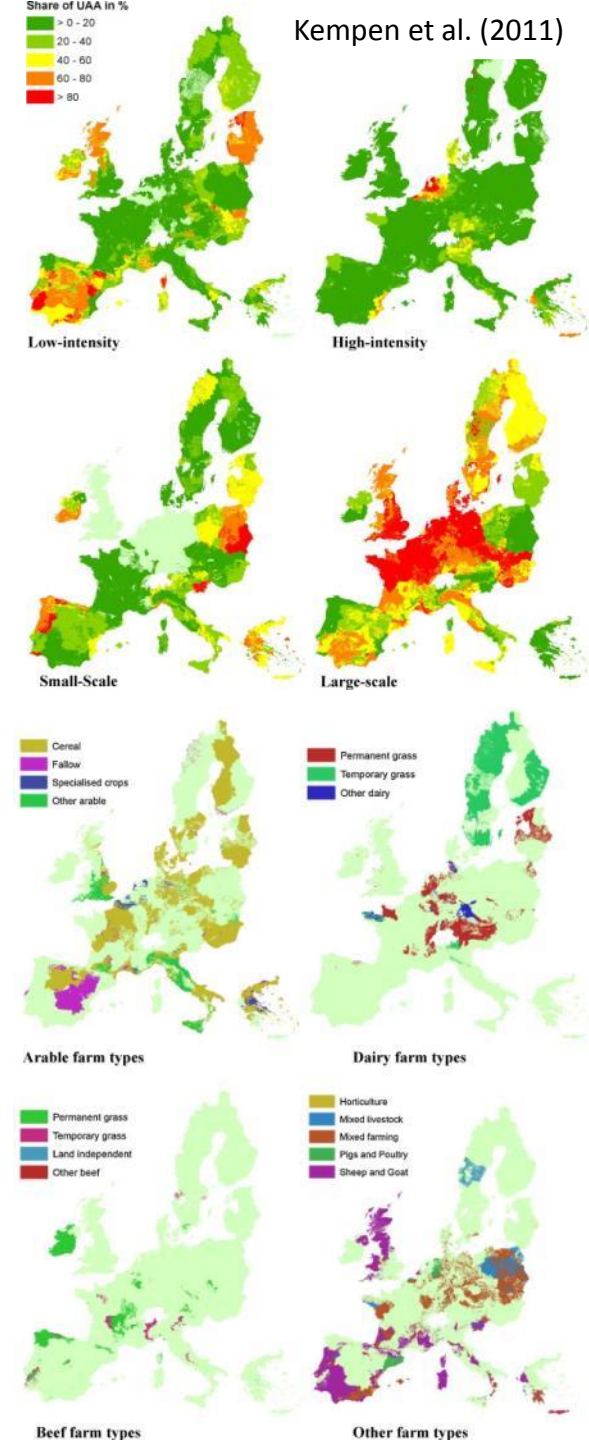
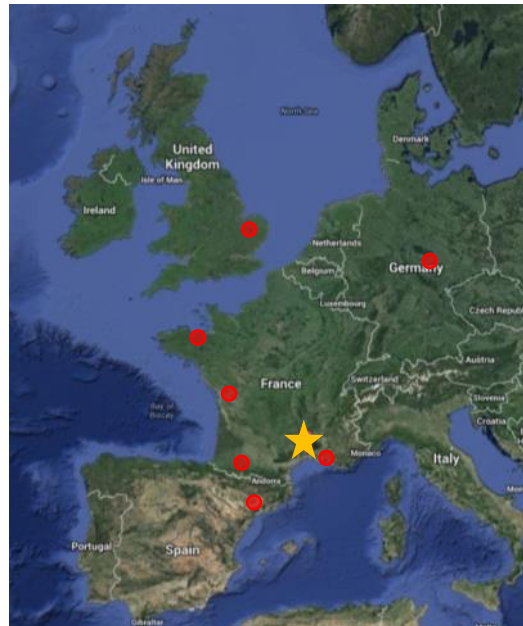
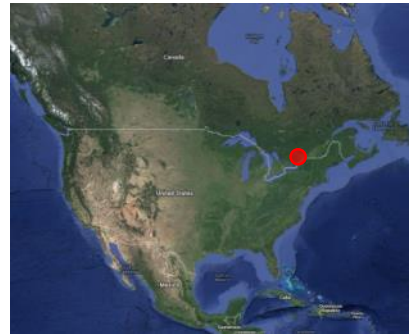
Farmland heterogeneity



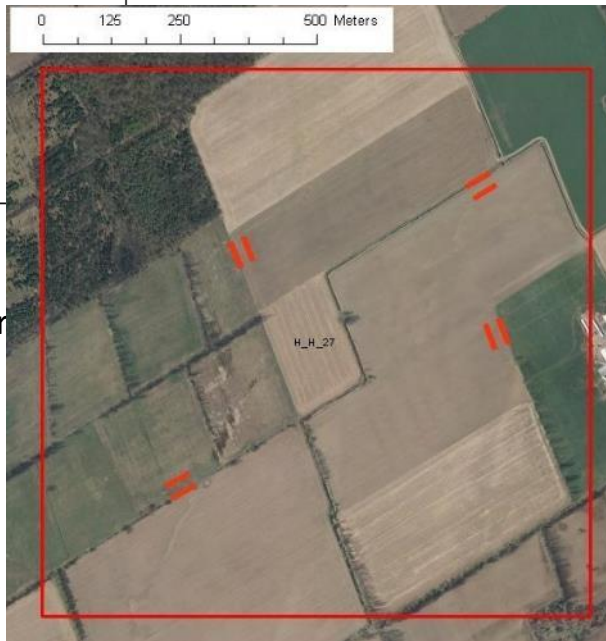
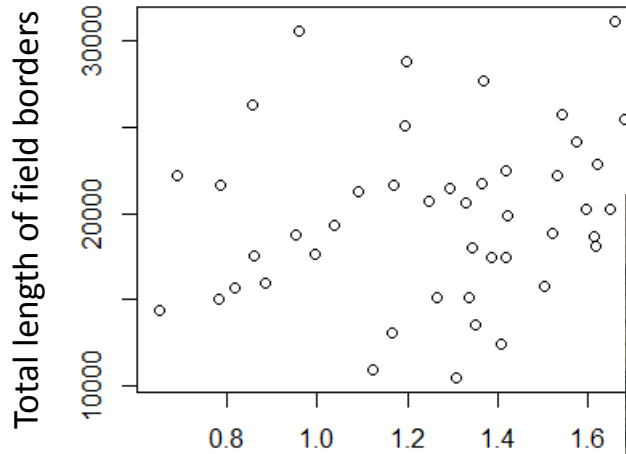
Farmland heterogeneity



8 regions



Common protocols across regions



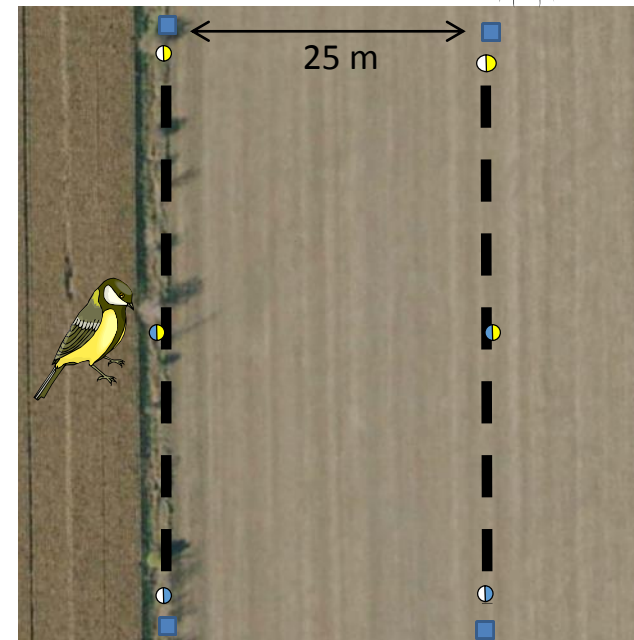
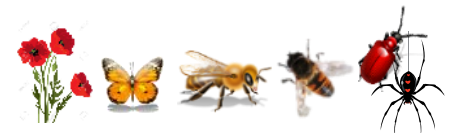
Shannon diversity index of agriculture

1. Landscape selection

- ⇒ 1 x 1 km
 - ⇒ 2 independent gradients
 - ⇒ 10-40% semi-natural habitat
 - ⇒ 30-90 landscapes/region
- Total: 435 landscapes

2. Sampling site selection

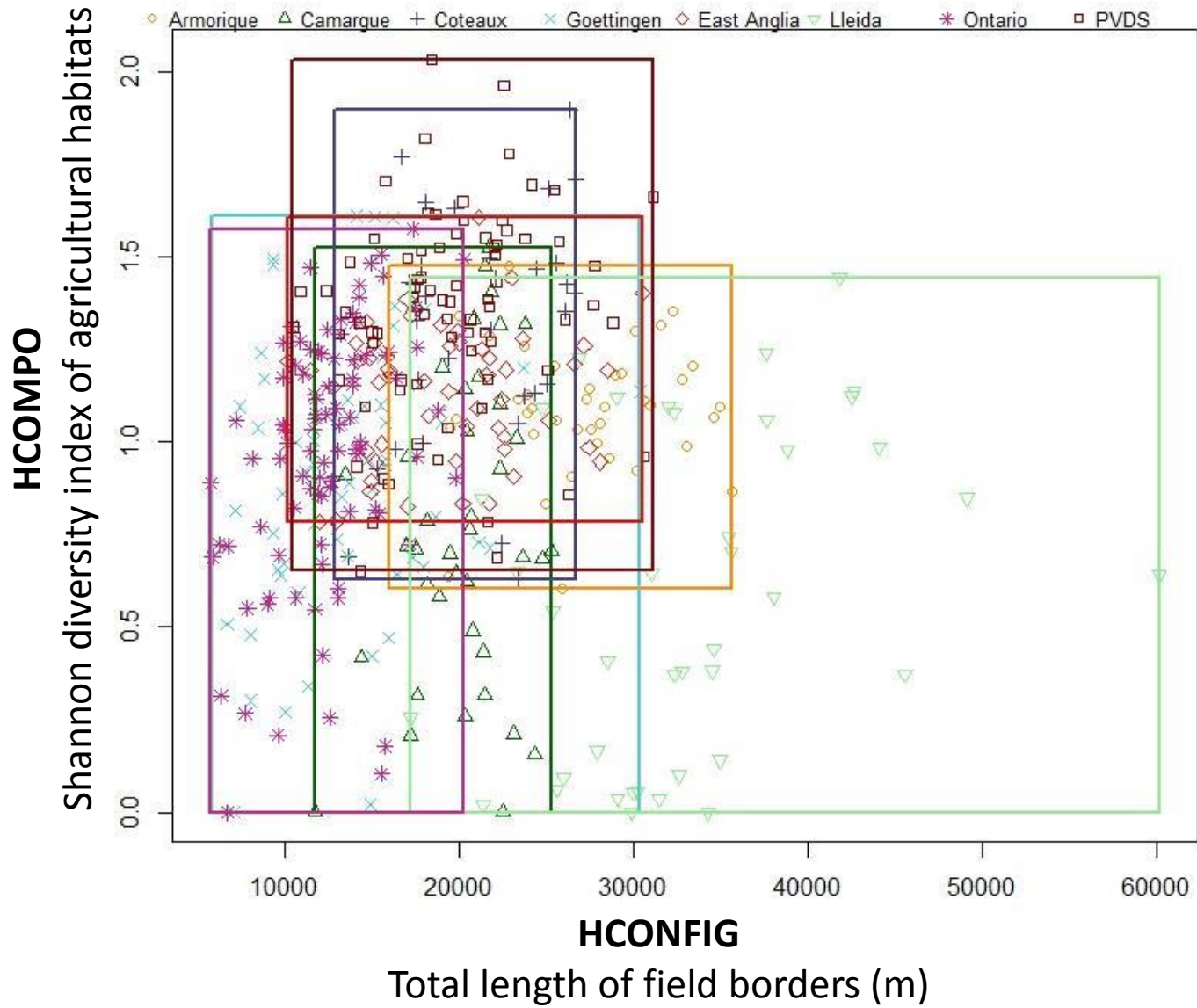
- ⇒ 3 representative fields (cereal, corn, grassland)
- Total: 1305 fields



3. Biodiversity

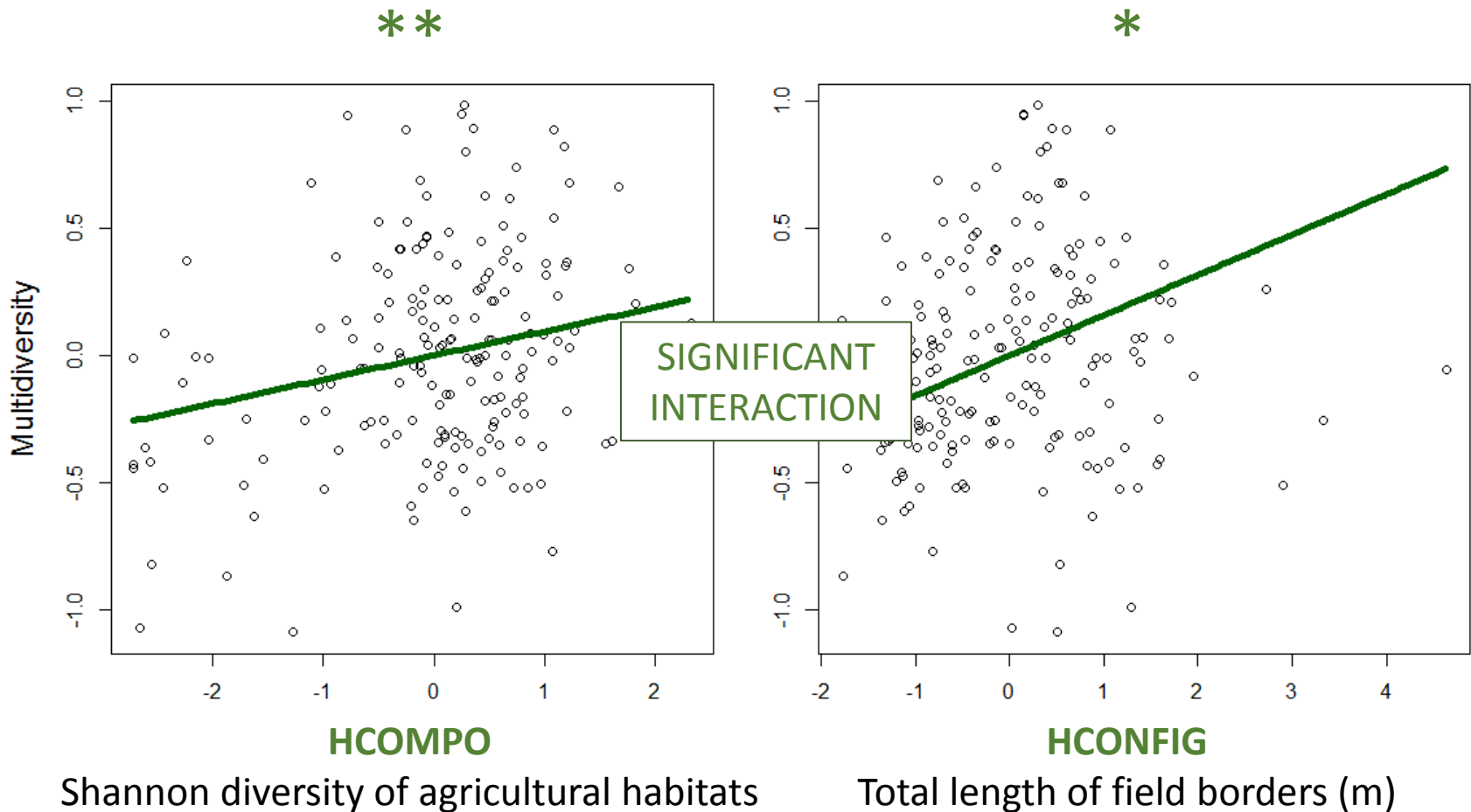
7 taxa, >2795 species

Farmland heterogeneity gradients



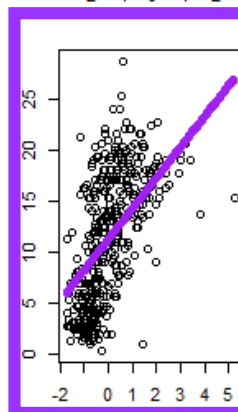
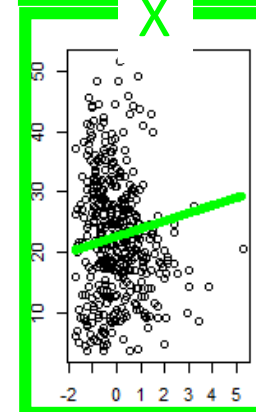
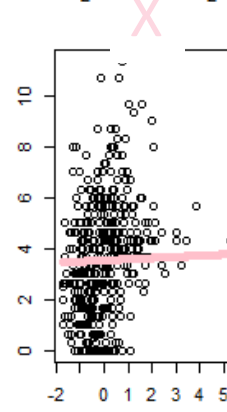
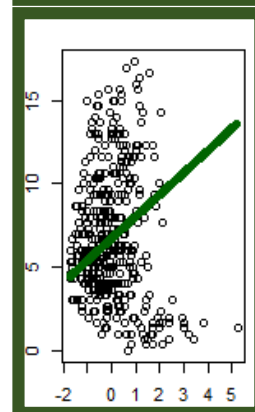
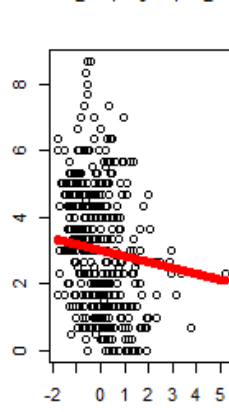
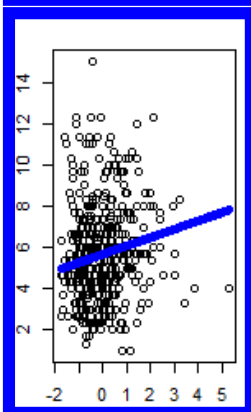
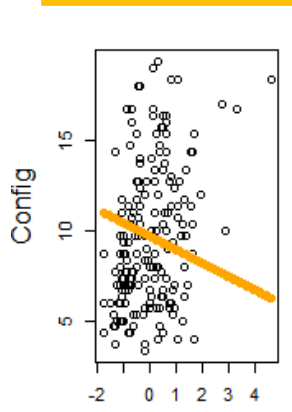
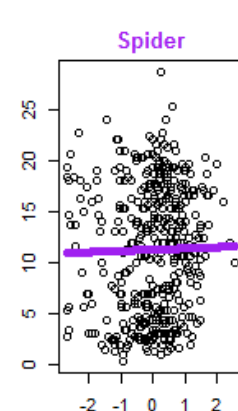
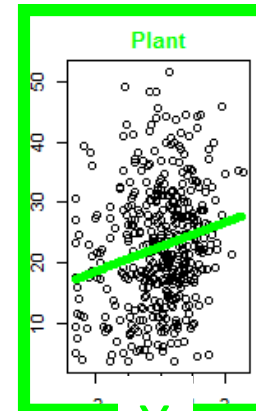
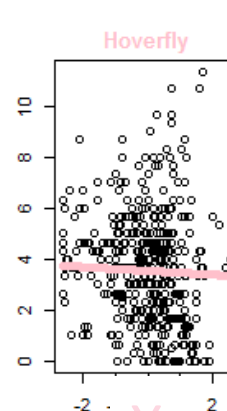
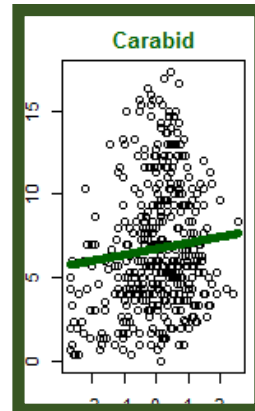
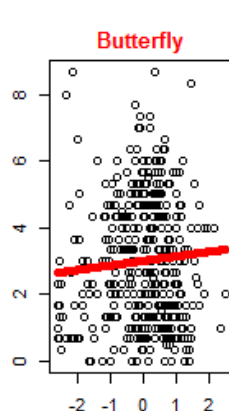
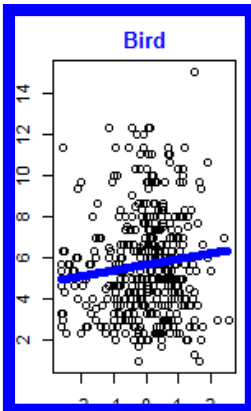
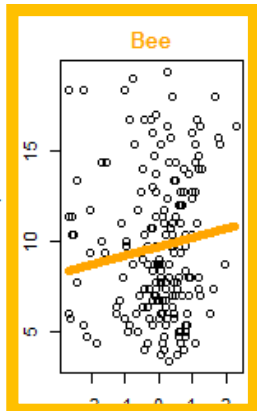
Farmland heterogeneity effects

1) Response across taxa and regions : Multidiversity index (Allan et al. 2013)



Farmland heterogeneity effects

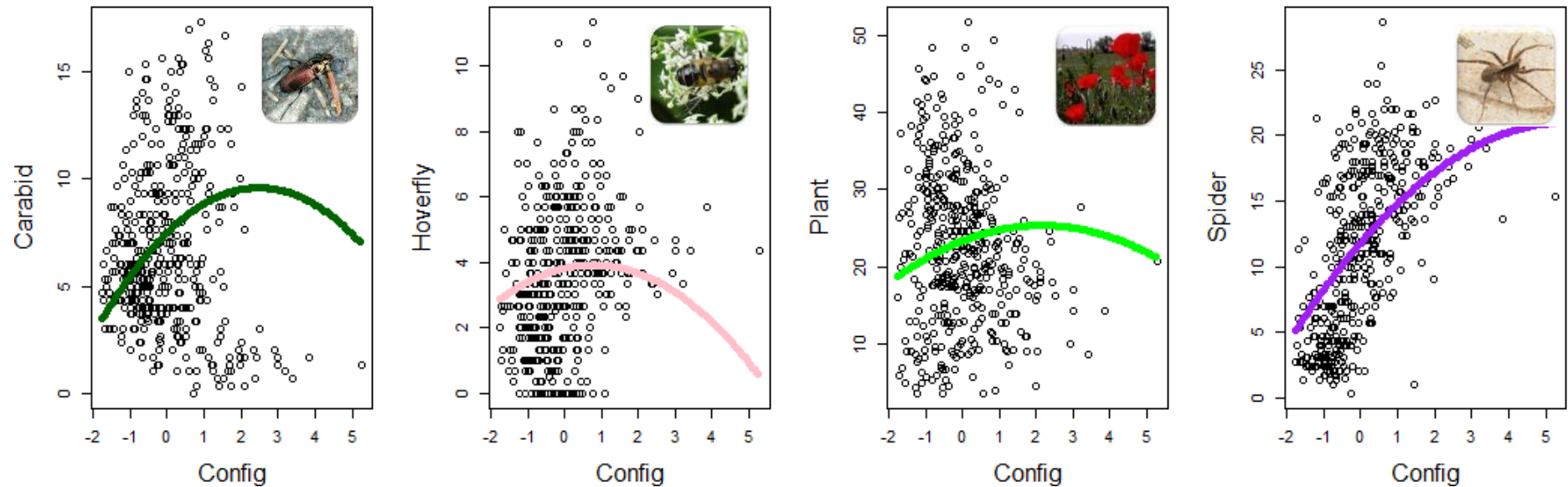
2) Variations between taxa:



Farmland heterogeneity effects

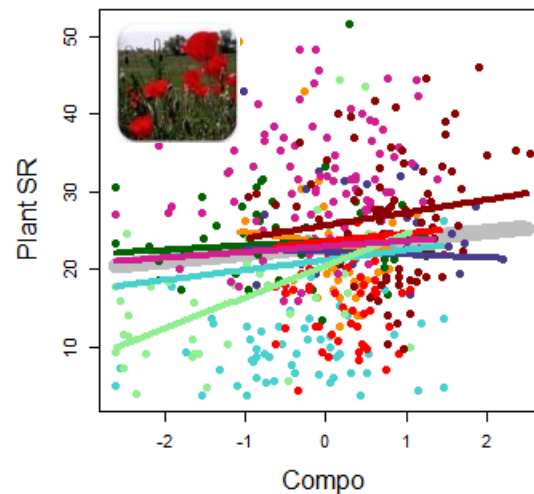
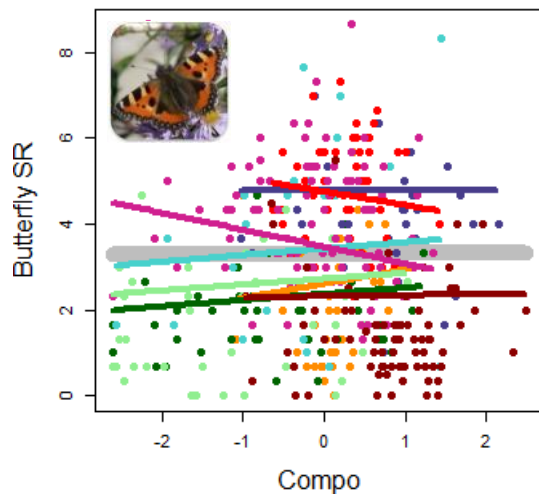
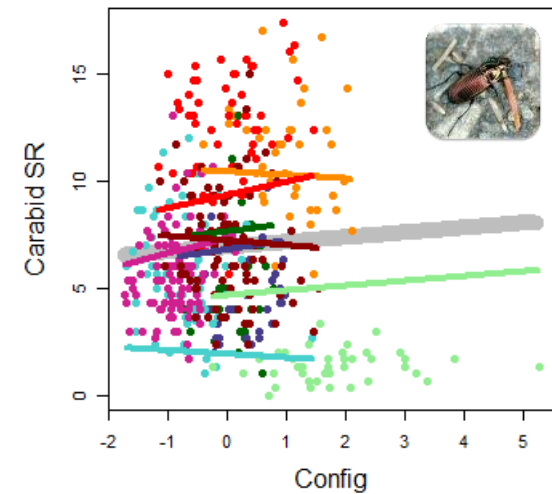
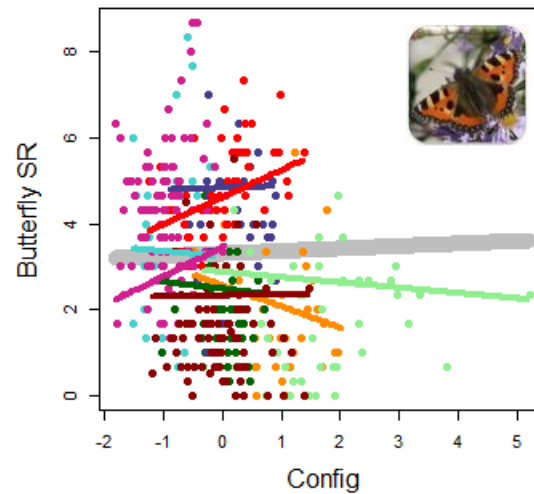
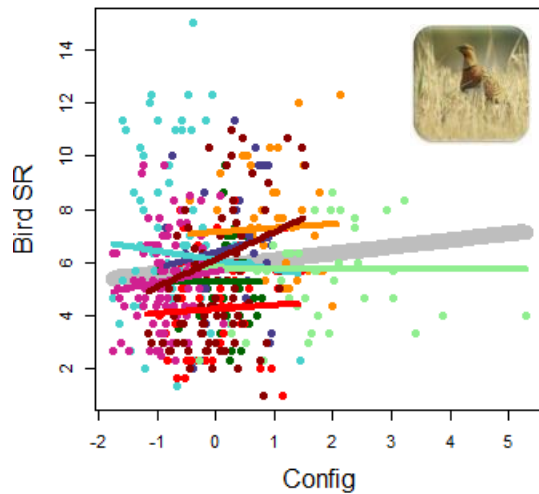
2) Variations between taxa:

Non-linear effects of Farmland configurational heterogeneity (4 taxa)



Farmland heterogeneity effects

3) Variations between regions: Slopes significantly \neq between regions for 4 taxa

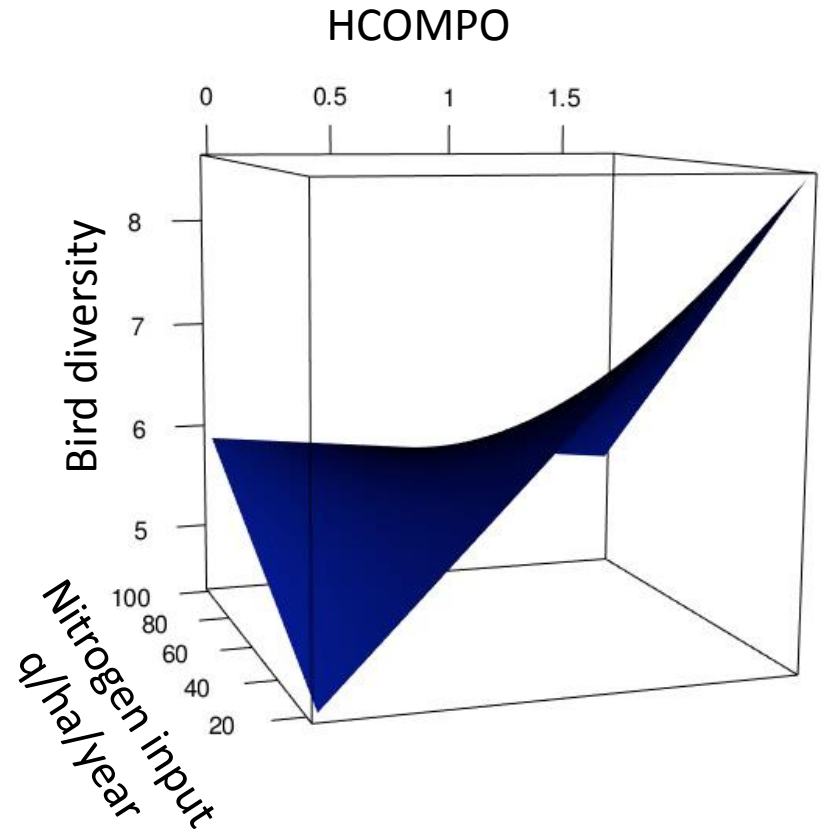
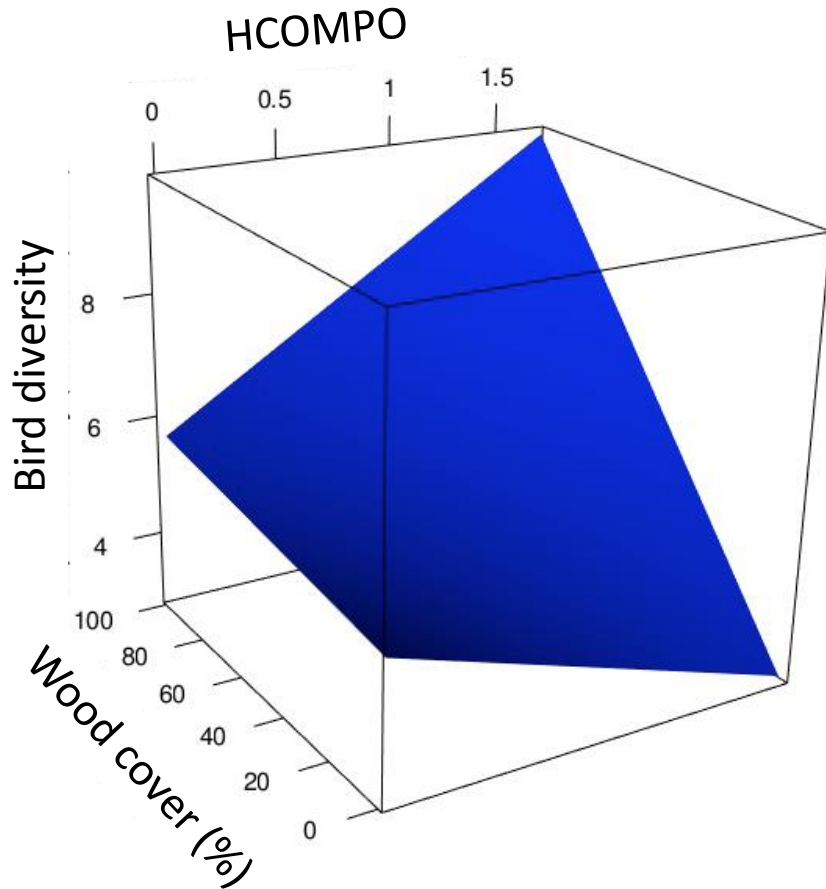


Armorique
Camargue
Coteaux
East Anglia
Goettingen
Lleida
Ontario
PVDS

Complex interactions



Significant interactions between several factors on bird diversity



First conclusions of the FarmLand project

✓ Farmland heterogeneity has a **positive effect on biodiversity** – after controlling for the effects of semi-natural habitats

✓ **Complex interactions:**

Region

Farmland compositional ↔ configurational heterogeneity

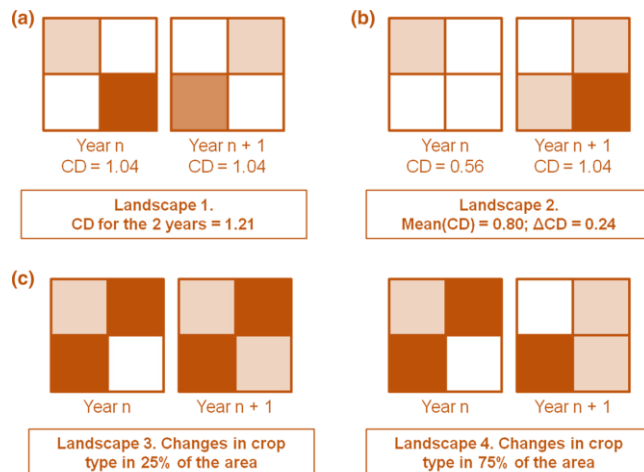
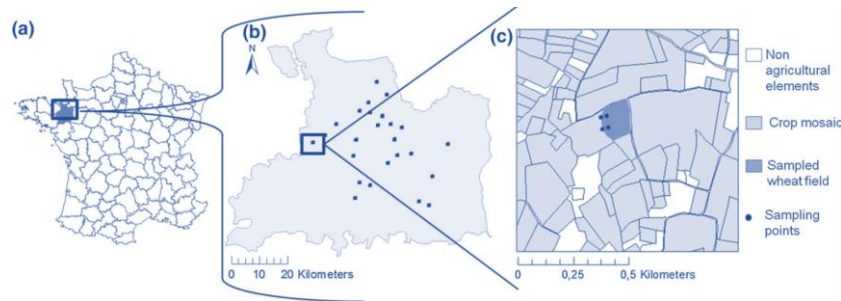
Farmland heterogeneity ↔ Semi-natural % ↔ Practices

➤ **Agricultural policies should be adapted to the regional context**

➤ **Agricultural policies should target field size reductions - while maintaining semi-natural habitats and reducing agrochemical**

Biodiversity conservation through spatio-temporal heterogeneity

Spatial and temporal heterogeneity of the crop mosaic influences carabid beetles in agricultural landscapes (Bertrand et al. 2016)



Take-home messages

- ✓ Overemphasis on the role of semi-natural habitats, land sparing, connectivity (e.g. Tschanrtke et al. 2016)
- ✓ Conservation policies should harness the positive role of the « matrix » for biodiversity, in particular the role of configurational heterogeneity
- ✓ Conceptual and methodological frameworks are still needed to understand the role of accumulated time lags and temporal heterogeneity