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# Does increasing crop heterogeneity benefit species diversity?

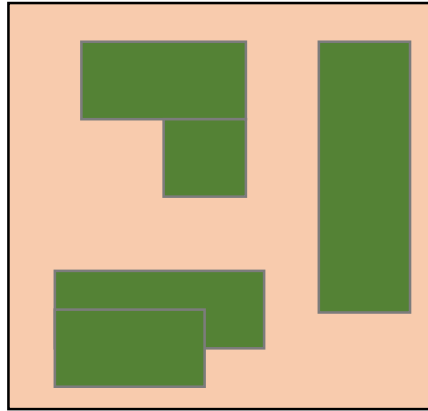
Cross-taxon congruence across a gradient of agricultural landscapes

Clélia Sirami, DYNAFOR-INRA, Toulouse, France

representing the **FarmLand consortium**



# From fragmentation to functional heterogeneity



## Patch-matrix paradigm

Historical dominance

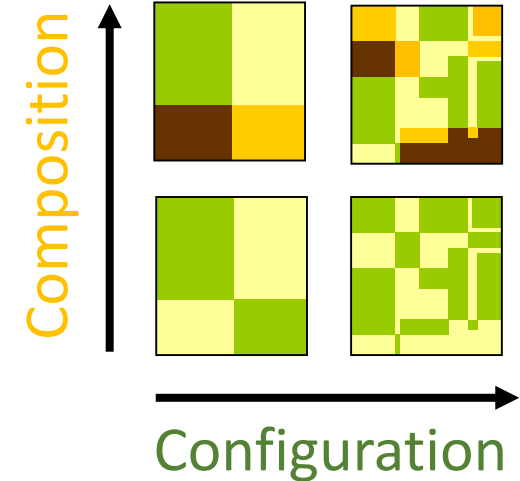
=> Habitat fragmentation



## Mosaic landscape

Paradigm shift

=> Landscape heterogeneity

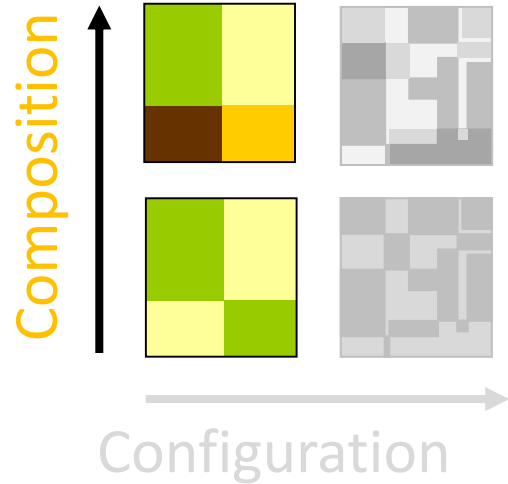


## Functional heterogeneity

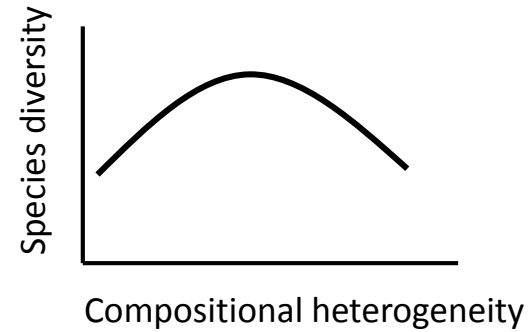
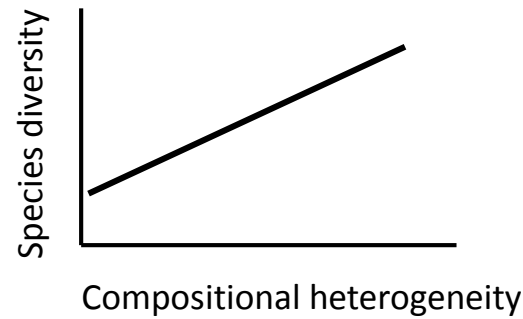
Composition/configuration

(Fahrig et al. 2011)

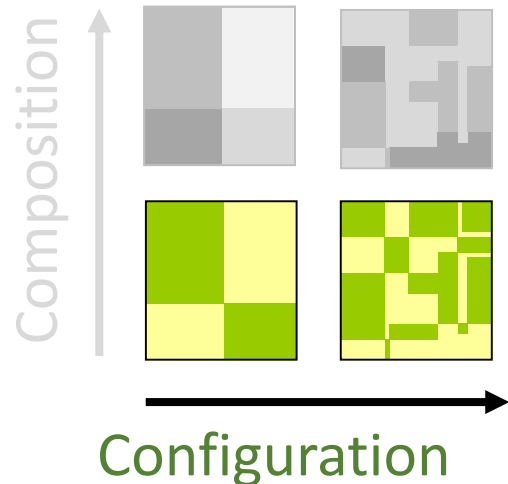
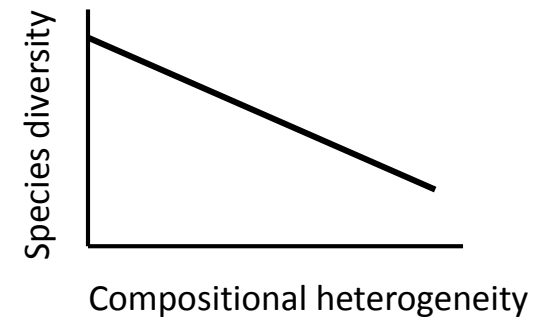
# Heterogeneity-biodiversity relationships



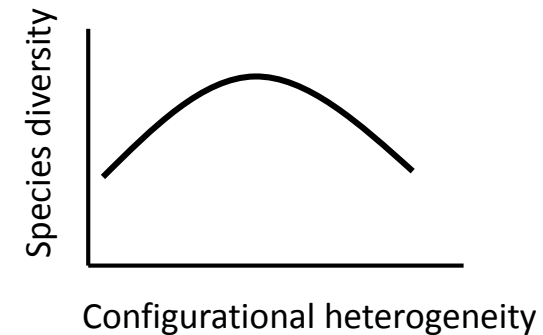
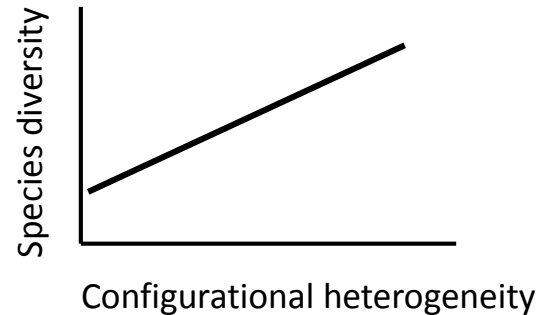
Species in ≠ habitats  
Landscape complementation



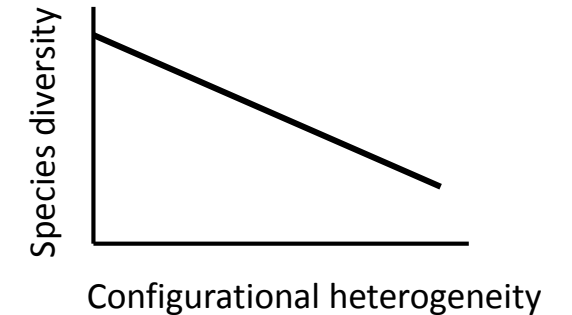
Total habitat area requirement  
Habitats with >>> diversity



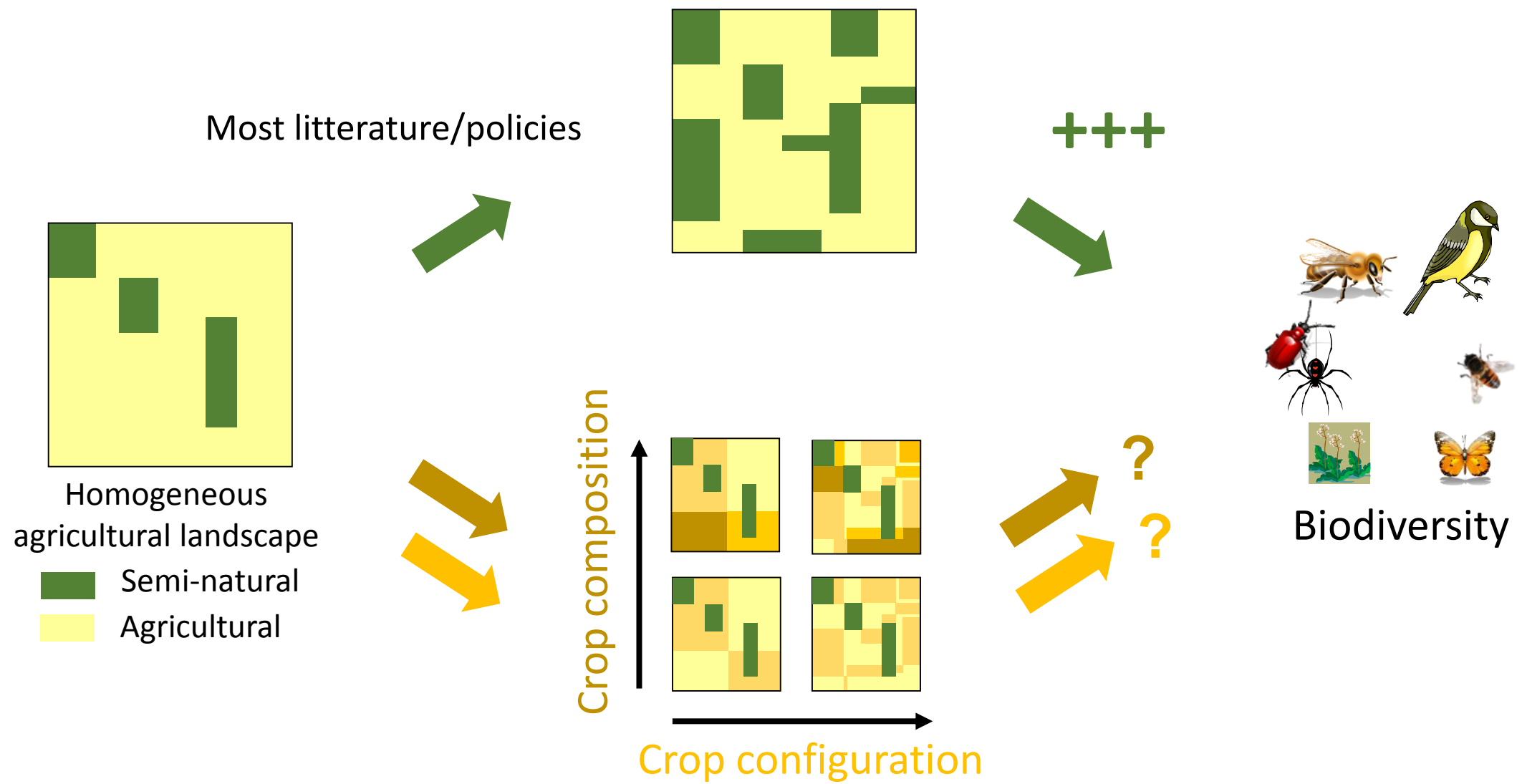
Patch permeability/connectivity  
Landscape complementation



Negative edge effect  
Minimum patch size requirement



# Heterogeneity-biodiversity in agricultural landscapes





# Testing the heterogeneity-biodiversity paradigm within the production area of the landscape across 8 regions



L. Fahrig



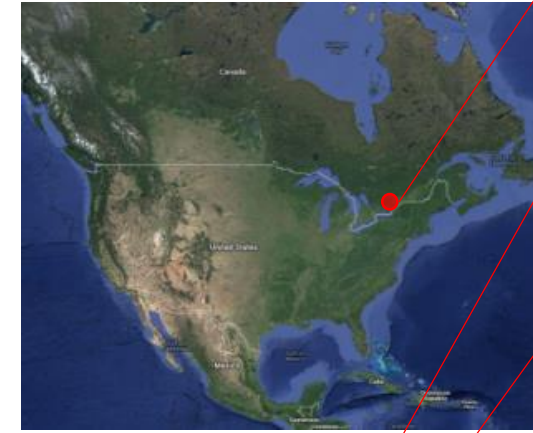
G. Siriwardena



T. Tschardtke



L. Brotons



Ontario



East Anglia



Armorique



PVDS



Goettingen



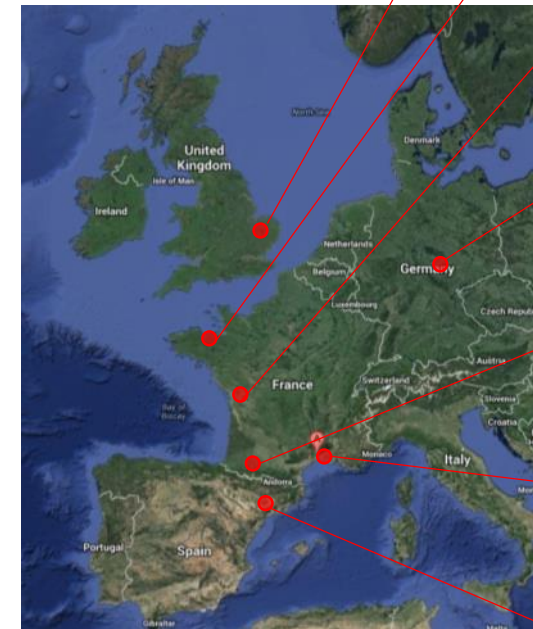
Coteaux



Camargue



Lleida



V. Bretagnolle



JL. Martin



F. Burel



B. Poulin

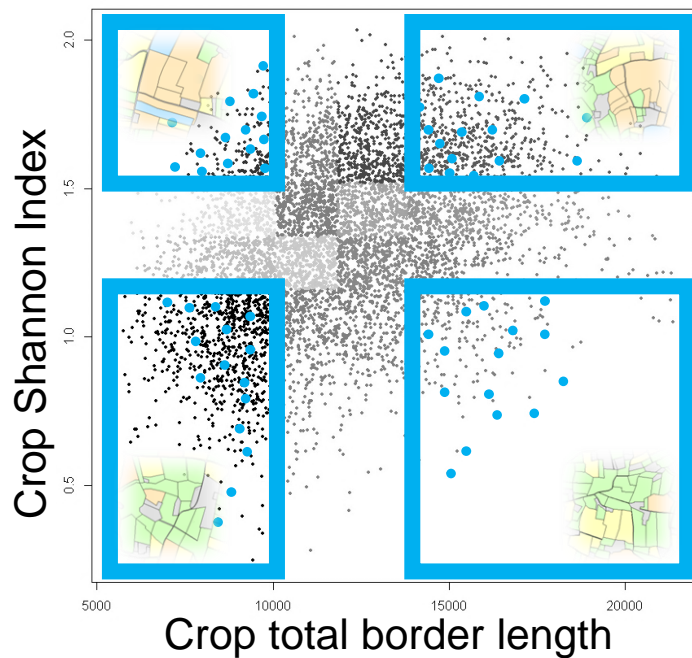


A. Ouin



# Common protocols across 8 regions

## 1. Landscape selection



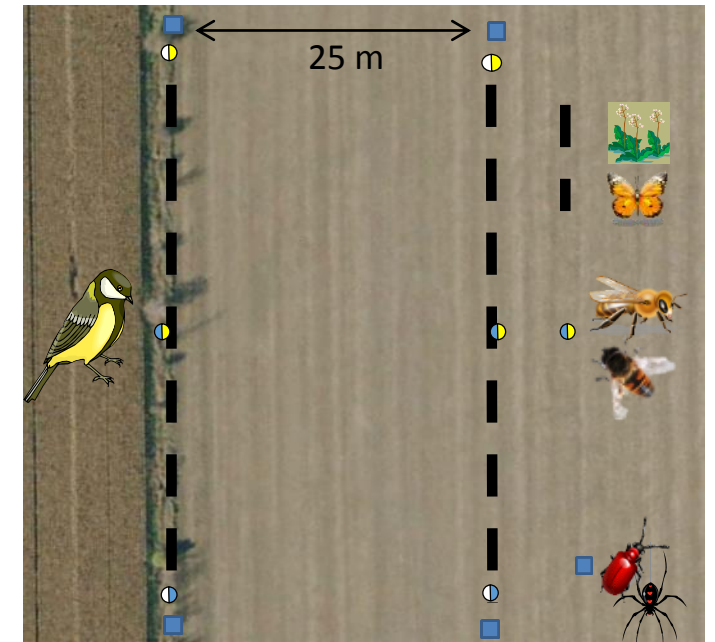
⇒ Independant gradients  
with limited variations in non crop cover

## 2. Sampling site selection



⇒ 3/4 representative sites

## 3. Biodiversity sampling

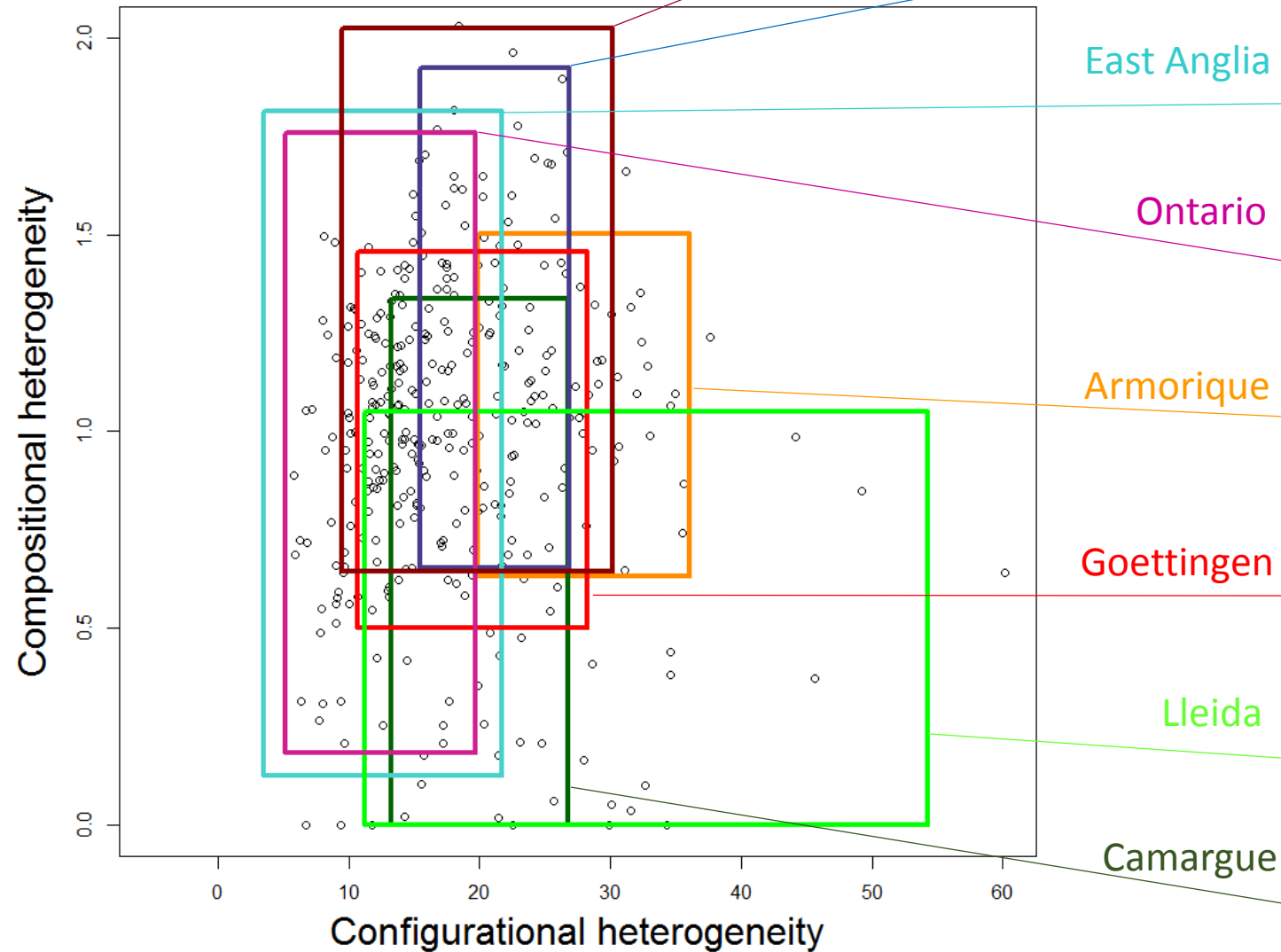


⇒ 7 taxa with contrasting traits

# Crop heterogeneity gradients

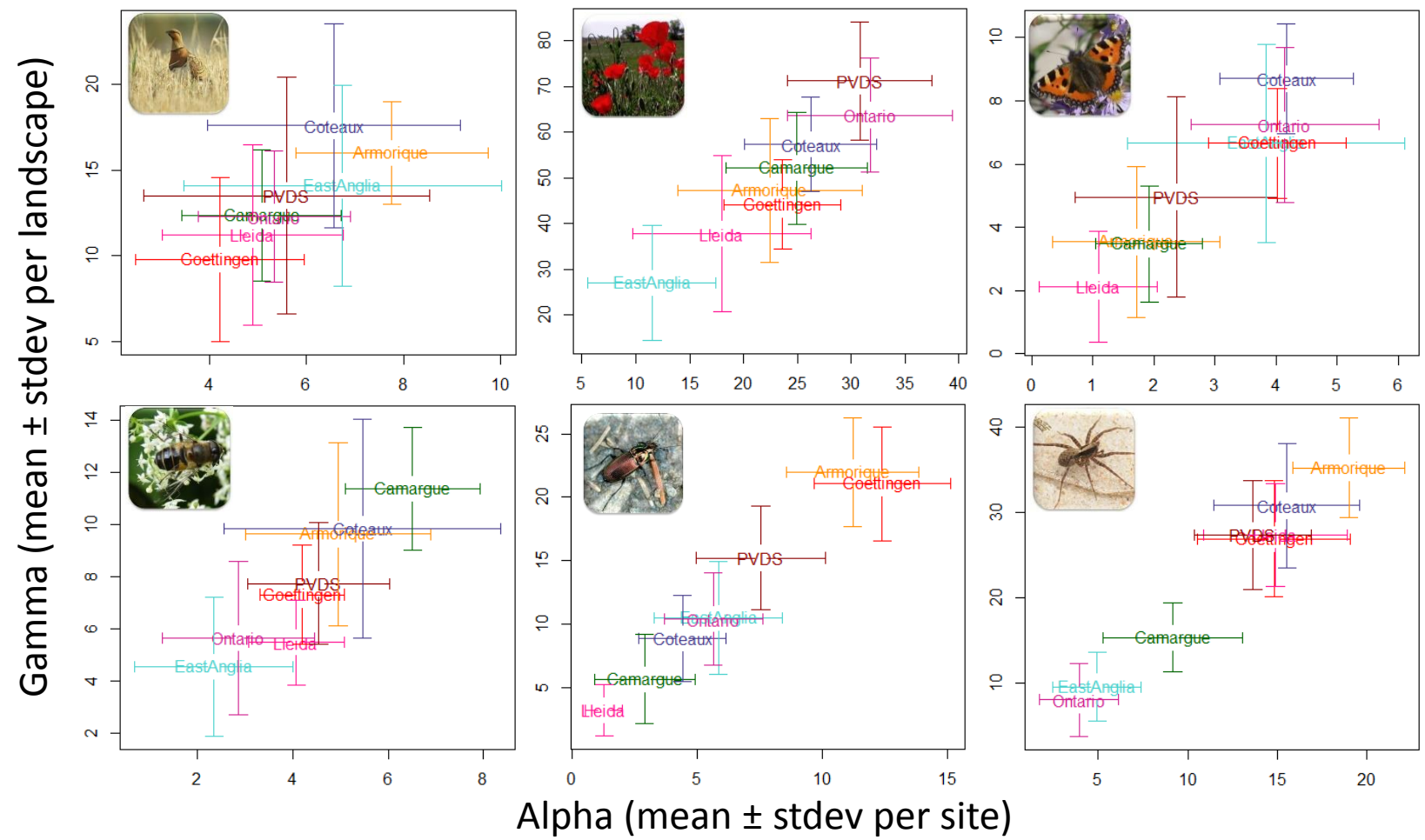
**Multi-region study  
=> wider gradients**

**Contrasting regions  
BUT  
Overlapping gradients  
=> testing generality**

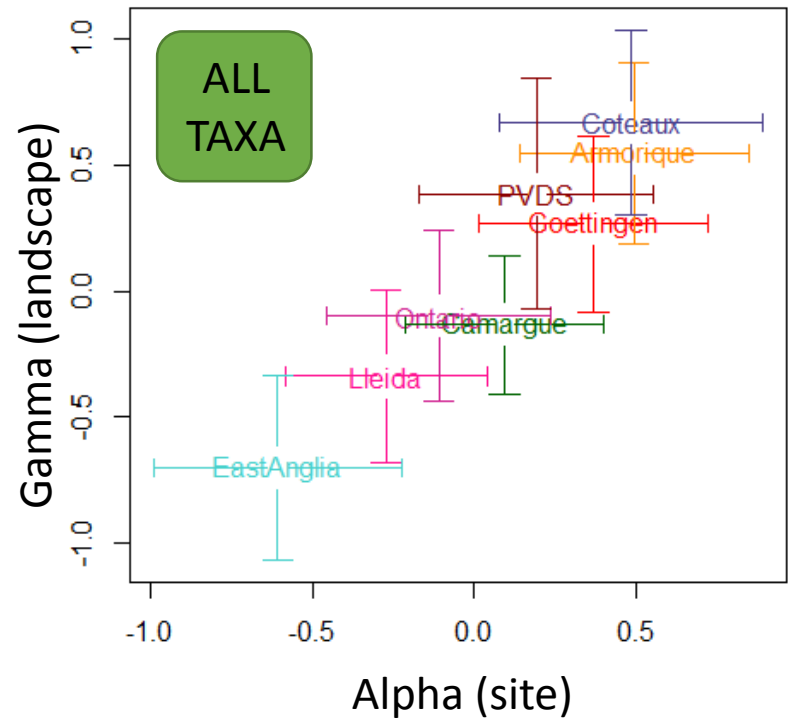




# Species diversity across 7 taxa and 8 regions



## Multidiversity (Mean scaled diversity across all taxa)



=> Distinct gradients of diversity

# Testing the effect of crop heterogeneity on biodiversity

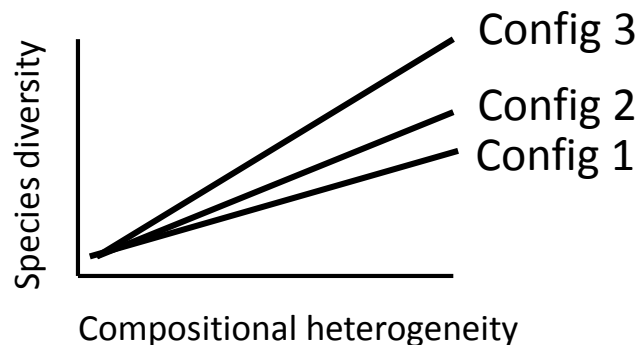
Models ran with function MCMCglmm and compared using DIC

Fixed effects: Crop compositional heterogeneity + Crop configurational heterogeneity

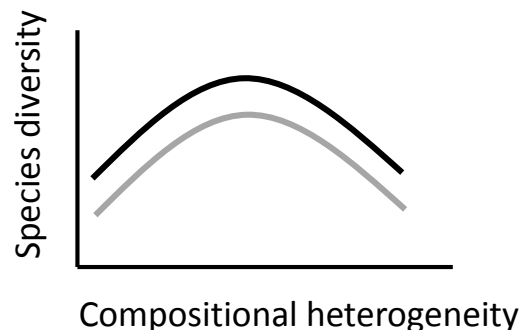
Covariate: Non crop cover

Random effect: Regional effect on intercepts

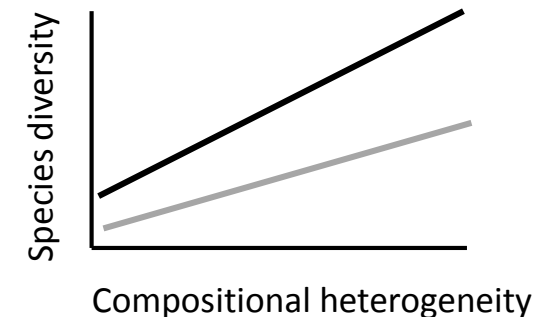
1) Interaction compo\*config



2) Quadratic effects



3) Random regional effect on slopes



# Testing the effect of crop heterogeneity on biodiversity

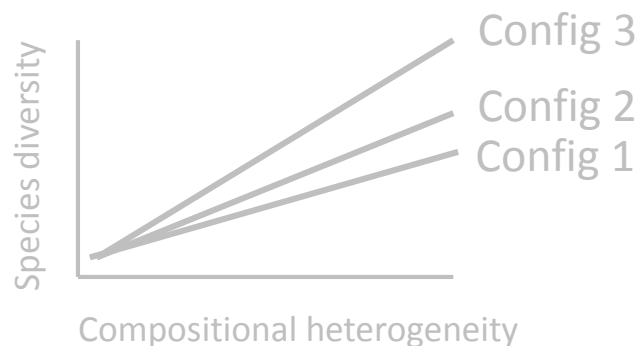
Models ran with function MCMCglmm and compared using DIC

Fixed effects: Crop compositional heterogeneity + Crop configurational heterogeneity

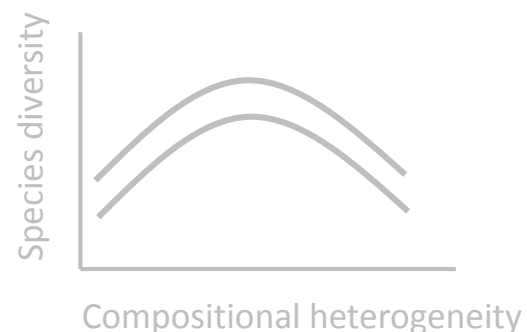
Covariate: Non crop cover

Random effect: Regional effect on intercepts

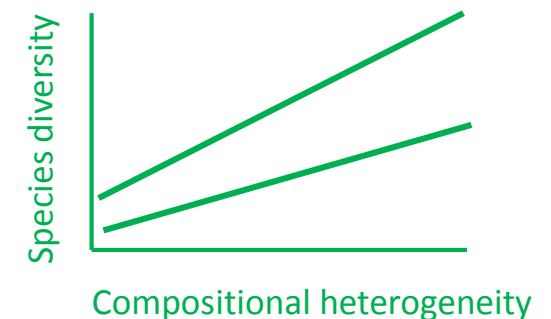
1) Interaction compo\*config



2) Quadratic effects



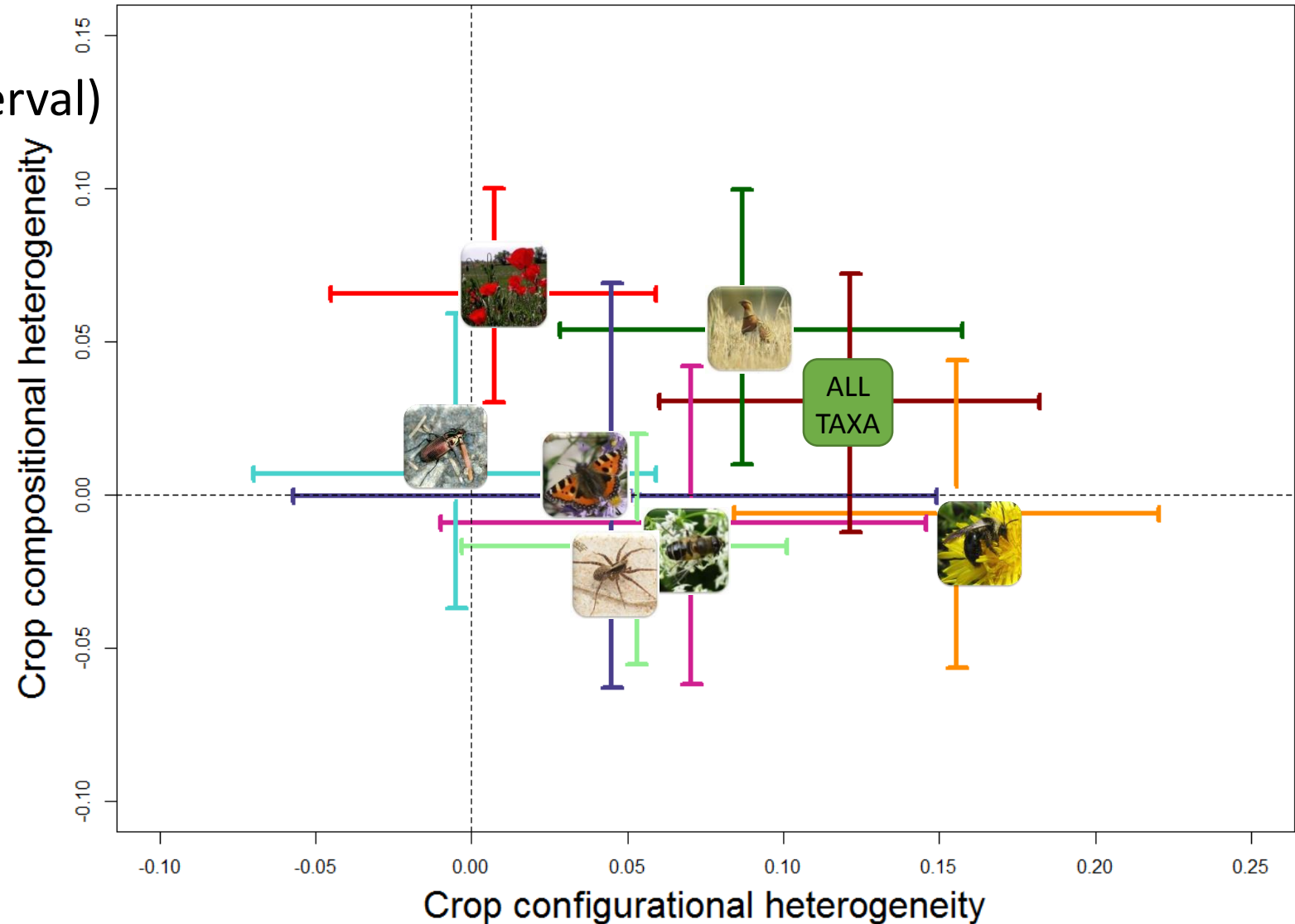
3) Random regional effect on slopes



# Response variations across taxa

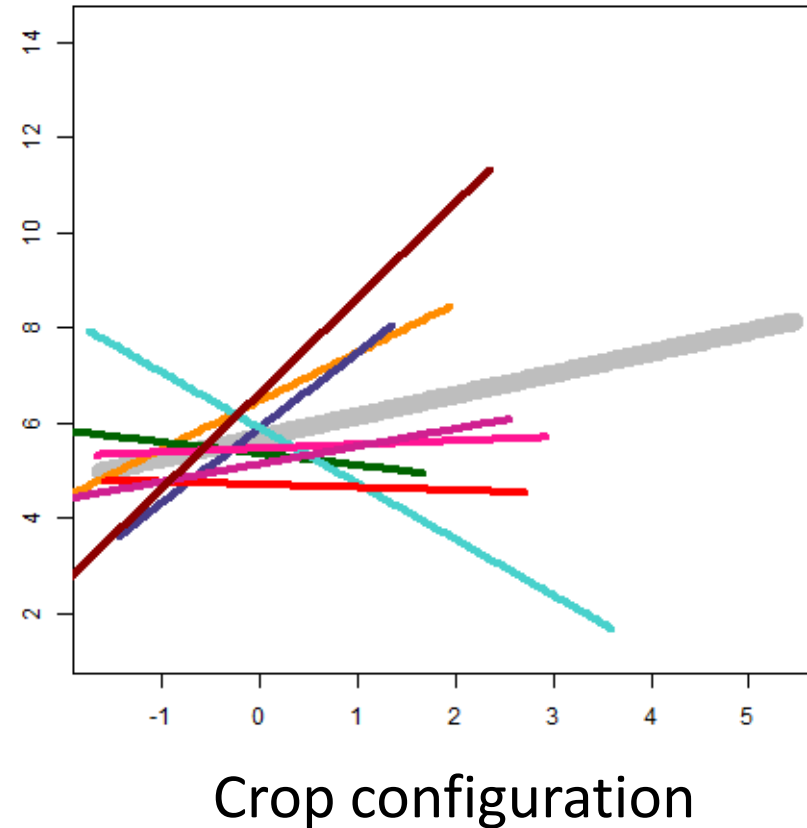
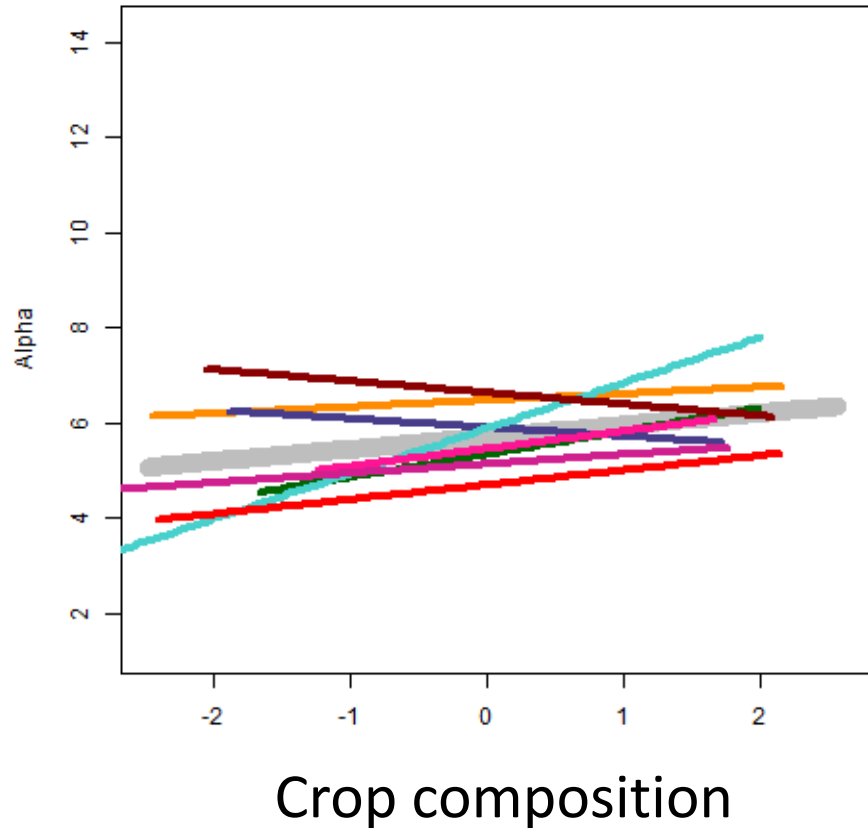
Gamma diversity  
(mean and credible interval)

NB: similar results for  $\alpha$



# Significant differences between regions

## Bird alpha diversity



- PVDS
- Coteaux
- Armorique
- Ontario
- Lleida
- Goettingen
- Camargue
- East Anglia
- Average effect

# Complex effects of crop heterogeneity

- General positive effect of crop heterogeneity on diversity
- Stronger effect of configurational heterogeneity (except plants)

BUT...

- Variations across taxa (e.g. composition for plant vs. configuration for bee)
- Strong regional effects for some taxa => effect may be context-dependent!

# More from the FarmLand project

## IALE S22 Tuesday

- Taxon response **C. Bertrand & A. Baillod (carabid/spider); A. Alignier (plant)**
- Regional scale response **K. Lindsay (Ontario)**

## ICCB 2015

- Relationship between biodiversity and ecosystem services **C. Sirami**
- From ecological results to guidelines **C. Vuillot**

... and further cross-taxa and transdisciplinary analyses to follow.

# Implications for agricultural policy

- Increasing crop configurational heterogeneity (correlated or not with linear elements between crops) seems more efficient than increasing crop diversity for most taxa
  - Increasing crop diversity benefits wild plant and bird diversity
  - Effect size of non-crop cover was comparable or smaller than effect sizes for crop heterogeneity
- => Managing the crop mosaic may be as efficient as - if not more than - increasing non-crop cover (within the range we studied)



# Acknowledgments



[clelia.sirami@toulouse.inra.fr](mailto:clelia.sirami@toulouse.inra.fr)

[www.farmland-biodiversity.org](http://www.farmland-biodiversity.org)