Aires de répartitions, métacommunautés et biodiversité : du théorique à l'appliqué

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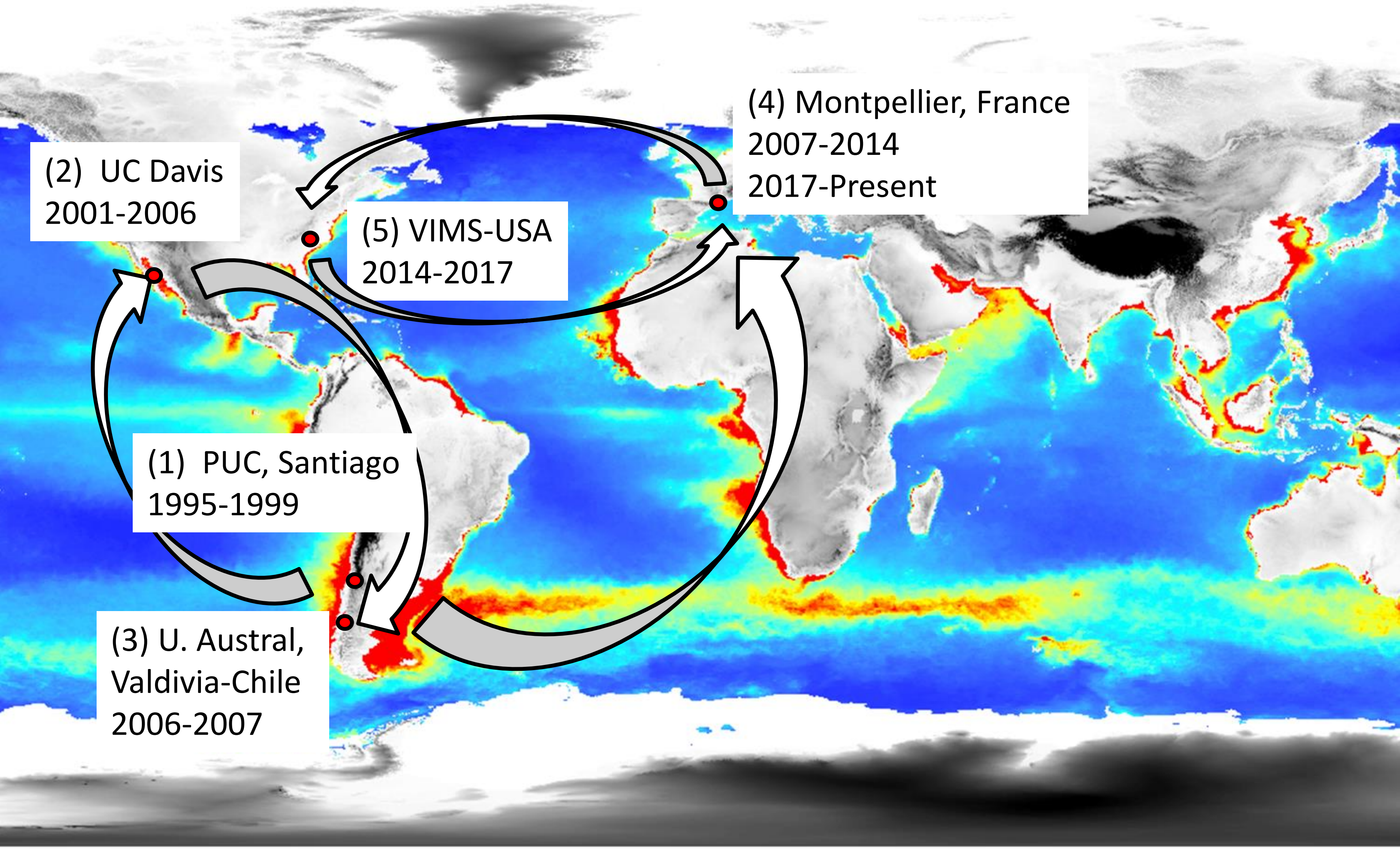
Parcours


(4) Montpellier, France
2007-2014
2017-Present
(2) UC Davis
2001-2006
(5) VIMS-USA
2014-2017
(1) PUC, Santiago
1995-1999
(3) U. Austral,
Valdivia-Chile
2006-2007

Etudiants

- Encadrements direct: 2 licence, 2 M1, 8 M2, 1 masters USA, 1 doctorant
- Comités de thèse et co-publications étudiants
- Enseignement niveau master et doctorat en SIG, statistiques, biologie de populations. Au total autour de 400h.

Etudiants actuels

Dorian Frisch
M1, U. Rennes

Isis Poinas
Doctorante

Changements climatiques et zones de contact entre *Rhabdomys sp.* en Afrique du Sud
Collaboration avec Guila Ganem (ISEM)
Projets Labex, OSU, ANR en cours d'evaluation

Effets non-intentionnels des pratiques agricoles sur la biodiversité des bordures
Collaboration avec Guillaume Fried (ANSES)
Projet ANSES-INRAE

Etudiants actuels

Comités de thèse

Jingwei Song, PhD Candidate
W&M, VIMS, USA
Supervisor: Jan McDowell

An Investigation of Local Adaptation of Speckled Trout, *Cynoscion nebulosus,* along the U.S. East Coast

Hannah Bevan, PhD Candidate
U Central Florida, USA
Supervisor: David Jenkins

Why, when, and how to best apply species distribution analyses

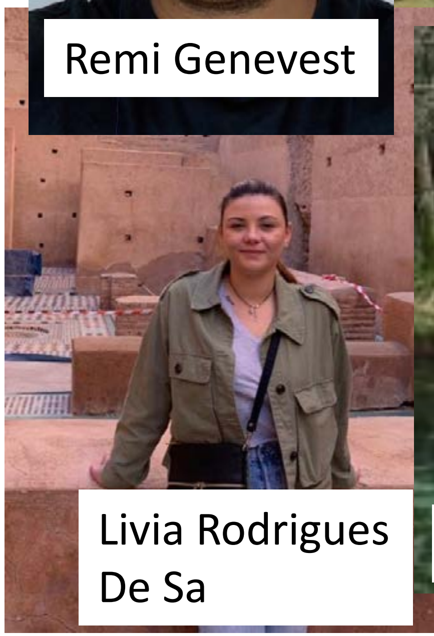
Etudiants


Claire Dufour

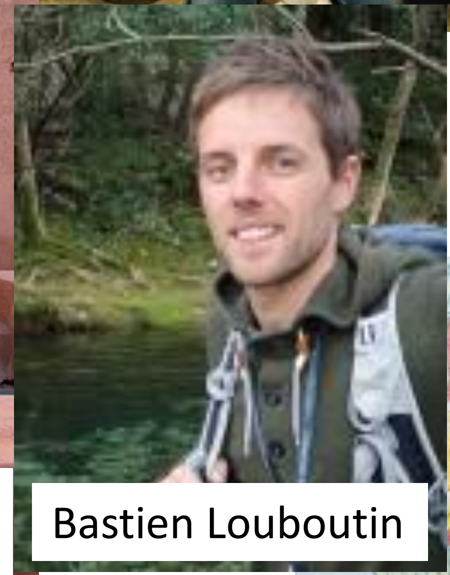

Annabelle Sueur


Laura Henckel


Remi Genevest


Livia Rodrigues De Sa


Manon Perrigault


Bastien Louboutin


Sophie Monsarrat


Natalia Carrasco


Paula Iturralde-Polit

Diversity and origins of life have fascinated biologists for centuries

Simon Levin, MacArthur Award lecture in 1989 "The problem of pattern and scale in ecology"

"Applied challenges, such as the prediction of the ecological causes and consequences of global climate change, require the **interfacing of phenomena that occur on very different scales** of space, time, and ecological organization"

"The key to prediction and understanding lies in the elucidation of **mechanisms underlying observed patterns**"

"Our efforts to develop theories of the way ecosystems or communities are organized must revolve around attempts to discover **patterns that can be quantified within systems, and compared across systems**"

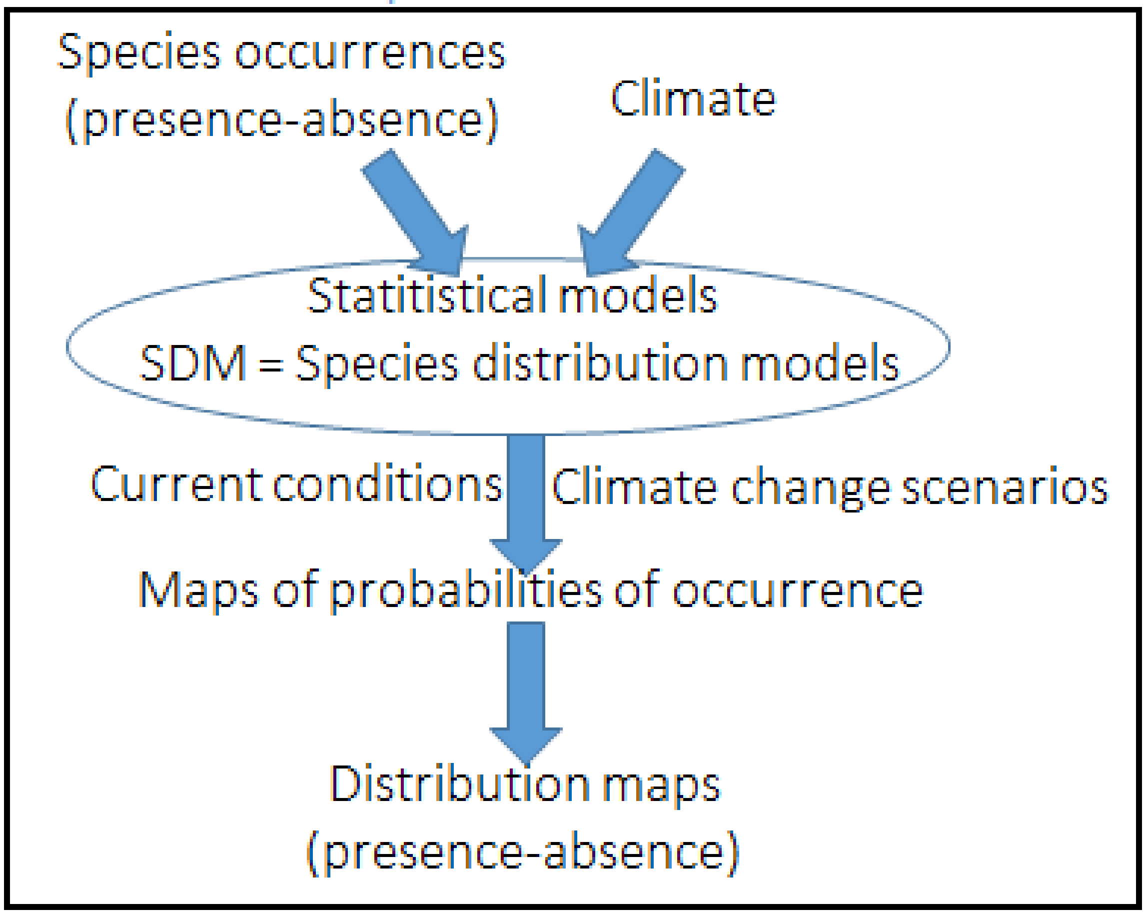
Jerome Chave: “what have we learned in 20 years?”

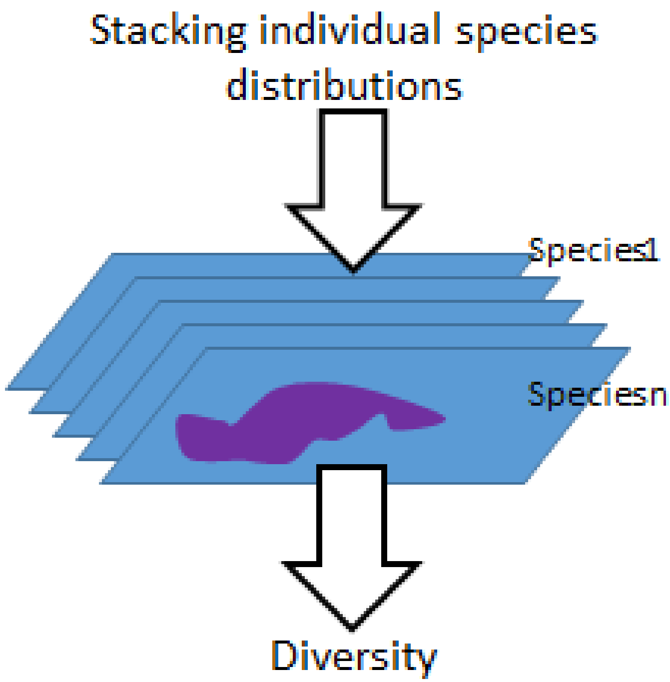
Chave (2013) Ecology Letters

There has been **4 major technological revolutions**:

- The advent of the **numeric era**
- **Molecular biology** technological advances
- **Environmental sensing** (including environmental but also tracking movement)
- Development of **global communications**: global collaborations, citizen science

Species distribution models (SDMs)





Agricultural challenges

- **Food security under a growing population**: we will need to produce more quickly
- **Agriculture** is the main **cause of habitat fragmentation and habitat loss**: need to find a way to stop converting land from natural habitat
- Important **contributor to climate change** (emission of CO_2, disruption of nitrogen cycle): we need to produce differently
- **Human health concerns**: we need to consume more greens and fruits and change our production system

SDMs in the agricultural context

- Major crops: physiological modelling (but…)
- **Insect / arthropod pests**
- **Insects as vectors of disease**

SDMs in the agricultural context

- Usually opportunistic presence data
- Systematic surveys are rare
- Pests are often missed if they are not in the mist of an outbreak
- Absence data is often under-reported or not recorded at all

Virtual Ecology

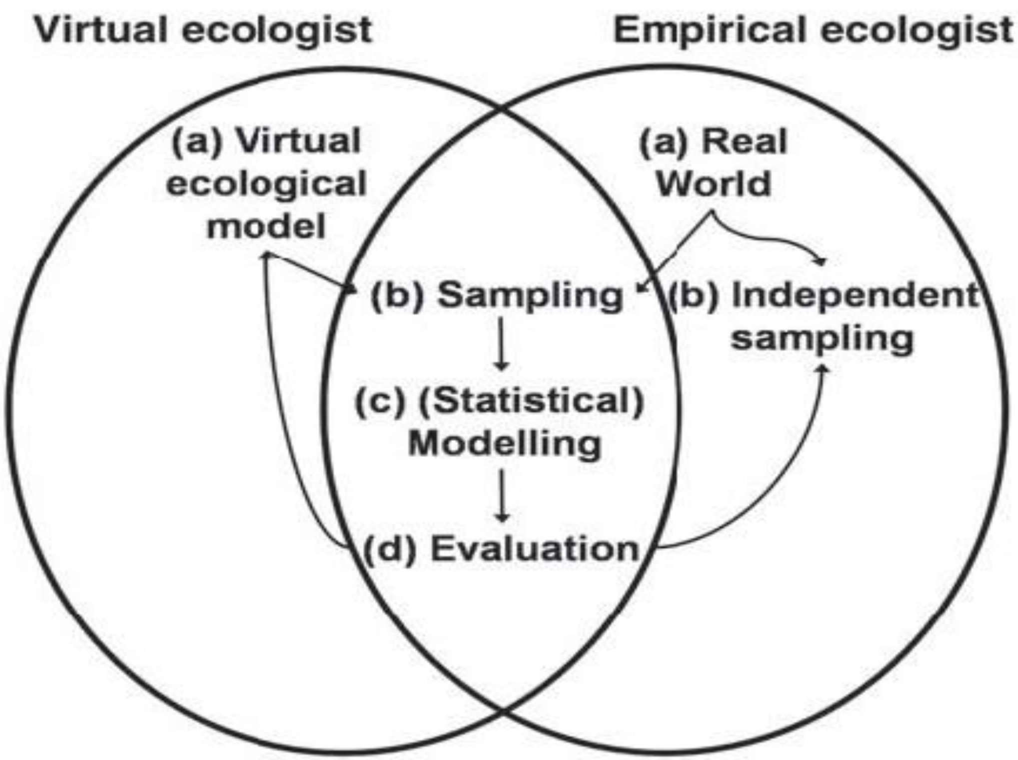


Figure 1. The elements of the virtual ecologist approach.

Zurrell et al 2010 *Oikos*

Outline

I- Species distribution models

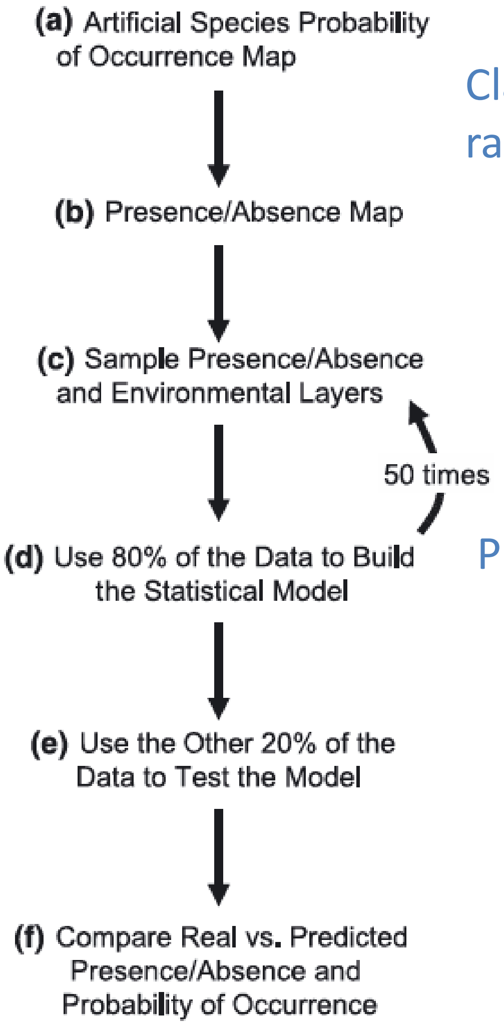
- Virtual species: what have we learnt?
- The role of uncertainty in predicting species distributions

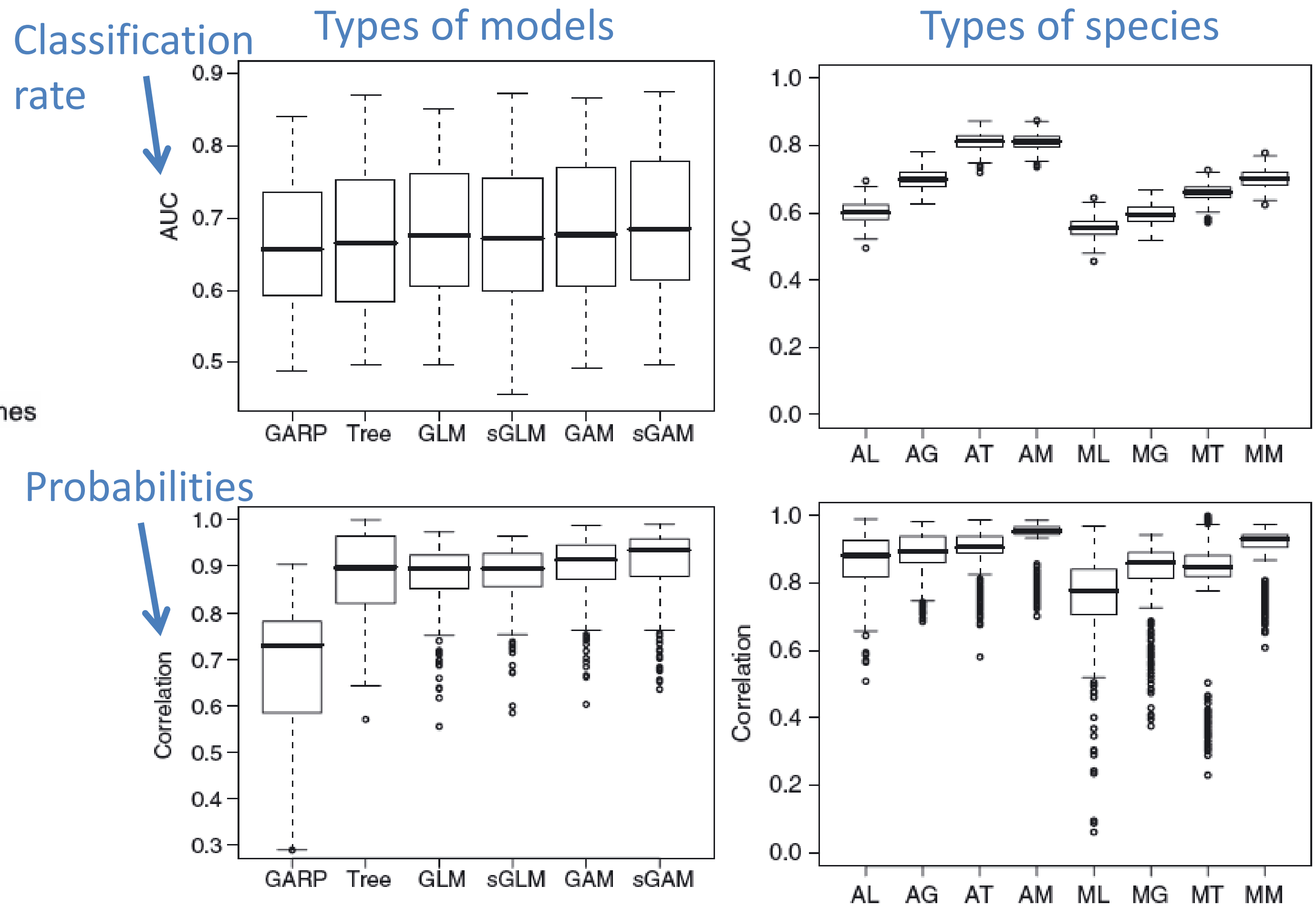
II- Metacommunities and multiple facets of diversity

I - Species distribution models

Virtual species: what have I learnt?

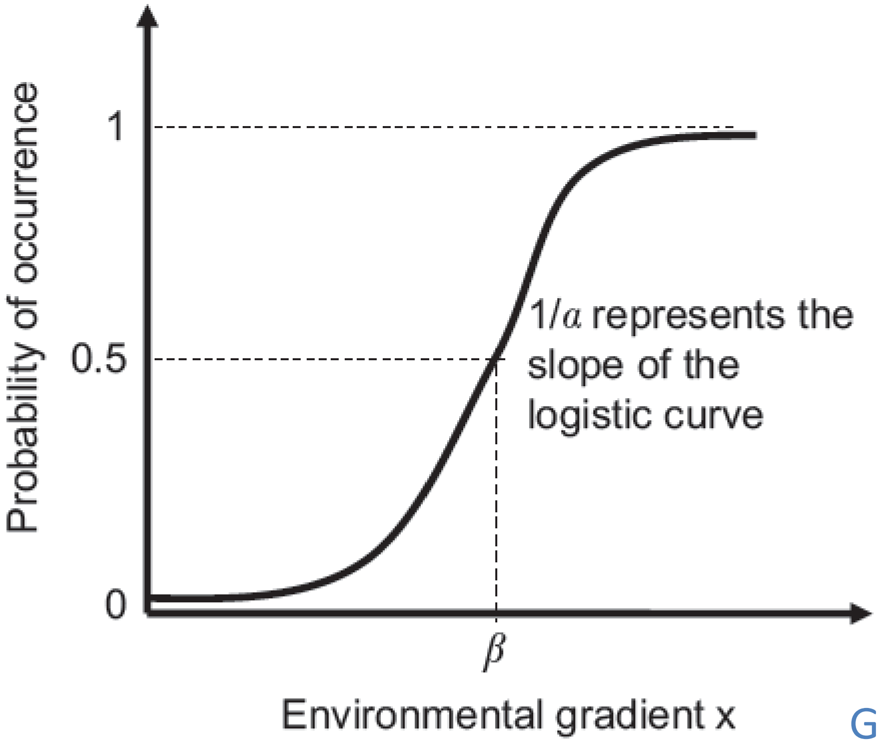
Virtual Species

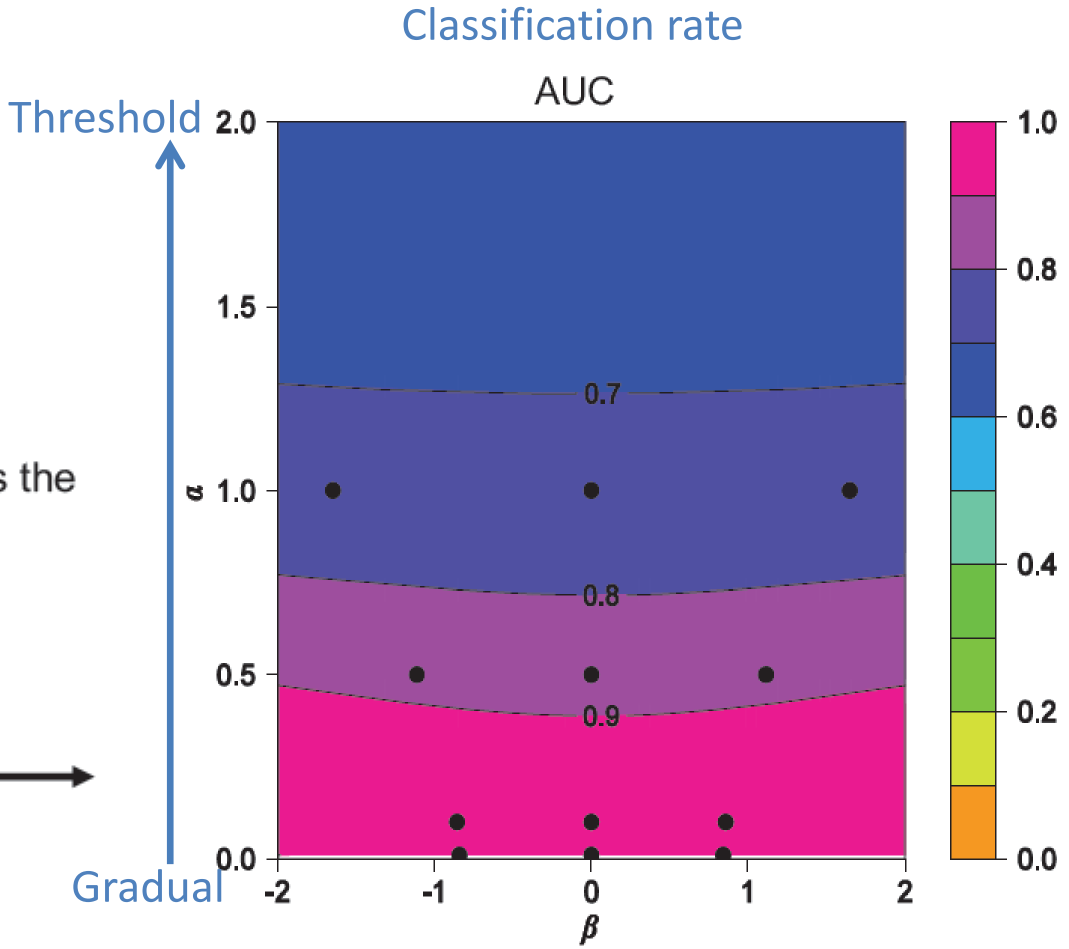




Meynard & Quinn 2007 *Journal of Biogeography*

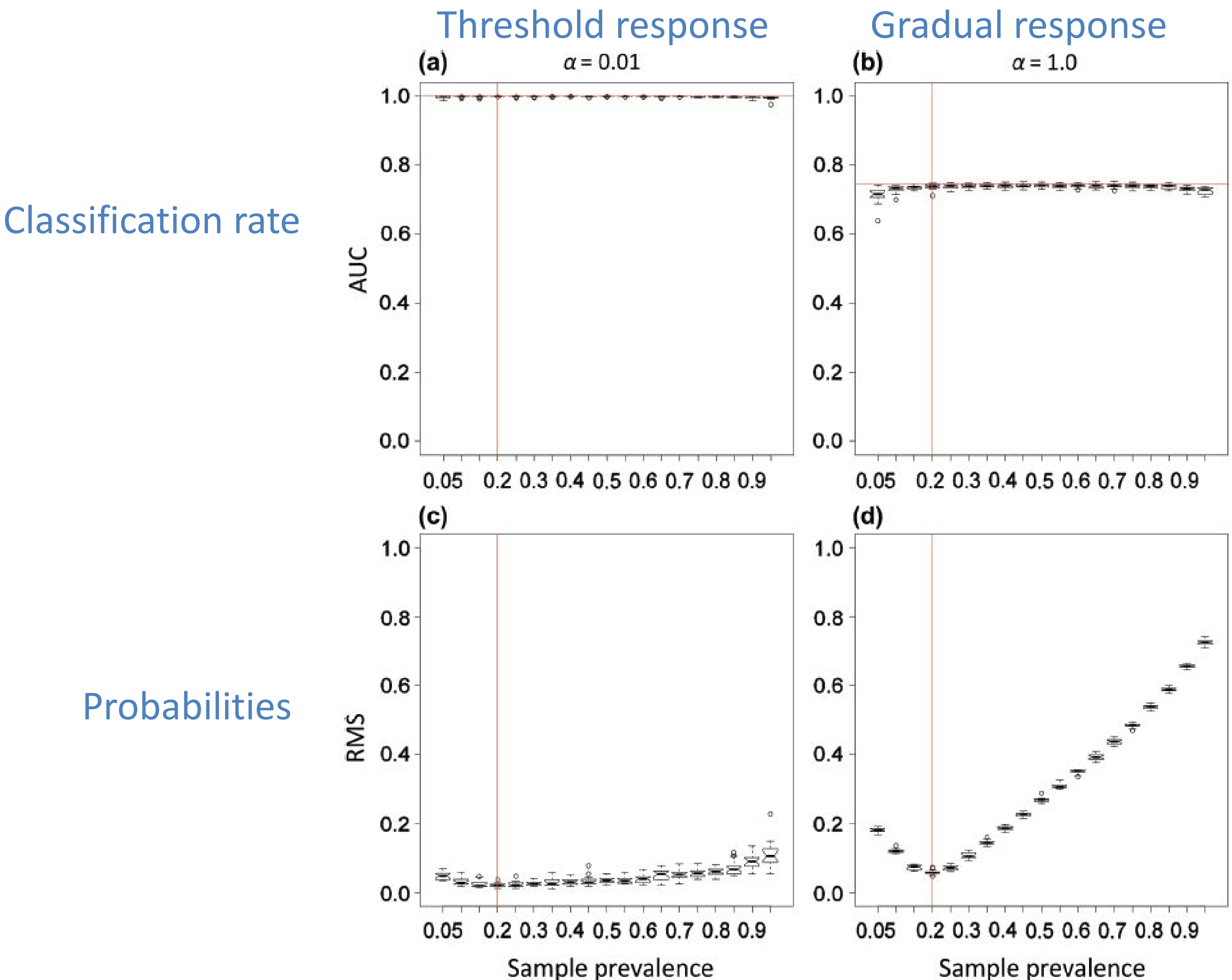
Virtual Species





Meynard & Kaplan 2012 *Ecography*

Virtual Species

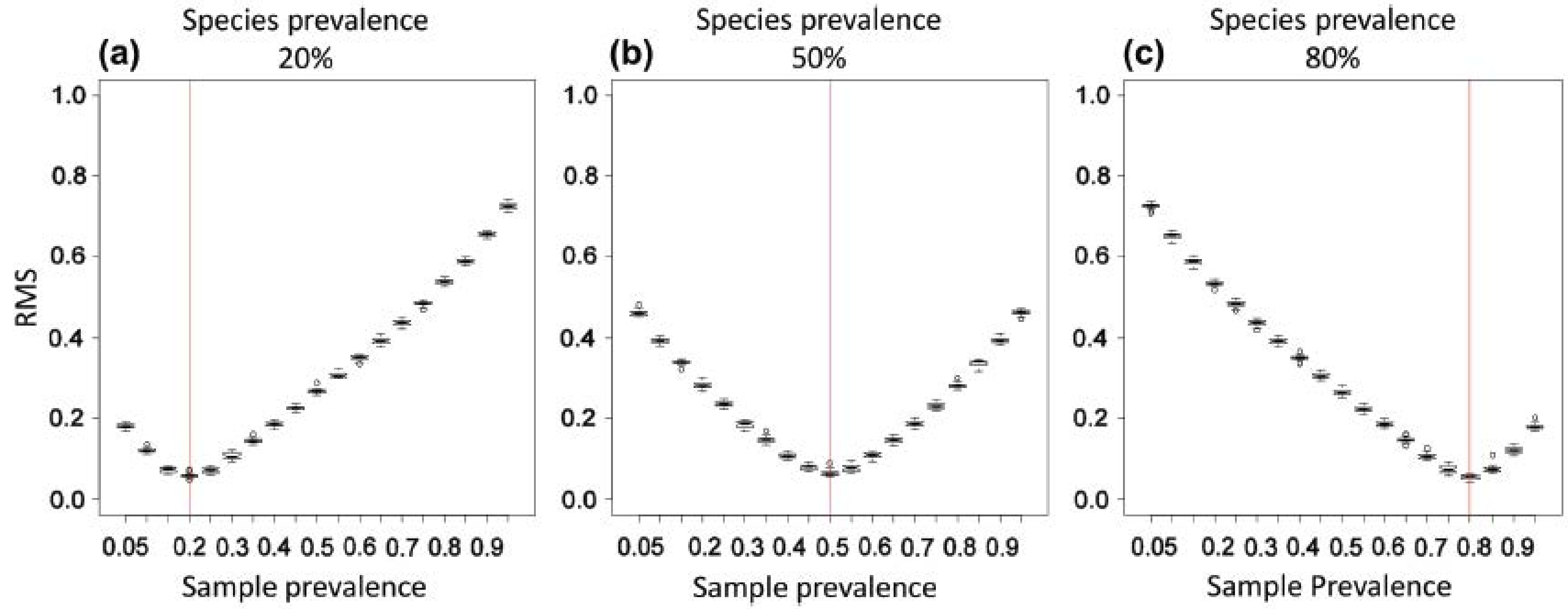


Meynard & Kaplan 2012 *Ecography*

Virtual Species

Prediction of Probabilities

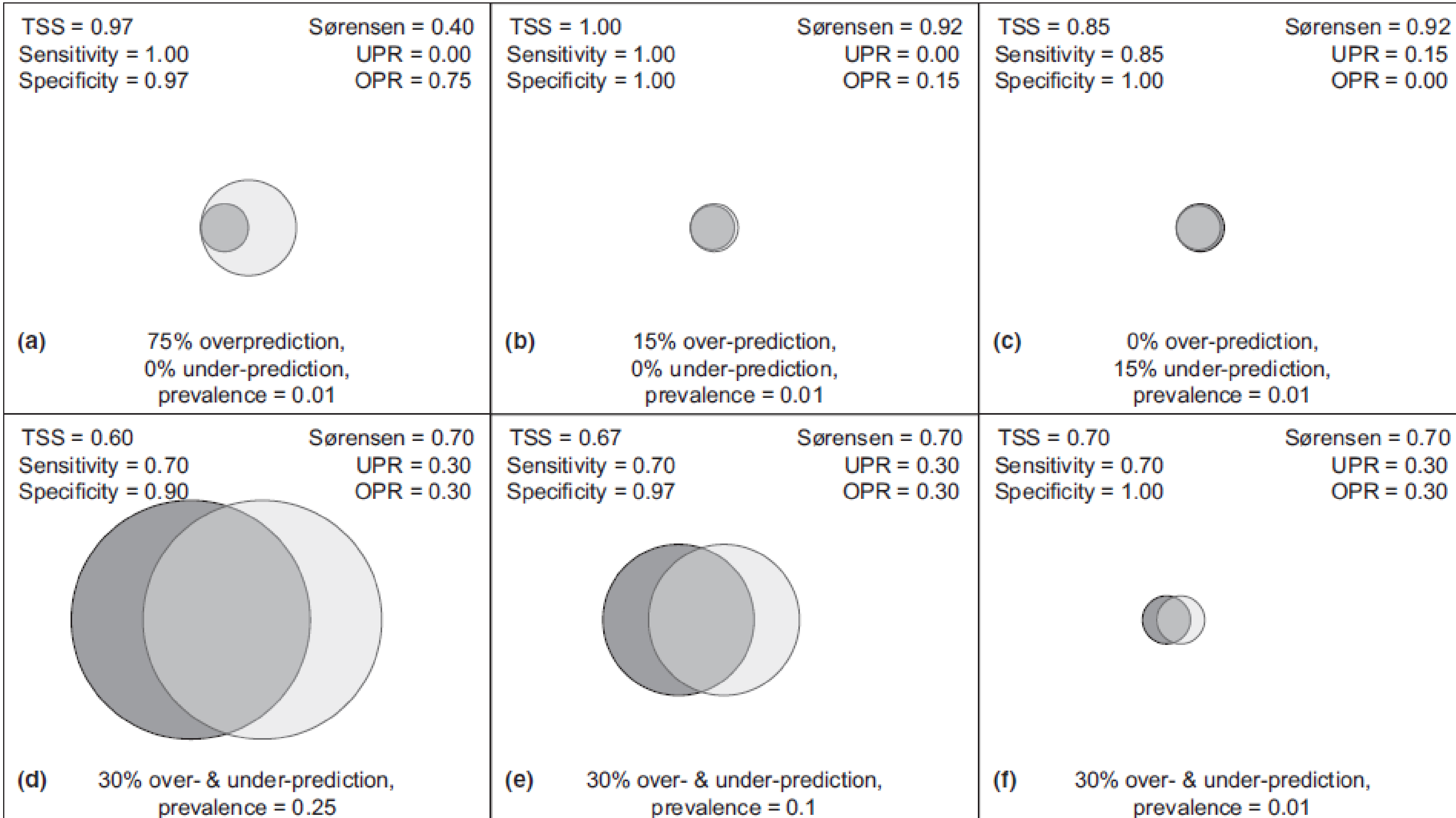
Prevalence



Meynard & Kaplan 2012 *Ecography*

Virtual Species

Prediction of the range



Leroy et al 2018 *Journal of Biogeography*

Virtual Species

Standards for virtual species studies

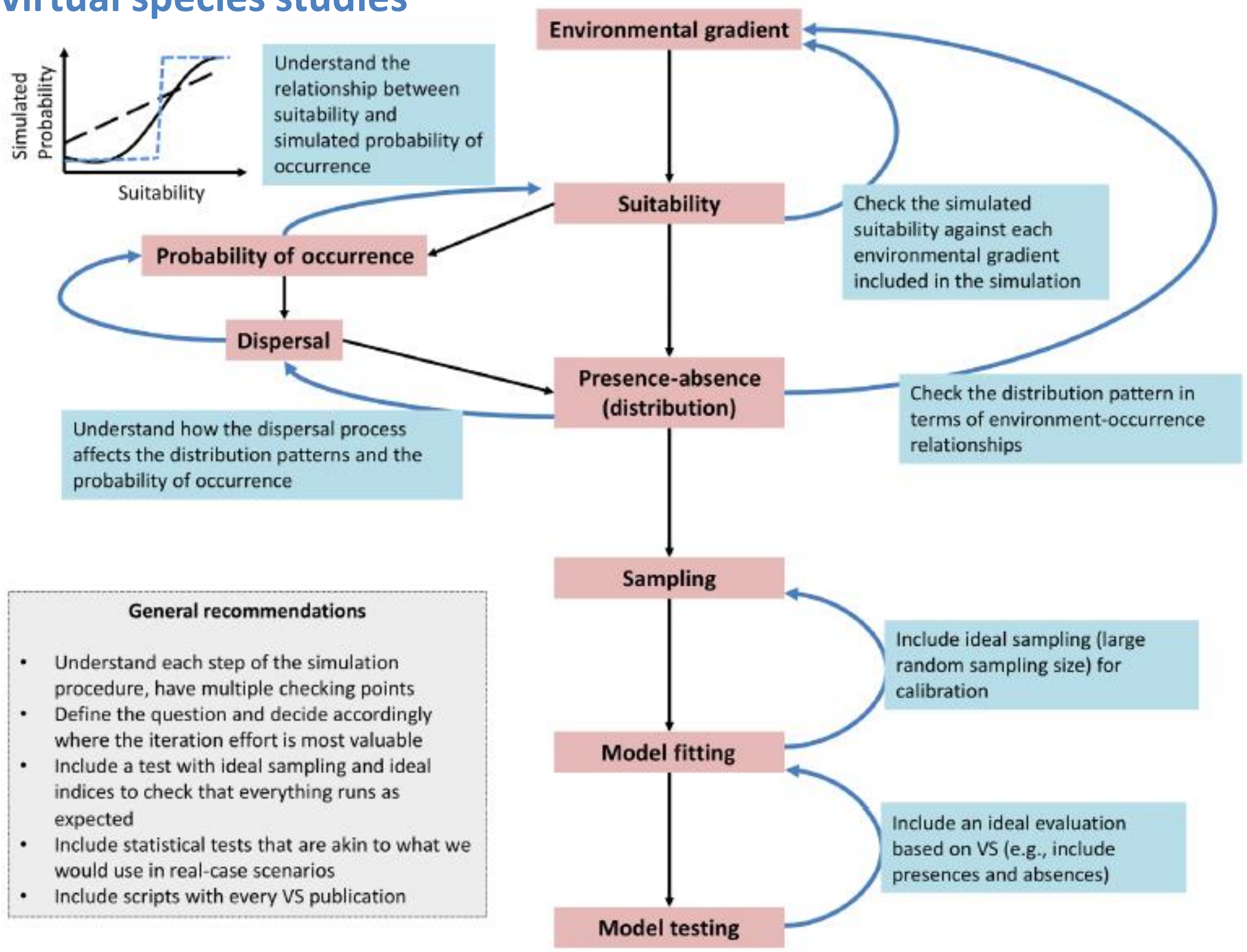
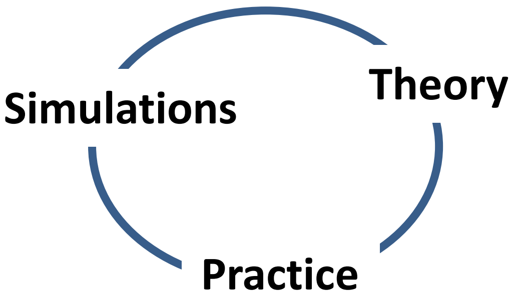
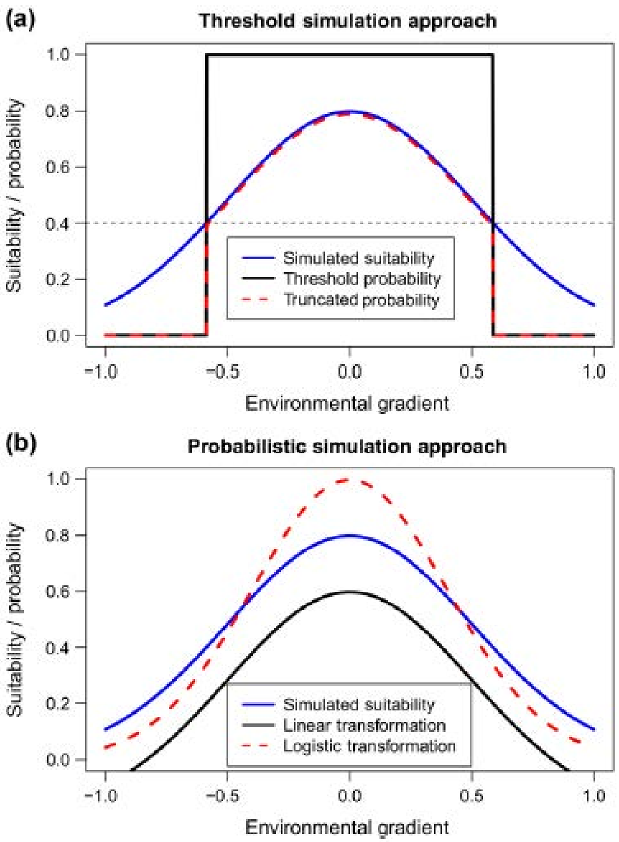


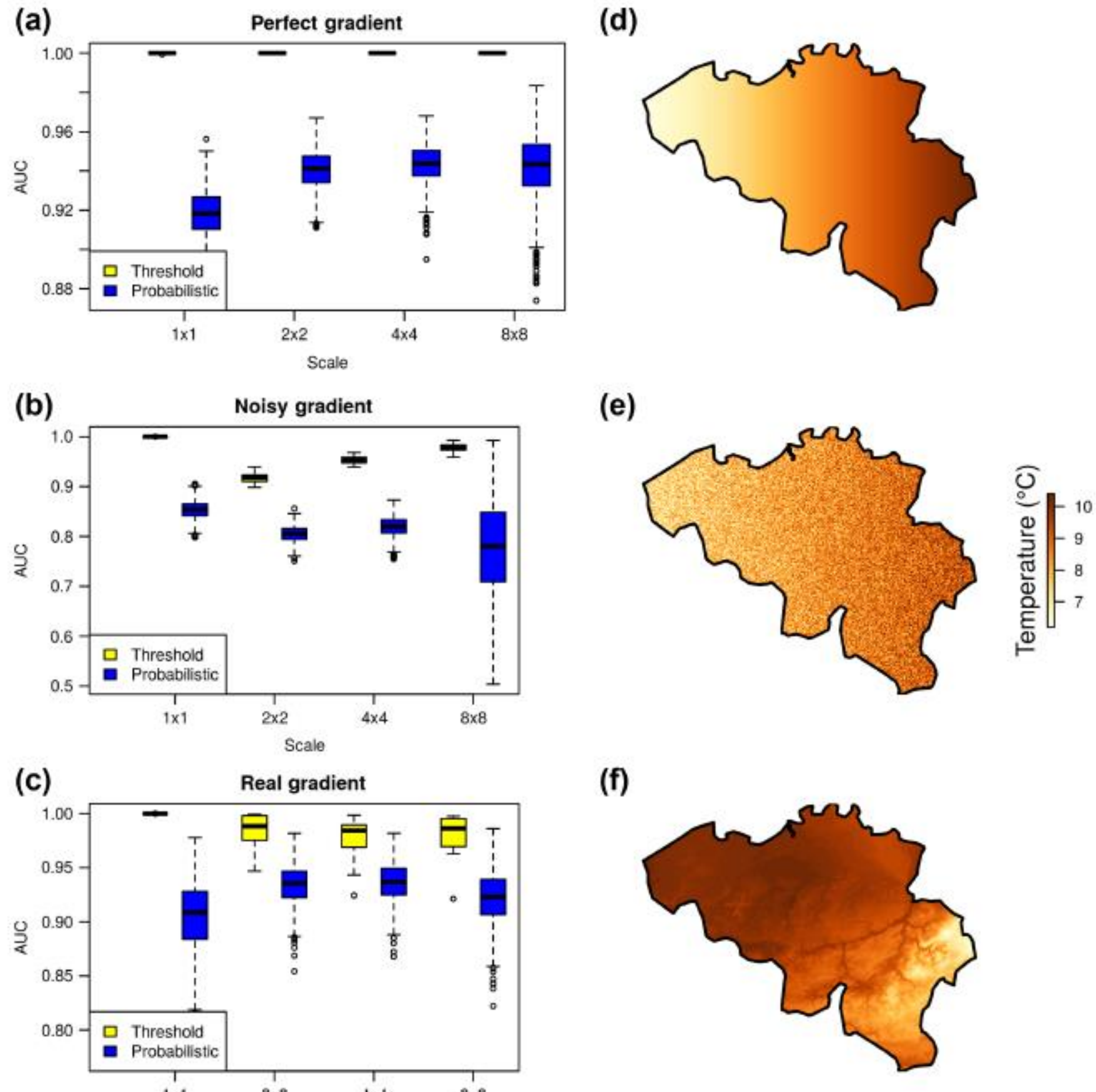
Figure 3. Graphical representation of recommendations and guidelines proposed in section 'General recommendations and guidelines' for future virtual species studies.

Meynard et al 2019 *Ecography*

Virtual Species

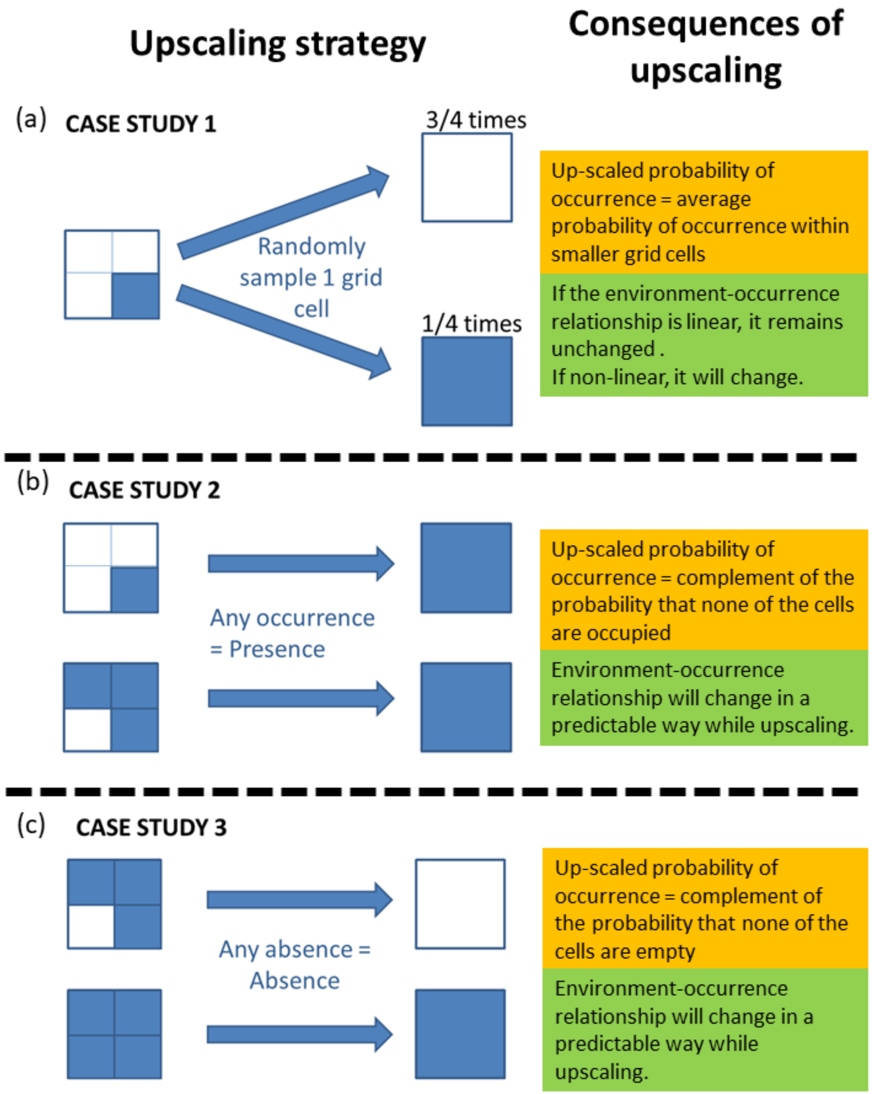


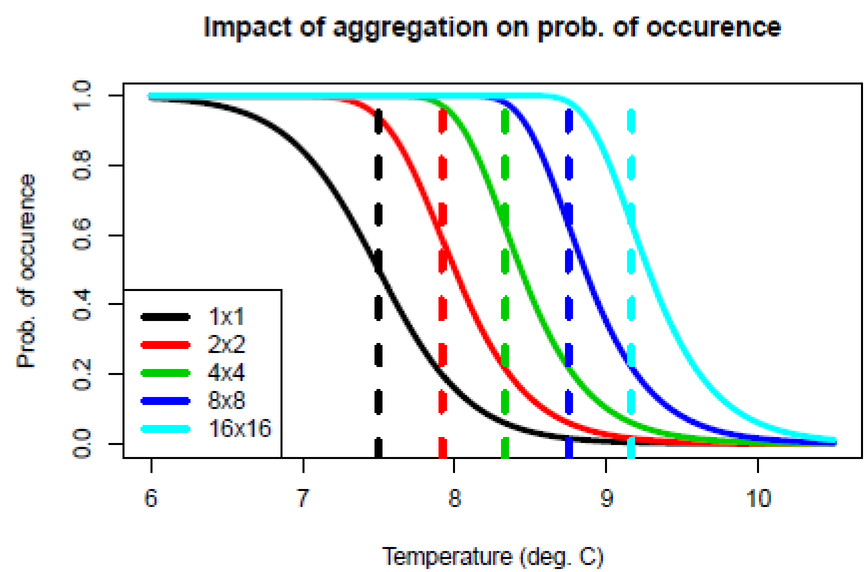




Meynard et al 2019 *Ecography*

A theoretical framework of upscaling for species distribution models





Meynard & Kaplan *(In Prep)*

Virtual Species

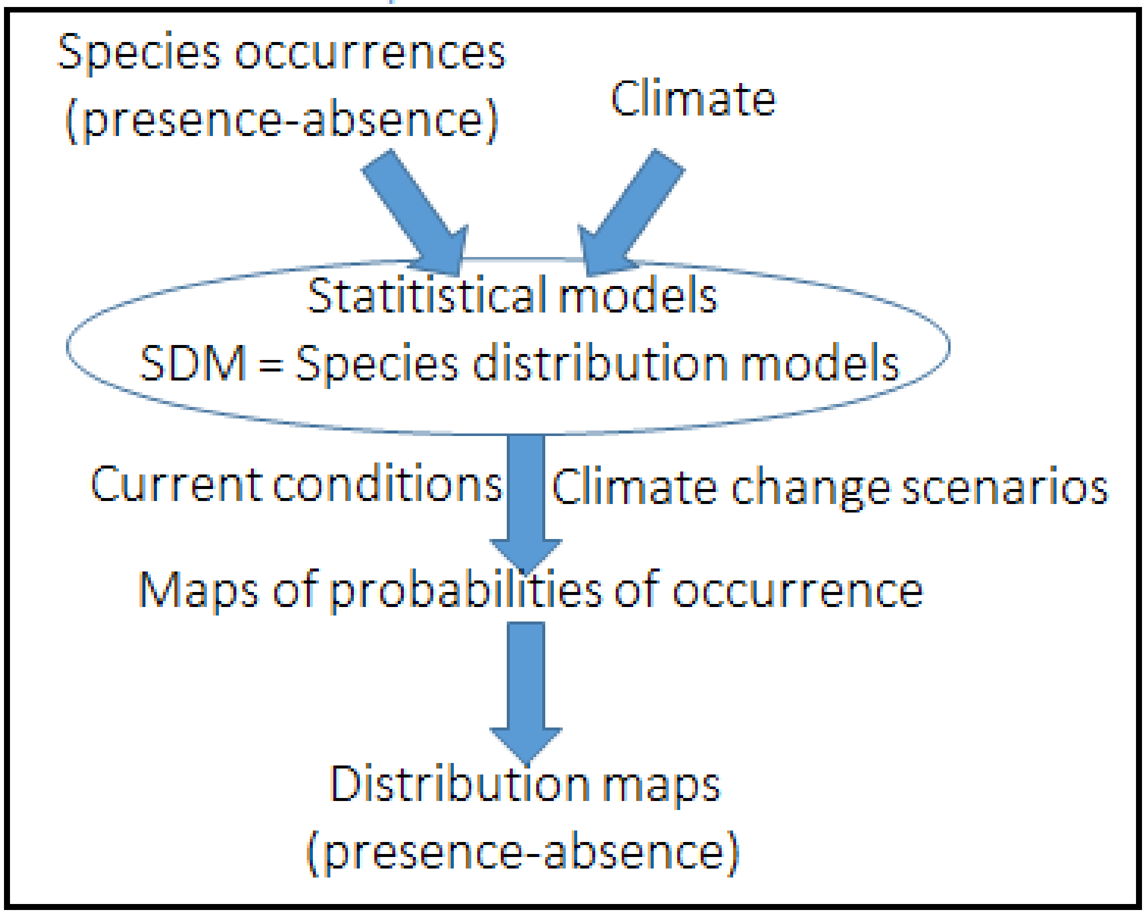
- Predictive ability in terms of probabilities versus presence-absence classifications are not equivalent
- Upscaling data usually changes BOTH the probability of occurrence AND the shape of the environment-occurrence relationship in a predictable way

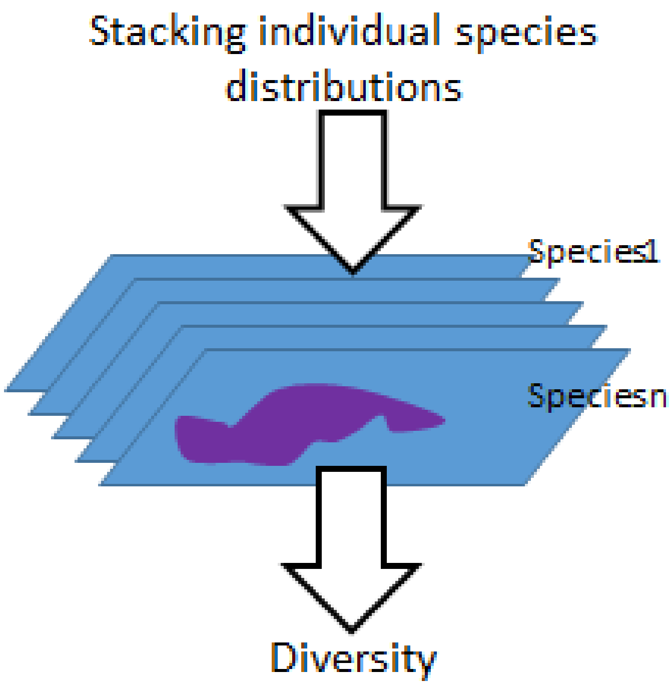
I - Species distribution models

Uncertainties

Uncertainties

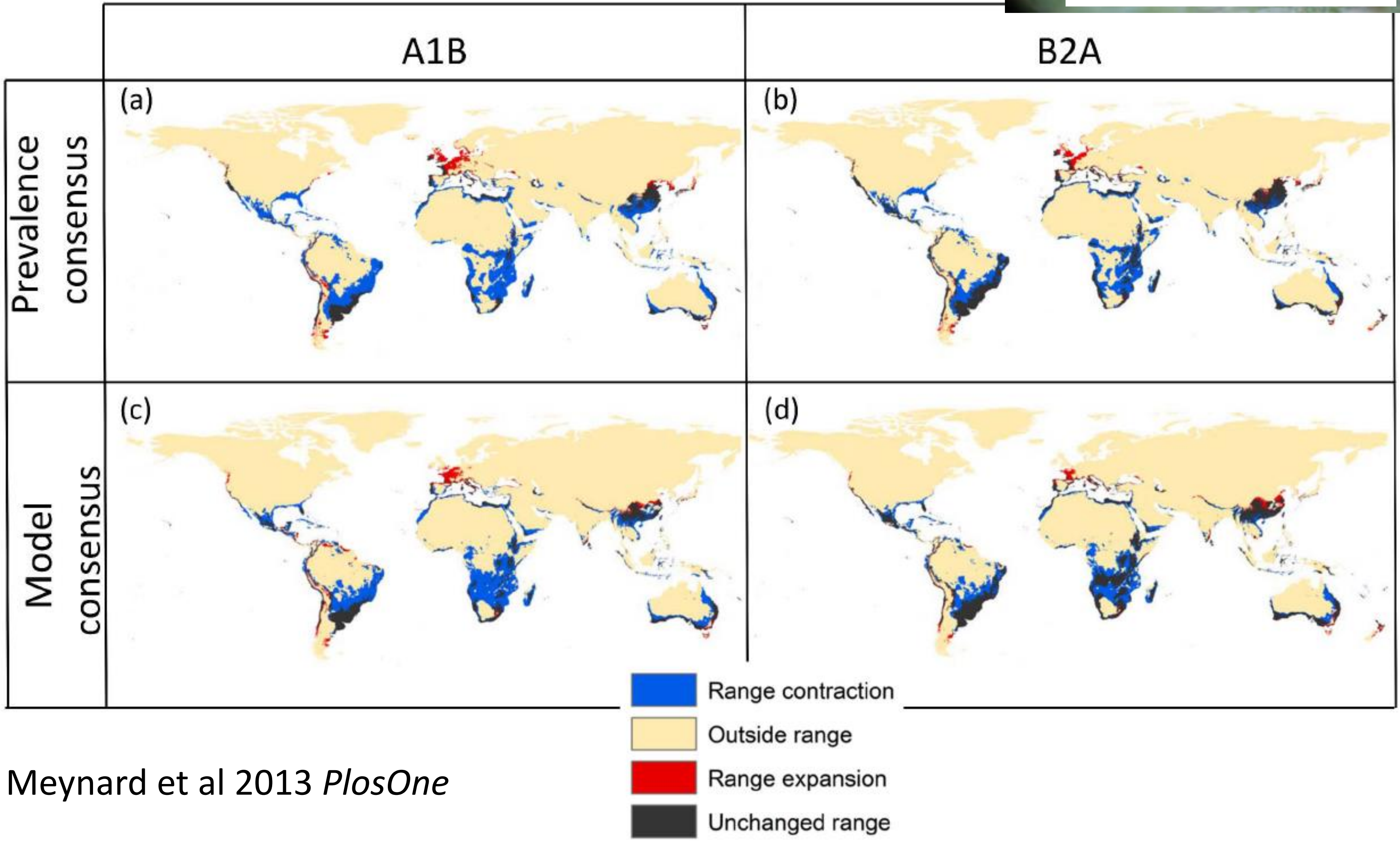
Species distribution models (SDMs)





Uncertainties

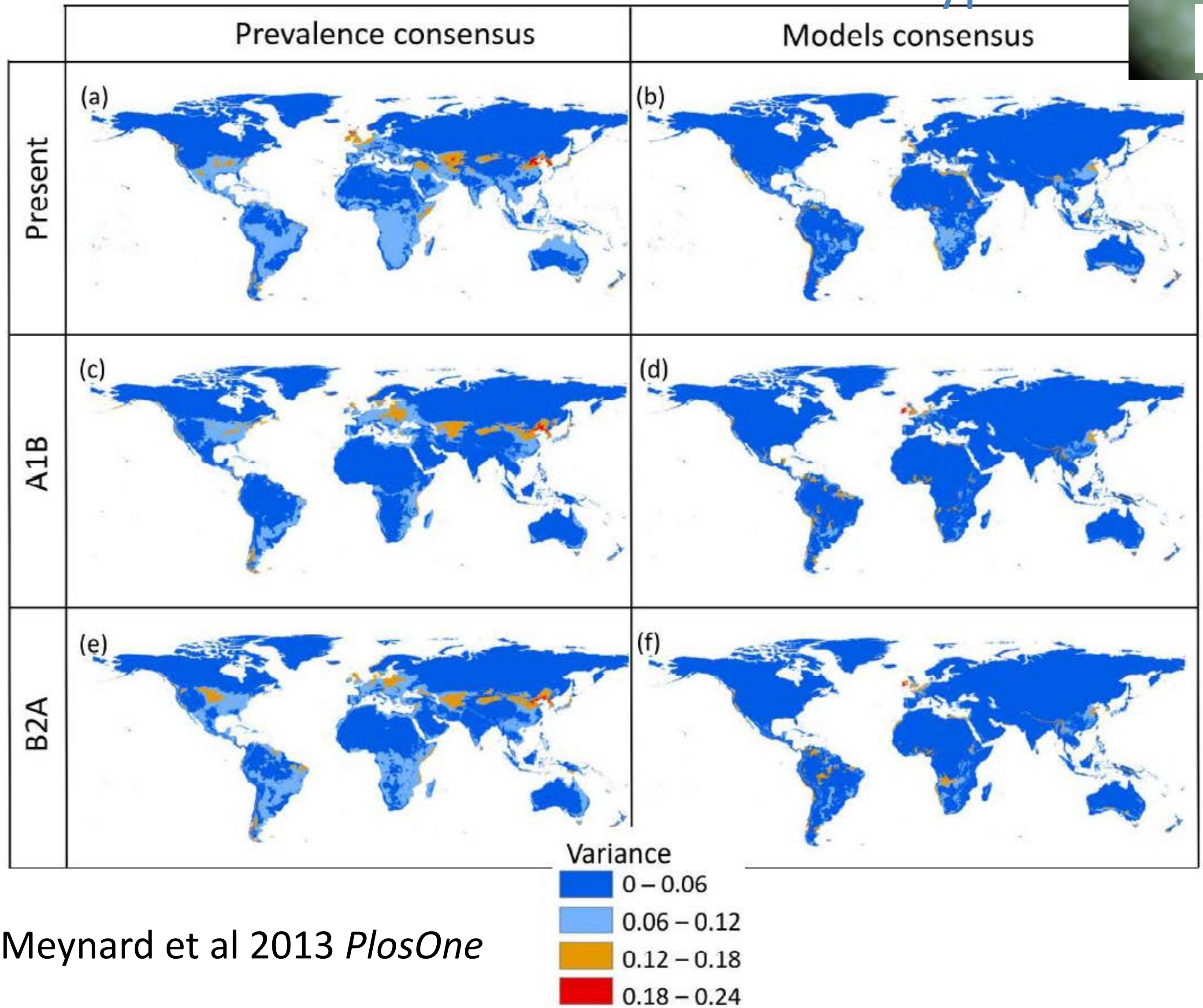
Prevalence and model types



Meynard et al 2013 *PlosOne*

Uncertainties

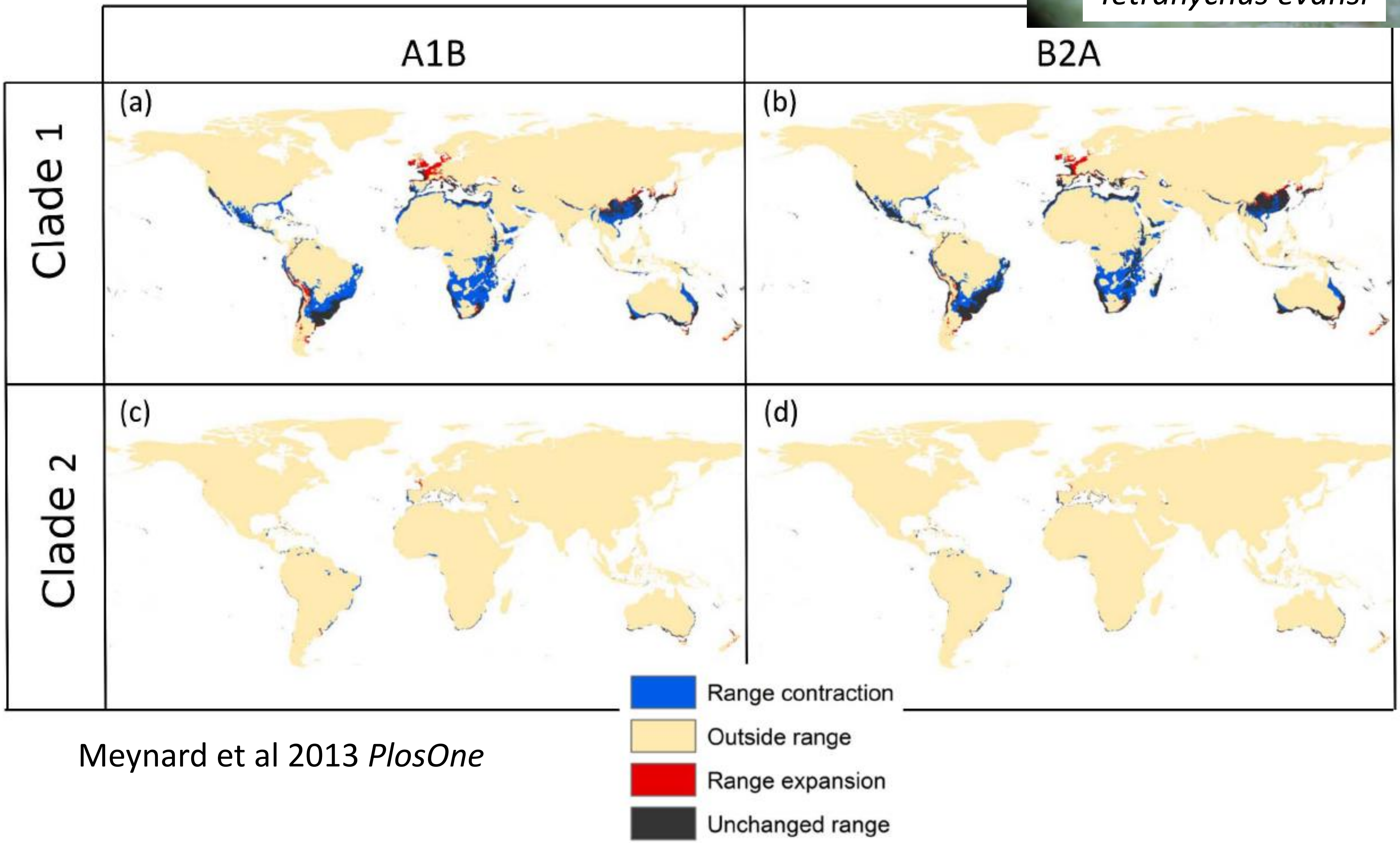
Prevalence and model types



Meynard et al 2013 *PlosOne*

Uncertainties

Species vs sub-species



Meynard et al 2013 *PlosOne*

Uncertainties

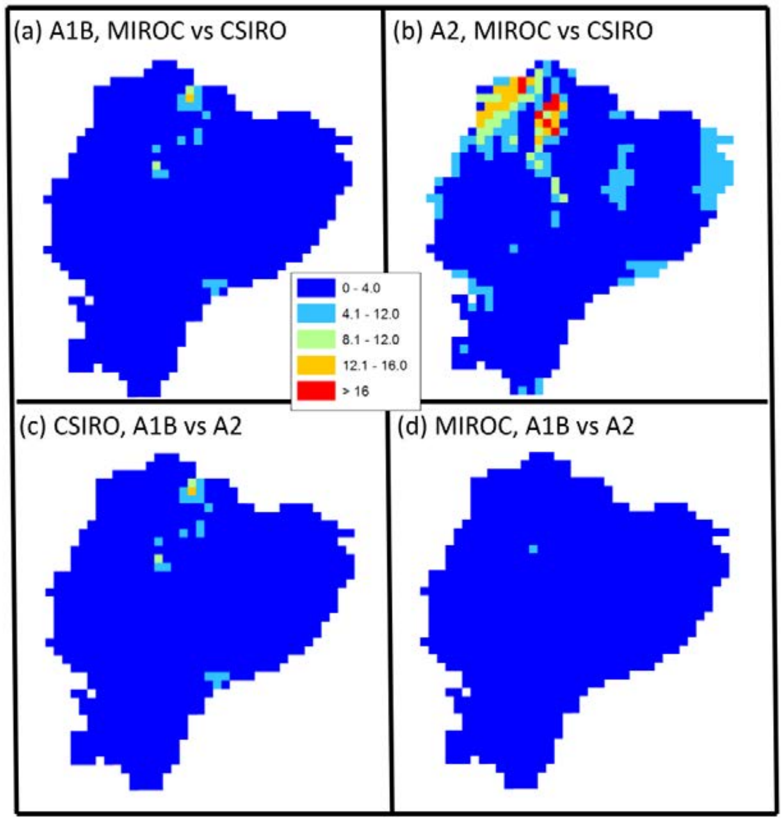
Climate model vs socio-economic scenario

200 mammals in Ecuador

A1B A2

Between GCMs

Between scenarios



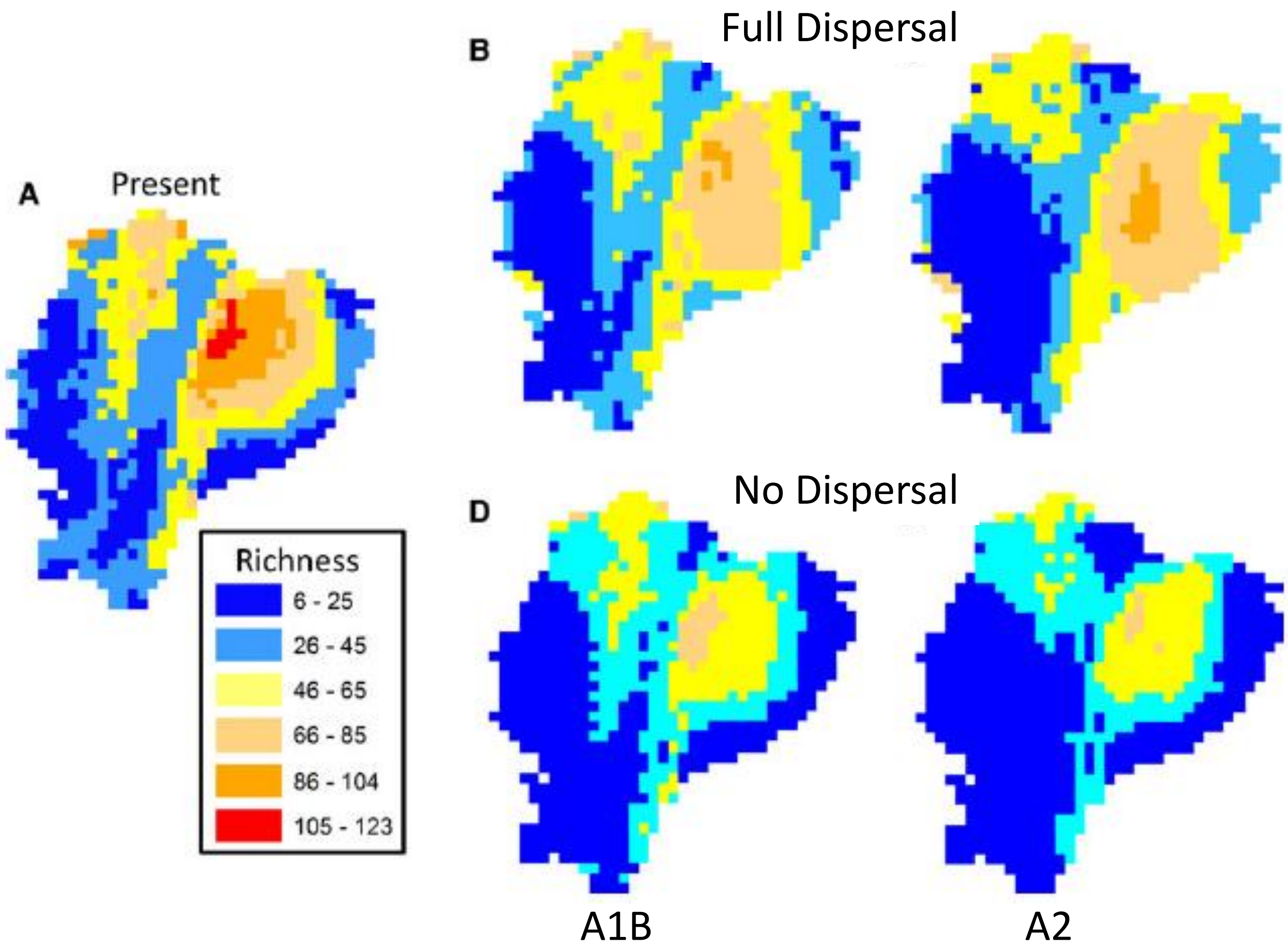
For A2, there are great differences between GCMs

Coefficient of variation between richness estimates in 2080.

Iturralde-Polit et al 2017 *Biotropica*

Uncertainties

Dispersal scenario



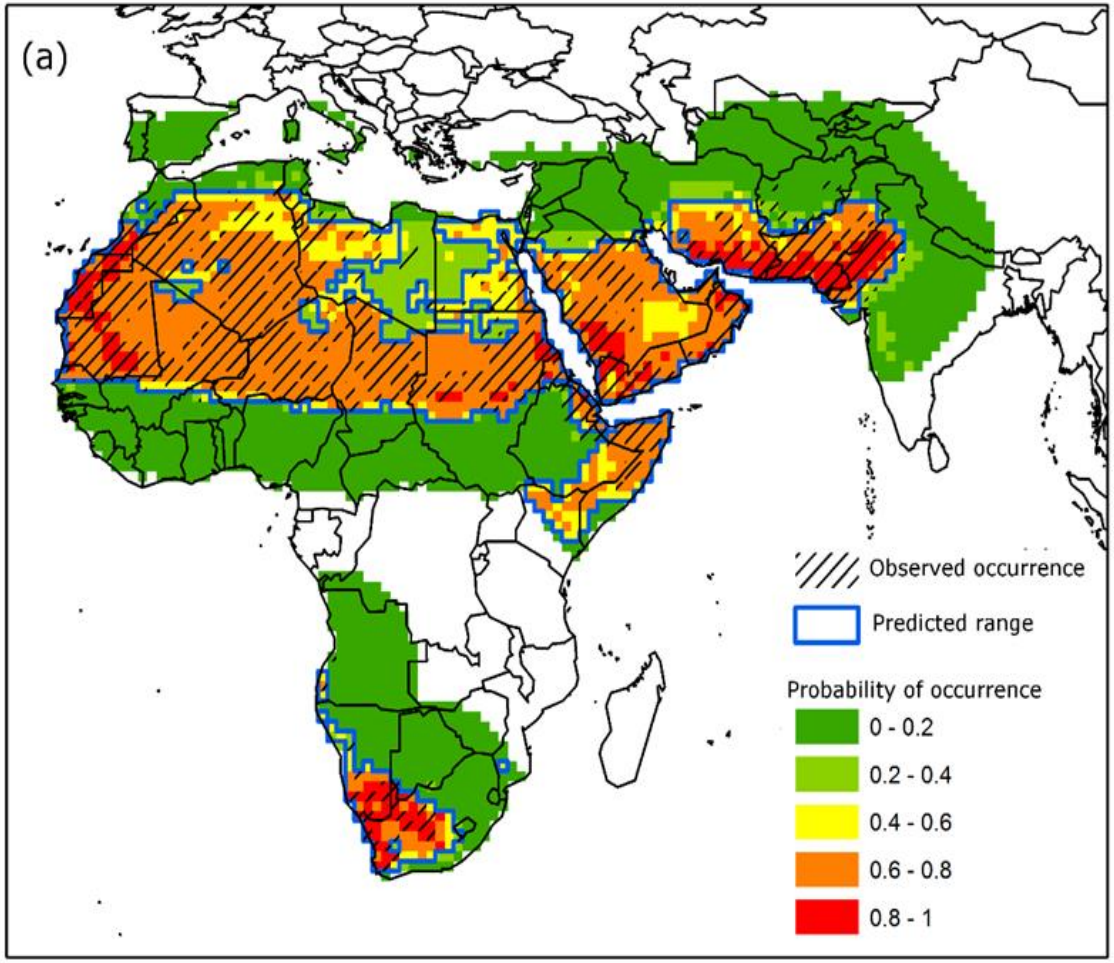
Iturralde-Polit et al 2017 *Biotropica*

Uncertainties

Types of models

Ensemble forecasting
with 8 different models

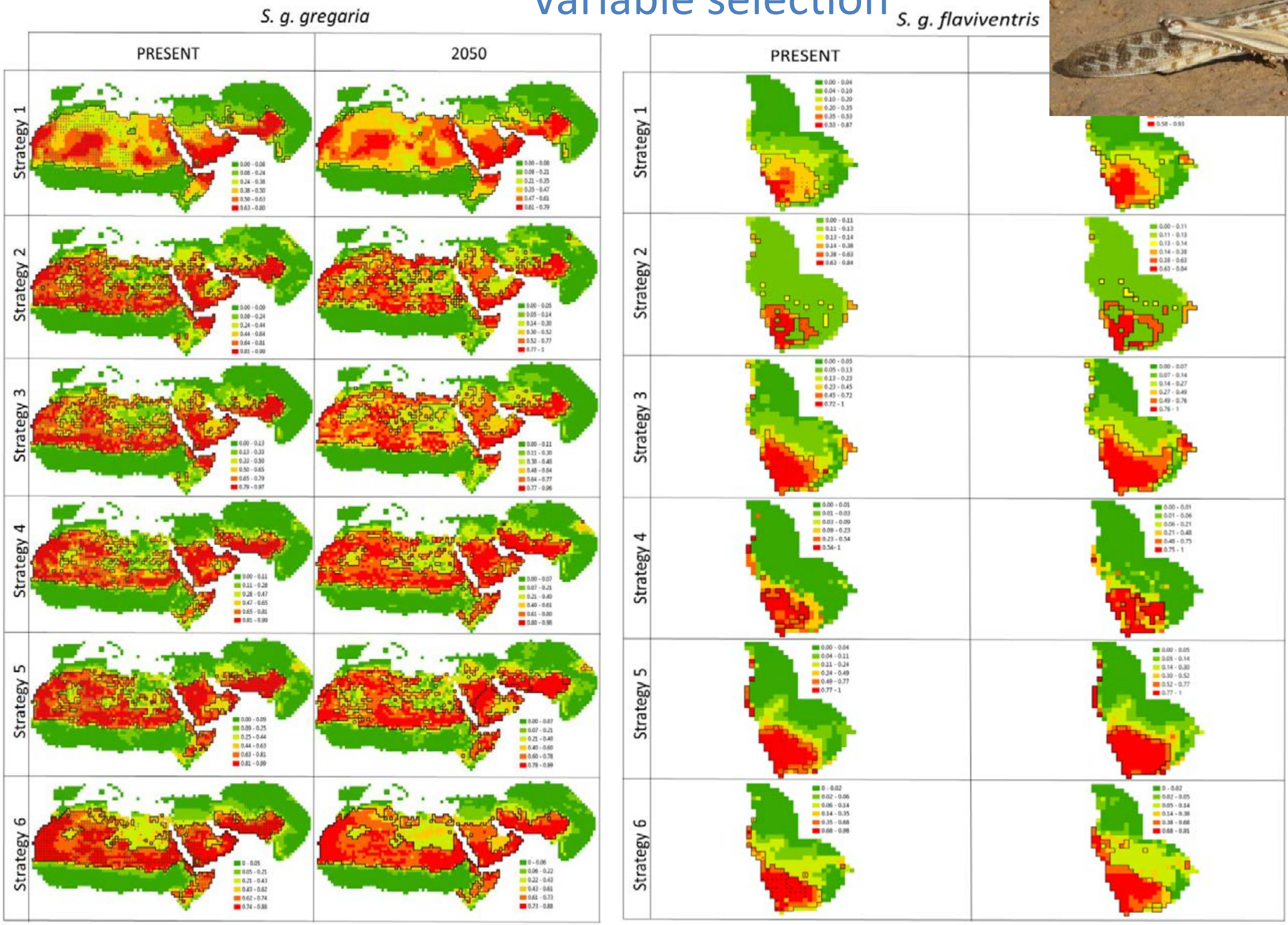
- Maxent
- Bioclim
- Domain
- GAM
- GLM
- BRT
- RandomForest
- Classification trees



Meynard et al 2017
Global Change Biology

Uncertainties

Variable selection



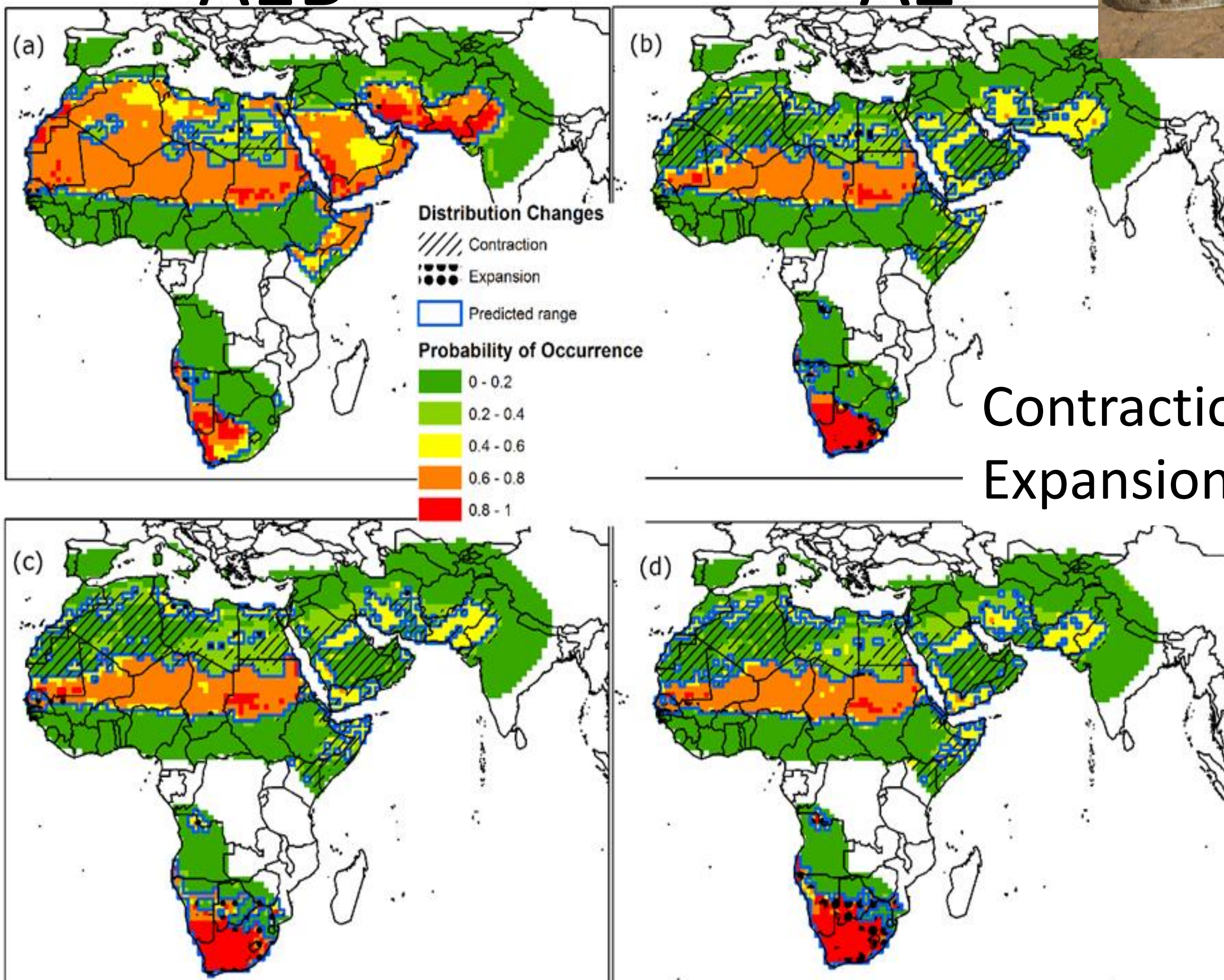
Uncertainties

Climatic scenarios

A1B A2

2050

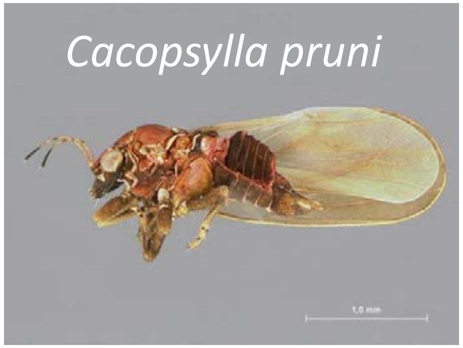
2090

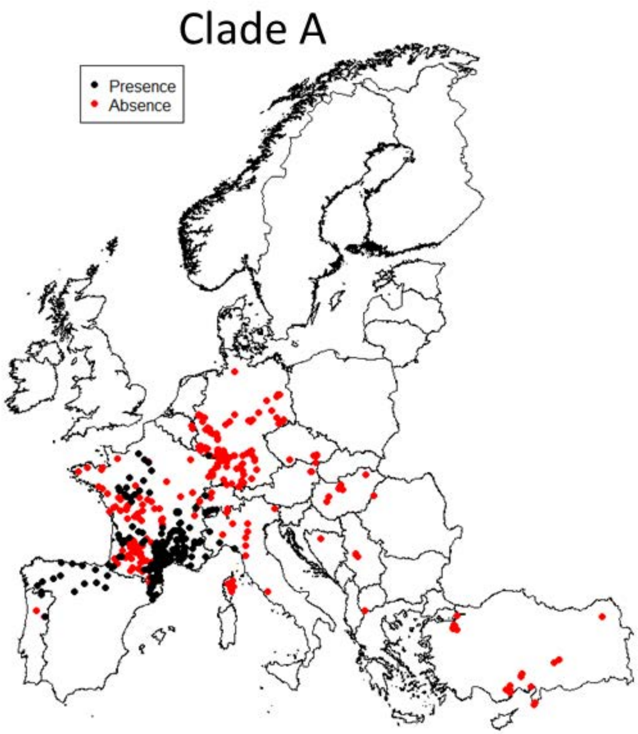


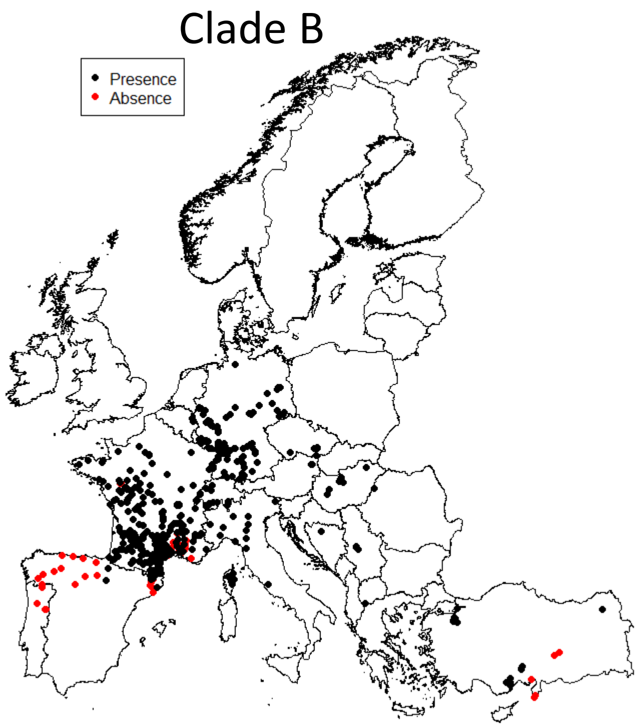
Contraction in the north
Expansion in the south

Meynard et al 2017
Global Change Biology

Occurrence data

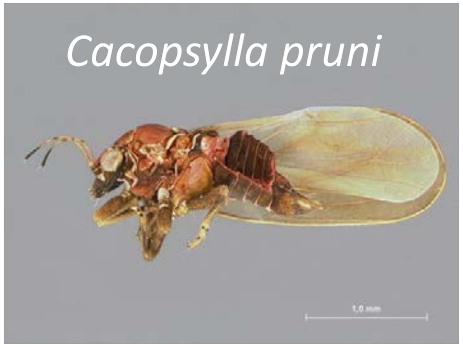






Presence-only data modelling

Adding Pseudo-Absences (PA)



Iterative approach

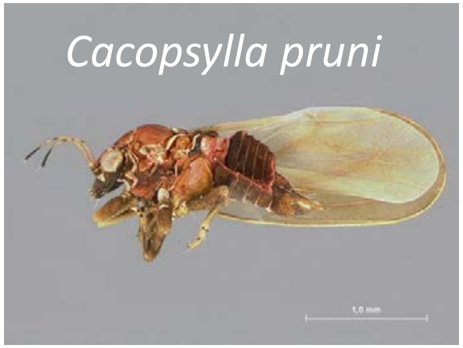
Repeat 100 times
3 types of models

4 PA strategies
↓
Sample (80% training)
↓
Projection
↓
1200 projections

Consensus map | Uncertainty map

Presence-only data modelling

Adding Pseudo-Absences (PA)



Iterative approach

4 PA strategies → Sample → Projection → 1200 projections → Consensus map / Uncertainty map

Effect of pseudo-absence strategy

Effect of occurrence subset

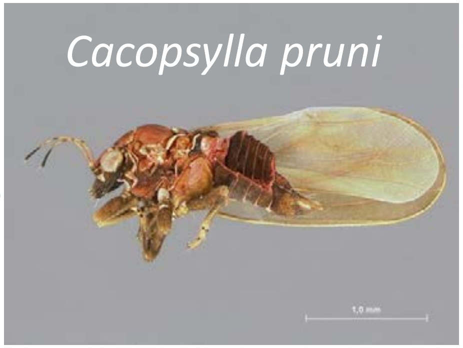
Repeat 100 times
3 types of models

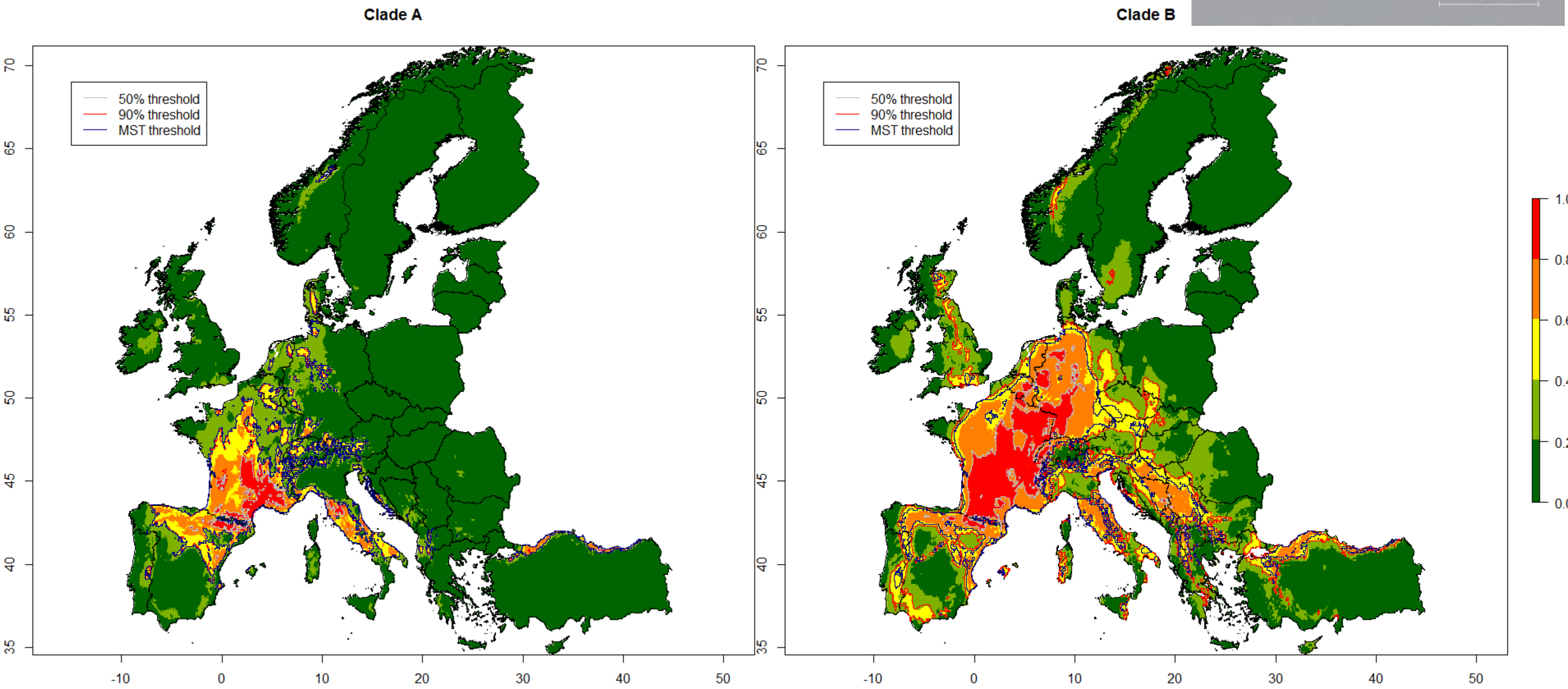
Effect of statistical model

Consensus map

Uncertainty map

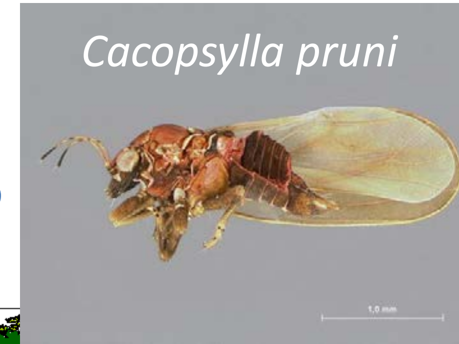
Psyllid current distributions

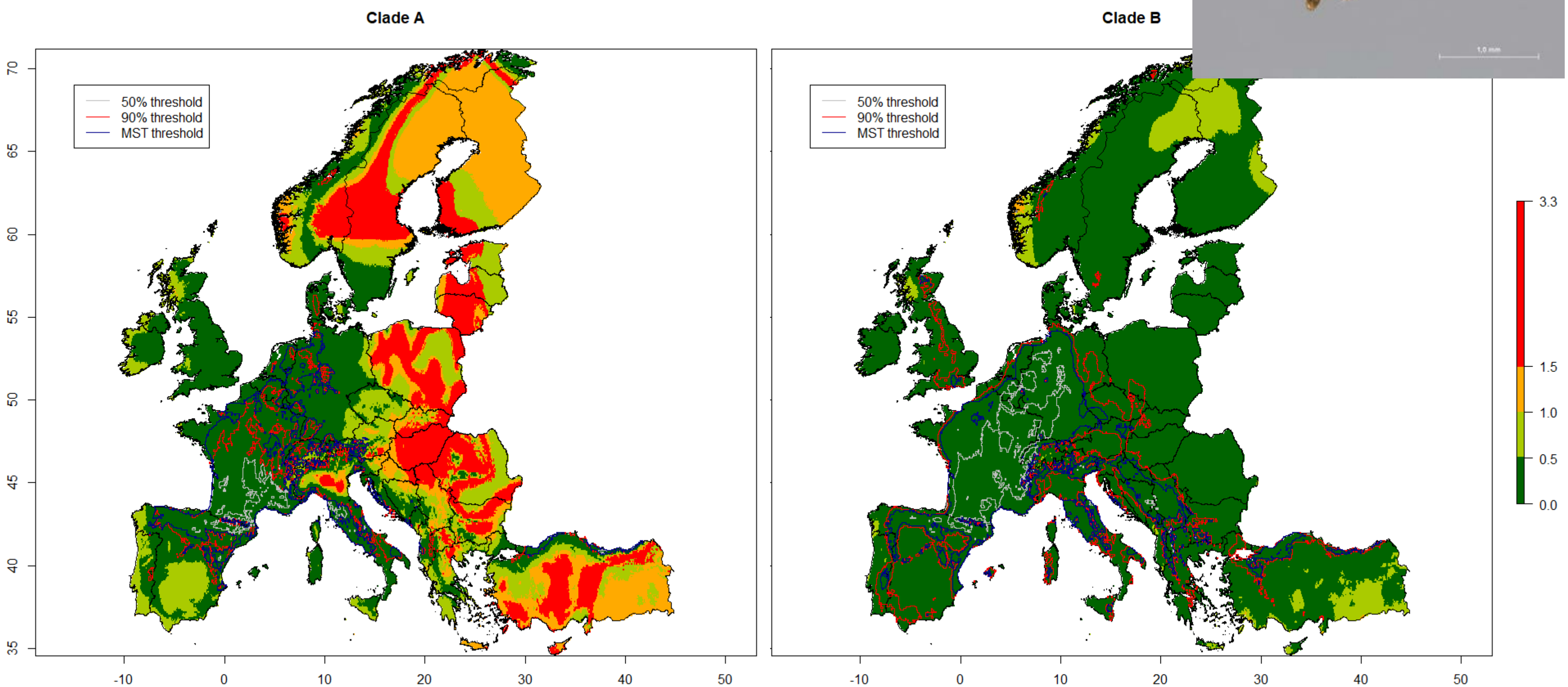




Consensus from 1,200 maps:
3 models x 4 PA methods x 100 iterations each

Psyllid current distributions

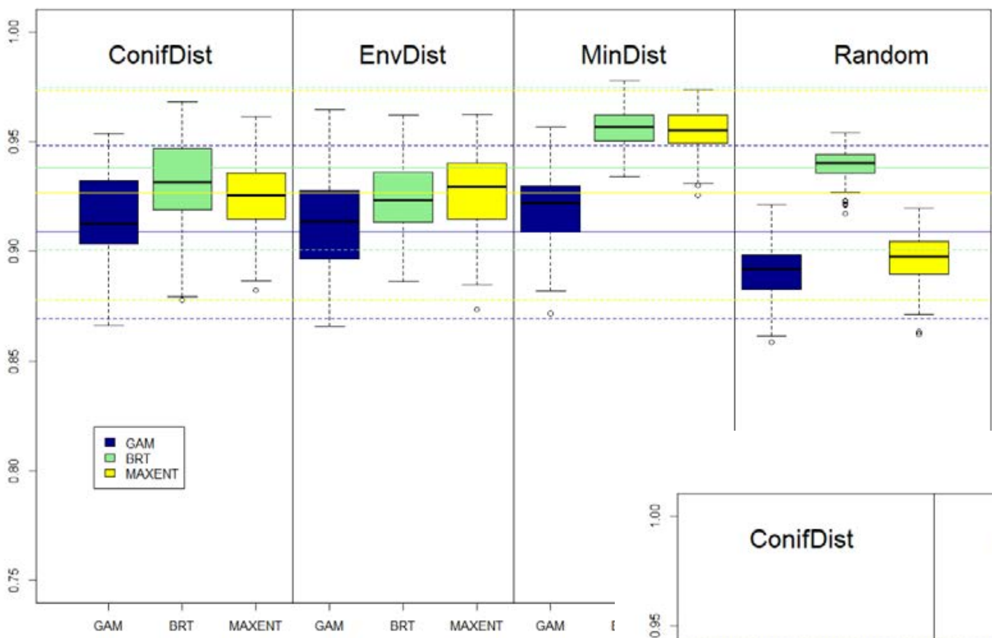




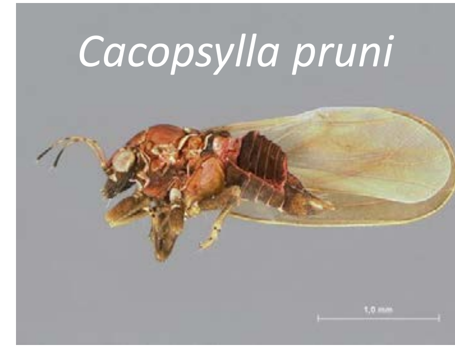
CV between 1,200 maps (standard deviation / mean):
3 models x 4 PA methods x 100 iterations each

Uncertainties

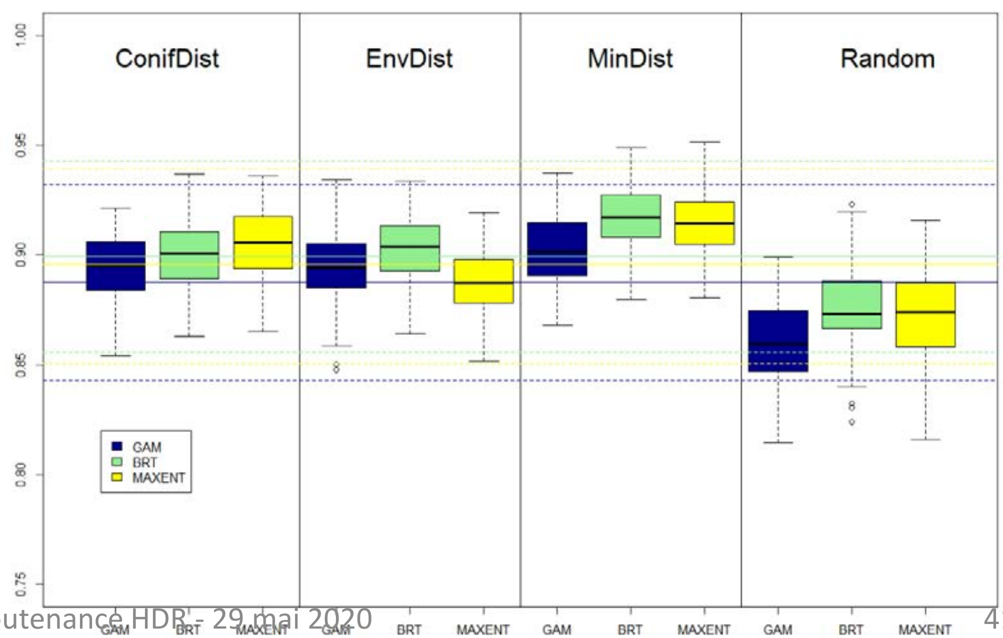
Types of pseudo-absences



Clade A

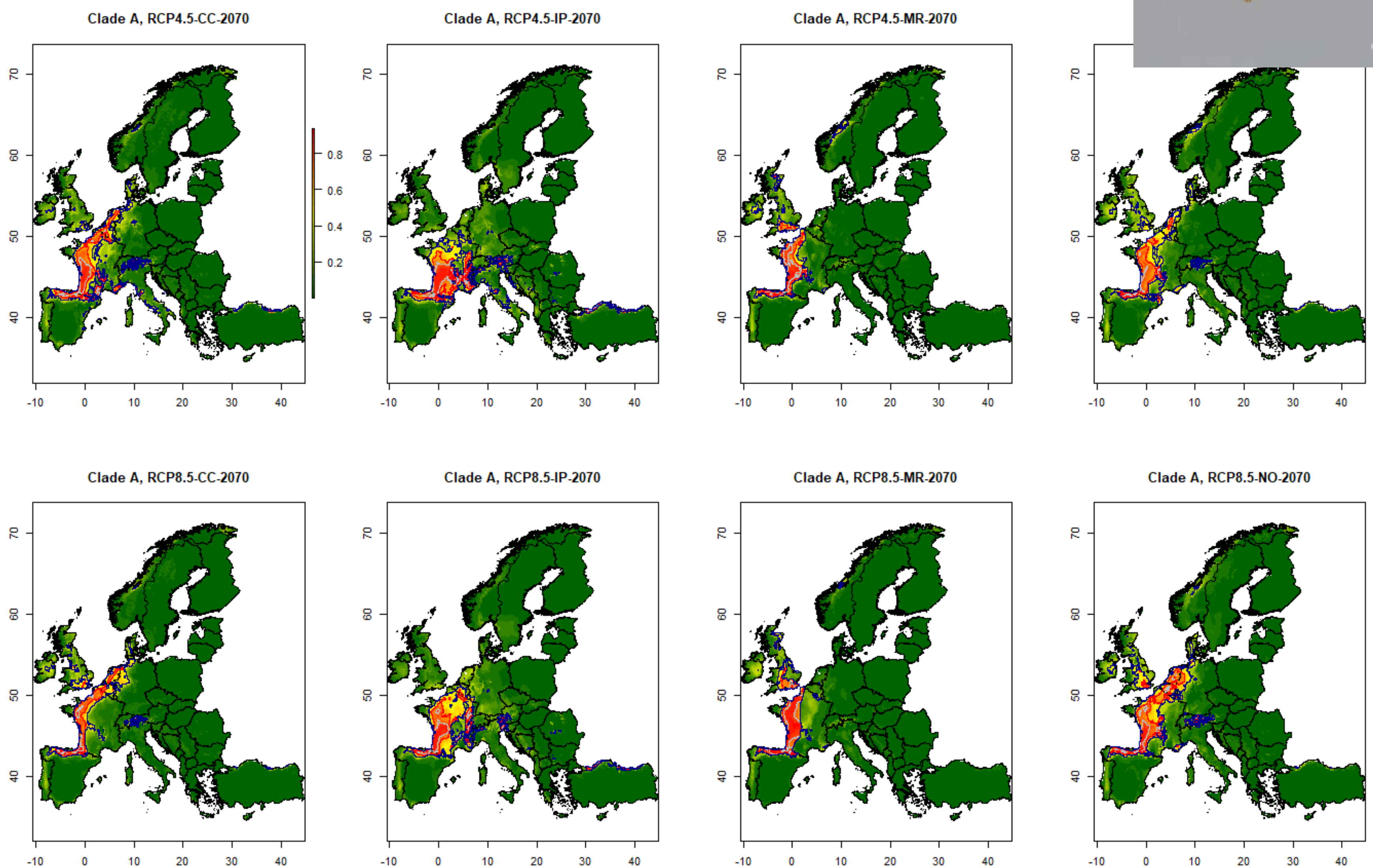


Clade B



Uncertainties

Climate models x SE scenario

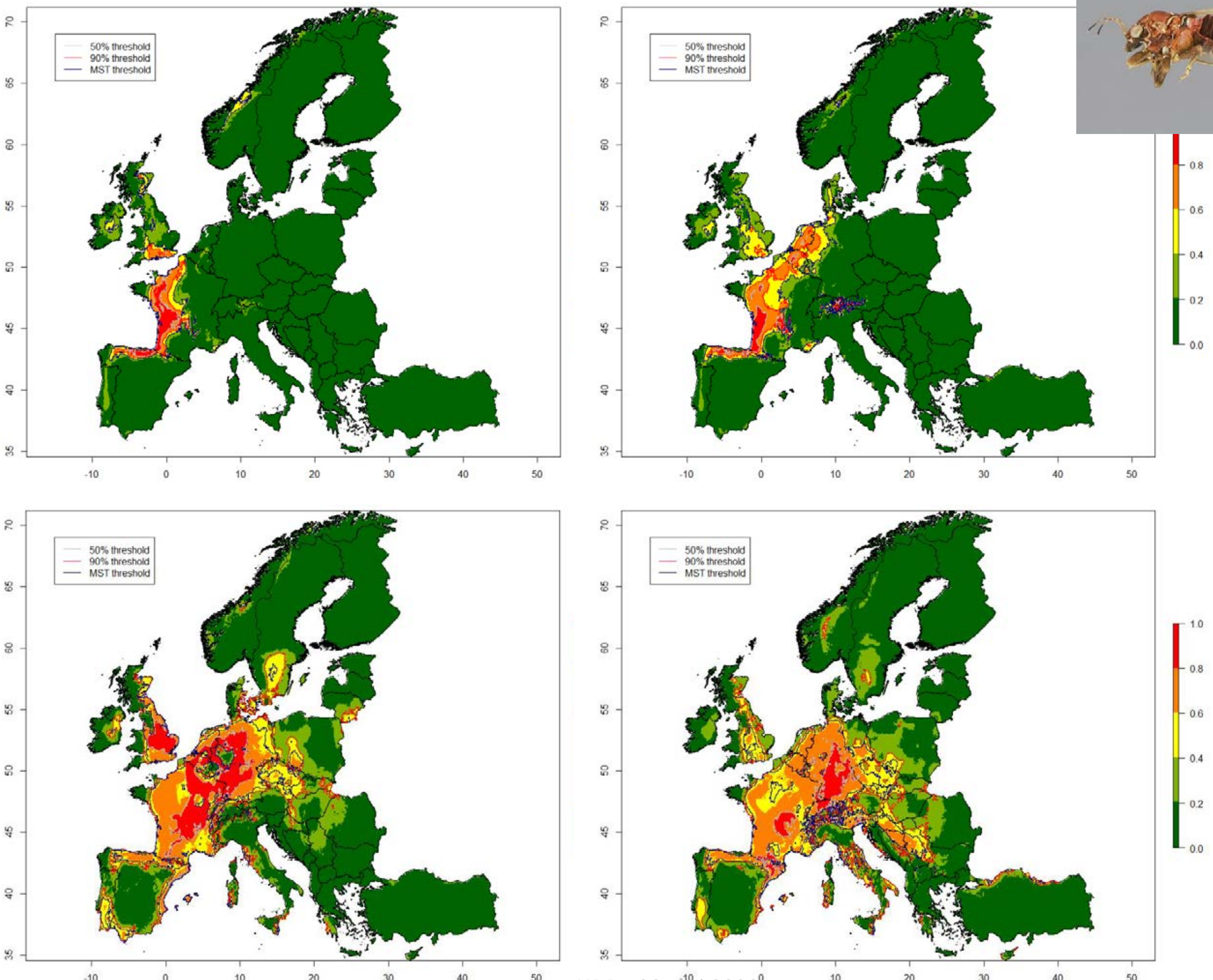


RCP 4.5 - MR

RCP 8.5 - NO

Clade A

Clade B

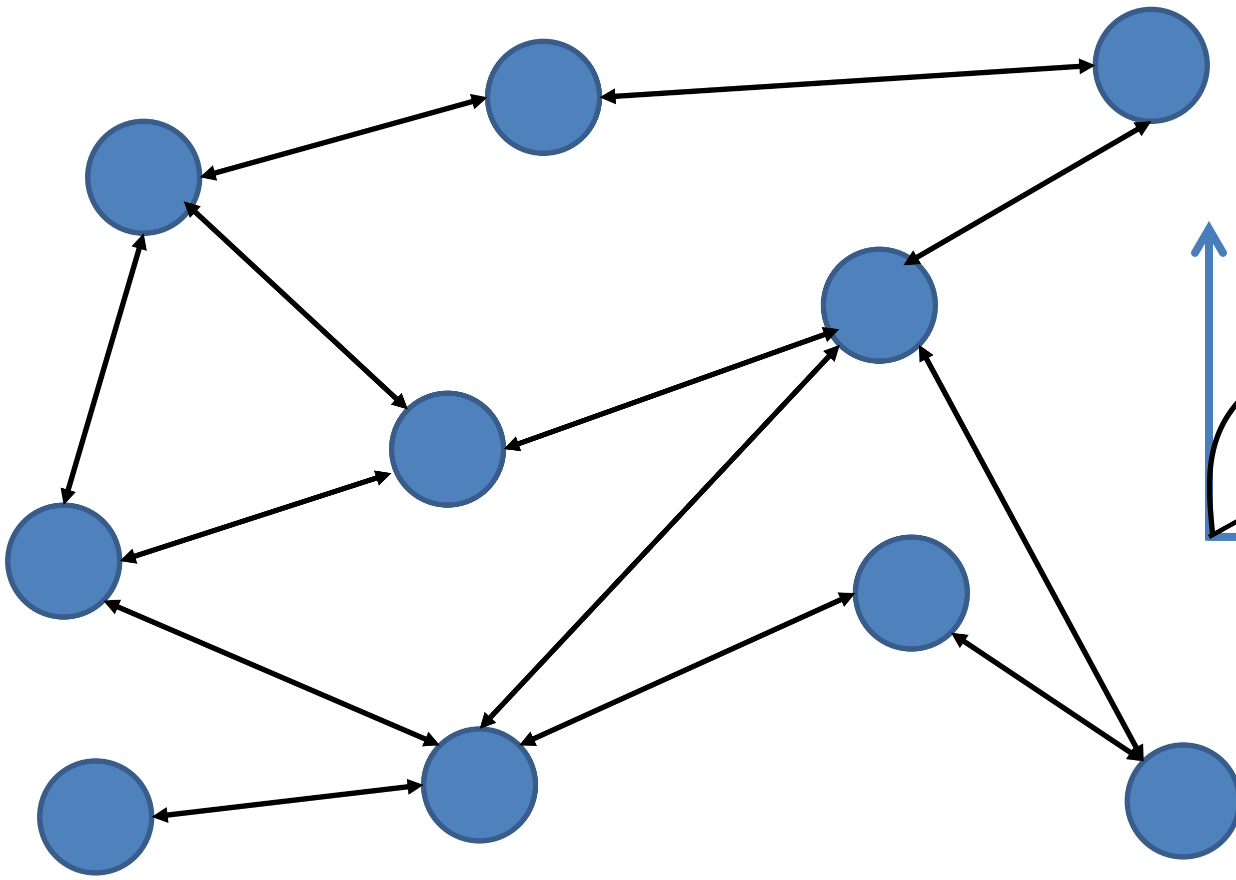


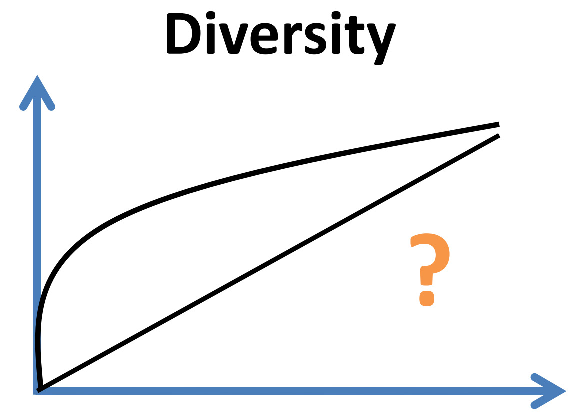
Uncertainties

- There is no solution for SDMs with presence-only data that will fit all cases
- Combining modelling with iterations to integrate sources of uncertainty
- Ensemble forecasting has been advocated for model uncertainty: can be extended to other sources of uncertainty
- Another alternative: use virtual species to do sensitivity analyses

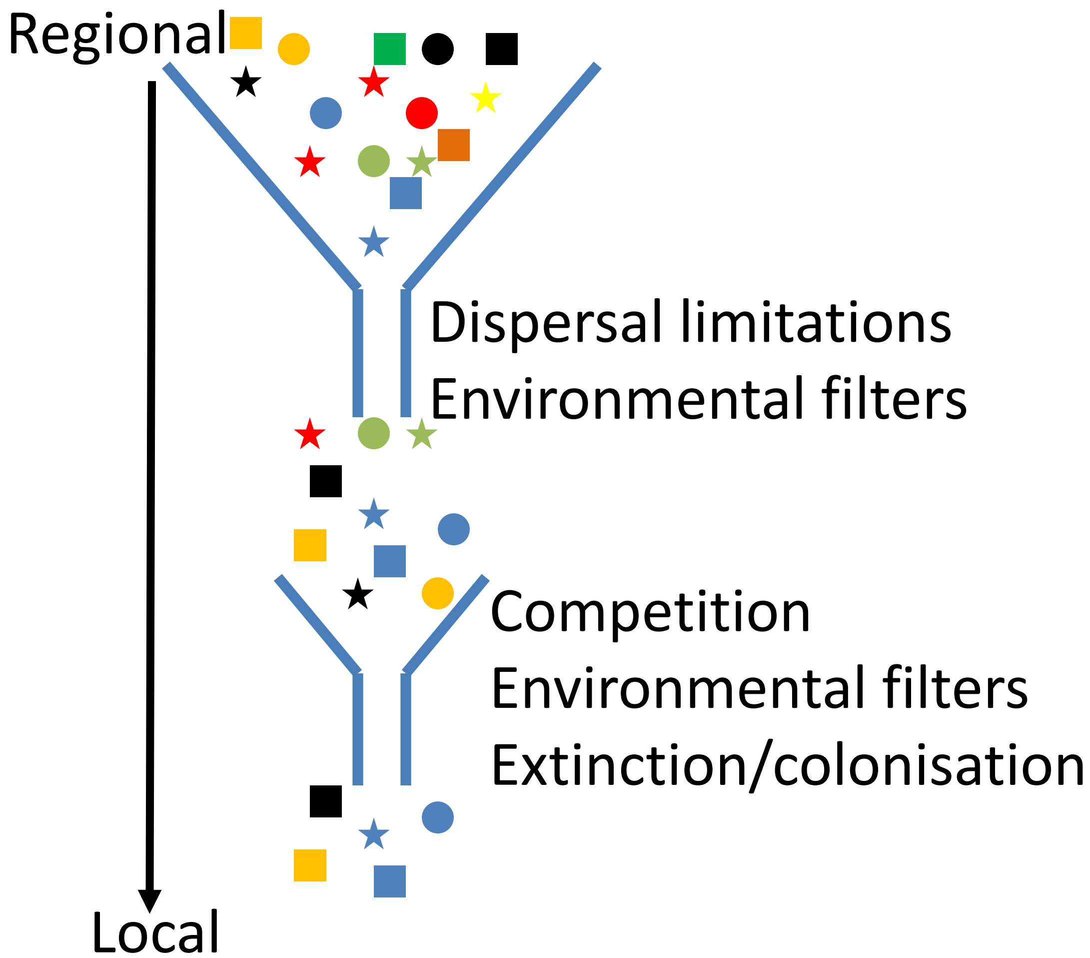
II – Metacommunities and multiple facets of diversity

Metacommunities





Processes driving diversity at different scales

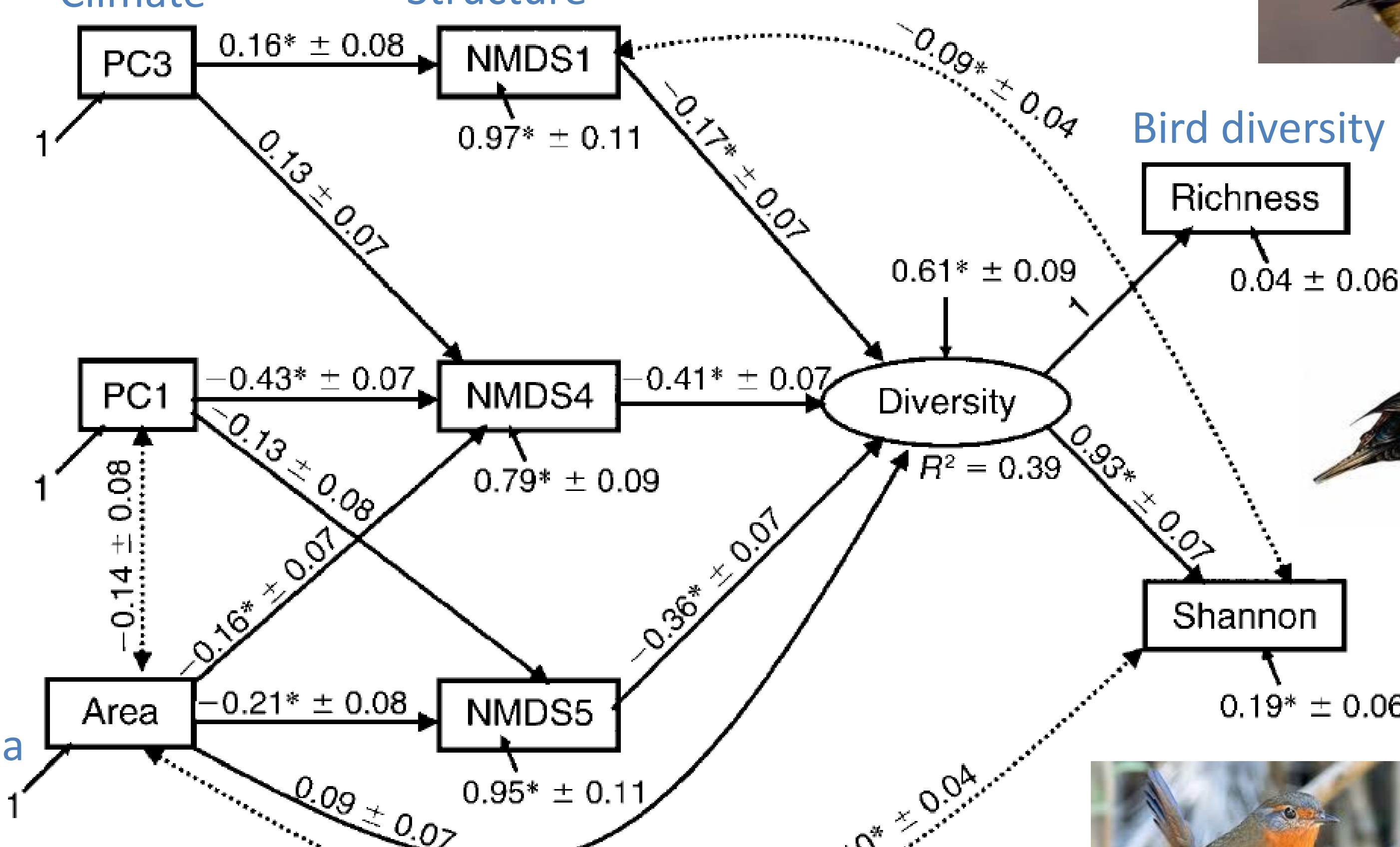


Spatial structure
Environmental correlations

Phylogenetic and functional structure

Processes driving diversity at different scales

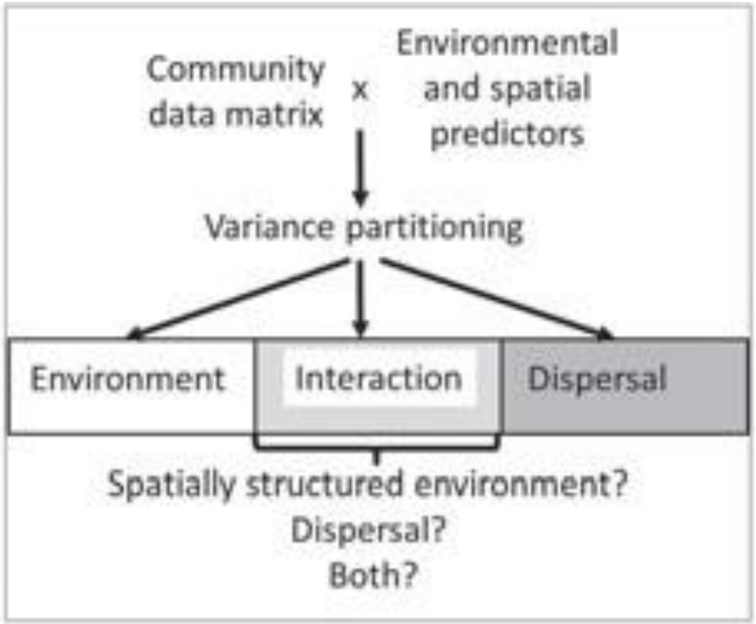
Bird diversity in Chilean temperate forests



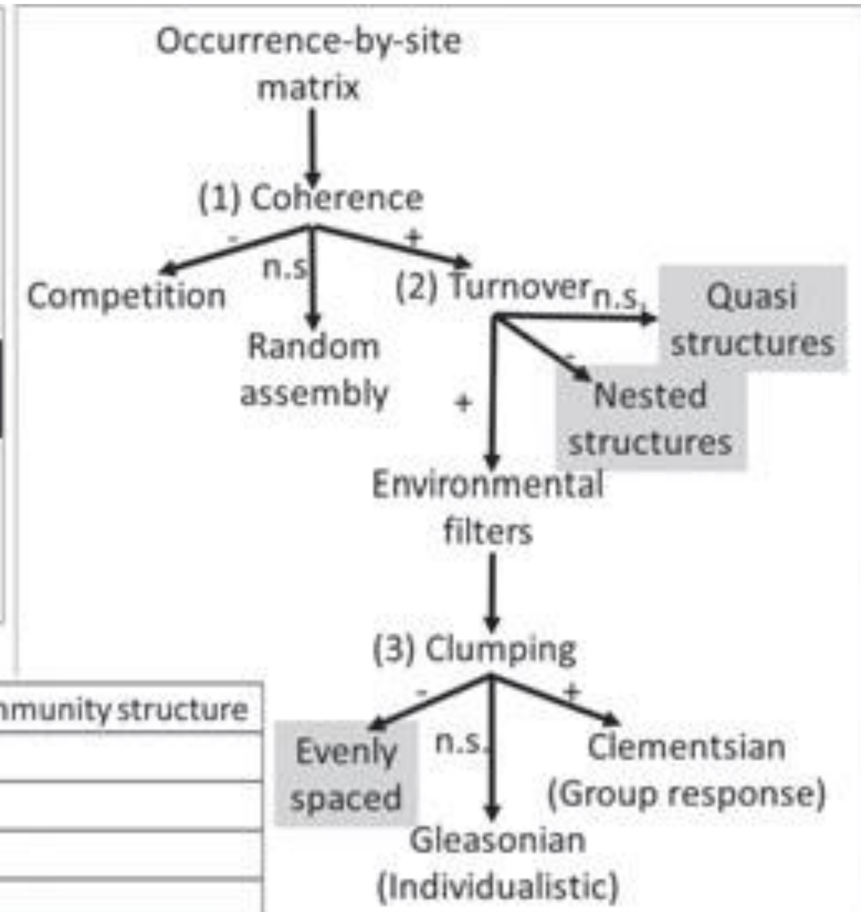
Meynard & Quinn 2008 *Ecology*

Metacommunities

Variance partitioning



Metacommunity structure approach

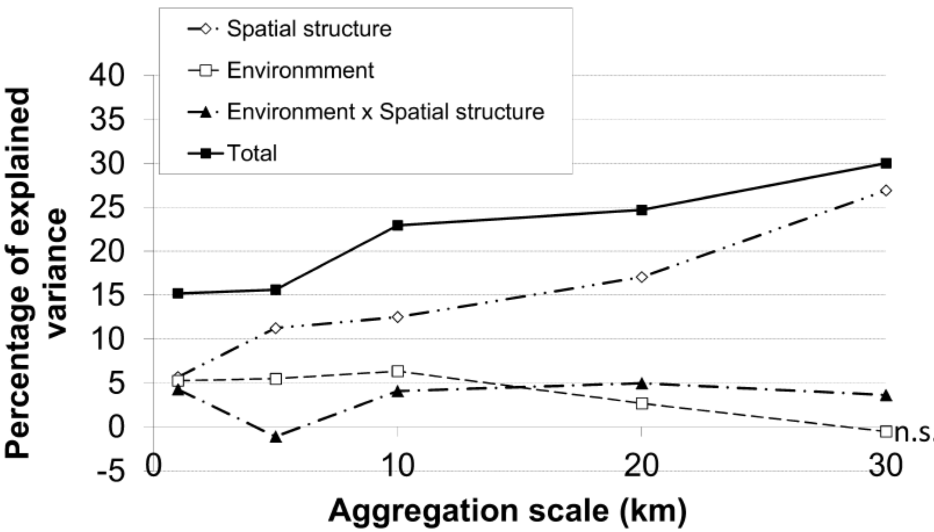


Ecological process	Variance partitioning	Metacommunity structure
Random assembly	No	Yes
Competition	No	Yes
Environmental filtering	Yes	Yes
Dispersal	Yes	No

Meynard et al 2013 *Journal of Biogeography*

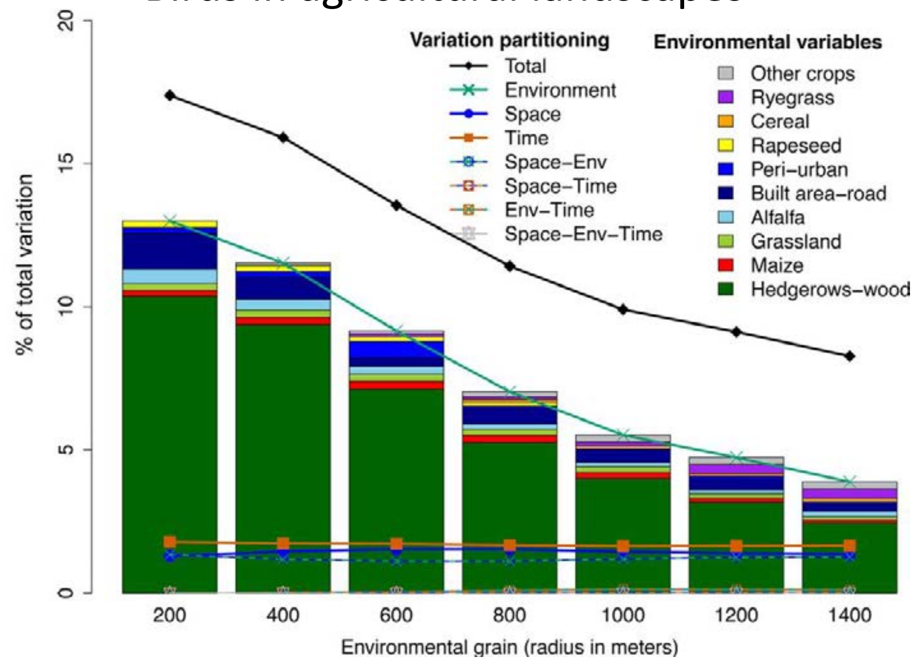
Metacommunities

Alpine grasslands



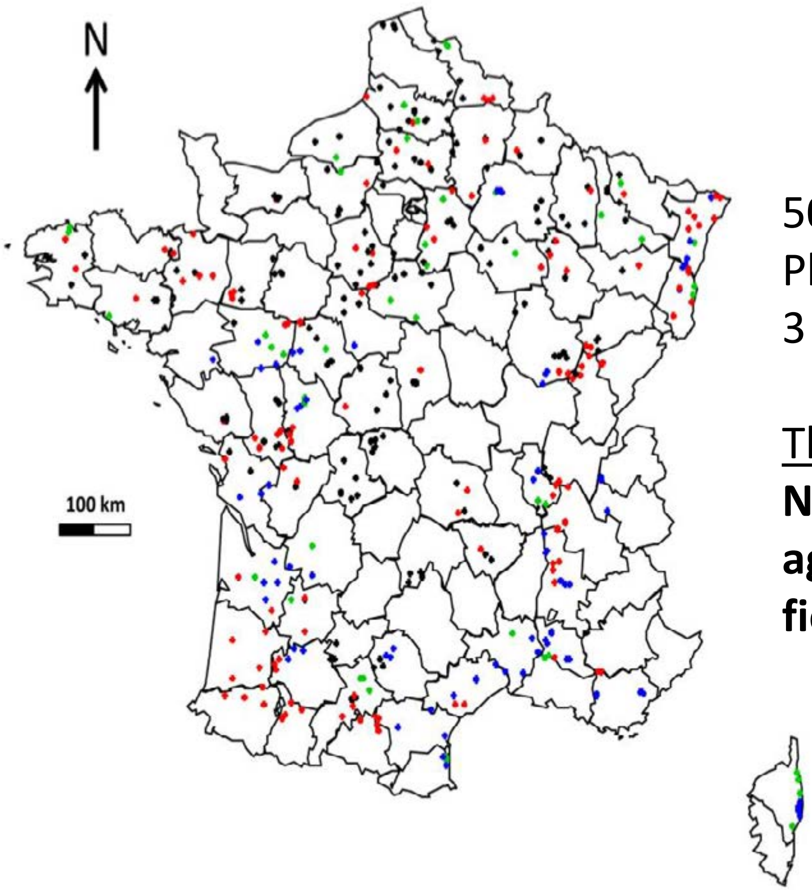
Meynard et al 2013 *Journal of Biogeography*

Birds in agricultural landscapes



Henckel et al 2019 *PlosOne*

« Le réseau 500 ENI »



500 plots across France in field margins
Plants, coleoptera, birds, worms
3 main types of cultures

<u>Thesis project </u>(Isis Poinas):
Non-intentional consequences of agricultural practices on biodiversity in field margins: metacommunity perspective

In collaboration with Guillaume Fried (ANSES)

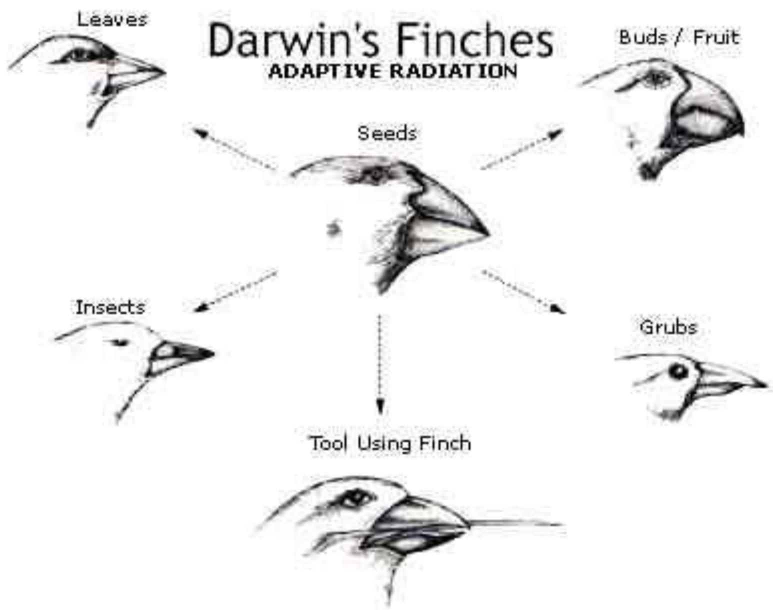
Diversity and origins of life have fascinated biologists for centuries

Functional diversity:
diversity of functions or life forms accumulated in an area or community




- Conserve diversity of life forms and shapes
- Ecosystem functioning and services

Phylogenetic diversity:
evolutionary history accumulated in an area or community



- Proxy for functional diversity
- Evolutionary history
- Evolutionary potential

The virtual ecologist in diversity studies

THEORY	**PROCESS**
Neutral	Random dispersal-competition
Environmental filtering	Environment filters out species
Colonization / extinction	Dispersal X competition
Mass effect	Dispersal X environment

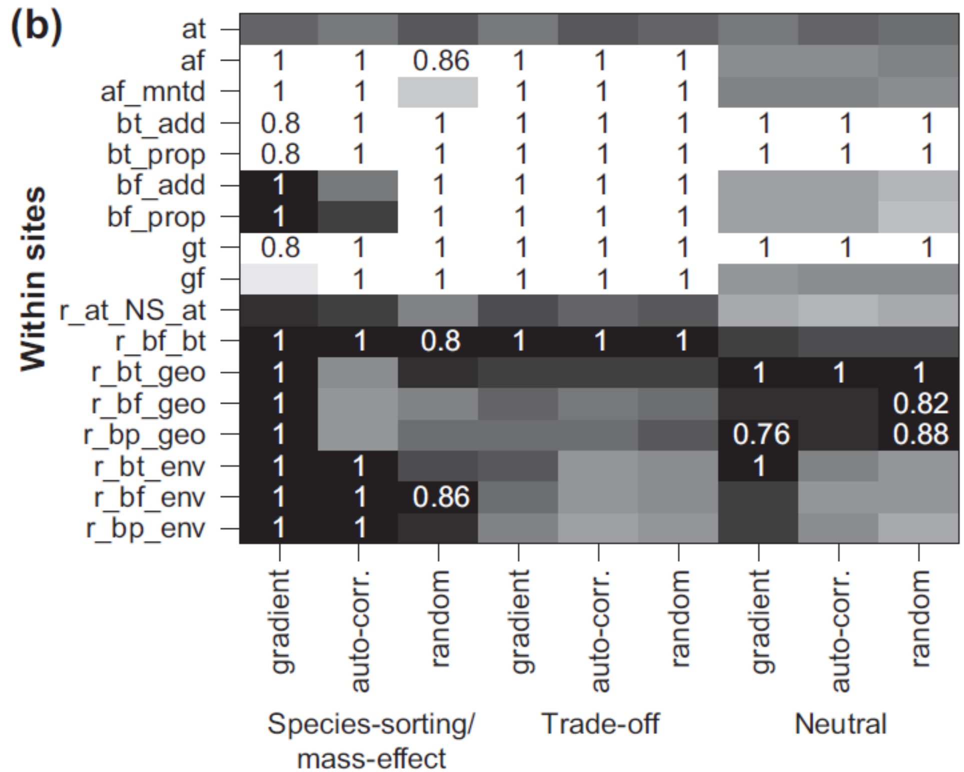
- Can we distinguish different theories from the empirical patterns of diversity?

Munkemuller et al (2012) *Ecography* 35: 468-480

The virtual ecologist in diversity studies

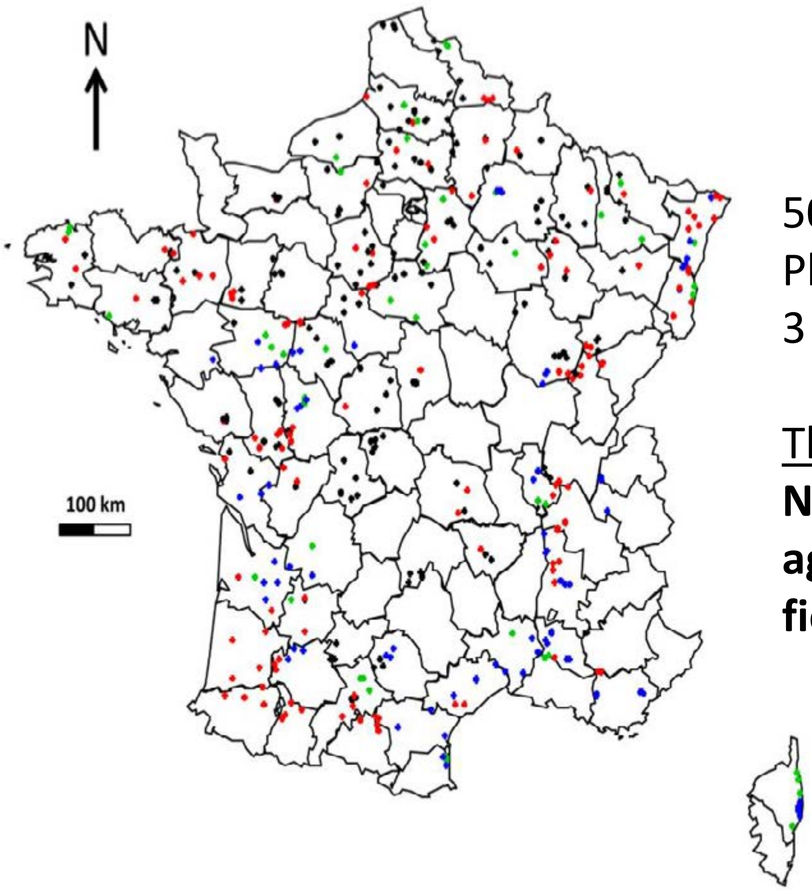
- **No single index** on itself could identify the correct process, but some combinations of indices, especially those involving correlations between **beta diversity and environmental turnover**, and diversity indices including **functional traits**, did better

Success at identifying processes behind diversity patterns



Munkemuller et al (2012) *Ecography* 35: 468-480

« Le réseau 500 ENI »



500 plots across France in field margins
Plants, coleoptera, birds, worms
3 main types of cultures

Thesis project (Isis Poinas):
Non-intentional consequences of agricultural practices on biodiversity in field margins: metacommunity perspective

In collaboration with Guillaume Fried (ANSES)

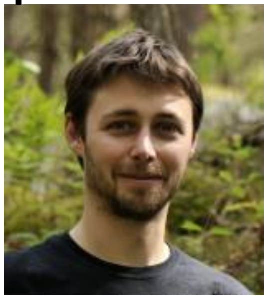
Metacommunities in agricultural landscapes

- Unintended consequences of agricultural practices
- Regulatory action at national level, management practices at the local level
- Scale vs processes
- Multiple facets of diversity
- Synchrony between taxonomic groups (plants and coleoptera)

Collaborations

Virtual Species

David M Kaplan
IRD-MARBEC



Boris Leroy
MNHN

MP Chapuis
Cirad-CBGP

Desert Locusts

Michel Lecoq
Cirad

Cyril Piou
Cirad-CBGP

Psyllids

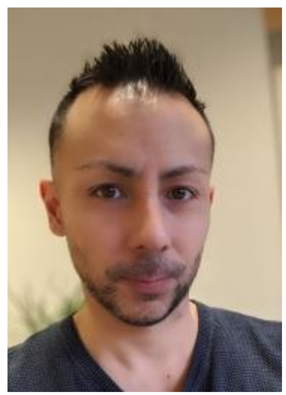
Nicolas Sauvion
INRAE- BGPI

Spider Mites

Maria Navajas
INRAE-CBGP

Alain Migeon
INRAE-CBGP

Insect macroecology



Gael Kergoat
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Coffee plants and CC

Valerie Poncet
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Stephanie Manel
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Reseau ENI
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