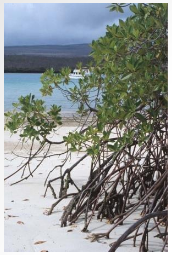
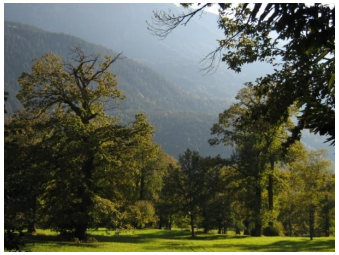



Pechiazul *(Luscinia svecica)*

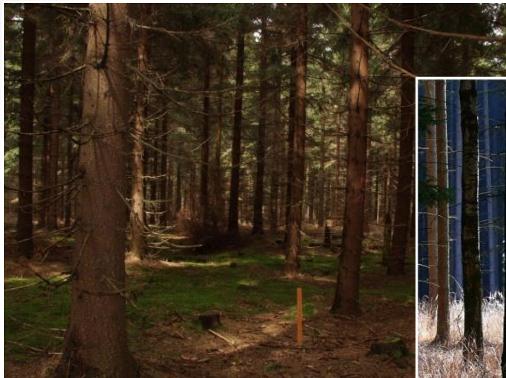
Biodiversity:

responses to global change and the challenge of long term monitoring

Fernando Valladares

CSIC

Universidad Rey Juan Carlos




- Biodiversity change
  - Factor of global change
- Impact on “ecosystem functioning” and the delivery of “ecosystem services”?
- **“Does biodiversity matter?”**

Ecosystem functioning

- "Activities, processes or properties of ecosystems that are influenced by its biota"

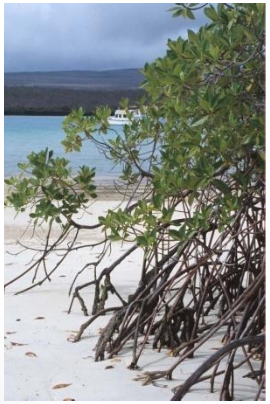
Ecosystem services

- "The benefits people obtain from ecosystems"
- "Provisioning Services"
  - Ecosystem goods
    - Food, wood and fibre, biofuels, pharmaceutical products, genetic resources, clean water, ...

© Firnhaber

Ecosystem services

- "The benefits people obtain from ecosystems"
- "Regulating Services"
  - Protection against flooding and erosion, pollination, water purification, climate regulation, disease regulation, ...




Ecosystem services

- "The benefits people obtain from ecosystems"
- "Cultural Services"
  - Spiritual and aesthetic values, recreation, tourism, science, …

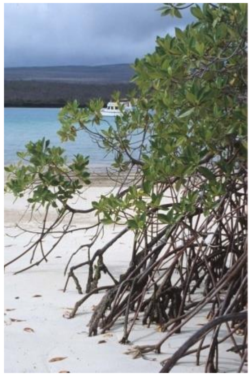
Ecosystem services

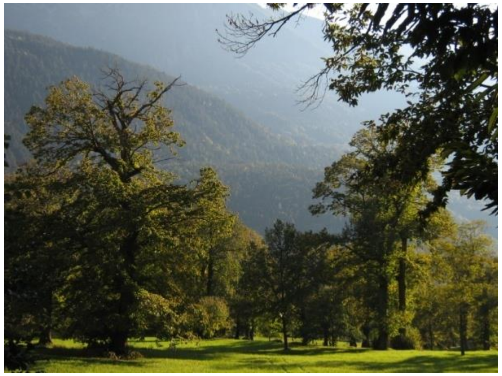
- “The benefits people obtain from ecosystems”
- “Supporting Services”
  - Primary production, nutrient and water cycling, soil formation, …
  - Ecological processes
  - Basis for the provision of other services



Outline

- It has long been recognized that biodiversity involves not only different species but also different life forms and functional strategies.



Outline

- Species can thus be seen as alternative solutions to changing challenges.
- Biodiversity also encapsulates the notion of intraspecific variability and population differentiation so the portfolio of responses includes a range of alternatives on local adaptation and plasticity that we are just beginning to uncover.

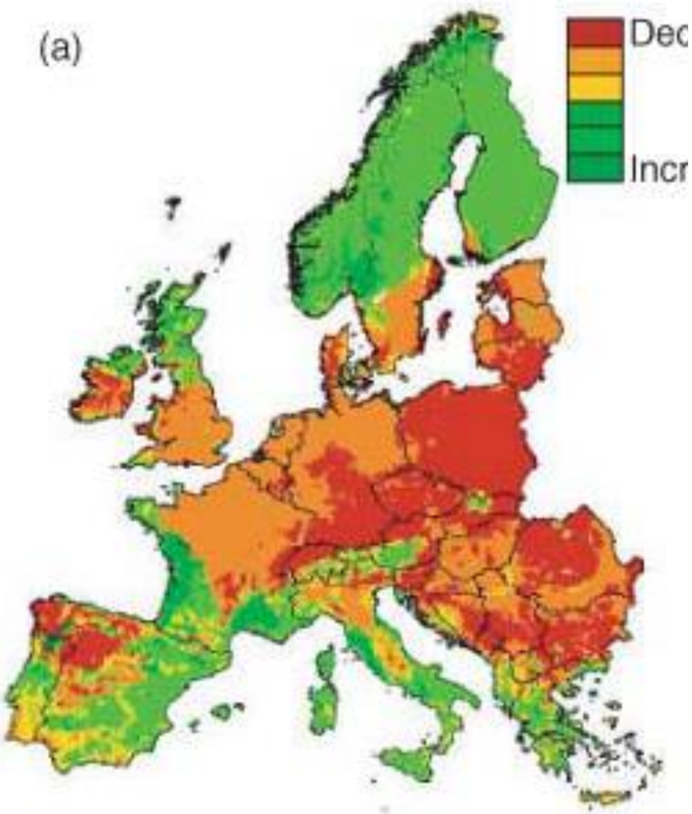
Outline

- In a rapidly changing world, species respond differently to environmental changes, which prevents generalization and introduces uncertainties in community composition and dynamics in future scenarios.

Research opportunities

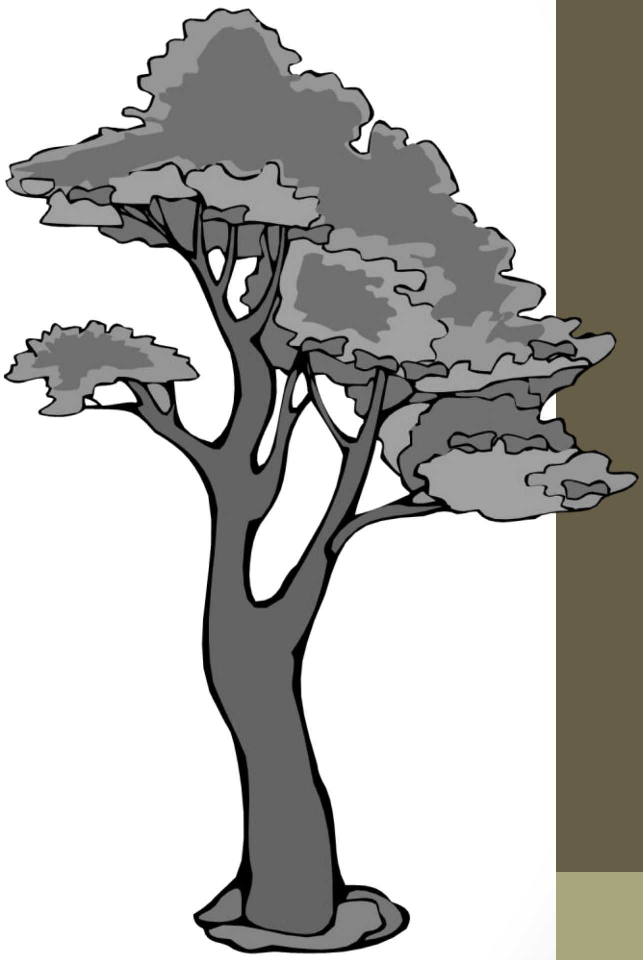
- Understanding species coexistence
- Unveiling mechanisms of species response
- Quantifying species interactions
- Estimating threats
- Predicting future distributions and scenarios
- Suggesting actions

The case of forest trees
Focus in Europe
Probably applies to many groups of organisms



Trees

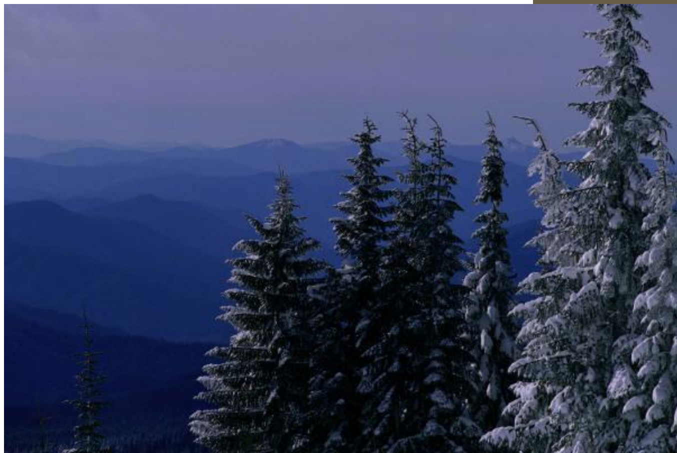
- From an evolutionary point of view, trees have at least one intriguing feature: they tend to have high levels of genetic diversity, but at the same time, they are known for their low evolutionary rates.
- Thus, trees are characterized by a counterintuitive combination of rapid micro-evolutionary change and a low macro-evolutionary change.



Hase & Petit 2006

Trees

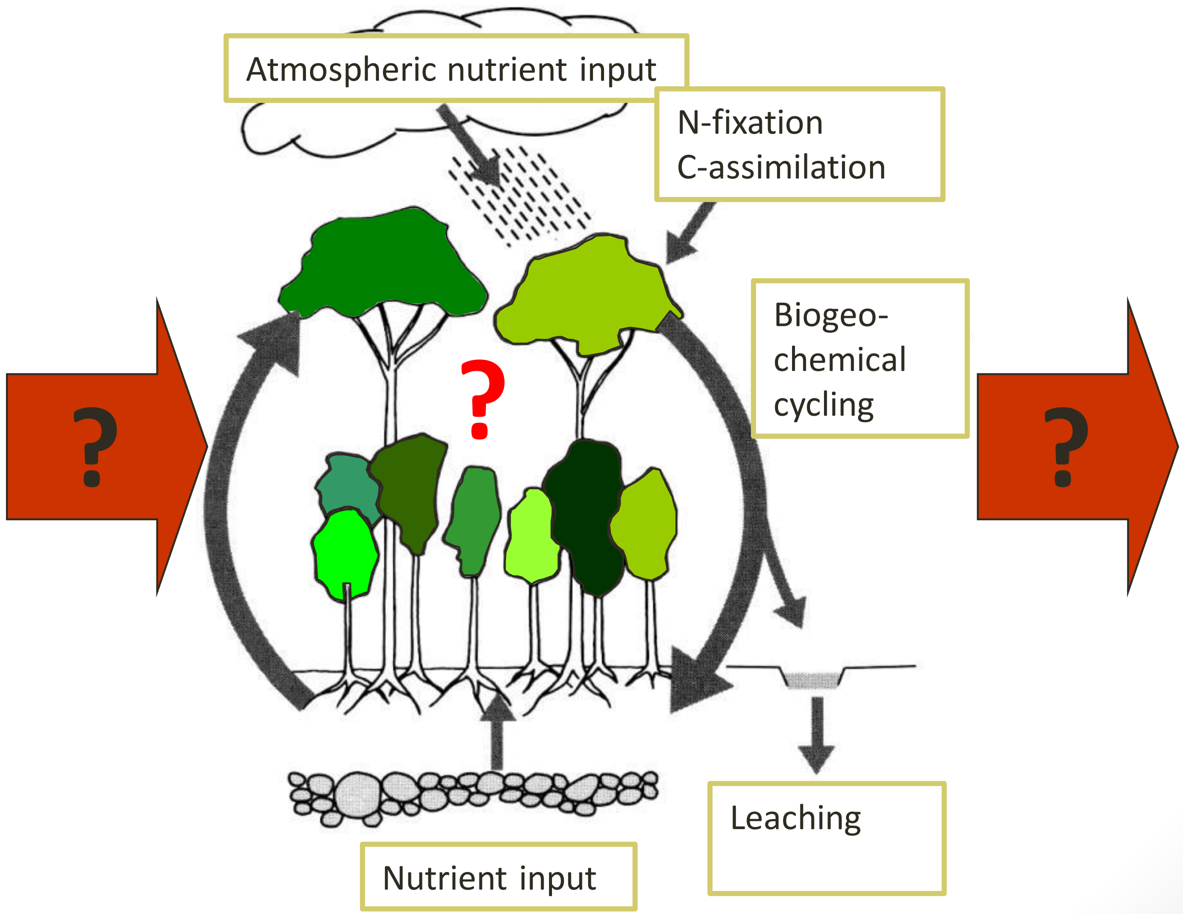
- Trees are exposed to highly heterogeneous environmental conditions within their lifetime and across their ranges of distribution, which contributes to the maintenance of their genetic diversity.
- Trees are not only highly diverse but also highly fecund, allowing them to respond to high selection intensity and to adapt quickly to local conditions.

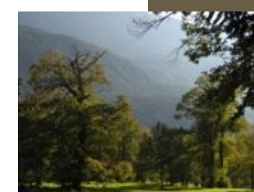


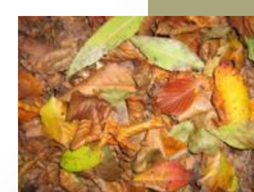
Hase & Petit 2006

- What are the impacts of global changes for forest biodiversity and ecosystem functioning?
- **What is the functional role of biodiversity in forests?**
- What are the consequences for ecosystem services?





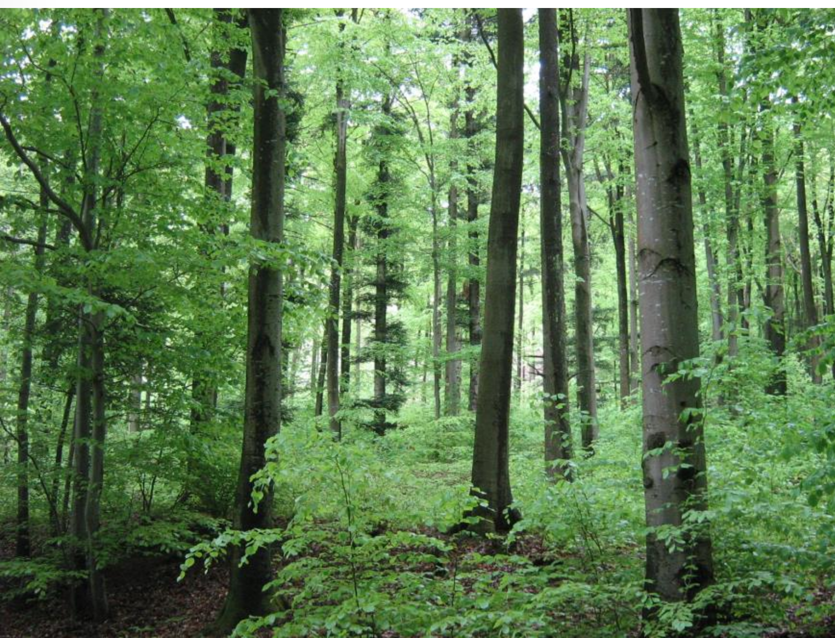
Insurance function of biodiversity

- High biodiversity ensures ecosystem stability in face of environmental changes, because
  - some species are able to resist to disturbances,
  - the loss of some species and their functions might be compensated by others,
  - species can adapt to environmental changes.

- Analogy to economics: the portfolio effect
  - long-standing principle in economics that more diversified portfolios are less volatile, because the sum of many items is less variable than the average item.

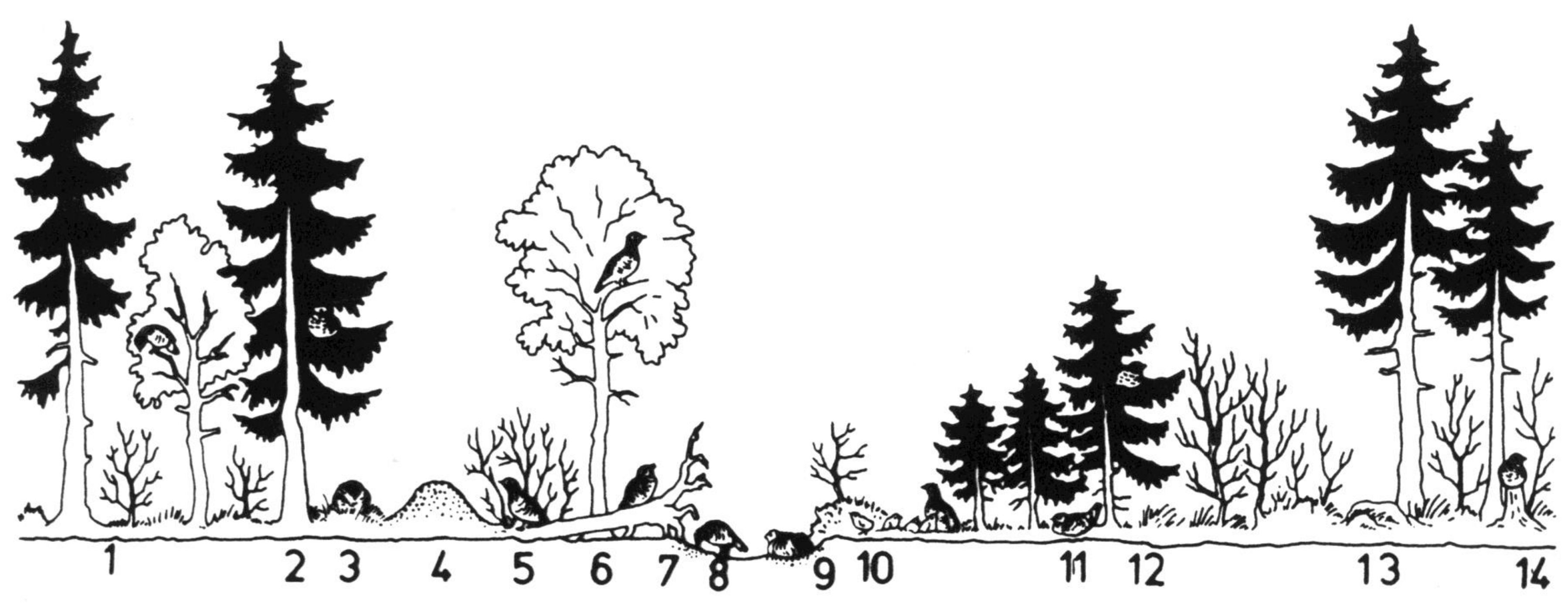
Niche complementarity

- Each species plays a specific role in the ecosystem (has its own niche)
  - Differences in above- and belowground architecture, sun- and shade-adapted species, early- and late-successional species
  - in sum they are more efficient than each individual species



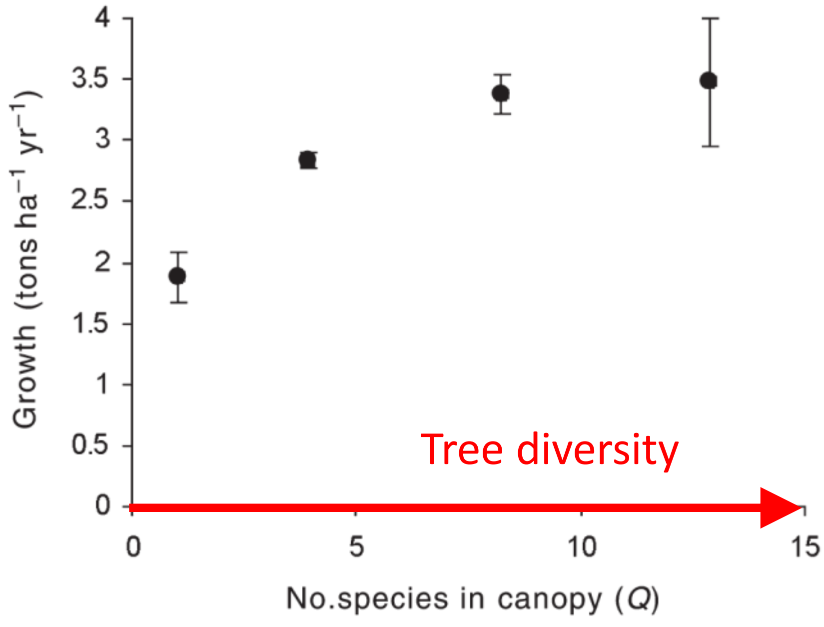
Habitat provisioning

- The more tree species in an ecosystem, the more opportunities for other organisms to coexist
  - Structural diversity
  - Different requirements of associated flora and fauna

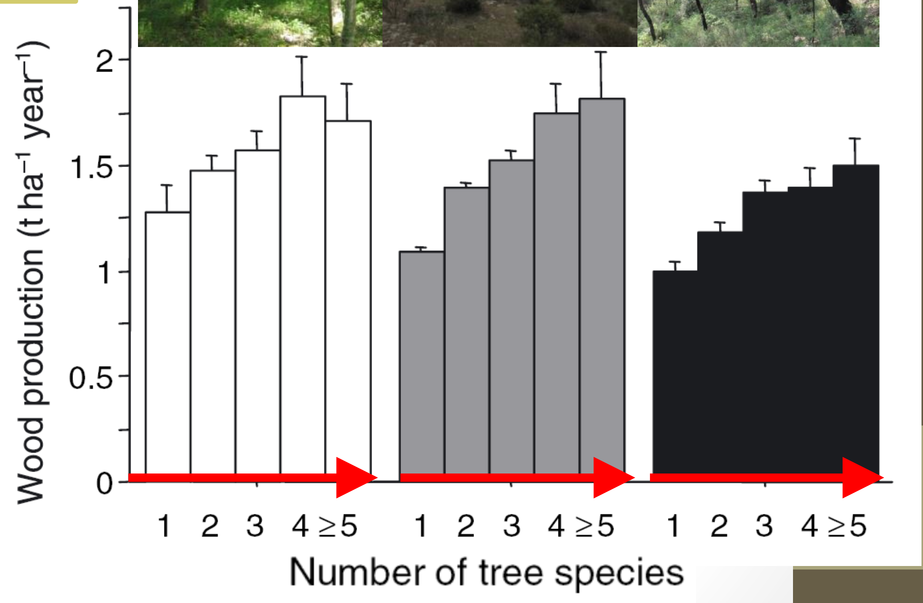


Analysing large datasets: forest inventuries

- Positive diversity-production relationship



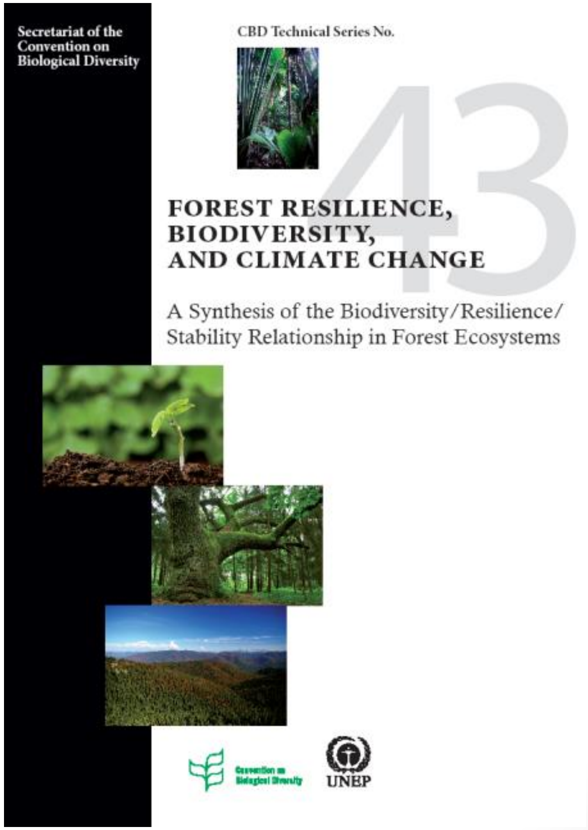
Caspersen & Pacala 2001 *Ecological Research*



Vilà et al. 2007 *Ecology Letters*

Important syntheses

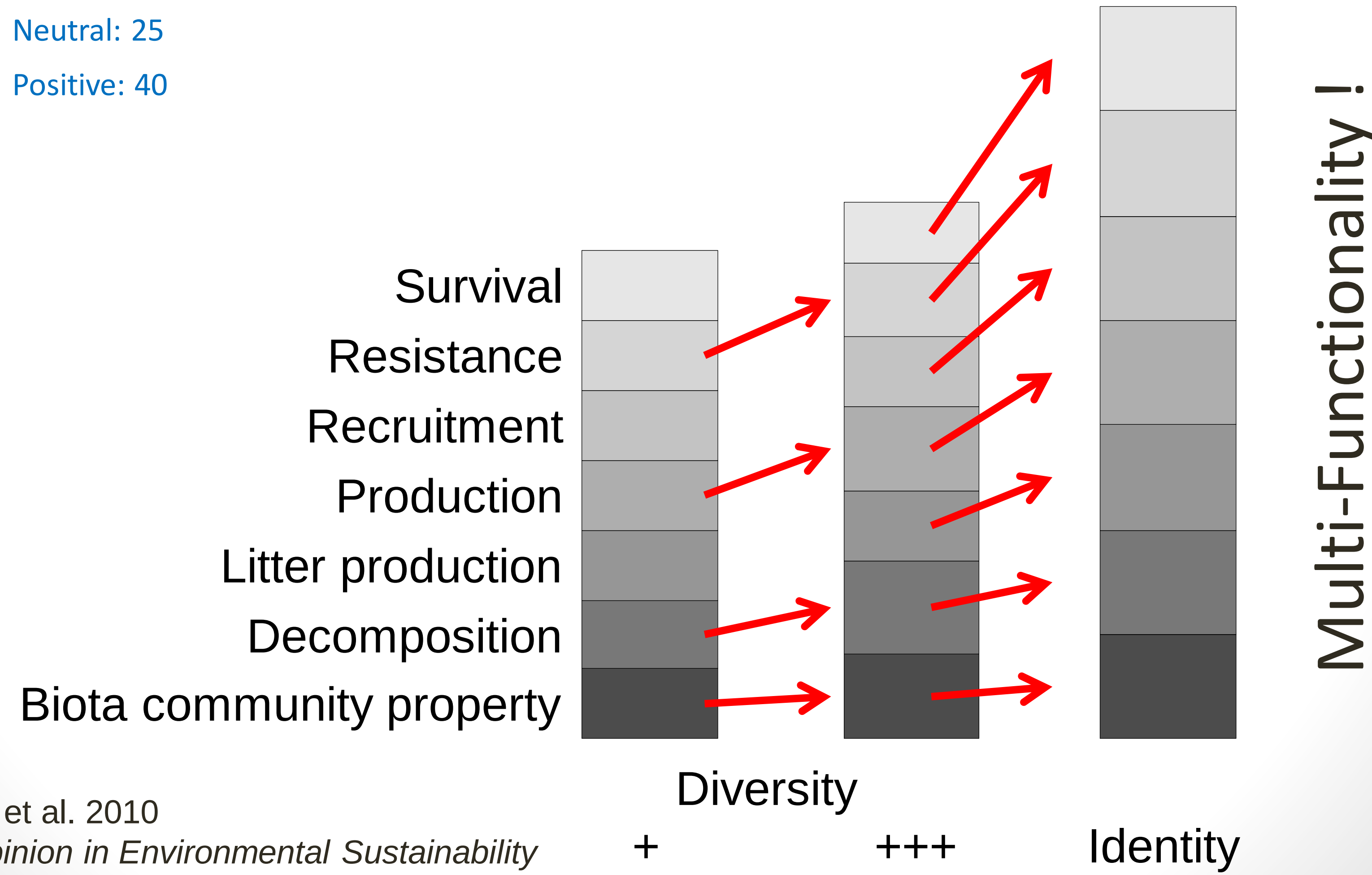
- Effects of tree species richness on stand production :
  - Neutral: 5
  - Positive: 15
  - Tree diversity may increase resilience towards climate-induced disturbances



Thompson et al. 2009 *CBD*

Important syntheses

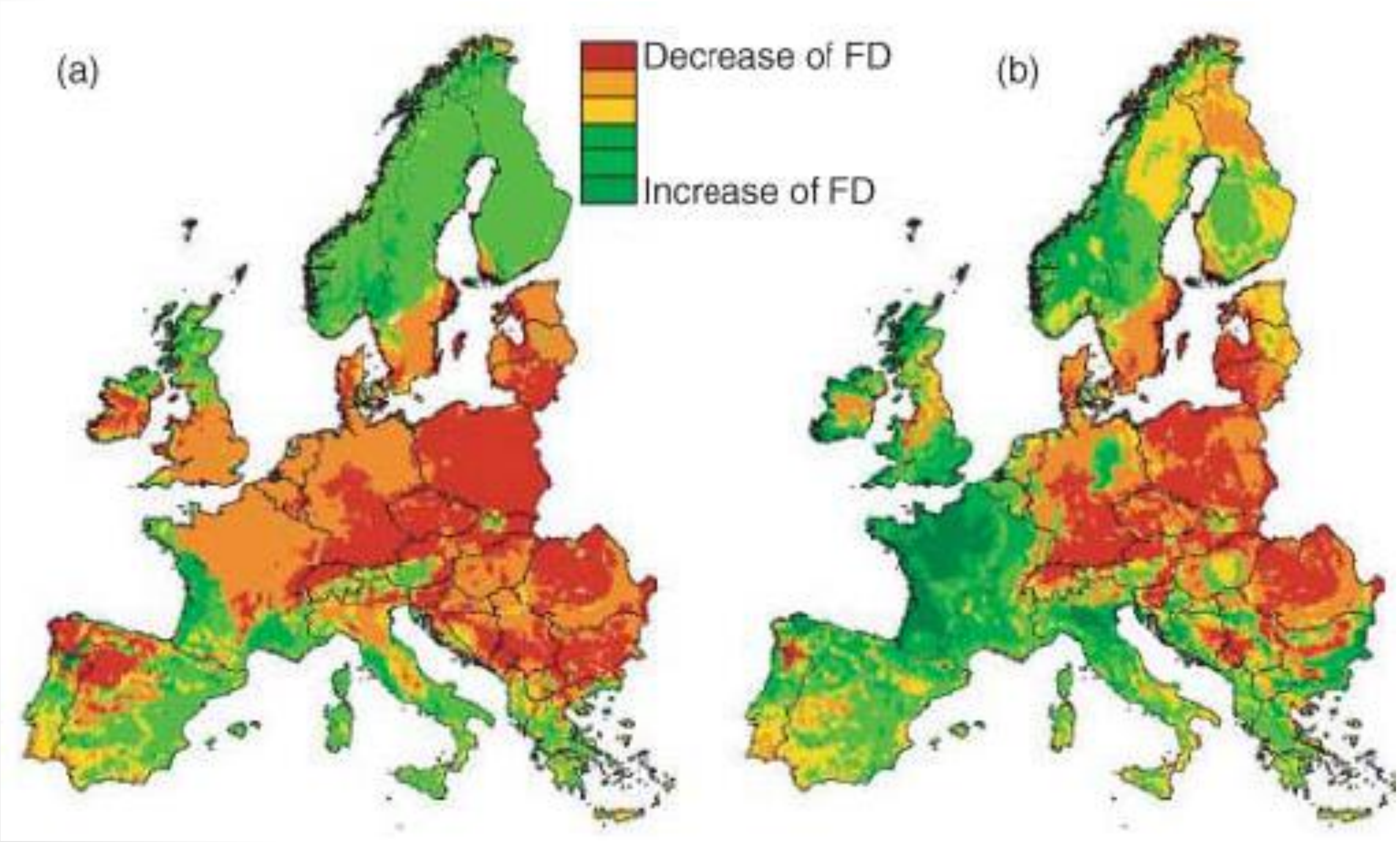
- Effects of tree diversity on ecosystem functions:
  - Negative: 5
  - Neutral: 25
  - Positive: 40



Nadrowski et al. 2010
Current Opinion in Environmental Sustainability

Climate change and functional diversity of European forests

2050 (no dispersal) 2050 (with dispersal)



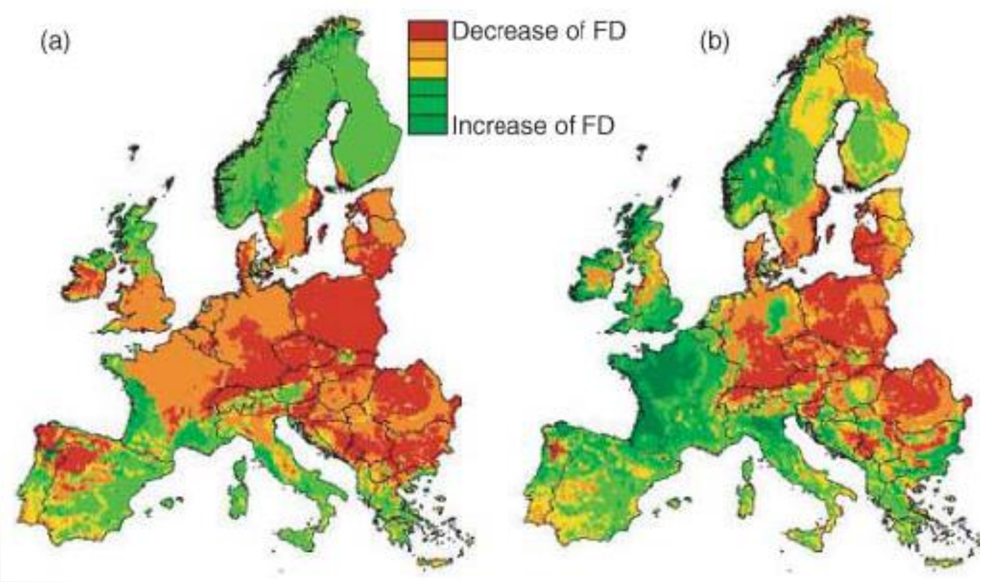
Thuiller et al. 2006

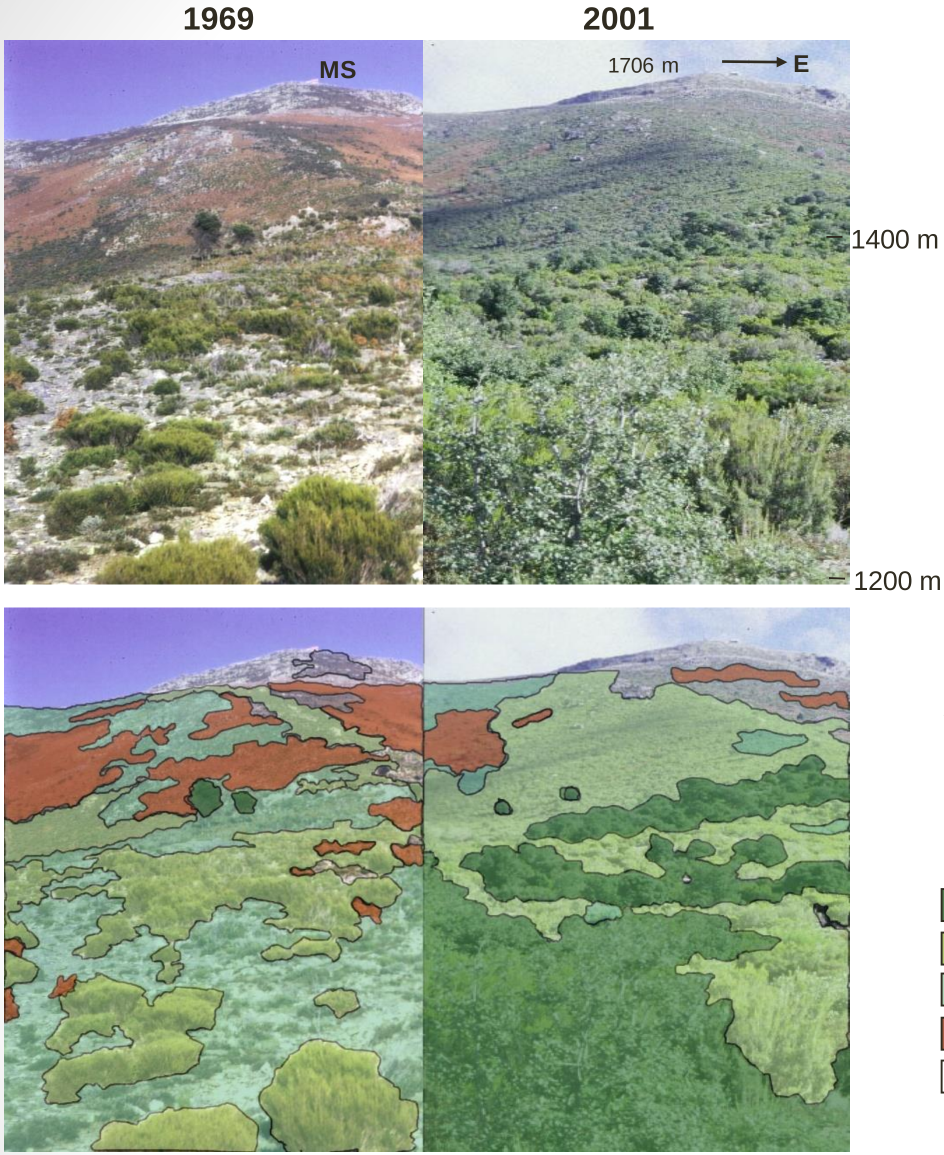


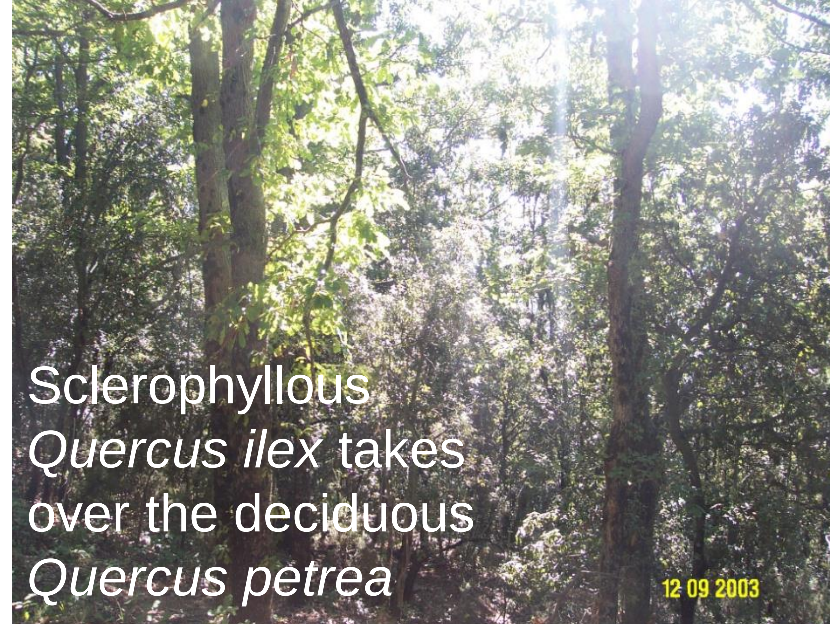


Are these maps realistic? (I)

Is species future distribution simply a projection of current distribution as a function of climate?







Altitudinal shift of Quercus ilex

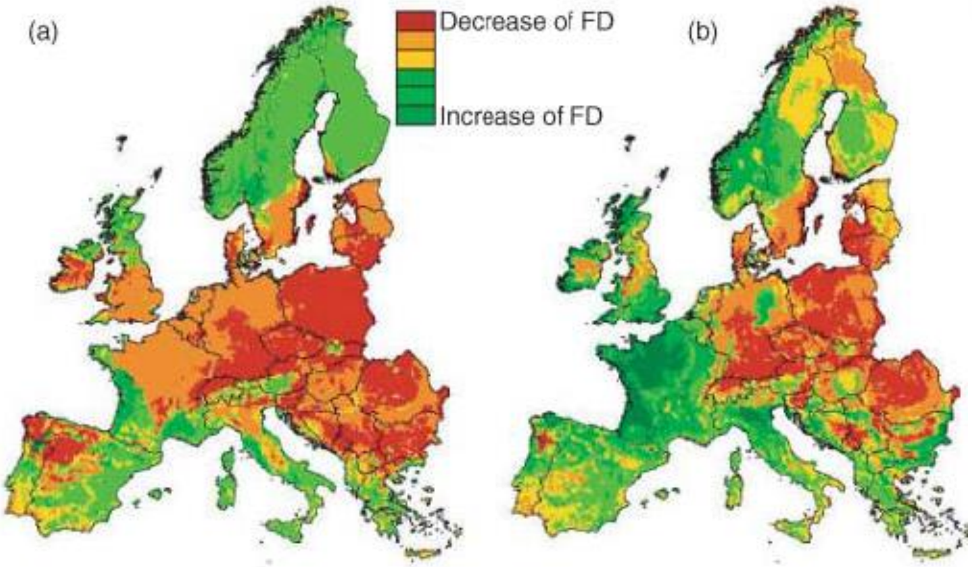
- *Quercus ilex* young forest
- *Erica scoparia* heathland
- *Calluna vulgaris* heathland
- *Pteridium aquilinum* fernland
- Grassland *and Cytisus scoparius*
- **MS** Meteorological station

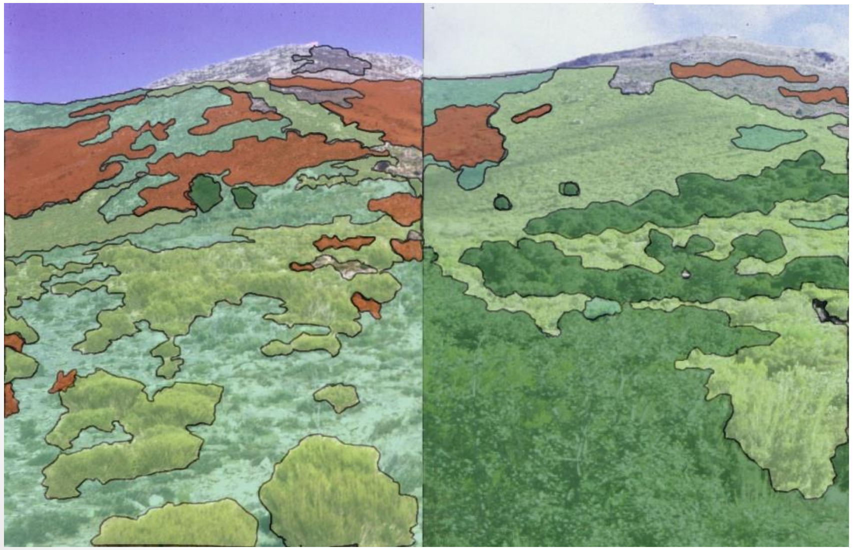
Peñuelas and Boada, 2003 *Global Change Biol*, 9, 131-140

Peñuelas *et al.* 2007 *Ecography,* 30, 830-838

Do these maps match?

Observation and local/regional maps less pesimistic scenarios than models over large areas



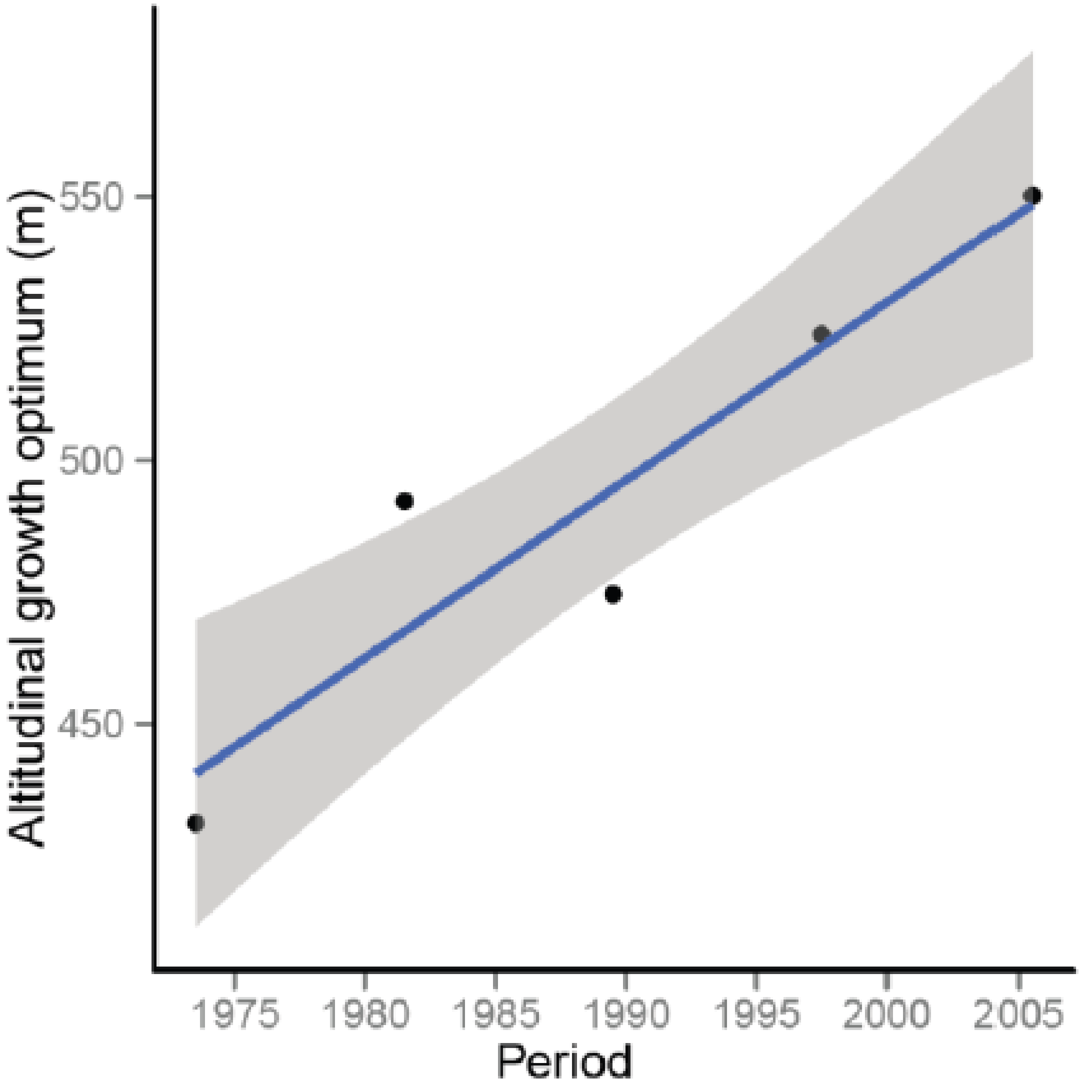


Extinctions that are not seen… movements that are less extreme

DENDROECOLOGY

Cores along elevation gradients

Beech (*Fagus sylvatica*)

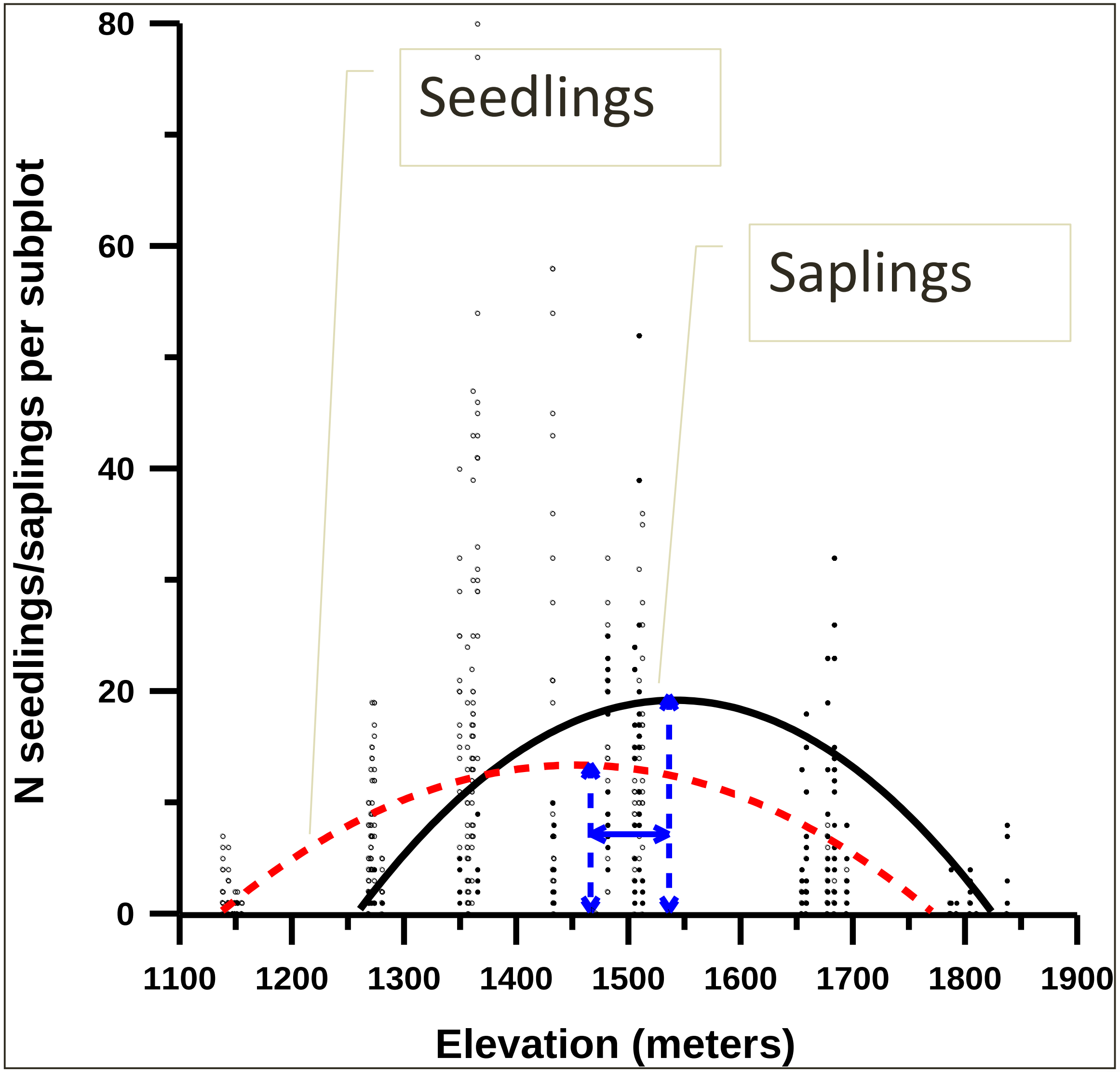


Delzon et al.

DEMOGRAPHY

Age classes along elevation gradients

Pinus sylvestris

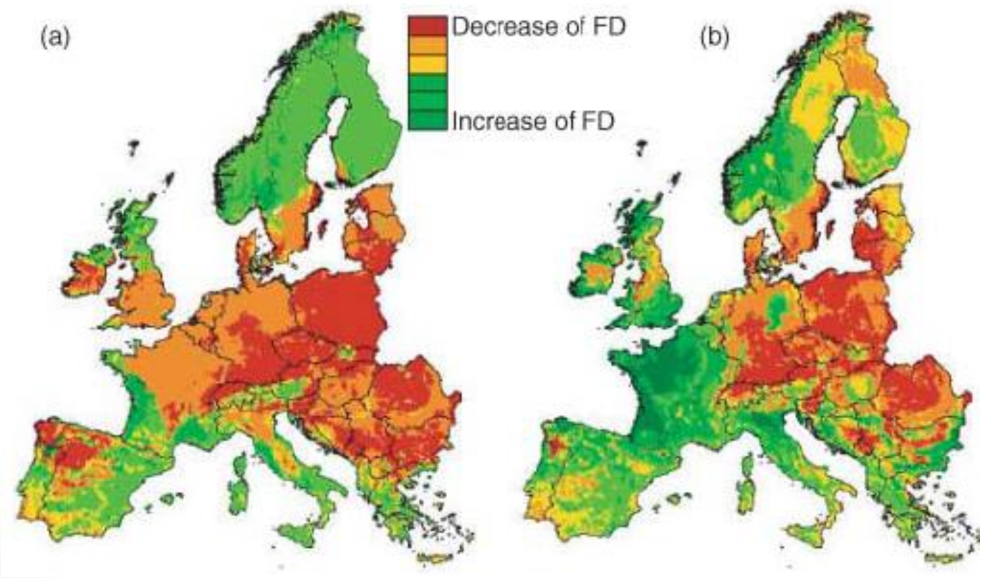


Benavides et al. 2012

Are these maps realistic? (II)

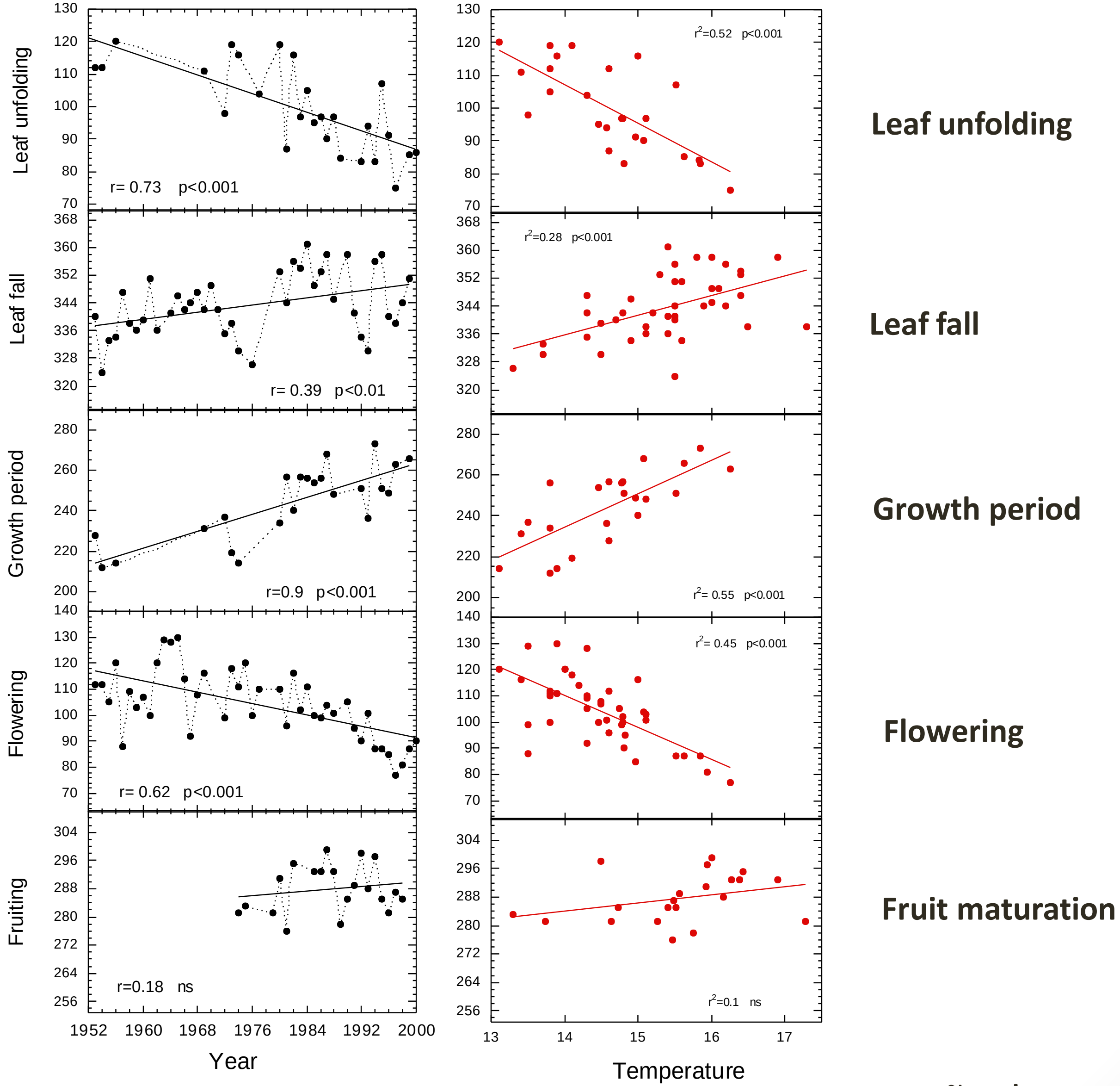
What about the acclimation capacity of trees ?

What about their plasticity ?



Phenology Montseny, NE Spain

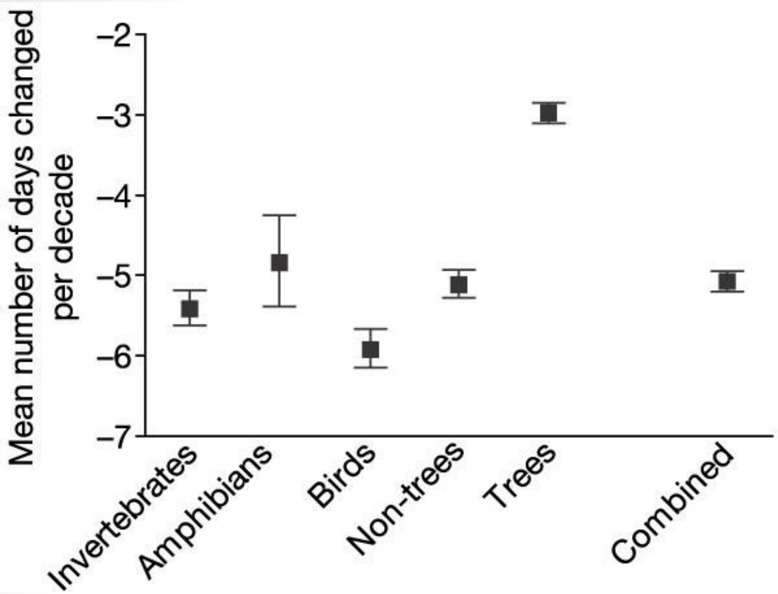
Malus domestica

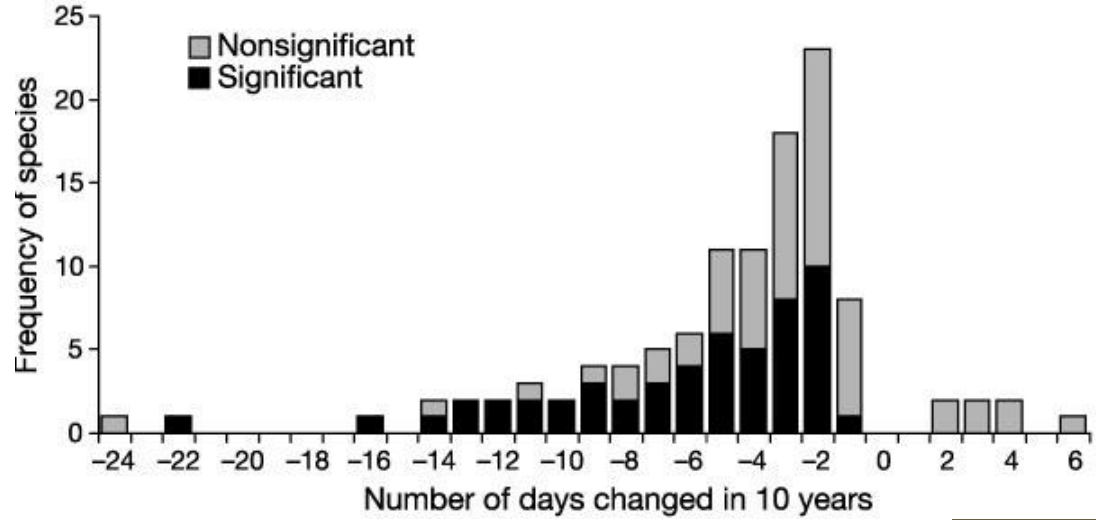


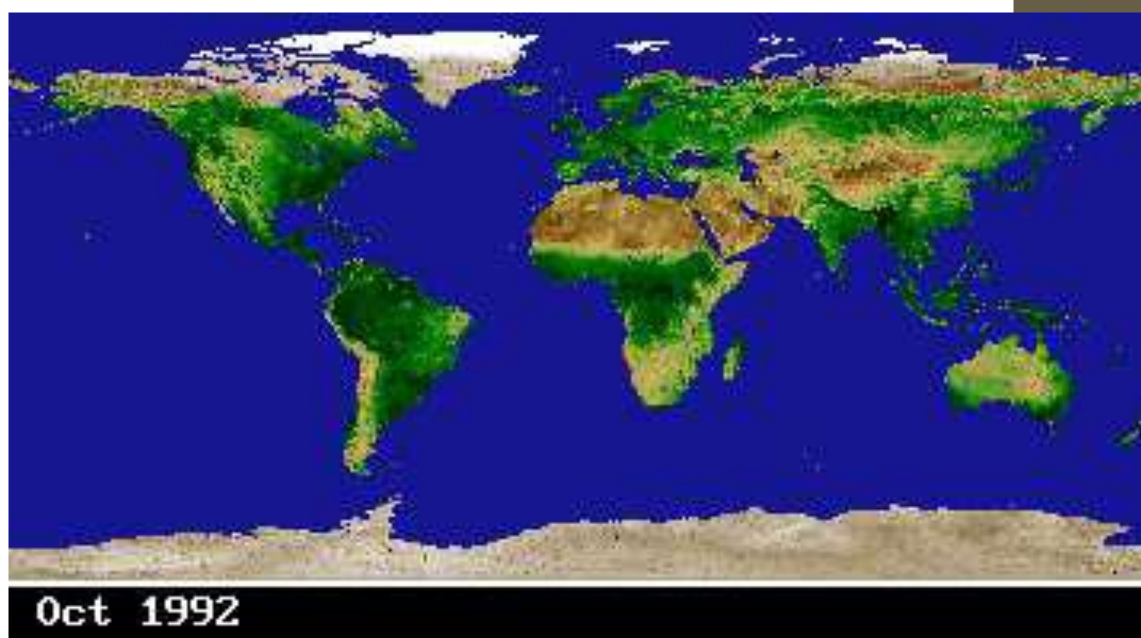
Peñuelas et al 2004, 2006

Phenology, a global response

A global phenomenon

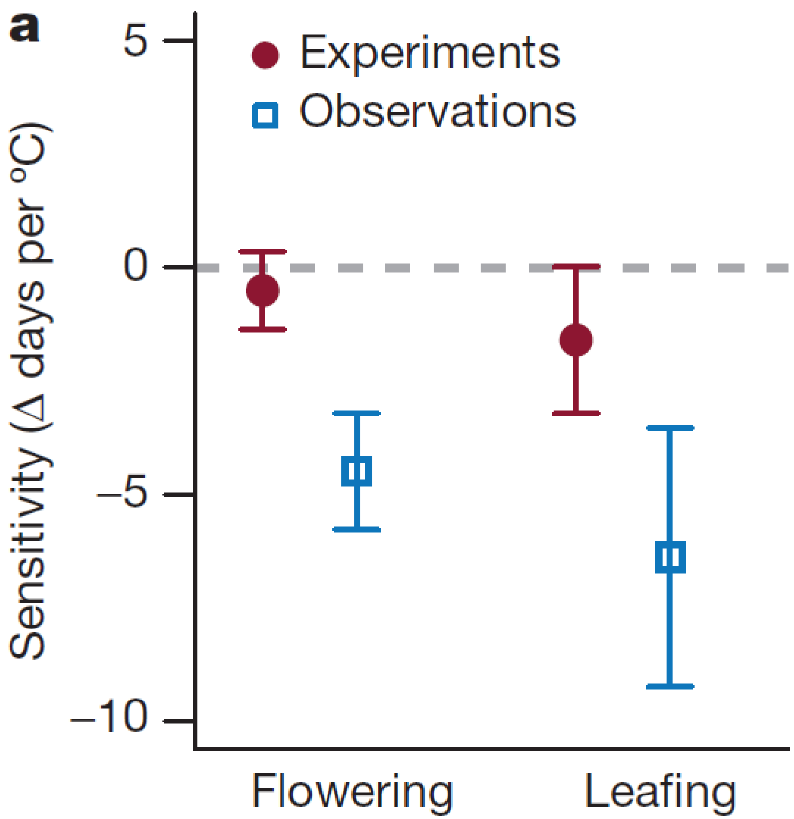






Phenology is complex

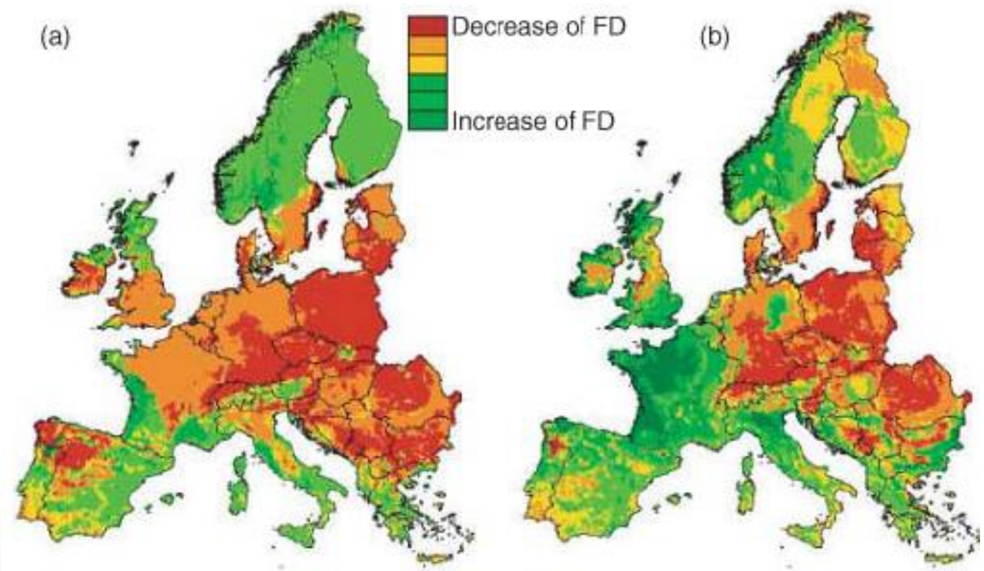
Mismatches between experiments and observations



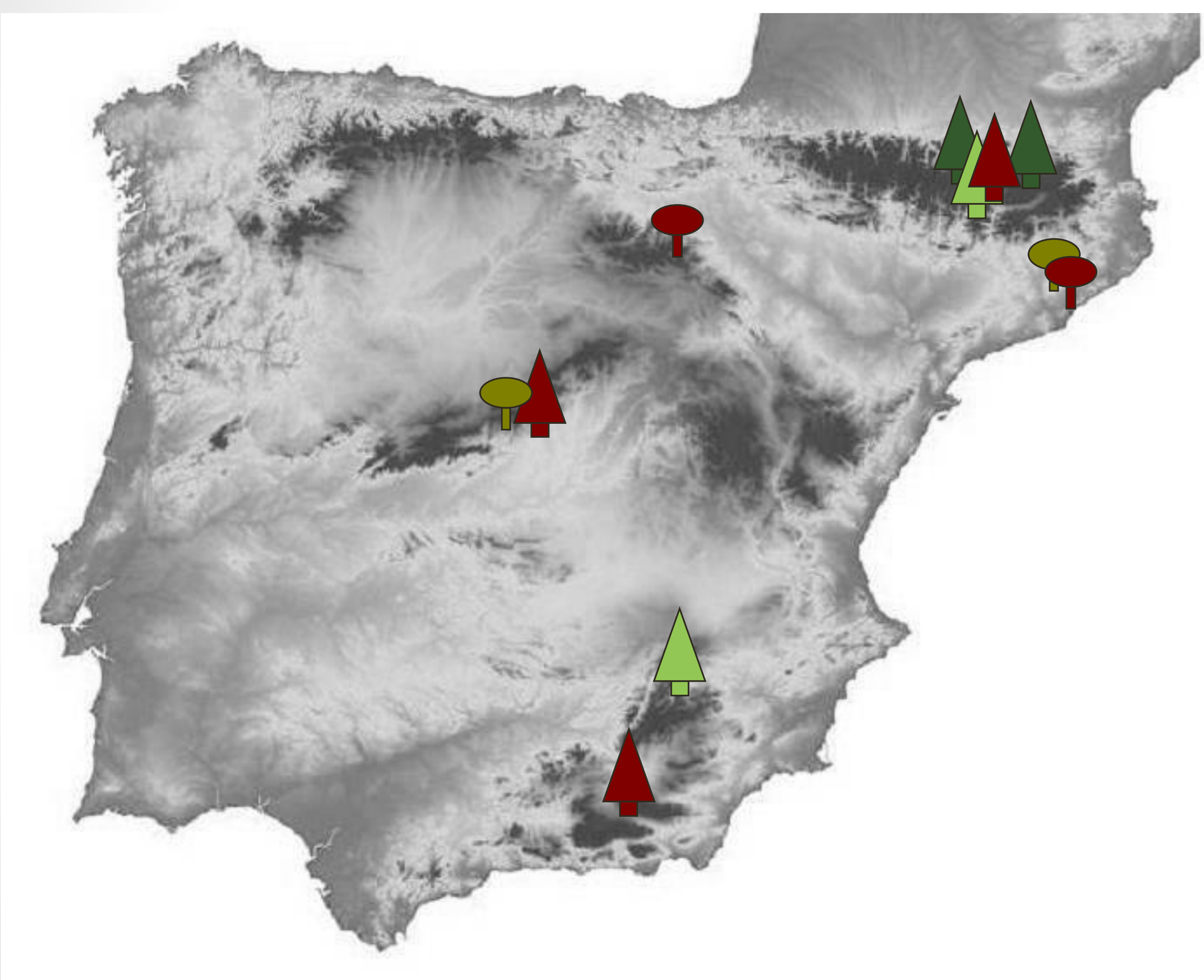
Wolkovitch et al. 2012. Nature

Are these maps realistic? (III)

Are all species responding equally to a change in climate?



Sampling sites (CONSOLIDER-MONTES)



Pinus sylvestris

Sort
Guadarrama
Sierra Nevada

Fagus sylvatica

Montseny
Sierra Cebollera

Pinus nigra

Solsona
Sierra Segura

Pinus uncinata

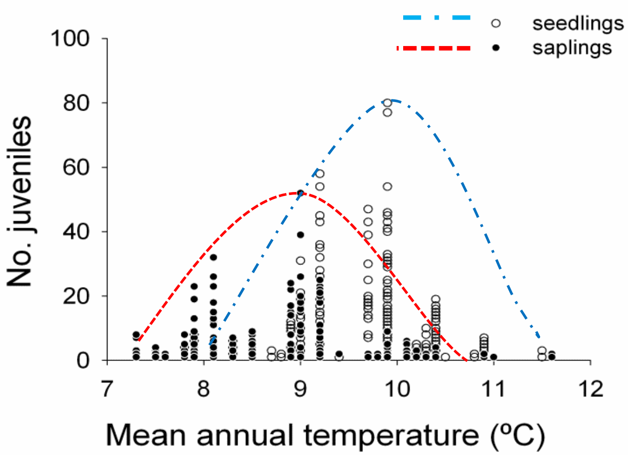
Cerdanya
Aigüetortes

Quercus ilex

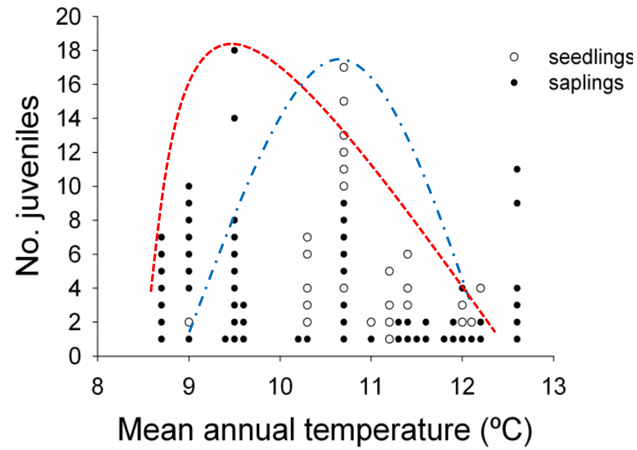
Guadarrama
Montseny

Distribution of juveniles according to mean annual temperature

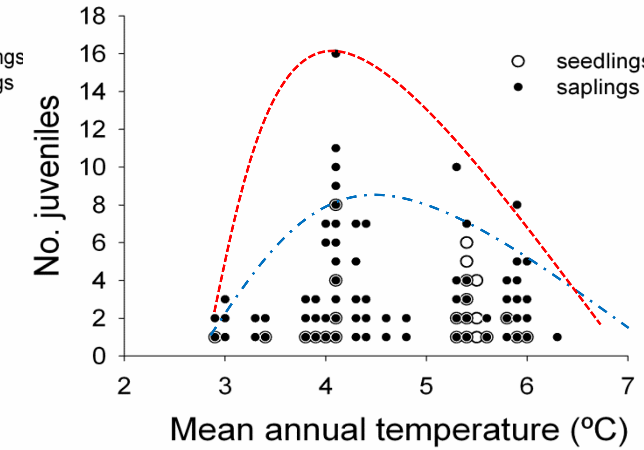
Pinus sylvestris



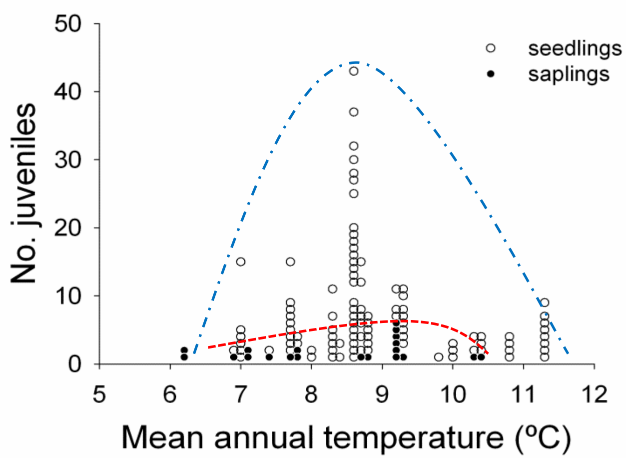
Pinus nigra



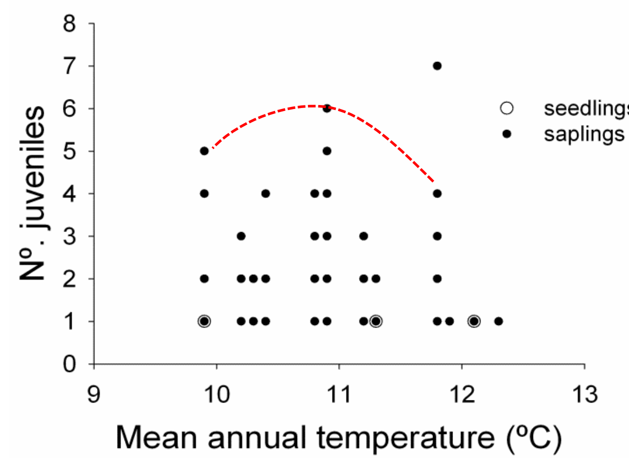
Pinus uncinata



Fagus sylvatica

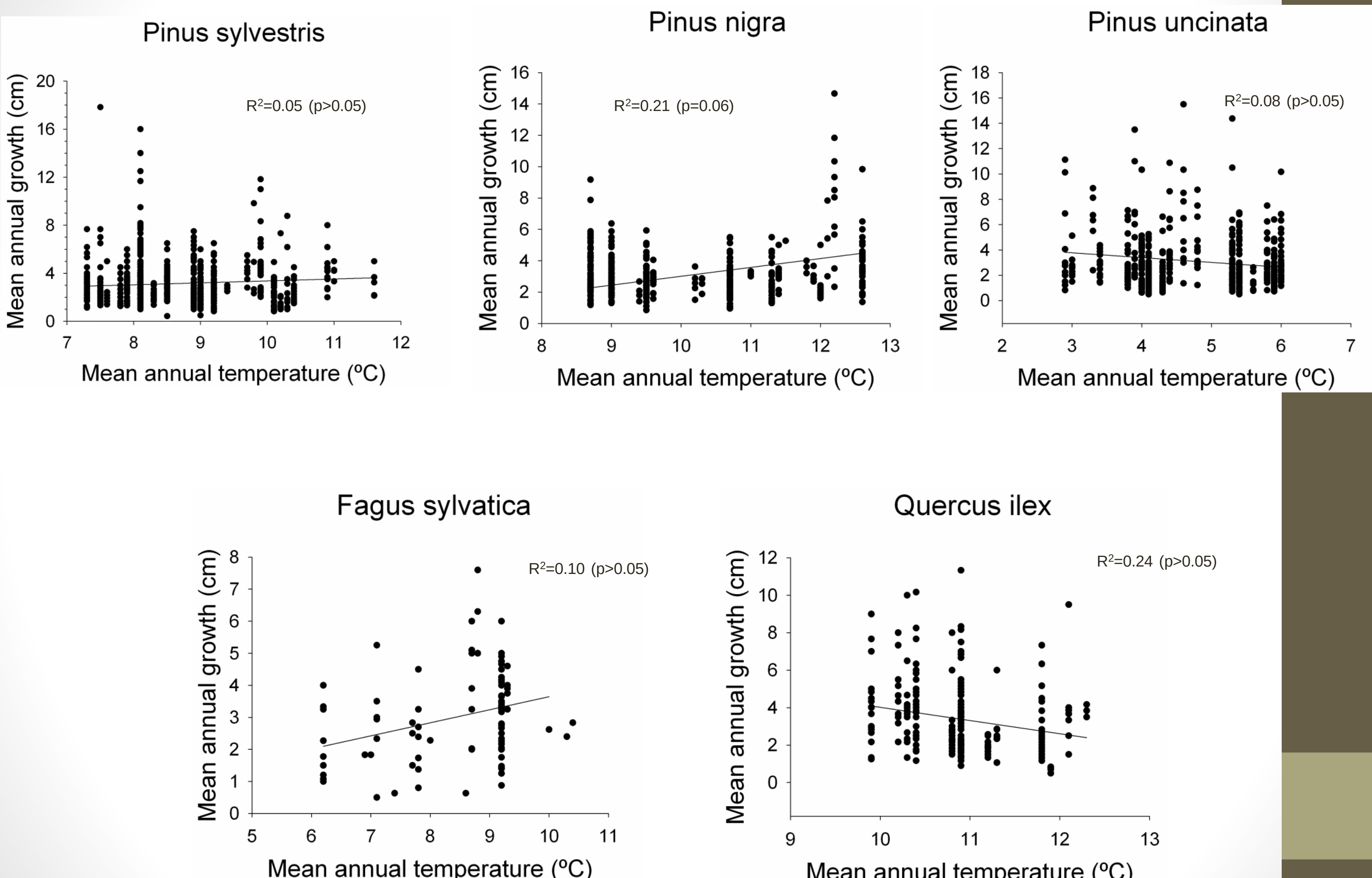


Quercus ilex



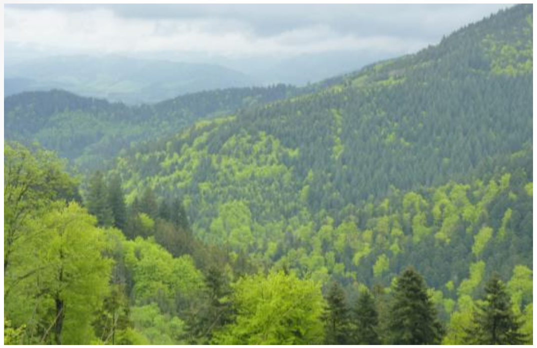
Benavides, Valladares
et al. 2012 PLOS One

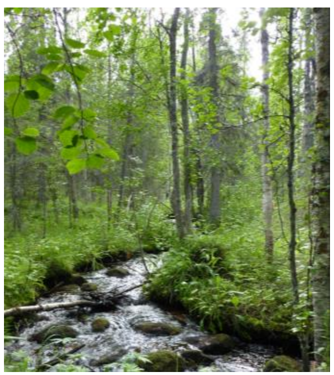
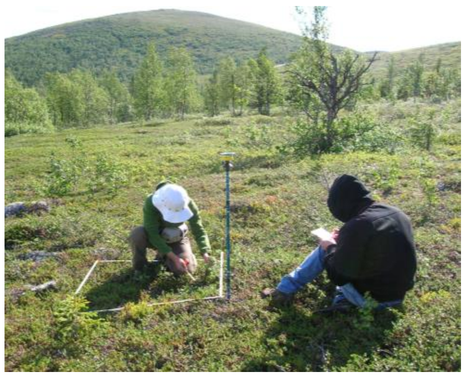
Mean annual growth according mean annual temperature

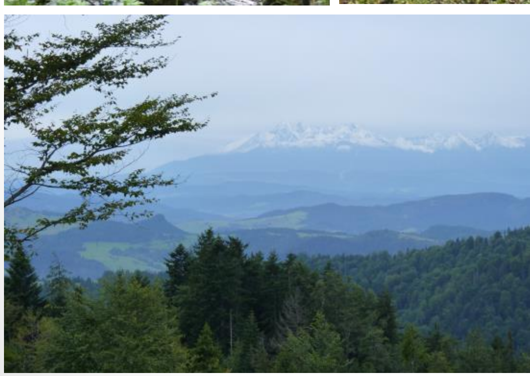


Benavides, Valladares et al. 2012 PLOS One

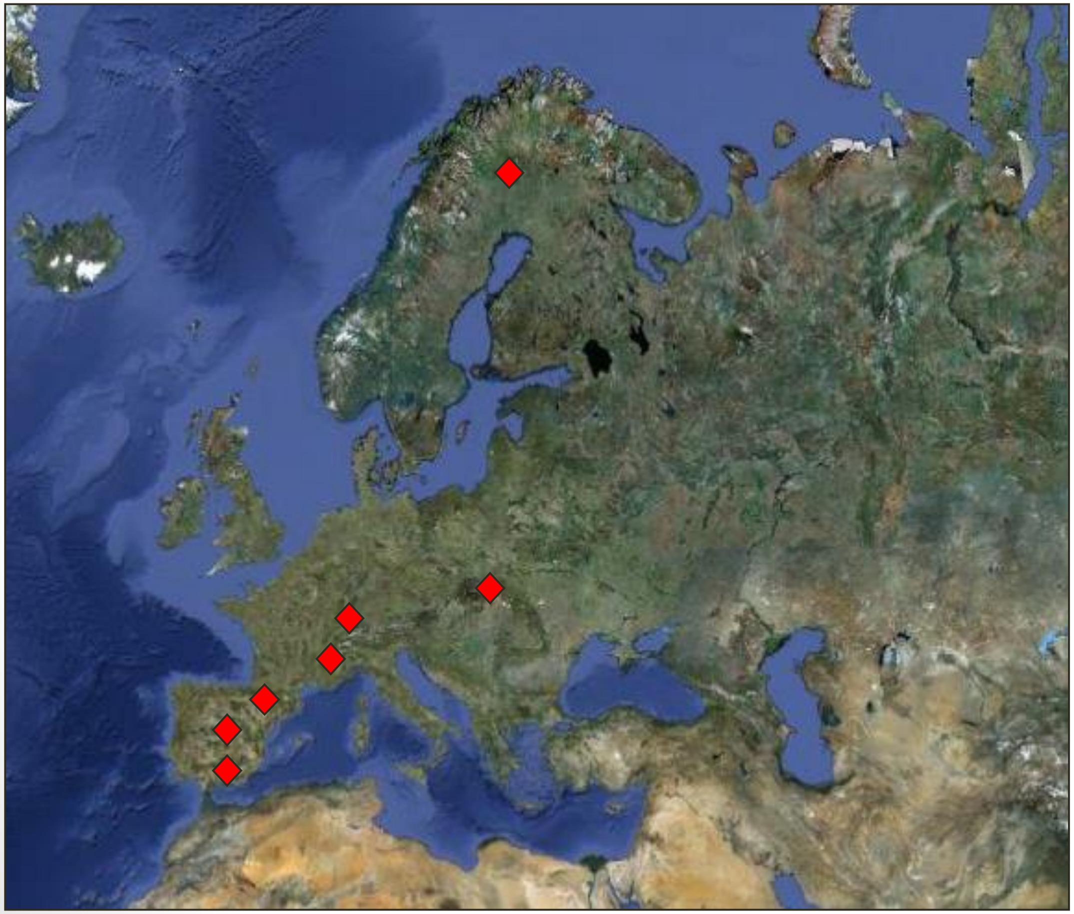
Expanding the study to Europe



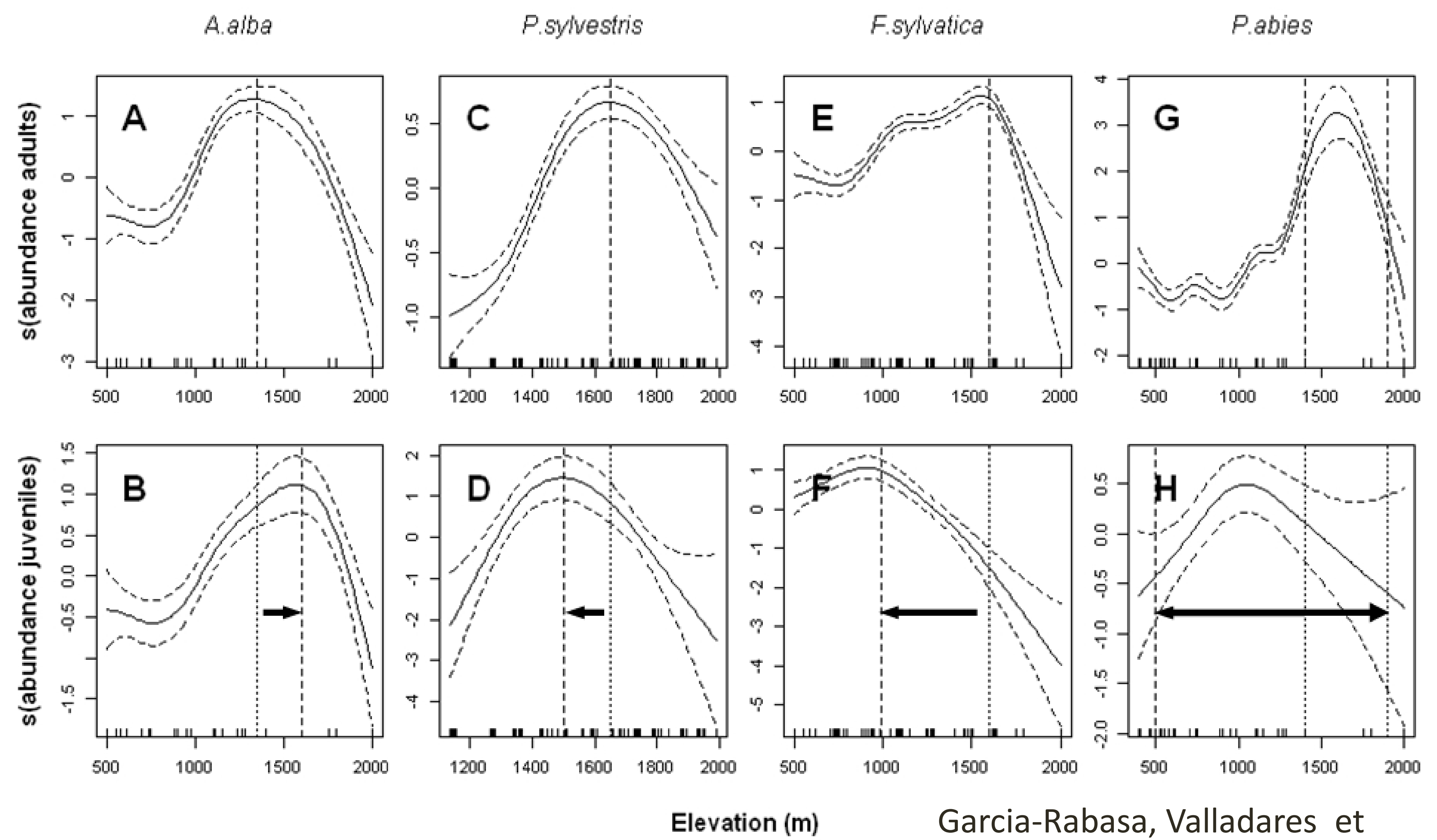



Expanding the study to Europe



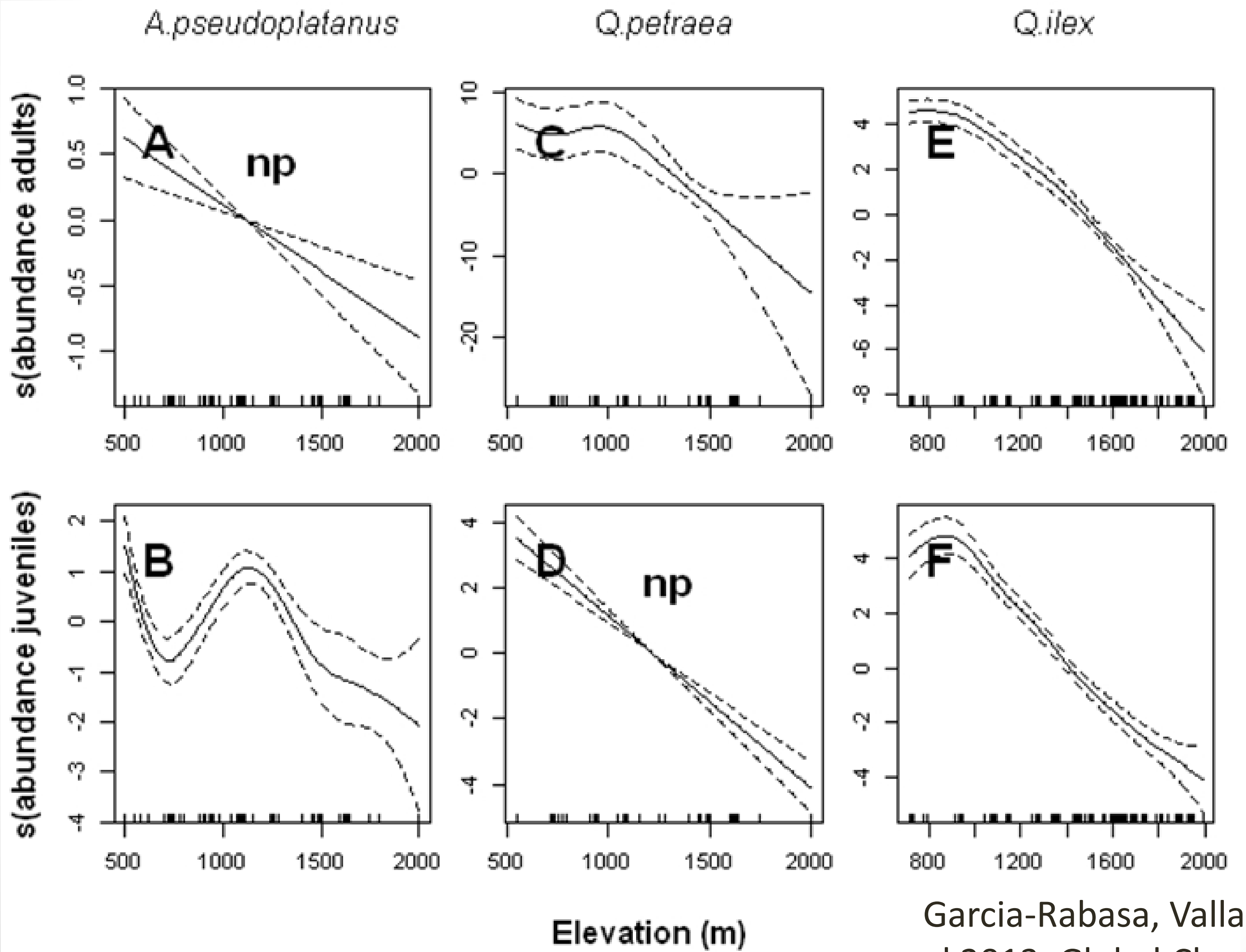
Sierra Nevada (Spain)
Valsain (Spain)
Montseny (Spain)
Belledone (France)
Black Forest (Germany)
Dundret (Sweden)
Kroscienko (Poland)

GAMM modelling



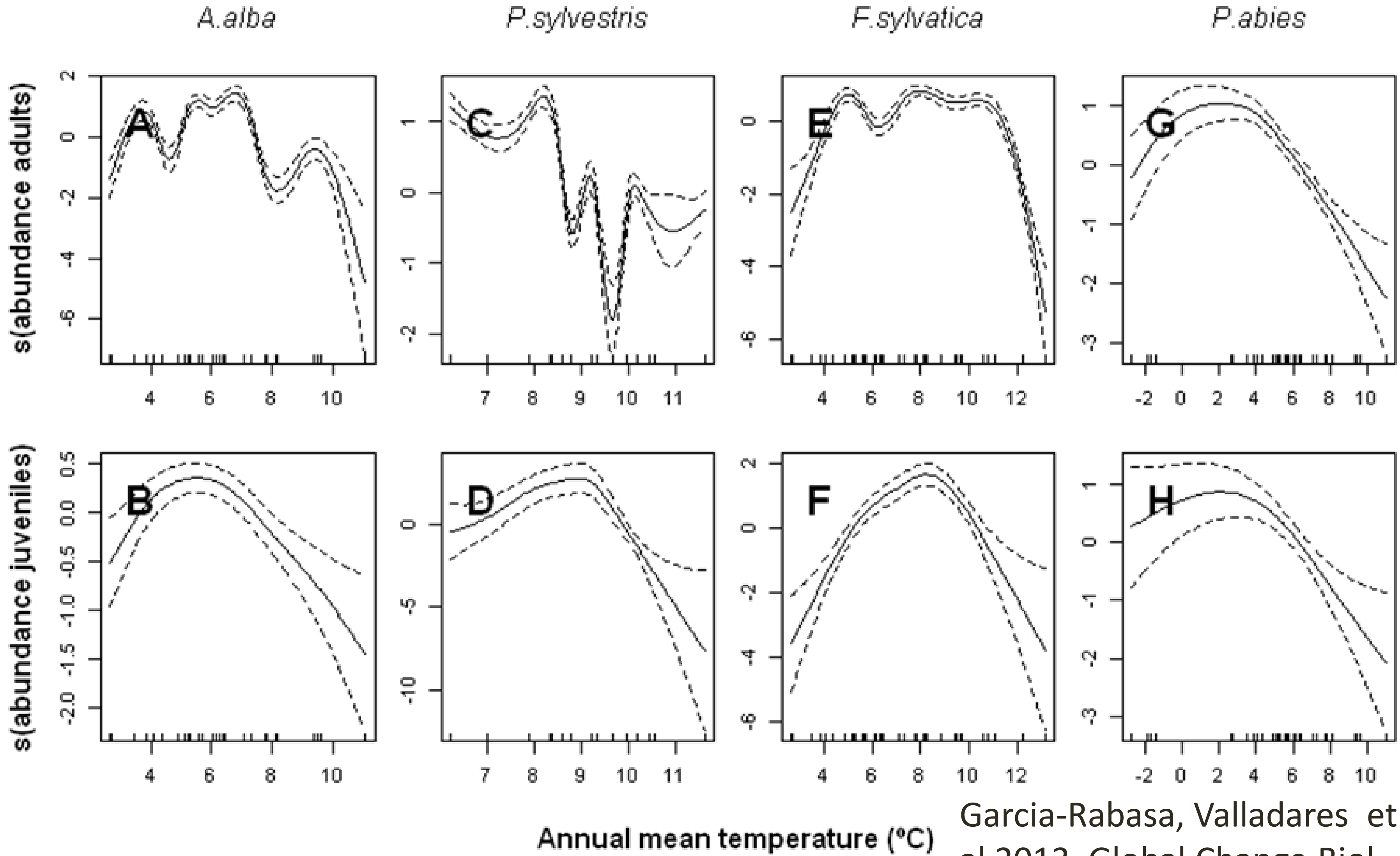
Garcia-Rabasa, Valladares et al 2013. Global Change Biol

GAMM modelling (sps no change)



Garcia-Rabasa, Valladares et al 2013. Global Change Biol

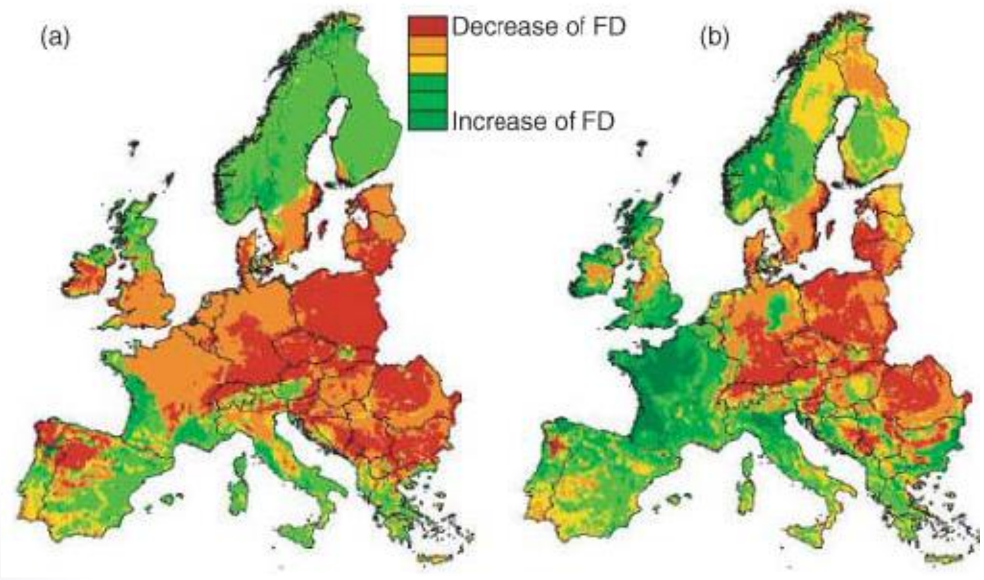
Temperature explains most but not all the observed change



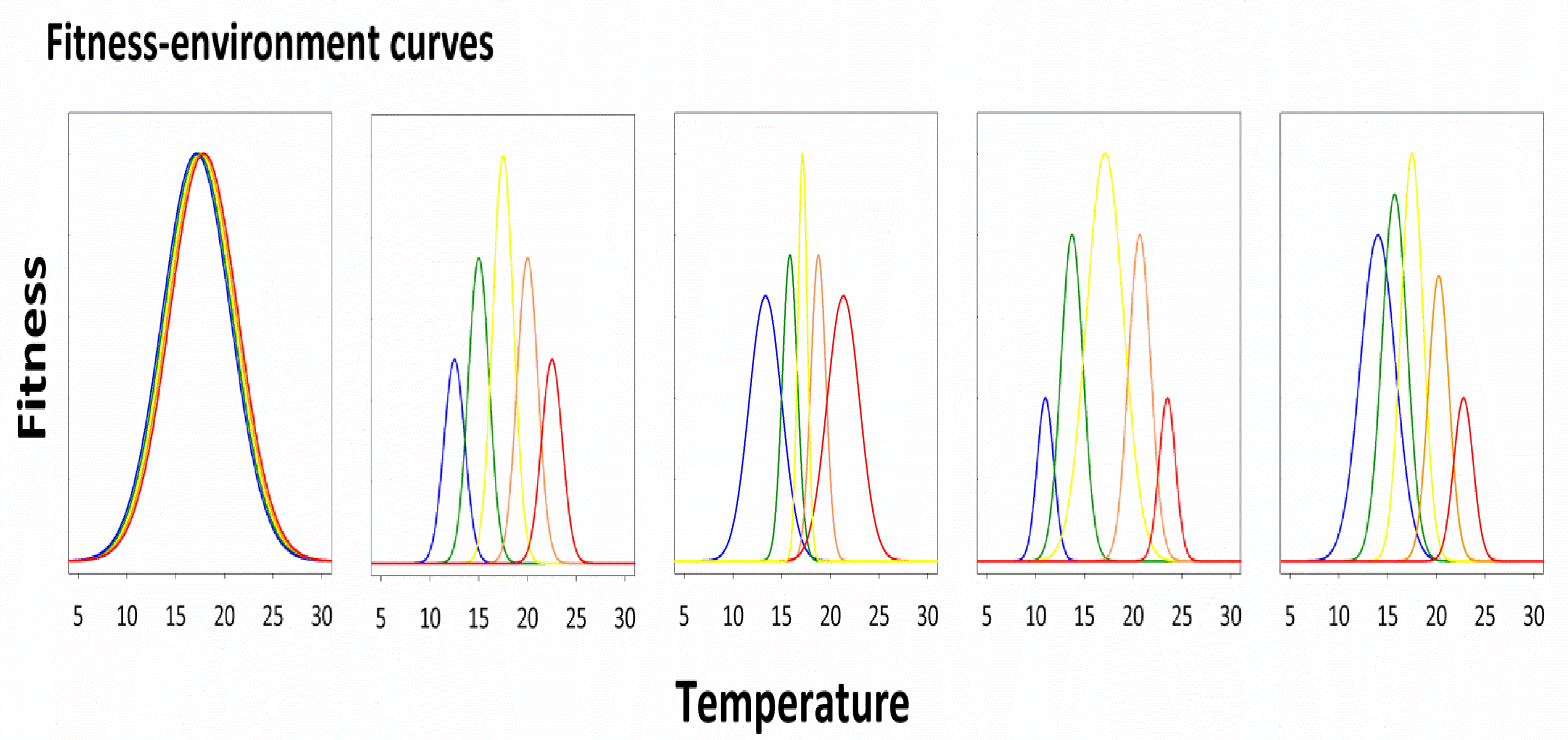
Garcia-Rabasa, Valladares et al 2013. Global Change Biol

Are these maps realistic? (IV)

Are species composed by homogeneous populations?
What about local adaptation?

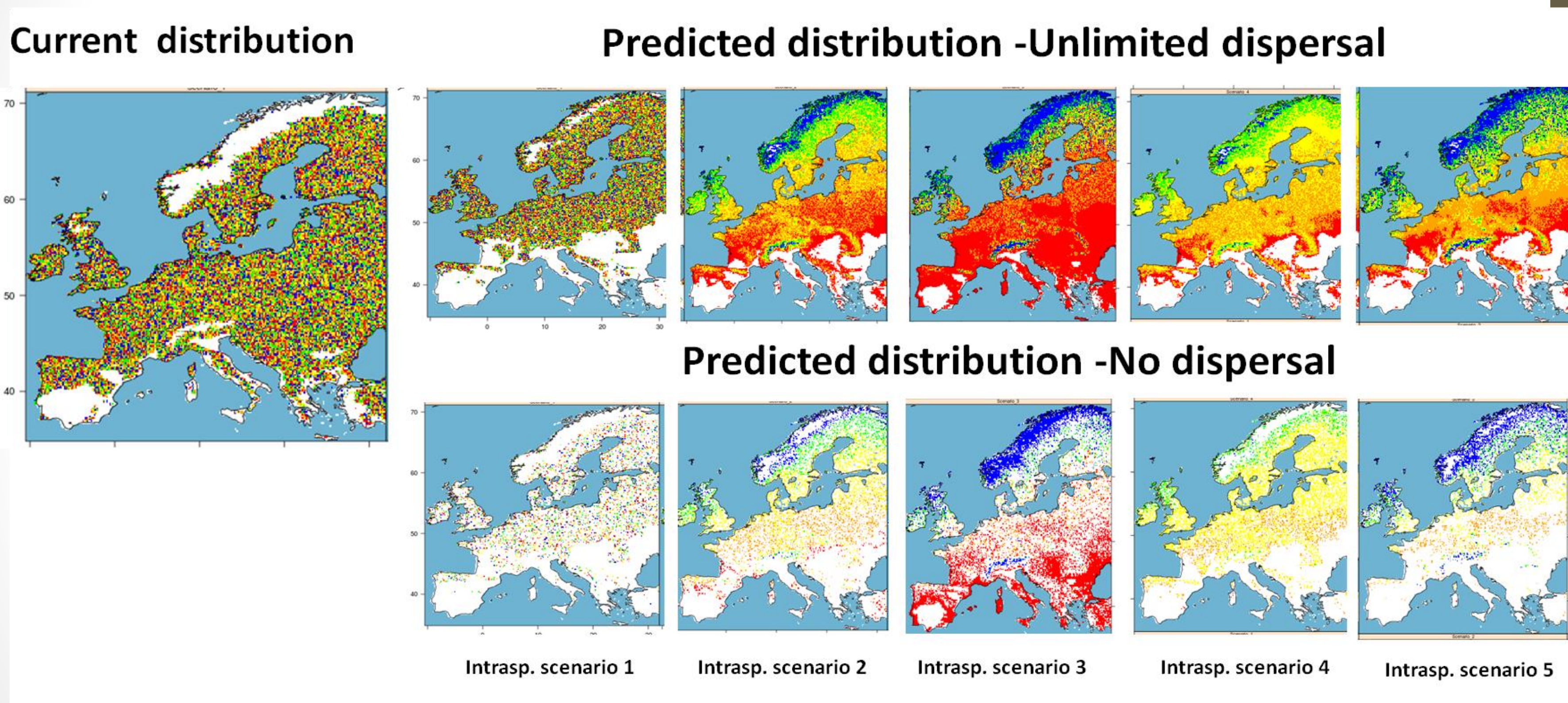


Population differentiation
(5 scenarios)



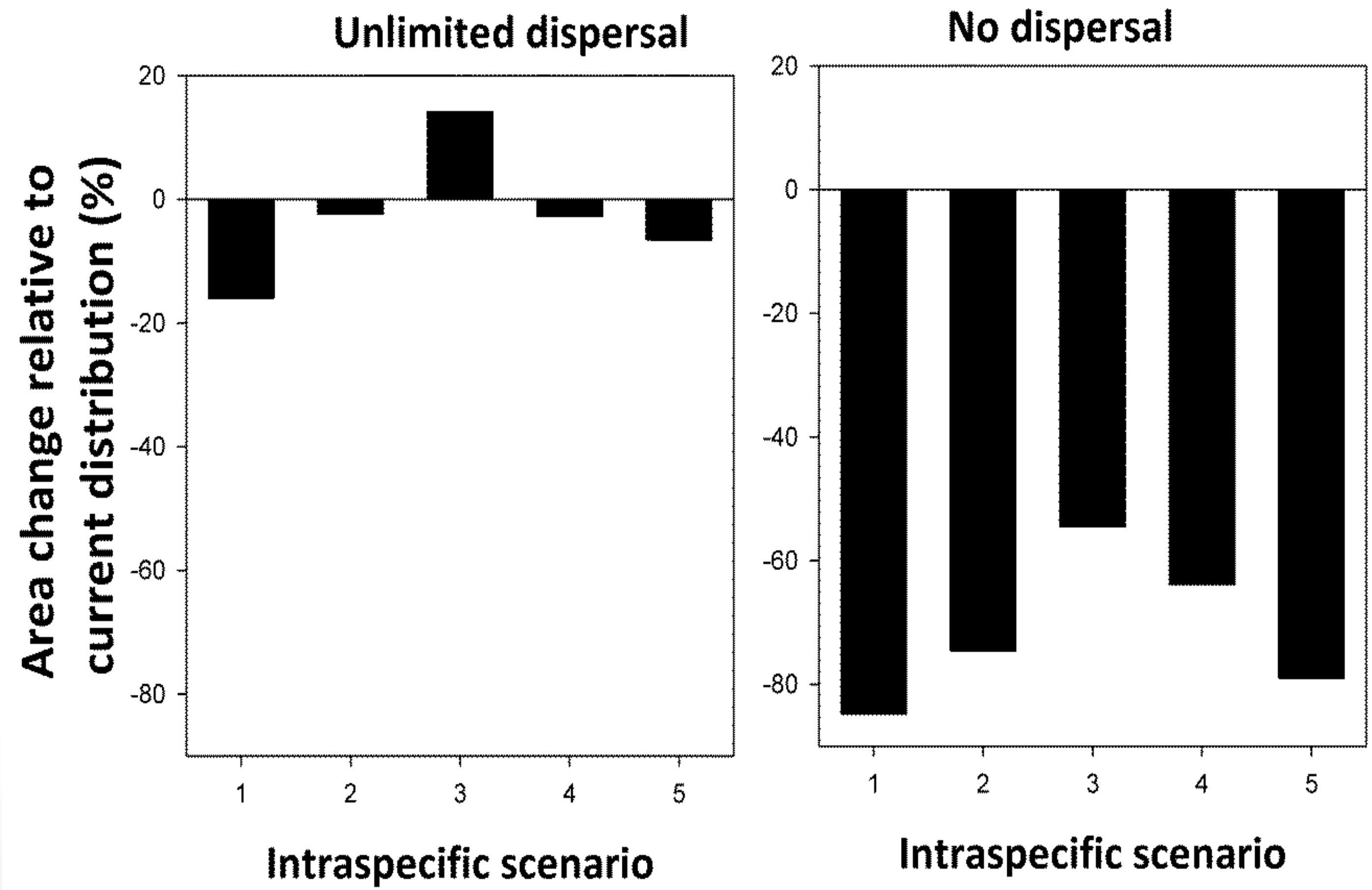
Valladares et al 2014 (Ecology Letters)

Implications for modelled distribution



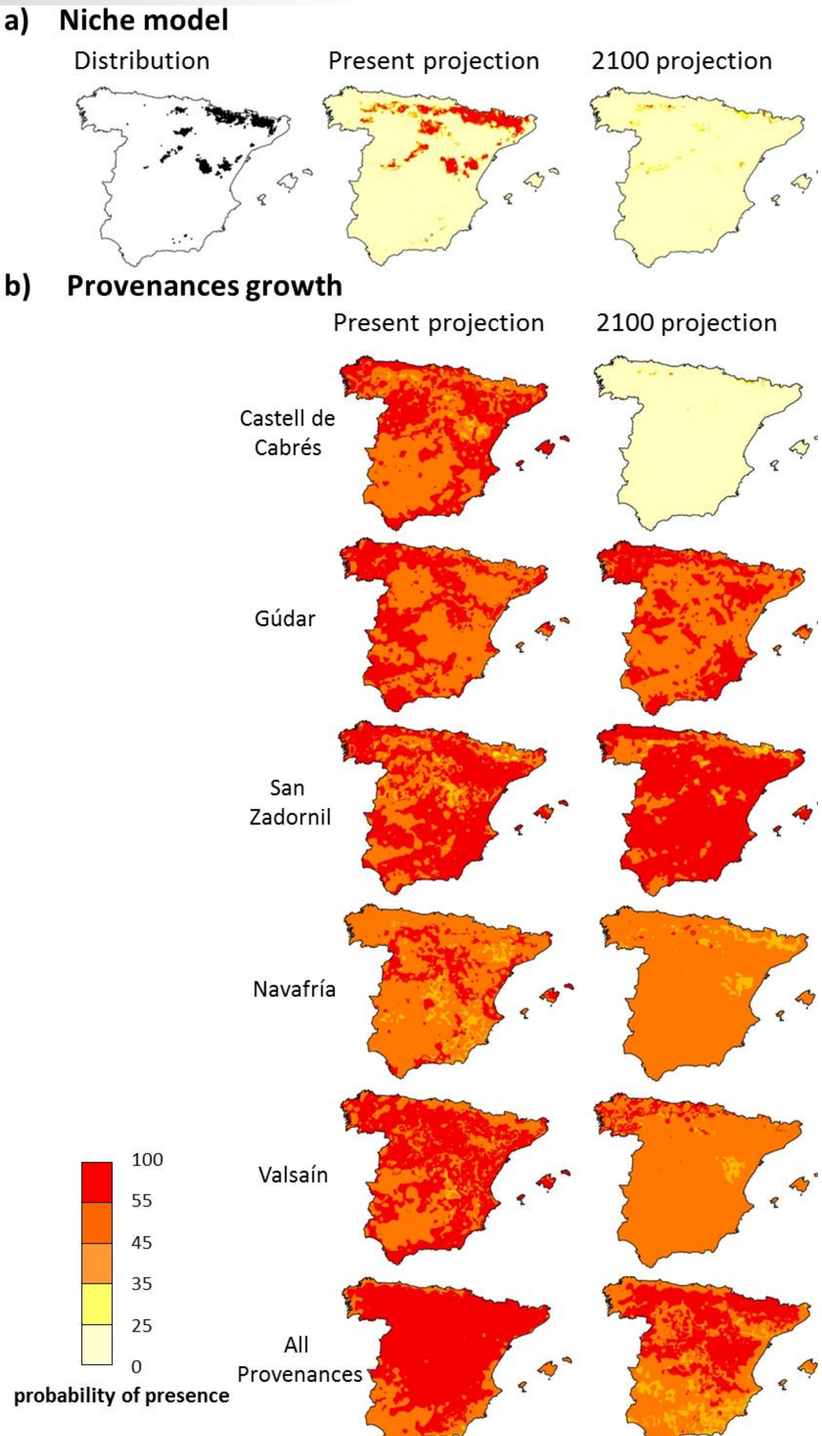
Valladares et al 2014 (Ecology Letters)

Implications for modelled distribution



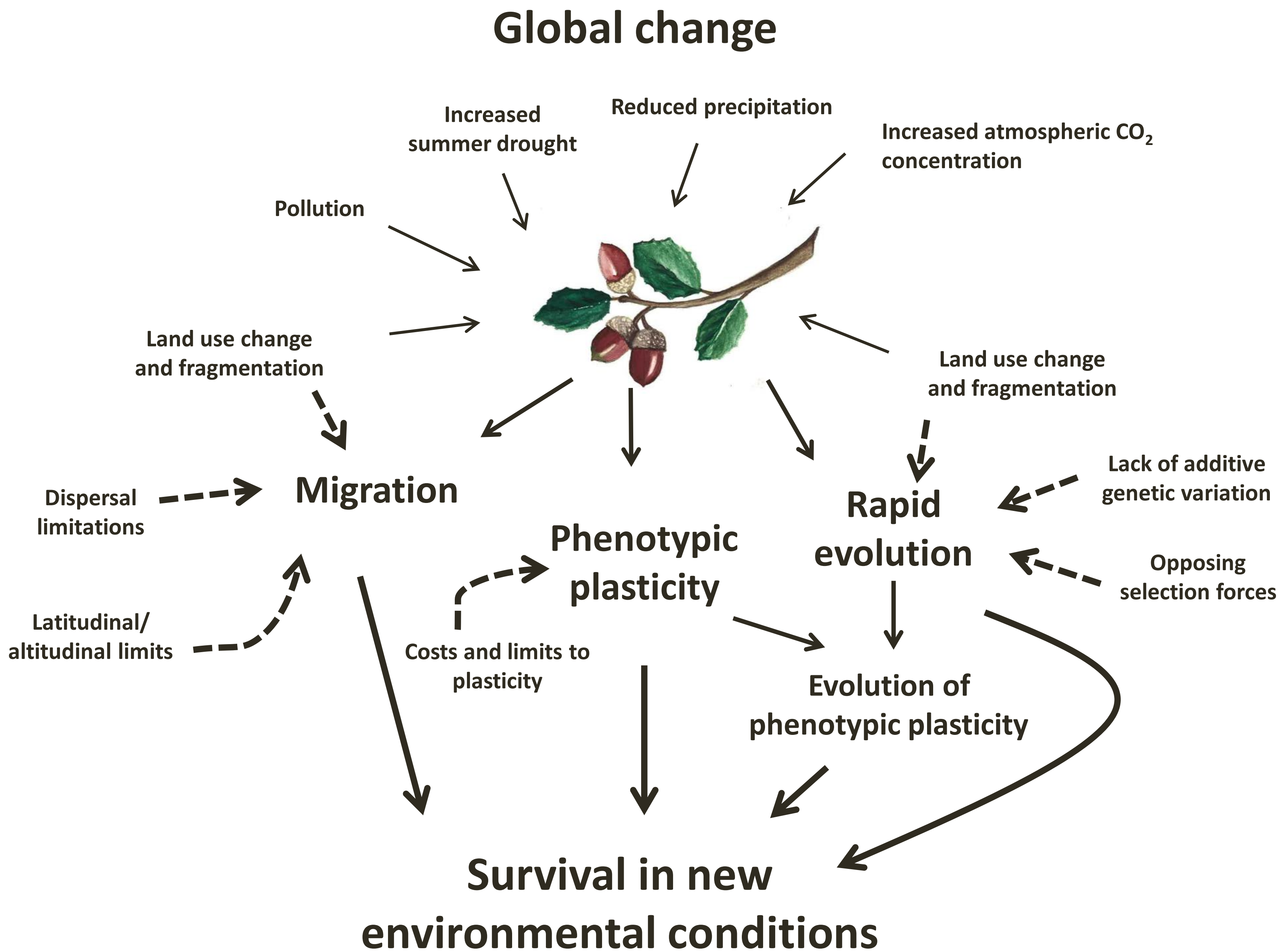
Valladares et al 2014 Ecology Letters

Modelling provenance data



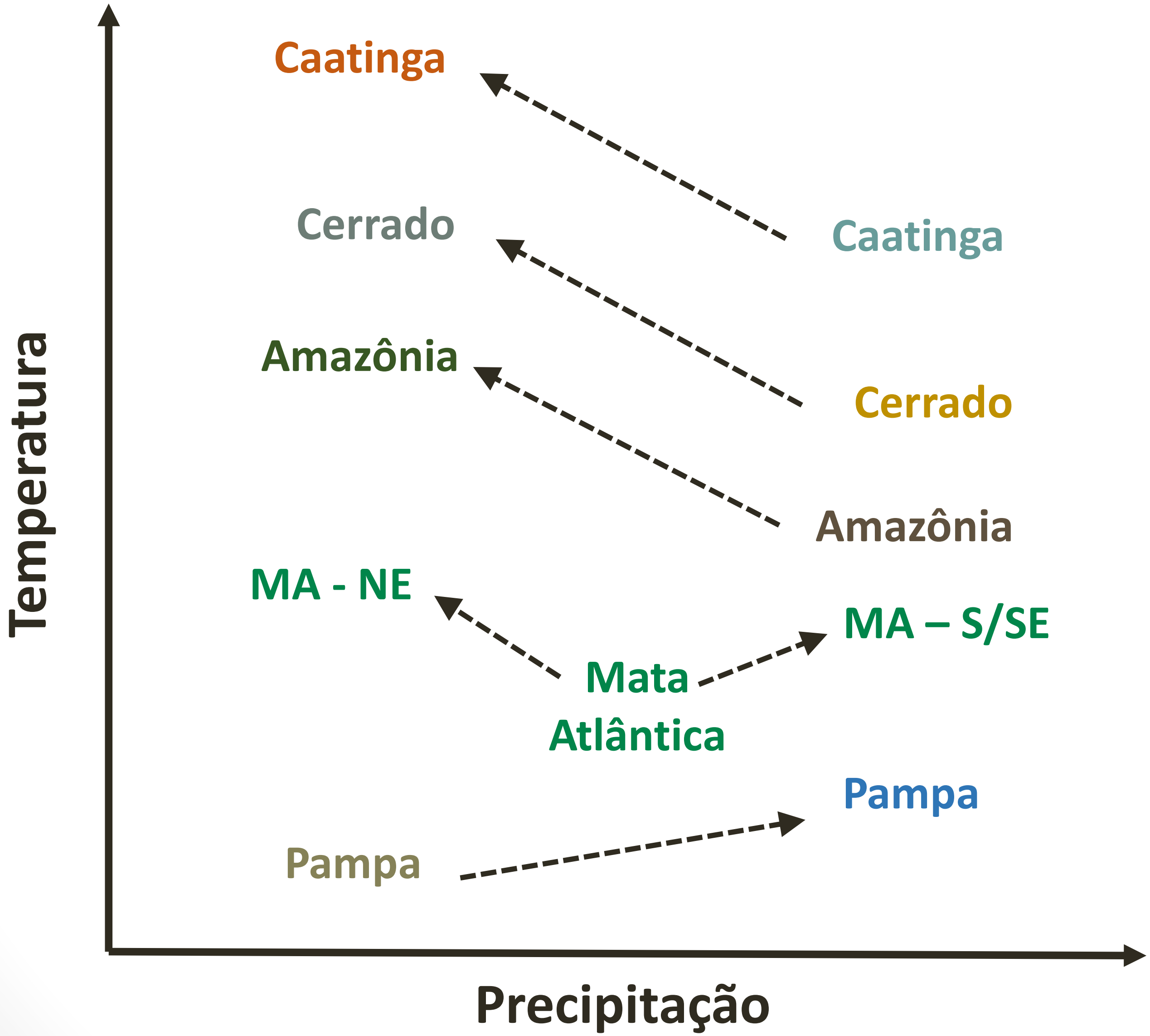
Pinus sylvestris

Valladares et al 2012 (in prep)



Matesanz & Valladares 2014 EEB

Biomas do Brasil



Processo de savanização da Amazônia

Escola Nacional de Botânica Tropical

Amazonian Deforestation and Regional Climate Change

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(Manuscript received 7 December 1990, in final form 29 April 1991)

VOLUME 4 JOURNAL OF CLIMATE OCTOBER 1991

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Current Opinion in Environmental Sustainability

'Tipping points' for the Amazon forest

Carlos Afonso Nobre and Laura De Simone Borma

Theor Appl Climatol (2012) 109:73–79
DOI 10.1007/s00704-011-0560-3

ORIGINAL PAPER

Tropical land savannization: impact of global warming

Sergio H. Franchito · V. Brahmananda Rao ·
J. Pablo R. Fernandez

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B

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Testing the Amazon savannization hypothesis: fire effects on invasion of a neotropical forest by native cerrado and exotic pasture grasses

Divino V. Silvério[1,2], Paulo M. Brando[2,3,4], Jennifer K. Balch[5], Francis E. Putz[6], Daniel C. Nepstad[2], Claudinei Oliveira-Santos[2] and Mercedes M. C. Bustamante[1]

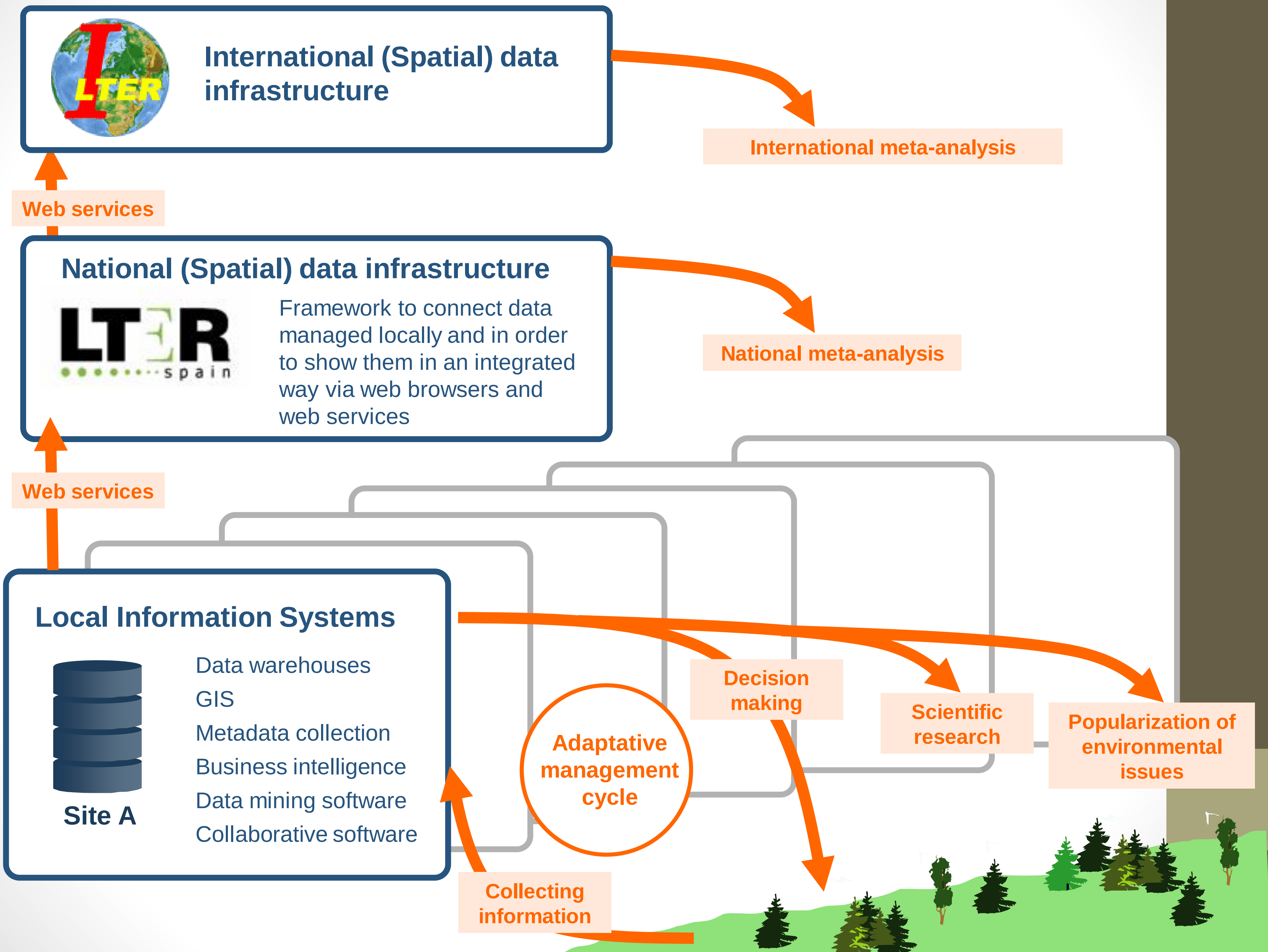
100 YEARS Journal of Ecology British Ecological Society

Climate change will increase savannas at the expense of forests and treeless vegetation in tropical and subtropical Americas

José D. Anadón[1,2]*, Osvaldo E. Sala[2,3] and Fernando T. Maestre[4]

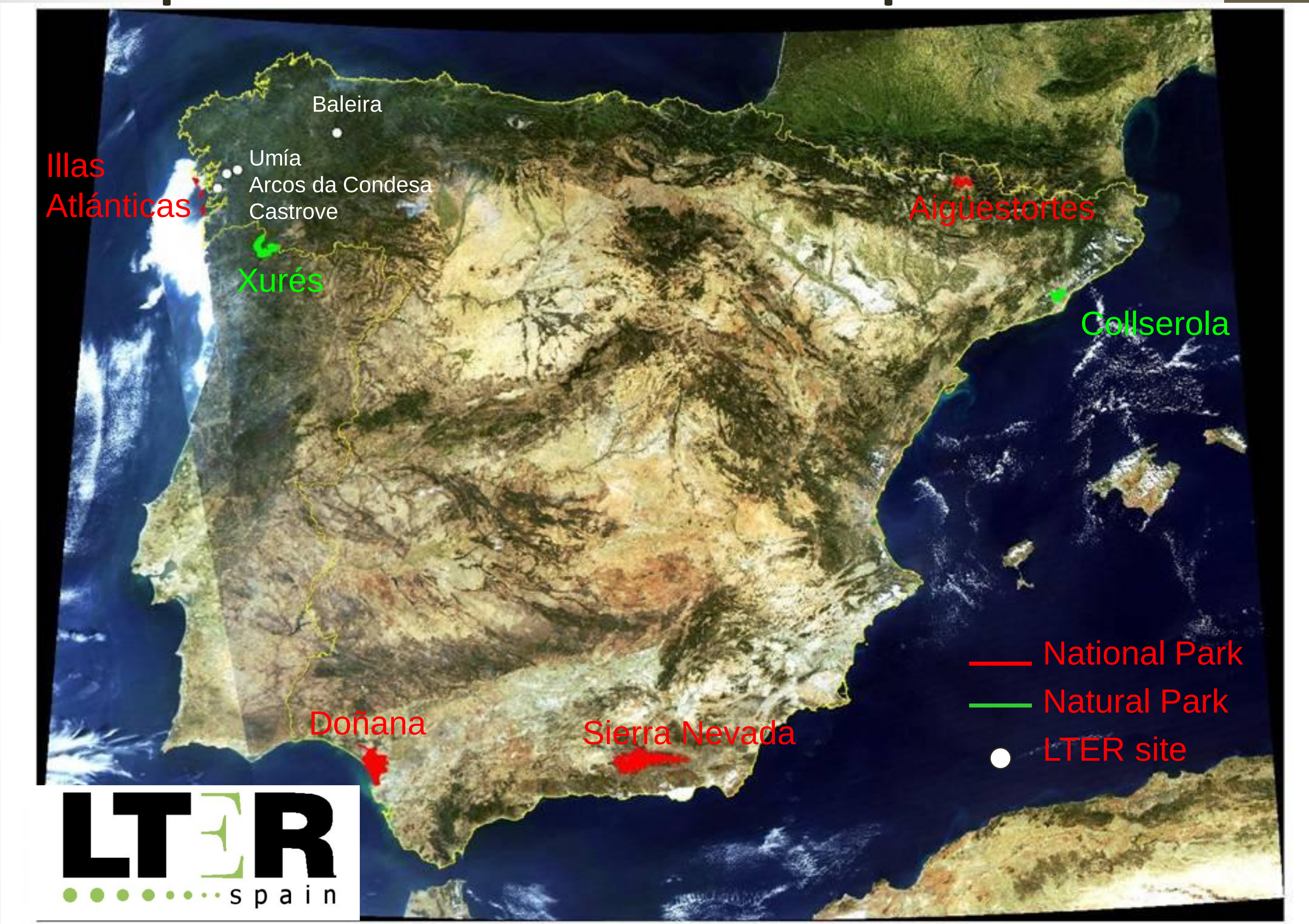
The challange for long term monitoring

- It is very important to ensure a long term monitoring, even if not very detailed
- It is challaneging to mantain and fund long term monitoring: creative strategy and coordination
- Learning by doing
- Learning from others



International (Spatial) data infrastructure
LTER
International meta-analysis
Web services
National (Spatial) data infrastructure
LTER spain
Framework to connect data managed locally and in order to show them in an integrated way via web browsers and web services
National meta-analysis
Web services
Local Information Systems
Data warehouses
GIS
Metadata collection
Business intelligence
Data mining software
Collaborative software
Site A
Decision making
Scientific research
Popularization of environmental issues
Adaptative management cycle
Collecting information

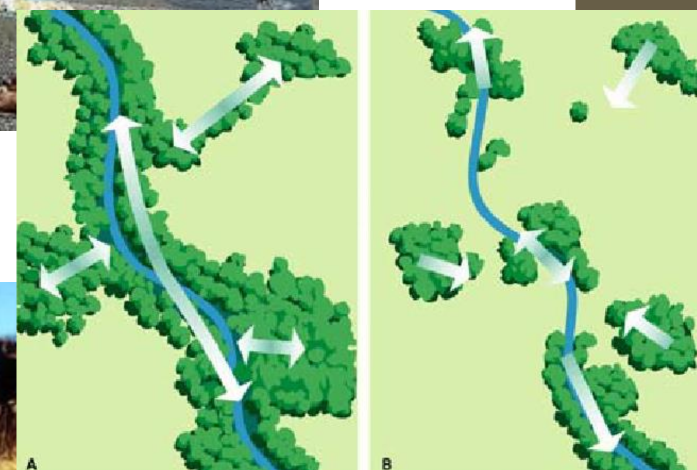
3. Proposed network of sites and platforms

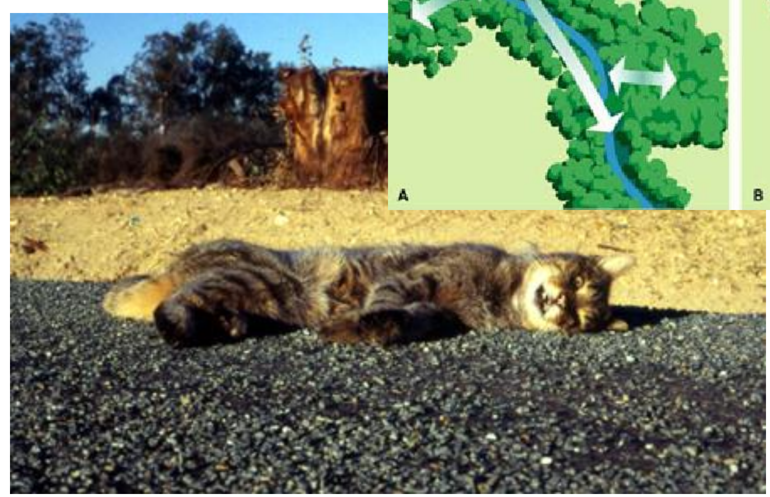


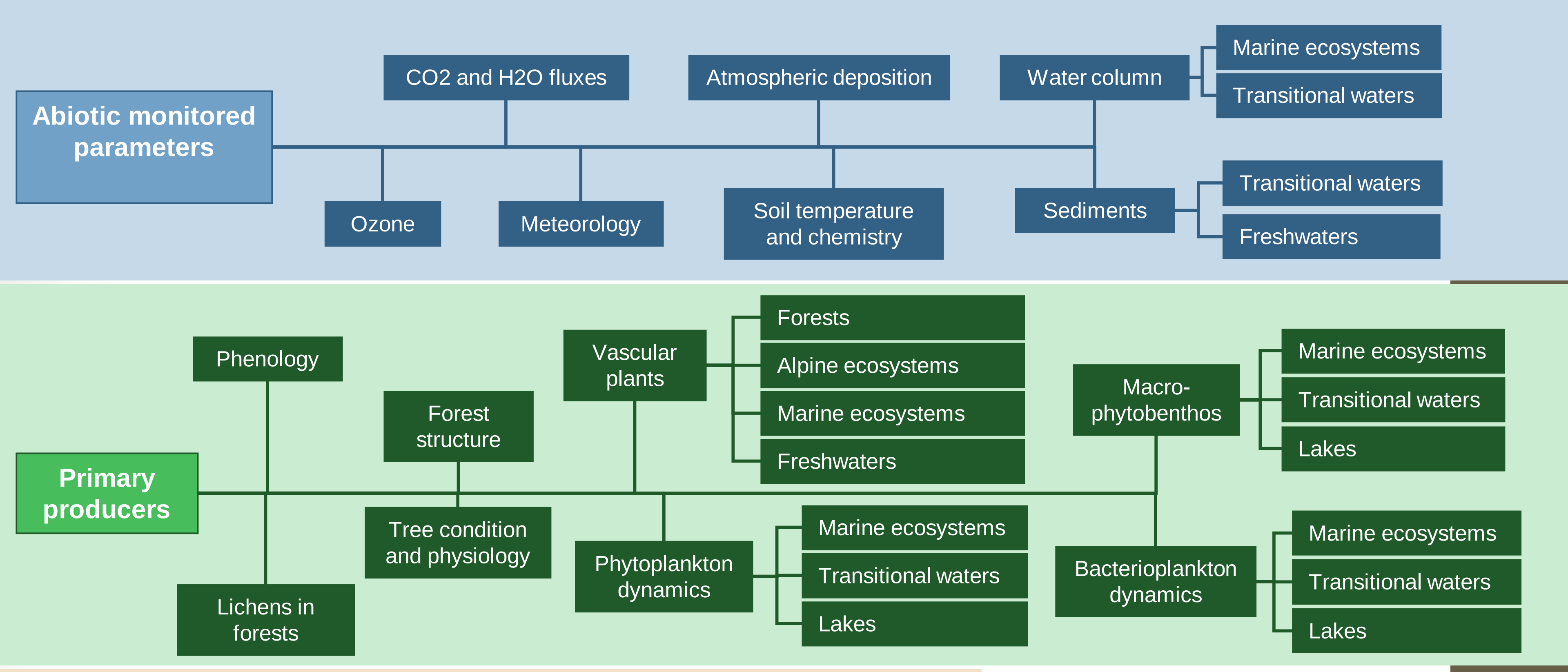
2. Representativity of Spanish Ecosystems

Biodiversity threats

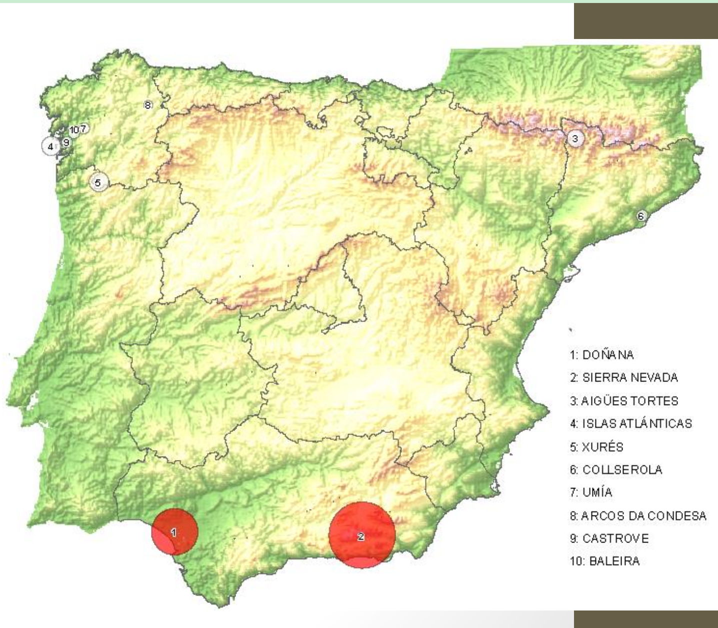
Massive Urbanization
Land use intensification
Fragmentation
Water and Air Pollution
Wetlands drainage
Large Wildfires
Overgrazing
Overfishing
Water supply shortages
Spread of Exotic Ssp…



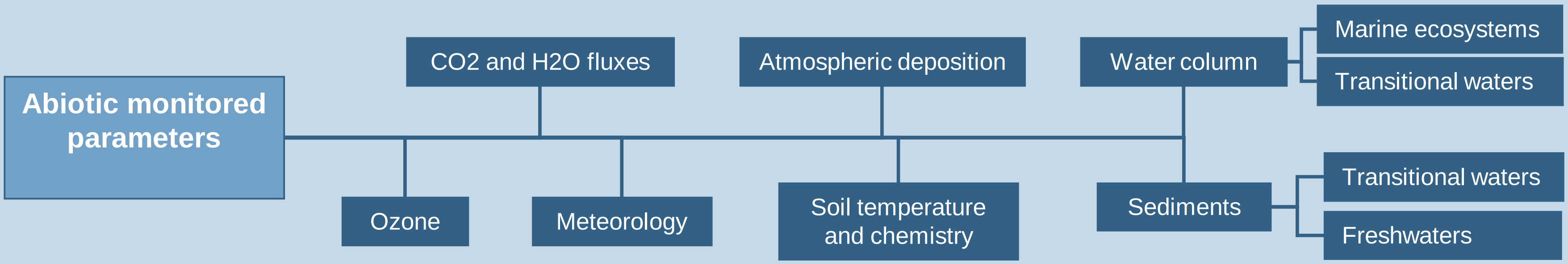




Abiotic monitored parameters
CO2 and H2O fluxes
Atmospheric deposition
Water column
Marine ecosystems
Transitional waters
Ozone
Meteorology
Soil temperature and chemistry
Sediments
Transitional waters
Freshwaters
Primary producers
Phenology
Forest structure
Vascular plants
Forests
Alpine ecosystems
Marine ecosystems
Freshwaters
Macro-phytobenthos
Marine ecosystems
Transitional waters
Lakes
Lichens in forests
Tree condition and physiology
Phytoplankton dynamics
Marine ecosystems
Transitional waters
Lakes
Bacterioplankton dynamics
Marine ecosystems
Transitional waters
Lakes
Consumers
Deadwood in forests
Invertebrates in terrestrial ecosystems
Necton community
Marine ecosystems
Transitional waters
Lakes
Amphibians
Birds
Mammals
Zooplankton dynamics in marine ecosystems
Zoobenthos dynamics in marine ecosystems
Others
Fragmentation of natural areas
Naturalness / environmental quality
Allien species



1: DOÑANA
2: SIERRA NEVADA
3: AIGÜES TORTES
4: ISLAS ATLÁNTICAS
5: XURÉS
6: COLLSEROLA
7: UMÍA
8: ARCOS DA CONDESA
9: CASTROVE
10: BALEIRA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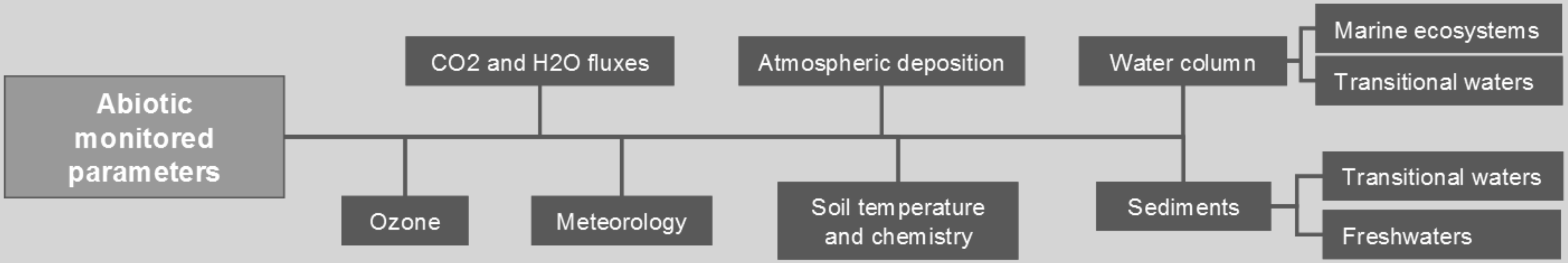
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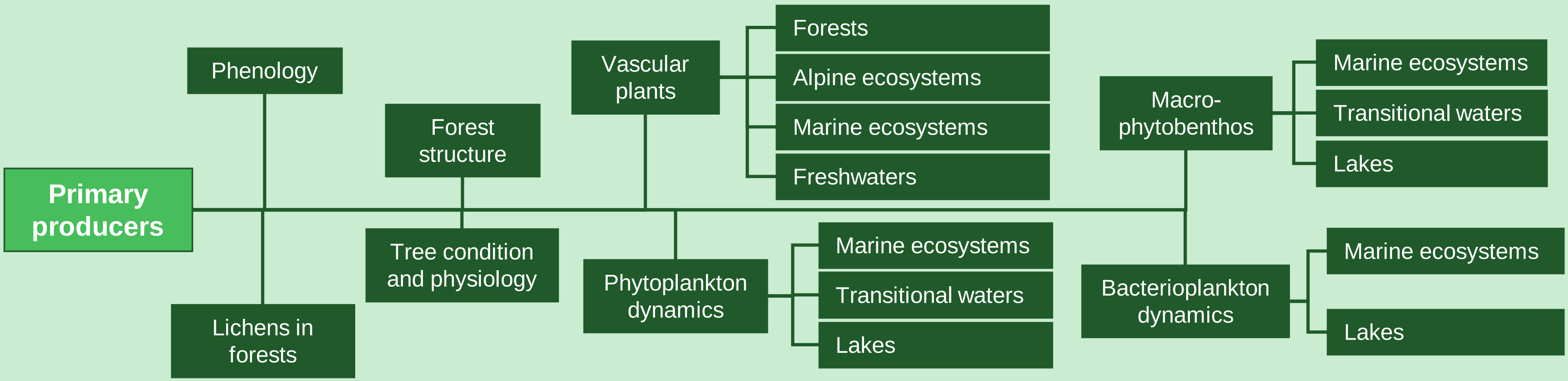
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Vascular plants
Forests
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Freshwaters
Macro-phytobenthos
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Transitional waters
Lakes
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Marine ecosystems
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Lakes
Bacterioplankton dynamics
Marine ecosystems
Lakes


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10: BALEIRA

Coordinated LTER-Spain monitoring

According to LTER-Europe recommended parameters

Abiotic component

PARAMETERS ASSESSED IN PARTICIPATING LTER SITES	Doñana	Sierra Nevada	Aiguestortes	Illes Atlanticas	Xures	Collserola	ROAGA Rio Um	ROAGA Arcos d Condesa	ROAGA Monte Castrove	ROAGA Baleira
Meteorology (Air temperature and humidity,	√	√	√	√	√	√	√	√	√	√
Soil temperature and chemistry	√	√	√	√				√	√	√
Athmospheric deposition (N, S etc)	√	√	√	√				√	√	√
Water column (temp, salinity, nutrients etc)				√						
Water column (temp, salinity, nutrients etc)	√	√			√	√	√	√		
Water column (temp, salinity, nutrients etc)	√	√	√							
Sediments (texture, redox, nutrients etc) in										
Sediments (texture, redox, nutrients etc) in							√			
Sediments (texture, redox, nutrients etc) in		√	√		√					
Ozone	√	√								

Sites & platforms common monitoring

Primary Producers

PARAMETERS ASSESSED IN PARTICIPATING LTER SITES	Doñana	Sierra Nevad:	Aiguestortes	Illes Atlantica	Xures	Collserola	ROAGA Rio Umia	ROAGA Arco da Condesa	ROAGA Mont Castrove	ROAGA Balei
Tree condition & Physiology (*)	√ (*)	√ (*)	√	√	√	√		√	√	√
Forest structure	√	√	√	√	√	√		√	√	√
Plant vascular species in forests	√	√	√	√	√	√		√	√	√
Plant vascular species in rural ecosystems										
Plant vascular species in alpine ecosystems		√	√							
Plant vascular species in marine ecosystems				√						
Plant vascular species in freshwaters	√		√		√		√			
Plant vascular species in transitional waters	√									
Phytoplankton dynamics in marine ecosystems				√						
Phytoplankton dynamics in transitional waters	√	√				√	√			
Phytoplankton dynamics in lakes			√							
Bacterioplankton dynamics in marine				√						
Bacterioplankton dynamics in transitional										
Bacterioplankton dynamics in lakes			√				√			
Macrophytobenthos in marine ecosystems				√						
Macrophytobenthos in transitional waters	√						√			
Macrophytobenthos in lakes			√							
Phenology	√	√	√	√				√	√	√
Lichens in forests						√				

Sites & platforms common monitoring

Consumers

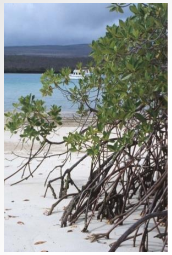
PARAMETERS ASSESSED IN PARTICIPATING LTER SITES	Doñana	Sierra Nevad	Aiguestortes	Illes Atlantica	Xures	Collserola	ROAGA Rio Umia	ROAGA Arco da Condesa	ROAGA Mont Castrove	ROAGA Balei
Zooplankton dynamics in marine ecosystems				√						
Zooplankton dynamics in transitional waters										
Zooplankton dynamics in lakes										
Zoobenthos in marine ecosystems				√						
Zoobenthos in transitional waters										
Zoobenthos in lakes										
Invertebrates in terrestrial ecosystems	√	√		√	√	√		√	√	√
Necton community in marine ecosystems				√						
Necton community in transitional waters	√				√		√			
Necton community in lakes			√							
Amphibians				√				√	√	√
Birds	√	√	√	√	√	√		√	√	√
Mammals			√			*				
Deadwood in forests				√				√	√	√

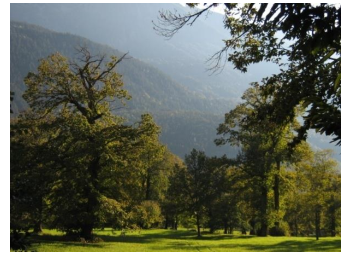
Others

Allien species	√			√		*		√	√	√
Naturalness / Environmental quality	√	√				√				
Fragmentation of natural areas	√	√	√			√				

Conclusions

1. We have moved too quickly to future species scenarios without a sound understanding of population-level processes
2. The response of trees to changing environments is likely to be determined by population responses at range margins.
3. Our knowledge on genetic diversity, phenotypic plasticity, and ecophysiological performance of fragmented populations of key tree species is still very limited, particularly in the rear edge (low latitudes and low elevations), where climate change is expected to have a large impact
4. Models are a crucial tool for evaluating the impact of climate change in European forests but they must incorporate more detail and attain greater biological realism
5. Monitoring is crucial but really challenging (economics, coordination, long term)




Pechiazul *(Luscinia svecica)*

Biodiversity:

grasping its implications in a changing world....