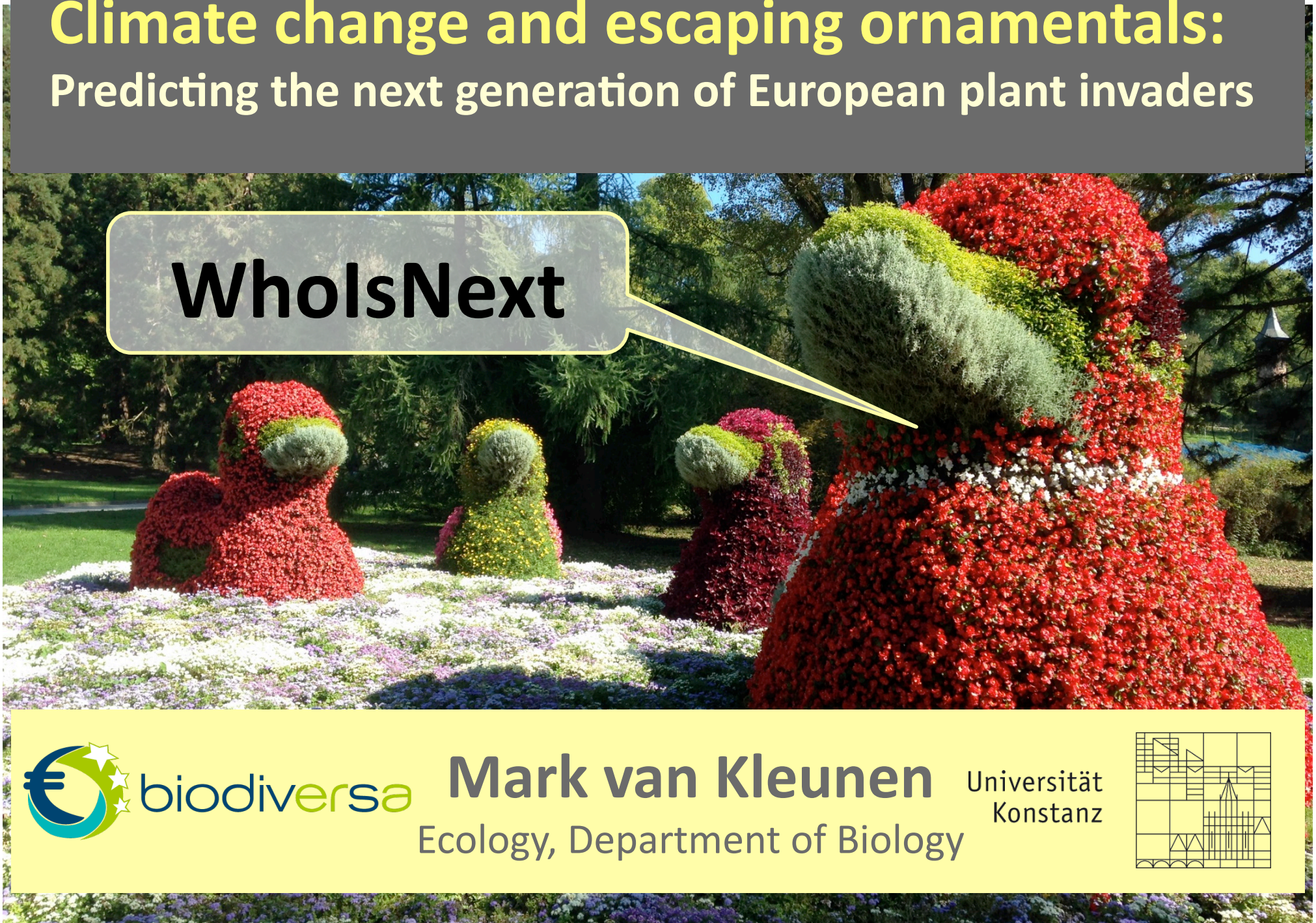
Climate change and escaping ornamentals:
Predicting the next generation of European plant invaders



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The WhoIsNext consortium

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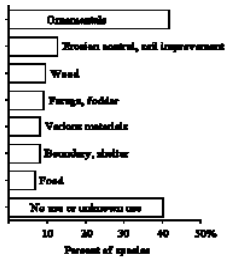
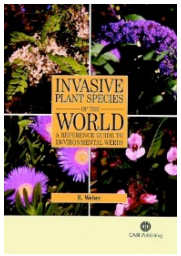
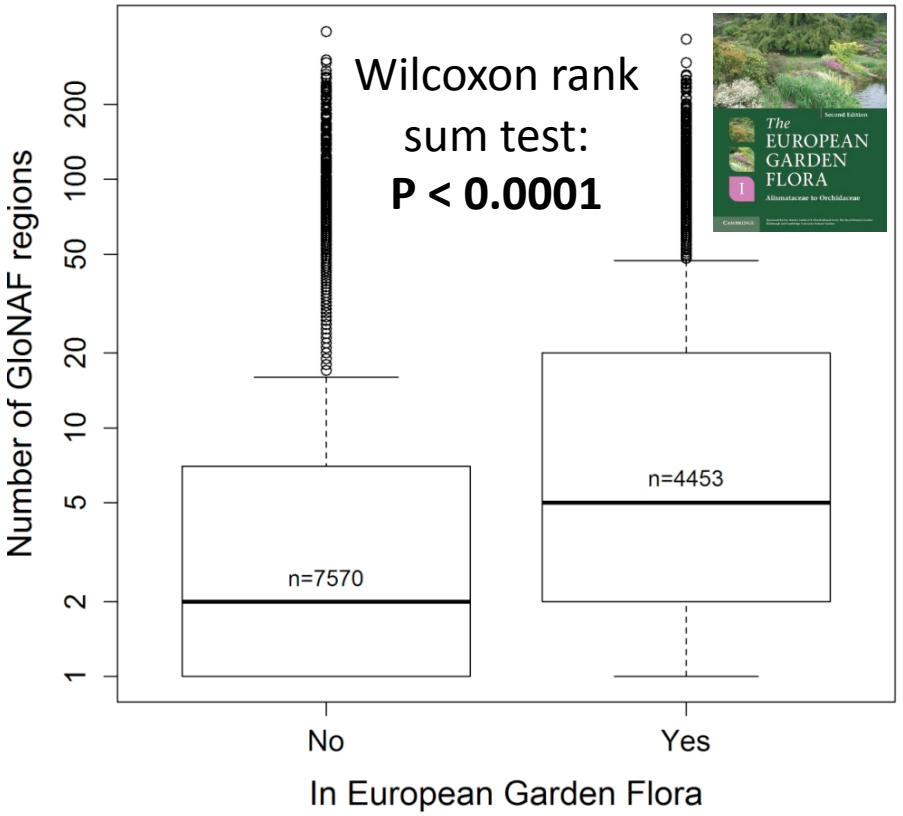
Horticulture

Horticulture is the major pathway for naturalized and invasive plants.





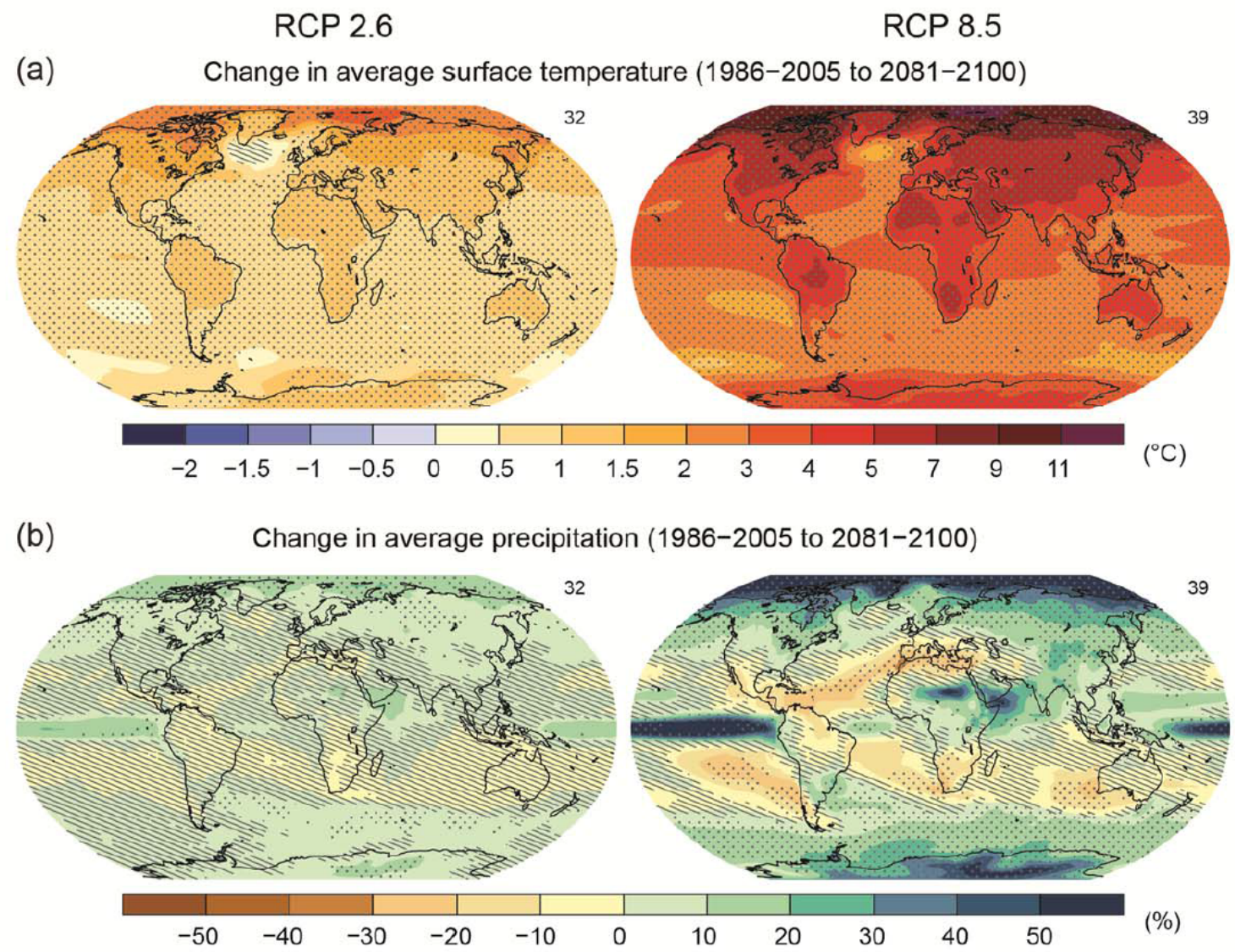


Many of our current garden plants originate from warmer parts of the world.

Weber 2003, Invasive Plant Species of the World; van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al. *in preparation*

Predicted climate change

The future climate might be more suitable for many of our ornamental plants.



IPCC 2013

WhoIsNext objectives

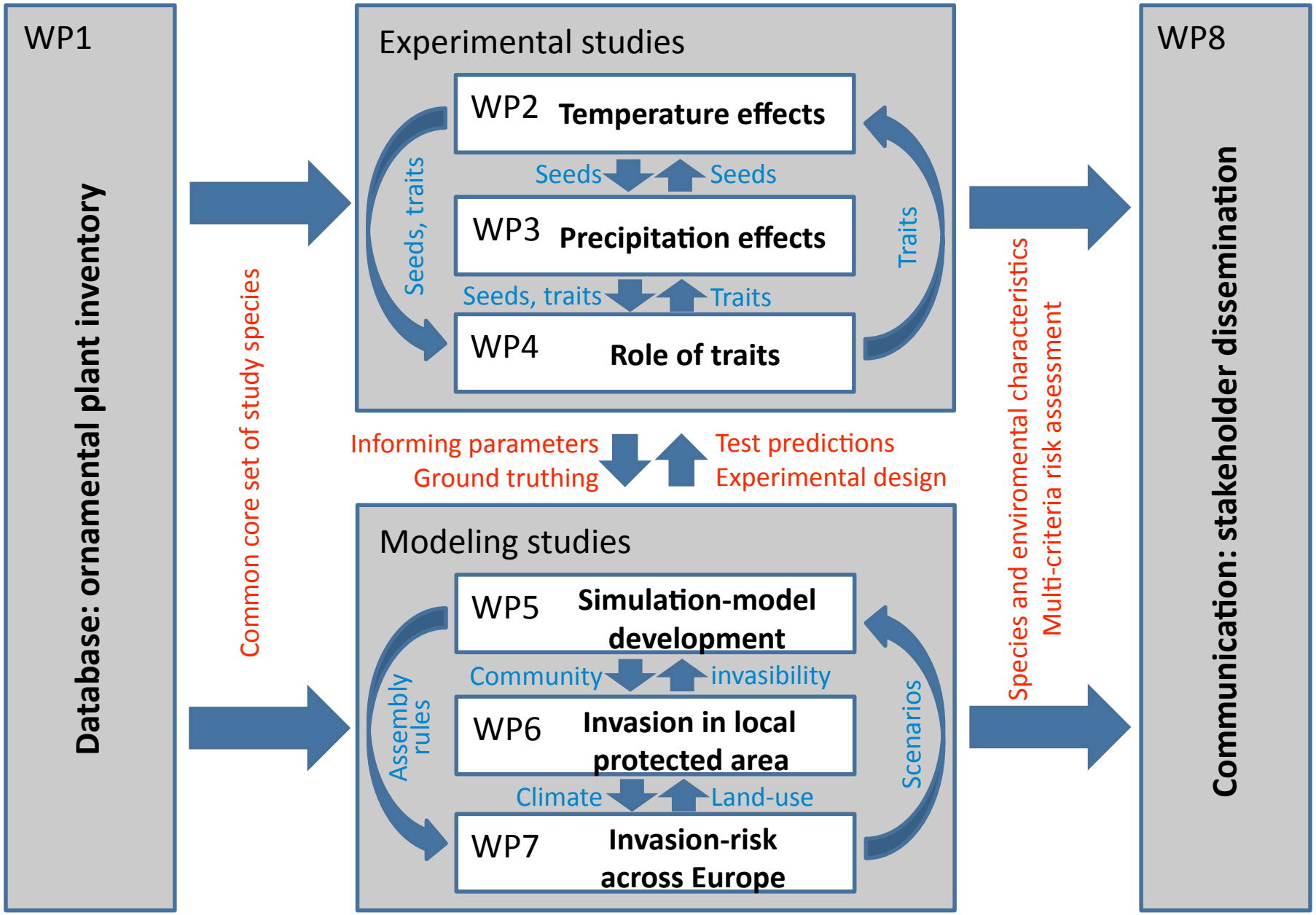
Which ornamental plant species might naturalize and become invasive under future climatic conditions, and **where in Europe** will these next invasions happen?

1. **Test experimentally whether changes in temperature and precipitation will enhance establishment and growth** of ornamental alien plants in native communities.

2. **Determine both empirically and through modelling which traits and ecological mechanisms favour the spread** of non-native ornamentals under current and future climate conditions.

3. **Develop simulation tools to determine which habitats and regions will be most vulnerable** to invasions of ornamental plants in the future.

WhoIsNext workplan



WP1 – Compilation and analysis of European garden-plant inventory

Garden plants get a head start on climate change

Sebastiaan Van der Veken[1*], Martin Hermy[1], Mark Vellend[2], Anne Knapen[1], and Kris Verheyen[3]

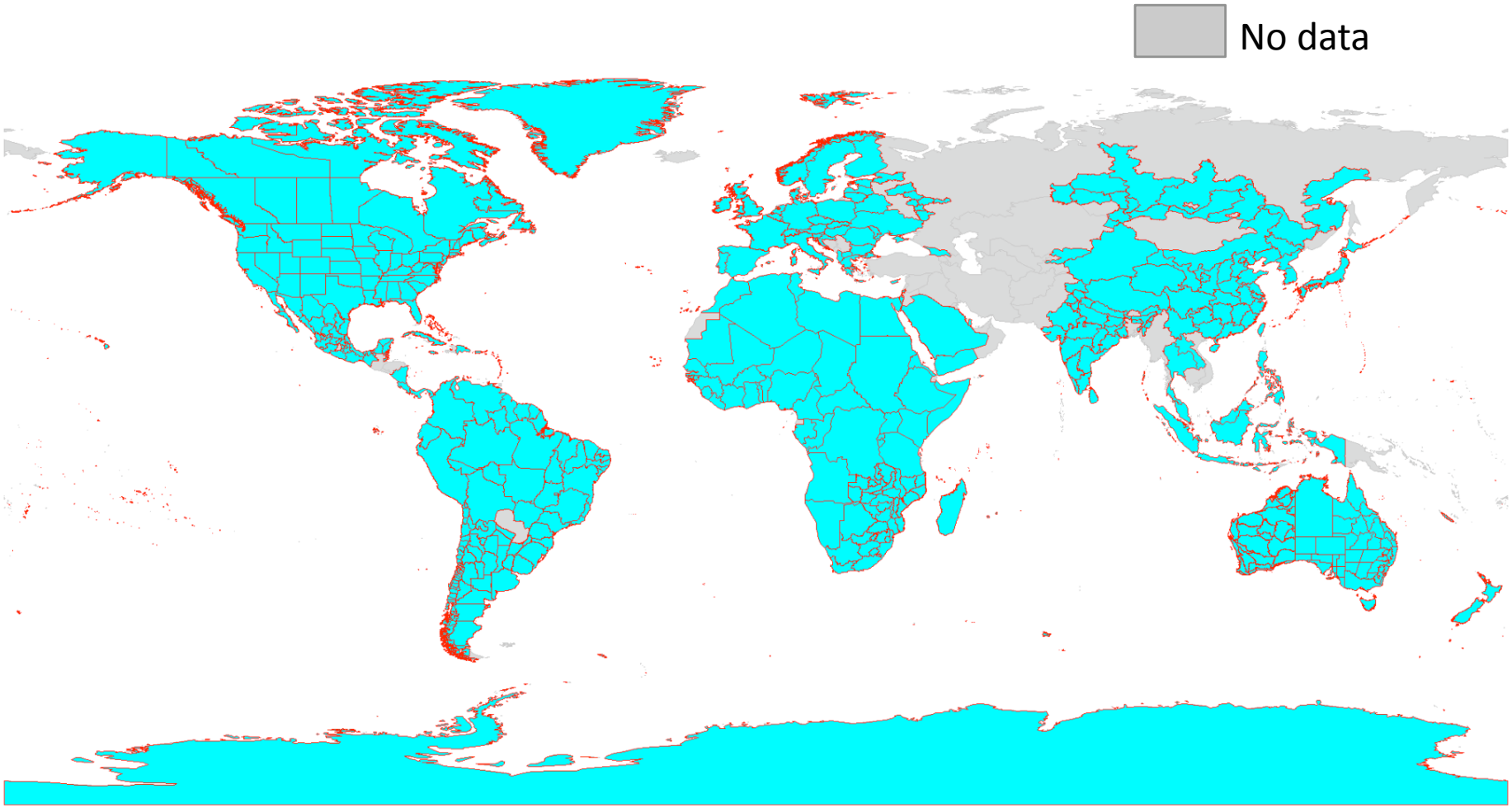
Cullen et al. 2011 The European Garden Flora; Van der Veken et al. 2008 Frontiers in Ecology and the Environment 6:212-216

The GloNAF database

The Global Naturalized Alien Flora database

12’413 vascular plant taxa (11’634 species)

828 non-overlapping regions



van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

Selected study species

Ornamental (37)

Achillea filipendulina
Aconitum carmichaelii
Amaranthus tricolor
Centaurea americana
Centaurea macrocephala
Cuminum cyminum
Digitalis trojana
Eragrostis trichodes
Eritrichium canum
Gilia tricolor
Helenium bigelovii
Helianthus debilis
Heliotropium arborescens
Iris domestica
Isotoma axillaris
Lilium formosanum
Lilium regale
Lobelia inflata
Lysimachia clethroides
Monarda fistulosa
Monarda punctata
Nemophila maculata
Nepeta racemosa
Nicotiana mutabilis
Nicotiana sylvestris
Pennisetum macrourum
Persicaria capitata
Persicaria virginiana
Petunia integrifolia
Platycodon grandiflorus
Potentilla atrosanguinea
Rudbeckia fulgida
Rudbeckia triloba
Salpiglossis sinuata
Solidago ptarmicoides
Verbena rigida
Zinnia peruviana

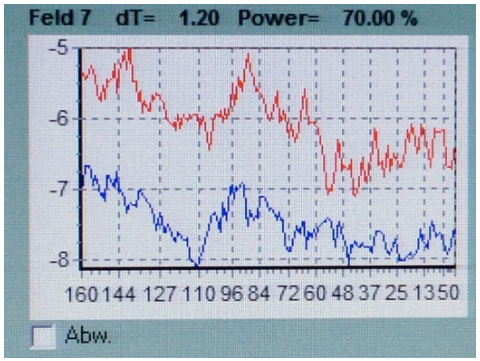
Naturalized (11)

Antirrhinum majus
Cerastium tomentosum
Consolida ajacis
Eranthis hyemalis
Hesperis matronalis
Hordeum jubatum
Mentha spicata
Pseudofumaria lutea
Salvia verticillata
Solidago canadensis
Viola odorata

Native (14)

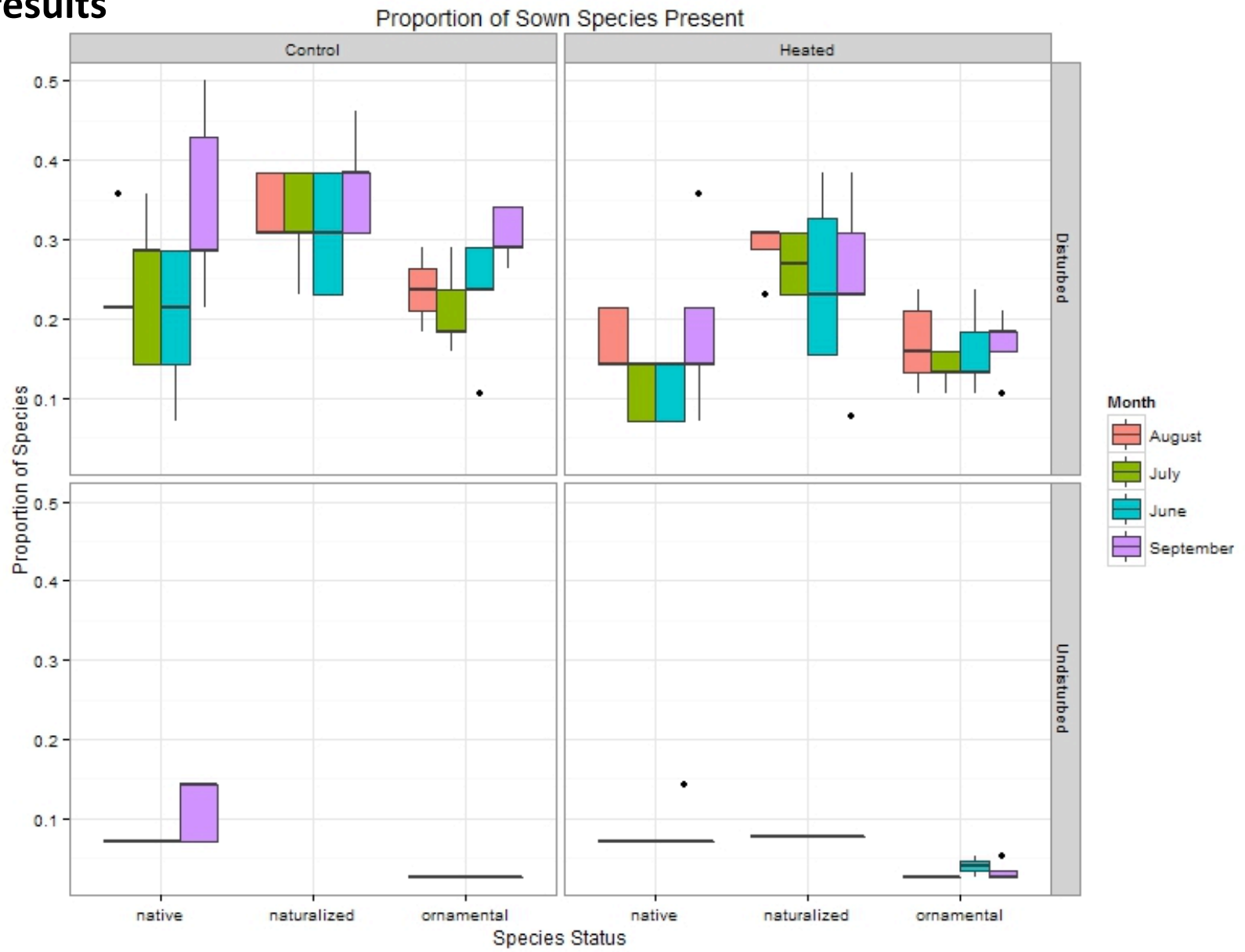
Achillea millefolium
Ajuga reptans Alba
Allium schoenoprasum
Aquilegia vulgaris
Atropa Belladonna
Iris sibirica
Lysimachia vulgaris
Origanum vulgare
Phleum pratense
Plantago media
Rumex crispus
Silene latifolia
Vicia sepium
Viola tricolor

WP2 – Effect of experimental warming on establishment



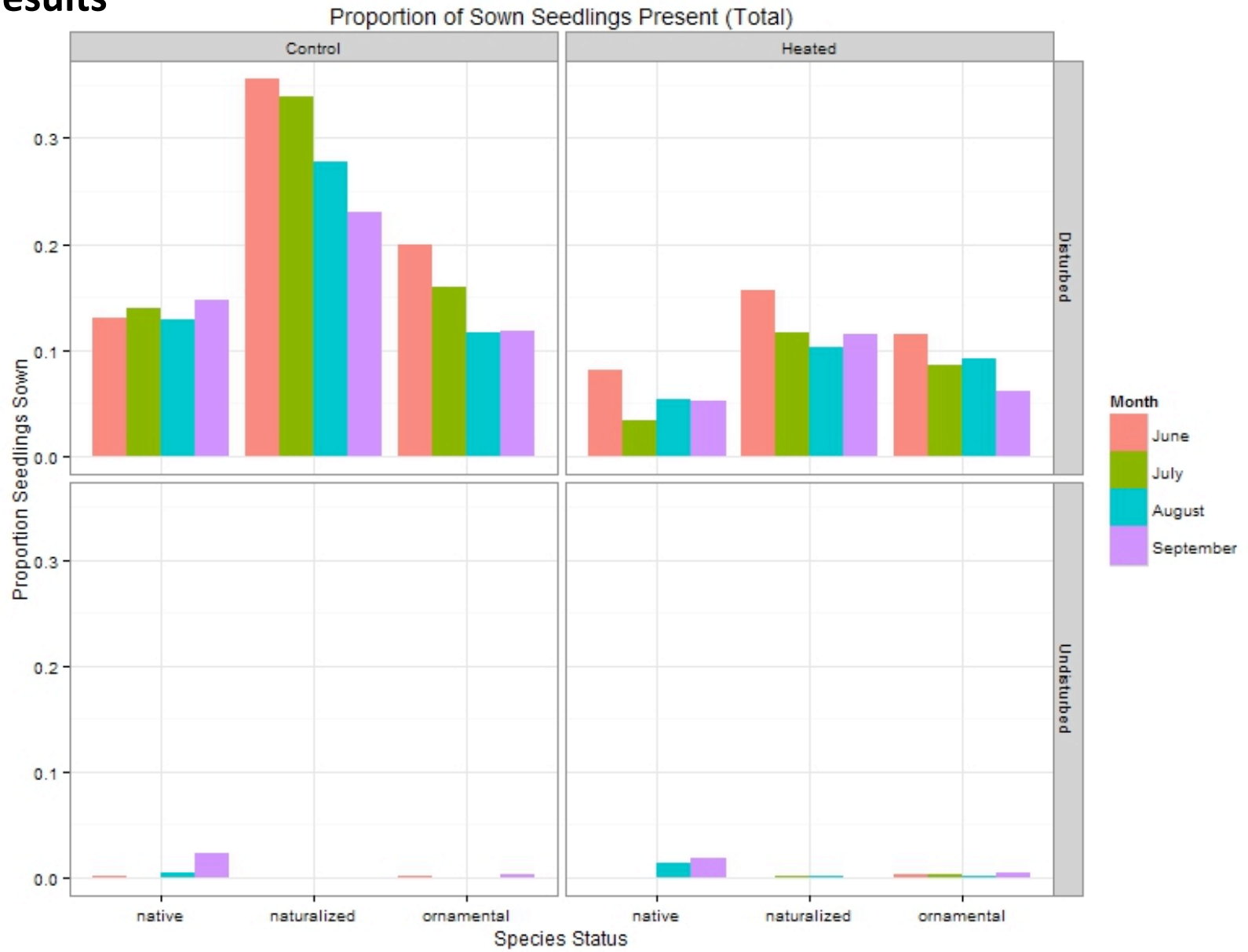
WP2 – Effect of experimental warming on establishment

Preliminary results

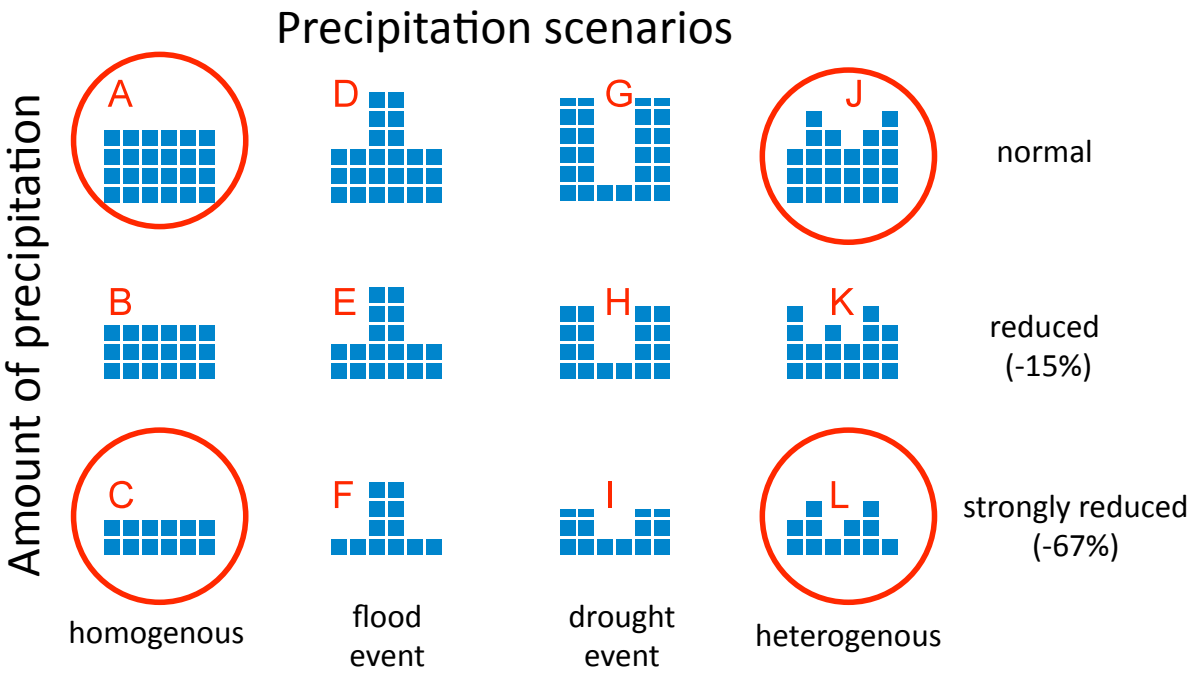


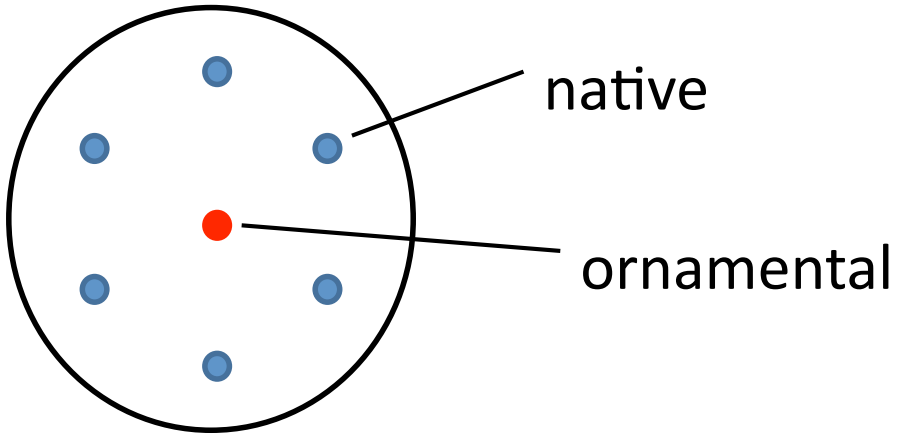
WP2 – Effect of experimental warming on establishment

Preliminary results



WP3 – Effect of changed precipitation on establishment





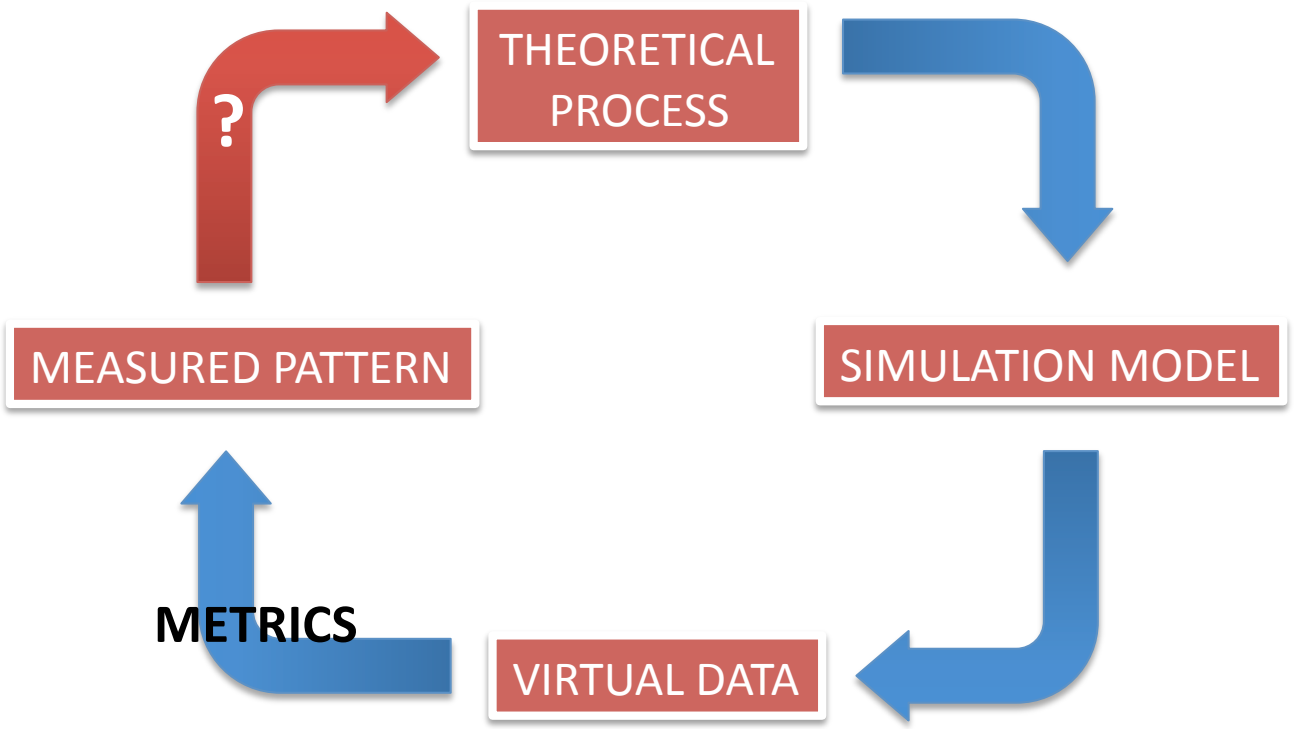
WP4 – Traits of the WhoIsNext study species

Assessment of traits to parameterize models

- Dispersal capability
- **Germination** and recruitment rate under different light conditions
- Breeding system and pollination agent
- Life span
- **Phenology, age of maturity**
- Tolerance to mowing/grazing
- **Growth under different light conditions**
- Temperature and precipitation tolerance
- Clonal growth rate
- Seed yield
- Seed attributes (mass, terminal velocity, surface structure)

WP5 – Simulation model for ornamental plant invasions

A virtual-ecologist approach: a process-based model with specific rules and parameters is used to simulate virtual data, so that the performance of statistical methods to recover the processes can be tested against a known truth.

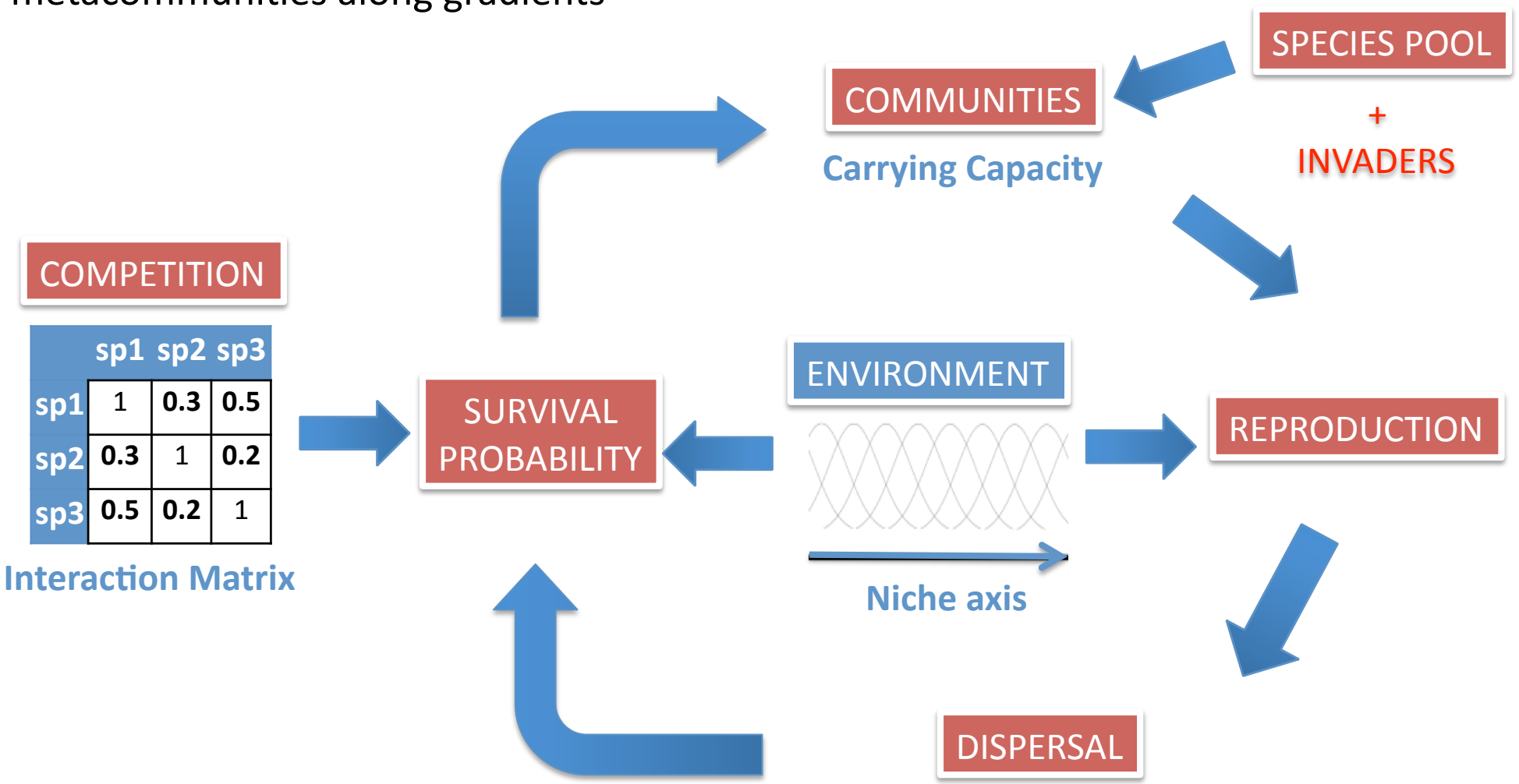


Zurell et al. 2010 Oikos 119:622-635

WP5 – Simulation model for ornamental plant invasions

Metacommunity-simulation model

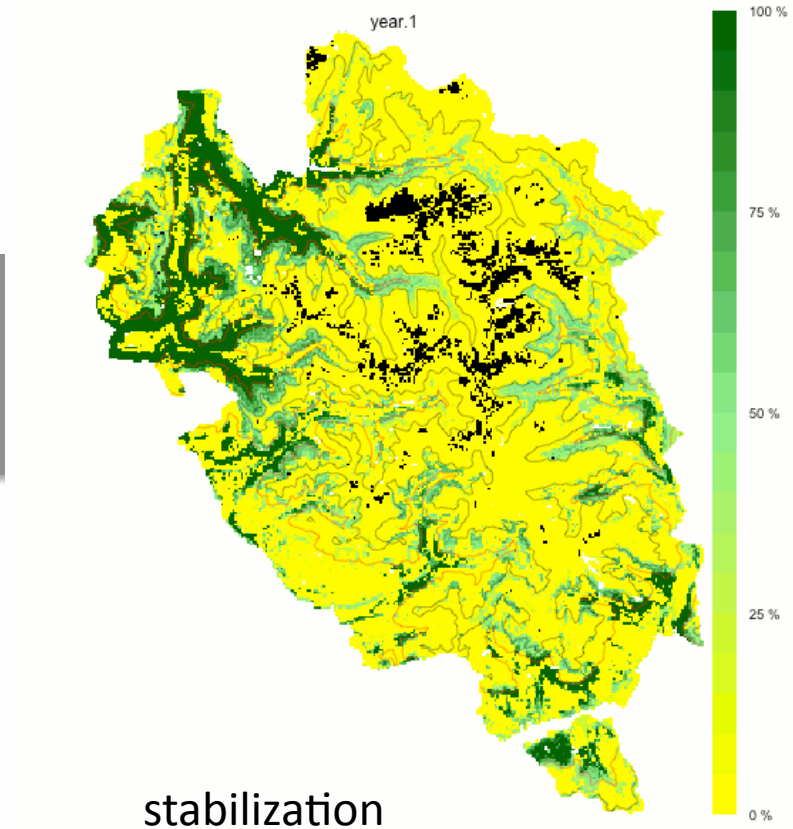
A stochastic, spatially-explicit, individual based model to simulate the dynamics of metacommunities along gradients



WP6 – Simulating ornamental plant invasion in a protected area

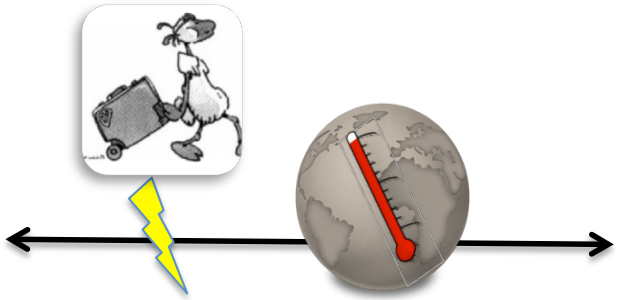
The **FATE-H hybrid-landscape model** is used to simulate the potential invasion of ornamental species (**PFTs**) in a real landscape under changing climate and landuse.

Ecrins National Park in the French Alps



Canopy closure (%)

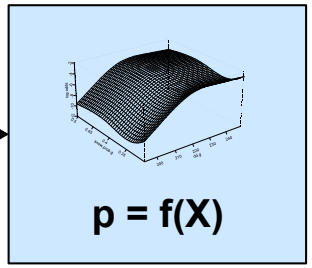
Abandonment and climate change

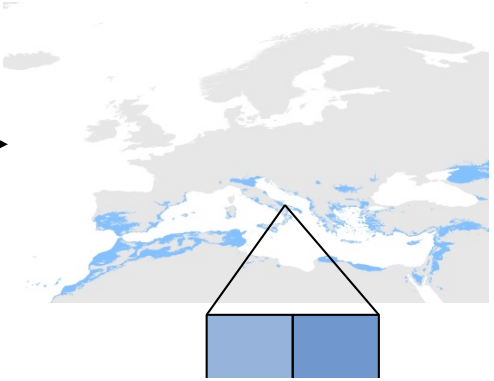


Find the best combination of traits that would allow a new PFT to invade.

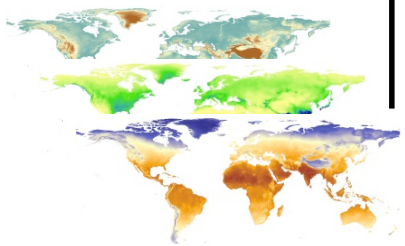
WP7 – Risk assessment under a future climate across Europe

Species distribution data

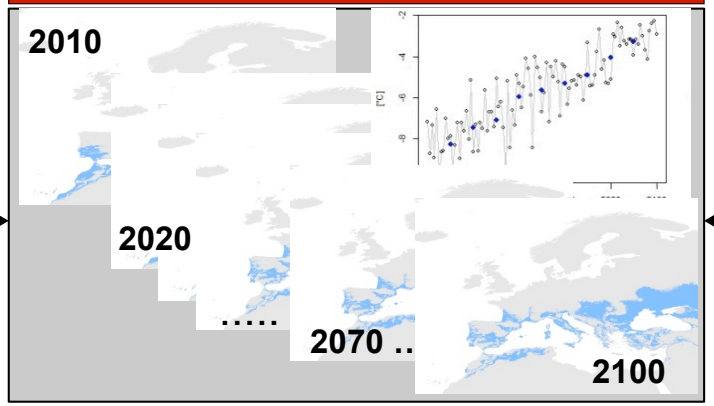


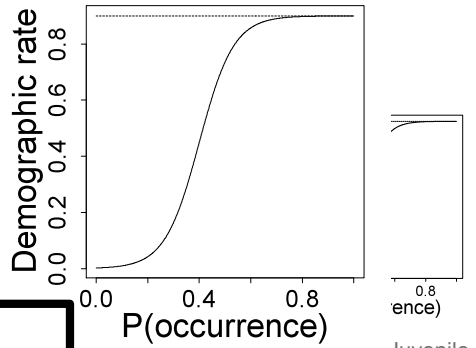


Climatic data

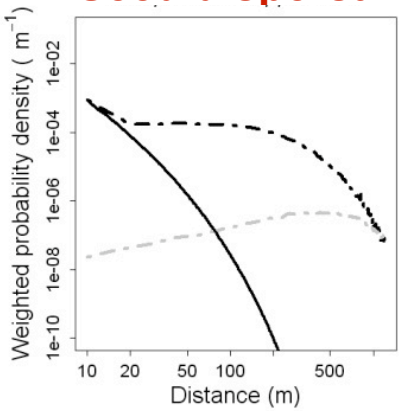


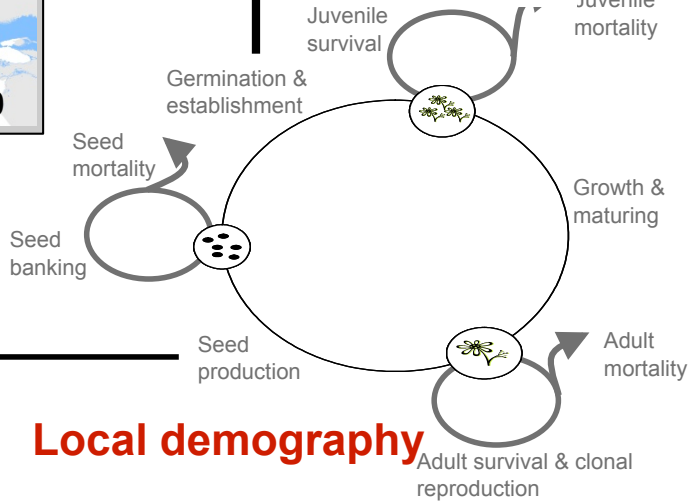
Spatio-temporal spread model





Seed dispersal





Local demography

Adult survival & clonal reproduction

WP8 – Stakeholder dissemination and policy advice

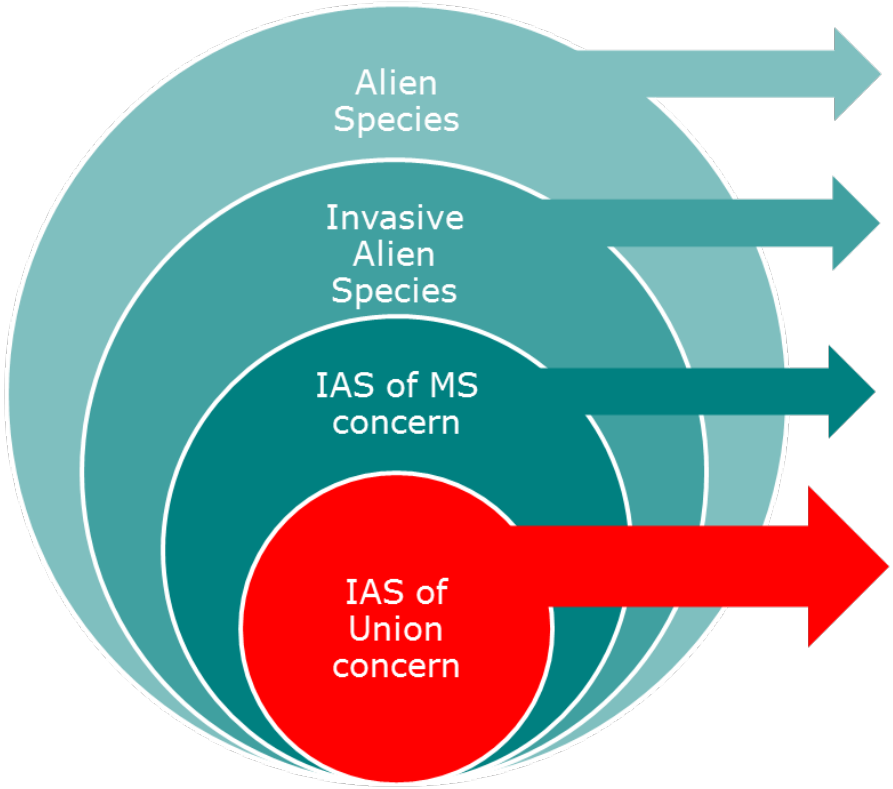
EUROPEAN COMMISSION

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the prevention and management of the introduction and spread of invasive alien species

List of alien species of EU-concern



- 12000+ species
- 1200-1500 species?
- ? species
- On the basis of risk assessment
- Member states have to take precautionary and management measures

→ need for screening of IAS invasion / impact potential

AICHI Target 9 (CBD)

By 2020, invasive alien species and **pathways are identified and prioritized, priority species are controlled or eradicated, and** measures are in place to **manage pathways to prevent** their introduction and establishment

To-do list

	WhoIsNext
• Define lists of species and pathways	√
• Identify priority pathways for focusing prevention	√
• Identify priority species for response	√

Dissemination of WhoIsNext results

- Usual means (publications, conferences, press)
- Webpage
- Two-day workshop for stakeholders
- Present results to horticultural industry (e.g. RHS Chelsea Flower Show)
- Collaboration with managers of Ecrins National Park
- Side project with the municipality of Radolfzell and the NGO *Deutsche Umwelthilfe*

Summary

With a combination of experimental and modelling studies, we will make predictions on which ornamental plant species might naturalize and become invasive under future climatic conditions, and where in Europe these new invasions will happen.

Thanks!

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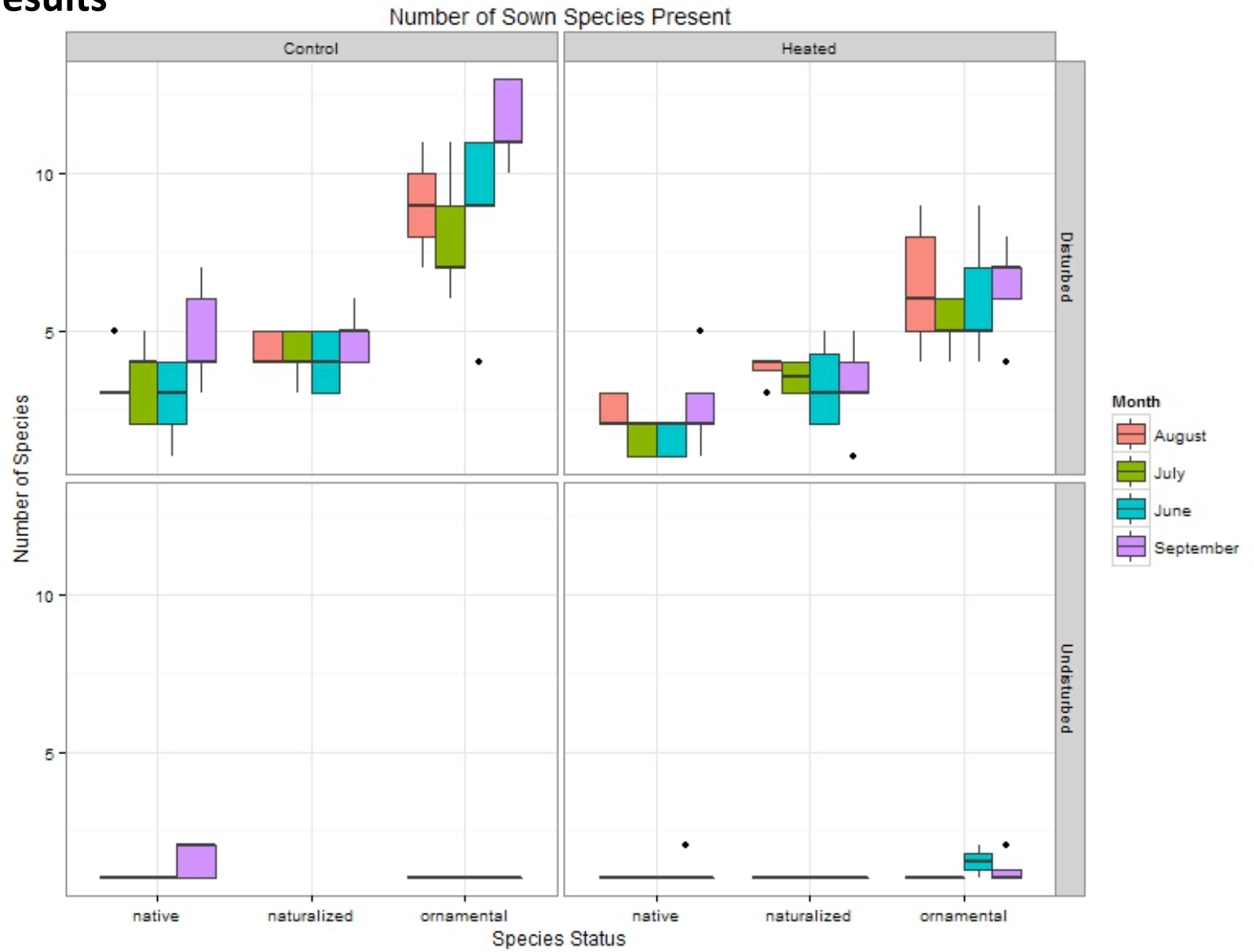
DFG Deutsche Forschungsgemeinschaft

ANR

FWF Der Wissenschaftsfonds.

WP2 – Effect of experimental warming on establishment

Preliminary results



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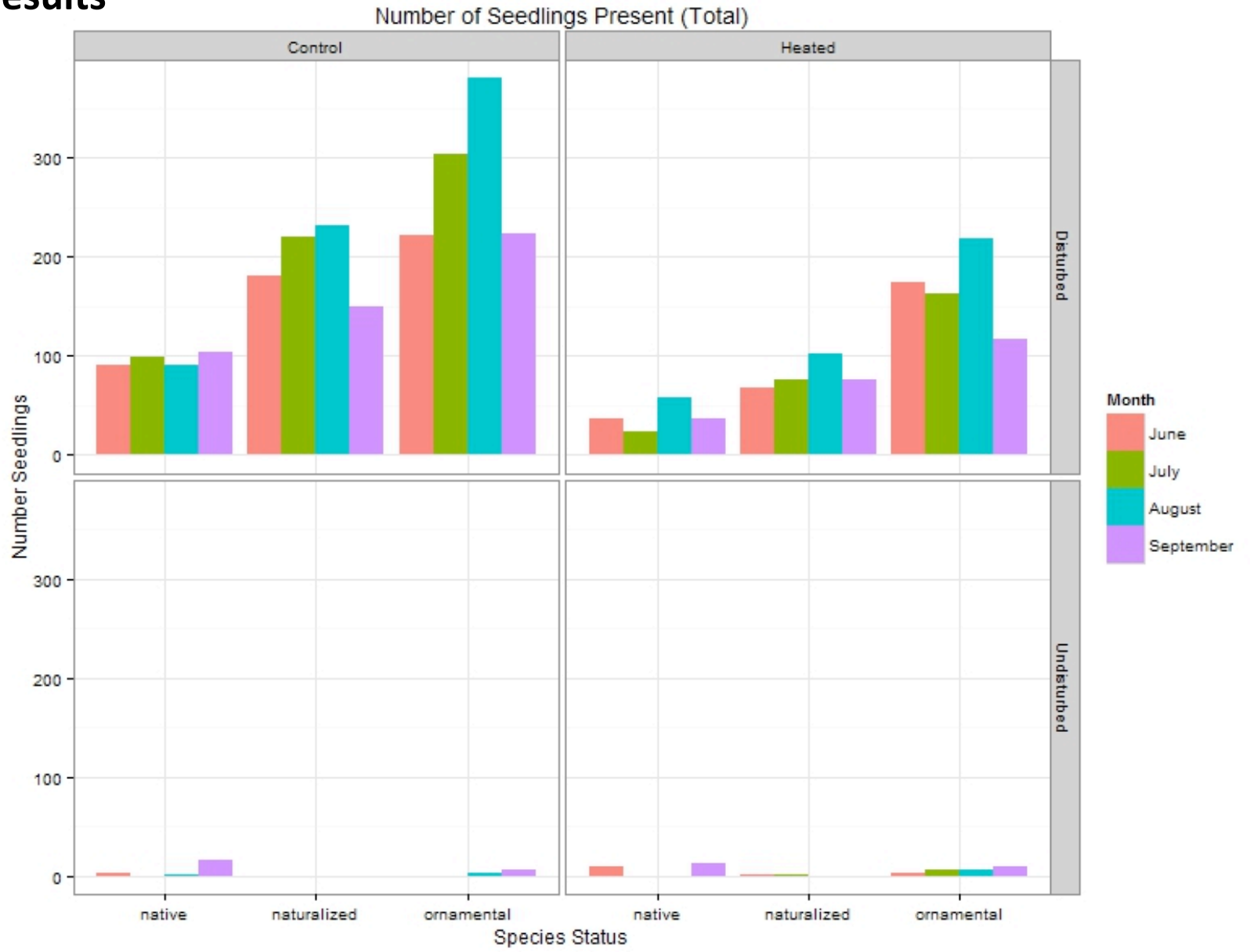

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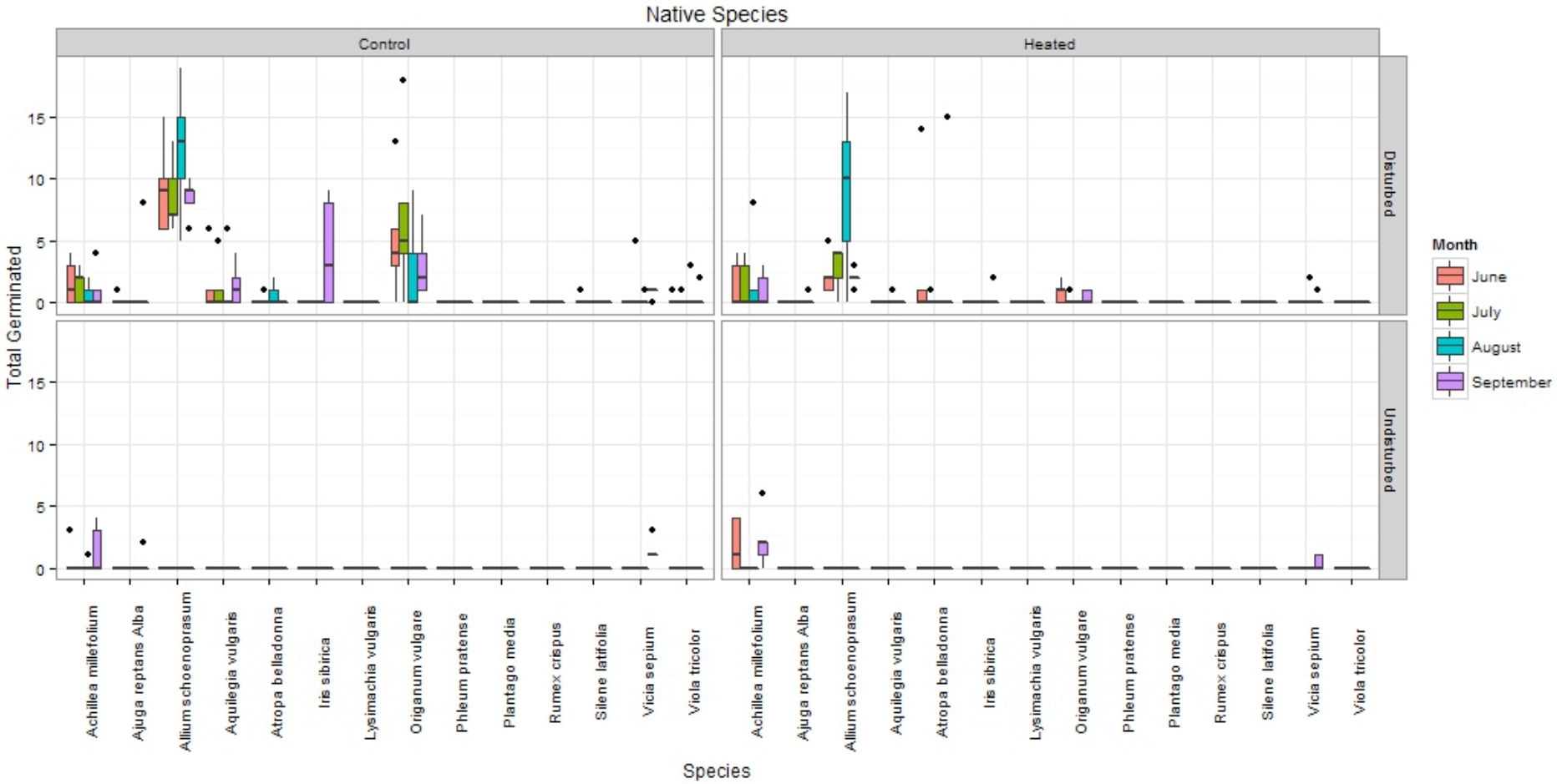

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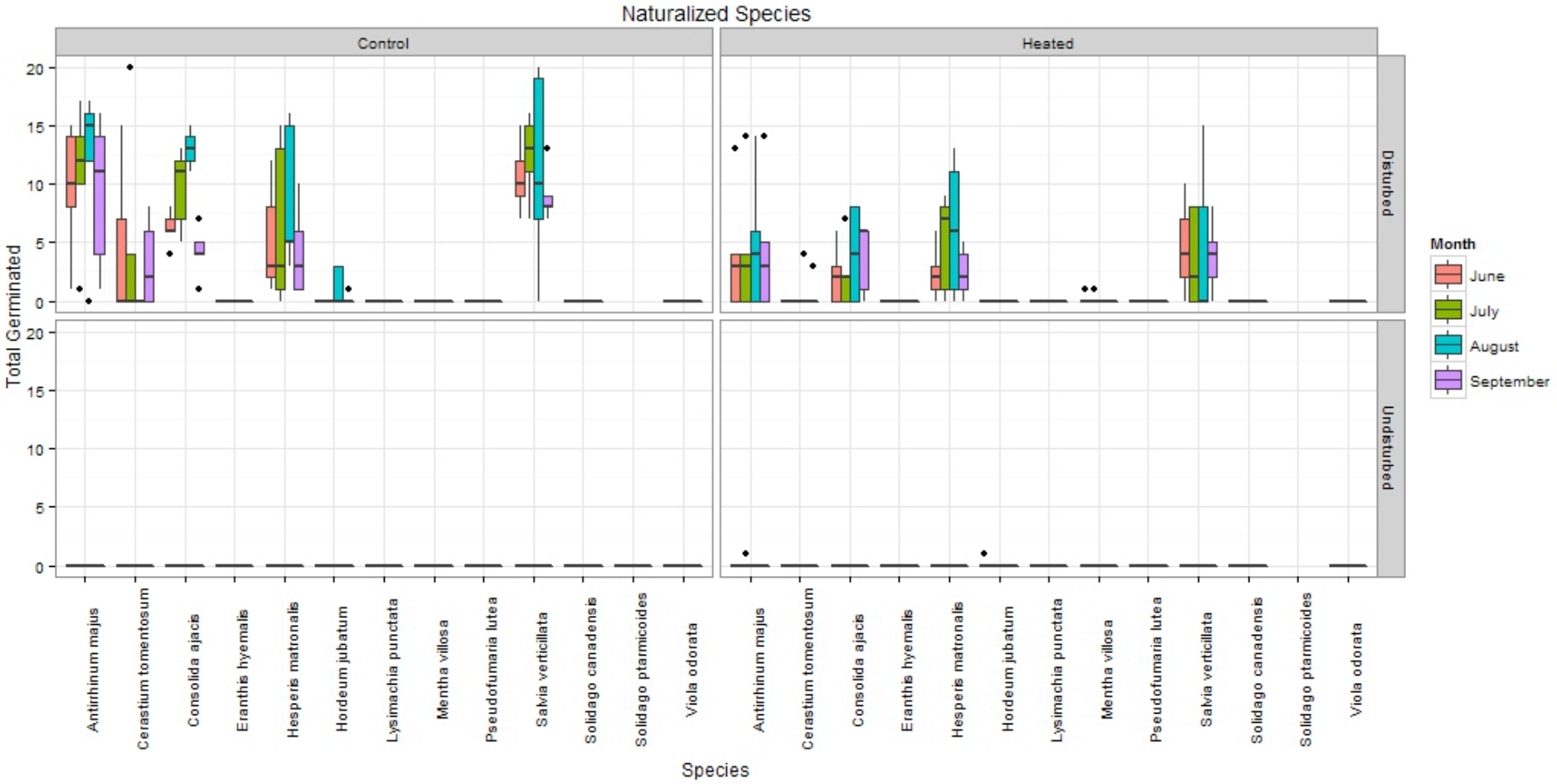

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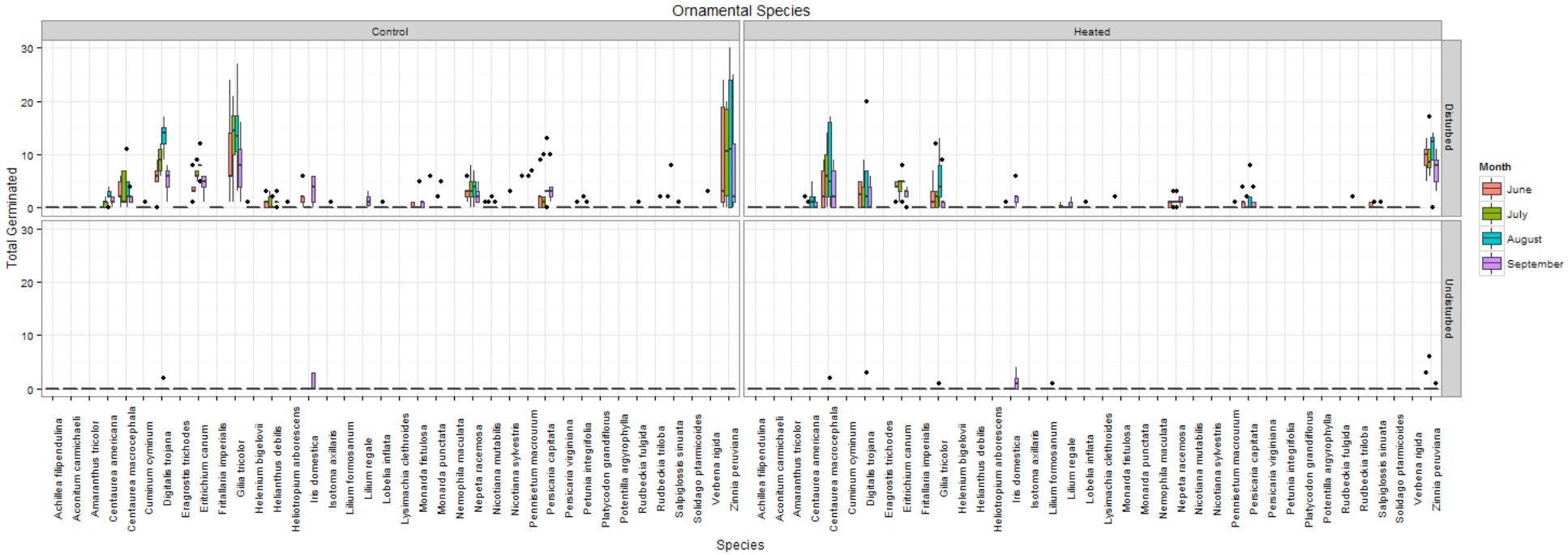
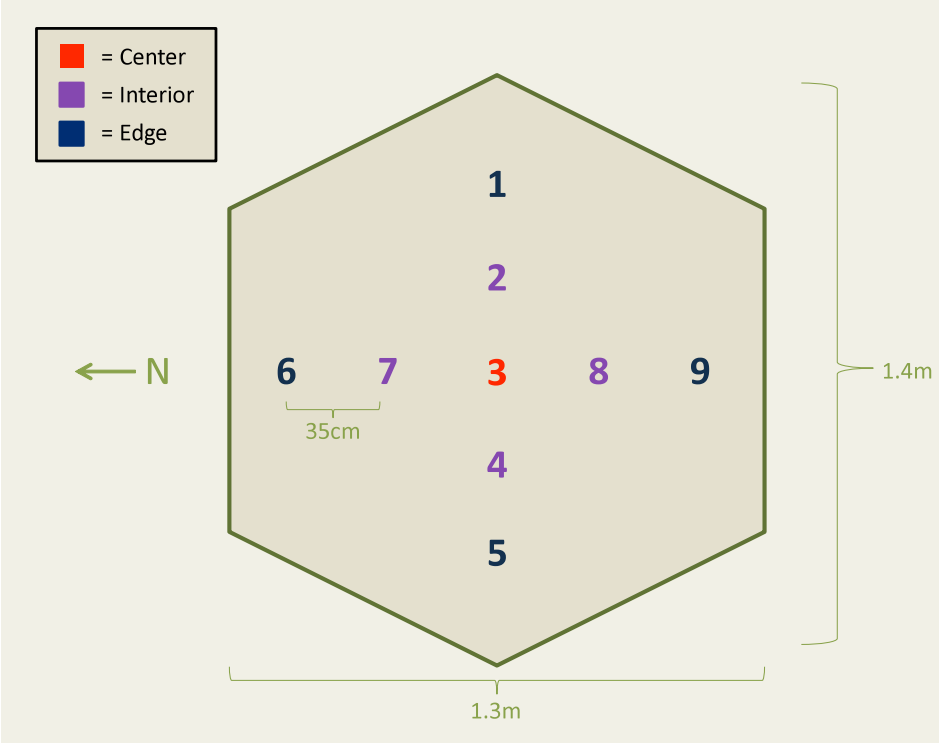


WP2 – Open-top chambers (OTCs)

Pilot experiment



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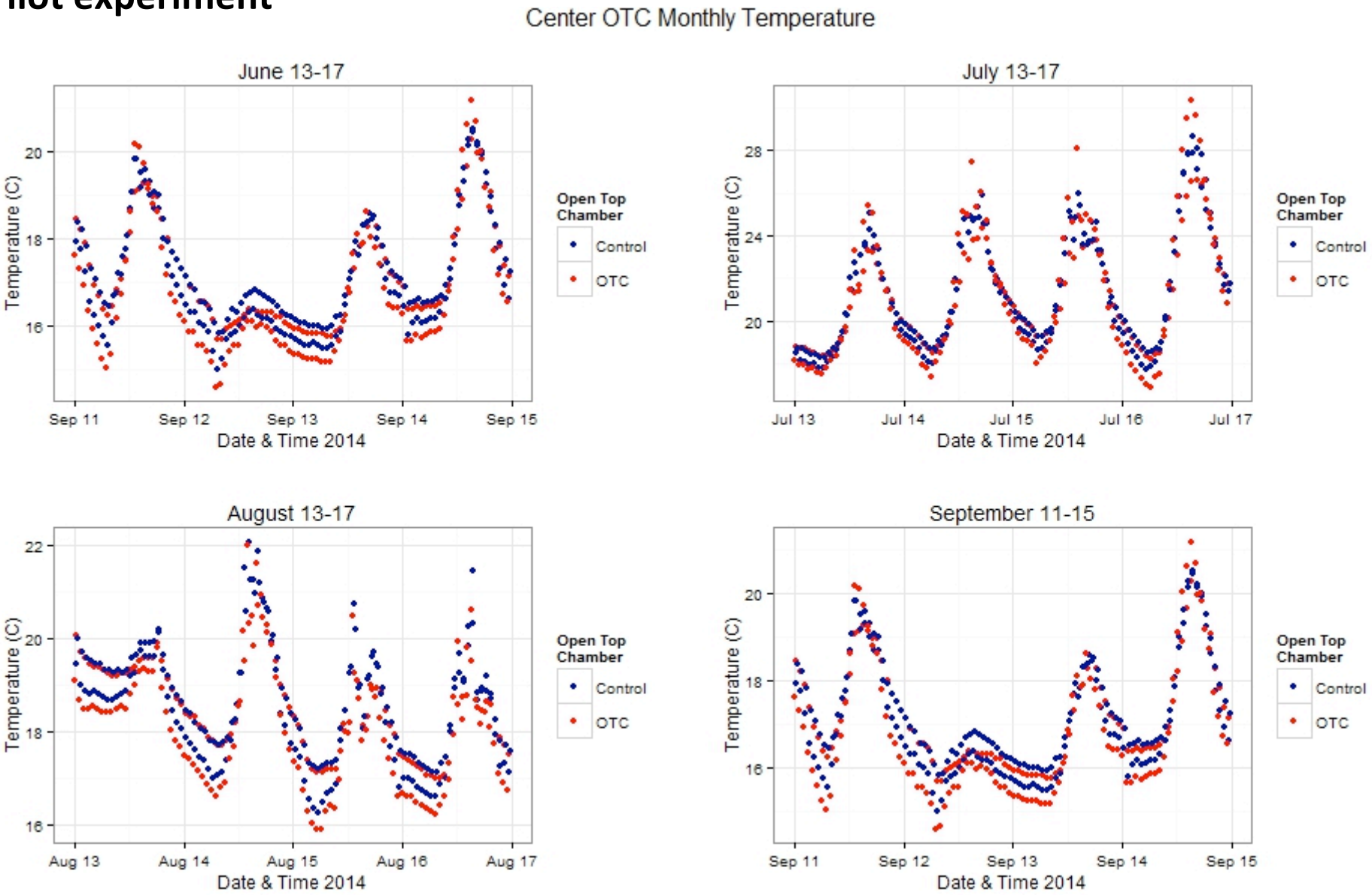

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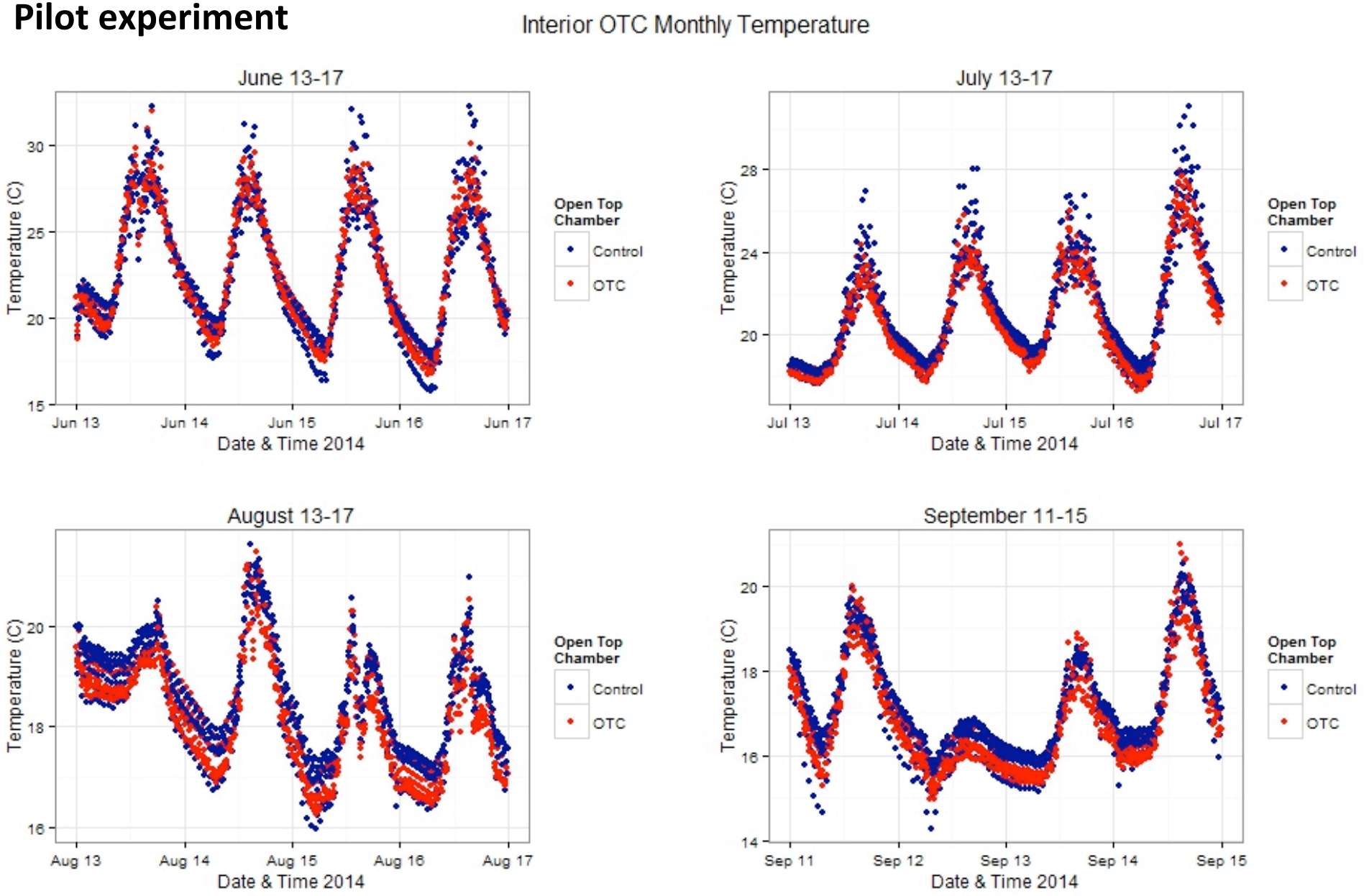

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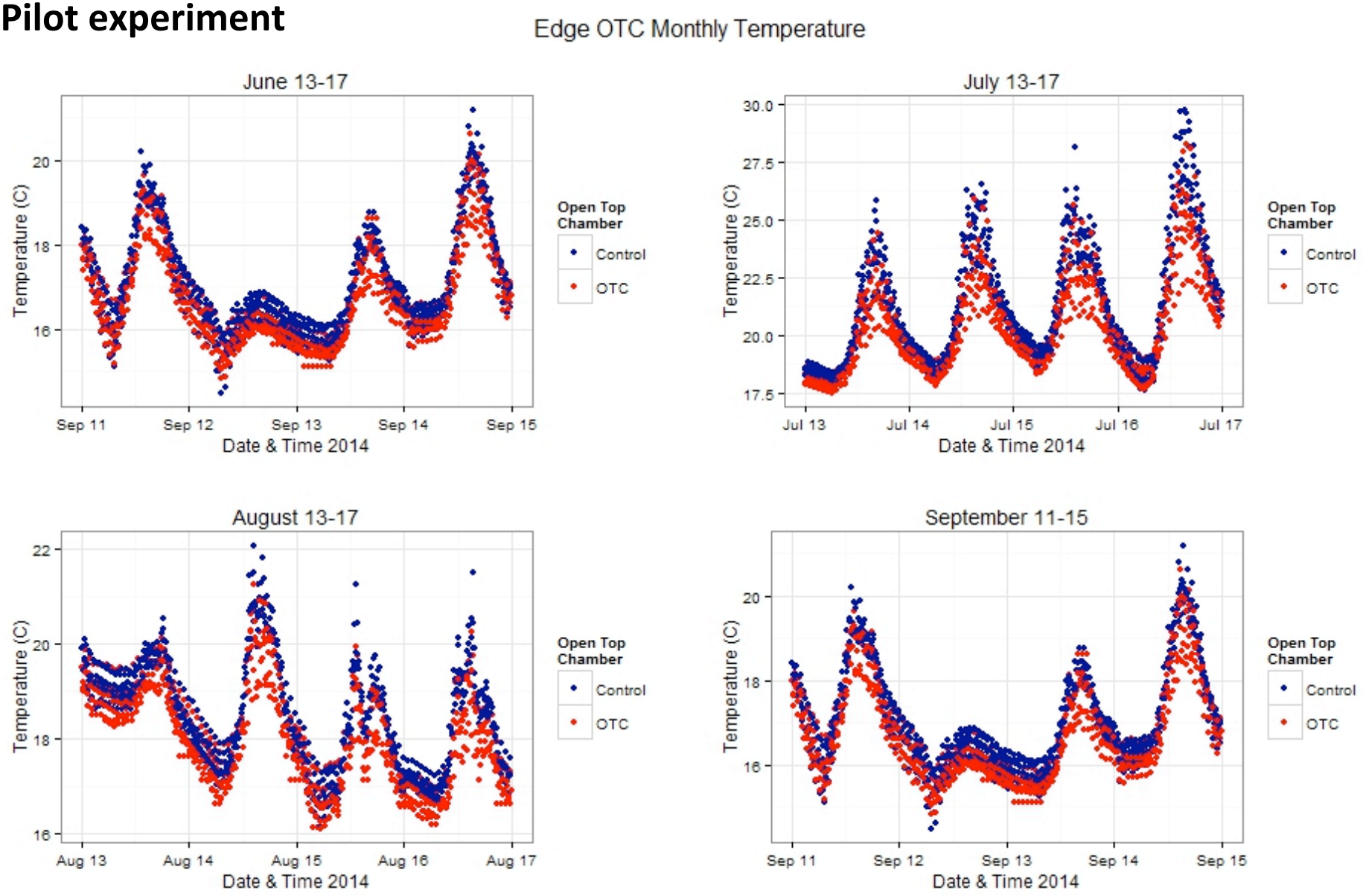
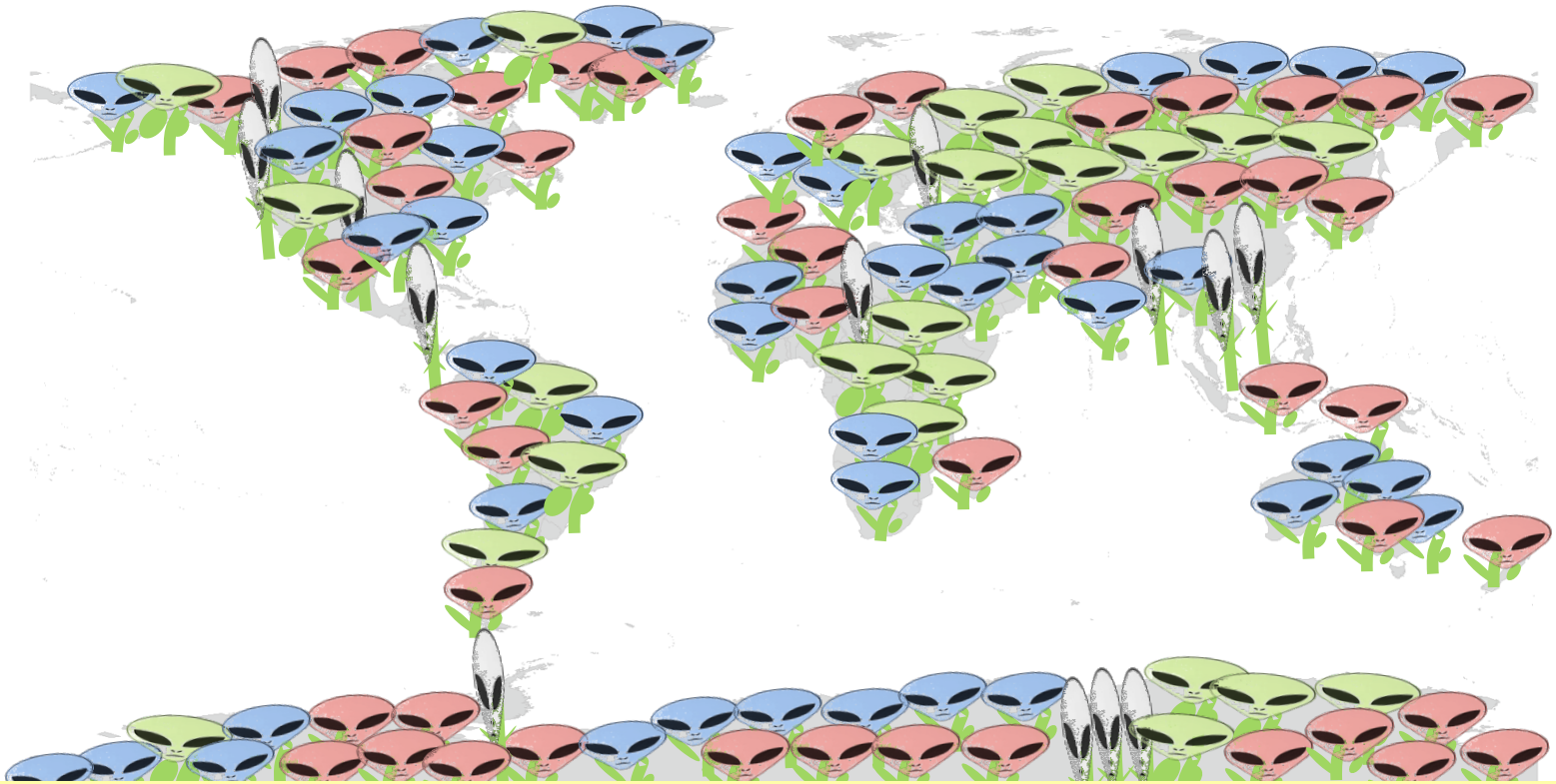


The GloNAF Database:
Patterns in the Global Naturalized Alien Flora



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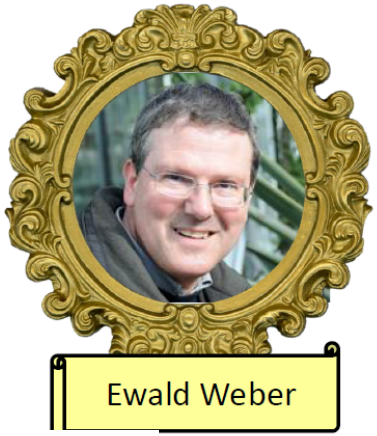
GloNAF core team


Petr Pyšek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Wayne Dawson


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Franz Essl

Island people

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Maria Schulze
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Zoltán Barina
Abida Zeddam
Silvana Masciadri
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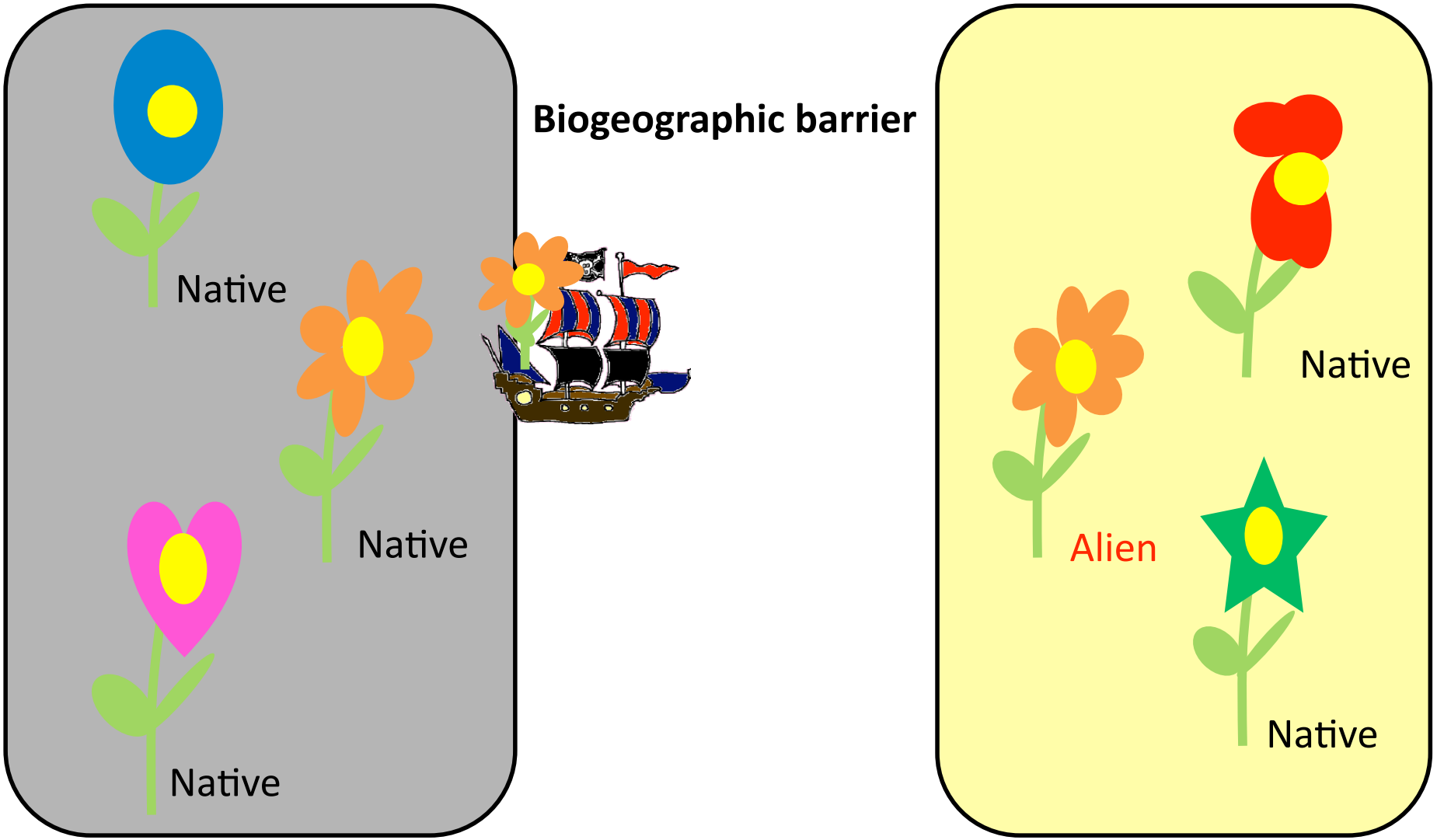
S.R. Majorov
Dietmar Moser
Zuzana Sixtová

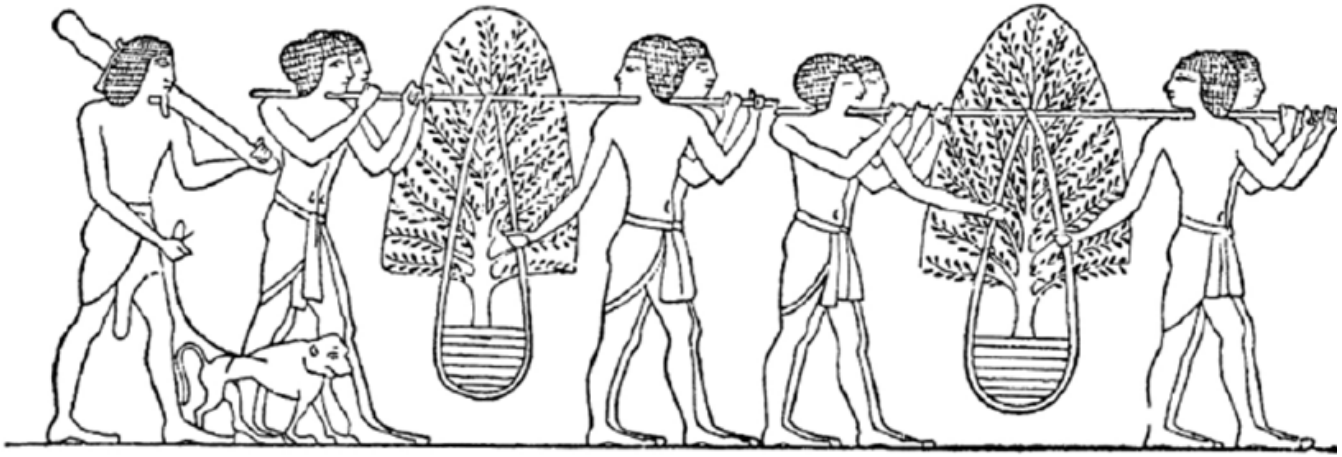
Alien plant species



Richardson et al. 2000 Diversity and Distributions 6:93-107

Anthropogenic break-down of biogeographic barriers

c. 1500 BC



Loading tree saplings on Queen Hatusu's ships. From *Deir el-Bahari* (Edwards 1892).

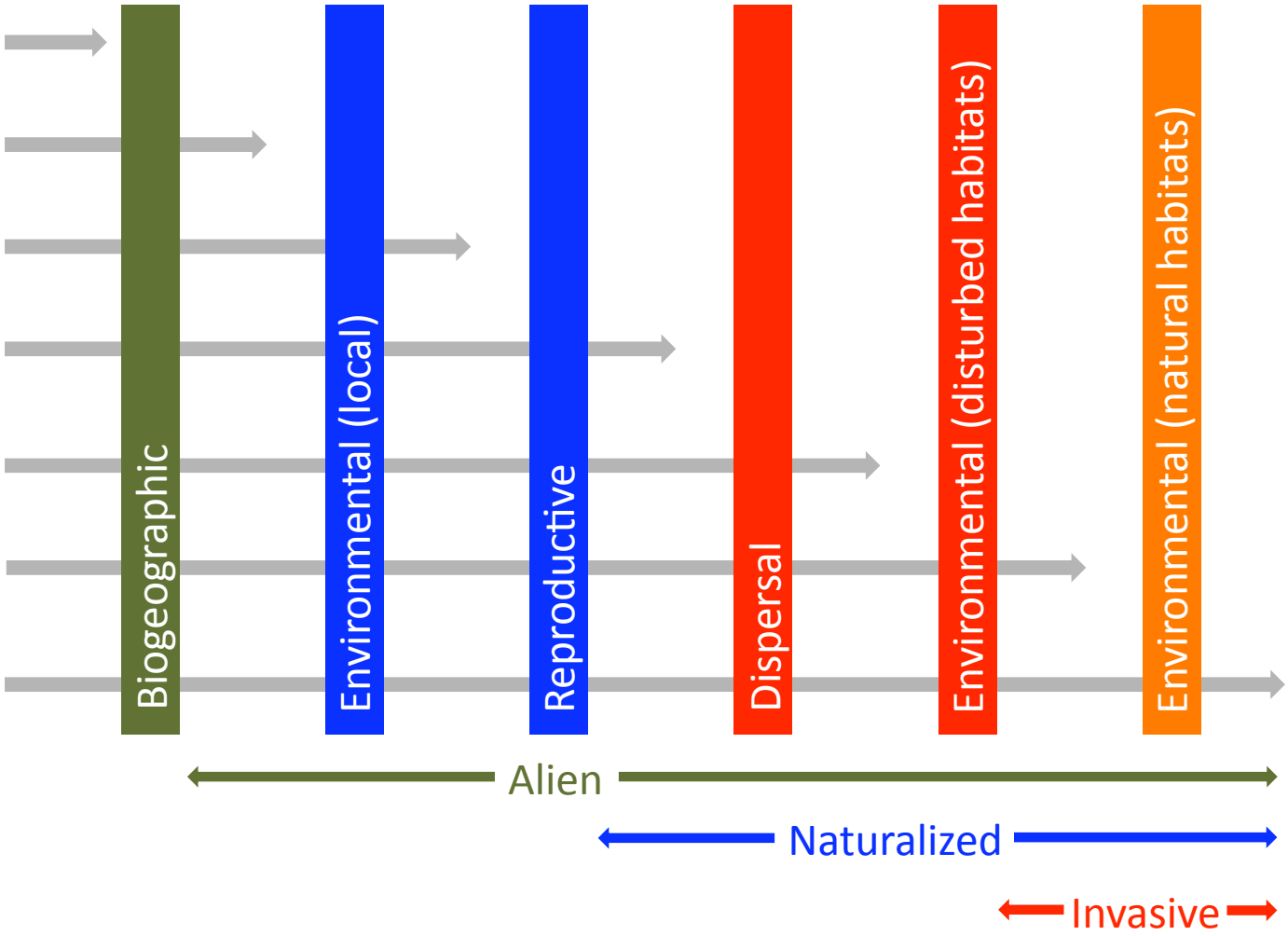
William Dampier
(1651-1715)

Ernest Henry Wilson
(1876-1930)

Ward 2004 The Plant Hunter´s Garden; http://openflights.org/data.html#route

Barriers during the invasion process

Few of the introduced aliens naturalize.



After Richardson et al. 2000 Diversity and Distributions 6:93-107; also see Blackburn et al. 2011 Trends in Ecology & Evolution 26:333-339

The questions

What are the global patterns?

- Which species are the **most widely naturalized** around the globe?
- Which **families are overrepresented**, and which ones are underrepresented?
- Which continent is **the major sink** of naturalized species?
- Which continent is **the major source** of naturalized species?
- How **similar are the naturalized floras** of different regions?
- What is the role of **horticultural usage**?

Compiling GloNAF

Data sources

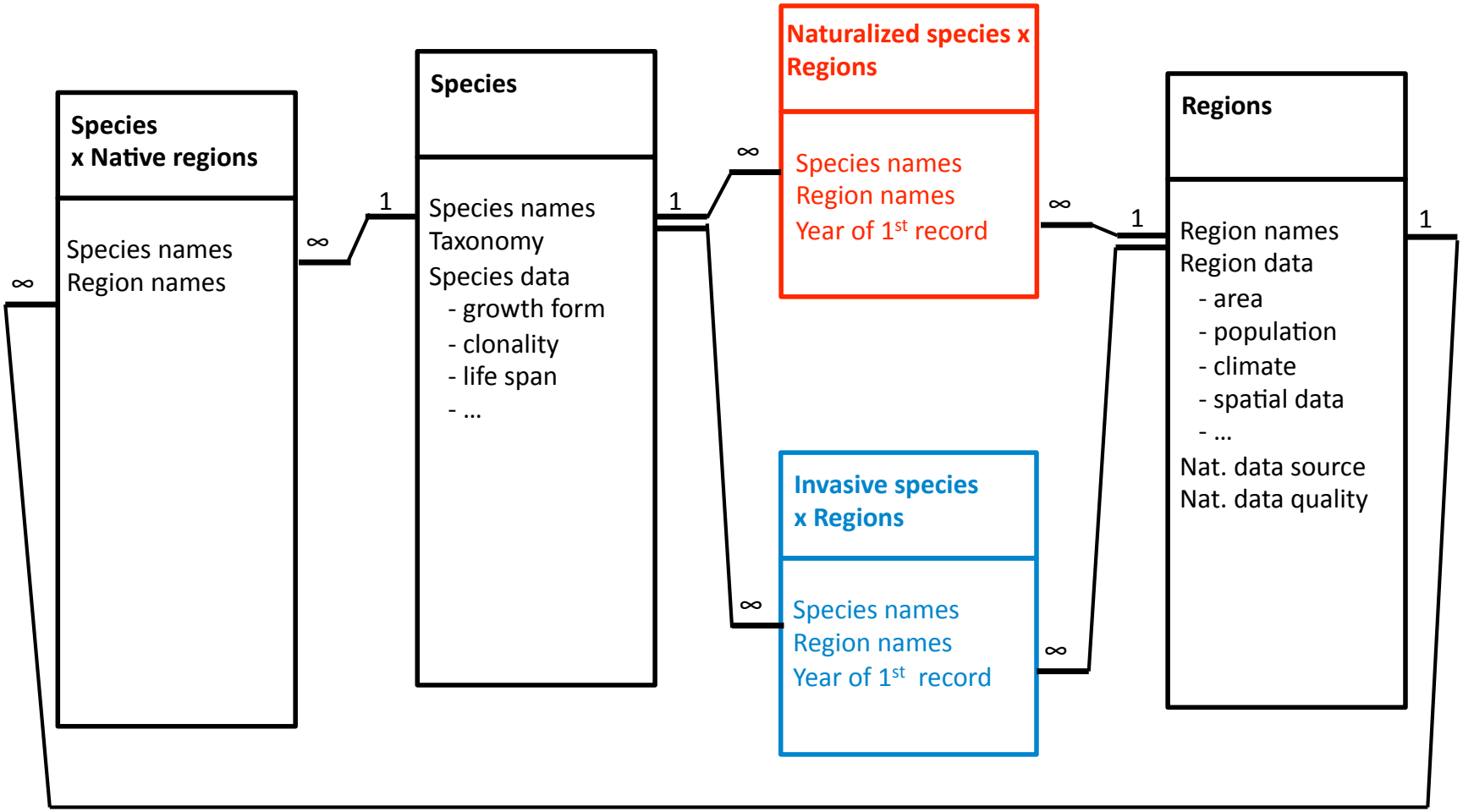
- Existing naturalized alien plant compendia (e.g. DAISIE)
- Regional or national alien plant lists (e.g. Madagascar)
- Floral compendia including aliens (e.g. BONAPI, the Plants of Africa))
- Online floras including aliens (e.g. Brazil)
- Flora books including aliens (e.g. New Caledonia)
- Species lists compiled specifically for GloNAF (e.g. Indian and Chinese provinces)

Taxonomic standardization

- The Plant List
- R-package Taxonstand
- GRIN, Google, …

Ultimate database structure of GloNAF

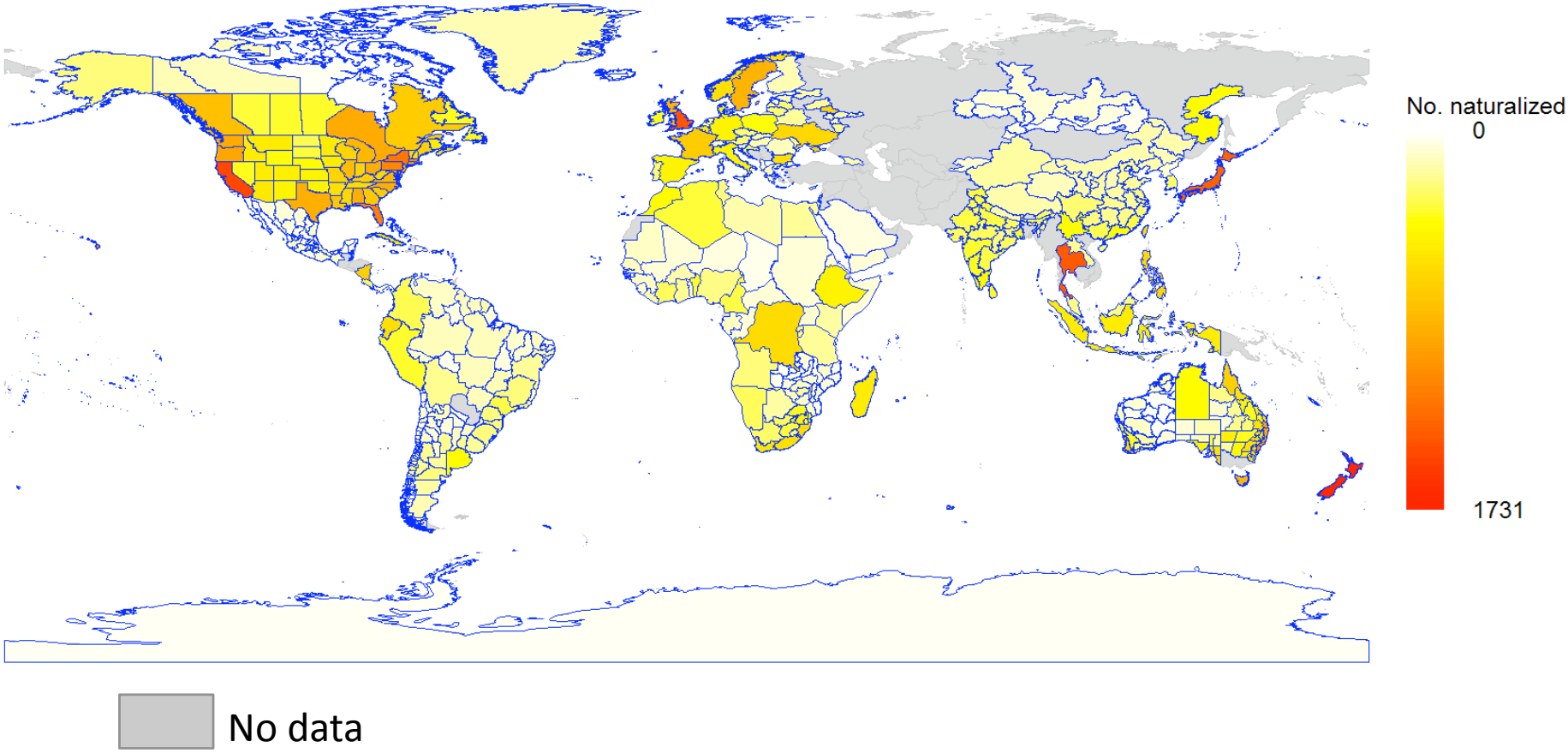
Access database



van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

The current GloNAF coverage

12’413 vascular plant taxa (11’634 species)
827 non-overlapping regions

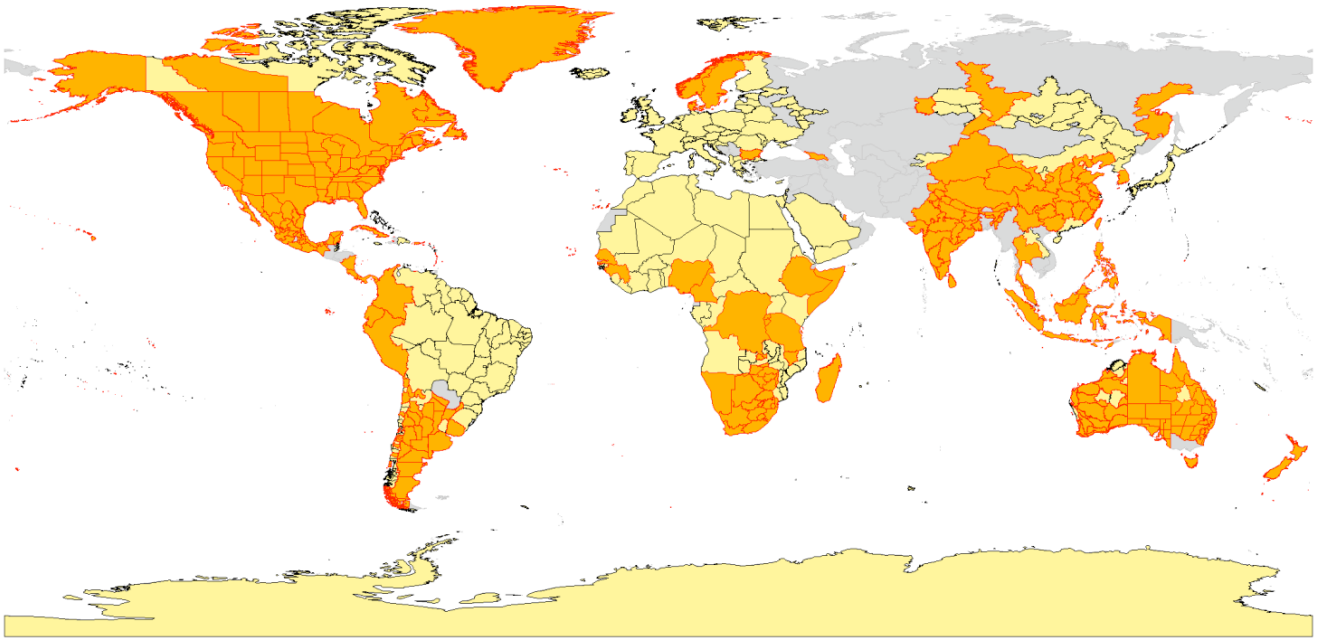


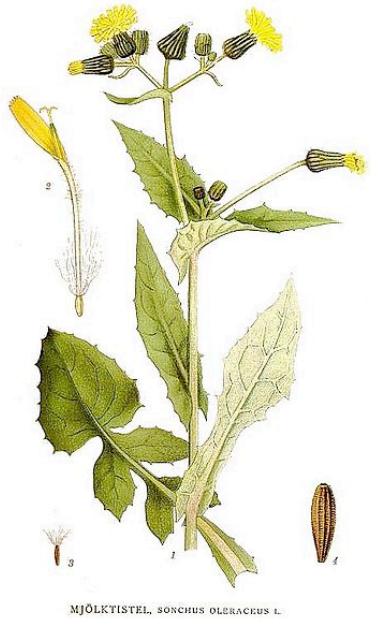
van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

The most widely naturalized species

Sonchus oleraceus (L.) L.

393 of the 827 GloNAF regions





http://commons.wikimedia.org/

GloNAF regions in which species has naturalized

GloNAF regions in which species is not known to have naturalized

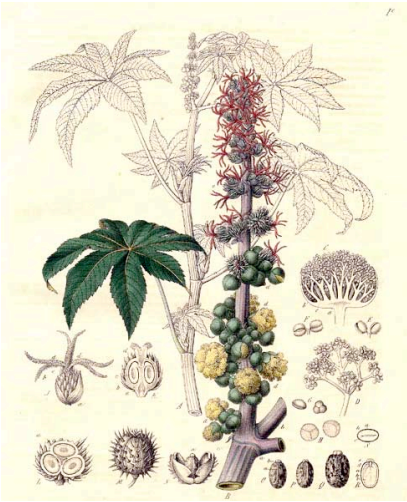
No data

van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

The most widely naturalized species

The top ten

Rank	Species	No. GloNAF regions (total: 827)
1	*Sonchus oleraceus* (L.) L.	393
2	*Ricinus communis* L.	366
3	*Eleusine indica* (L.) Gaertn.	302
4	*Chenopodium album* L.	295
5	*Capsella bursa-pastoris* (l.) Medik.	294
6	*Stellaria media* (L.) Vill.	273
7	*Echinochloa crus-galli* (L.) P. Beauv.	264
8	*Datura stramonium* L.	263
9	*Oxalis corniculata* L.	260
10	*Poa annua* L.	255



Ricinus communis L.

http://www.meemelink.com/prints_pages/21904.Ricinus.htm

Eleusine indica (L.) Gaertn.

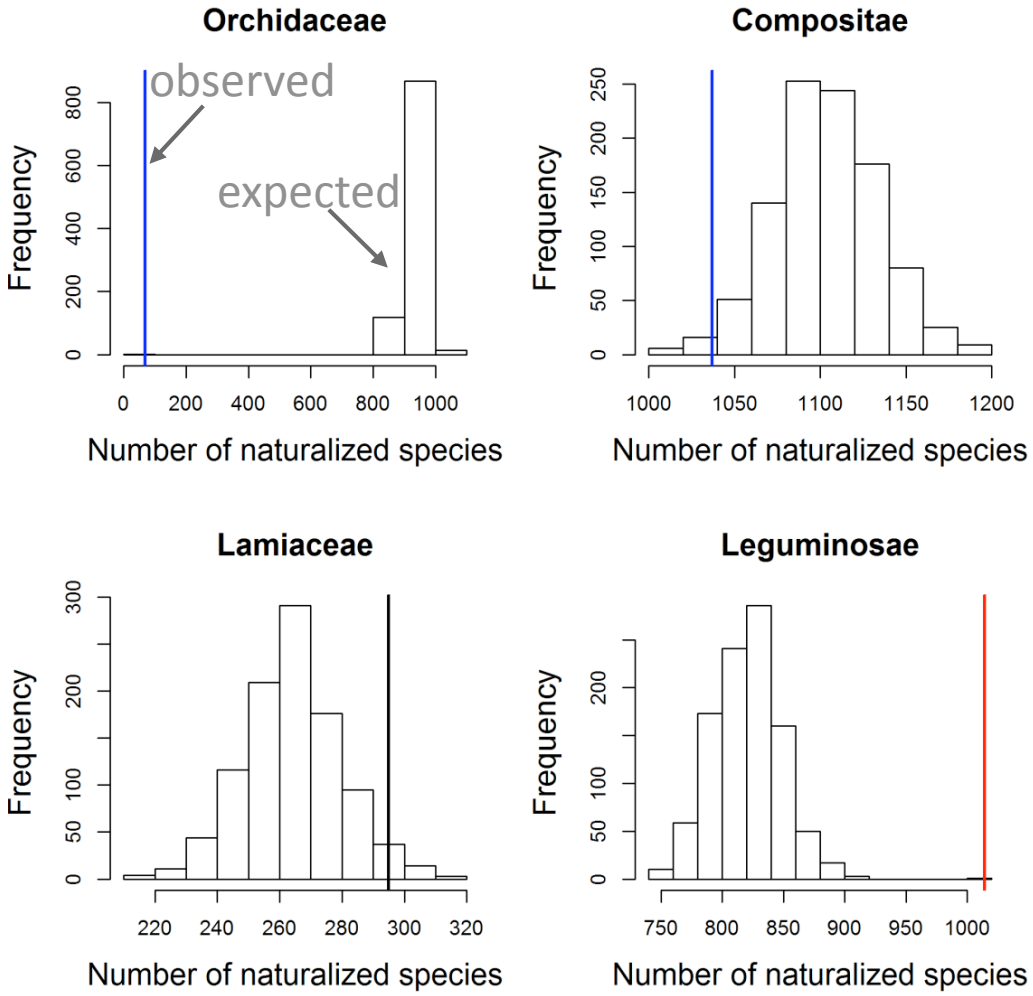
http://pages.wustl.edu/peblabguide/articles/1122

van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

Naturalized species among vascular plant families

Observed and expected numbers of naturalized species per family

Histograms of randomization results and observed values for a subset of families



More than expected

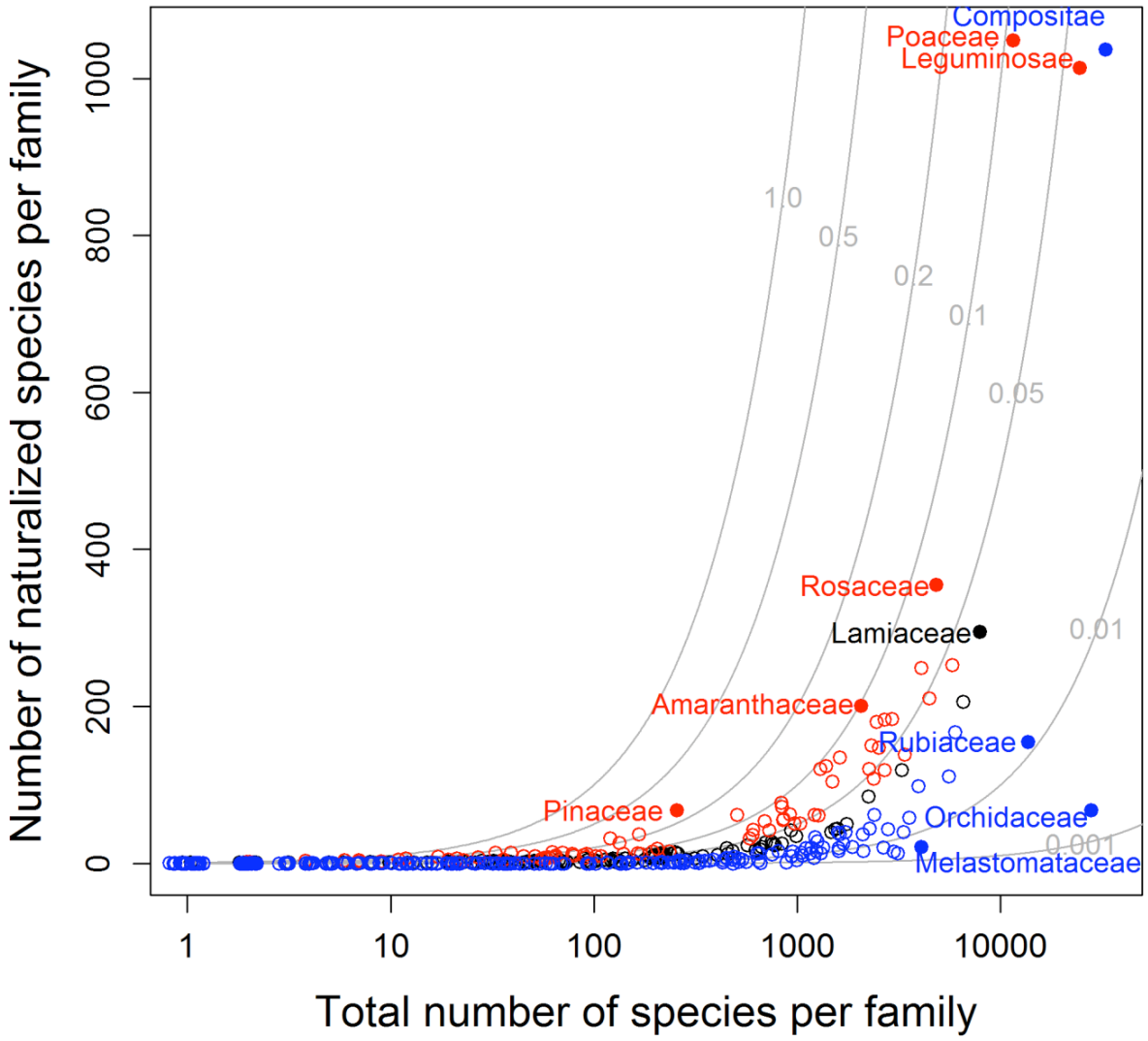
As expected

Fewer than expected

van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

Naturalized species among vascular plant families

10’580 out of 316’136 accepted vascular plant species (3.3%)

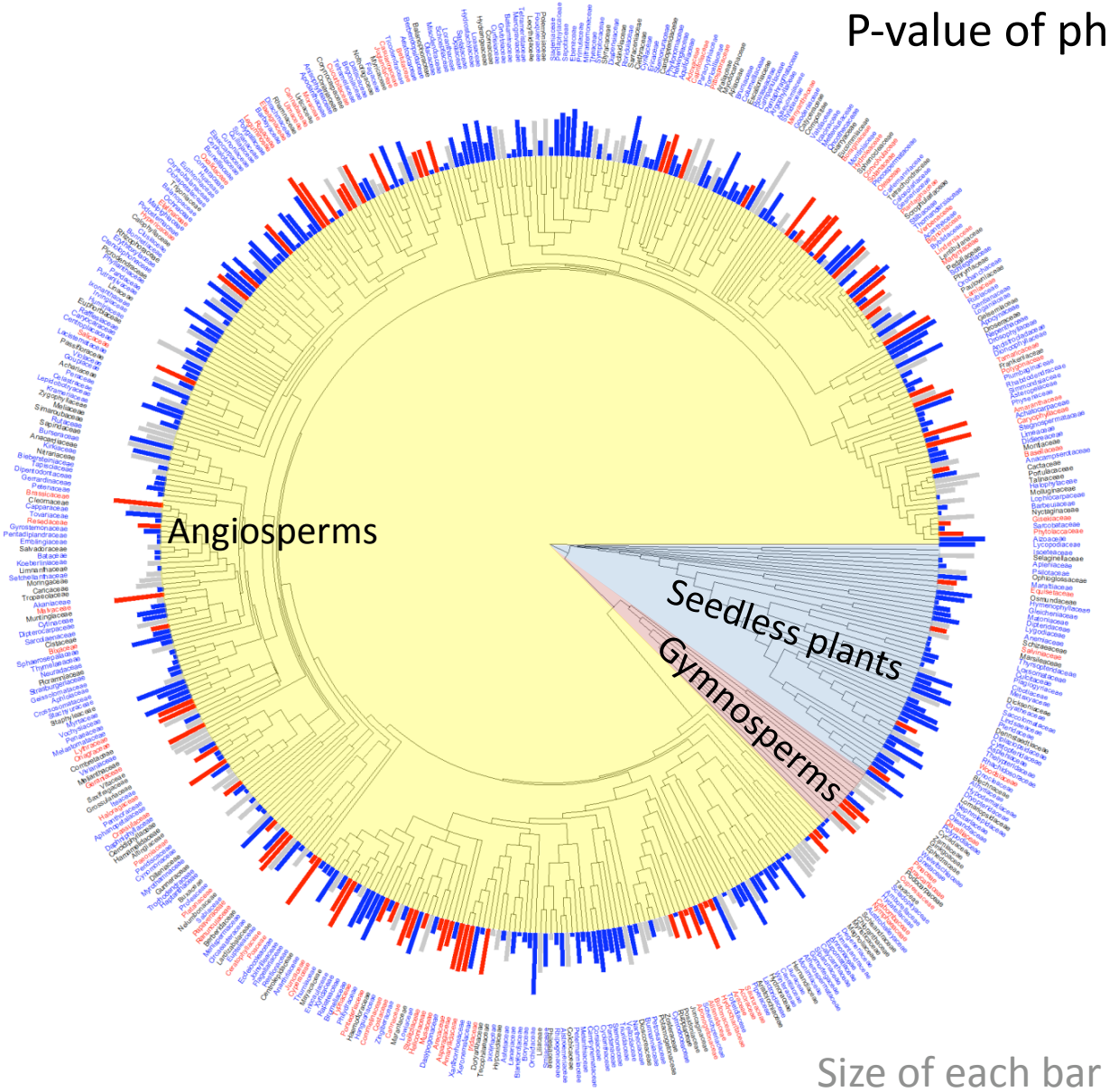


- More than expected
- As expected
- Fewer than expected

van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

Naturalized species among vascular plant families

P-value of phylogenetic signal: 0.0550



More than expected

As expected

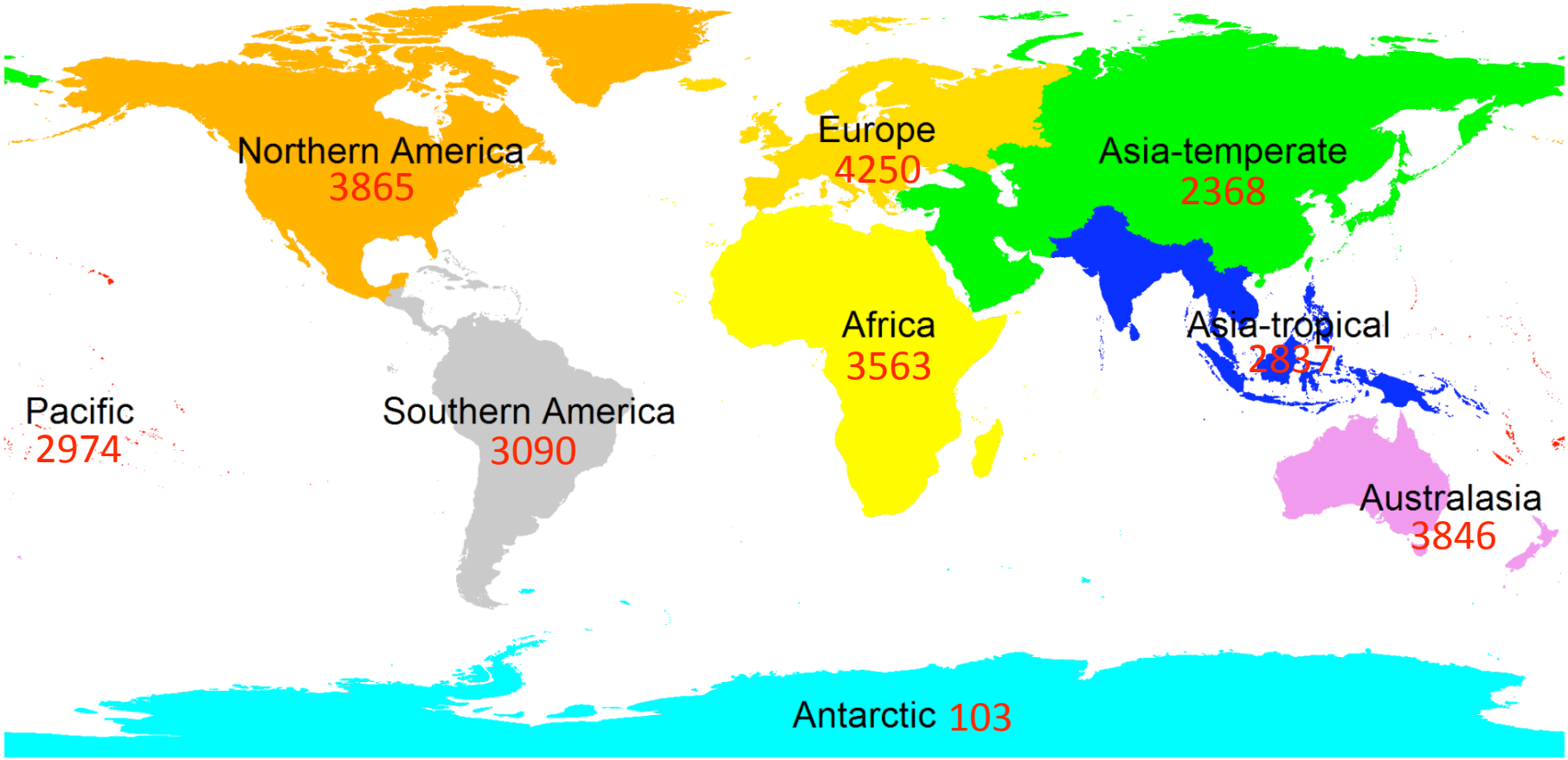
Fewer than expected

Size of each bar indicates the size of the family

van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

Number of naturalized taxa per TDWG continent

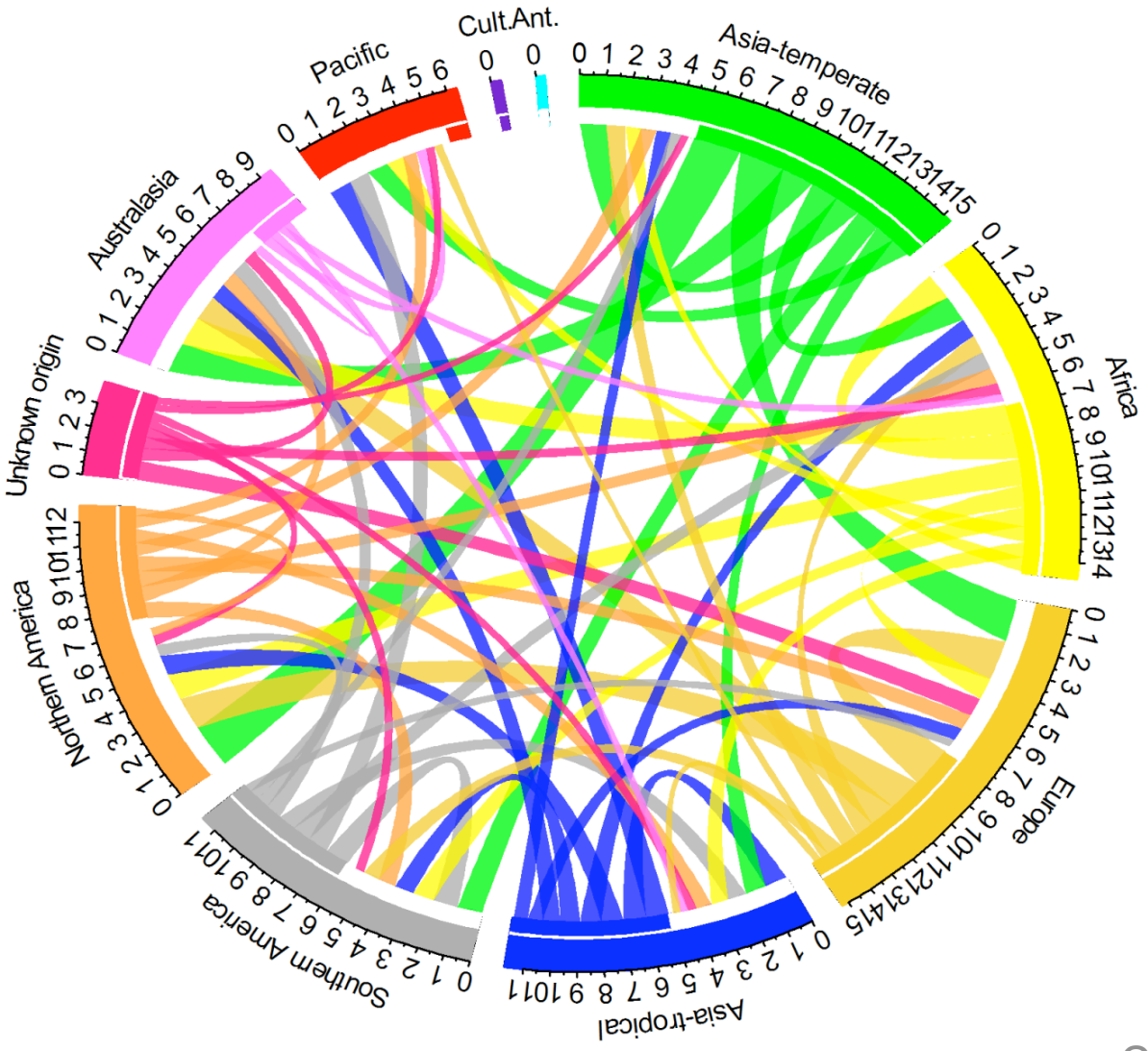
Europe is the largest sink for naturalized taxa.



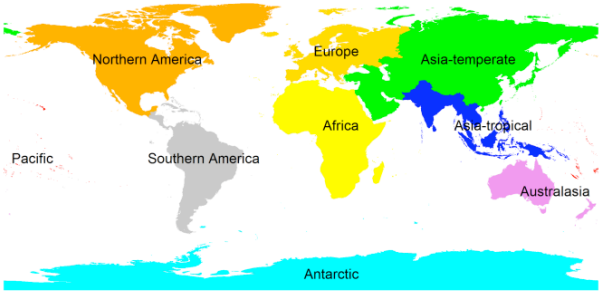
van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

The global flow of naturalized taxa

Asia-temperate is the major donor of naturalized taxa (preliminary result)



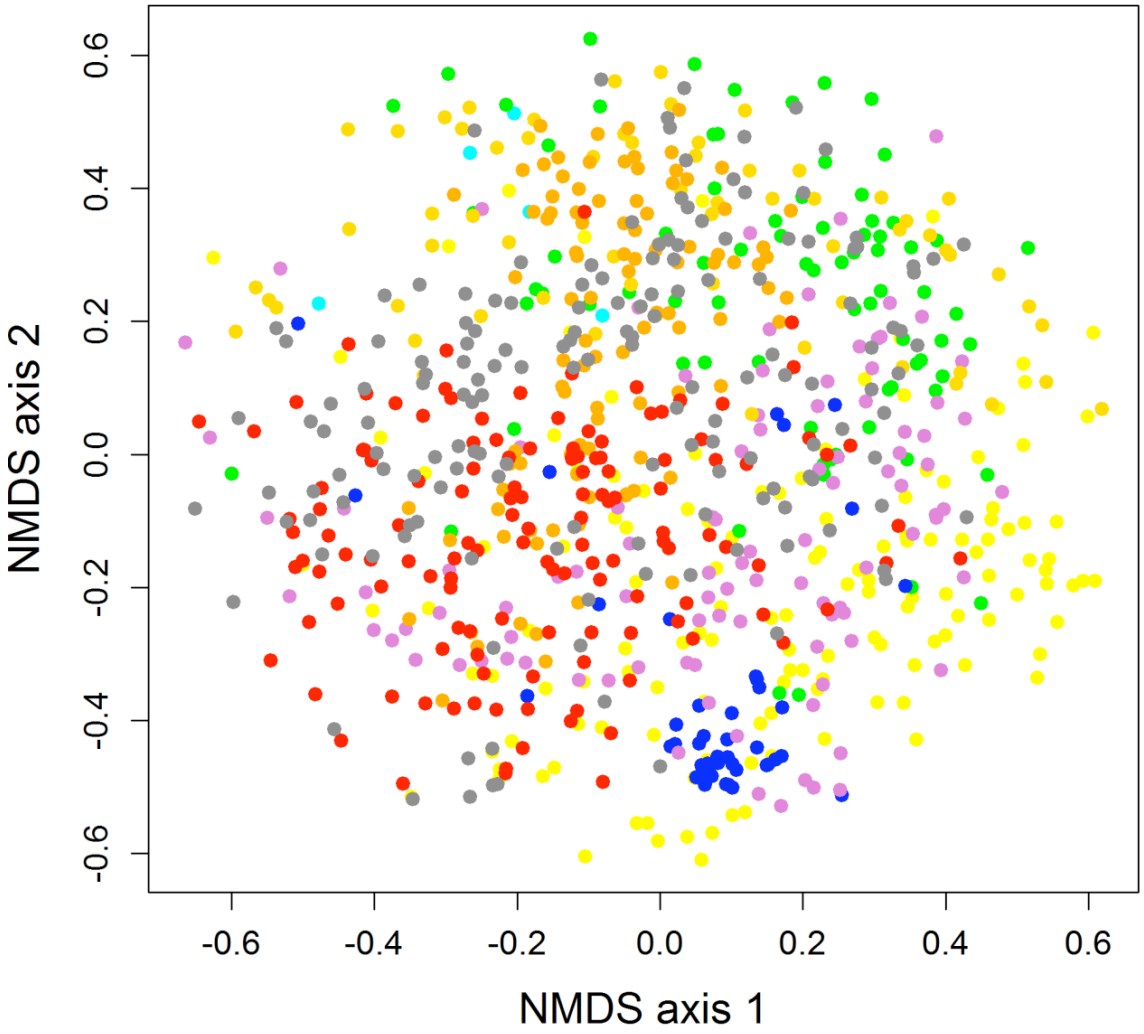
TDWG continents



Only top 50% of flows are shown.

Similarity in composition of the naturalized floras

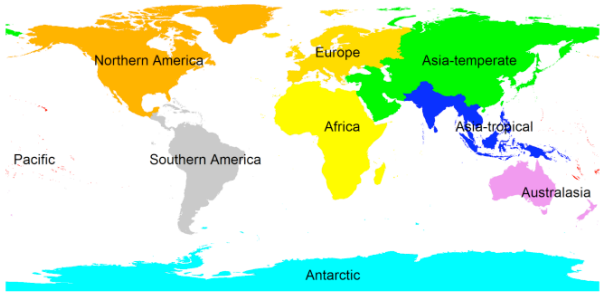
NMDS axis 1 and 2 values for each of the 827 GloNAF regions



Permanova for TDWG continent

$F_{8,818} = 14.65$, $P < 0.001$

TDWG continents



NMDS-analysis

Jaccard-dissimilarity matrix

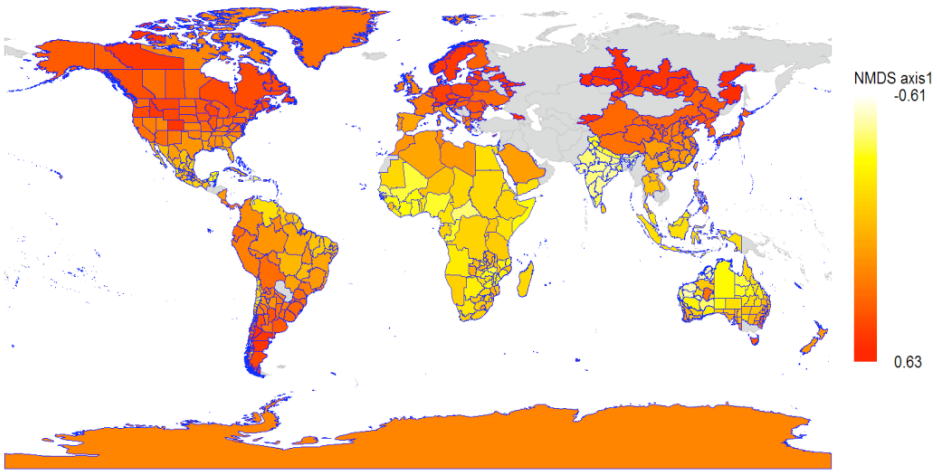
6 dimensions

Stress = 0.195

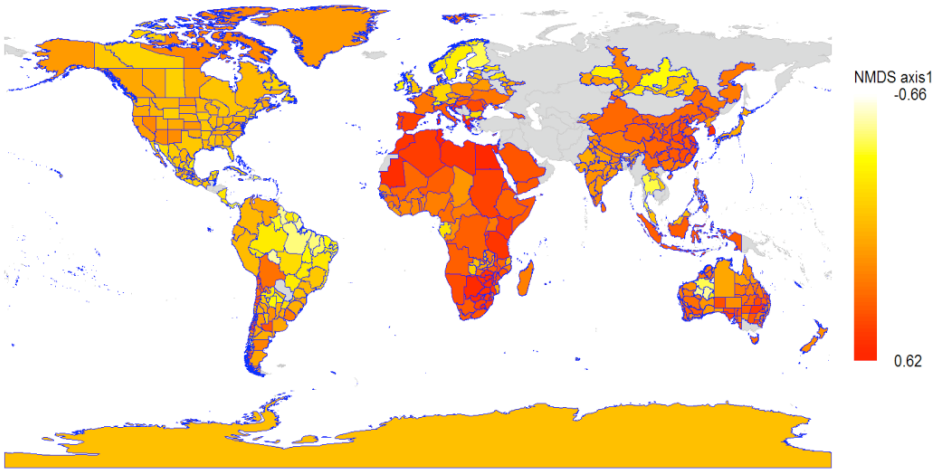
van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

Similarity in composition of the naturalized floras

NMDS axis 1



NMDS axis 2



NMDS-analysis

Jaccard-dissimilarity matrix

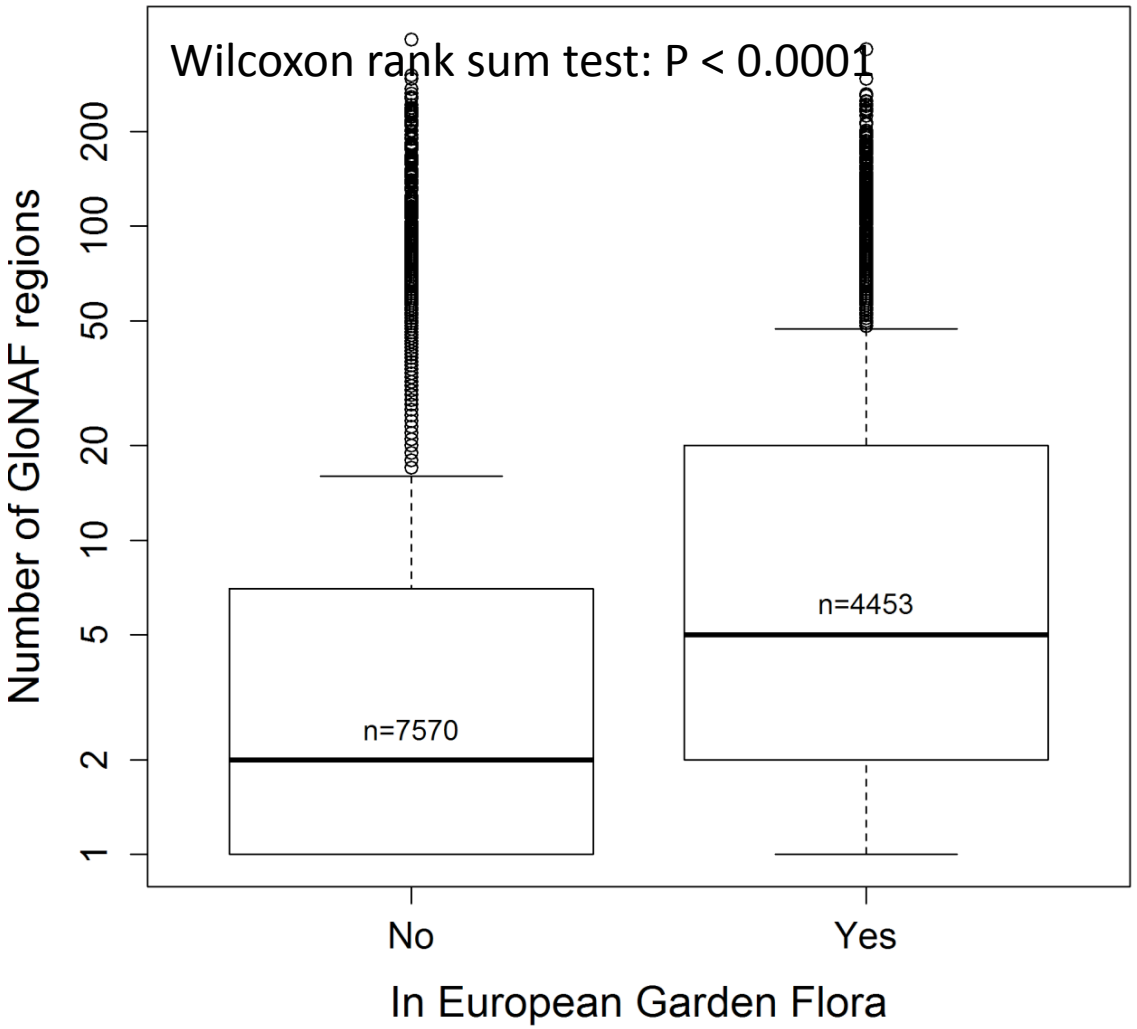
6 dimensions

Stress = 0.195

van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

International horticultural usage

At least **37.0%** of GloNAF **angiosperm** taxa (96.8% of all GloNAF taxa) are used **in international horticulture**.



van Kleunen, Essl, Pergl, Winter, Dawson, Weber, Pyšek et al., *in preparation*

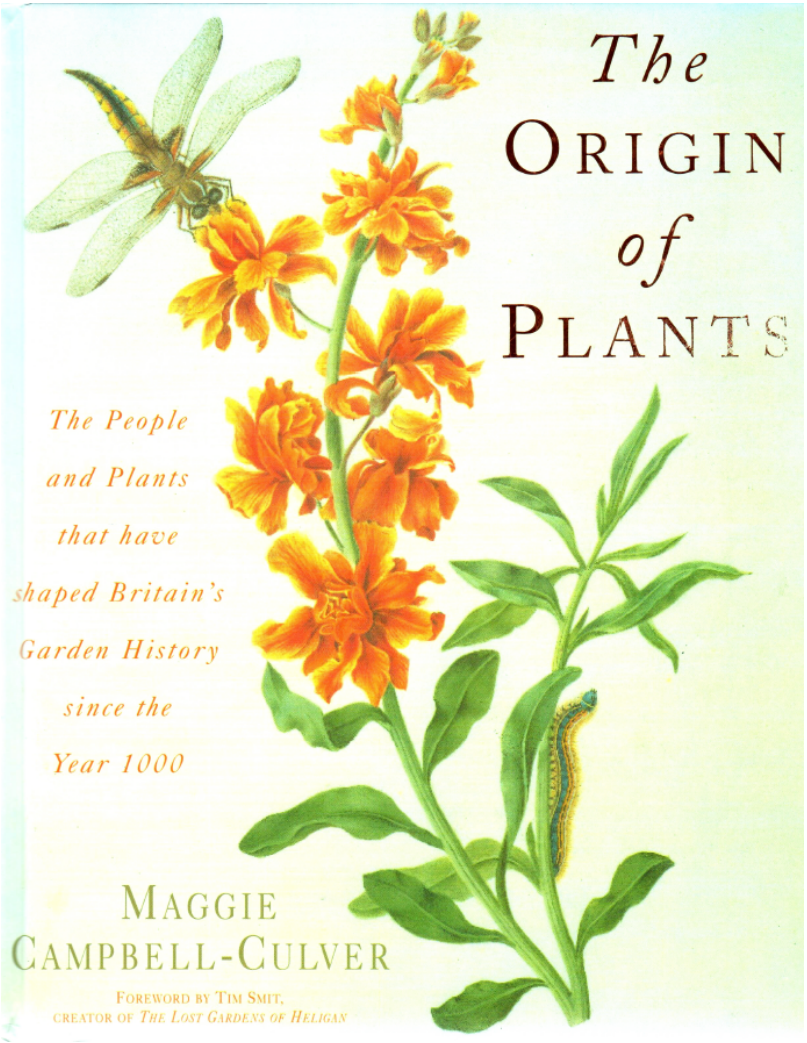
Conclusions

GloNAF revealed

- The top10 naturalized species is led by *Sonchus oleraceus*.
- Overrepresented families are found spread across the whole vascular family tree, with a weak phylogenetic signal.
- Europe is the largest sink of naturalized taxa.
- Asia-temperate is the major source of naturalized taxa.
- There are significant differences among continents in the composition of their naturalized floras.
- Angiosperm species used in horticulture are more widely naturalized.

Ornamental plant introduction data

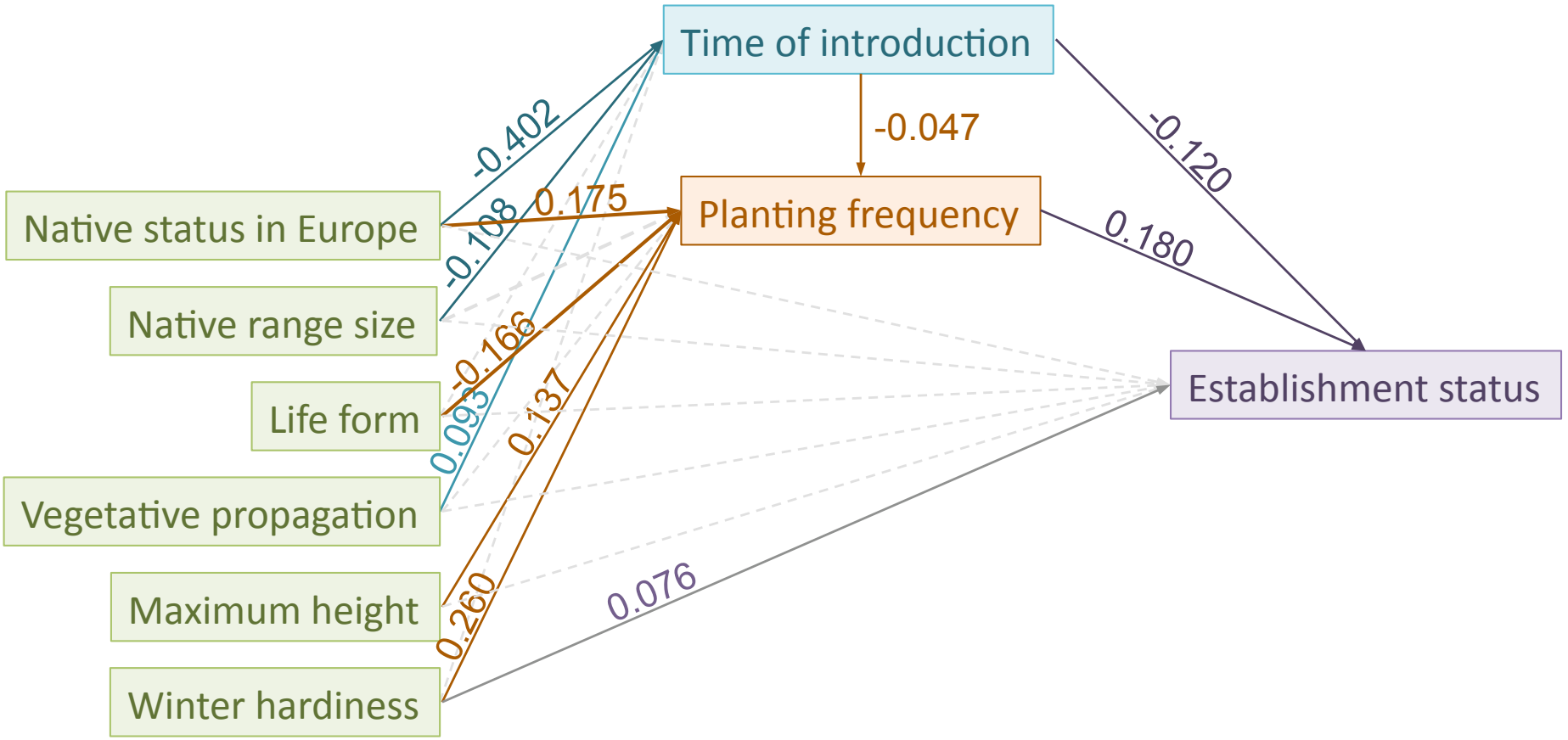
Compilations of data on historical plant introductions



Maurel et al. *in preparation*

Test for an introduction bias

Data on introduction of 469 ornamental species in Central Europe

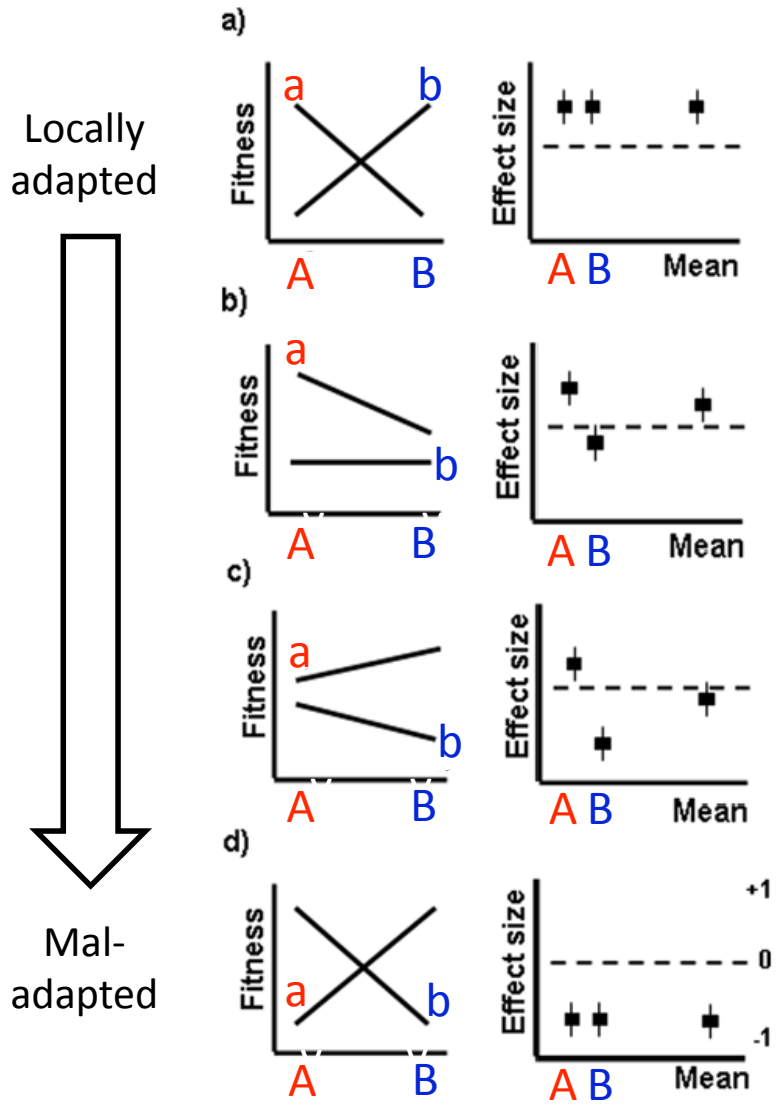


There is an introduction bias.

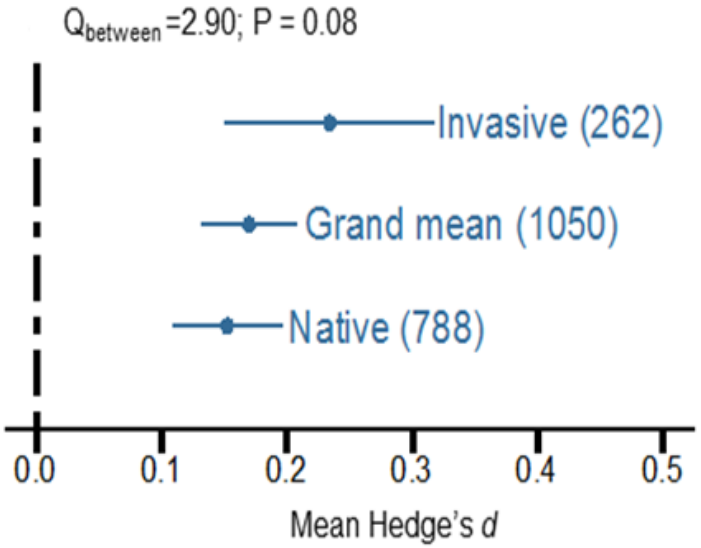
► Many species characteristics are only indirectly related to establishment success.

Local adaptation of natives and invasives

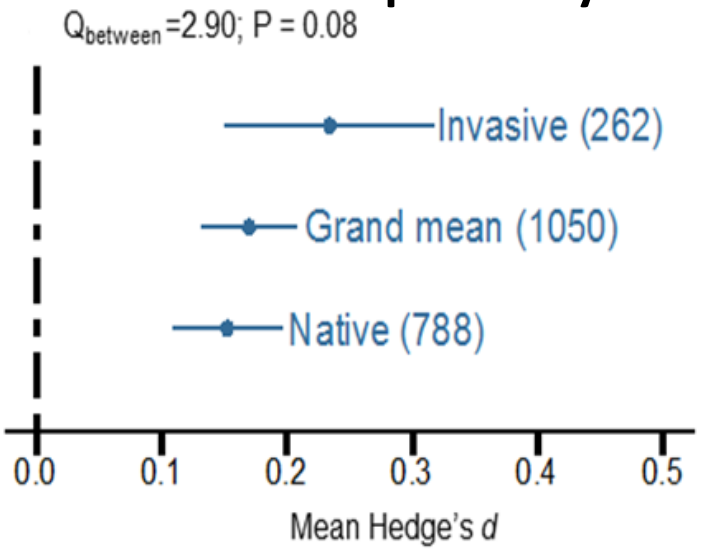
Meta-analysis of reciprocal transplants



Across all population pairs



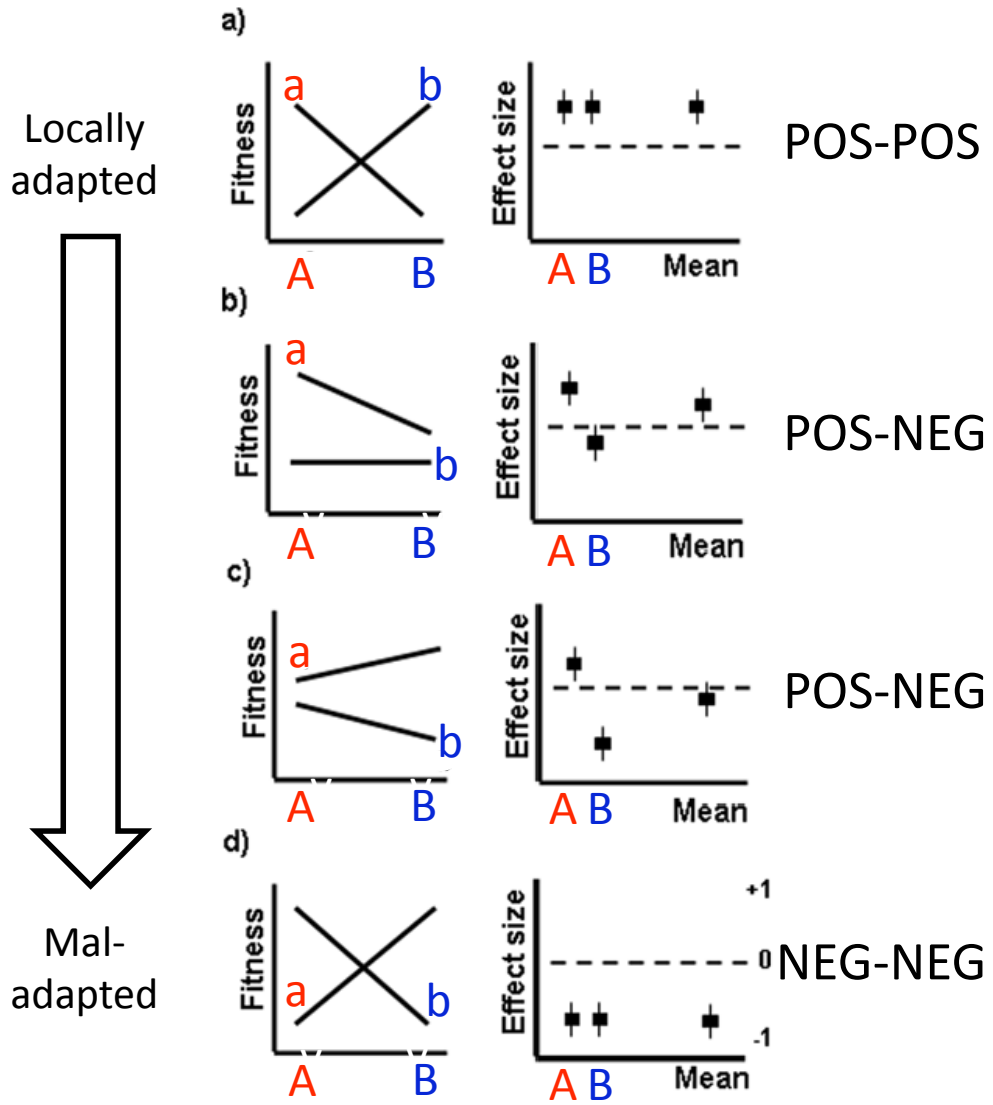
Combined per study

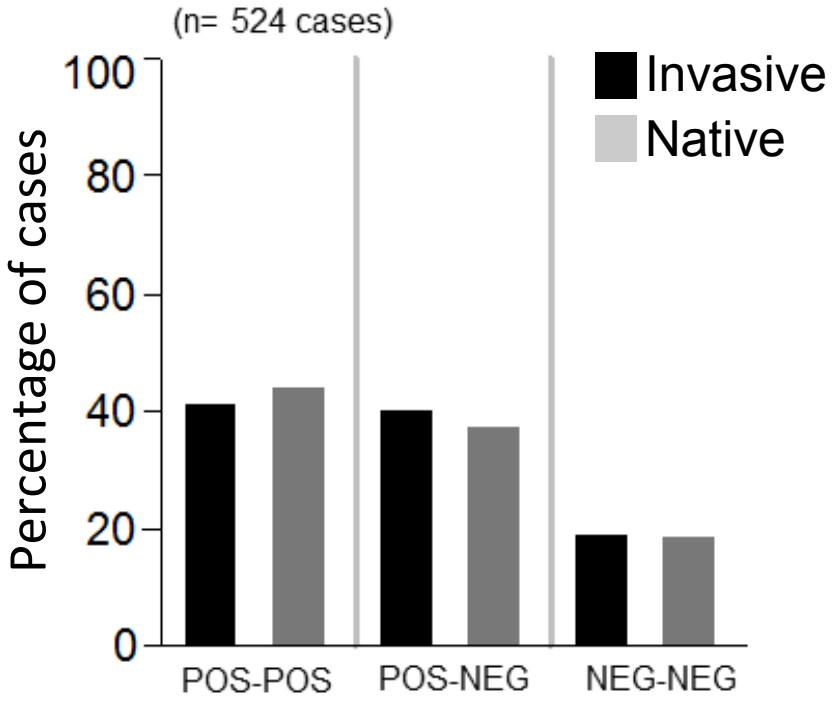


Leimu & Fischer 2008 PLoS One 3:e4010; Oduor et al. *submitted*

Local adaptation of natives and invasives

Meta-analysis of reciprocal transplants





Invasive species show similar degrees of local adaptation as native species do.

Leimu & Fischer 2008 PLoS One 3:e4010; Oduor et al. *submitted*


BiodivERsA2013-99(WhoIsNext)
Partner 3, Bossdorf, Germany, Tübingen

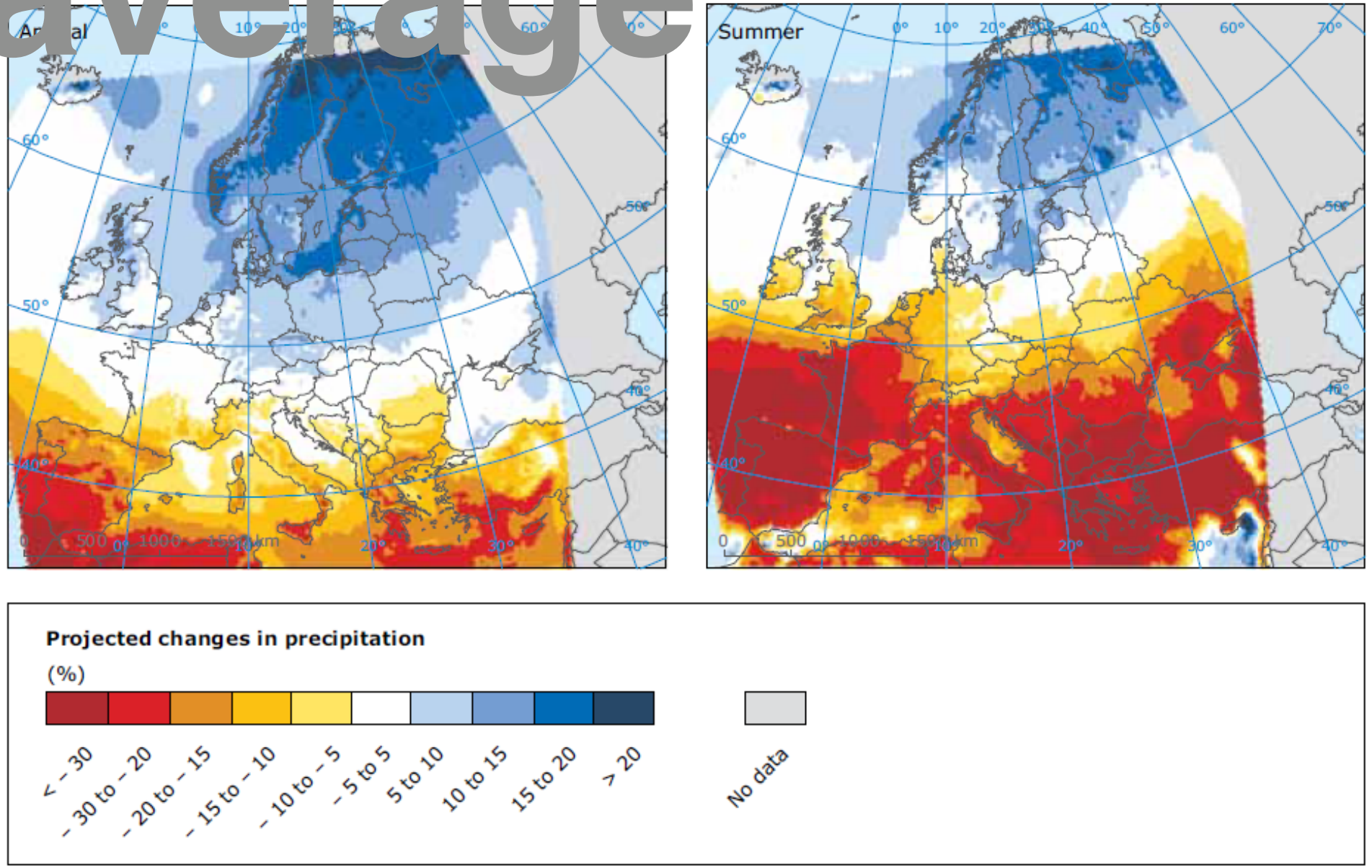
Svenja

Madalin

Oliver

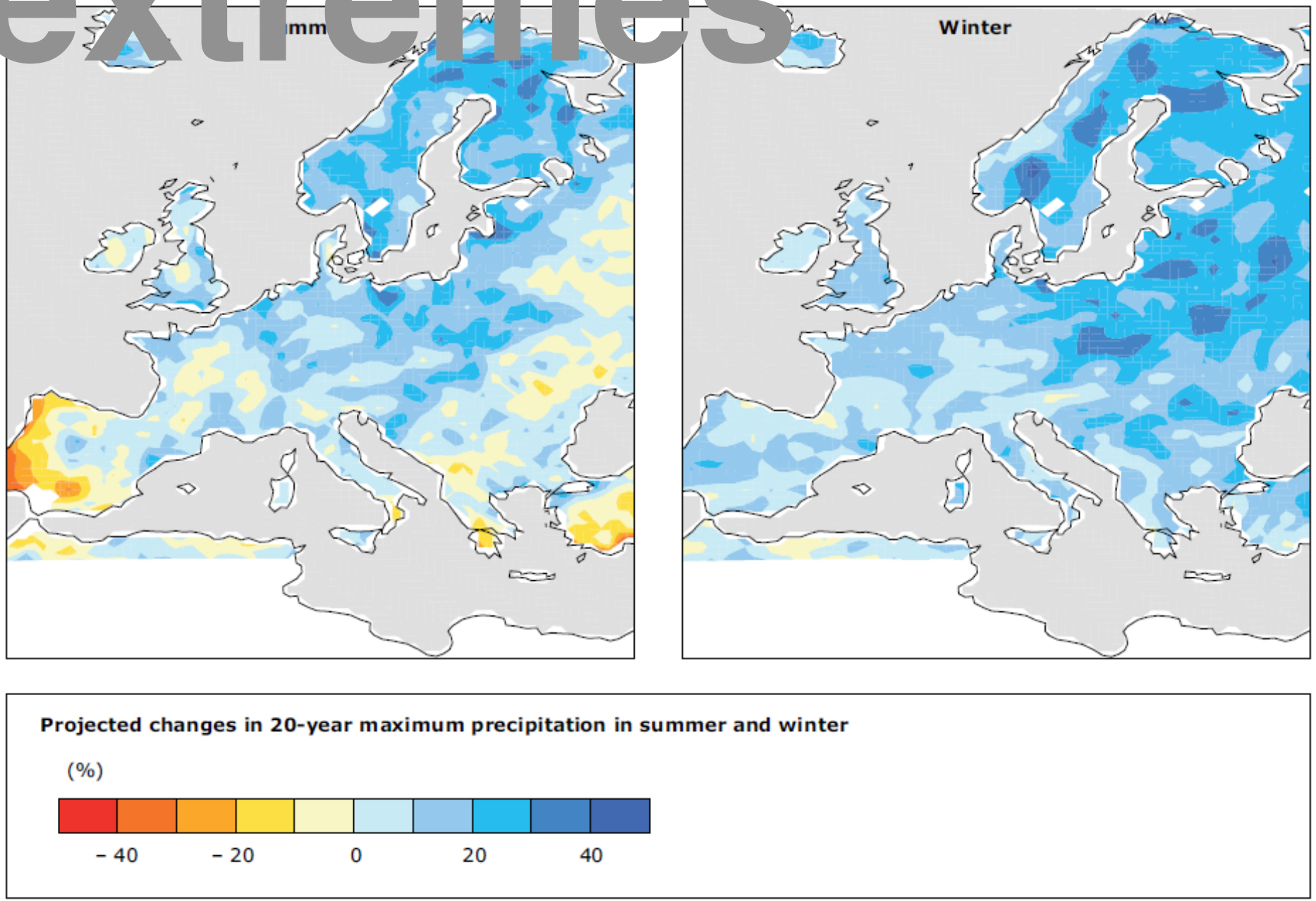
Change in precipitation

average



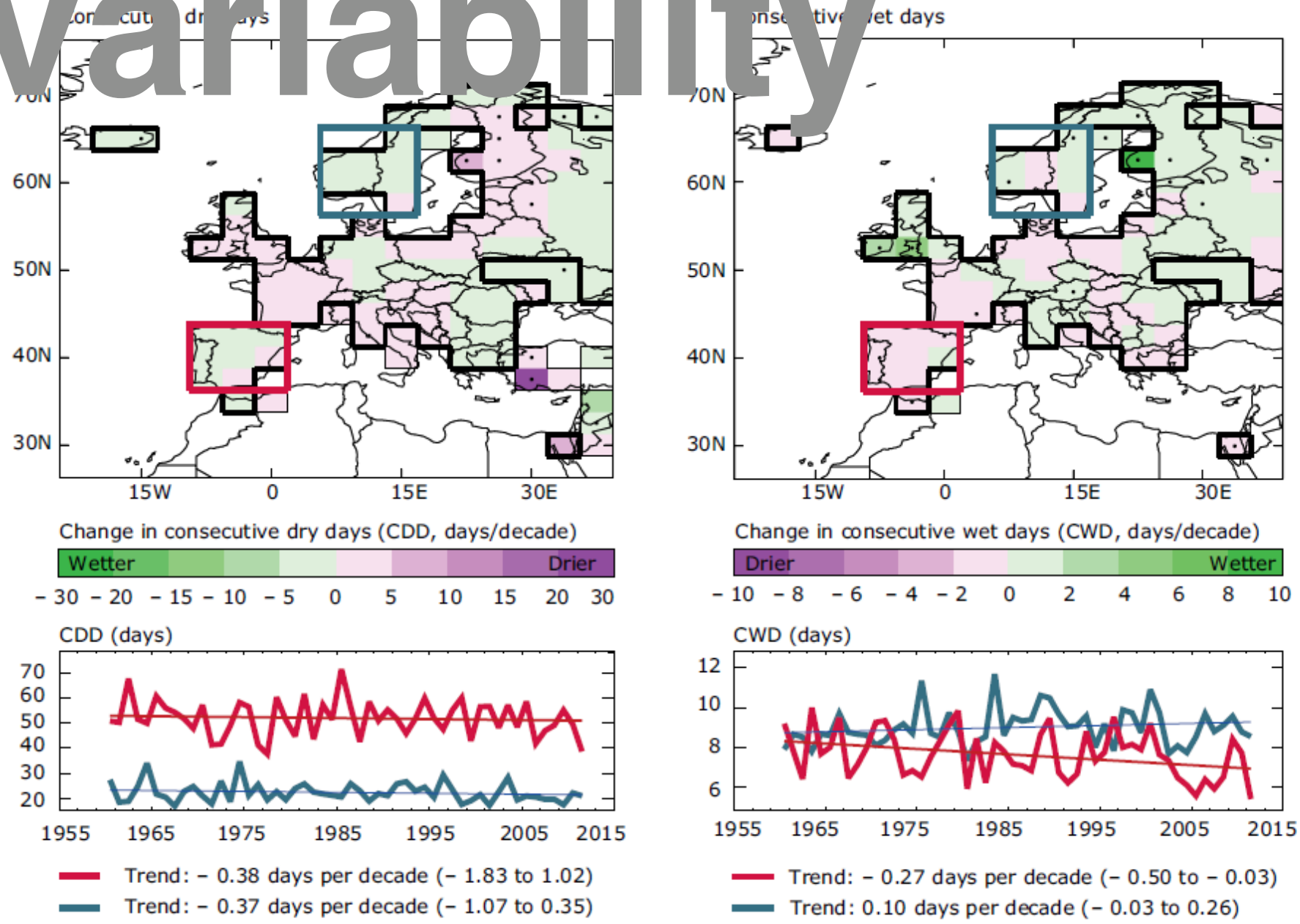
EEA (2012) Climate change, impacts and vulnerability in Europe. EEA Report 12/2012

extremes



EEA (2012) Climate change, impacts and vulnerability in Europe. EEA Report 12/2012

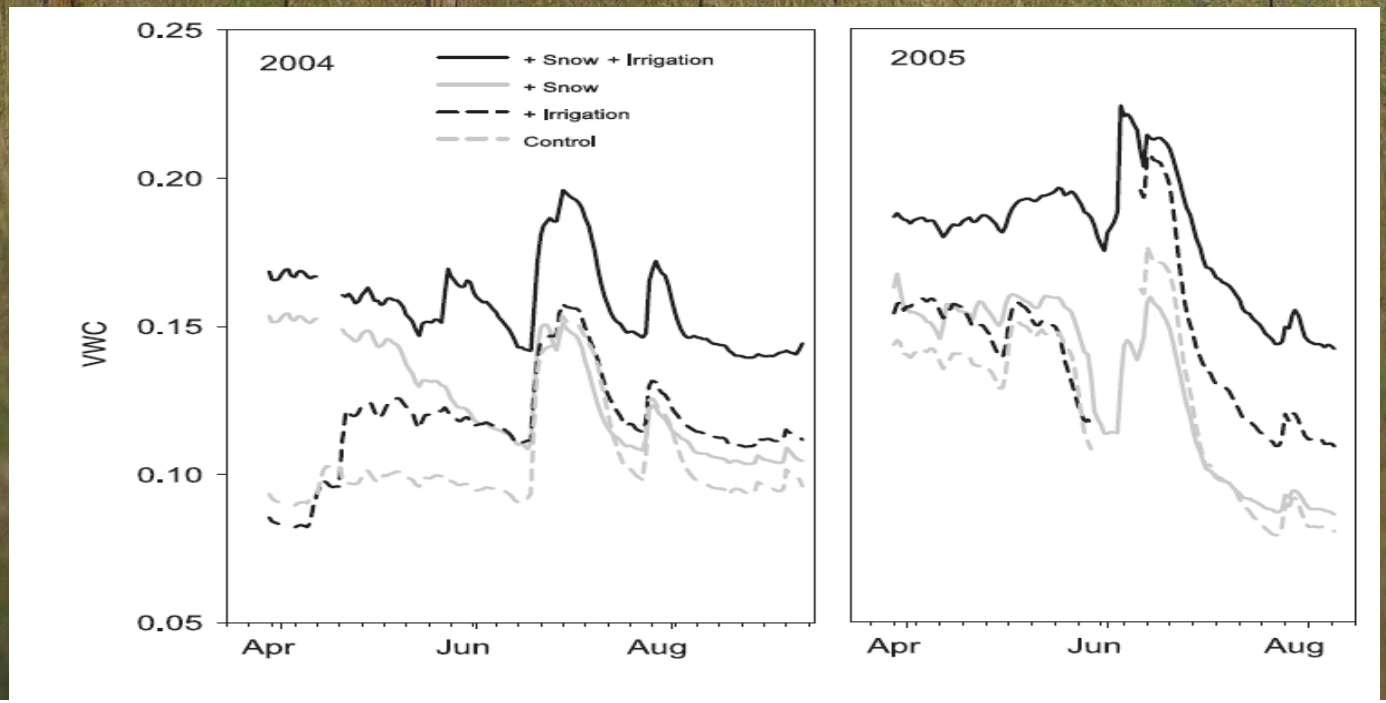
variability



EEA (2012) Climate change, impacts and vulnerability in Europe. EEA Report 12/2012

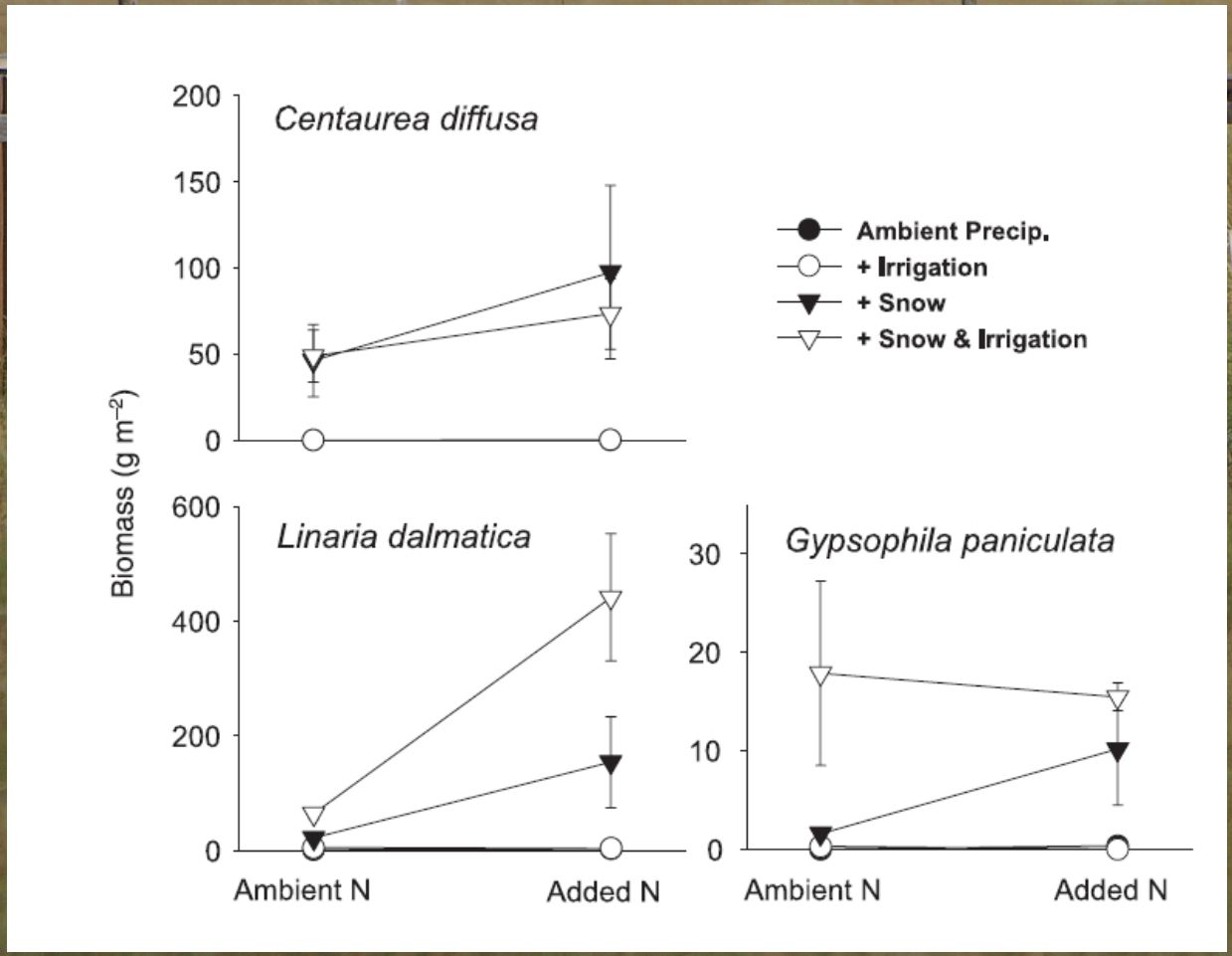
average

High Plains
Grassland Research Station, Wyoming

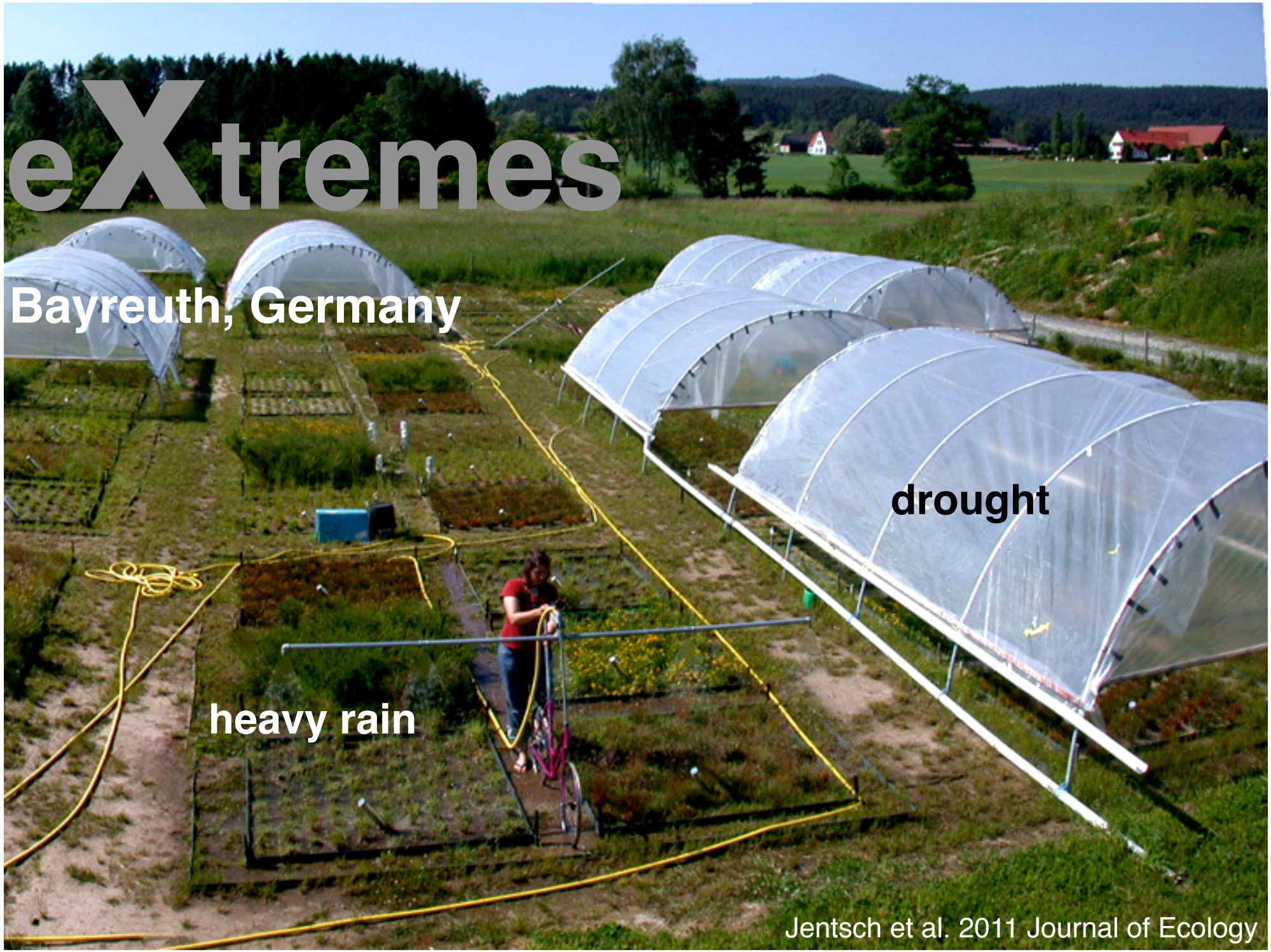


average

High Plains
Grassland Research Station, Wyoming



Blumenthal et al. 2008 *New Phyt.*

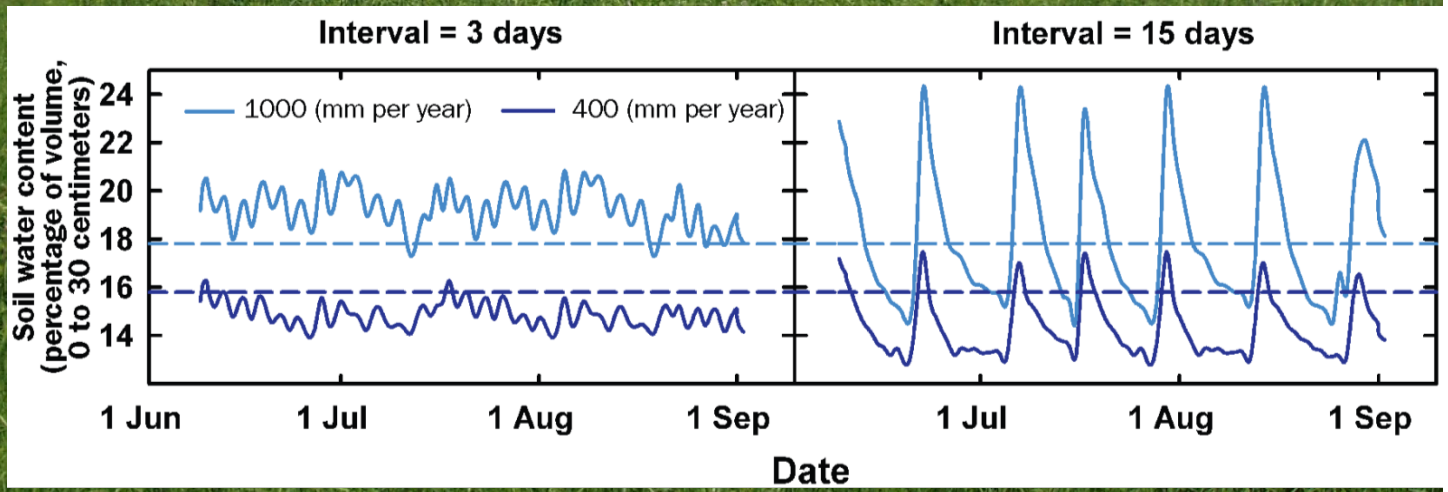

eXtremes
Bayreuth, Germany
drought
heavy rain
Jentsch et al. 2011 Journal of Ecology

Ecosystem function	Response parameter
Primary production	Aboveground net primary production
	Nitrogen fixing plants
	Plant cover
	Below ground biomass
	Shoot/root ratio
Water regulation	Soil moisture
	Leaf water potential
	Leaf carbon isotope signal
Carbon fixation	Efficiency of photosynthetic light conversion
	Leaf gas exchange
	Soil respiration
	Maximum leaf and canopy uptake rates
Nutrient cycling	Decomposition rate
	Mycorrhization rate
	Soil microbial biomass
	Soil enzyme activity
	Plant available soil $NO3^-$
	Plant available soil $NH4^+$
	Soil microbial N
	Leaf carbon to nitrogen ratio
	Leaf protein content
	Leaf carbohydrate content
	Leaf nitrogen isotope signal
Community responses	Invasibility
	Plant compositional change
	Competitive effect
	Facilitative effect
	Senescence
	Variability in length of flowering
	Variability in flower phenology
	Anti-herbivore defense
	1° consumer abundance

Jentsch et al. 2011 Journal of Ecology

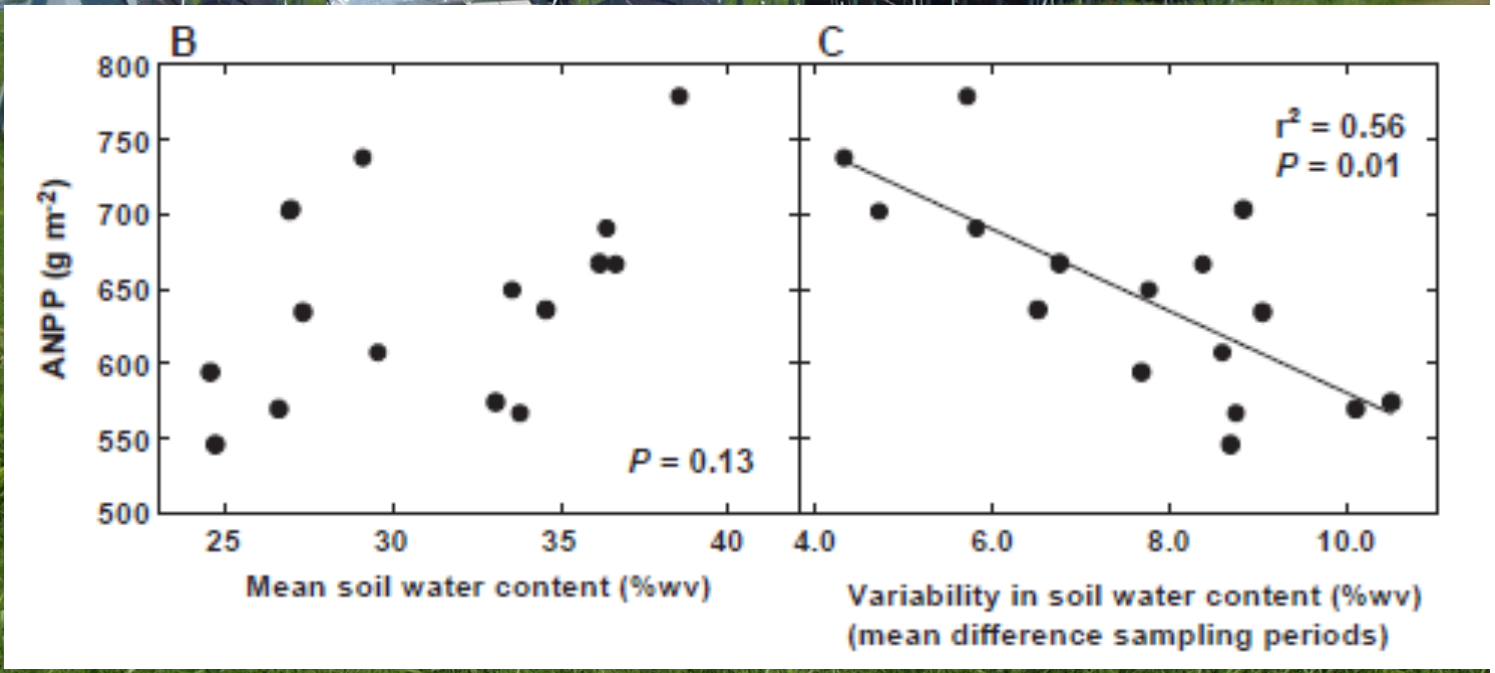
variability

Konza prairie, Kansas



Knapp et. al 2002 Science

variability

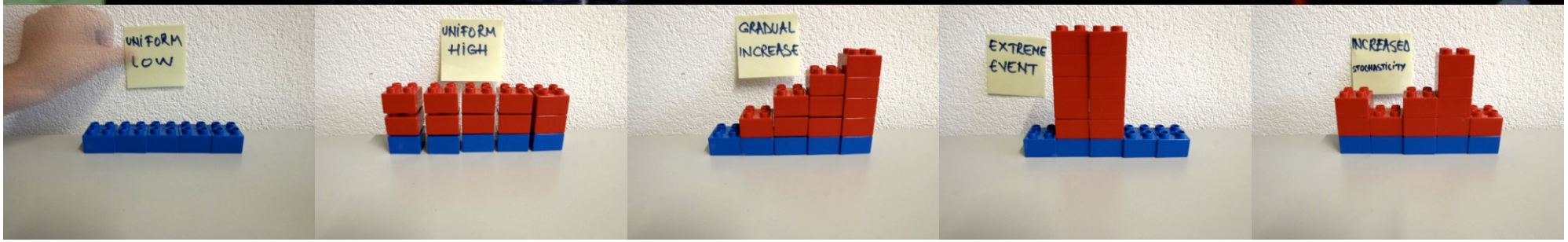


Knapp et. al 2002 *Science*

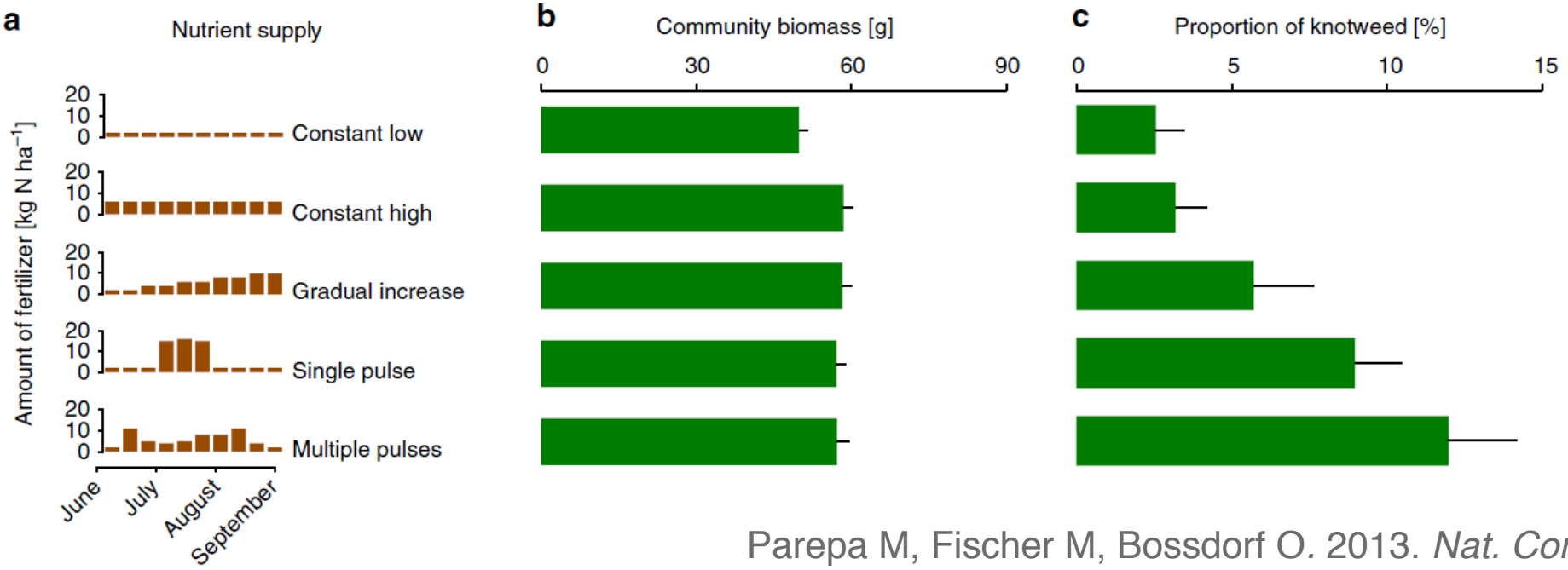
variability

20 Kg N/ha

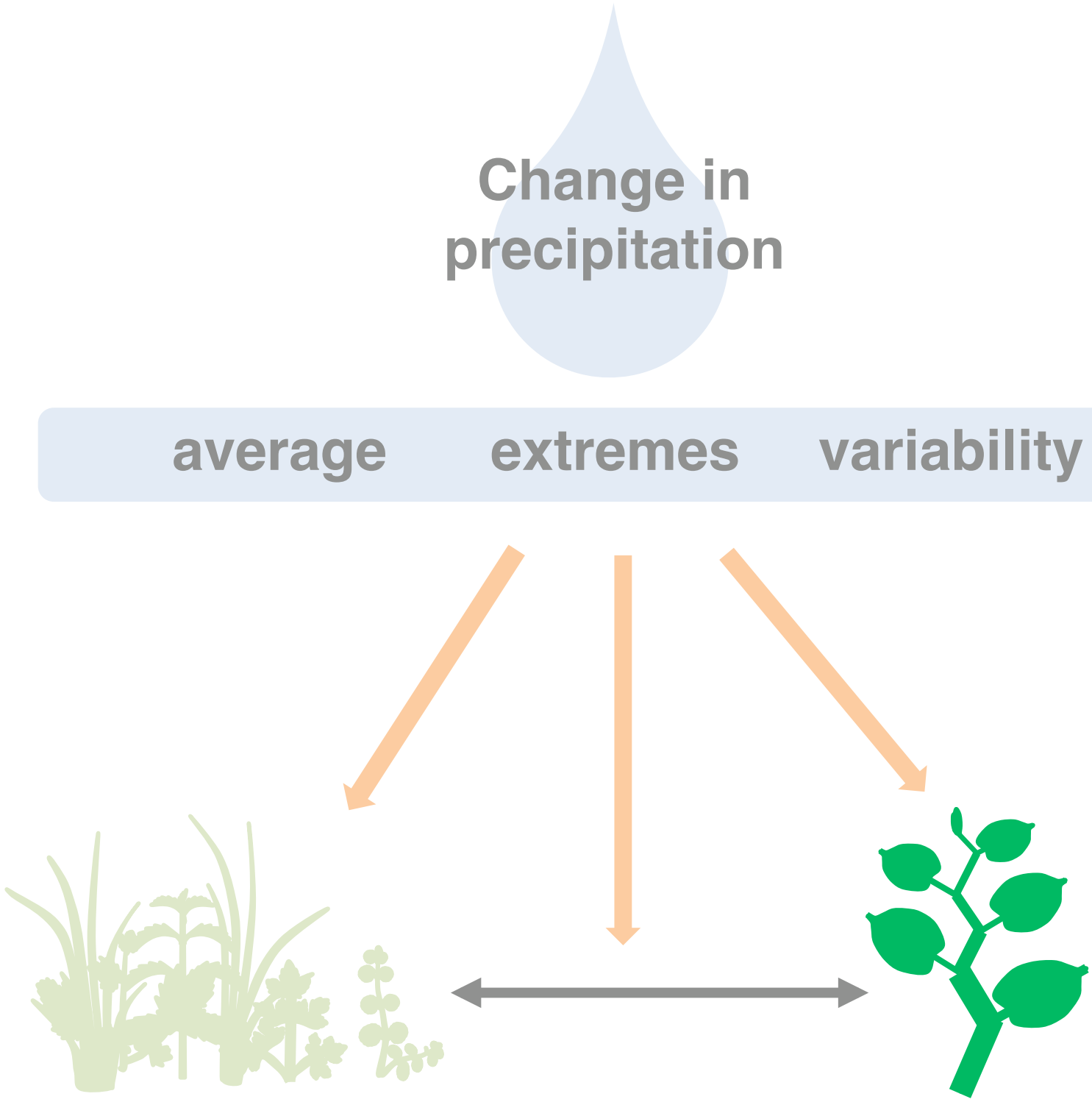
60 Kg N/ha



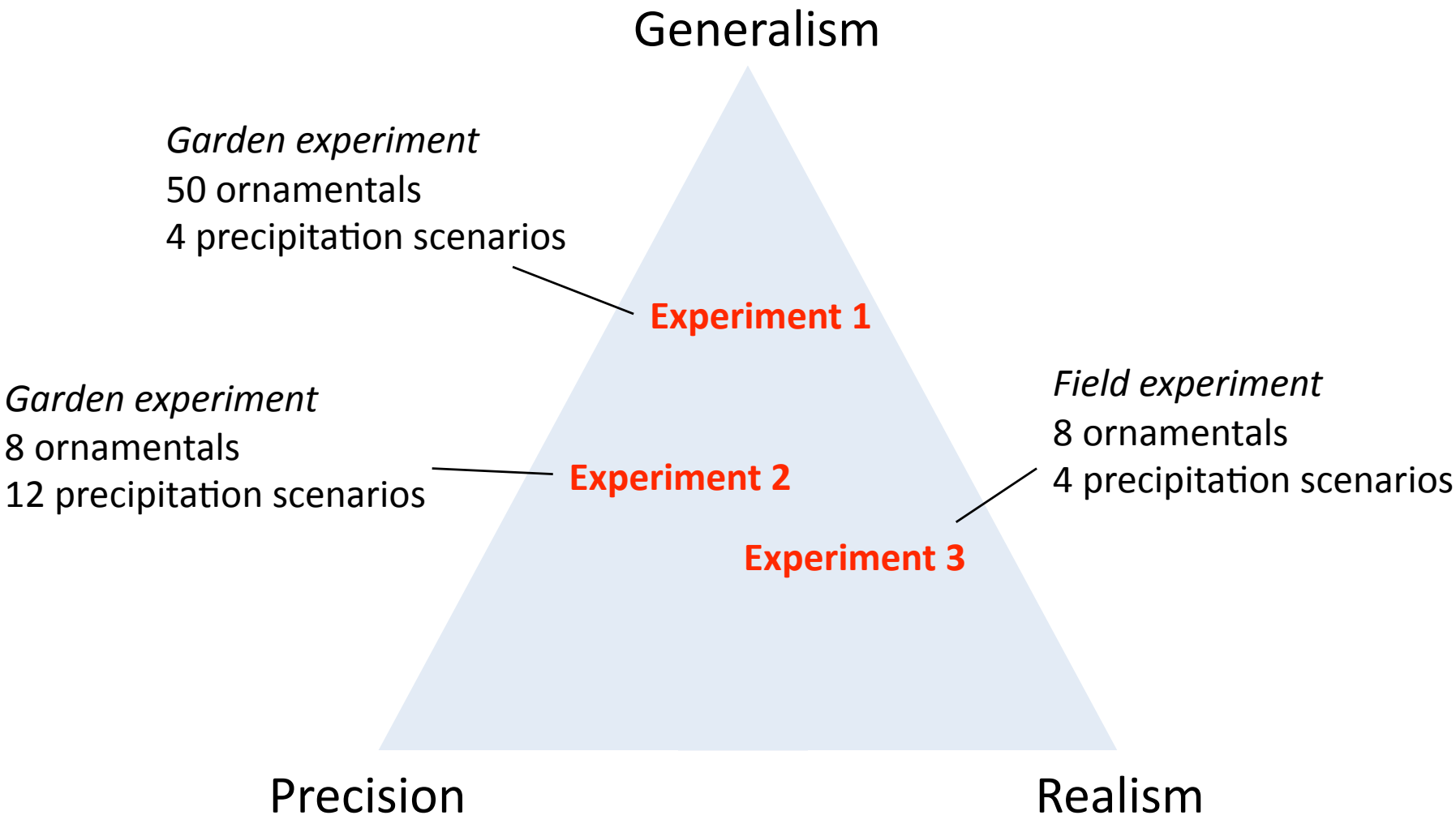
variability

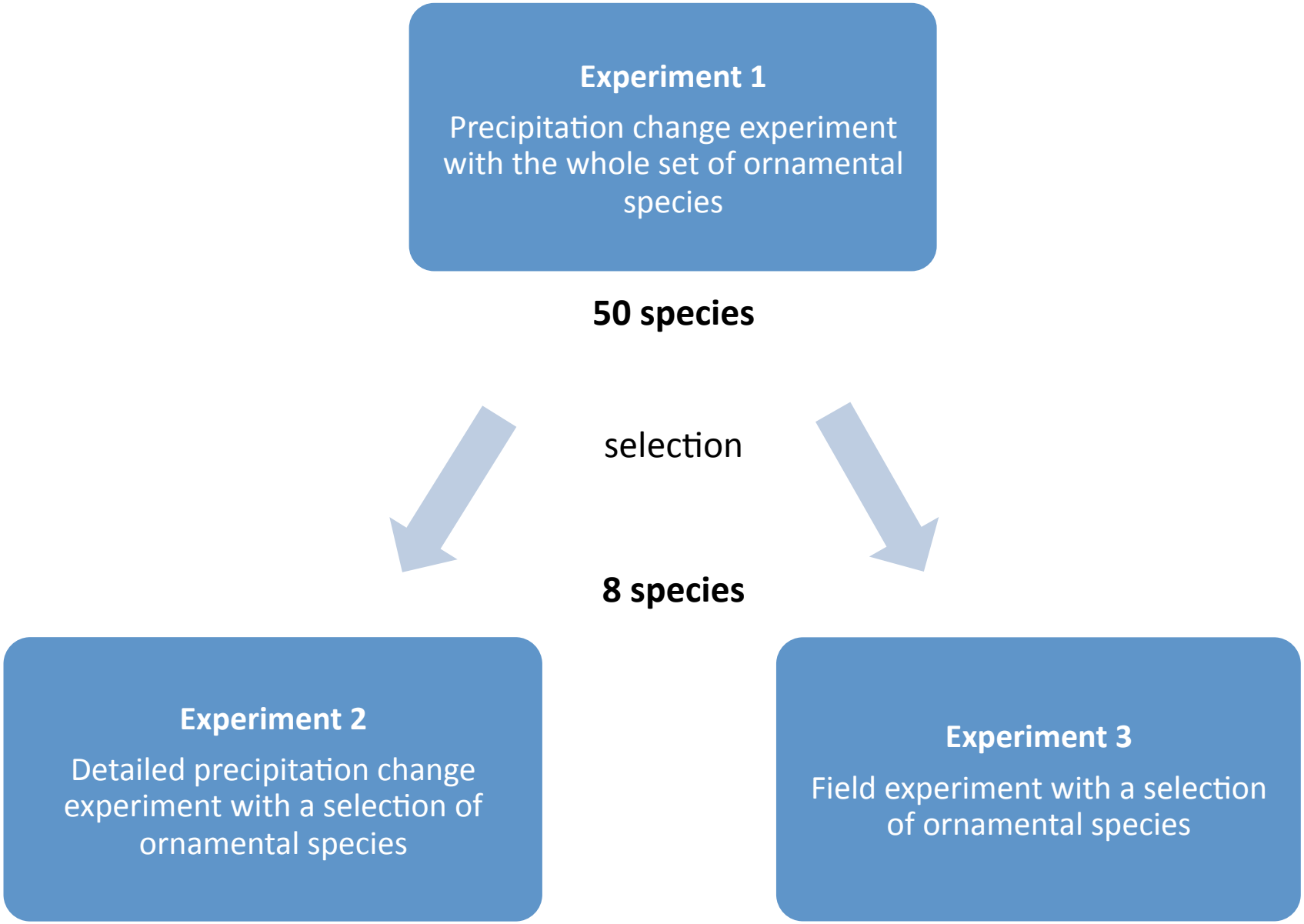


Parepa M, Fischer M, Bossdorf O. 2013. *Nat. Comm.*


Change in precipitation
average
extremes
variability

Generalism-Precision-Realism Trade-off

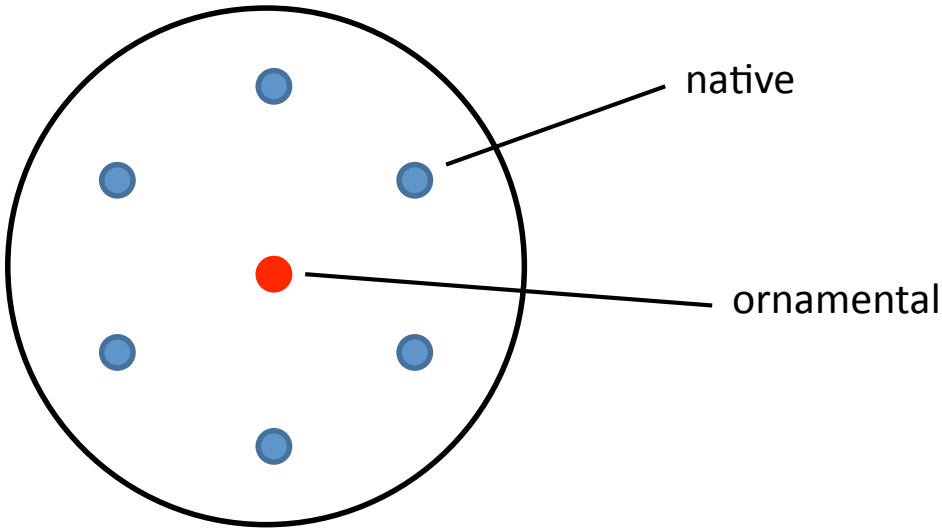



Experiment 1
Precipitation change experiment with the whole set of ornamental species
50 species
selection
8 species
Experiment 2
Detailed precipitation change experiment with a selection of ornamental species
Experiment 3
Field experiment with a selection of ornamental species

Experiment 1

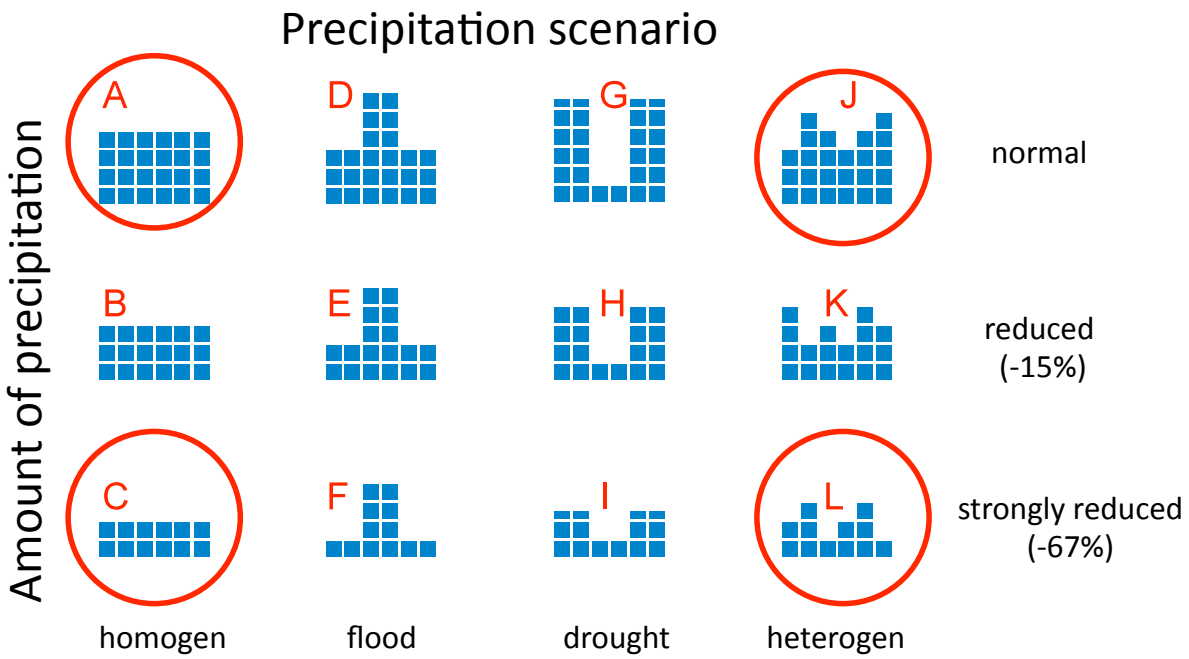
garden experiment, 50 ornamentals, 4 , precipitation scenarios

- Whole set of ornamental species
- Experimental unit: Arrangement of one ornamental plant and six native plants of six different species (=native community) in pots. Size?



Experiment 1

garden experiment, 50 ornamentals, 4 precipitation scenarios



50 ornamentals x 4 precipitation scenarios x 3 replicates = 600 pots

+ controls: 4 precipitation scenarios x 10 replicates = 40 pots

= 640 pots in total

Experiment 1 **garden experiment, 50 species, 4 precipitation scenarios**

Measurements

- Biomass, developement of flowers and seeds, traits associated with drought

Analysis

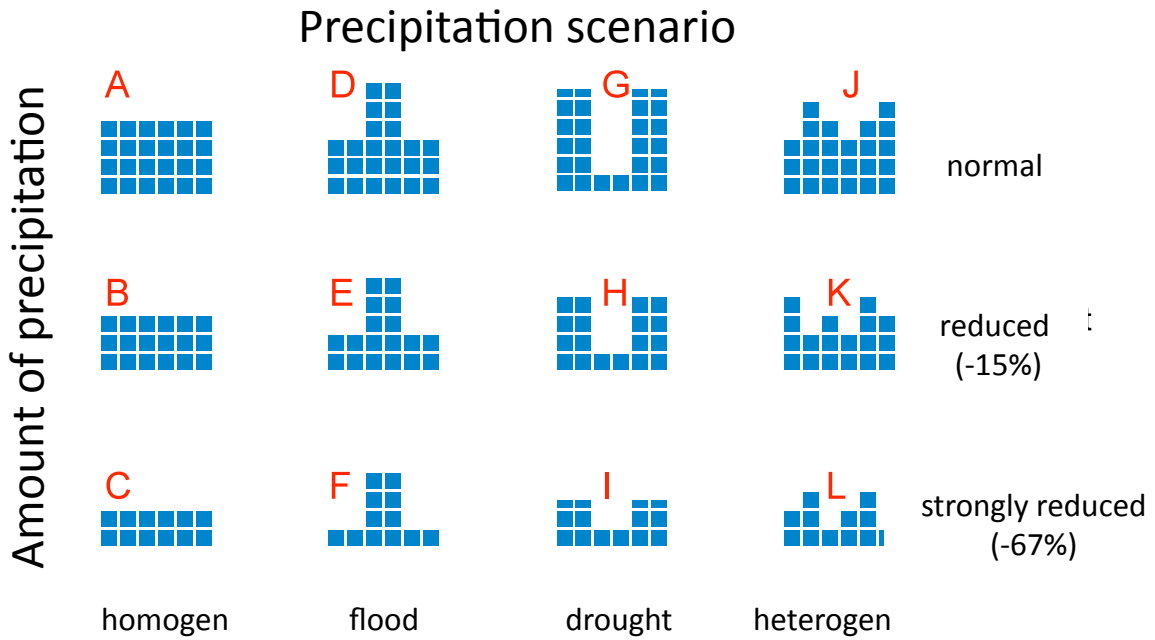
- Effect of reduced precipitation and increased precipitation variability on the ornamental‘s performance (general and on the individual level)
- Impact of ornamental species and precipitation change on the performance of the native species

→ Selection of ornamental species for Experiment 2 and Experiment 3

Experiment 2

garden experiment, 8 ornamentals, 12 precipiation scenarios

- Experimental set-up similar to Experiment 1
- Detailed precipitation scenarios including extreme events (flood, drought)



Experiment 2 **garden experiment, 8 ornamentals, 12 precipitation scenarios**

8 ornamentals x 12 precipitation scenarios x 3 replicates = 288 pots

+ controls: 12 precipitation scenarios x 10 replicates = 120 pots

= 408 pots in total

Measurements

- Biomass, developement of flowers and seeds, traits associated with drought

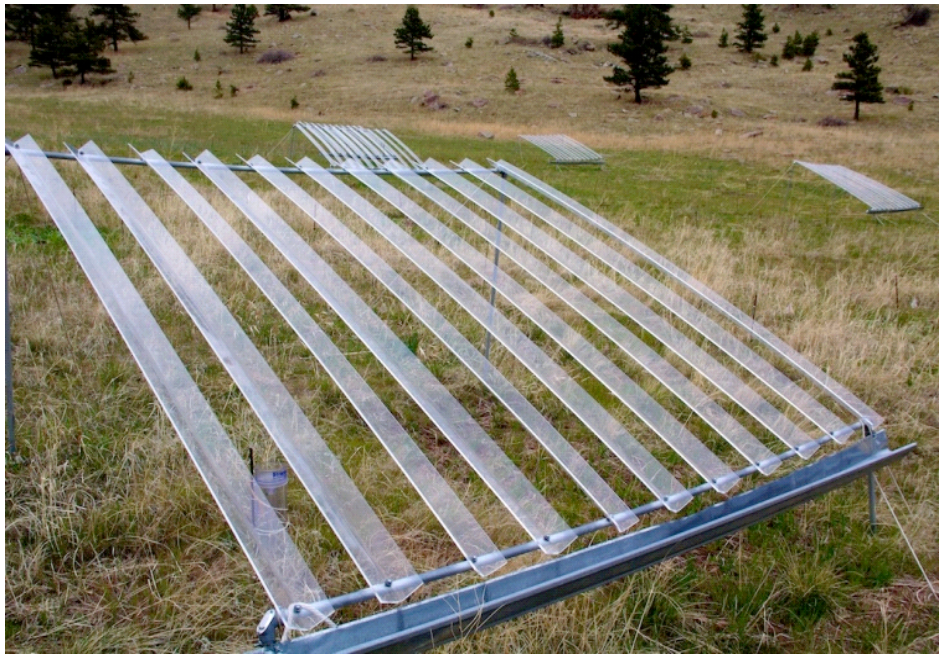
Analysis

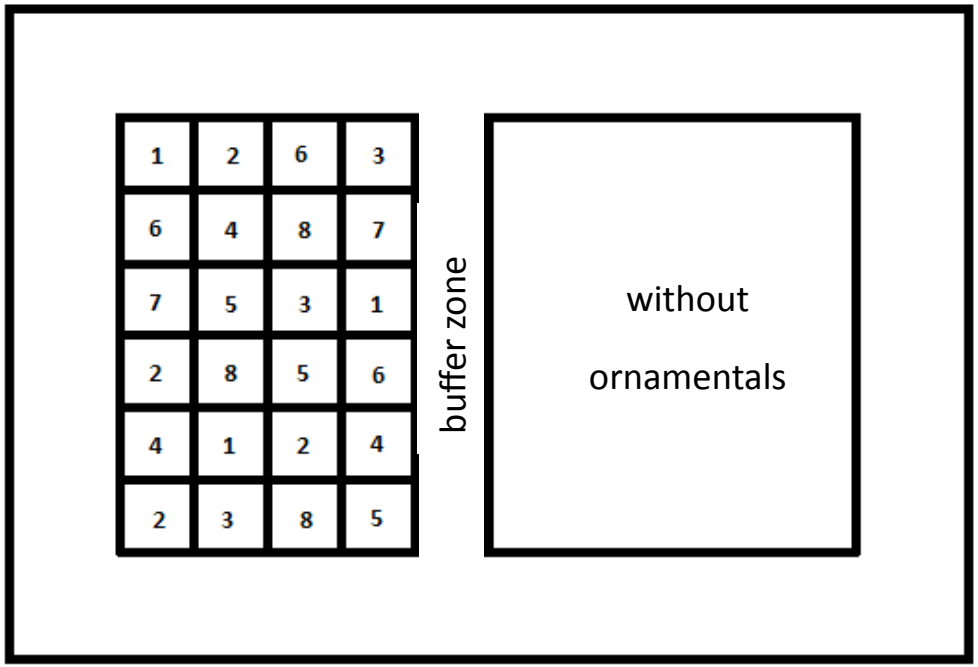
- Effect of precipitation amount (3 levels) and the type of variability (4 types) on the ornamental‘s performance
- Impact of ornamental species and precipitation change on the performance of the native species

Experiment 3

field experiment, 8 ornamentals, 4 precipitation scenarios

- Rainout shelters designed after standards of the International Drought Experiment (DroughtNet; coordinated by Colorado State University)

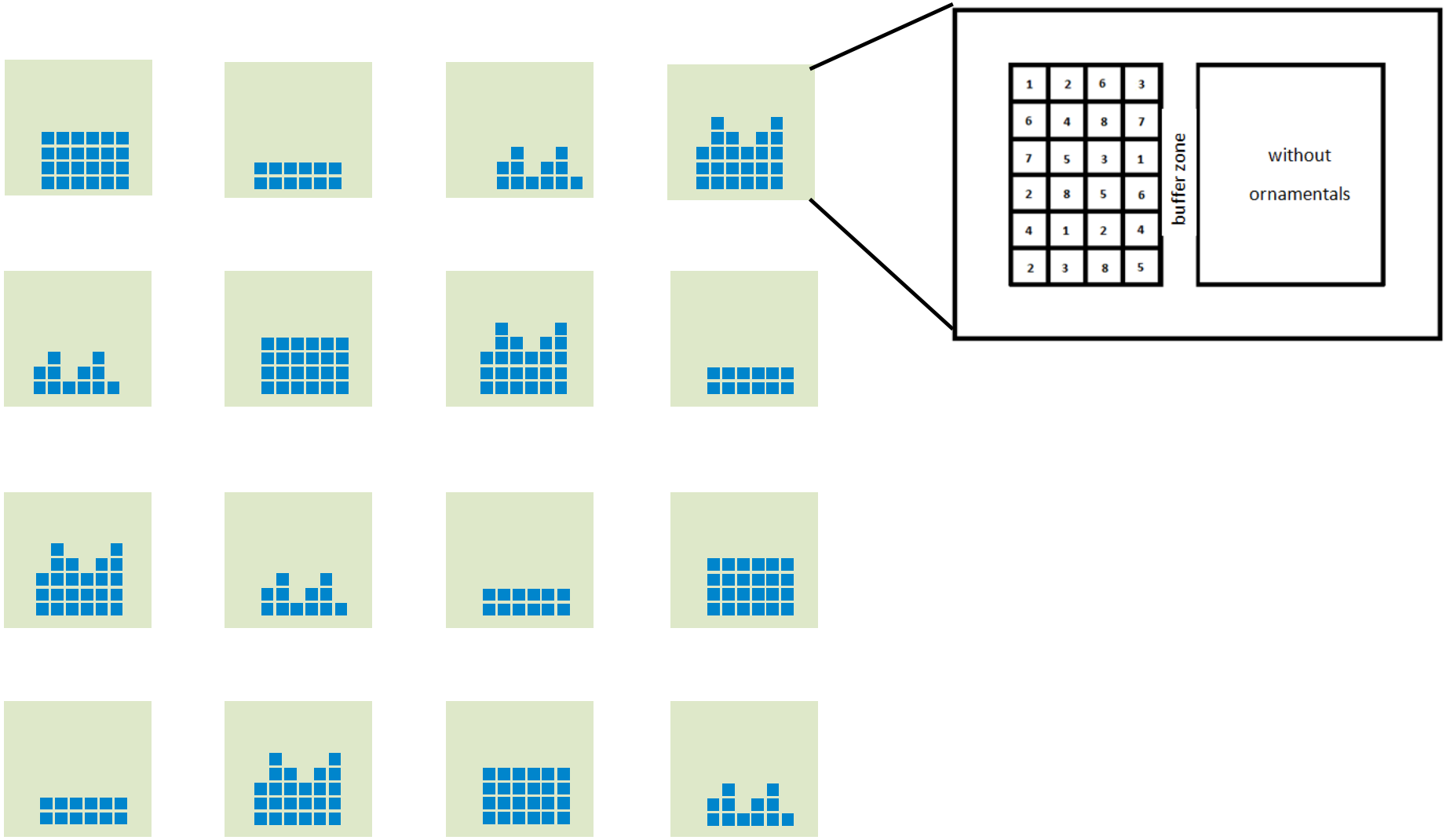




- Different habitat types (low and high fertility meadows, ruderal sites?)

Experiment 3

field experiment, 8 ornamentals, 4 precipiation scenarios



Experiment 3 **field experiment, 8 ornamentals, 4 precipiation scenarios**

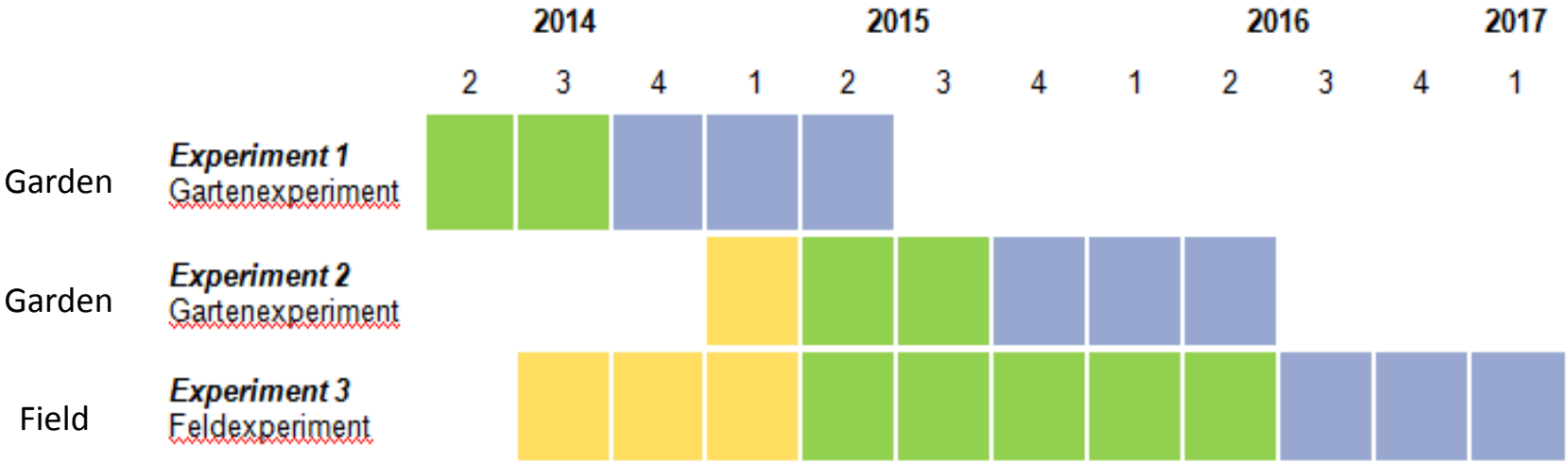
Measurements

- Biomass, developement of flowers and seeds, traits associated with drought
- Species composition, dominance hierachies

Analysis

- Performance of ornamentals in different habitat types (and impact on the community)
- Change in biomass/species composition/dominance hierachies of natives under different precipitation scenarios

Time schedule



yellow= preparation /experimental set-up; green = Durchführung des Experiments; blue = data analysis and publication
1 = January-March, 2 = April-June, 3 = July-September, 4 = October-December

Problems/open questions

Germination duration → unequal size of seedlings at the start of the experiment

Selection of natives

How much do I need to water the plants for creating approriate precipitation scenarios???
Influencing factors:
Temperature, plant size…

4. Evolutionary potential of ornamentals in response to precipitation change

Cultivars

3 x Abelmoschus esculentus H5
3 x Abelmoschus moschatus H5
3 x Alternanthera ficoidea H5
3 x Anoda cristata H5
3 x Iresine herbstii H5
3 x Lobelia cardinalis H1
3 x Potentilla argyrophylla atrosanguinea H1
3 x Salpiglossis sinuata H5
5 x Cleome houtteana H5
6 x Datura metel H5
4 x Helianthus debilis H3
4 x Hosta ventricosa H2
13 x Lobelia erinus H3
10 x Mimulus hybridus H5 (HYBRID)
4 x Solanum muricatum H5 (HYBRID)


Italian White


Stella


Pan


Vanilla Ice


Sunny Babe

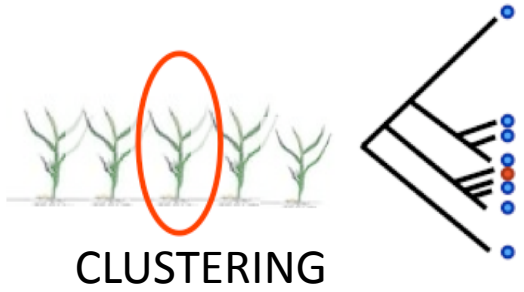

Italian Gree

WP5 - Modelling I: Developing and validating a simulation model for ornamental plant invasions

FUNCTIONAL/PHYLOGENETIC PATTERNS

Processes and Expected Patterns

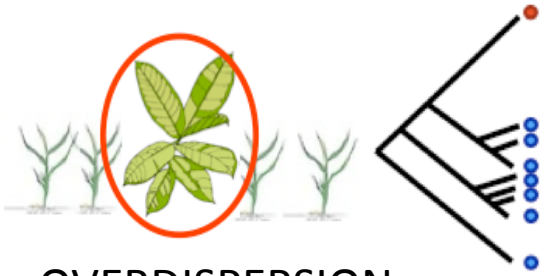
ENVIRONMENT →



CLUSTERING

↓ MDNS

COMPETITION →

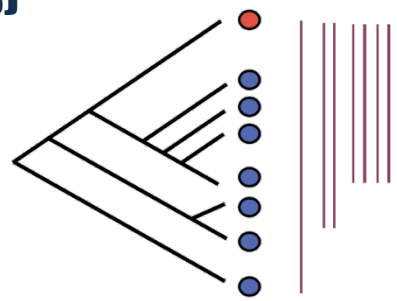


OVERDISPERSION

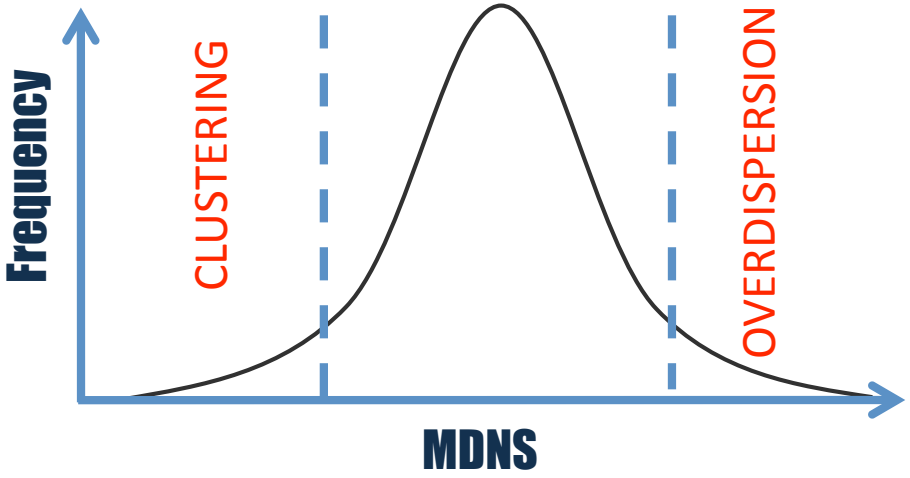
↑ MDNS

Distance metrics

Mean Distance to Native Species (MDNS)

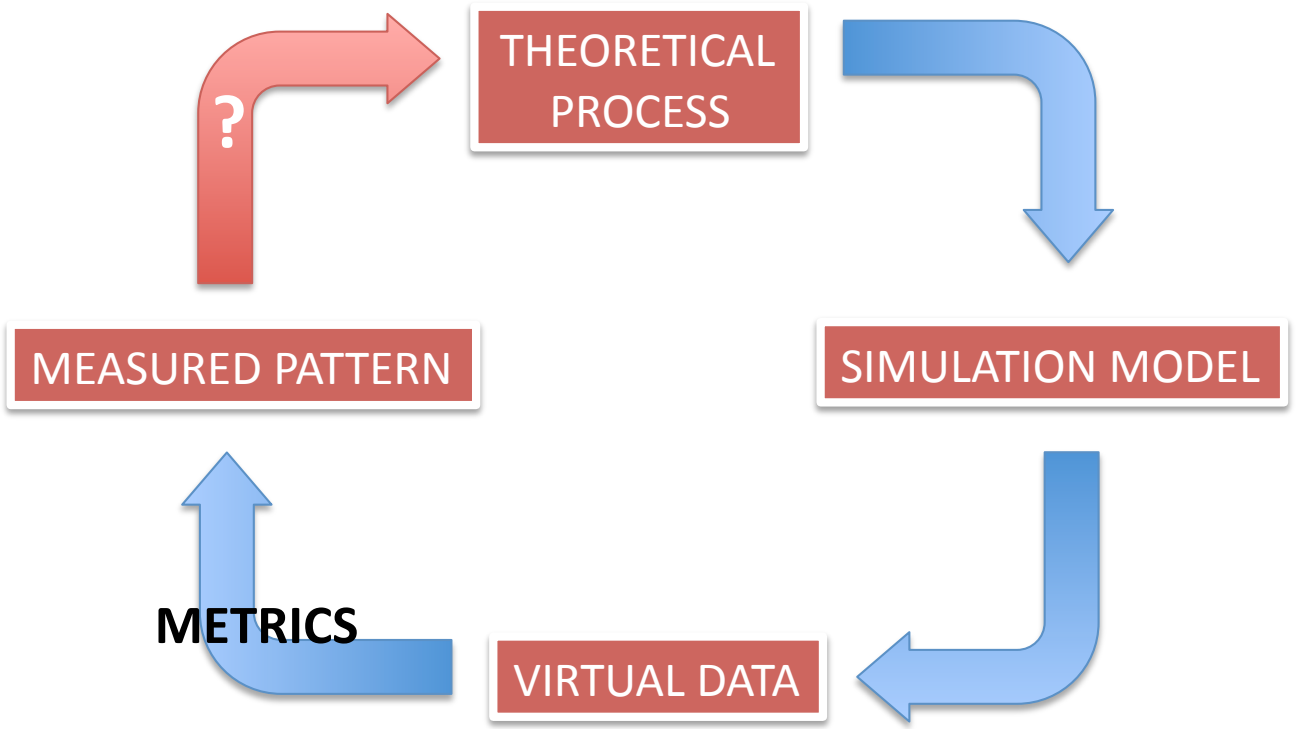


Null models



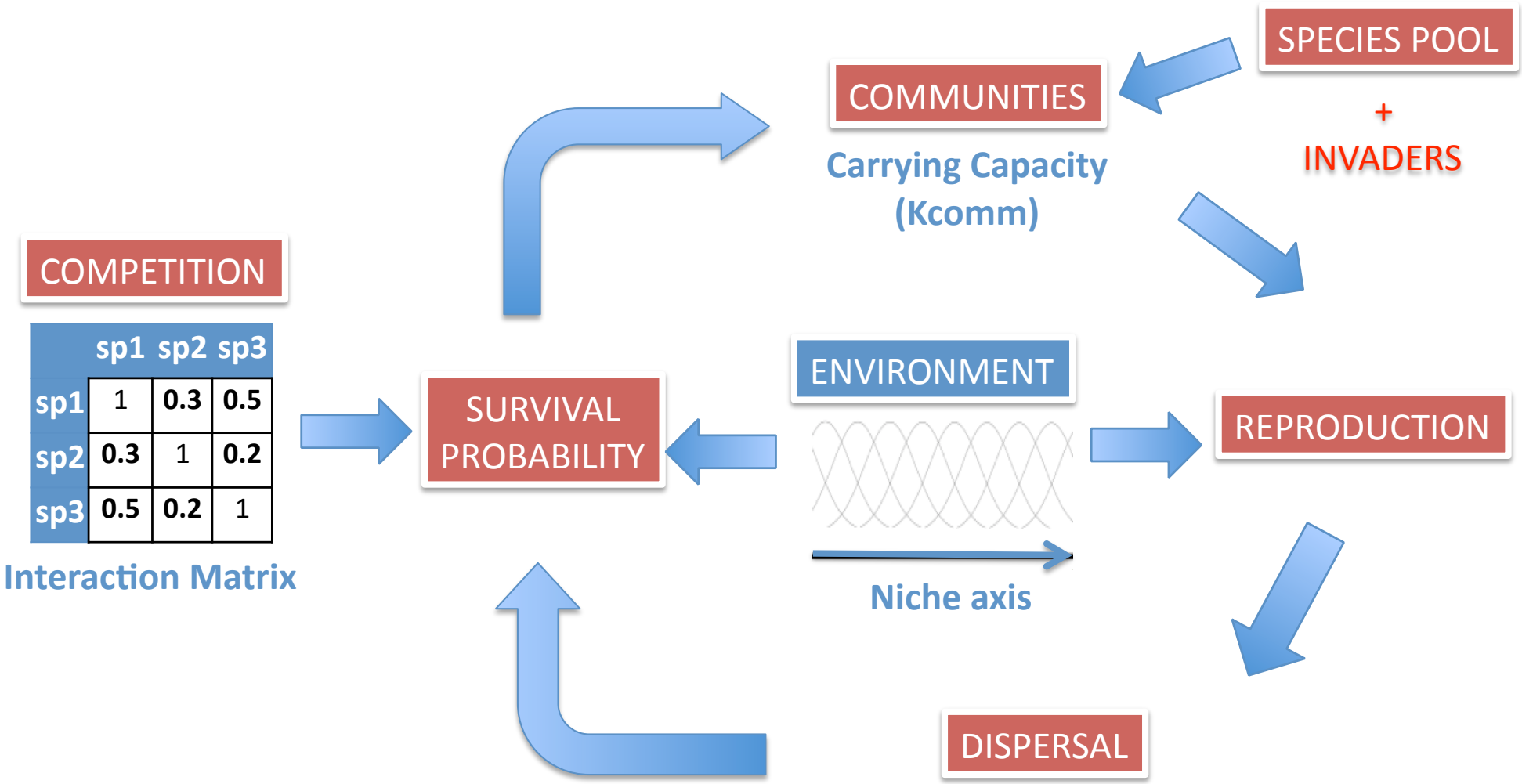
GENERAL METHOD

A **virtual-ecologist approach** (Zurell et al. 2010): a process-based model with specific rules and parameters is used to simulate virtual data, so that the performance of statistical methods to recover the processes can be tested against a known truth.

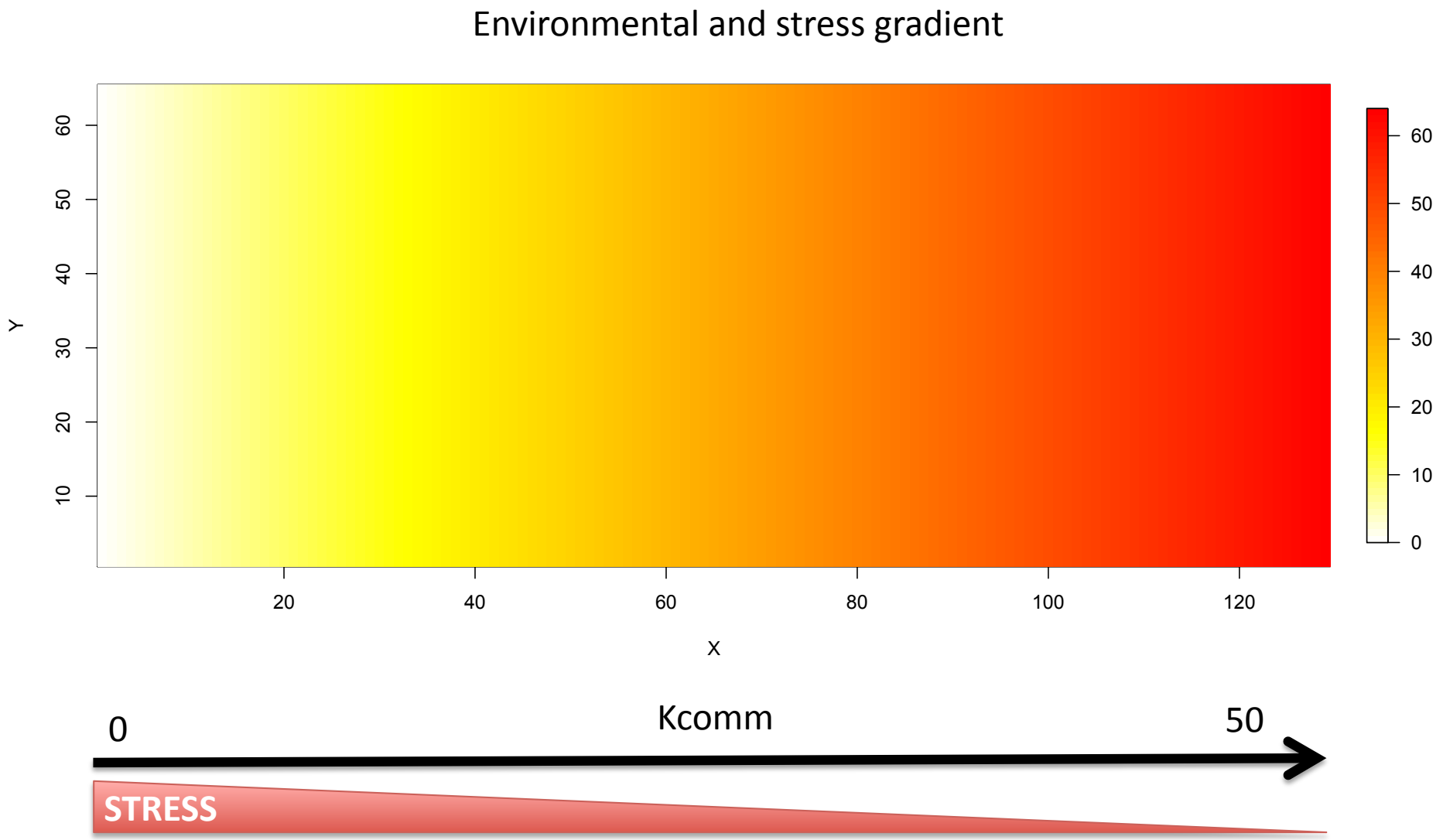


METACOMMUNITY SIMULATION MODEL

- Stochastic, spatially-explicit, individual based model to simulate the dynamics of metacommunities along gradients



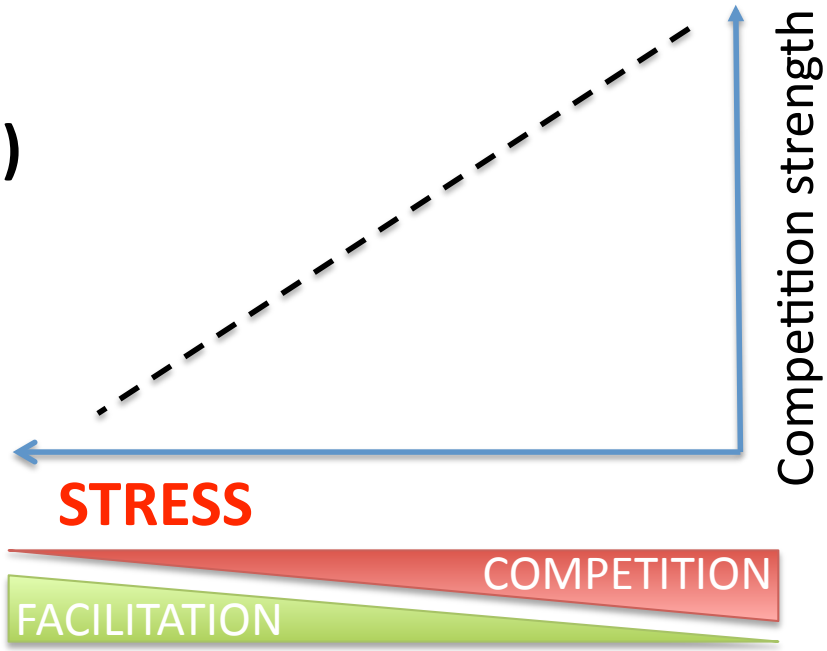
Landscape


Environmental and stress gradient
Y
10
20
30
40
50
60
X
20
40
60
80
100
120
0
10
20
30
40
50
60
0
Kcomm
50
STRESS

APPLICATION EXAMPLE

STRESS GRADIENT HYPOTHESIS (SGH)

SGH predicts that the frequency and/or strength of competition declines and facilitation increases with increasing environmental stress (Bruno et al. 2003, Callaway 2007, Maestre et al. 2009)



Question:

How do community assembly processes and functional metrics respond to stress gradient?

COMMUNITY ASSEMBLY PATTERNS

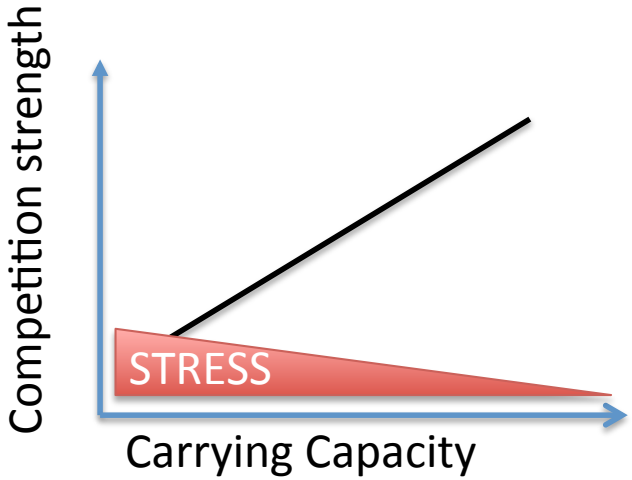
Functional Diversity index:
Mean Pairwise Distance among Species (MPD) based on Trait values

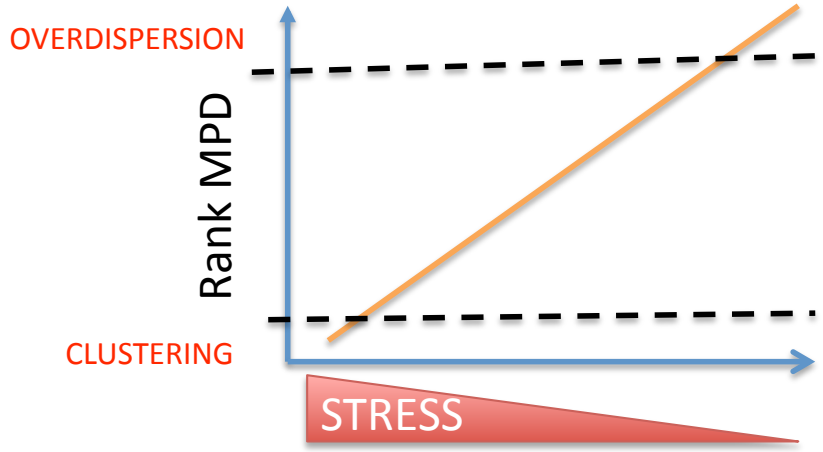
Standardization of index values with **Null-Model-expectations**:

- 1 non-constrained randomization
- 1 randomization constrained by environmental suitability of species

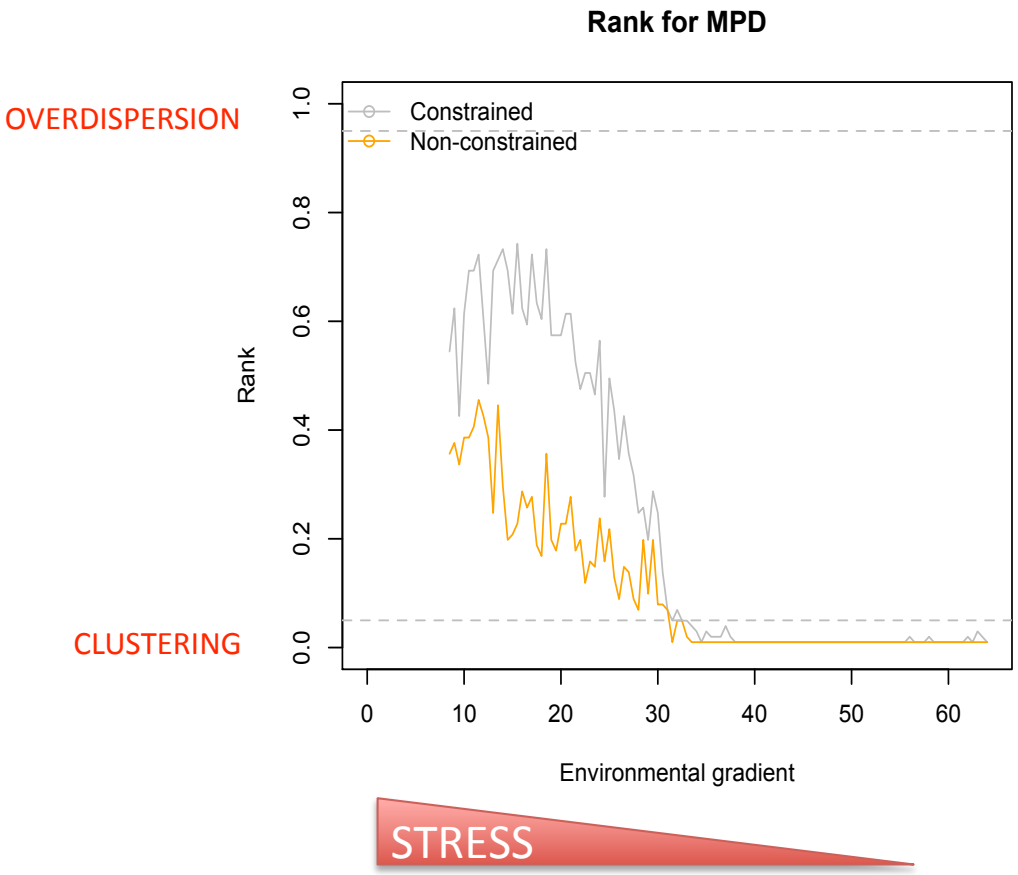
→ Rank of observed MPD

Hypothesis for stress gradient:





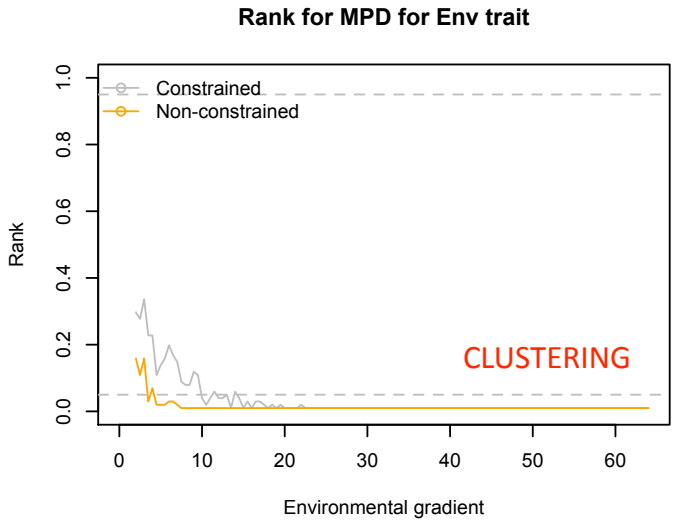
A) Same trait mediates environmental preference and competition



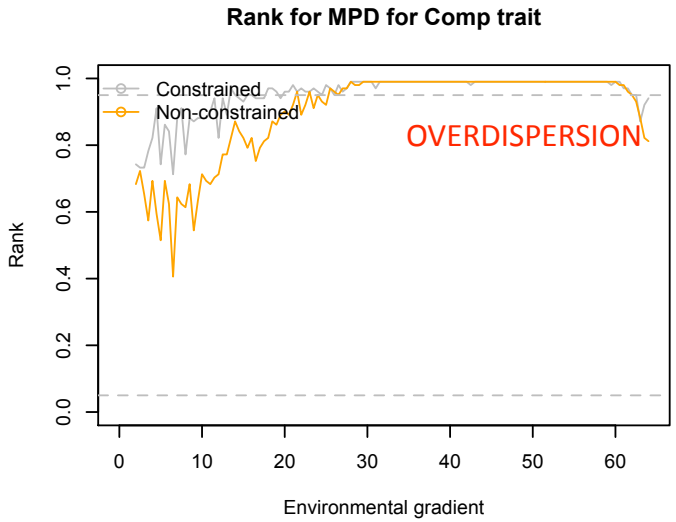
Because population is less tolerant to competition in harsh environment, competitive exclusion can occur more readily, even though intensity of competition is weaker (Hart & Marshall 2013)

B) 1 environmental filtering trait and 1 separate competition trait

ENVIRONMENT

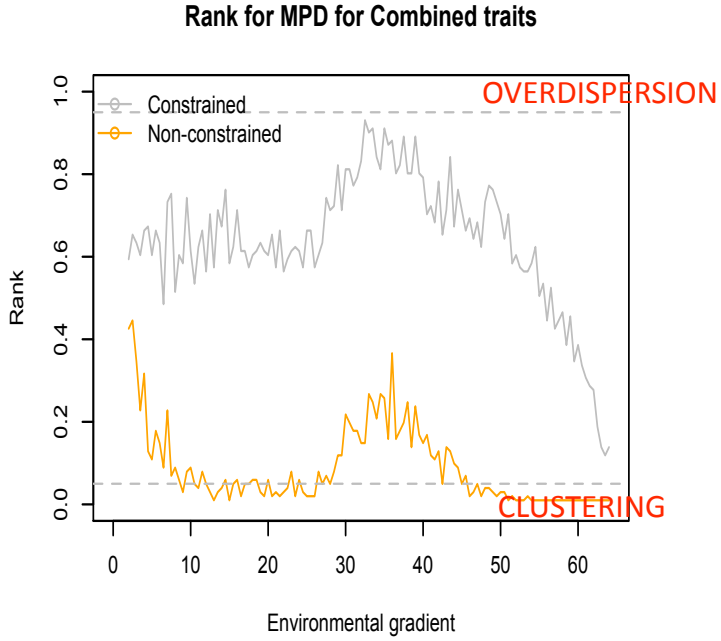


COMPETITION



COMPETITION

ENVIRONMENT



POSSIBLE QUESTIONS TO ADDRESS ON INVASIONS

- How do invasion patterns vary along a **stress gradient** with more competition on one end and more facilitation on other?

- What is the relative importance of **regional processes** influencing the species pool and **local assembly** for invasion success: Propagule pressure vs. dispersal ability.

- Other ideas?

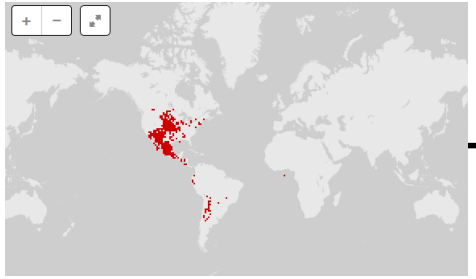
FWF

Der Wissenschaftsfonds.

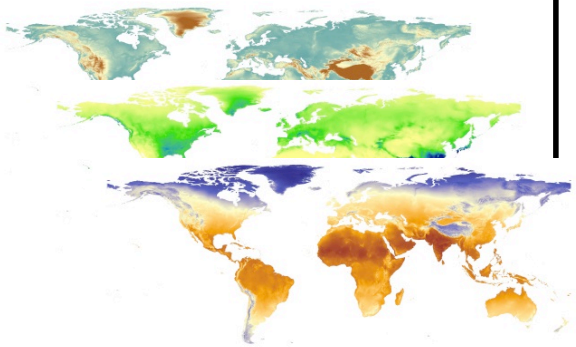
WP7 - Modelling III: Risk assessment under new climatic conditions across Europe

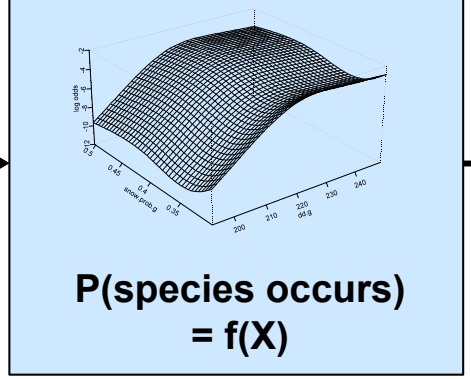
Stefan Dullinger, Franz Essl, Didi Moser,
Günter Klonner, Iwona Lamaszewska

Species occurrence data



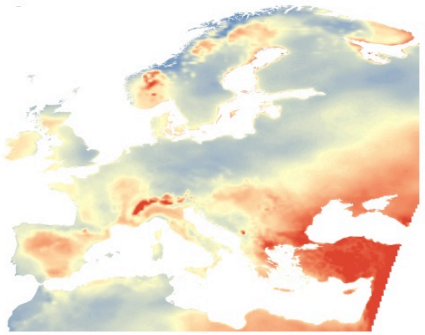
Climatic data





P(species occurs) = f(X)

Current potential distribution



Bouteloua curtipendula

Future potential distribution

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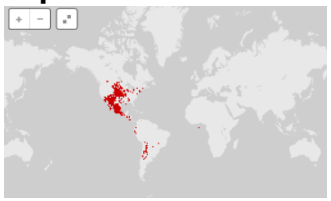
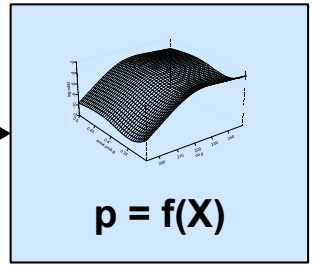
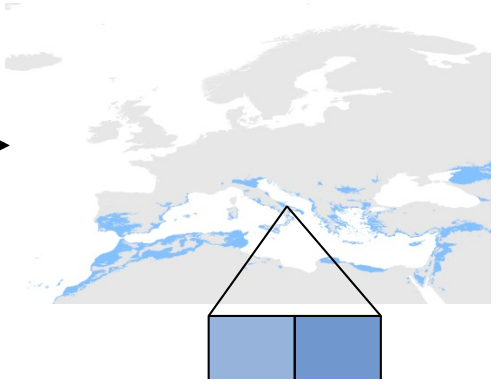
CVL

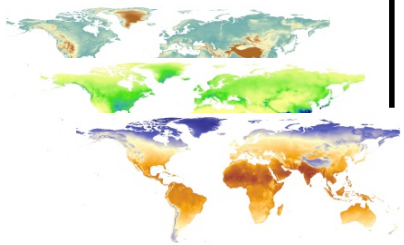
Species data



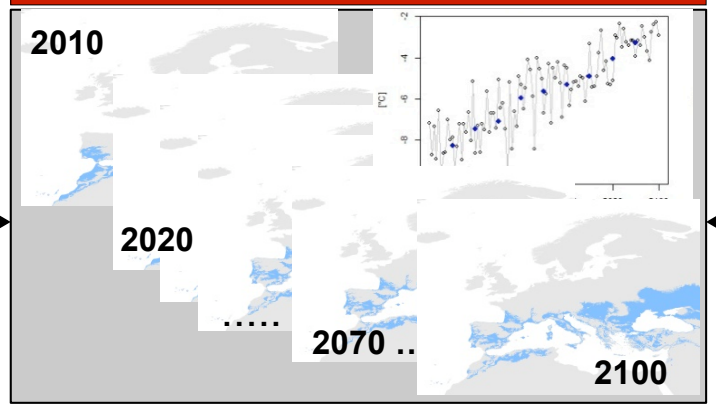


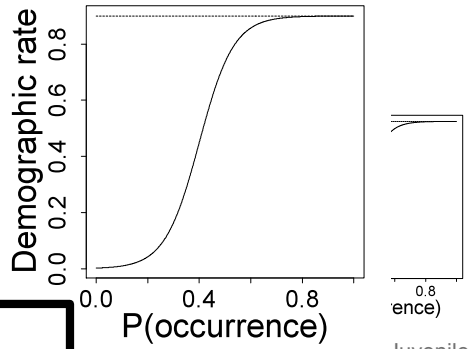


Climatic data

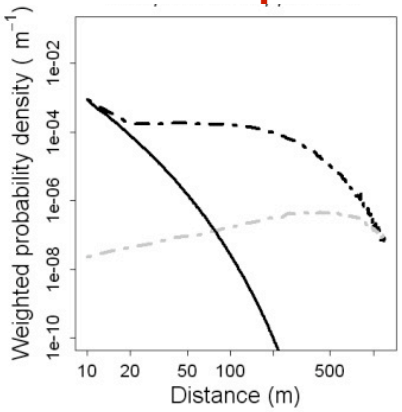


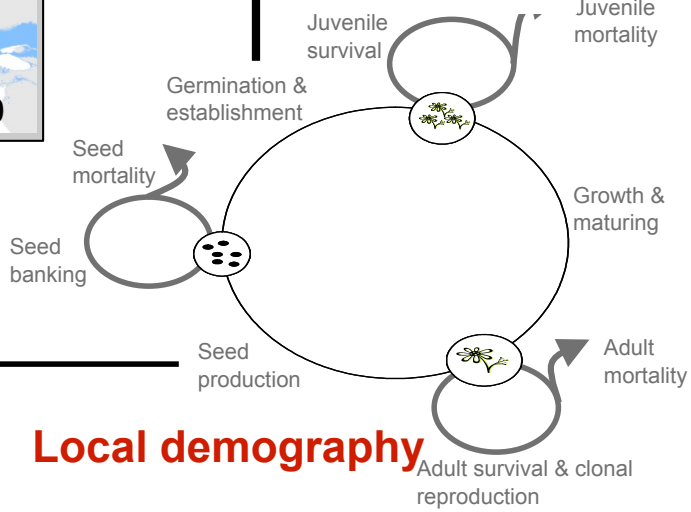
Spatio-temporal spread model





Seed dispersal





Local demography

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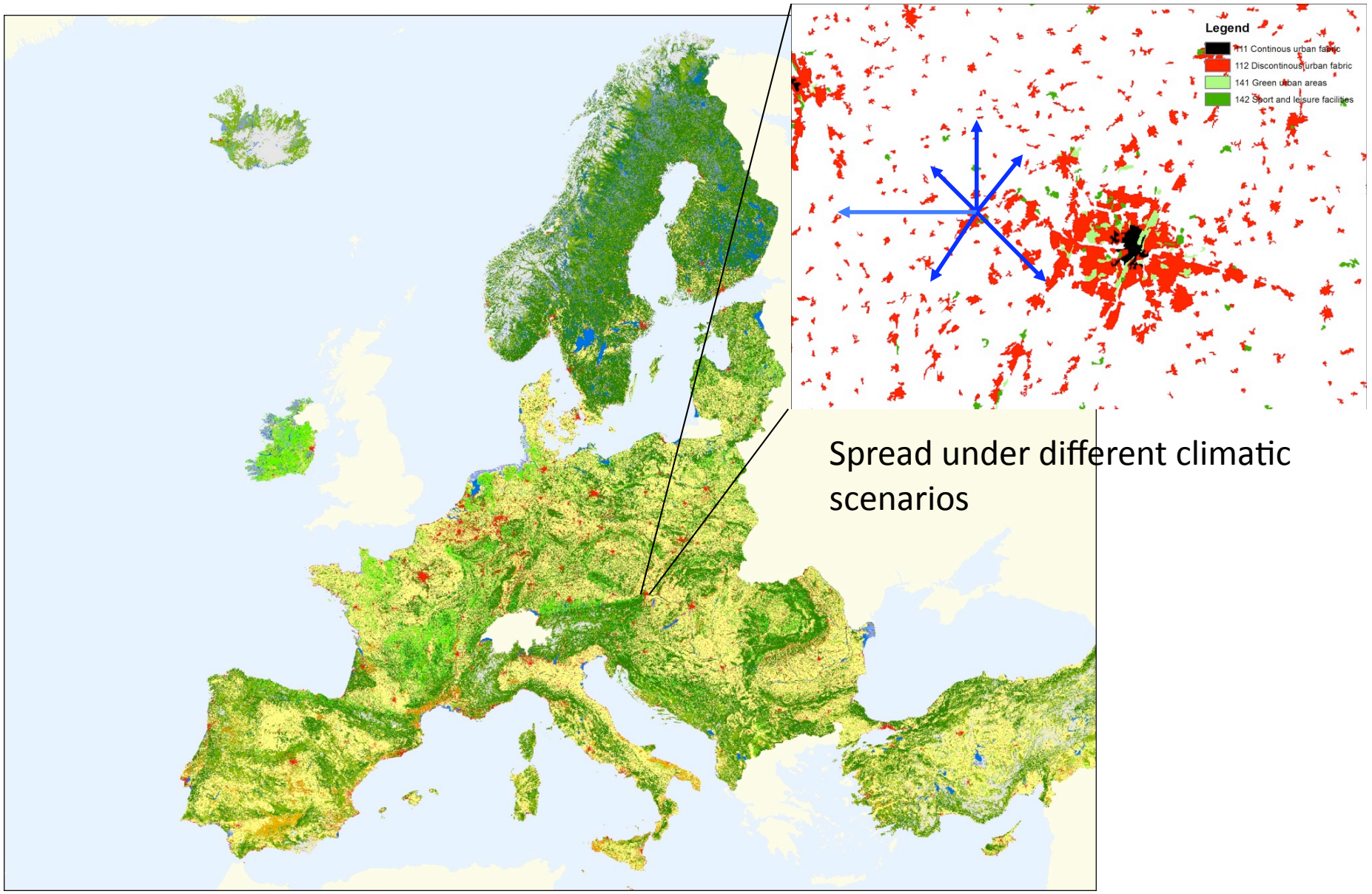

Spread under different climatic scenarios

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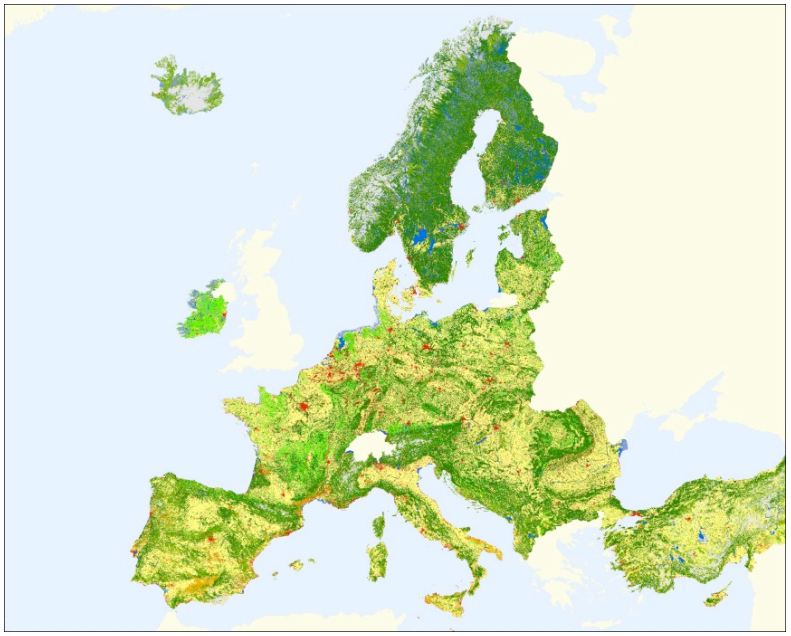
European scale model



- 250 m grid resolution
- Several levels of (assumed) planting intensities/species
- Carrying capacities varied among habitat types (CORINE & habitat info for species)
- Evaluating simulated occupancy patterns → effects of CC and management options on spread?

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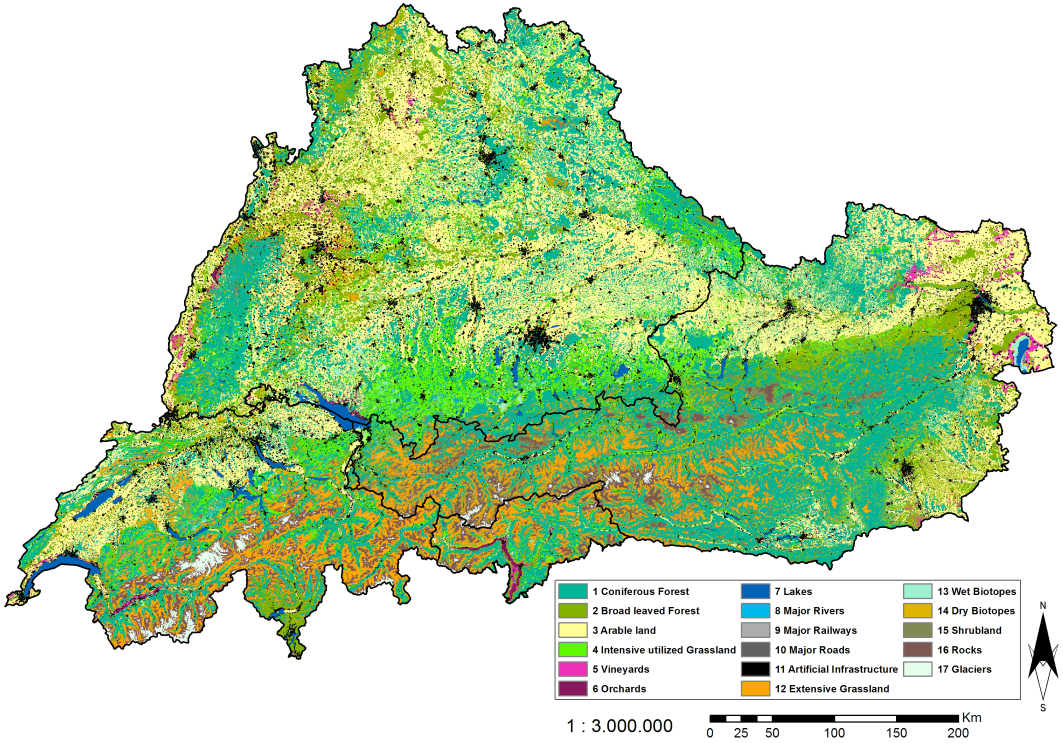
Regional scale (Central Europe)



Fine resolution habitat maps (20m pixel scale) of CE

Running models at fine scale and evaluate risk at scale of habitats of conservation concern (extensively used grasslands, fens etc.)

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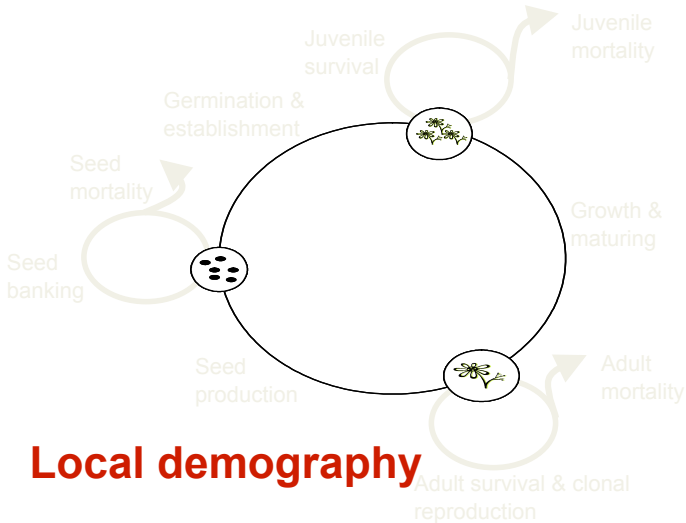
Data needs from experiments

- **Seed** data: size, weight, terminal velocity, shape parameters (~ 20 seeds per species)
- **Morphological** data: seed release height, size
- **Demograhic / vital rate** data: flowering frequency, seed set, germination rate, age of maturity (= first flowering), survival until first flowering, clonal propagation rate, seed persistence in soil
- Which are data are available at **which time** during the project?



Local demography

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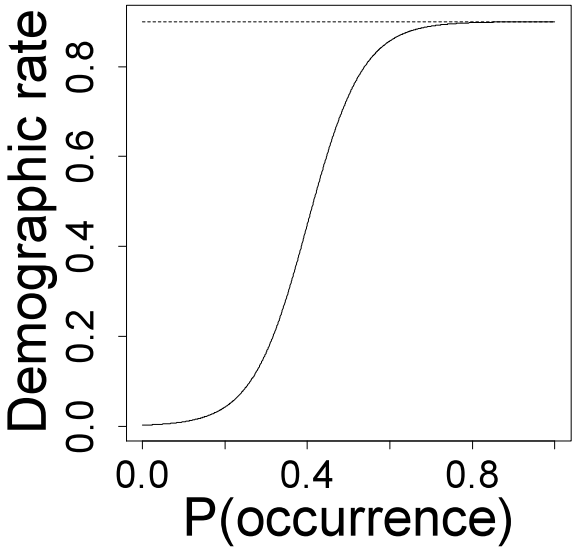
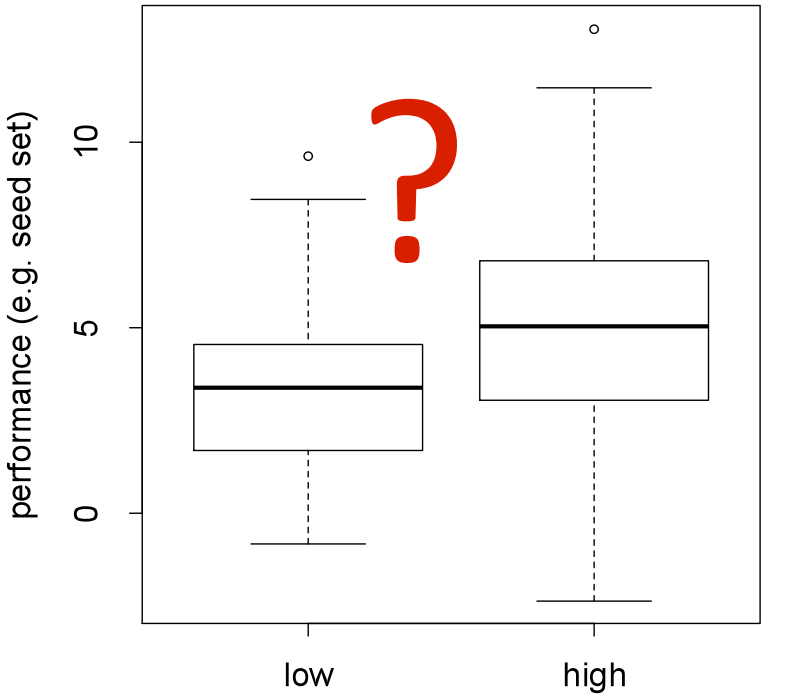
Data needs from experiments

Performance data ideally for all (climatic) treatments you use





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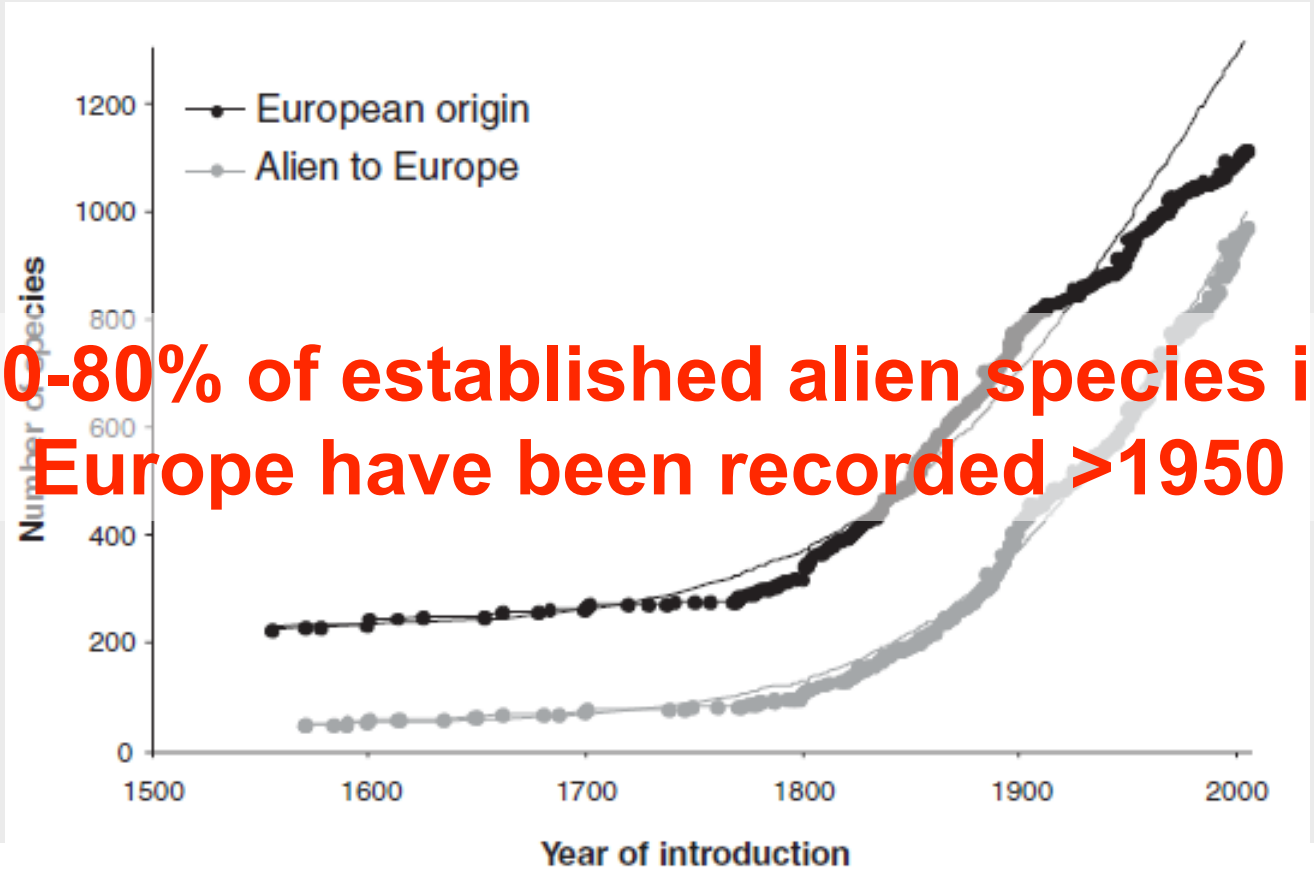
Who Is Next? Horticulture as a pathway for alien plants, stakeholder dissemination & policy advice

F. Essl, G. Kloner, I. Lamaszewska, D. Moser & S. Dullinger

Who Is Next? / 18-02-2014 / Konstanz

SOME BACKGROUND

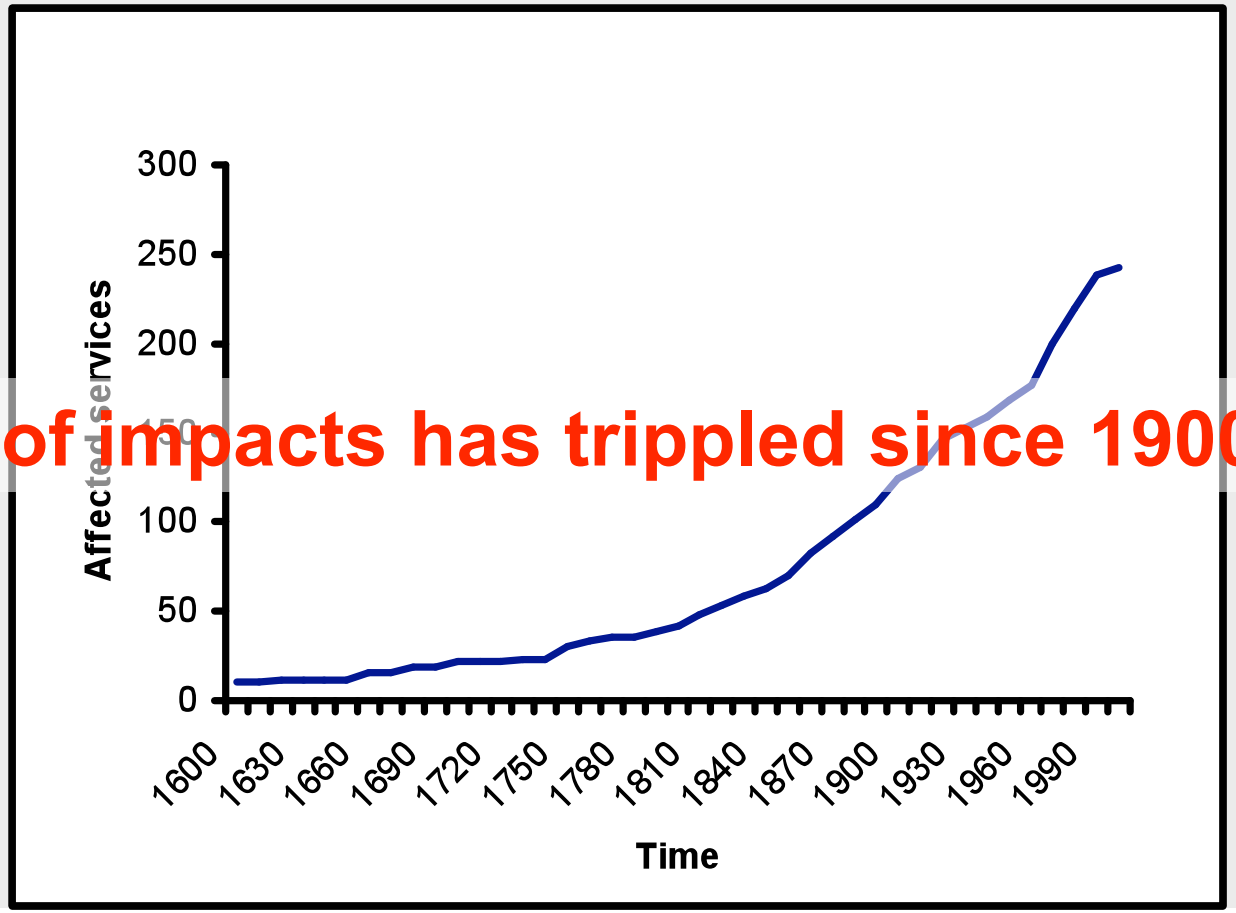
Numbers of alien species are rapidly increasing



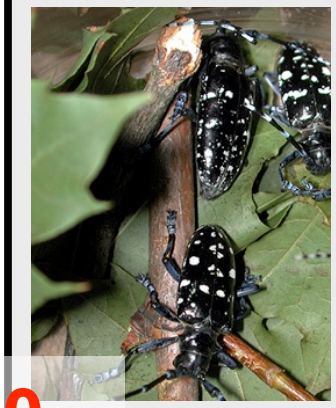
40-80% of established alien species in Europe have been recorded >1950

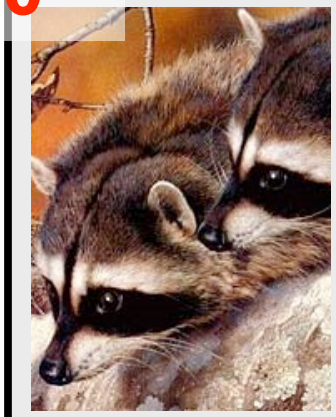
Lambdon et al. 2008, Preslia 80, 101-149

And so are their impacts: ecosystem services



# of impacts has trippled since 1900





Rabitsch et al. 2012, "*Number of affected ecosystem services over time for the DAISIE list of the '100 of the worst' IAS*"

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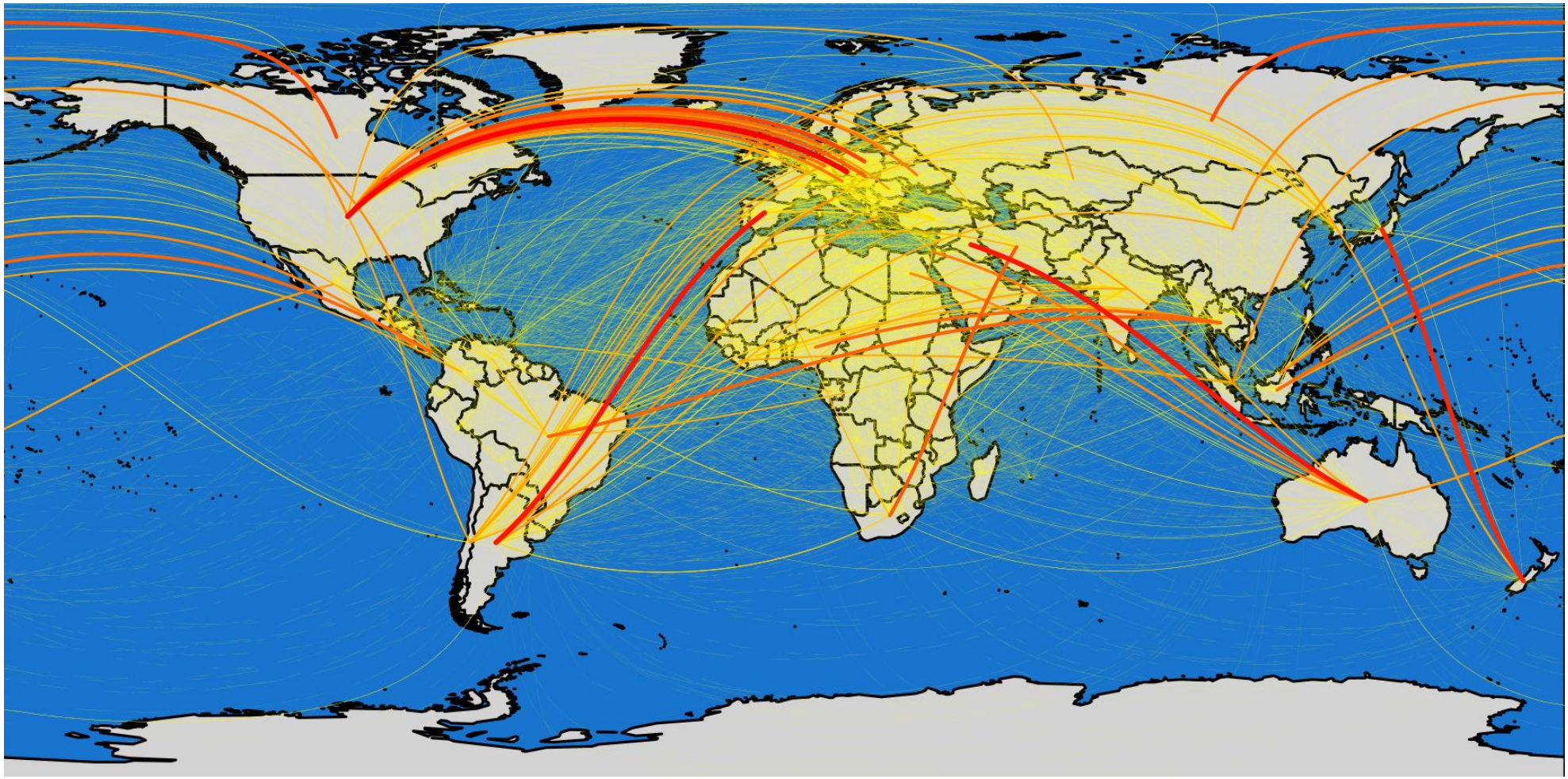
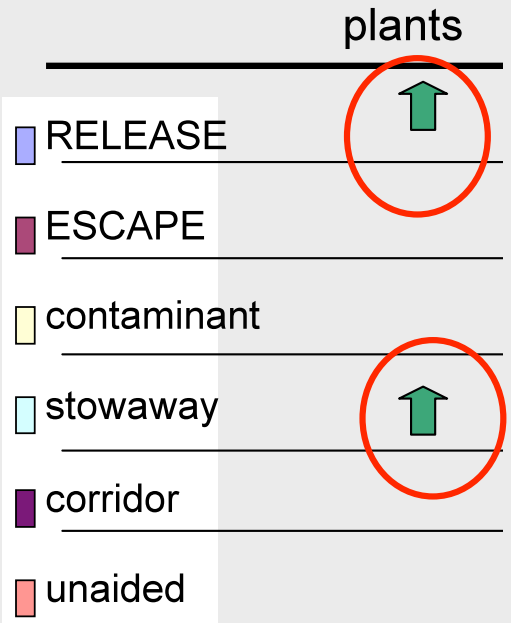
This is driven by globalization: trade (proxy for pathways)



Patterns of global bilateral trade, Seebens et al. in prep.

Understanding how pathways influence naturalization and invasion success may enhance prevention



Journal of Applied Ecology 2008, **45**, 403–414 doi: 10.1111/j.1365-2664.2007.01442.x

Grasping at the routes of biological invasions: a framework for integrating pathways into policy

P. E. Hulme[1,2*], S. Bacher[3], M. Kenis[4], S. Klotz[5], I. Kühn[5], D. Minchin[6], W. Nentwig[3], S. Olenin[7], V. Panov[8], J. Pergl[9], P. Pyšek[9,10], A. Roques[11], D. Sol[12], W. Solarz[13] and M. Vilà[14]

Some pathways are more likely to cause impacts of alien plants than others

Pergl et al. in prep.

Political context: AICHI Target 9 (CBD)

By 2020, invasive alien species and **pathways are identified and prioritized, priority species are controlled or eradicated, and** measures are in place to **manage pathways to prevent** their introduction and establishment

- Define lists of species and pathways
- Identify priority pathways for focusing prevention
- Identify priority species for response

The political context: EU Instrument on IAS

Brussels, 9.9.2013
COM(2013) 620 final

2013/0307 (COD)

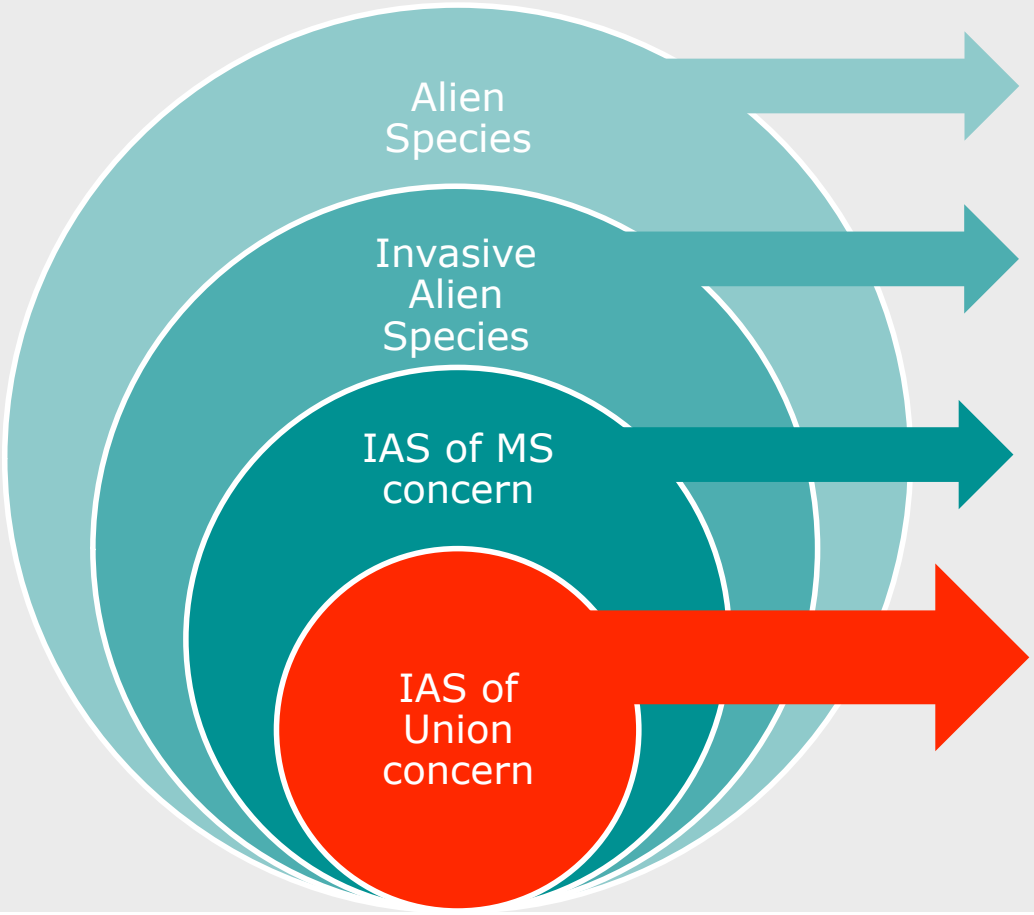
Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on the prevention and management of the introduction and spread of invasive alien species

{SWD(2013) 321 final}
{SWD(2013) 322 final}
{SWD(2013) 323 final}

List of alien species of EU-concern



- 12000+ species
- 1200-1500 species?
- ? species

- On the basis of risk assessment
- Member states have to take precautionary and management measures

→ need for screening of IAS invasion / impact potential

Identify priority pathways

Article 11

Action plans on the pathways of invasive alien species

Member States shall, by [*18 months from the entry into force of this Regulation – date to be inserted*] at the latest carry out a comprehensive analysis of the pathways of unintentional introduction and spread of invasive alien species in their territory and identify the pathways which require priority action ('priority pathways'), because of the volume of species or of the damage caused by the species entering the Union through them. In doing so, Member States shall in particular focus on an analysis of the pathways of introduction of invasive alien species of Union concern.

→ need to assess the importance of major invasion pathways

Roadmap for EU policy on IAS

- Currently in EU parlament for stakeholder and MS input
- EP intends to adopt IAS regulation in this legislative period (by End of March 2014)

	Commission	Member States
Year 1	Establish list of IAS of Union concern	Put in place border control MS with ORs: develop OR specific lists
Year 1.5		Put in place surveillance system Analyse and prioritise pathways
Year 3		Action plan on pathways (every 4 yrs) First reporting to the Commission (every 4 yrs)
Year 5	Review and report to EP and Council	
Year 7		Review action plan on pathways Second report to the Commission
Gradual	**Update of the list Develop information support mechanism**	**Propose IAS for listing with RA** **Prioritisation of pathway management based on experience acquired**

WP 8: Stakeholder dissemination and policy advice

The EU has endorsed the preparation of a dedicated instrument on IS, which will be presented in mid-2013. This instrument should (among other issues) fill policy gaps and help to identify and prioritize pathways and species, and prevent the introduction and establishment of new IAS (EC 2008, 2011). […]

Thus, we will actively disseminate and discuss the project results with relevant stakeholders and policy makers. A two-day workshop will be held towards the end of this project (project month 33), to which we will invite different stakeholders (horticulture, plant breeding industry, botanical gardens, horticultural societies), nature conservation managers, representatives of the European commission (DG ENV, EEA), representatives of national governments, and other researchers. The workshop will explore the importance and consequences of deliberate plant species introductions in an era of global change.

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Horticulture as pathway for plant invasions: towards a European Black List

- Identify plant species alien in Europe (GloNAF) which are used as ornamentals (European Garden Flora; incl. frequency of planting from online catalogues, cf. Van Keken et al. etc.)
- Identify plant species alien outside Europe, which are used as ornamentals in Europe
- Add species-specific information on reported impacts (GISD-database, Vila et al.-impact database) and simple traits: life form, region of origin, reproduction mode, hardiness (TRY, BiolFlor, European Garden Flora)

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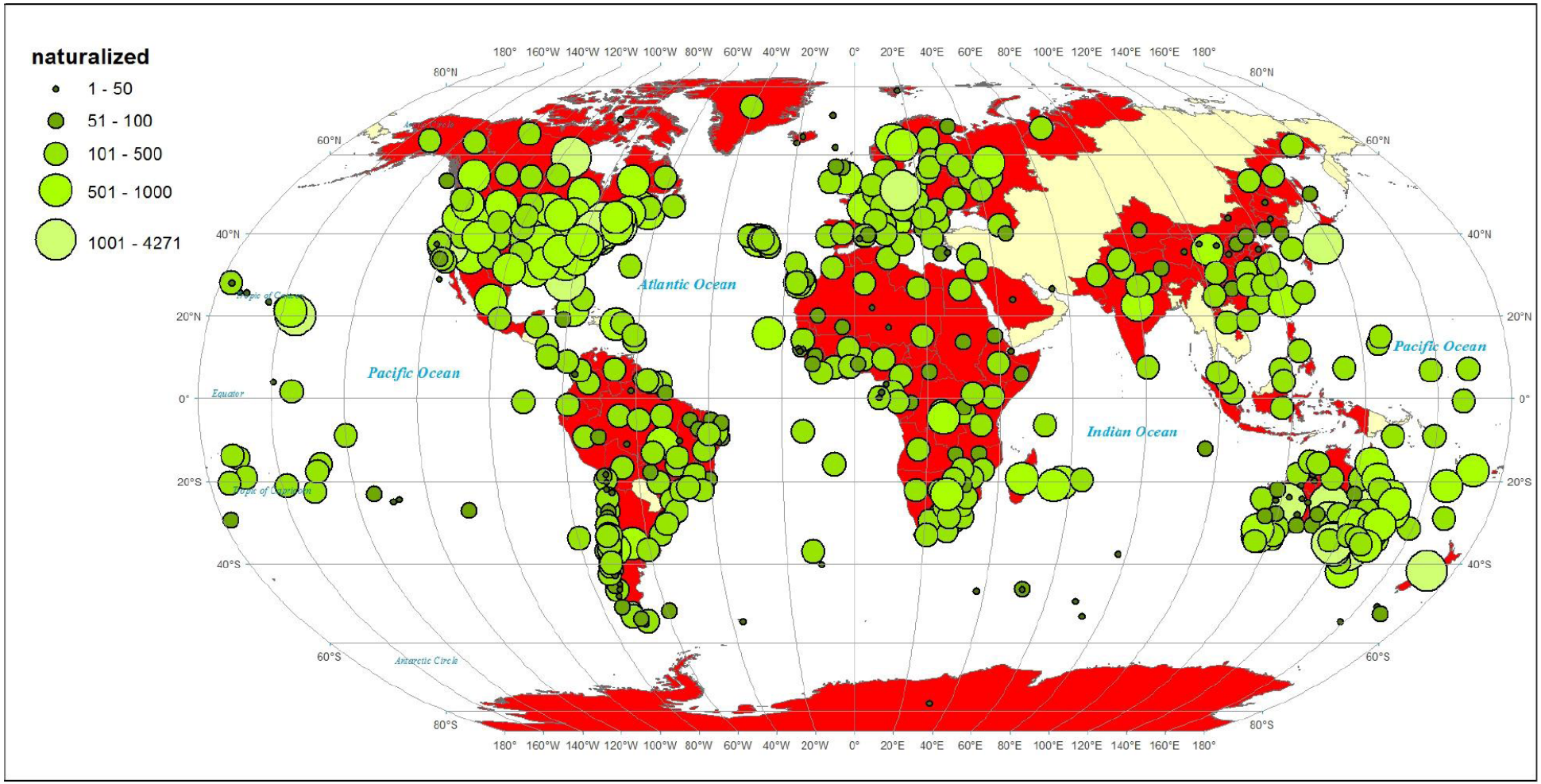
The GloNAF-database: alien plant distributions world-wide



>900 regions, c. 15,000 alien plant species; courtesy D Moser

Horticulture as pathway for plant invasions: expected results

- Establishing the European list of naturalized / invasive plant species introduced by horticulture (black list)
- Identifying potential future invaders for Europe (alert list): Which plants used as ornamentals in Europe invade elsewhere, and how frequently? Which one of these have recorded impacts and which ones?
- Does ornamental planting intensity increase the naturalization success (# countries invaded) and impact (# impacts recorded) in Europe? Are impacts more often recorded for alien plants introduced as ornamentals as for those not introduced by horticulture?

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Will climate change give ornamental species invasive outside Europe a headstart?

- Select Top 50 of ornamental plants recorded as naturalized outside from Europe adapted to warm climates (HD 4-5)
- SDM modelling (based on native and alien occurrences outside Europe, GBIF), and transfer of SDM-results to identify potential European range
- Compare with current distribution of cultivation of these species in Europe (cf. Van der Veken et al.)
- Use climate change scenarios to quantify overlap of current plantation with future climatically suitable regions in Europe

Contribution of WP8 to EU policy & Aichi targets?

- Define lists of species and pathways √
- Identify priority pathways for focusing prevention √
- Identify priority species for response √

→ inform the stakeholder WS (PM 33) and the wider community

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THIS IS THE END

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