Mind the functional gap - Functional assisted migration to sustain ecosystem functions under climate change

Prof. Koenraad Van Meerbeek – KU Leuven

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Division
Forest, Nature & Landscape

sGlobe lab
FROM INSIGHTS TO SOLUTIONS

erc
European Research Council
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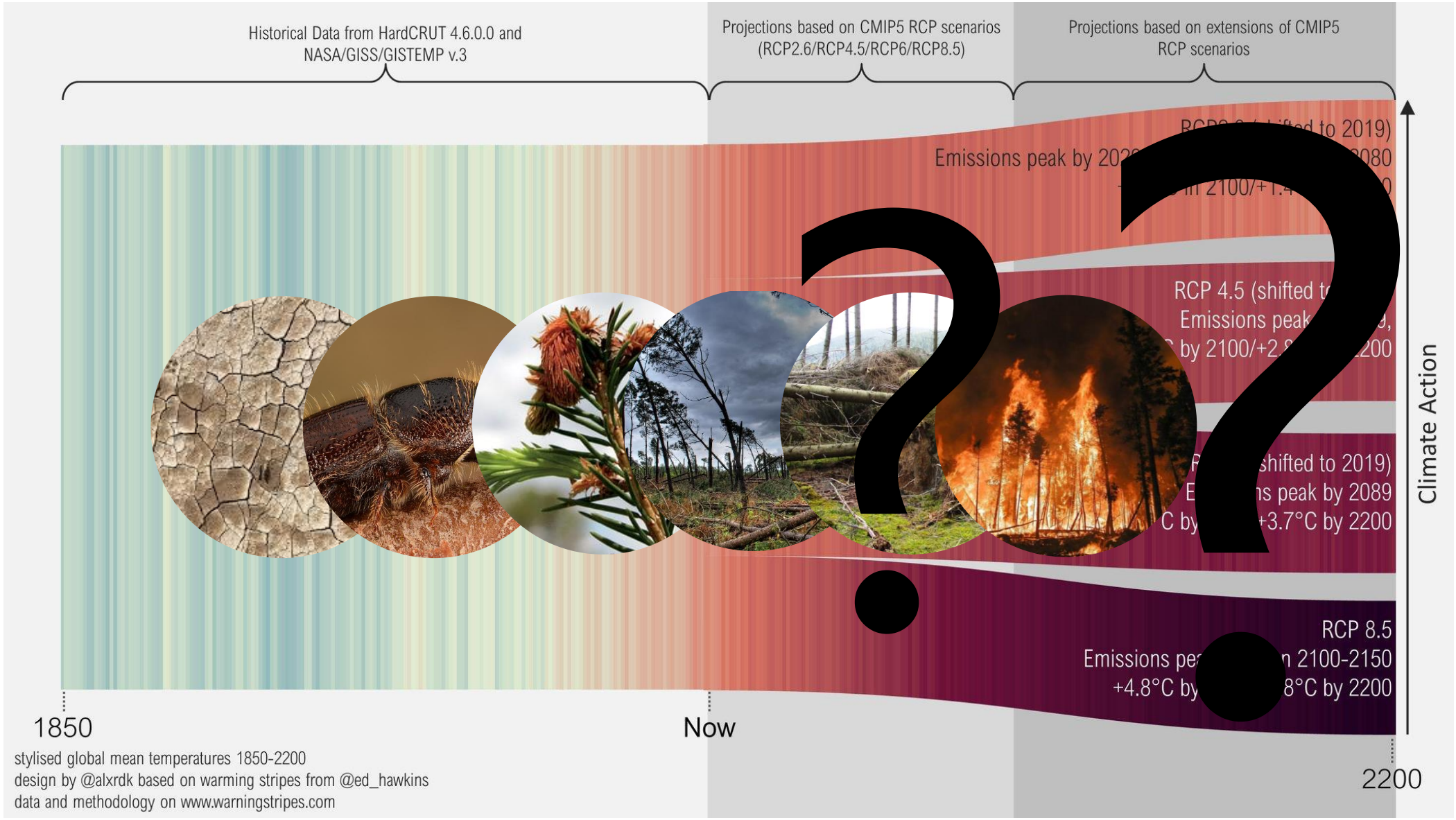
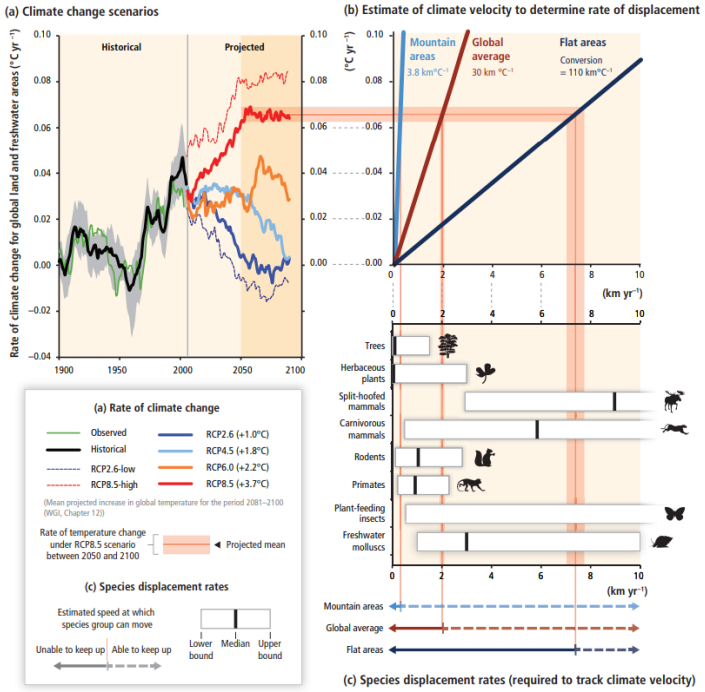
Climate change



Options under climate change

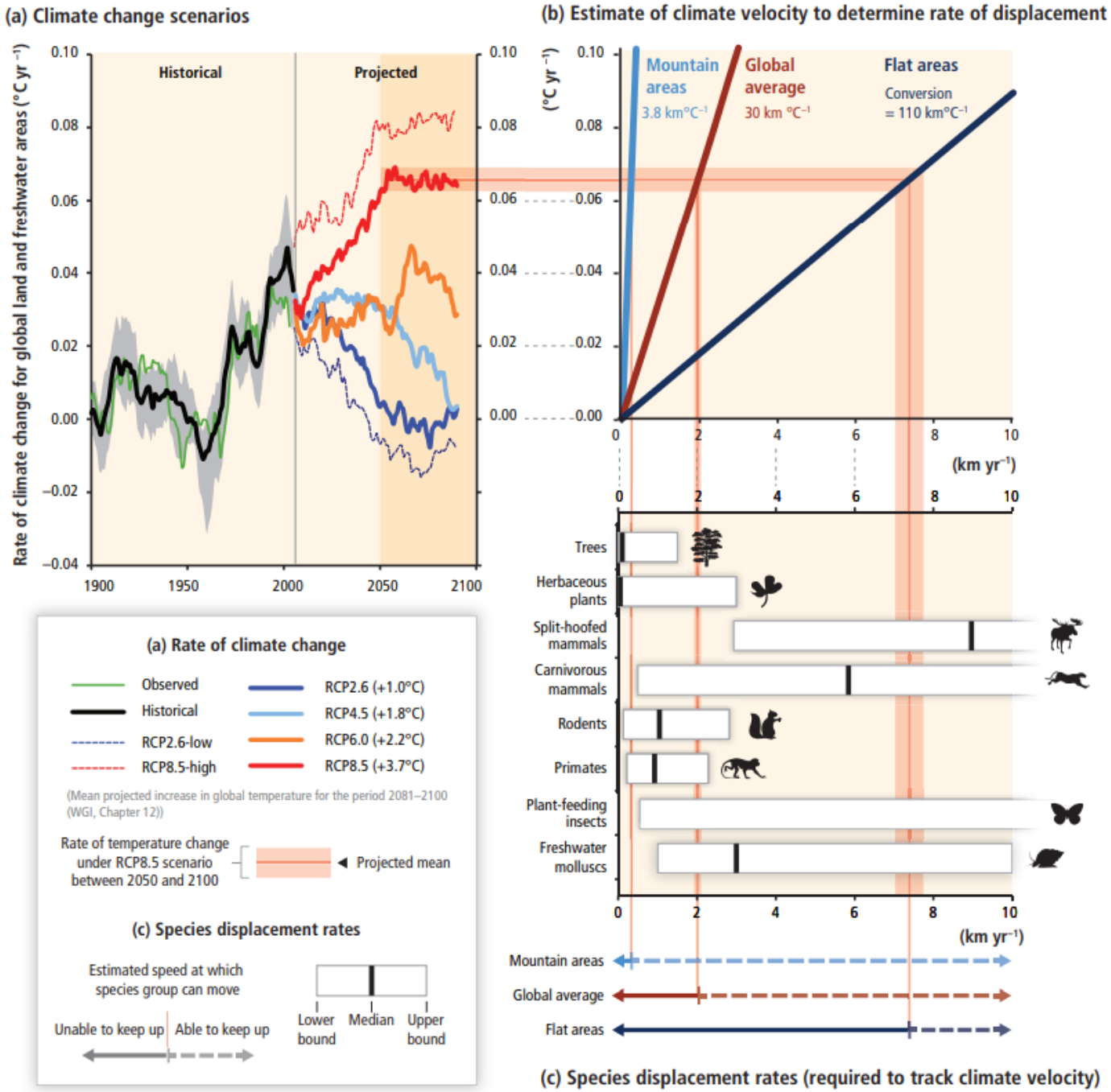
Migrate



Adapt

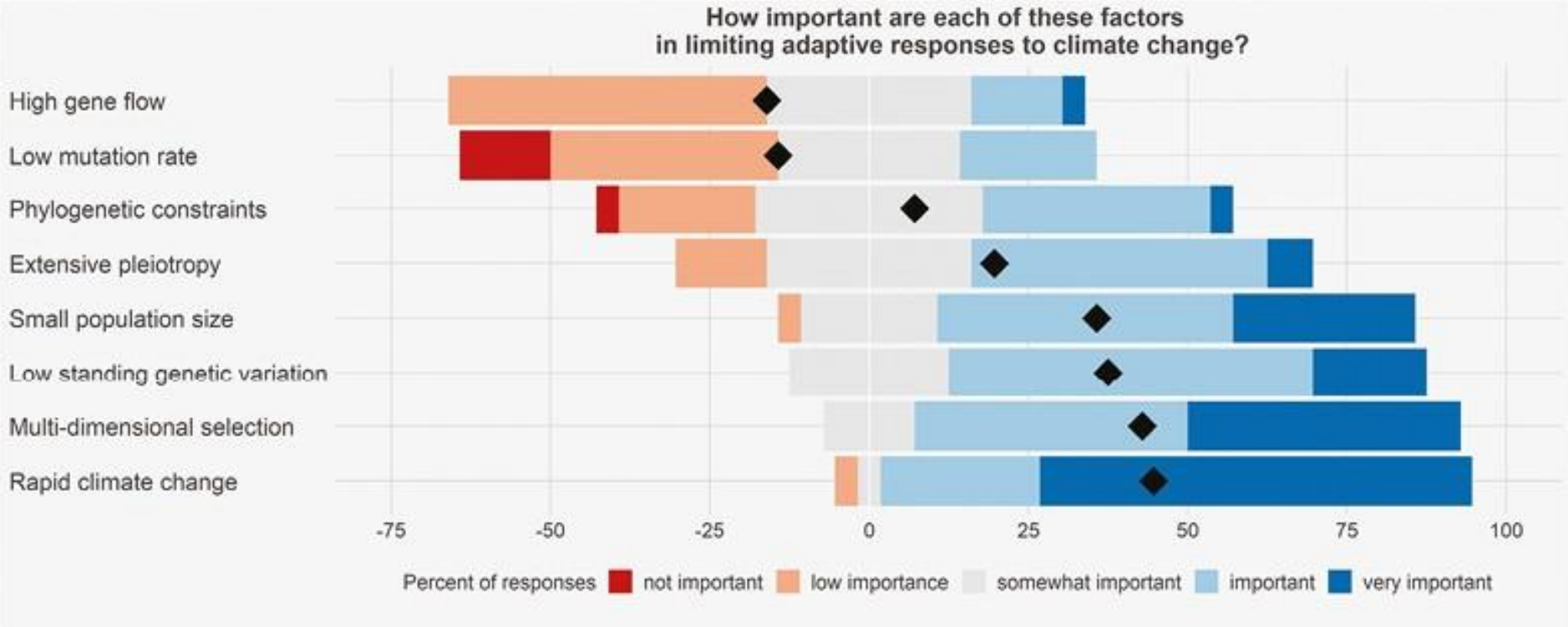
(Local) extinction

Migration



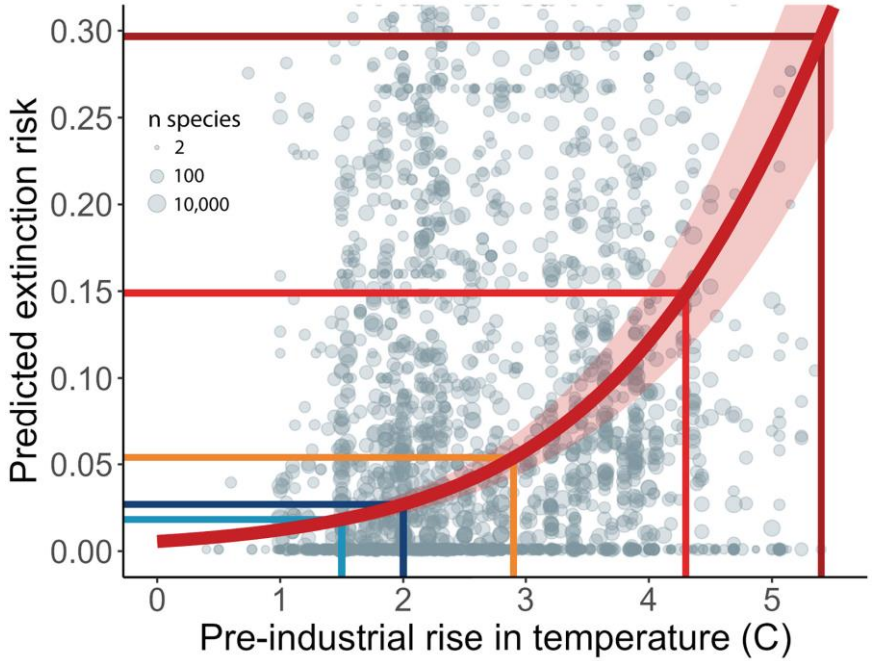
IPCC, 2014

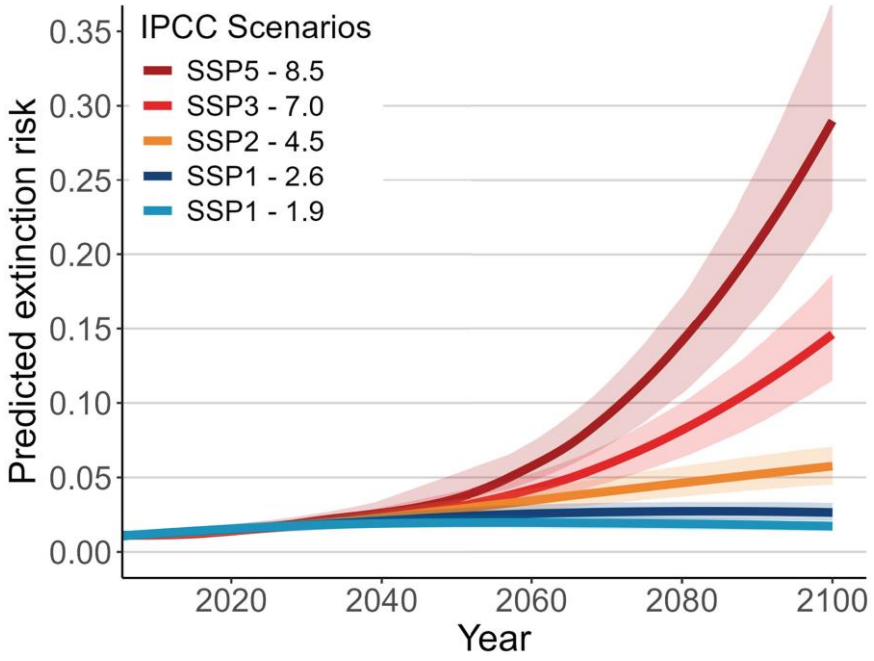
Adaptation

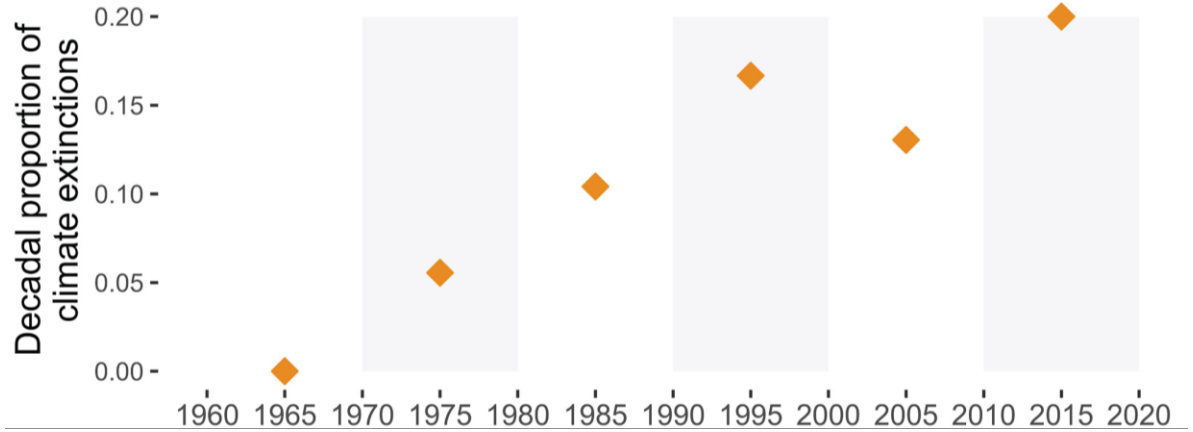


Urban et al. 2023. Evolution Letters

(Local) extinction

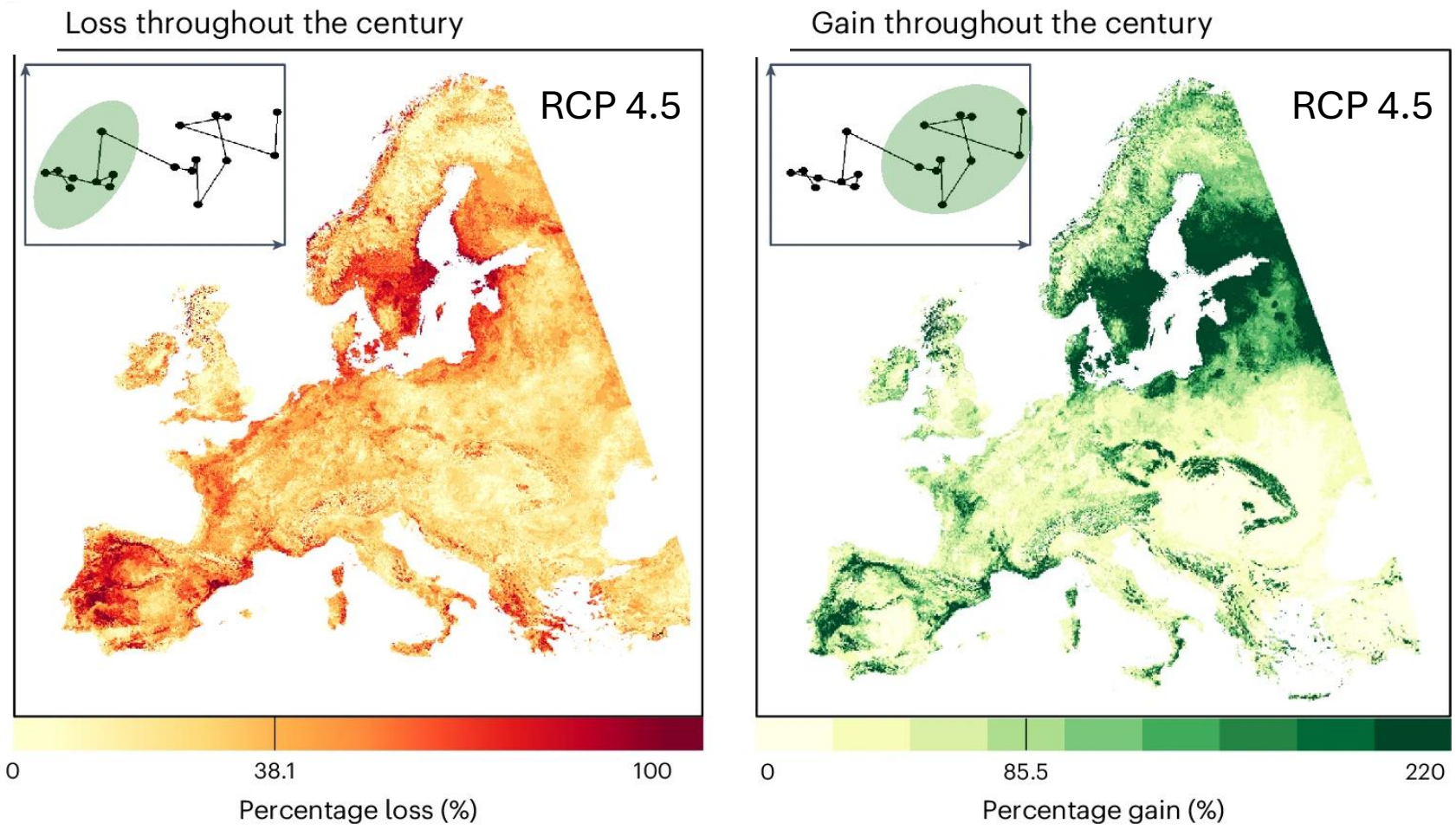






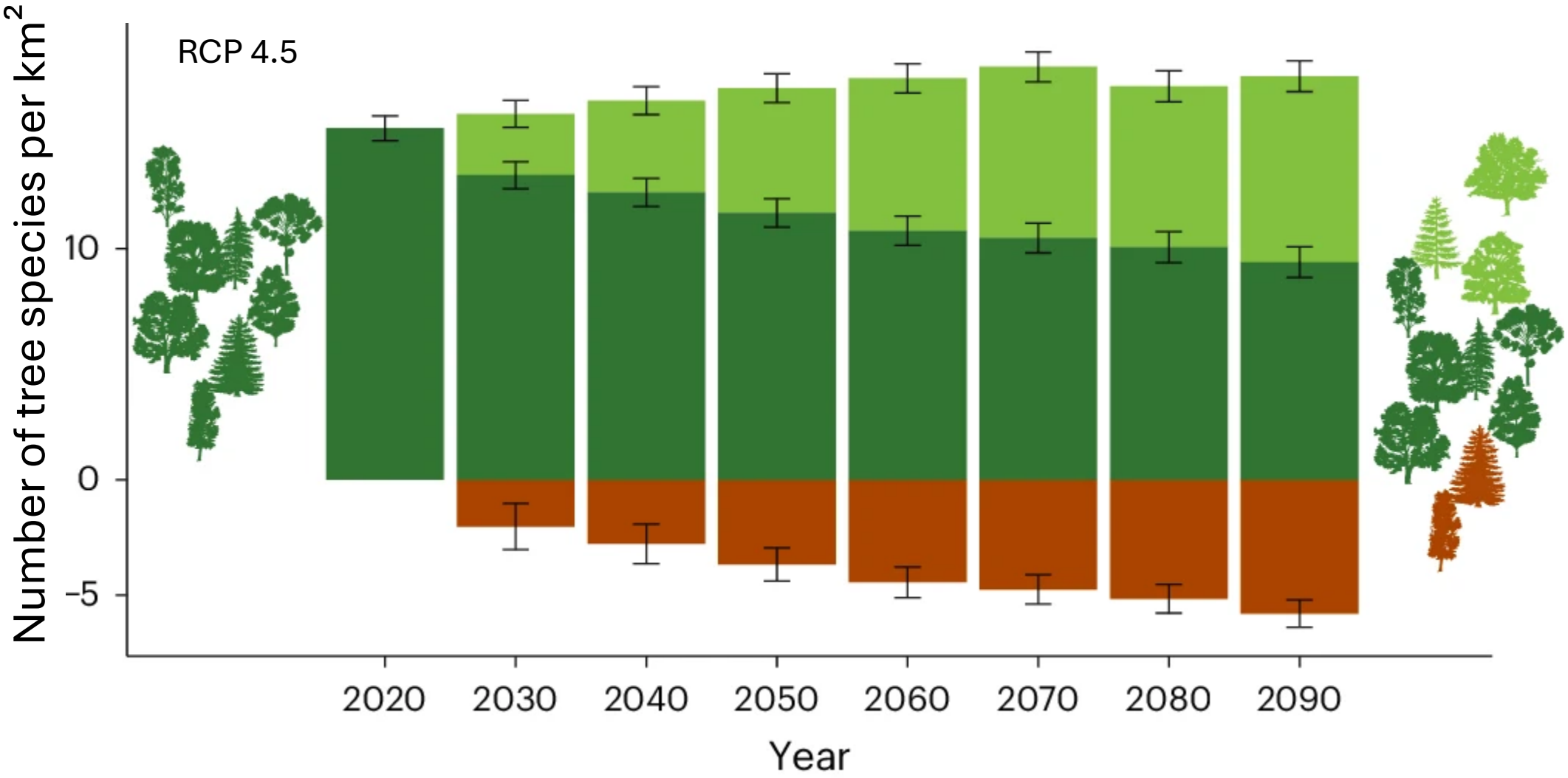
Urban, 2024. Science

Declining tree species pools



Wessely et al. 2024. Nature Ecology & Evolution

Declining tree species pools



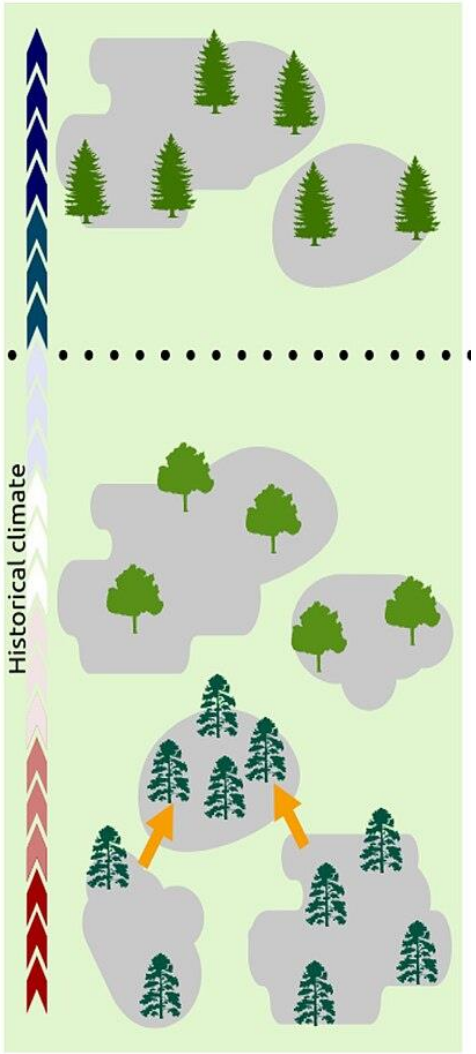
Wessely et al. 2024. Nature Ecology & Evolution

Degradation of forest resilience

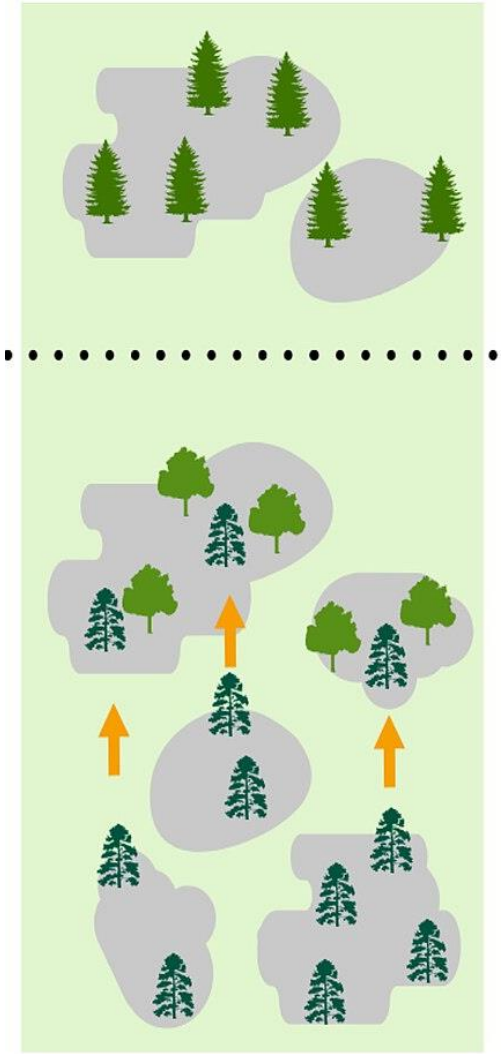
Hardtwald in Baden-Württemberg

Williams & Dumroese, 2013. Journal of Forestry

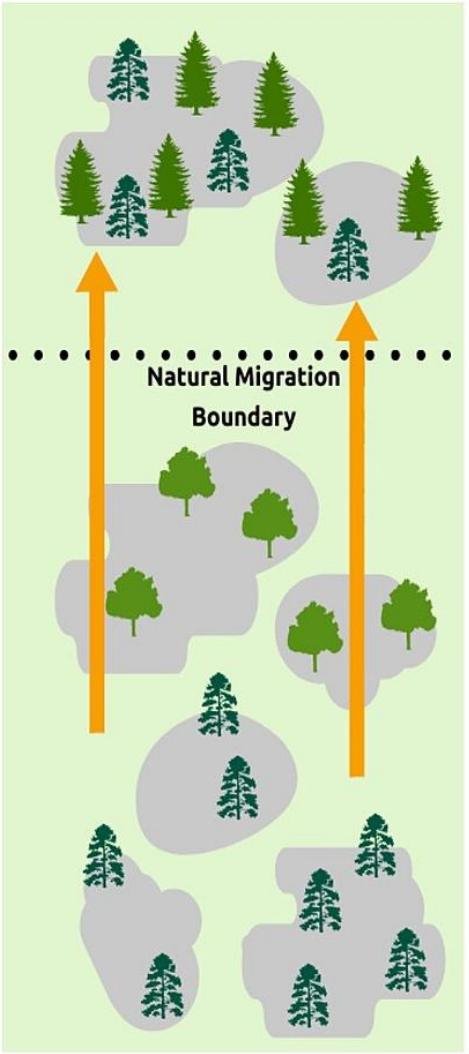
Assisted Migration



Assisted population migration



Assisted range expansion



Assisted species migration

Assisted Migration

"The translocation of representatives of a species or population harmed by climate change

to an area outside the indigenous range of that unit

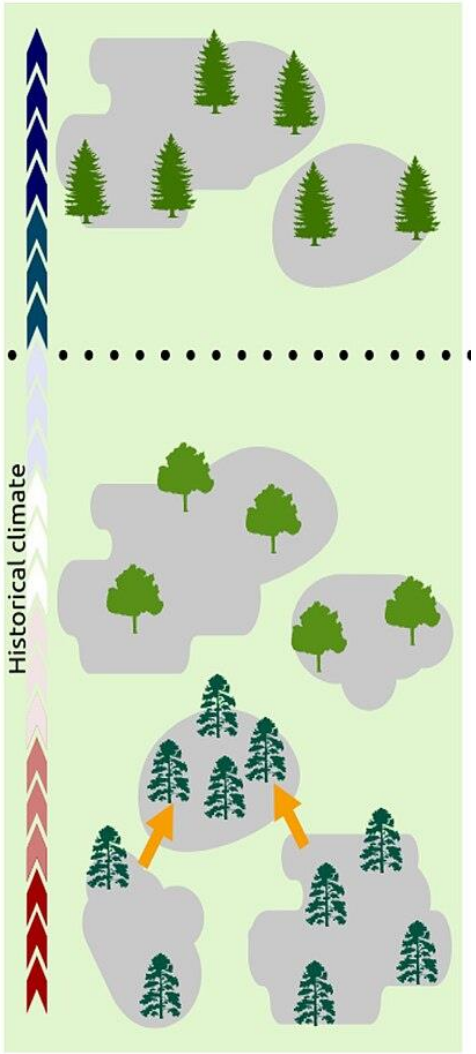
where it would be predicted to move as climate changes,

were it not for anthropogenic dispersal barriers or lack of time"

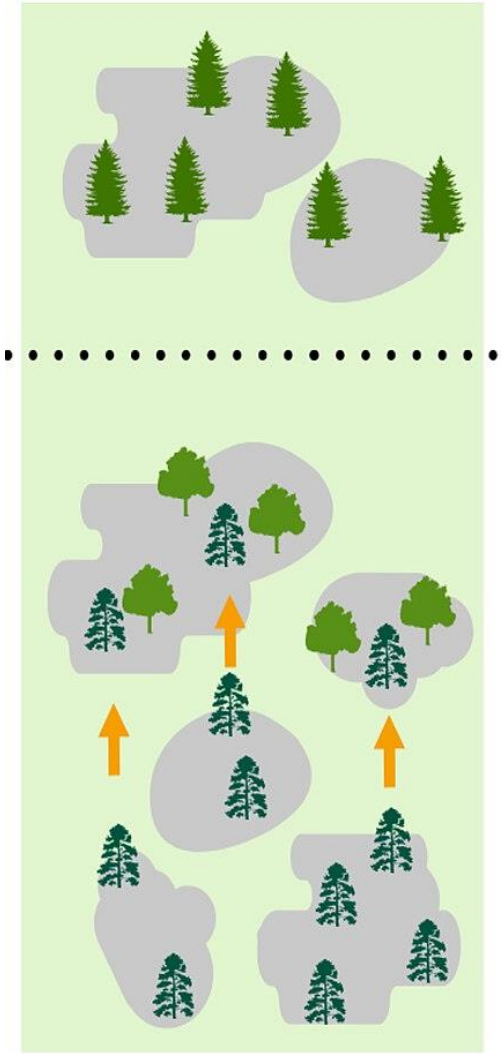
Hällfors et al. 2014. Plos One

Hällfors et al. 2014. Plos One

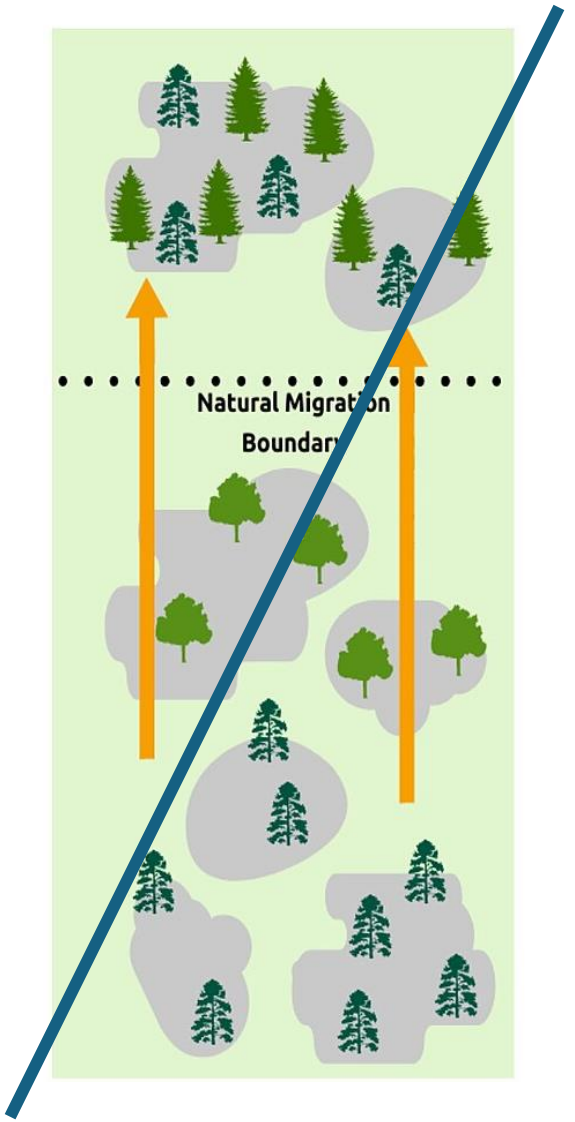
Assisted Migration



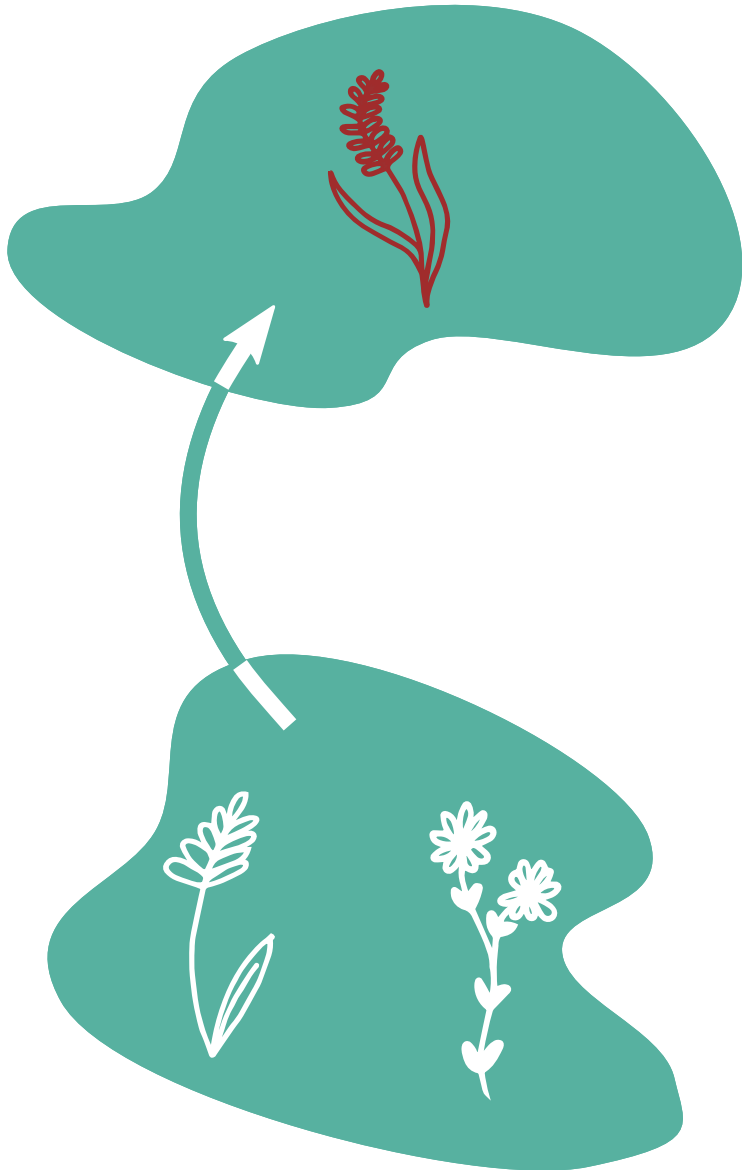
Assisted gene flow



Assisted range expansion



Risks and benefits assisted range expansion

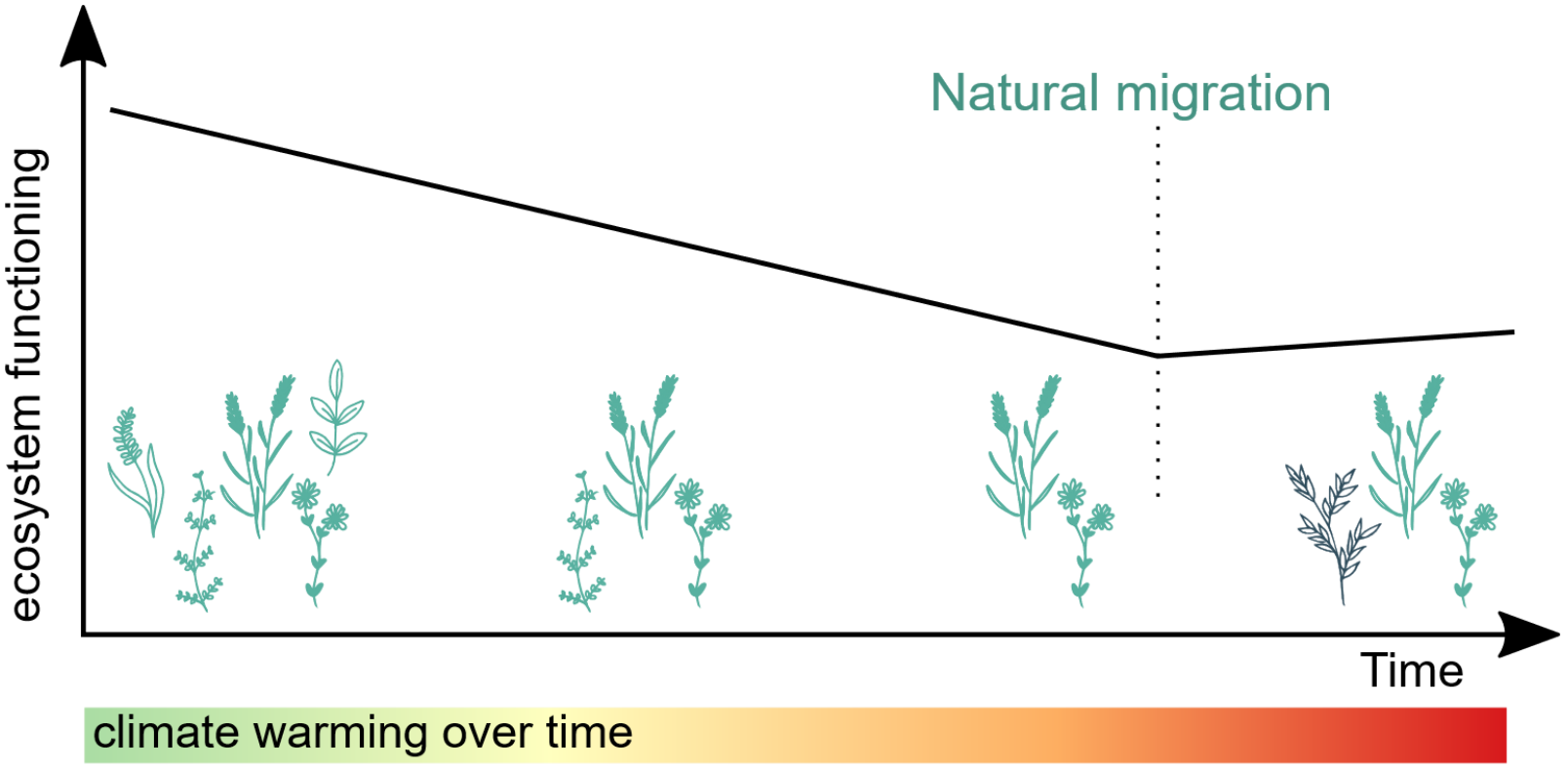


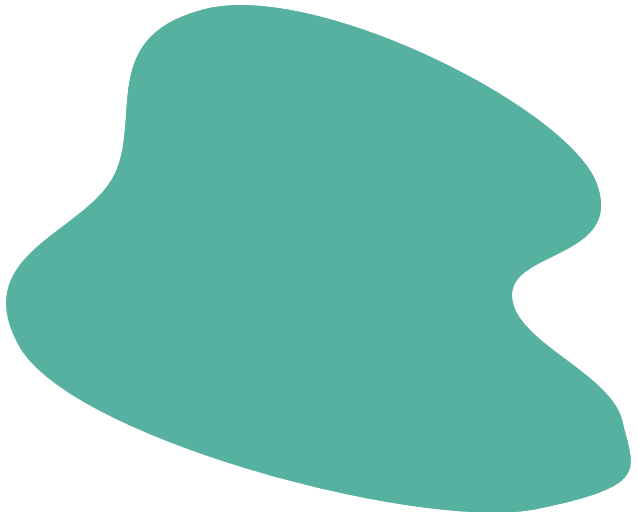
Perceived risk of introducing new invasive non-native species

Save species that are threatened by climate change

Prober et al. 2019. Ecological Monographs

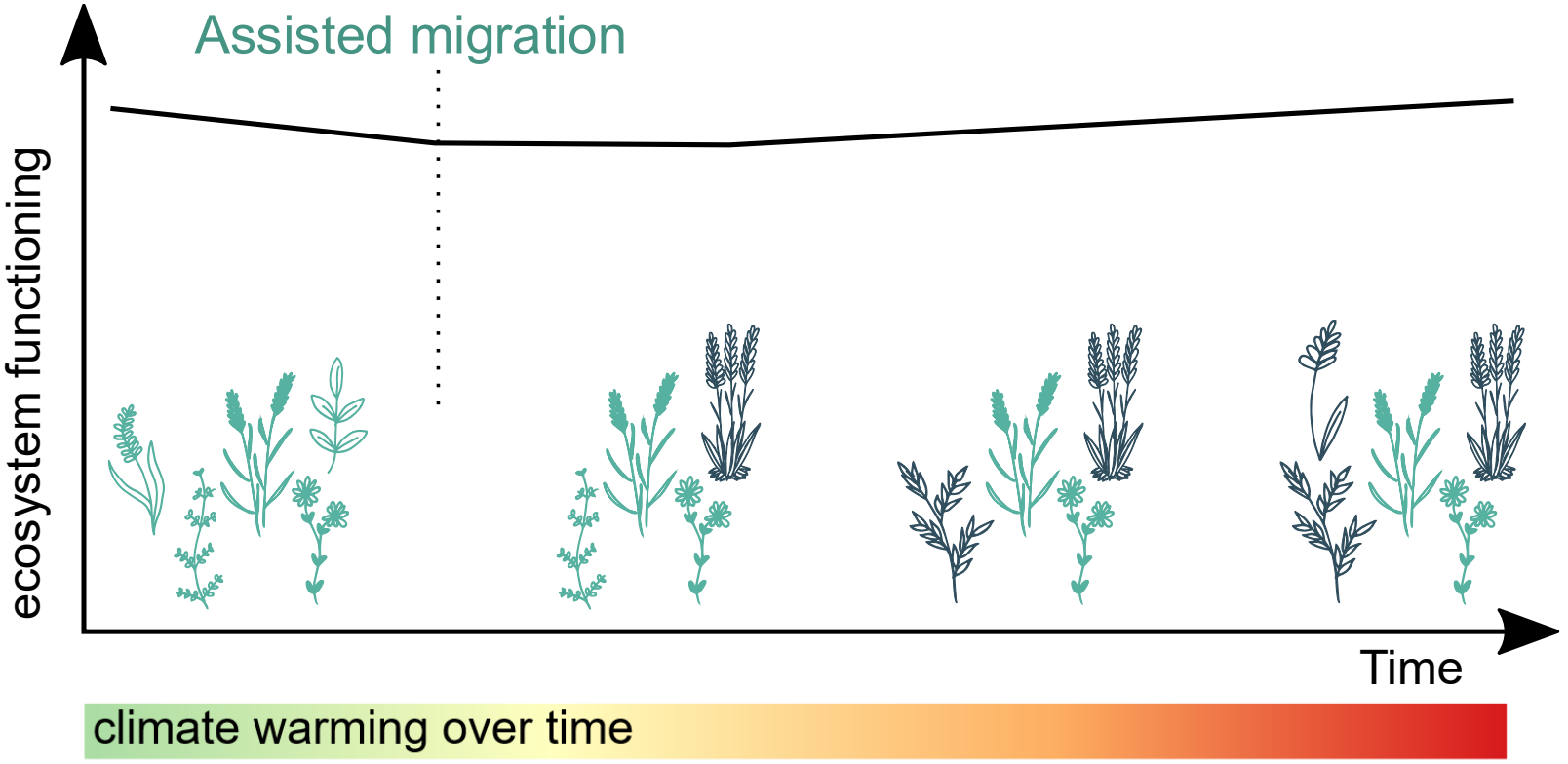
Ecosystem-functioning perspective

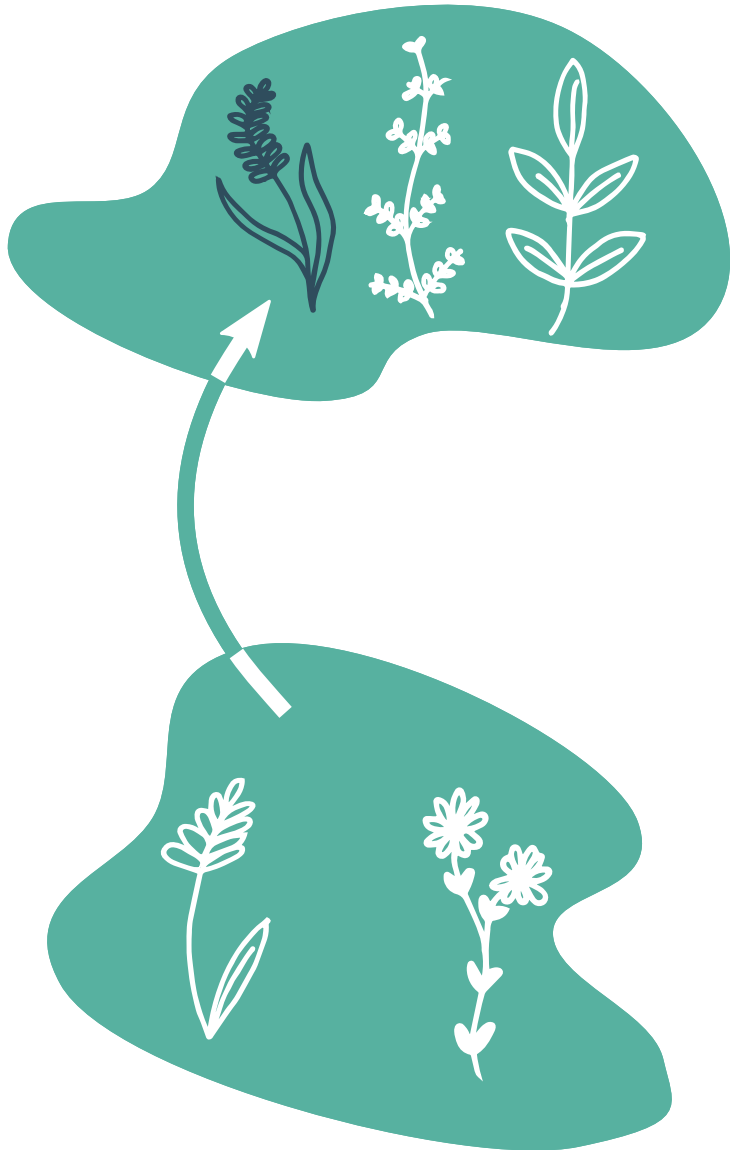




Van Meerbeek et al. 2025. EcoEvoRxiv

Ecosystem-functioning perspective





Van Meerbeek et al. 2025. EcoEvoRxiv

Functional Assisted Migration

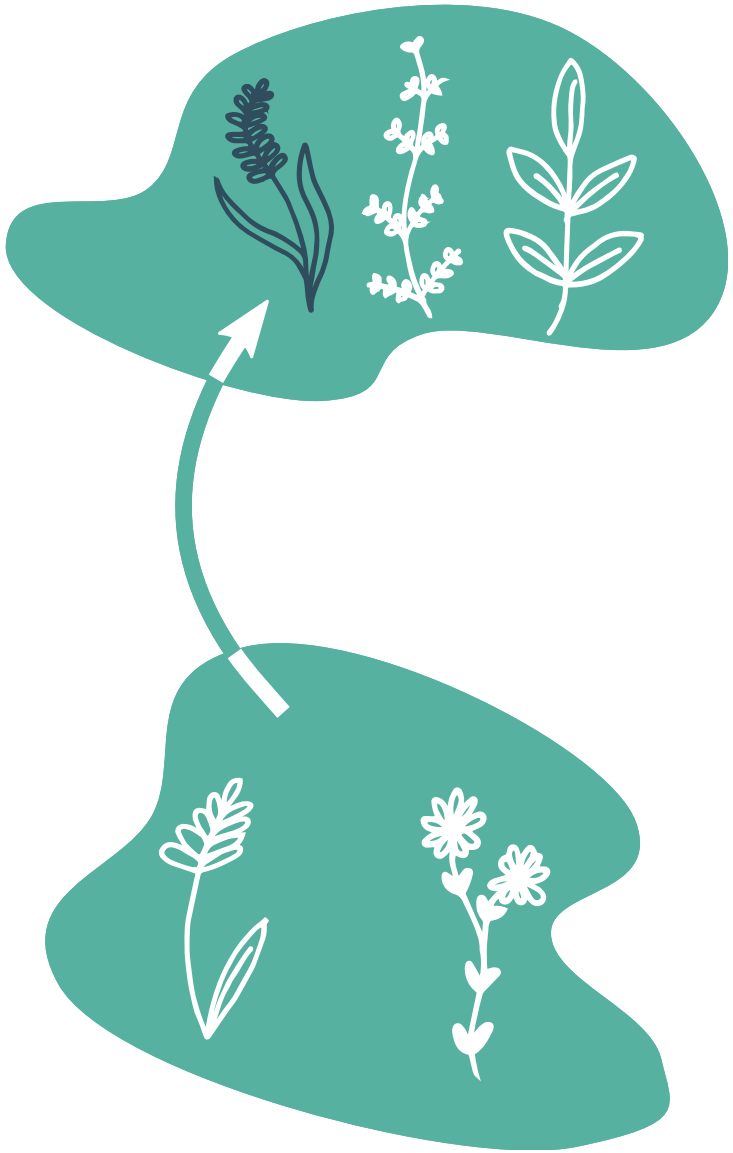
"The translocation of representatives of a species or population

to an area outside the indigenous range of that unit

where it would be predicted to move as climate changes,

were it not for anthropogenic dispersal barriers or lack of time

in order to preserve ecosystem functioning of the target region"



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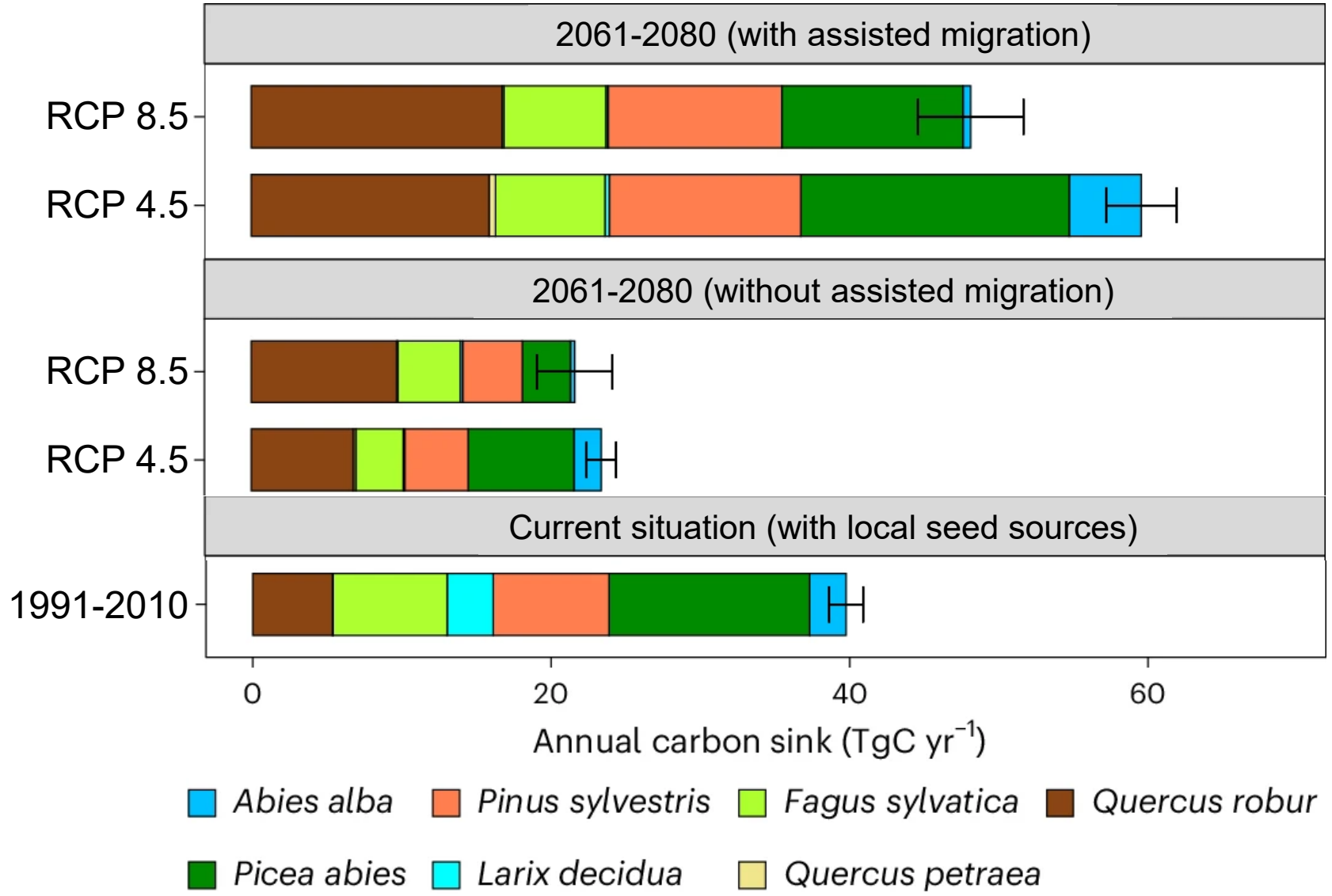
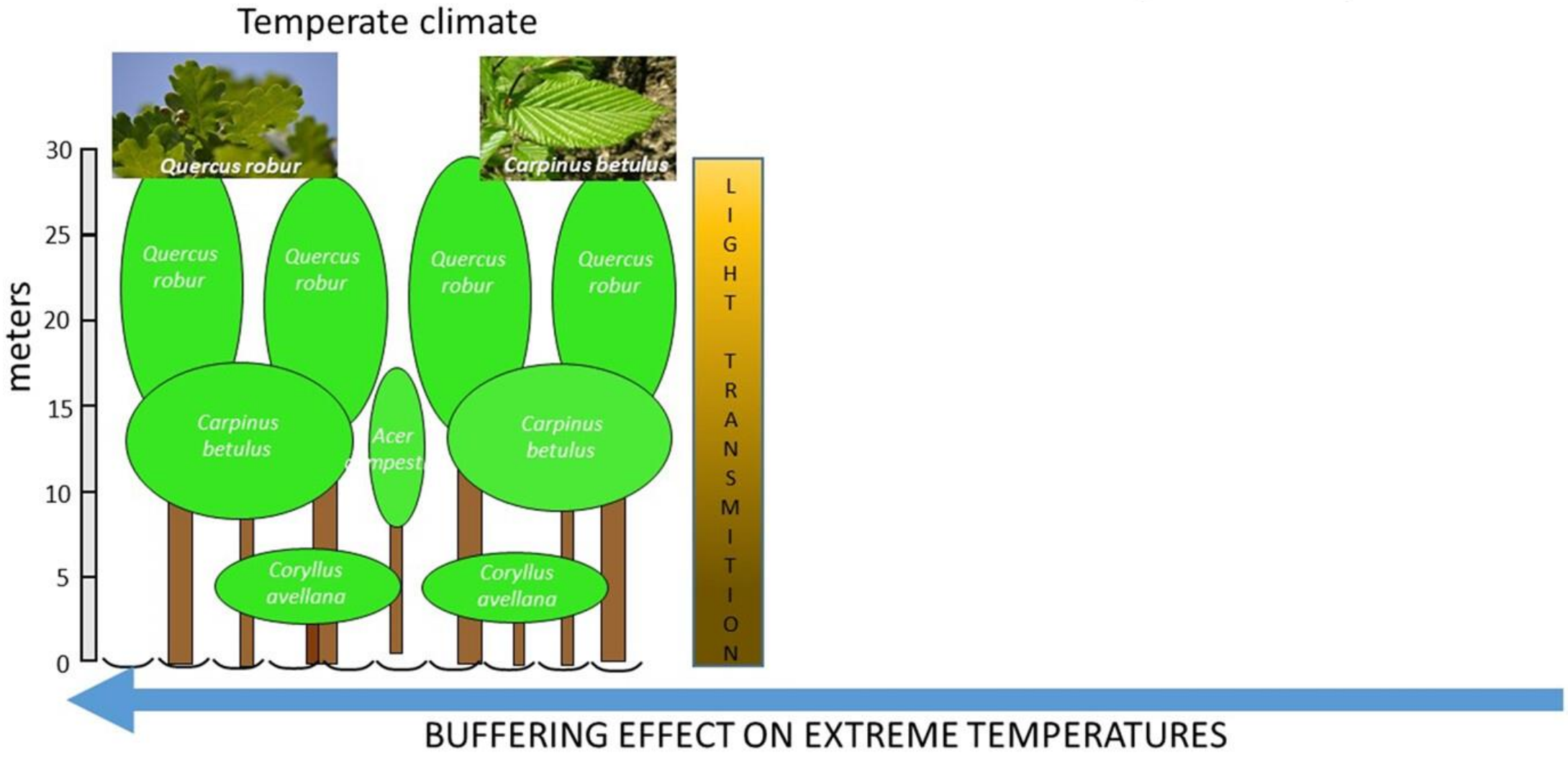
Forest carbon sink under climate change



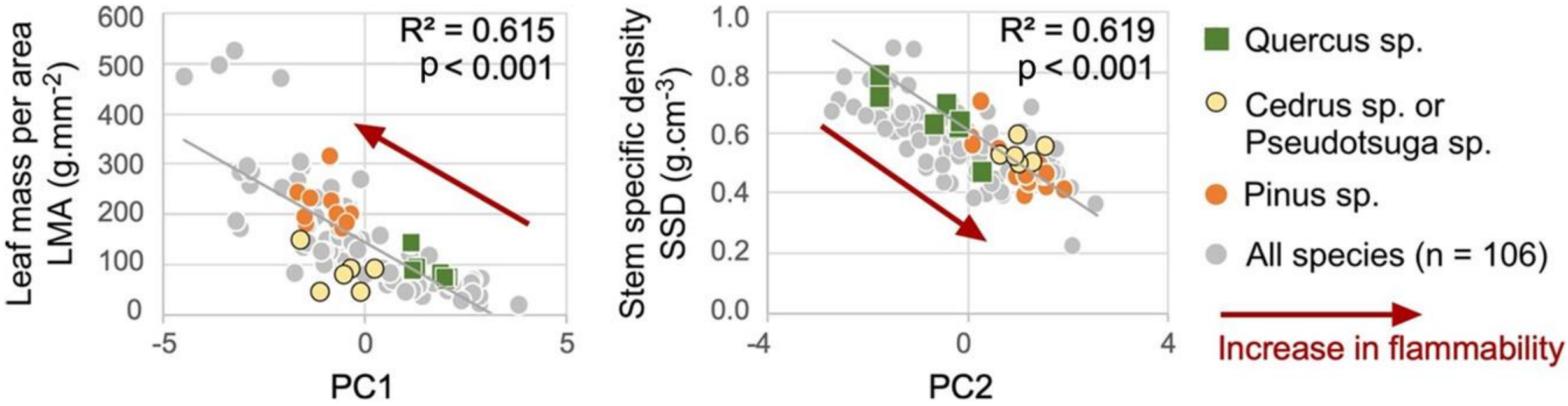
Chakraborty et al. 2024. Nature Climate Change

Decreasing microclimate buffer capacity?



Michalet et al. 2023. Oikos

Increase in flammability?

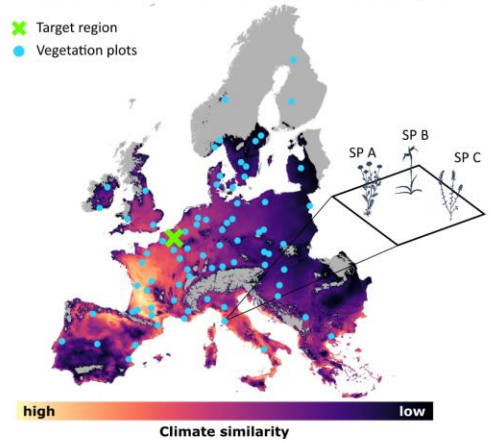


Michalet et al. 2023. Oikos

How to FAM?

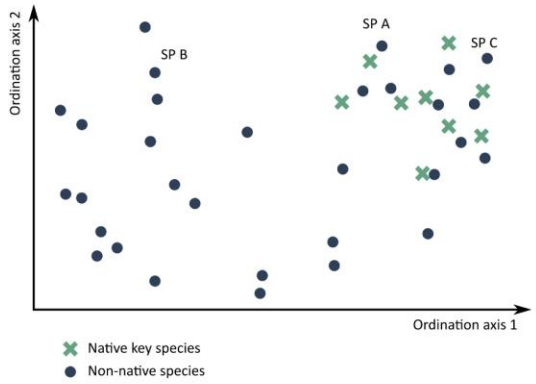
1. Climate analogues

Select vegetation plots in climate analogues of target region



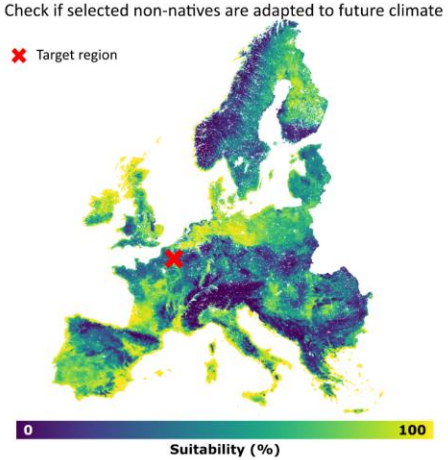
2. Co-occurrence analysis

Select species co-occuring with key species of native target community



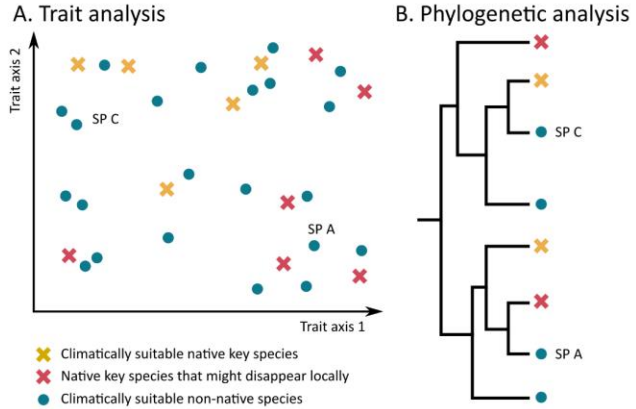
3. Climate suitability (SDM)

Identify native species that will disappear locally in the future
Check if selected non-natives are adapted to future climate



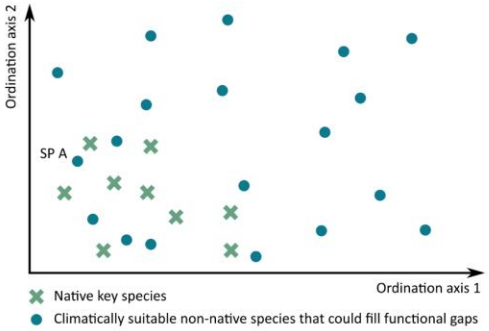
4. Functional gaps

Identify functional gaps left by native species that might disappear locally
Identify non-native species that can fill the predicted functional gaps



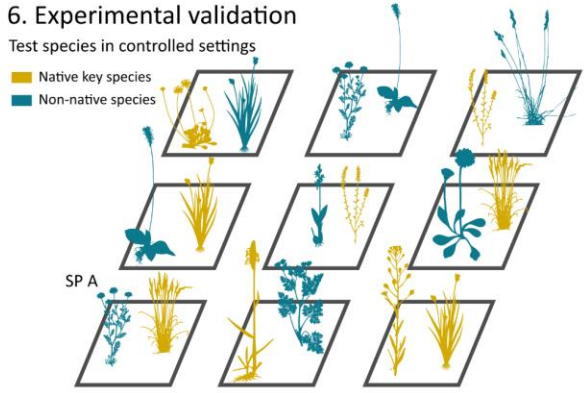
5. Edaphic suitability

Check if selected non-natives are adapted to edaphic conditions



6. Experimental validation

Test species in controlled settings



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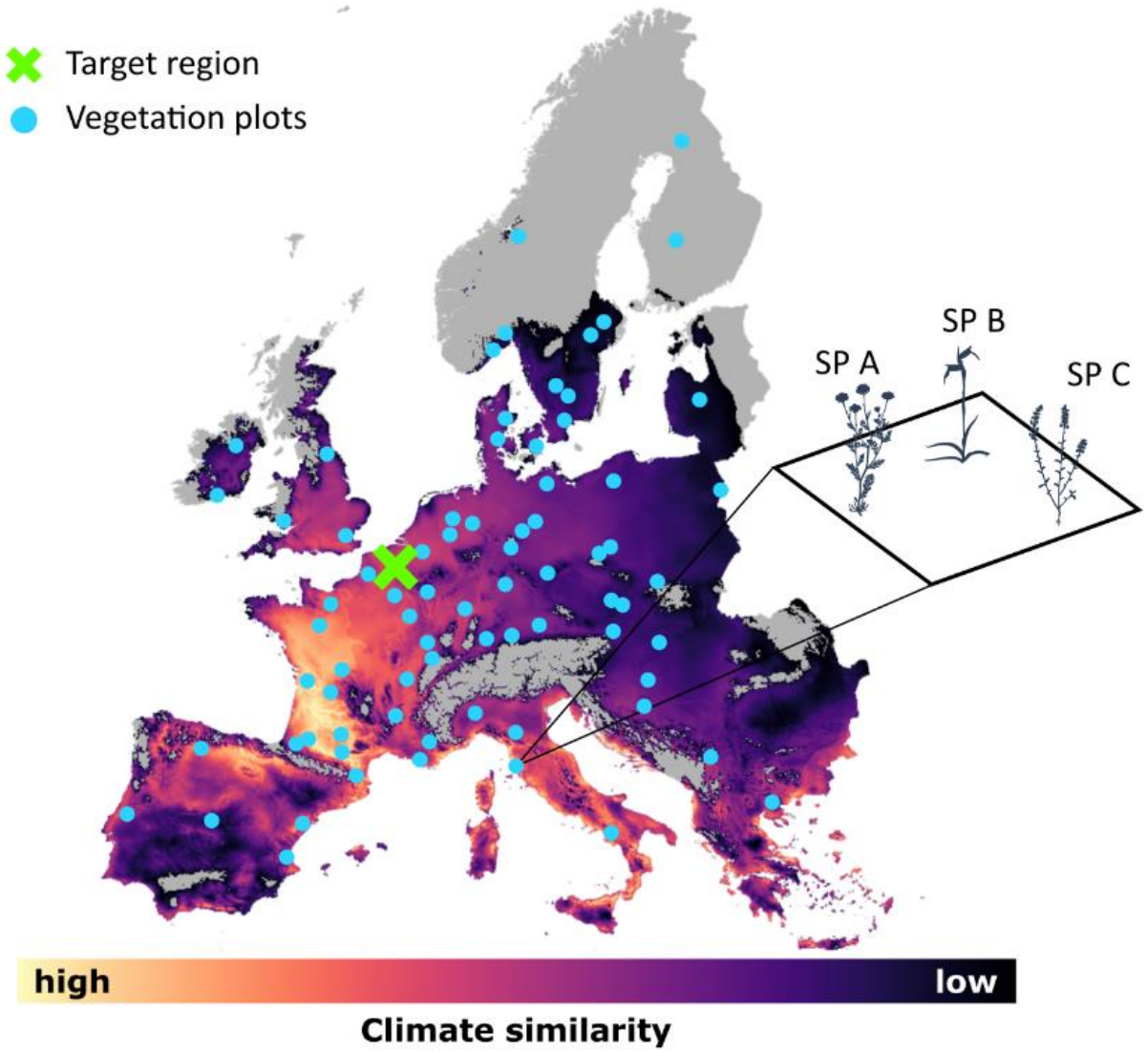
1. Climate analogues

Find climate analogue regions

Select vegetation plots in climate analogues of the target region



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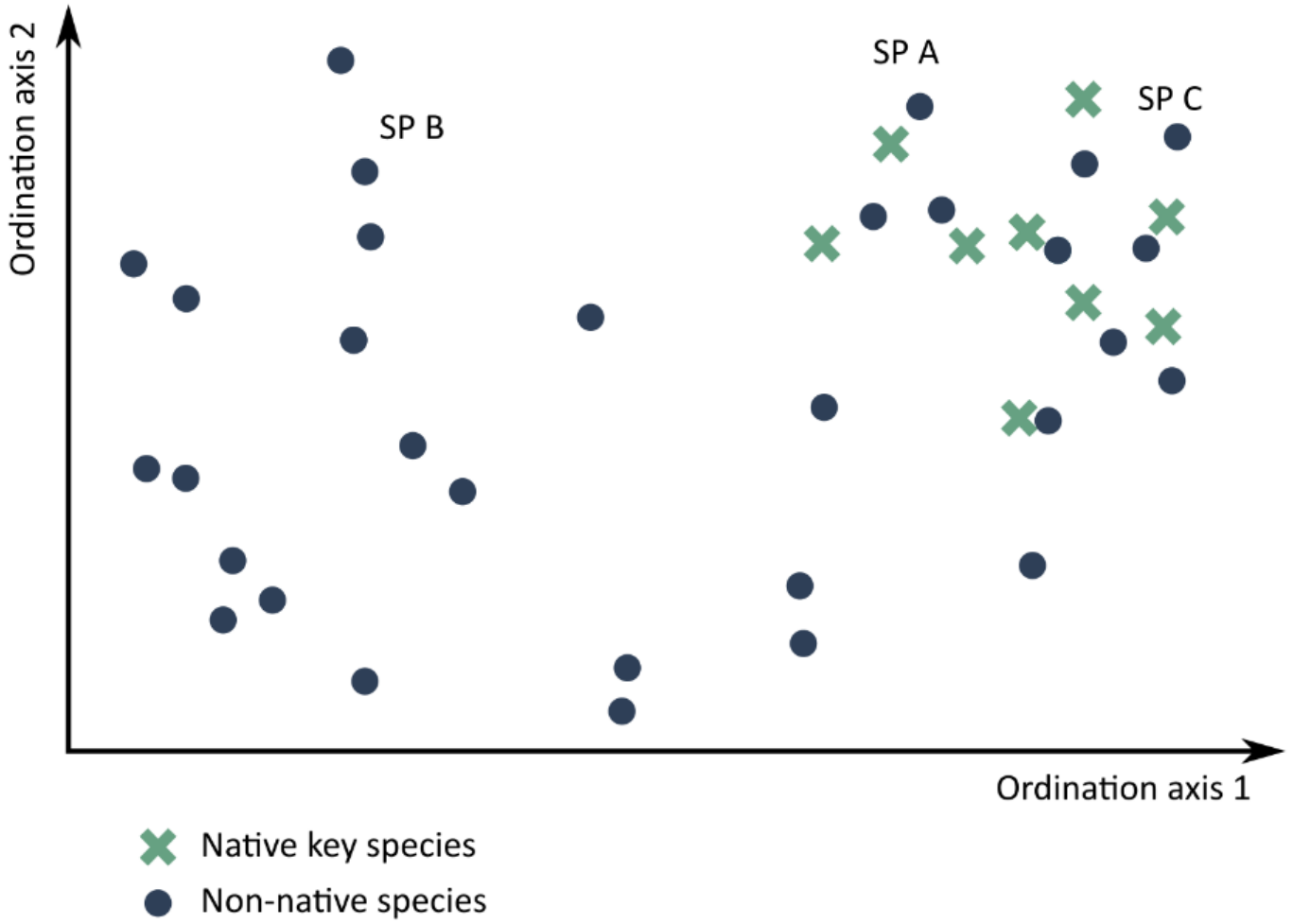
Select species co-occurring with key species of native target community



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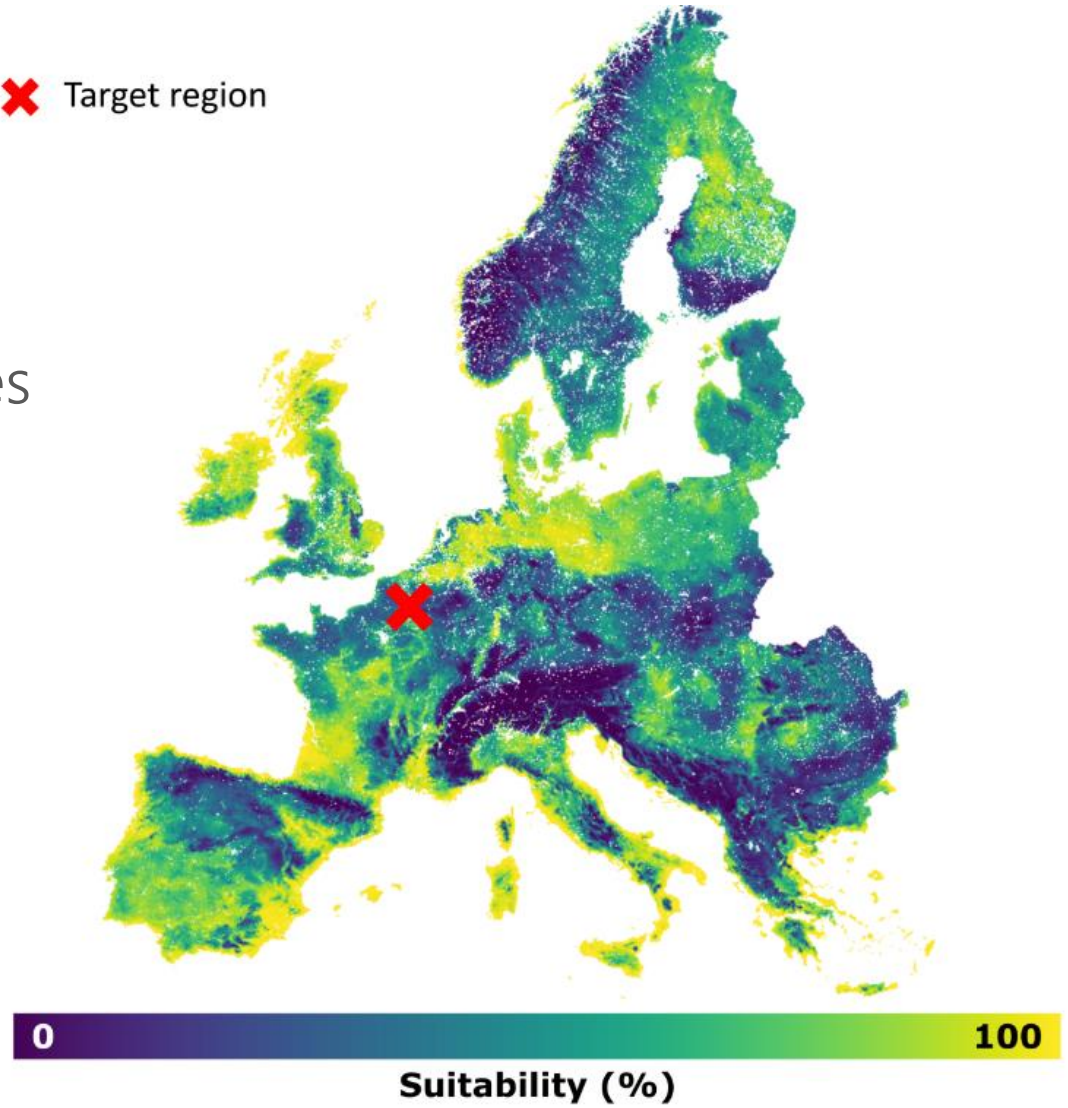
3. Climate suitability analysis

Identify native species that are likely to disappear locally in the future



Check if selected non-natives are adapted to future climate conditions

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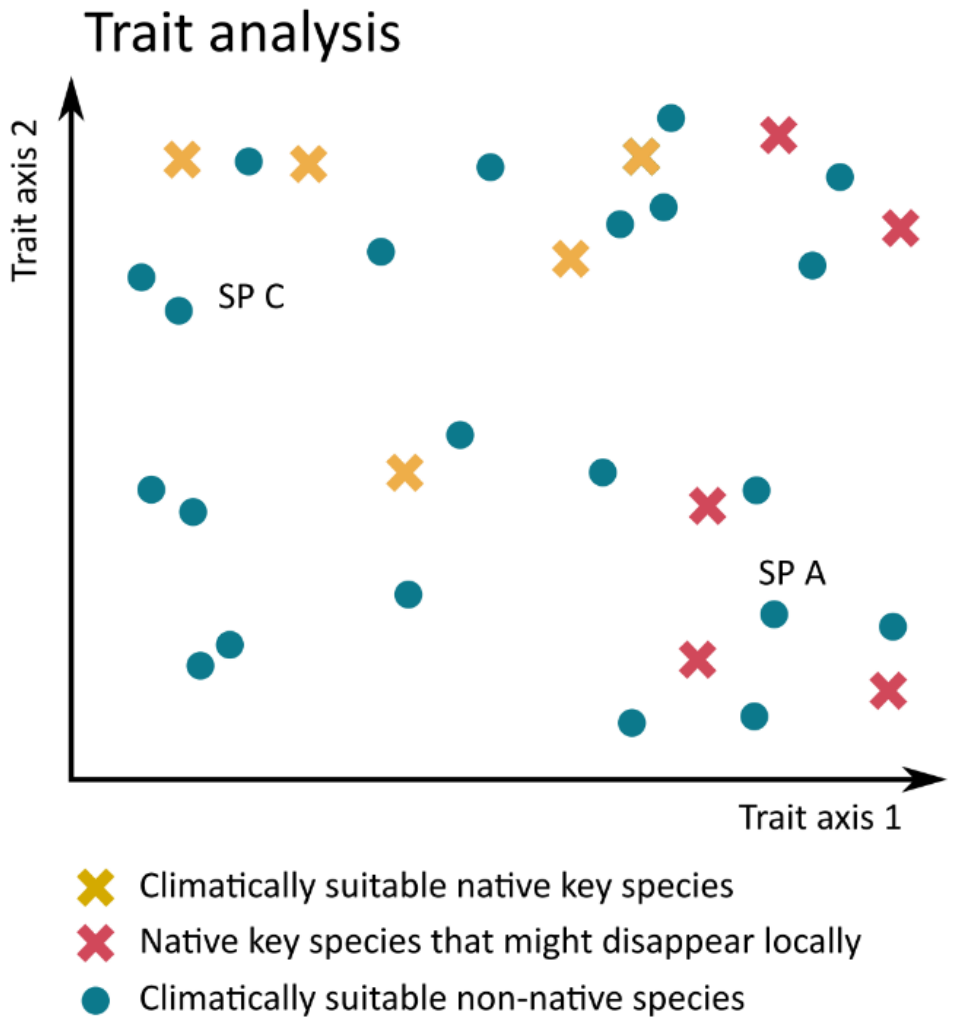
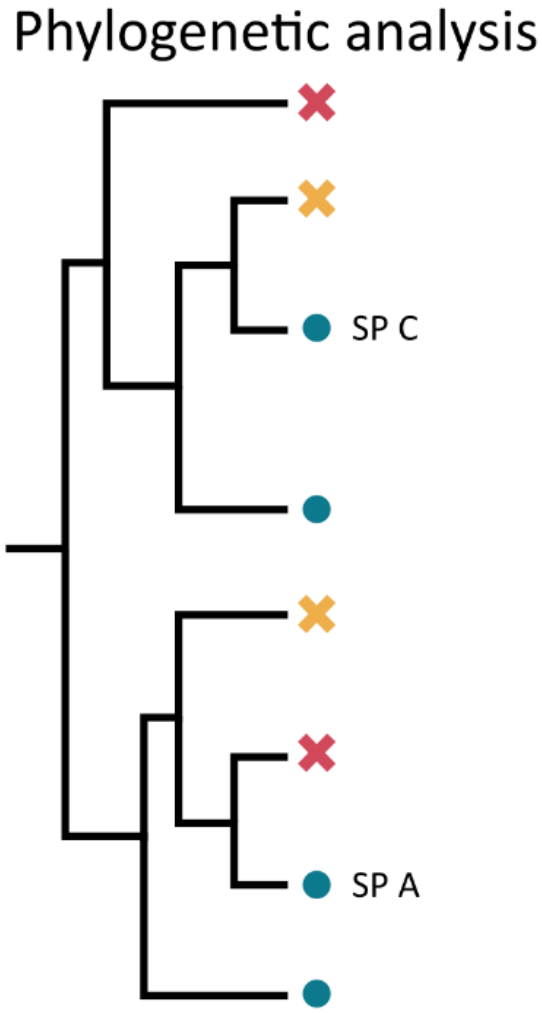
4. Functional gap analysis

Identify functional gaps left by native species that might disappear locally

Identify non-natives that are able to fill the predicted functional gaps





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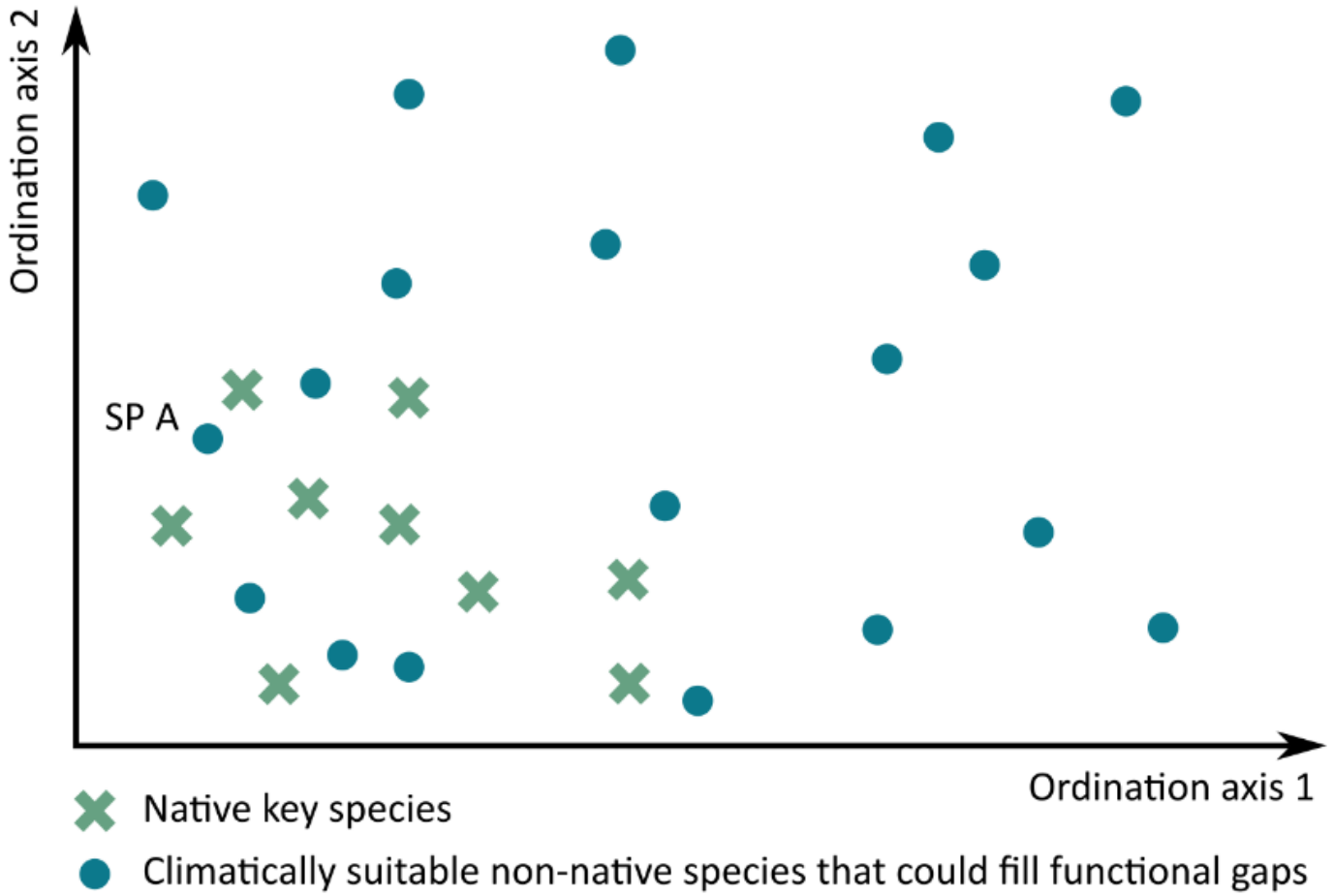

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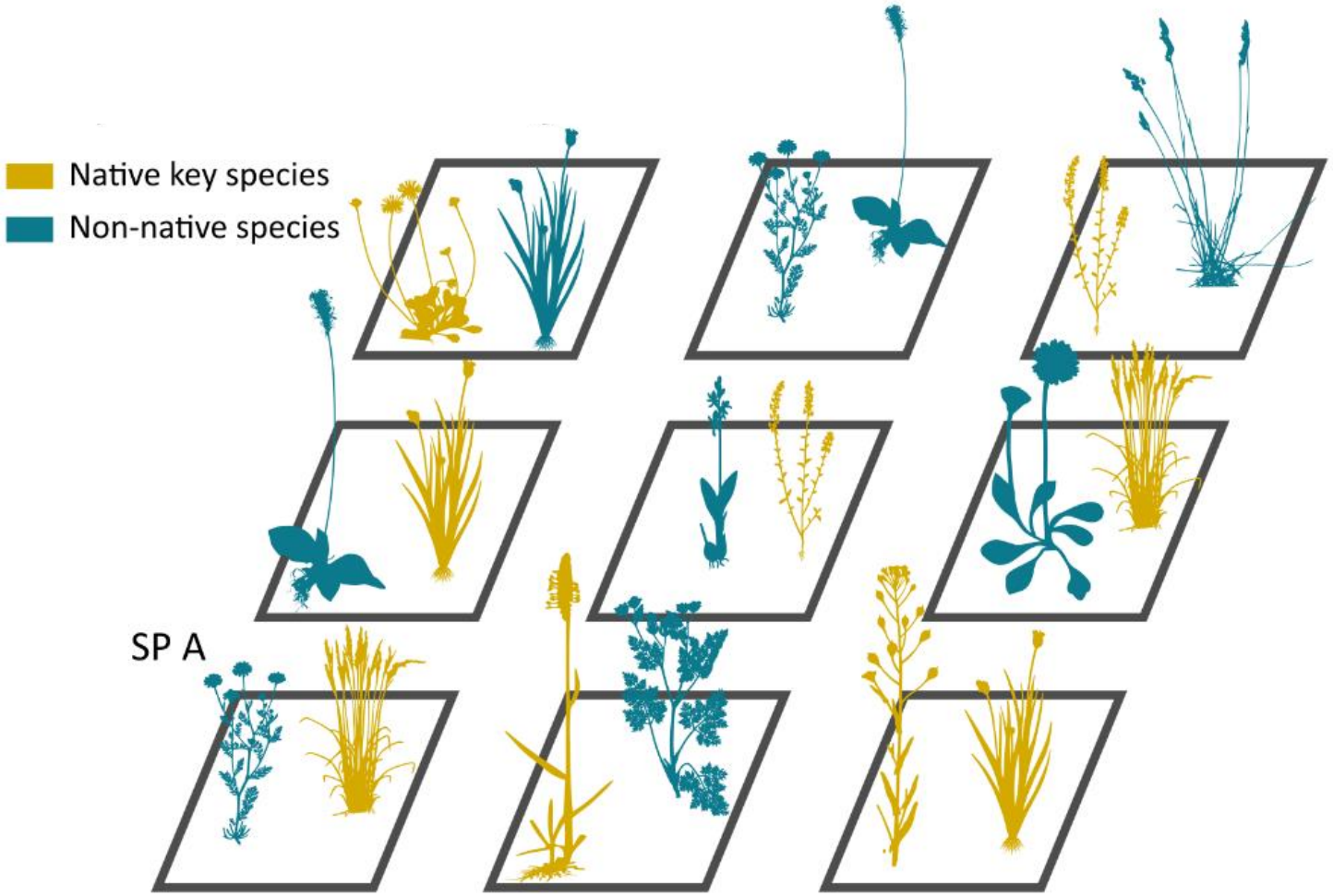
6. Expert check and experimental validation

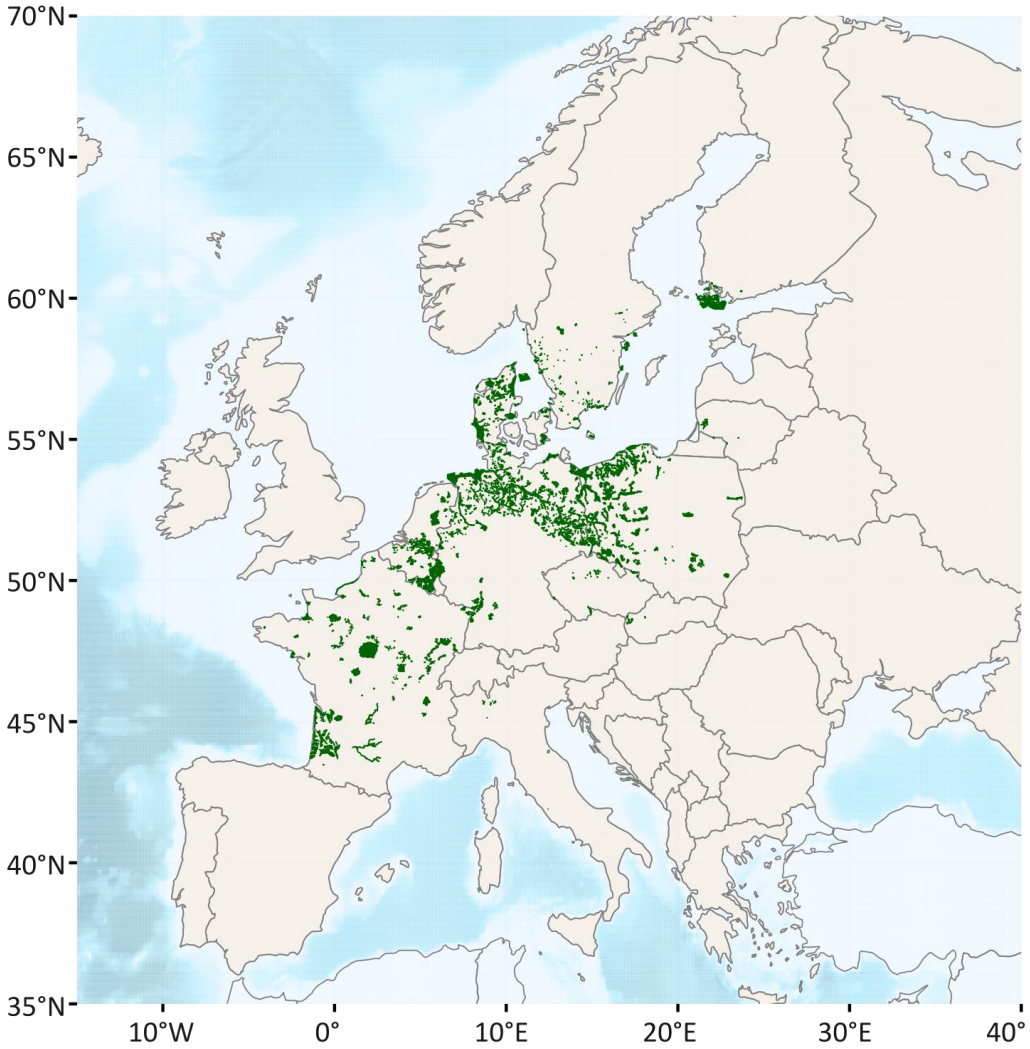
Check species disservices

Test species in controlled settings



Van Meerbeek et al. 2025. EcoEvoRxiv

Case study: Old acidophilous oak woods (9190)



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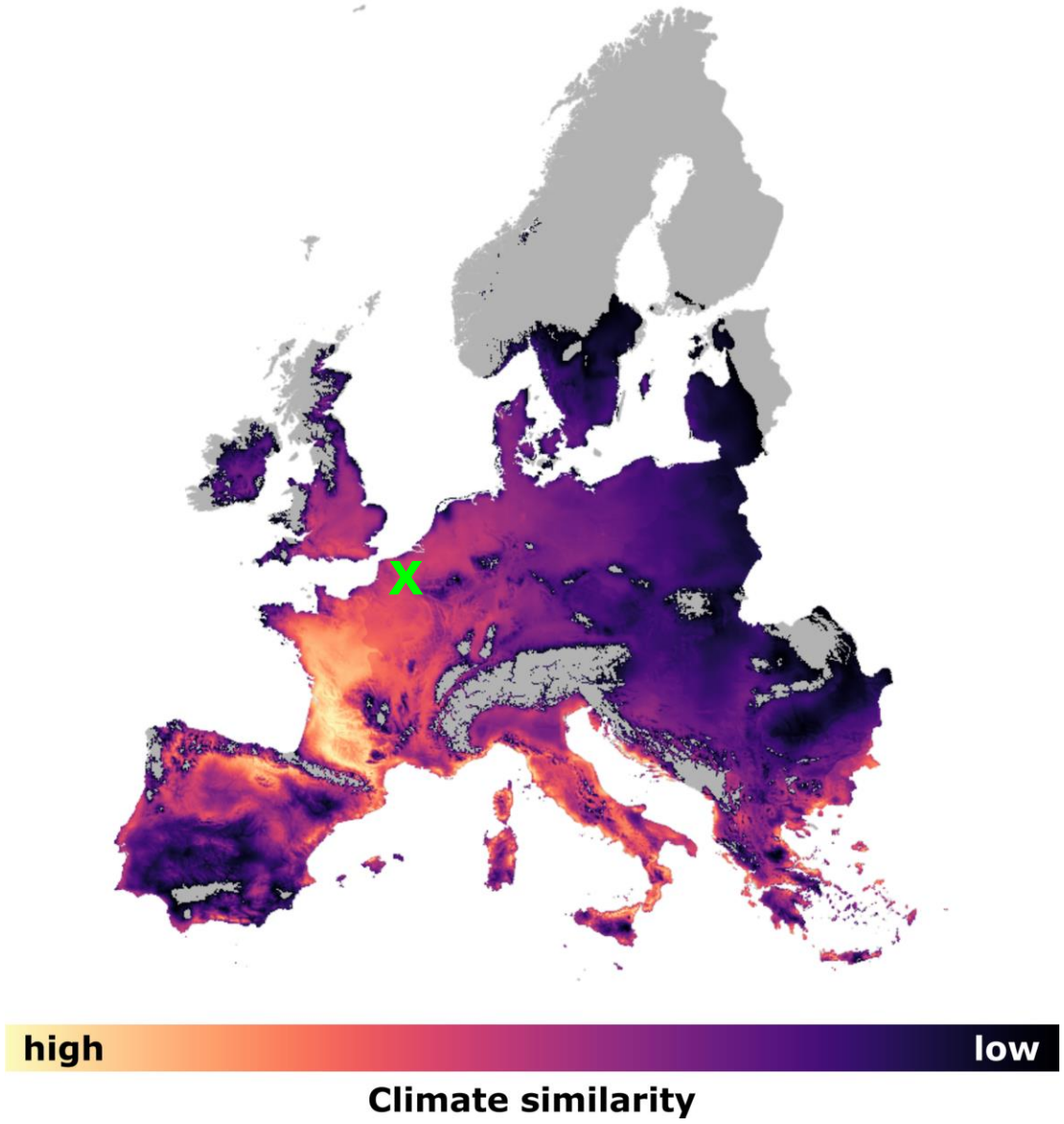
Case study: Climate analogues

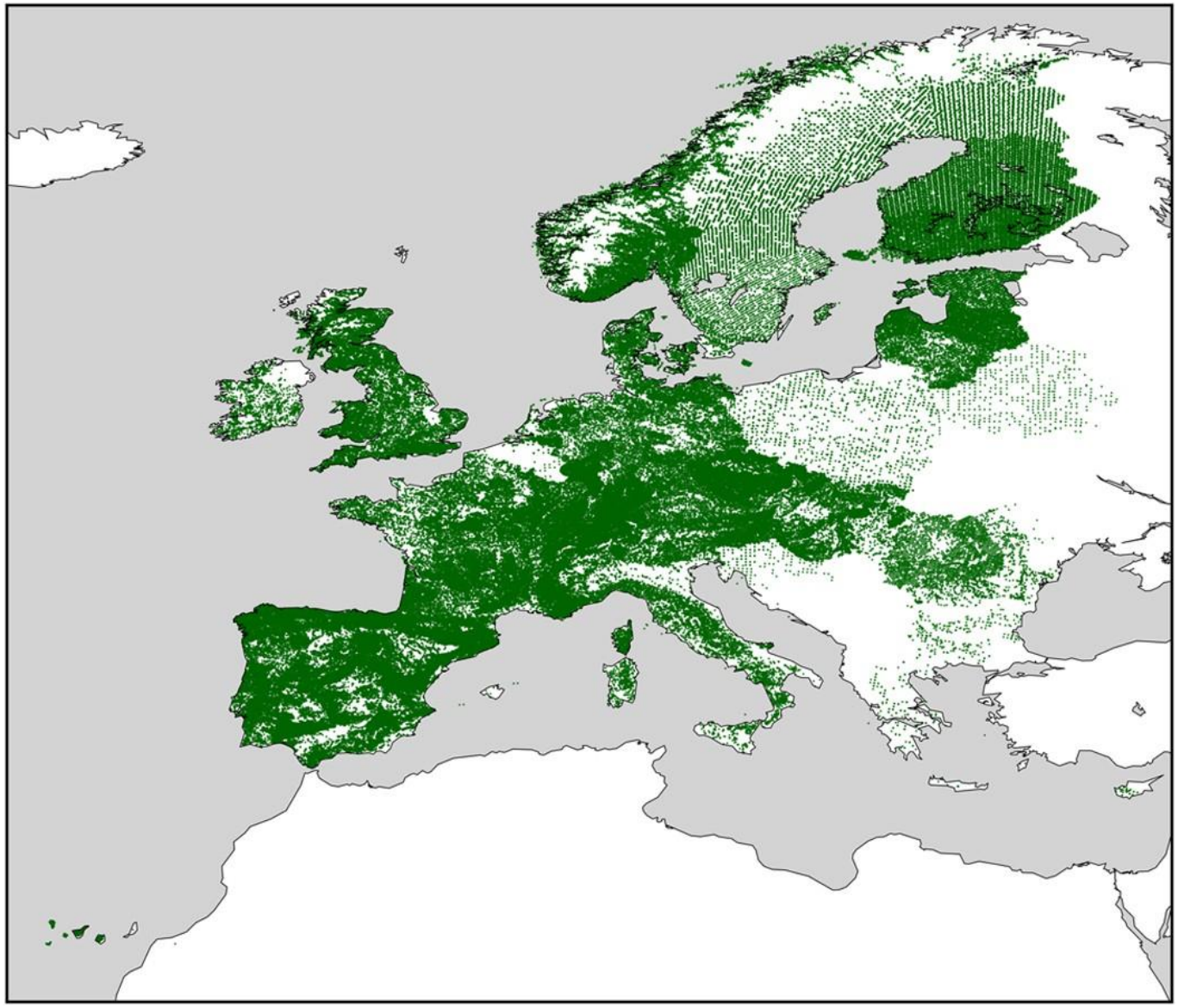
Euclidean distance from the target region in climate space



Van Meerbeek et al. 2025. EcoEvoRxiv

Case study: Co-occurrence analysis

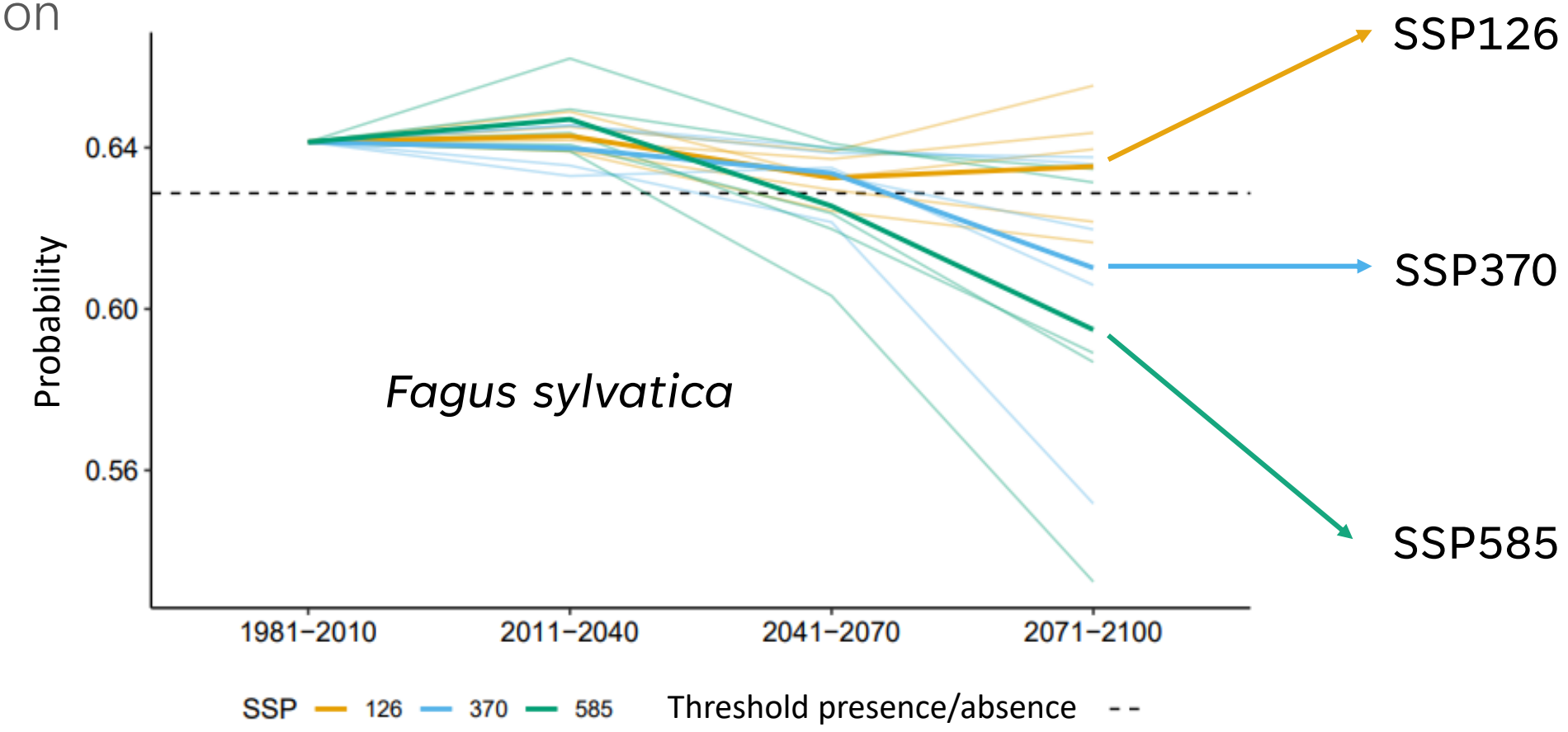
EU-Forest dataset (National Forest Inventory data)



Van Meerbeek et al. 2025. EcoEvoRxiv

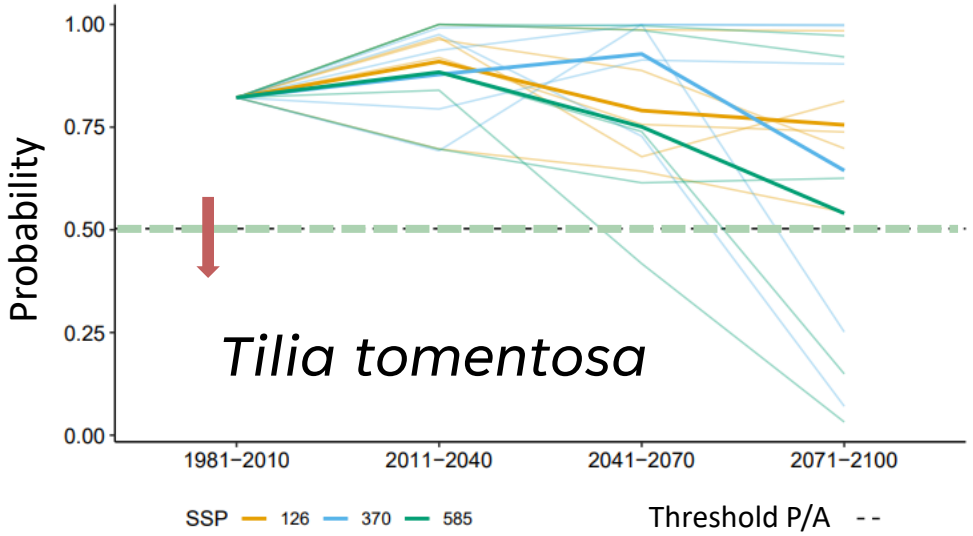
Case study: Climate suitability analysis

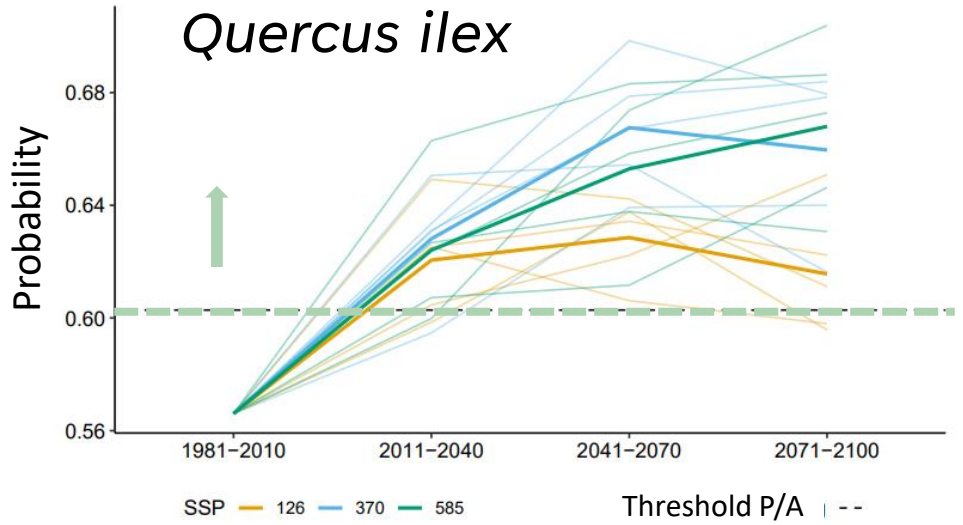
Species Distribution Modelling

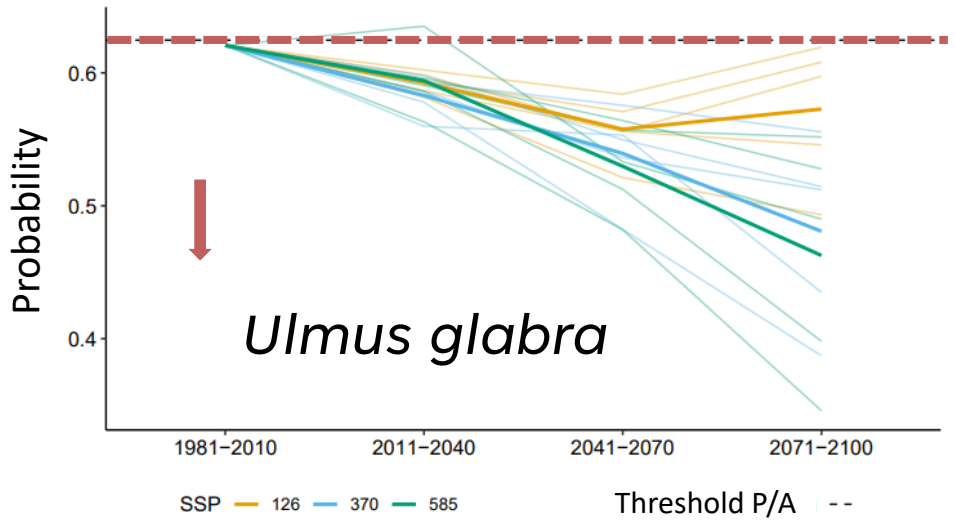


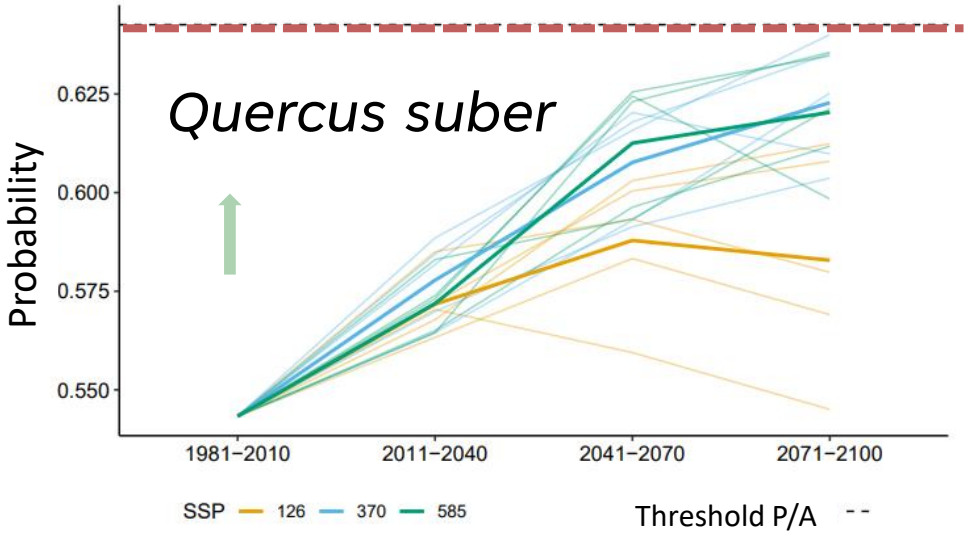
Desie et al. 2024

Case study: Climate suitability analysis



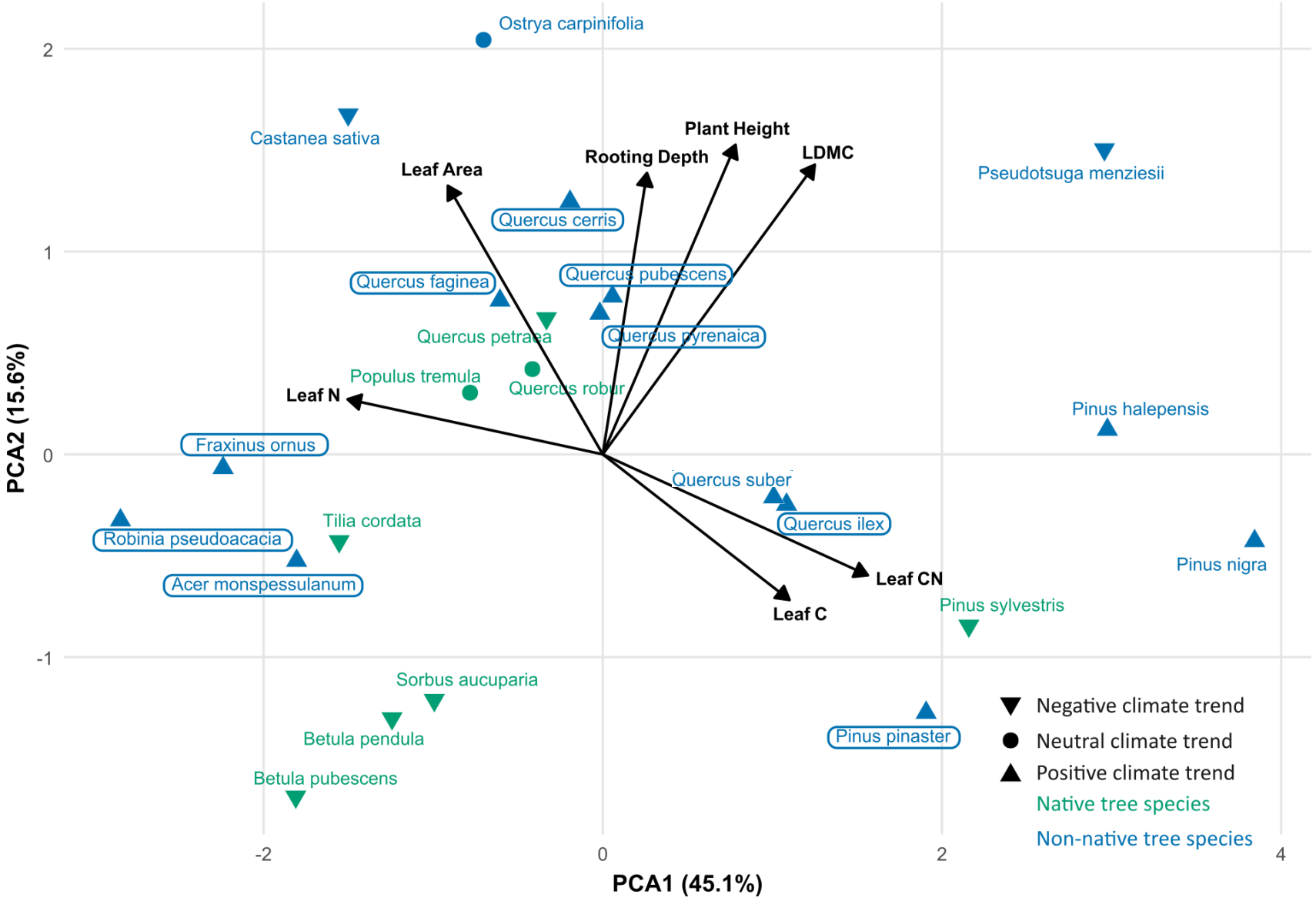






Desie et al. 2024

Case study: Functional gap analysis

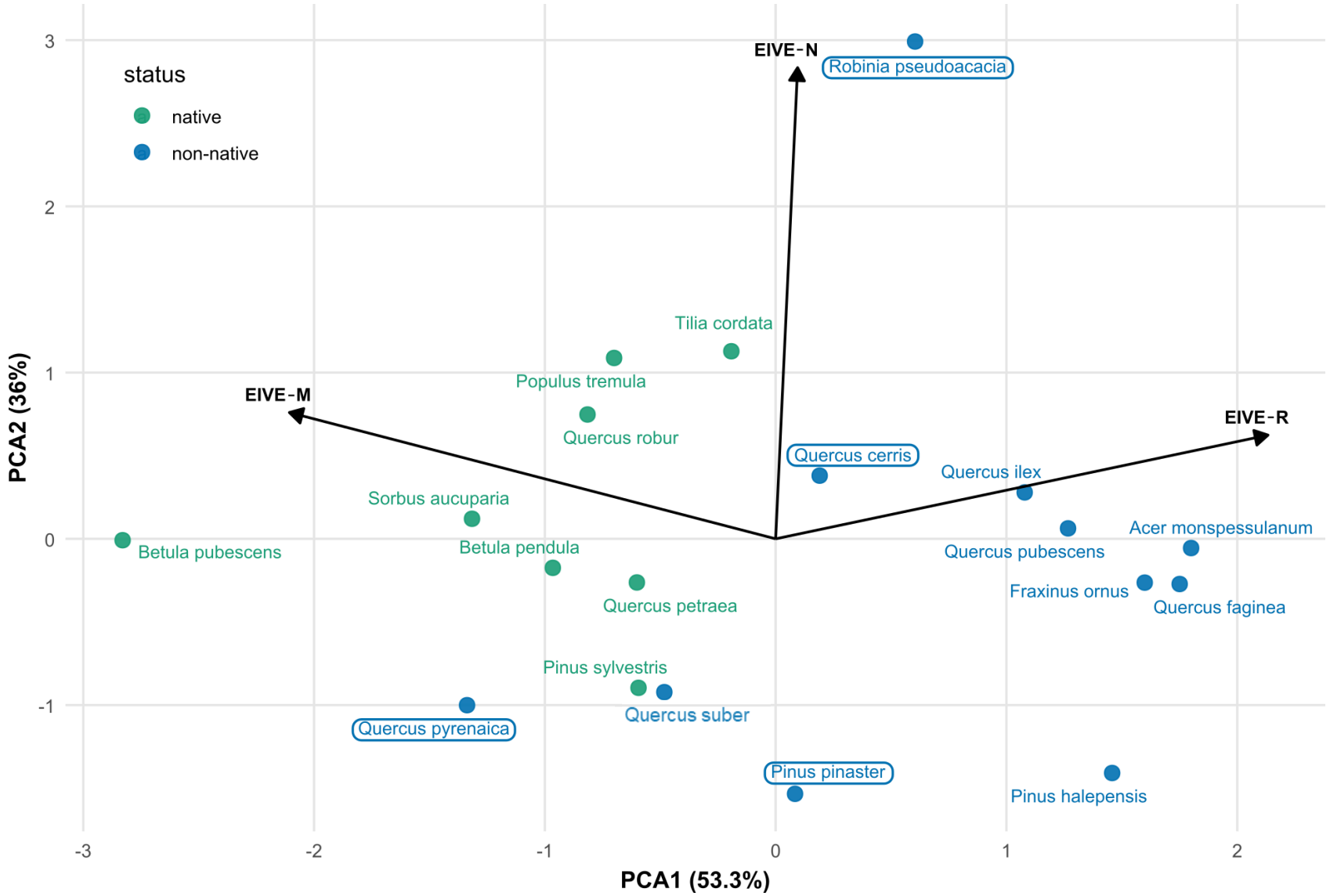


Species in functional trait space

Van Meerbeek et al. 2025. EcoEvoRxiv

Case study: Edaphic suitability

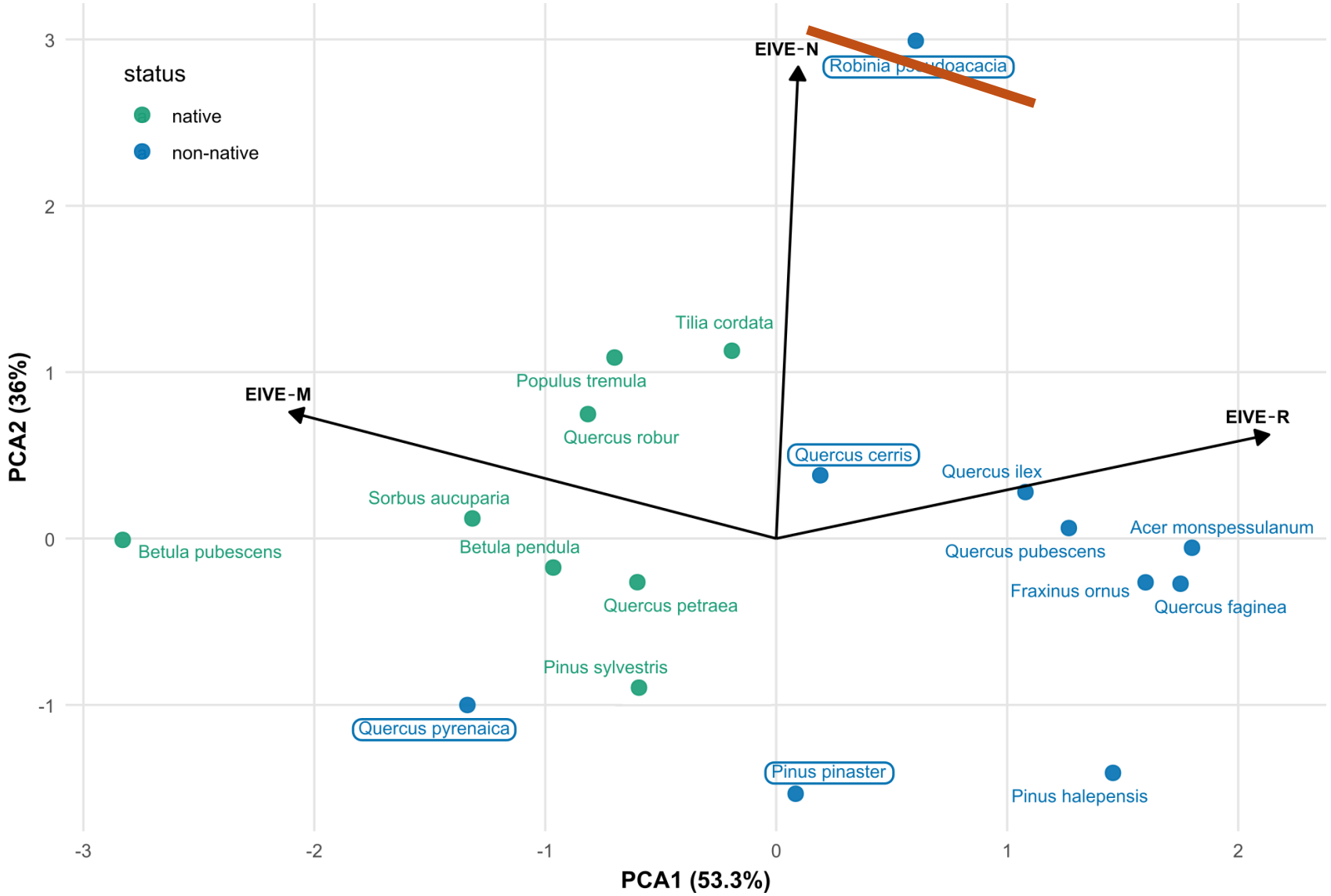
Species in edaphic space based on Ecological Indicator Values for Europe



Van Meerbeek et al. 2025. EcoEvoRxiv; Dengler et al. 2023. Vegetation Classification and Survey

Case study: Expert validation

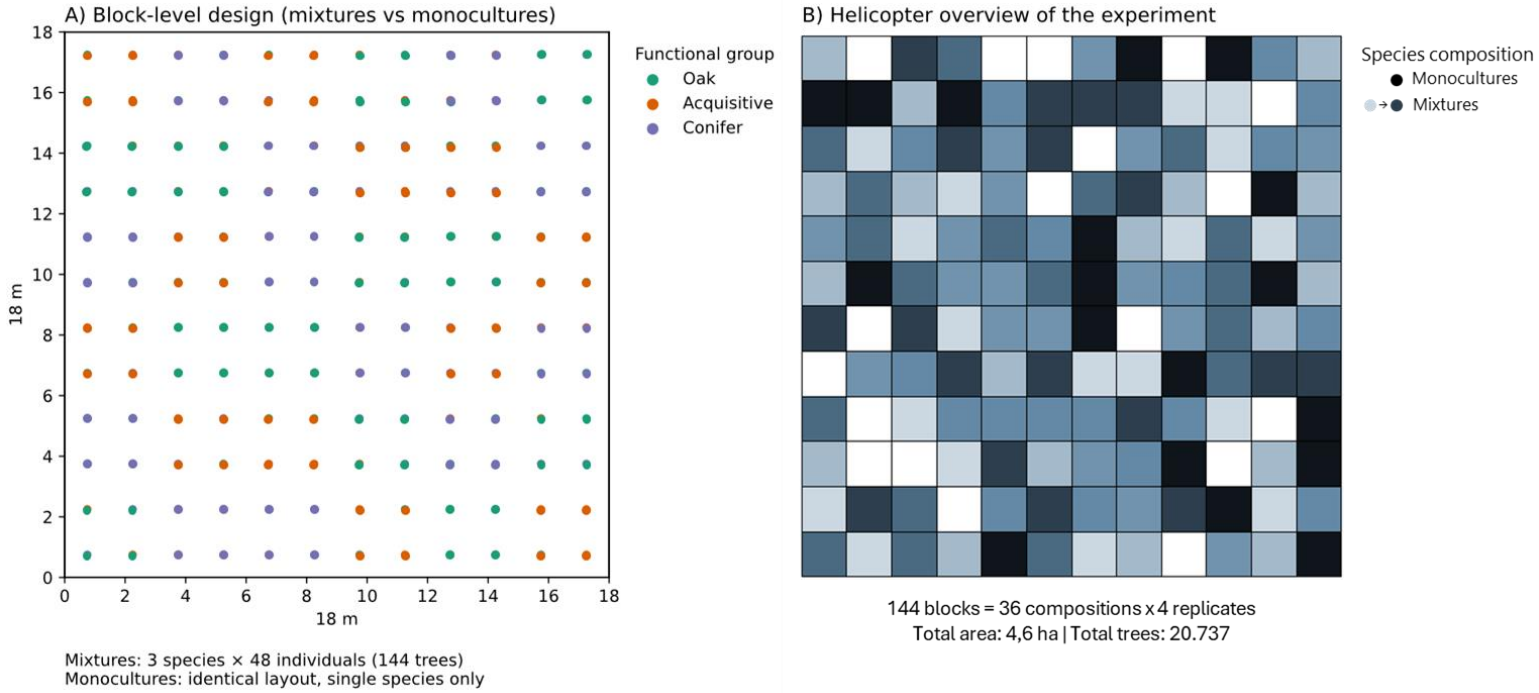
Potential for invasiveness?



Van Meerbeek et al. 2025. EcoEvoRxiv; Dengler et al. 2023. Vegetation Classification and Survey

Case study: Experimental validation

Climate adaptation	Species composition		
Treatment	**Oak**	**Acquisitive**	**Conservative**
9190 OG	*Quercus robur*	*Betula pendula*	*Pinus sylvestris*
9190 FAM	*Quercus pubescens*	*Populus tremula*	*Pinus pinaster*
9190 (Best score SDM)	*Quercus cerris*	*Tilia tomentosa*	*Pinus peuce*



FutureNature: Shaping future functional plant communities

Advance the understanding of assisted migration as a means to safeguard functioning ecosystems by

1) Observational research

2) Experimental research

Funded by the European Union

European Research Council
Established by the European Commission

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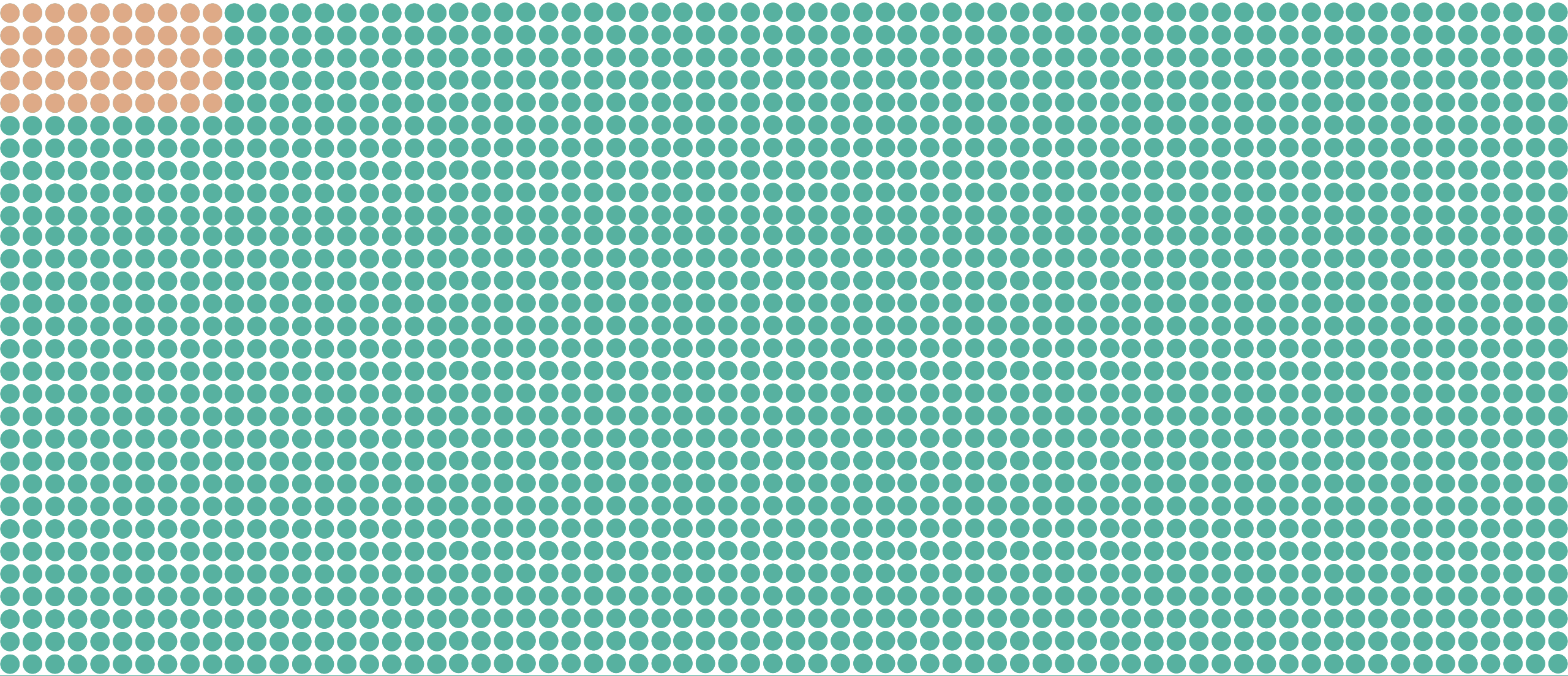
FutureNature: Shaping future functional plant communities



FutureNature

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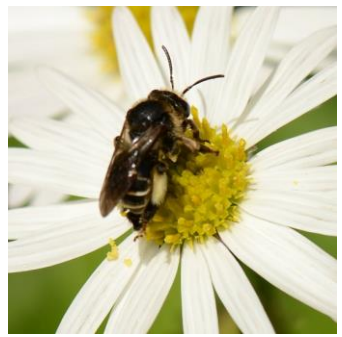
FutureNature: Shaping future functional plant communities

Objective 1:
Study the contribution of non-native plant species to biodiversity and ecosystem functioning


Erigeron annuus



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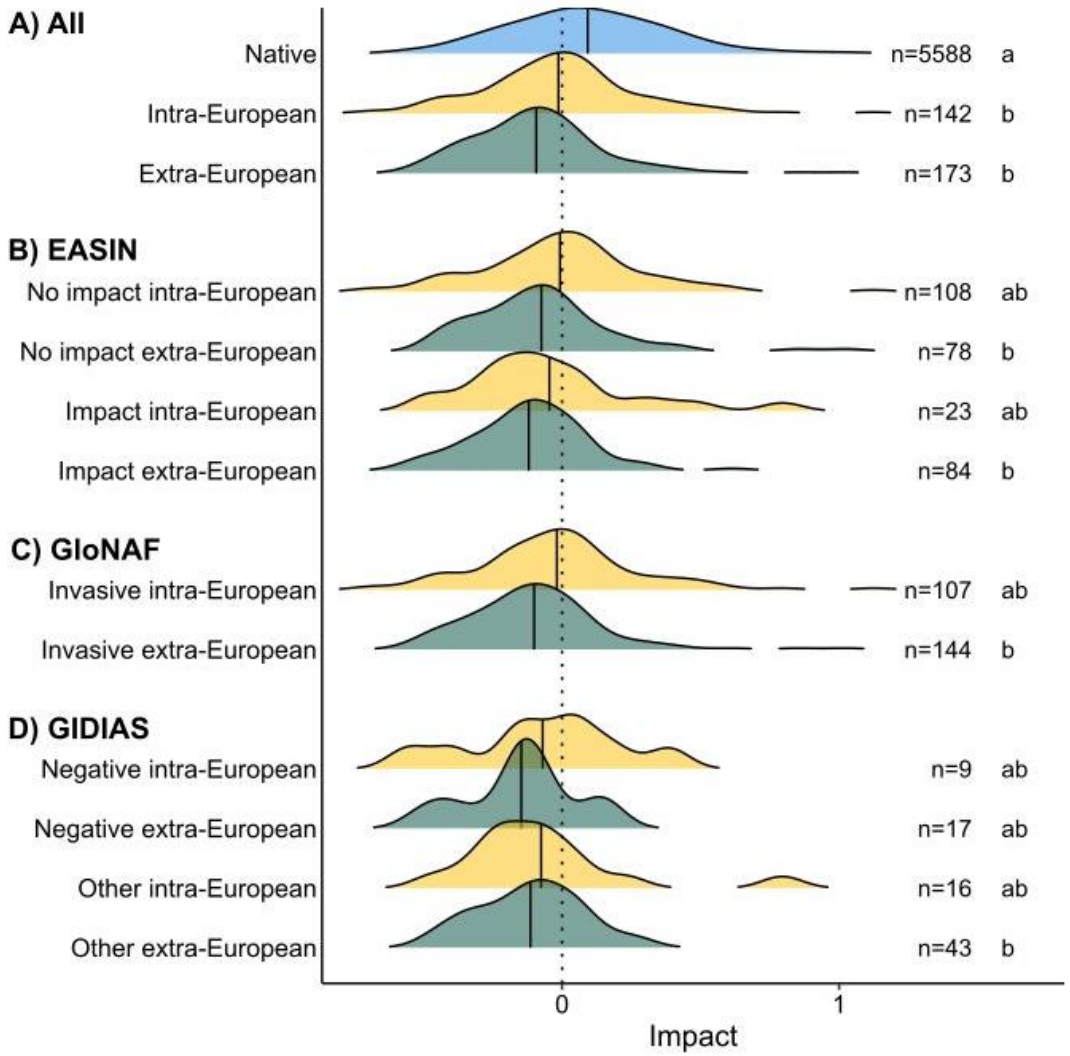

A large part of non-native plant species has a positive impact on local vascular plant species richness

Goossens et al. Under review

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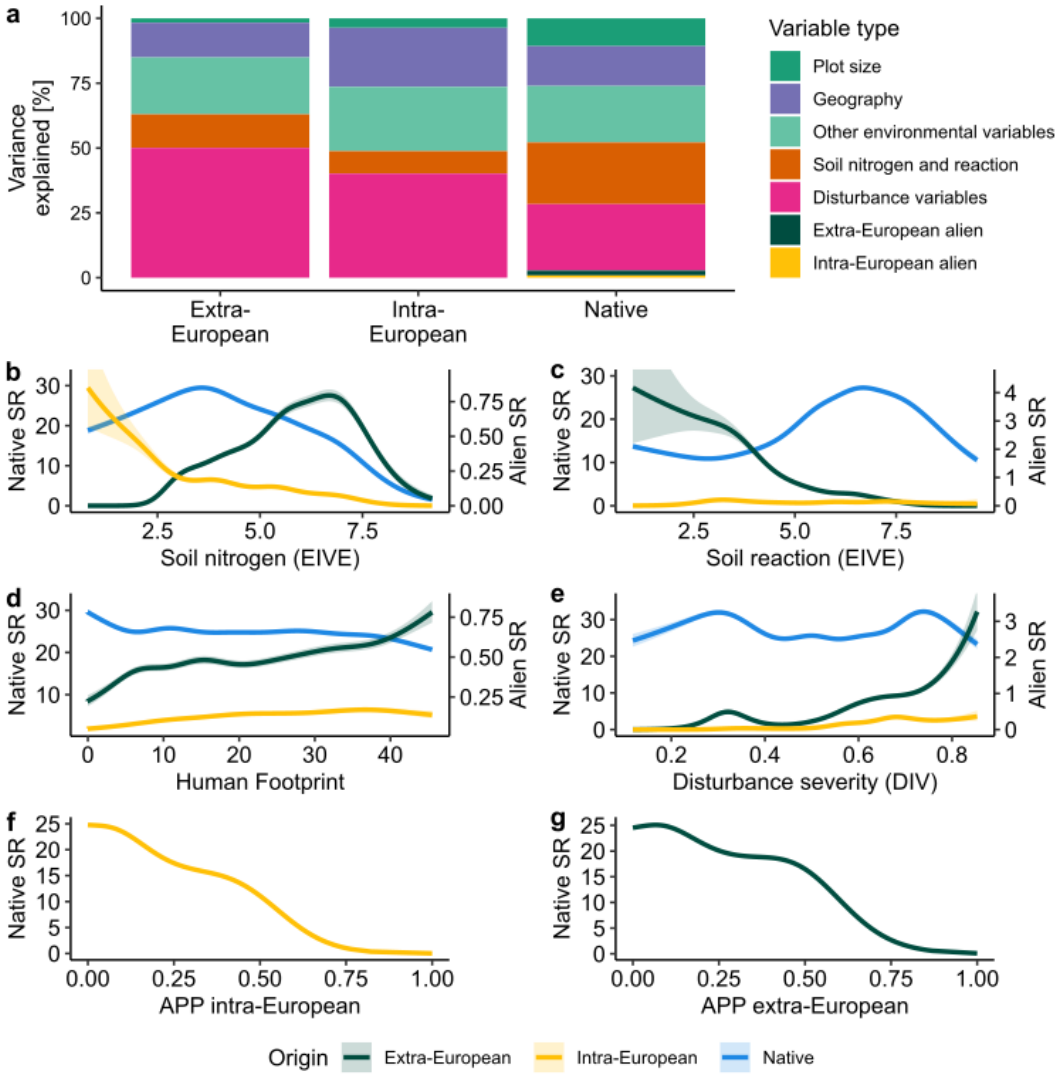

Non-native plants are minor drivers of local vascular plant diversity

Goossens et al. Under review

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Objective 2:
Study functional assisted migration in grasslands with a climate experiment

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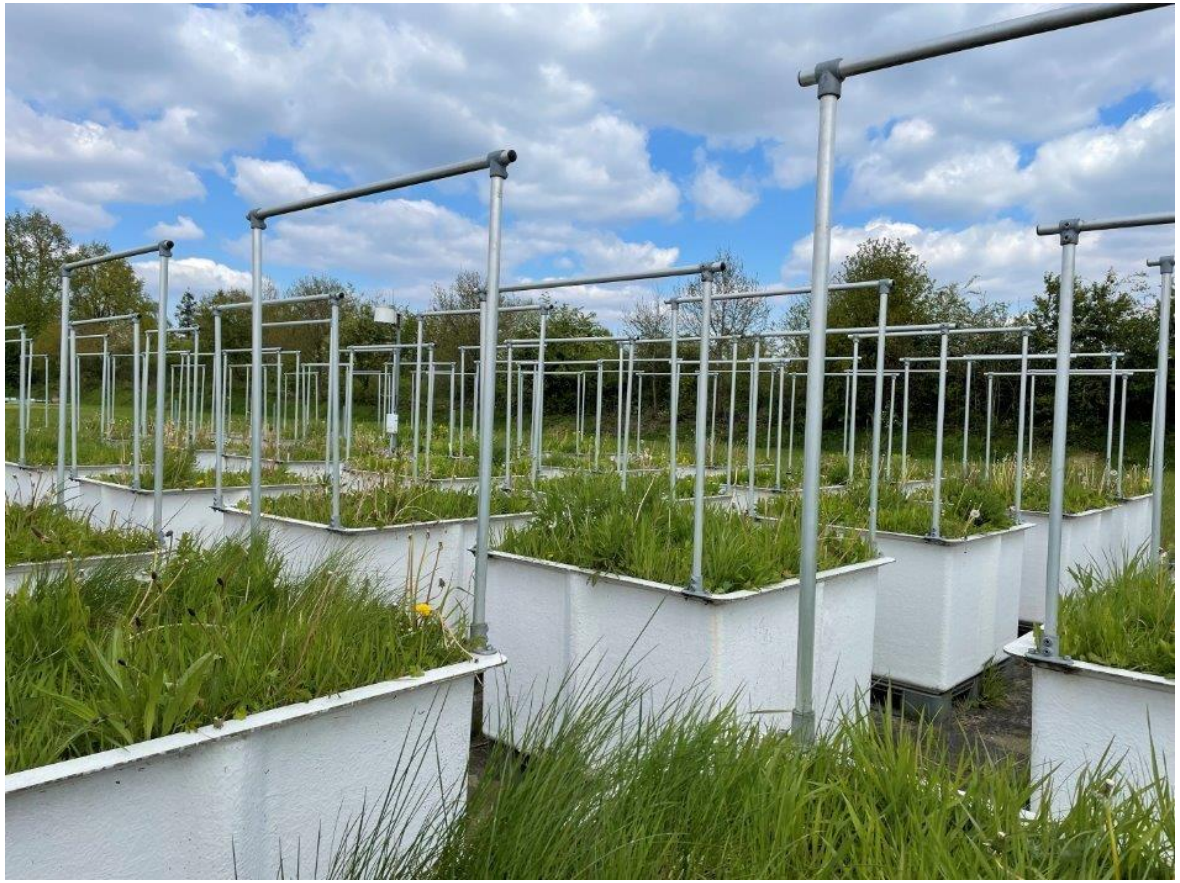

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Thanks for listening!

koenraad.vanmeerbeek@kuleuven.be

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