



Les forêts mélangées en Europe sont-elles plus résistantes aux sécheresses que les forêts pures?

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Tree diversity does not always improve resistance of forest ecosystems to drought

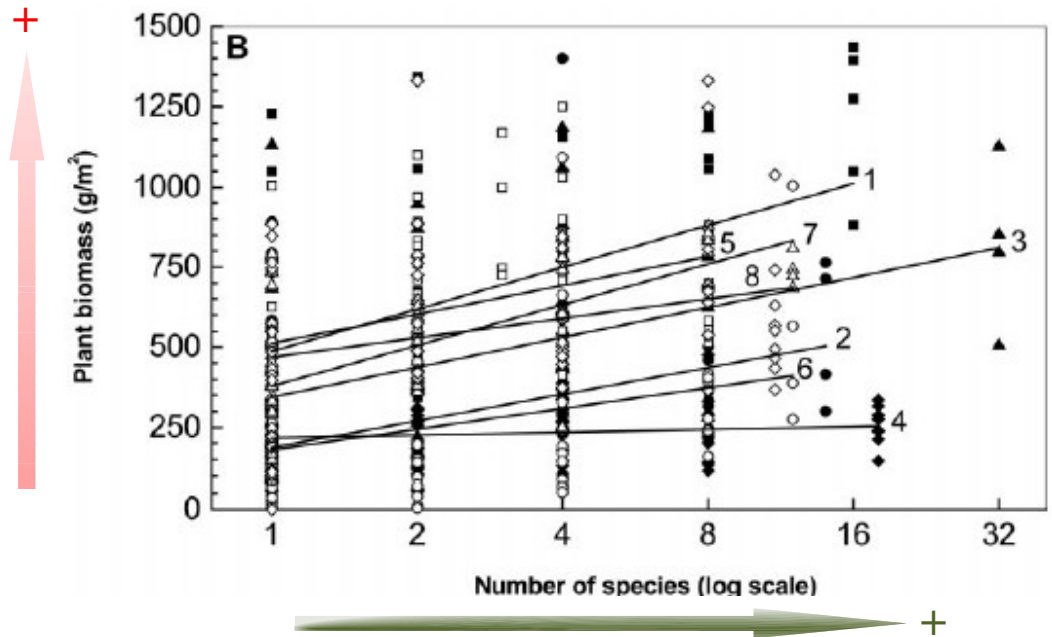
*Damien BONAL
Charlotte GROSSIORD
Arthur GESSLER
André GRANIER*



Biodiversity & Ecosystem functioning

Increasing species diversity can lead to important **benefits** for ecosystems

Biomass Production



Loreau *et al.* 2001

Higher biomass production in
more diverse ecosystems



Biodiversity & Ecosystem functioning

Increasing species diversity can lead to important **benefits** for ecosystems

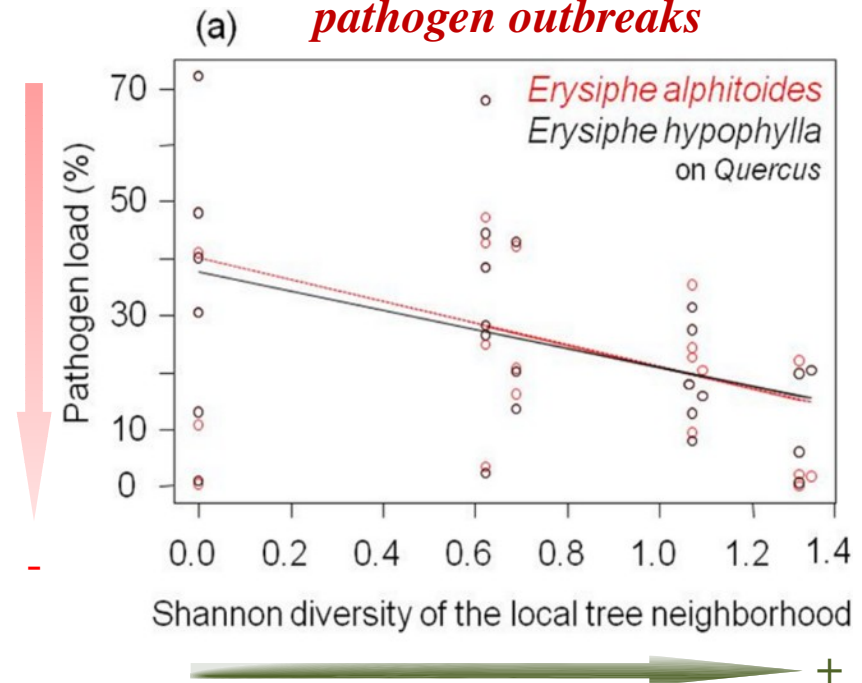


www.worldofstock.com



www.bbc.co.uk

Resistance against pest & pathogen outbreaks

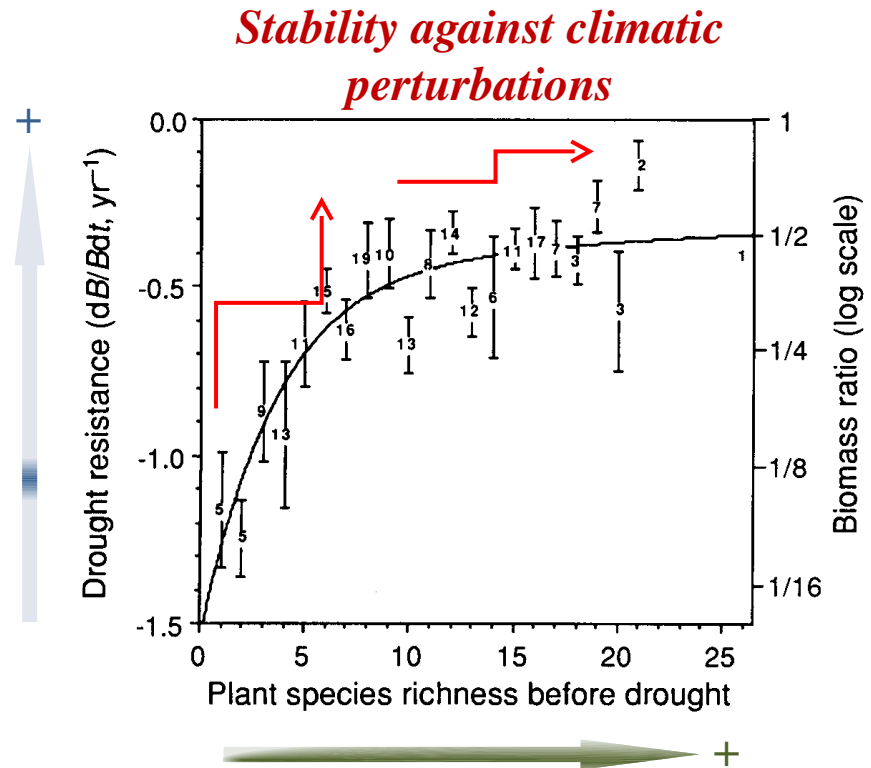
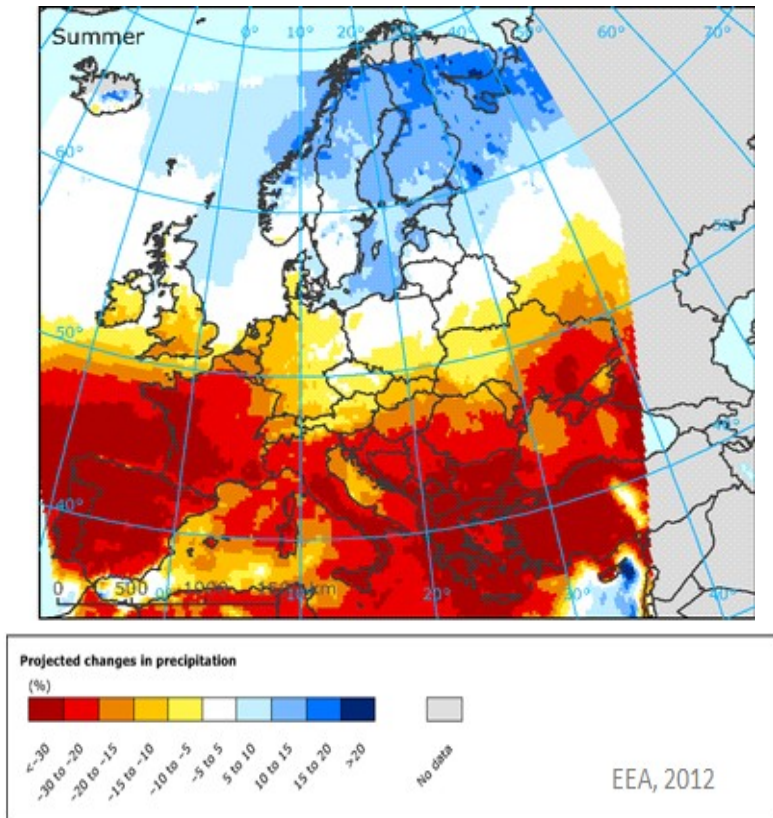


Hantsch *et al.* 2013

Lower foliar pathogen load in
more diverse ecosystems

Biodiversity & Ecosystem functioning

Are more diverse ecosystems **more resistant** to drought?

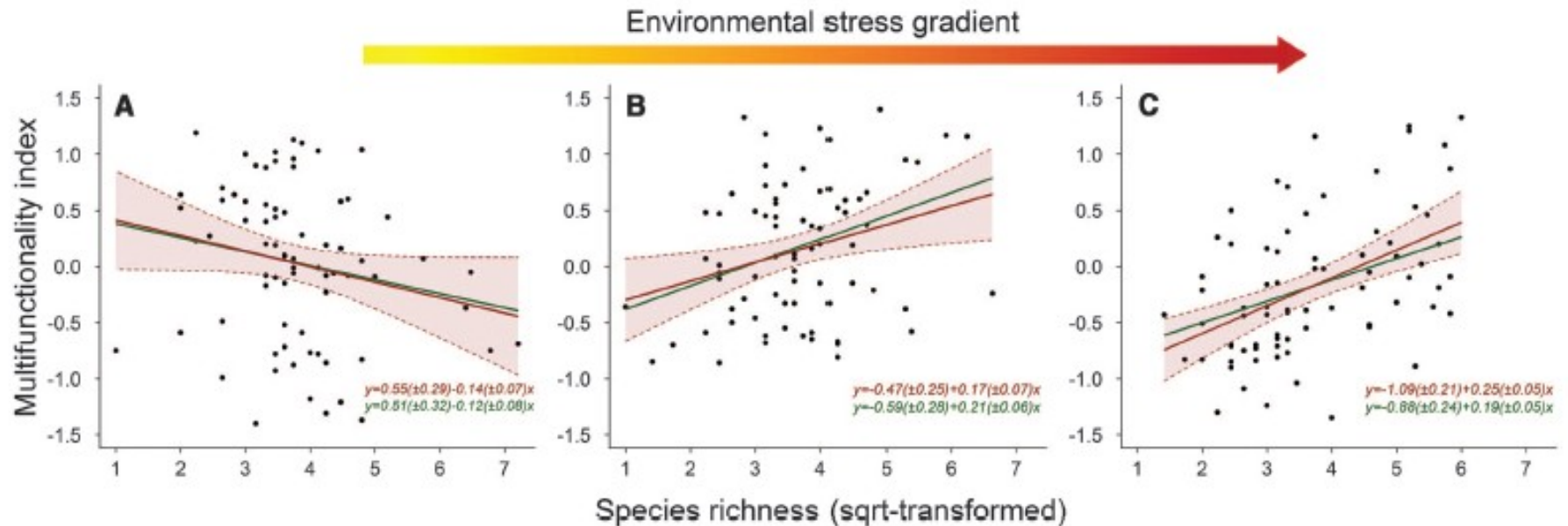


Tilman & Downing 1994

Increasing drought resistance in
more diverse communities

Influence of environmental conditions

Species interactions can shift from negative (competition) to positive (complementarity) as climatic conditions change
(Stress-gradient hypothesis, Bertness & Callaway, 1994)



Jucker & Coomes, 2012

Objectives

Test whether higher tree species diversity in forest ecosystems across Europe is associated with less drought exposure



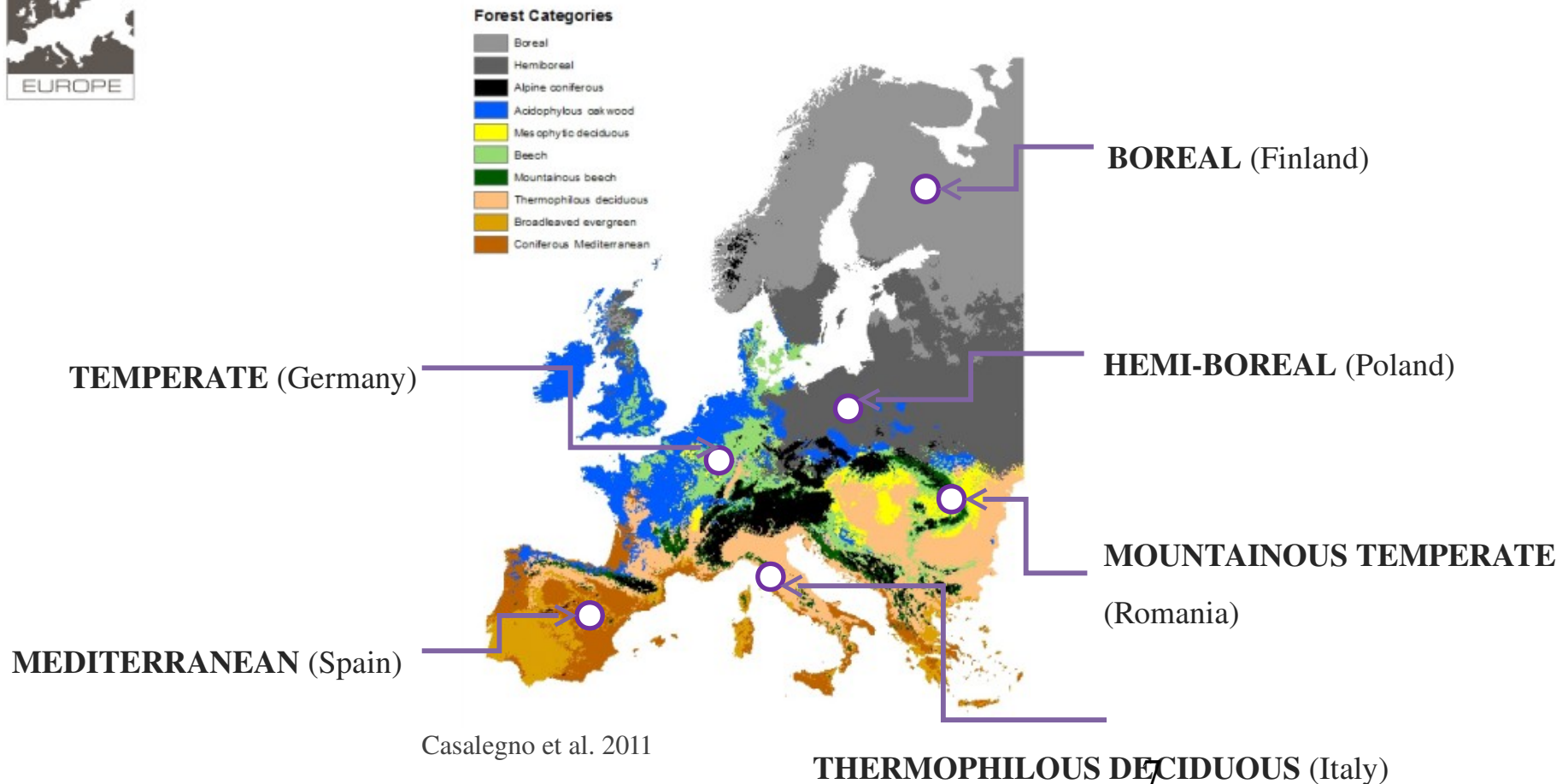
Grossiord C.



Study Sites

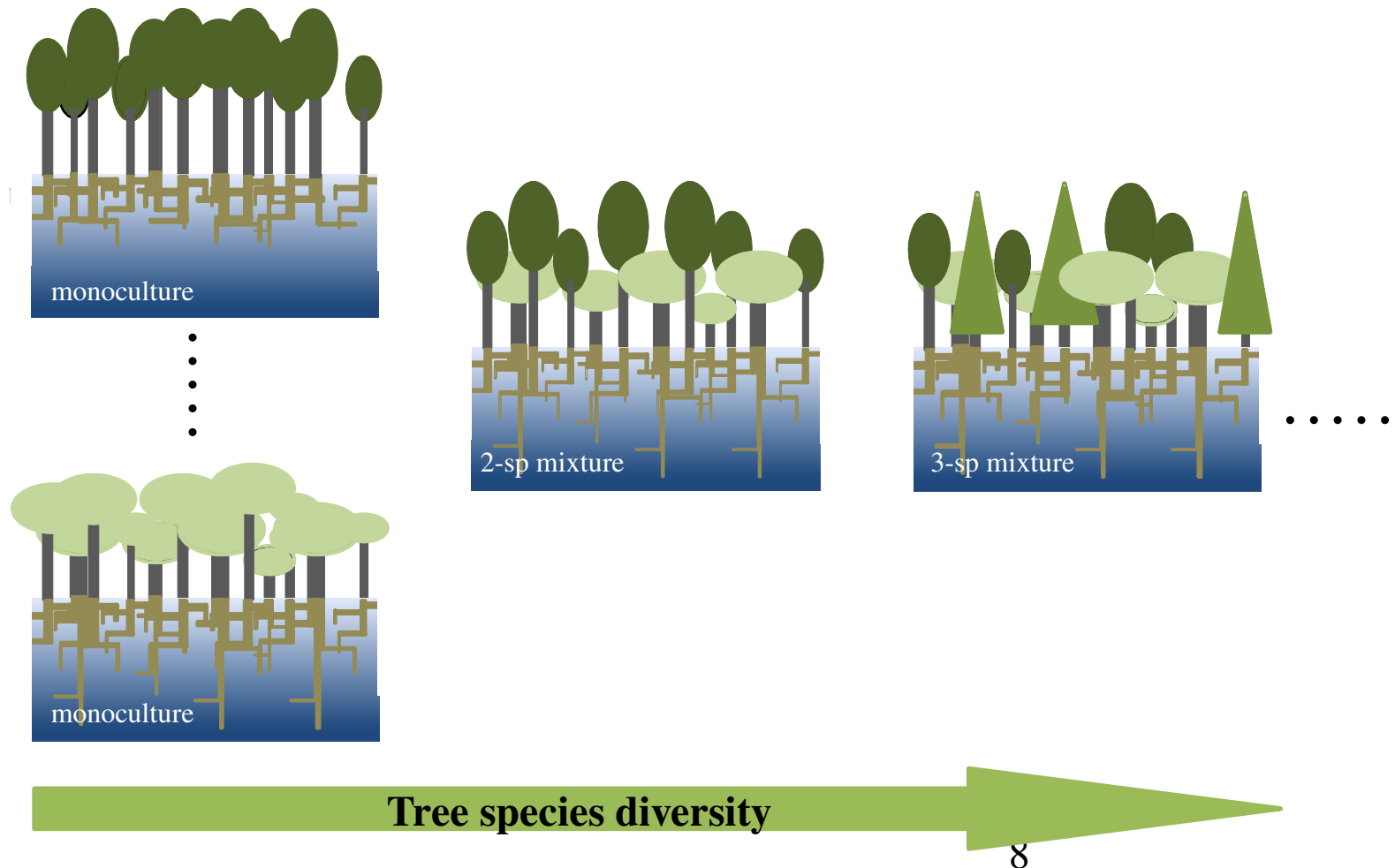


6 regions across **North - South** gradient in Europe to cover the **major forest types** and **climatic conditions**



Material and Methods

Comparison of ecosystem functioning for different levels of species mixture (1-5)



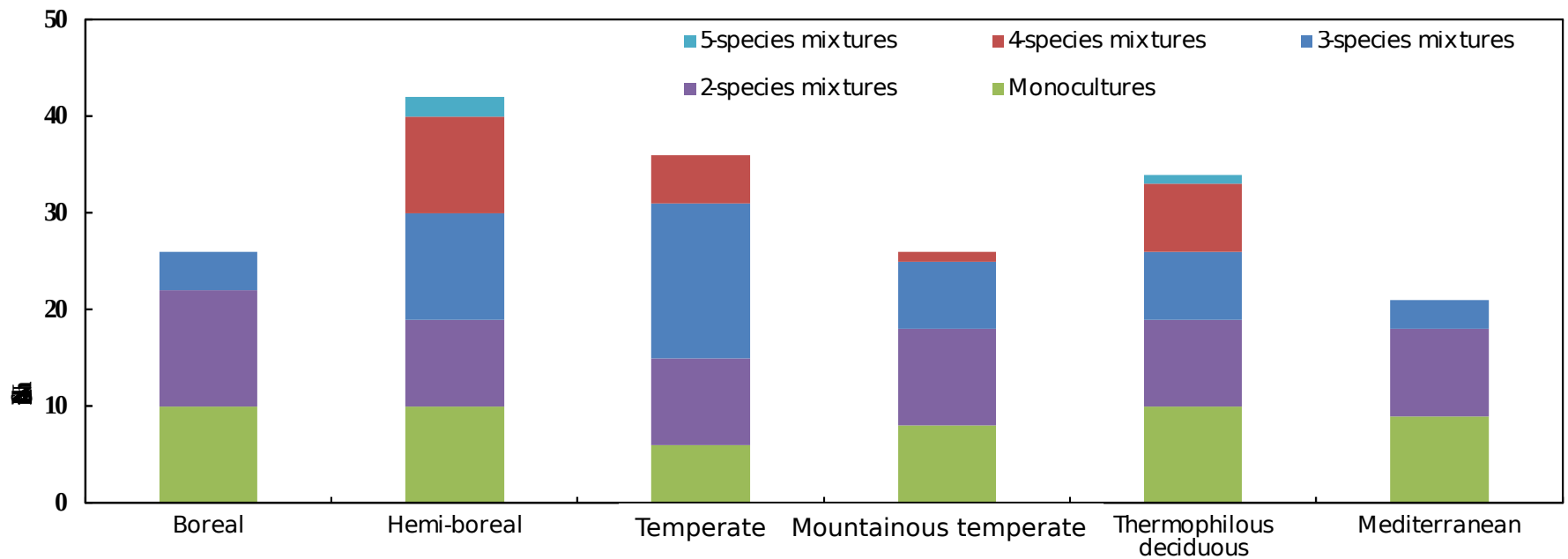
Material and Methods

- Selection of 25 to 42 stands (30×30m) varying in species richness in each studied region

Material and Methods

Stands with varying tree species richness

The variation in other confounding factors (soil, topography, land-use history,...) was kept at a minimum.



Material and Methods

- Selection of 25 to 42 stands (30×30m) varying in species richness in each studied region
- Extraction of wood cores from a selection of dominant and co-dominant trees of each species in each stand

6 trees in monoculture
3 trees/species in
mixtures



Material and Methods

- Selection of 25 to 42 stands (30×30m) varying in species richness in each studied region
- Extraction of wood cores from a selection of dominant and co-dominant trees of each species in each stand
- Selection of years (tree rings) with contrasting climatic conditions (**dry** vs. **wet**)

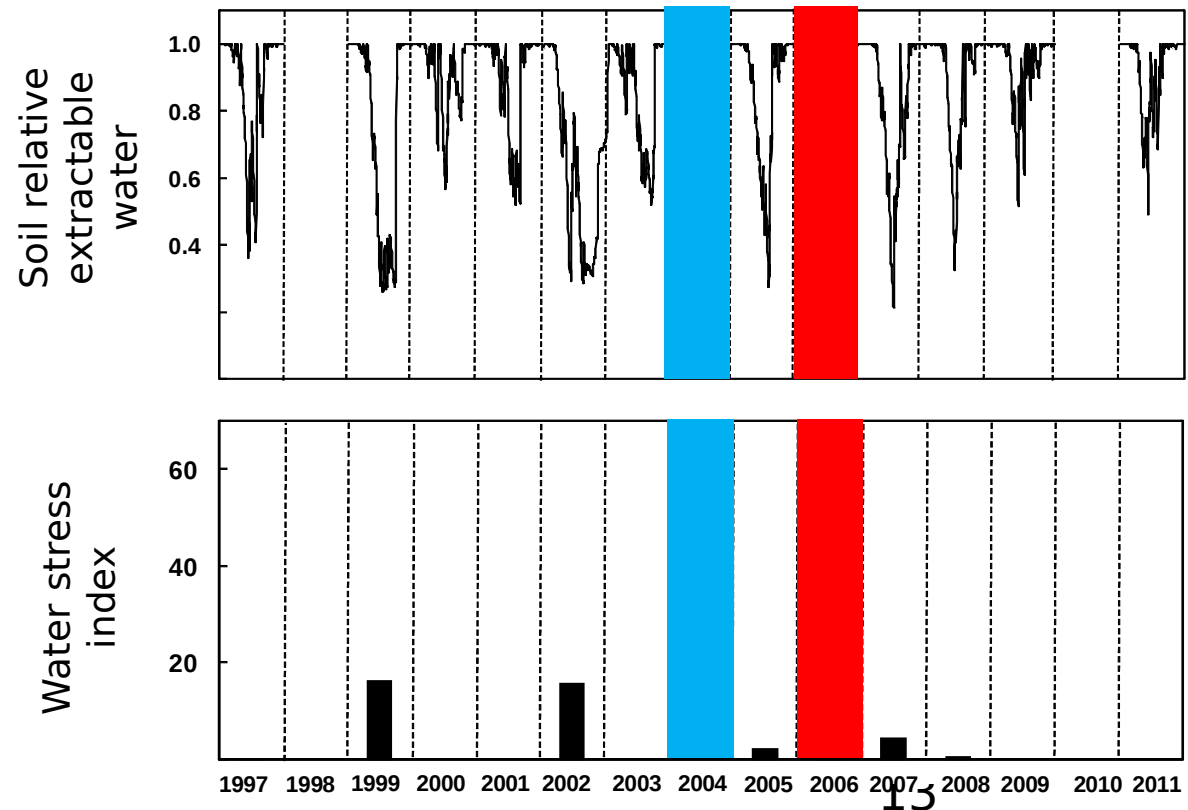
Material and Methods

Selection of years with contrasted climatic conditions

Selection of the driest and the wettest year over the last 15 years with daily climate data and the BILJOU water-balance model (Granier *et al.* 1999):



Example of
Finland



Material and Methods

- Selection of 25 to 42 stands (30×30m) varying in species richness in each studied region
- Extraction of wood cores from a selection of dominant and co-dominant trees of each species in each stand
- Selection of years (tree rings) with contrasting climatic conditions (**dry** vs. **wet**)
- Analyses of carbon isotope composition ($\delta^{13}\text{C}$)

Material and Methods

Sample preparation and analyses



For each core, we extracted the late wood from the two selected years

Samples were then analyzed for carbon isotope composition ($\delta^{13}\text{C}$, ‰) (PTEF nancy or UC Davis)

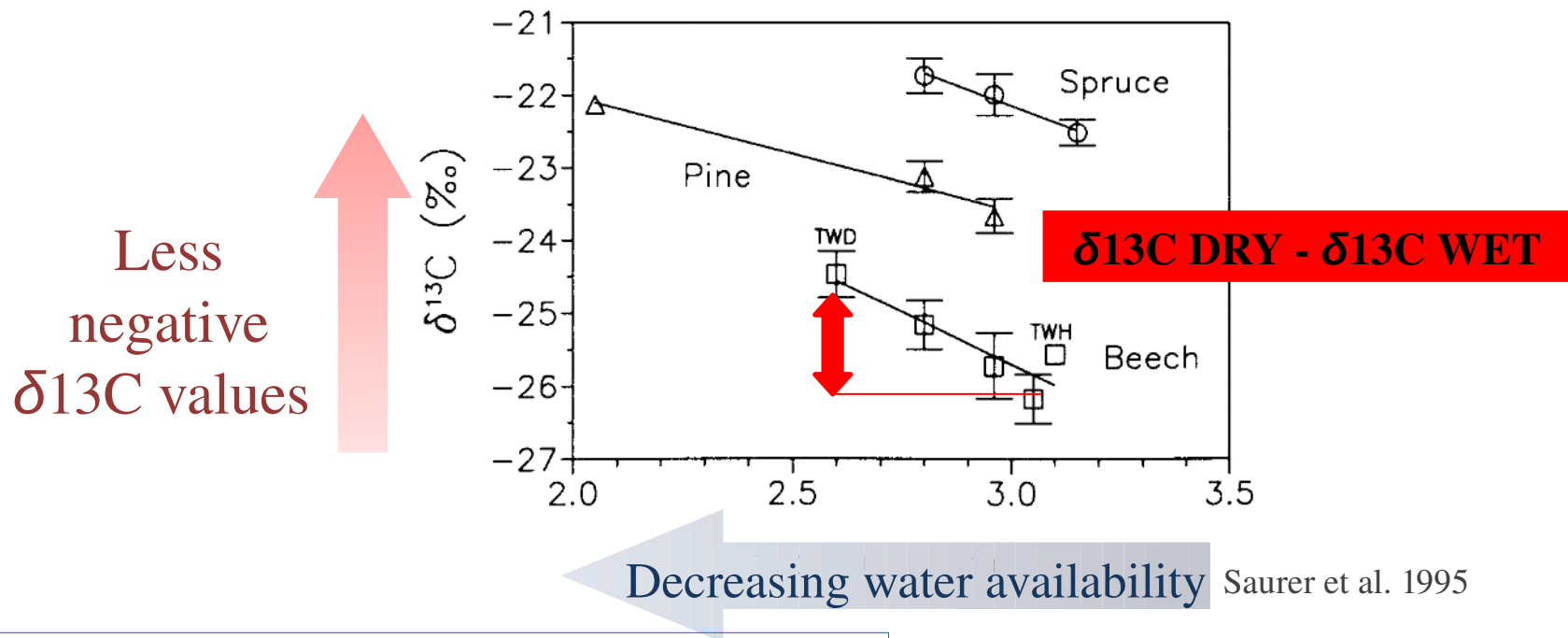


Material and Methods

- Selection of 25 to 42 stands (30×30m) varying in species richness in each studied region
- Extraction of wood cores from a selection of dominant and co-dominant trees of each species in each stand
- Selection of years (tree rings) with contrasting climatic conditions (**dry** vs. **wet**)
- Analyses of carbon isotope composition ($\delta^{13}\text{C}$) of latewood of each ring
- Calculation of plot-level $\delta^{13}\text{C}$

Material and Methods

- The difference in plot-level $\delta^{13}\text{C}$ between the **DRY** and the **WET** year can be used as a proxy of drought exposure



If difference in $\delta^{13}\text{C}$ is high, low resistance

If difference in $\delta^{13}\text{C}$ is low, high resistance



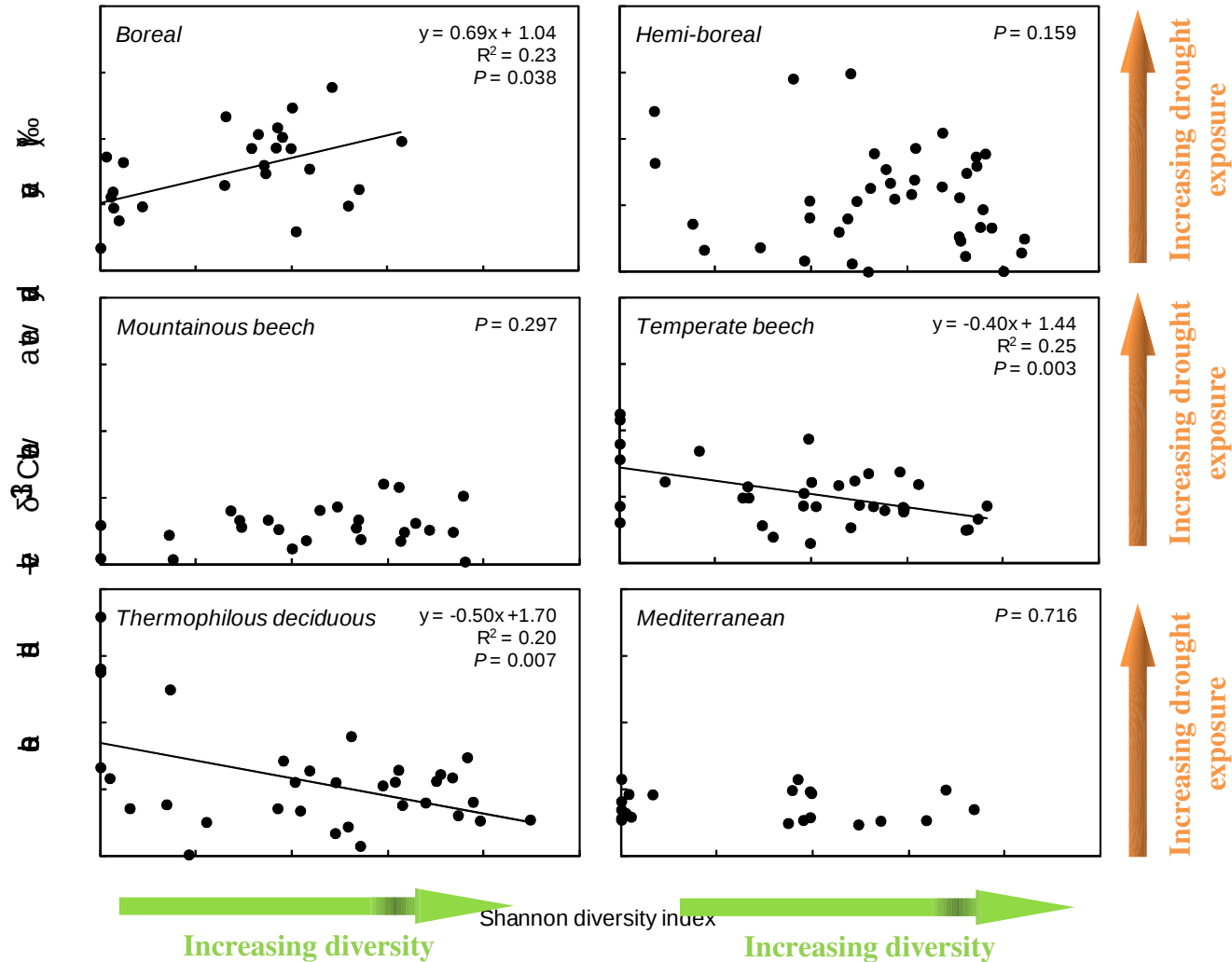
Tree diversity does not always improve resistance of forest ecosystems to drought

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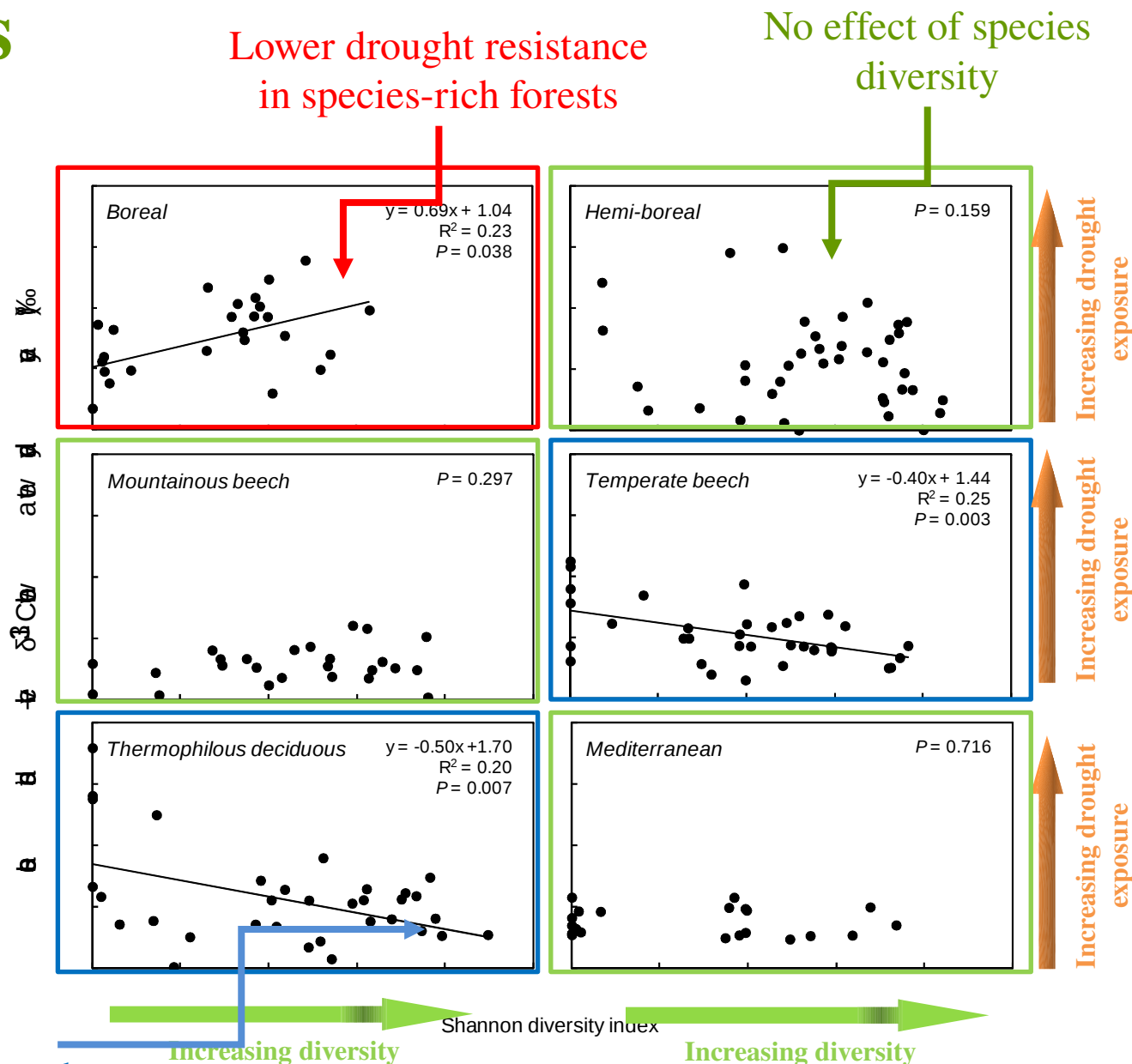
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Results

$\delta^{13}\text{C}$ values in DRY year always higher than in WET ones



Results



Higher drought
resistance in species-rich
forests

Results

Tree species diversity effects seem partially dependent on **climatic conditions**

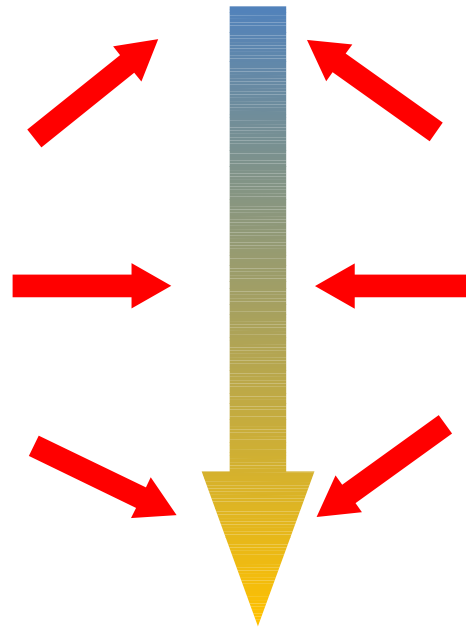
Rare events and low intensity of drought
Negative effects

Biotic conditions

(e.g. tree species composition)

Abiotic conditions

(e.g. soil type)



Frequent events and high intensity of drought
Positive effects

Conclusions

- Tree species diversity influences the functioning of forest ecosystems in terms of water and carbon acquisition and use
- More diverse forests may be more resistant to soil drought than pure ones, but not necessarily
- Favoring mixed forest ecosystems could be preferred in certain regions, not only to preserve biodiversity or sustain productivity in the context of climate changes, but also to delay the negative effect of drought

Perspectives

Thanks for your attention

