

The REINFFORCE network for adapting Atlantic forests under a changing climate:

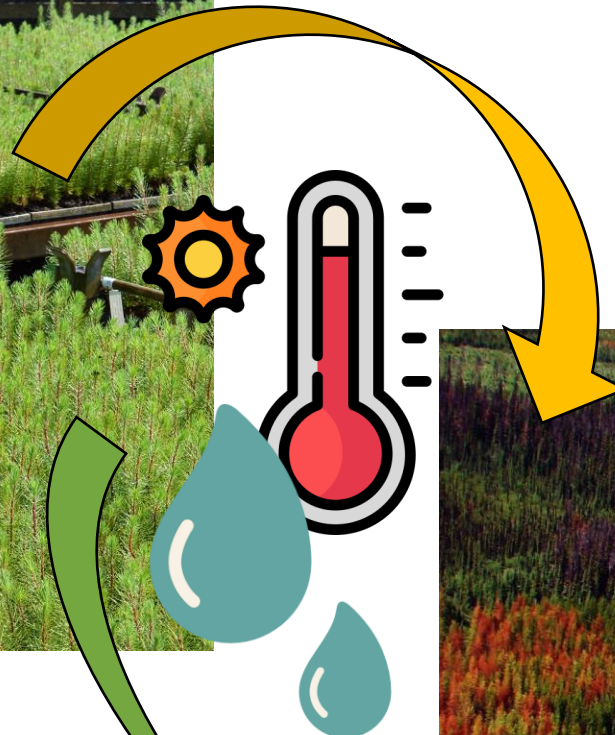
First empirical evidences on the potential adaptive performance of alternative species.

Hernán Serrano-León, Christophe Orazio ¹, António Henrique Correia ²

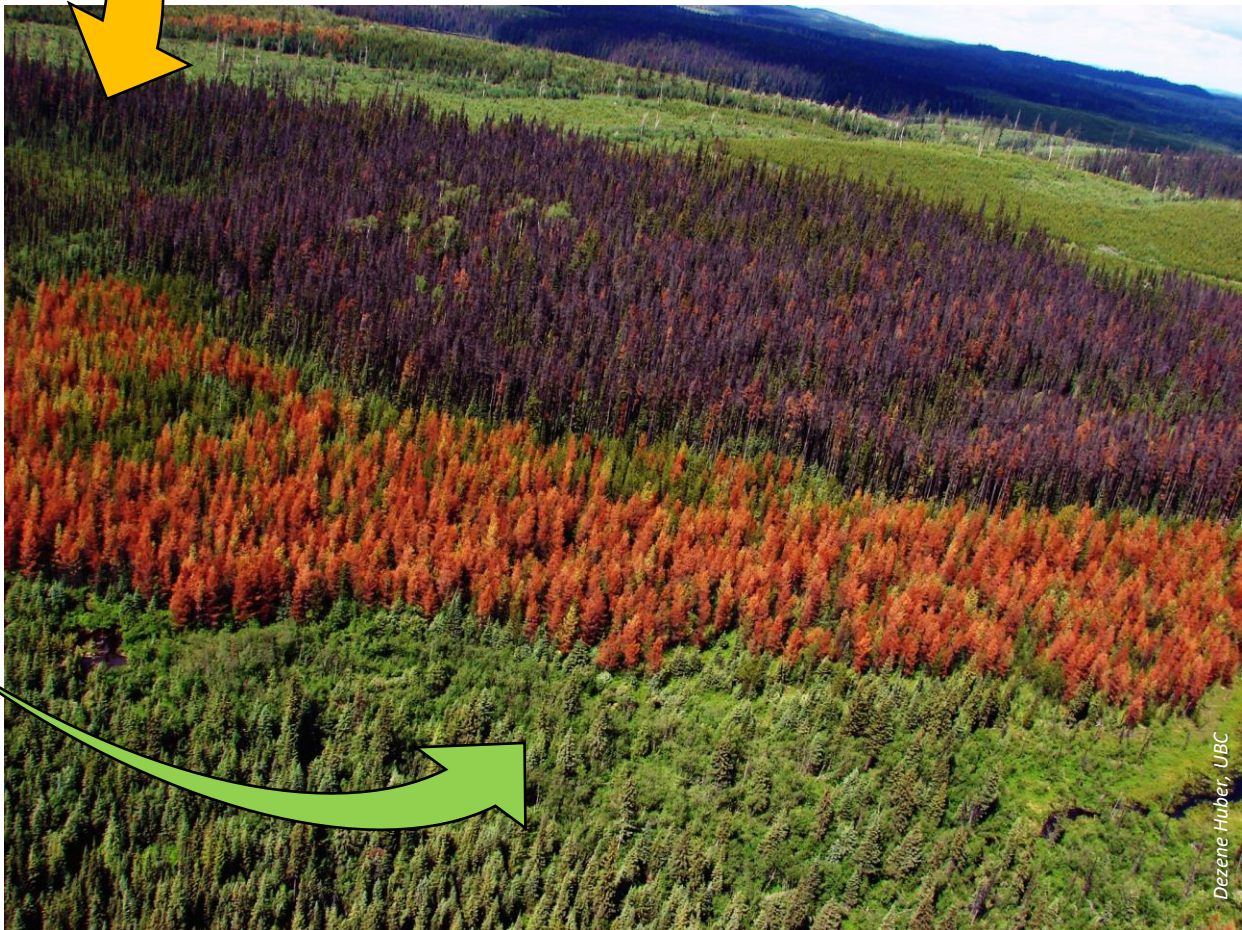
¹IEFC / ²ISA Universidade de Lisboa



Stephanie Hayes, EFIPLANT





Performance of alternative species/provenances under a future climate??

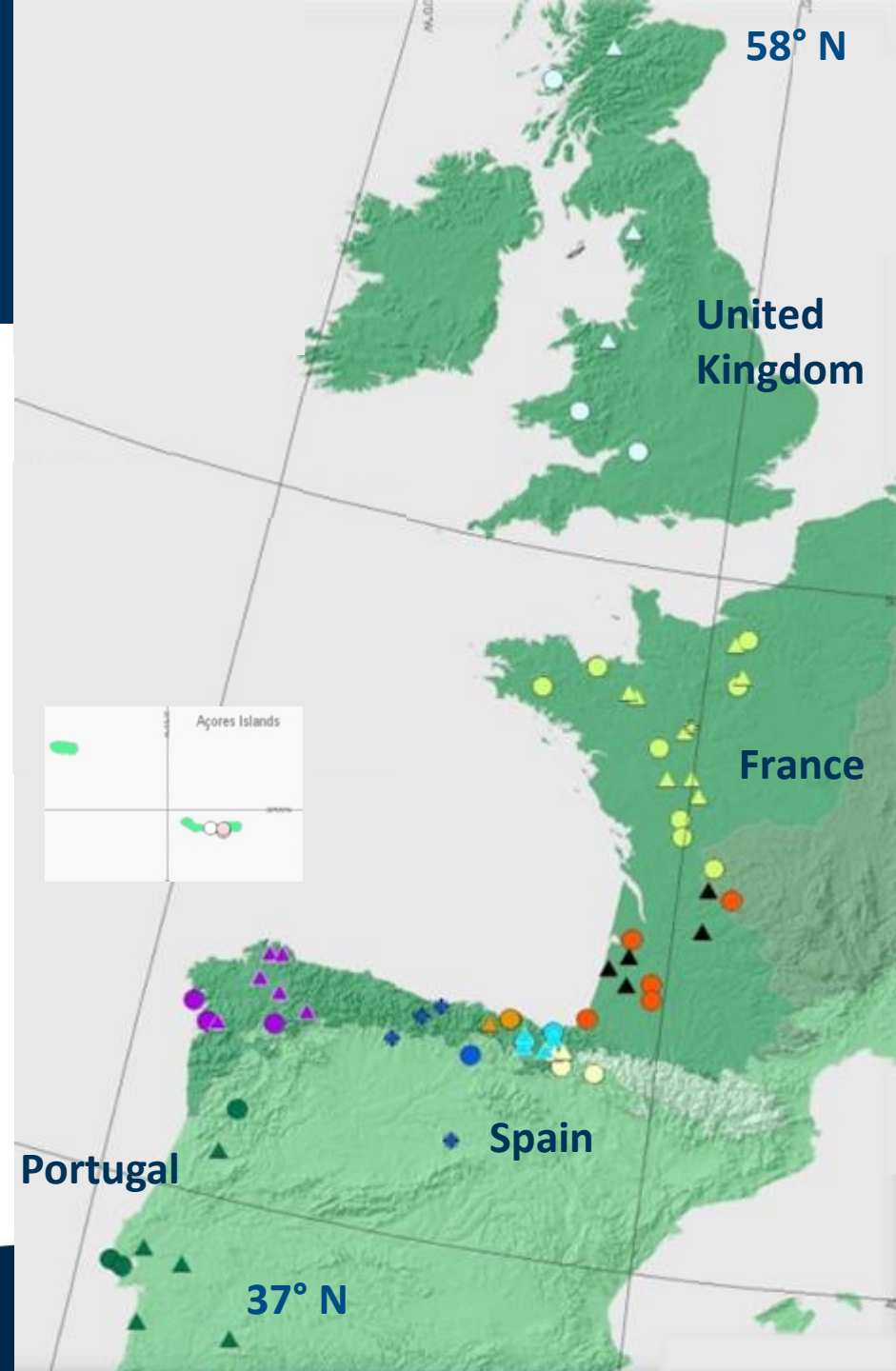


Dezene Huber, UBC



REsearch INFrastructure network for monitoring and adapting FORests to ClimatE change

- **Arboreta network (38 sites)** 
of **alternative species/provenances**
and common genetic material
- **Demonstration Sites network (41 sites)** 
of **adaptive silviculture** vs standard





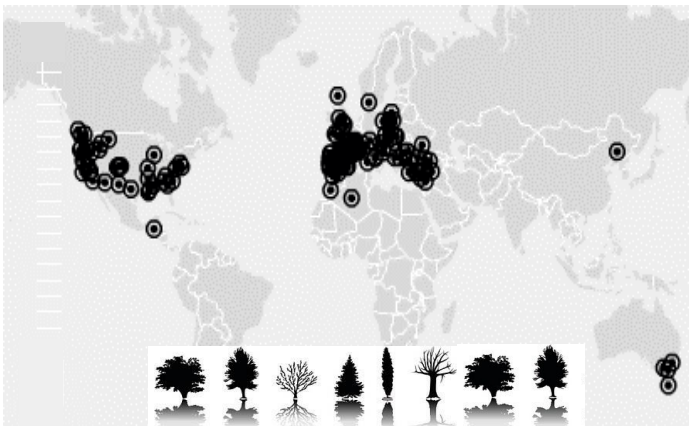
REsearch INFrastructure network for monitoring and adapting FORests to ClimatE change

- **12 partners** in **4 countries** committed for **15 years** (2014- 2029):
 - Establishment: Interreg Atlantic project (2009-2013)
 - Maintenance with partners core fund and national/regional funds
- **Common protocols** for **standard site maintenance** and **monitoring** (growth, health, weather)
- **Databases** (TREEDATA, FORESTRIALS)



Arboreta network of alternative species

- 38 arboreta sites along an Atlantic climate gradient
- 38 **European** and **non-European** species / 176 provenance origins



- *Acer pseudoplatanus*
- *Betula pendula*
- *Calocedrus decurrens*
- *Castanea sativa*
- *Cedrus atlantica*
- *Cedrus libani*
- *Ceratonia siliqua*
- *Cunninghamia lanceolata*
- *Cupressus sempervirens*
- *Eucalyptus nitens*
- *Eucalyptus globulus*
- *Eucalyptus gundal*
- *Fagus orientalis*
- *Fagus sylvatica*
- *Larix decidua*
- *Liquidambar styraciflua*
- *Pinus brutia*
- *Pinus caribaea*
- *Pinus elliotii*
- *Pinus nigra* ssp. *laricio*
- *Pinus nigra* ssp. *salzmannii*
- *Pinus pinaster*
- *Pinus peuce*
- *Pinus pinea*
- *Pinus ponderosa*
- *Pinus sylvestris*
- *Pinus taeda*
- *Pseudotsuga menziesii*
- *Quercus ilex*
- *Quercus ilex* ssp. *rotundifolia*
- *Quercus petraea*
- *Quercus robur*
- *Quercus rubra*
- *Quercus shumardii*
- *Quercus suber*
- *Robinia pseudoacacia*
- *Sequoia sempervirens*
- *Thuja plicata*

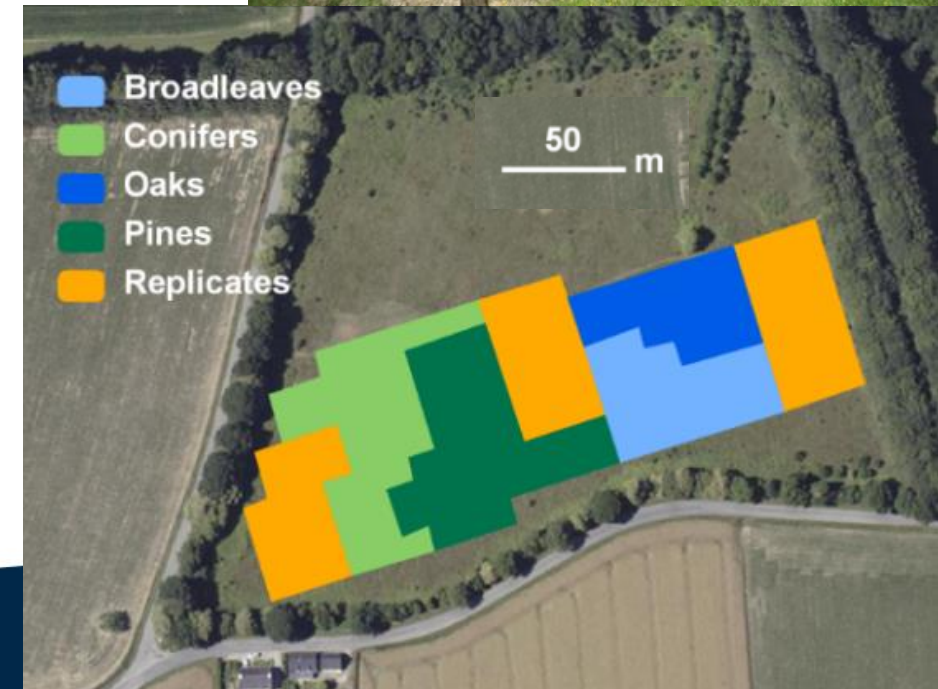
A common design for all arboreta

- 120.000 trees **planted** between **2011-2013**
- **Common genetic material** produced under same conditions and exposed to a climatic gradient

3 common proven/sp x **12 trees/prov**

- **Nested plots with 4 replicated species** for site variability assessment:

- *Betula pendula*
- *Cedrus atlantica*
- *Pinus pinaster*
- *Quercus robur*



First empirical evidences on the potential adaptive performance of alternative species





- **Height growth** and **Survival** at early stage (age 5)
- **Mixed linear models:**
 - Climate Transfer Distance from provenance origin to site
 - Climate at site
 - Species | Provenance effect (random)
 - Site effect (random)



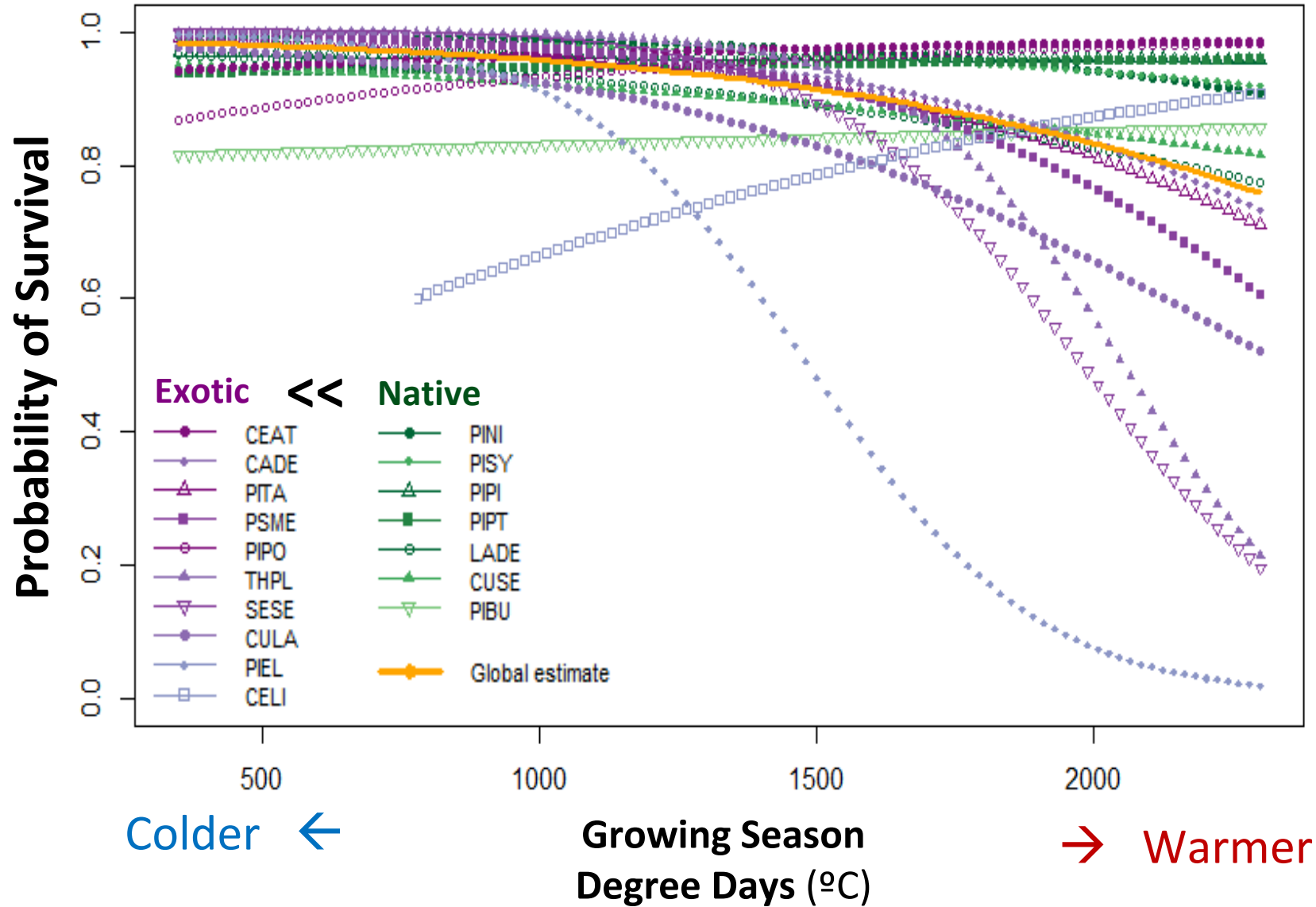
forests **Correia et al. 2018**

Article

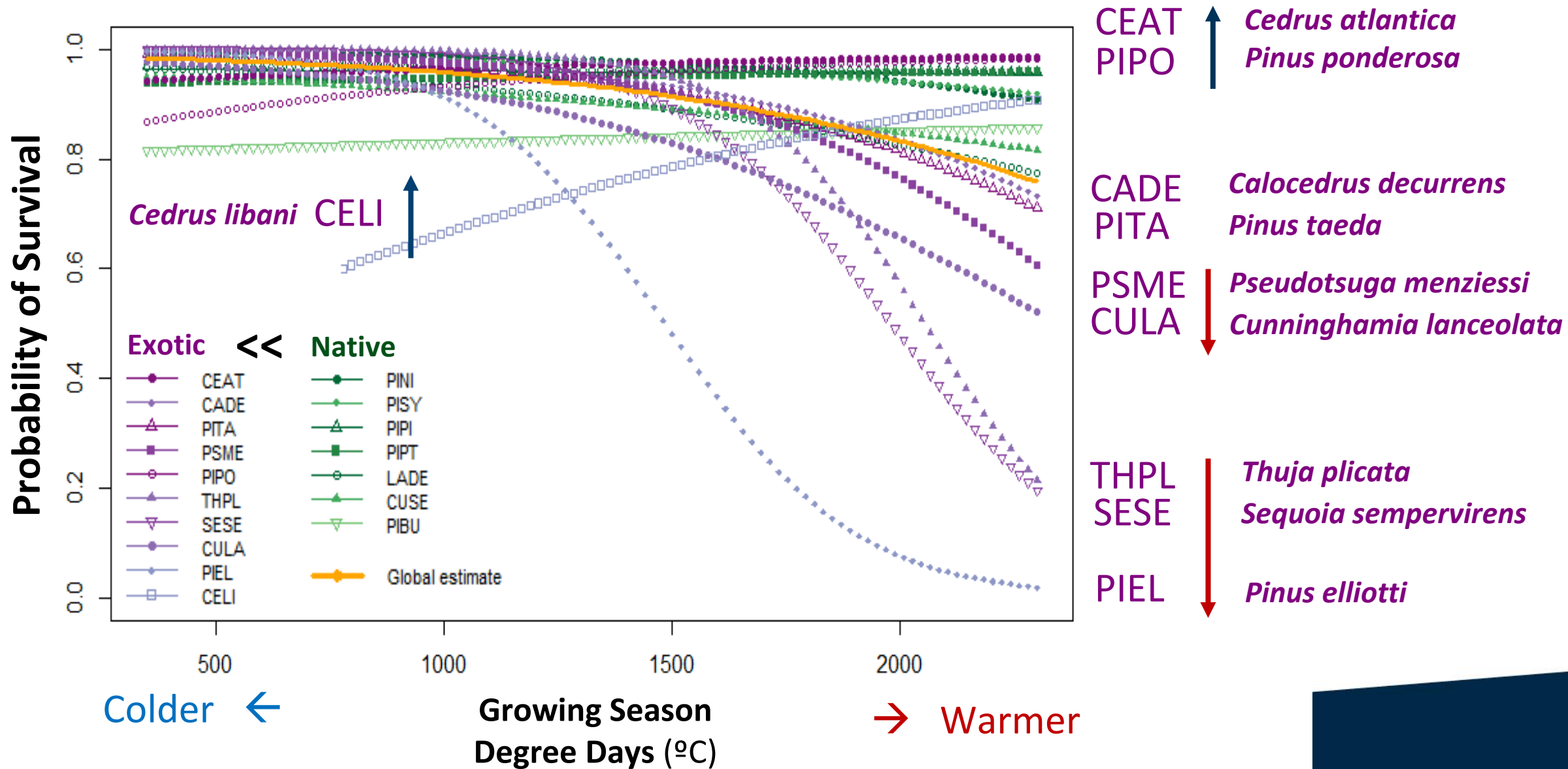
Early Survival and Growth Plasticity of 33 Species Planted in 38 Arboreta across the European Atlantic Area

Henrique António Correia ^{1,*}, Helena Maria Almeida ¹, Manuela Branco ¹, Margarida Tomé ¹, Rebeca Cordero Montoya ², Luisa Di Lucchio ², Alejandro Cantero ³, Julio Casero ⁴, Cristina Prieto ⁴, Felipe Bravo ⁴, Nahia Gartzia ⁵, Ander Arias ⁵, Richard Jinks ⁶, Eric Paillassa ⁷, Patrick Pastuszka ⁸, María José Rozados Lorenzo ⁹, Javier Francisco Silva Pando ⁹, María Carmen Traver ¹⁰, Silvia Zabalza ¹⁰, Carina Nóbrega ¹¹, Miguel Ferreira ¹² and Christophe Orazio ²

Estimated Survival probability - Conifers

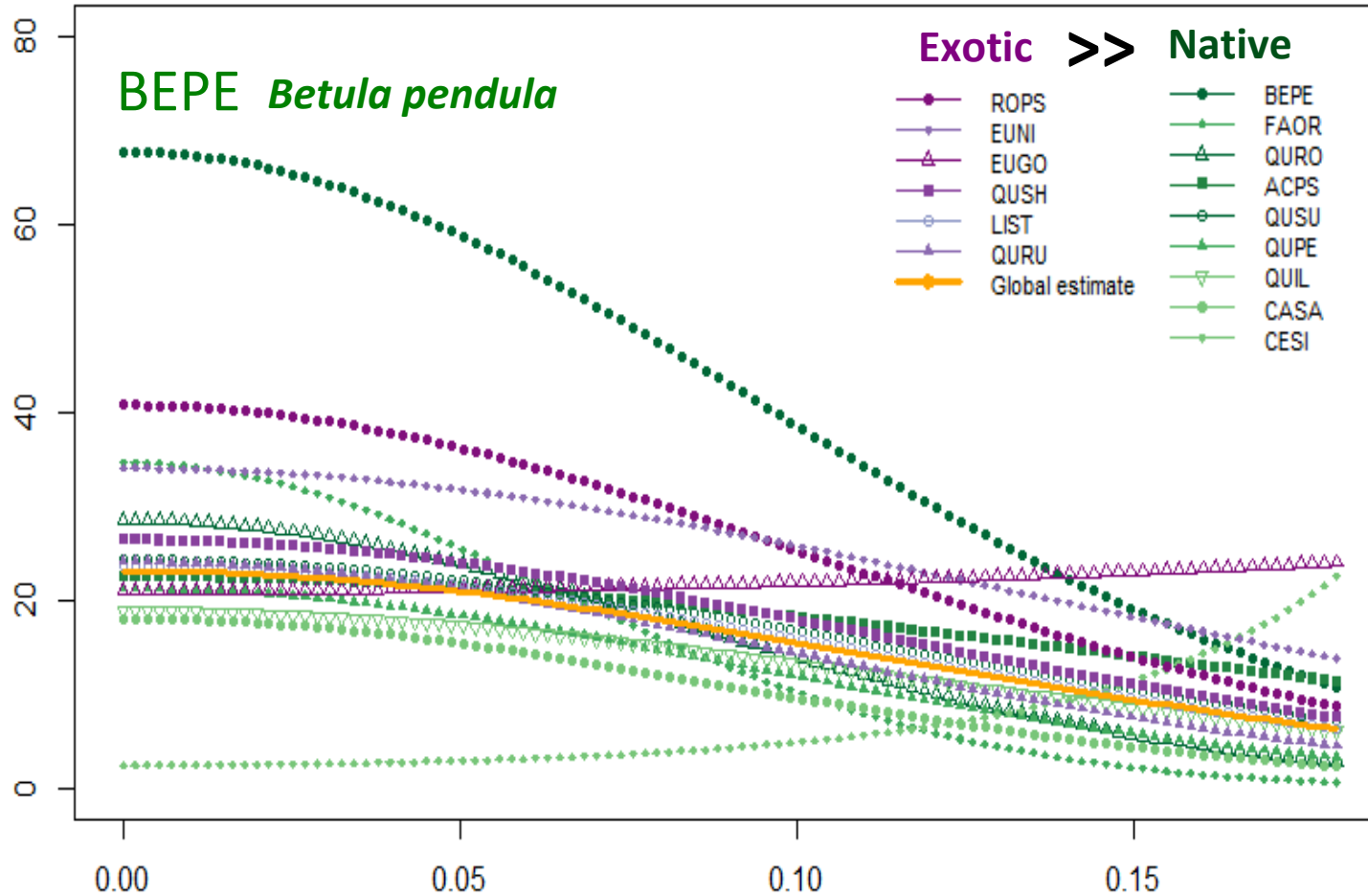


Estimated Survival probability - Conifers



Estimated Height Growth - Broadleaves

Height Growth
(cm/year)



Humid ←

Annual Dryness Index

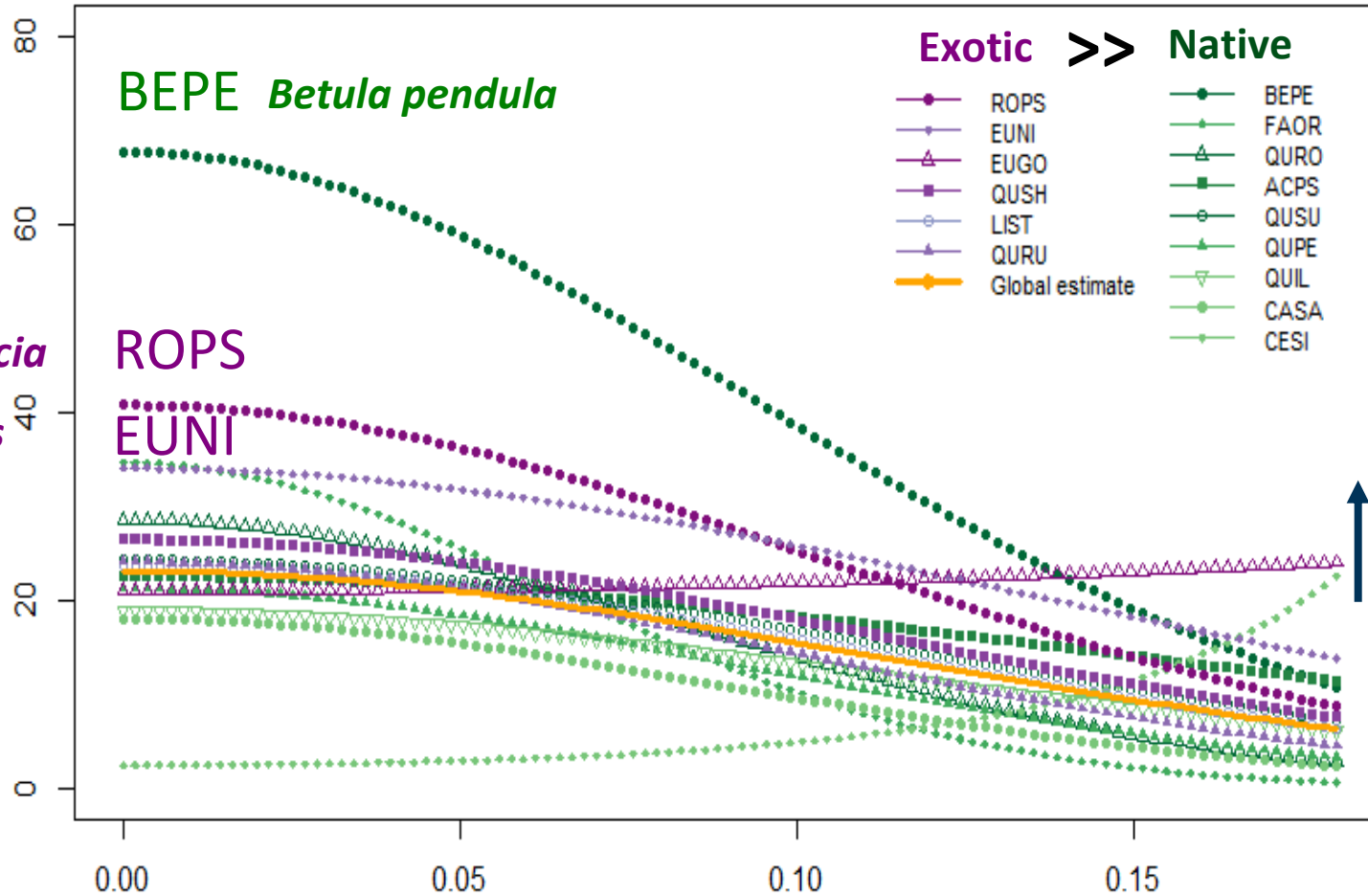
→ Drier

$$= \sqrt{(\text{Growing degree-days}) / \text{Precipitation}}$$

Estimated Height Growth - Broadleaves

Height Growth
(cm/year)

Robinia pseudoacacia
Eucalyptus nitens



EUGO *Eucalyptus globulus*
CESI *Ceratonia siliqua*

Humid ←

Annual Dryness Index

→ Drier

$$= \sqrt{\frac{\text{Growing degree-days}}{\text{Precipitation}}}$$

Conclusions REINFFORCE

- ❖ **Strategical tool for forest adaptation to CC**
- ❖ **Trade-offs potential growth gain - mortality risk under CC**
- ❖ **Adaptation performance differences **native** vs. **exotic** sps:**
 - Broadleaves: faster growth in **exotic** ↑
 - Conifers: lower survival in **exotic** ↓



Conclusions REINFFORCE

- ❖ **Strategical tool for forest adaptation to CC**
- ❖ **Trade-offs potential growth gain - mortality risk under CC**
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❖ **Potential for further research :**

Genetic analysis / Provenance adaptation plasticity / Phenology plasticity /
Effect of biotic-abiotic damage / ...





Contact us for research collaboration!

REINFFORCE.IEFC.NET

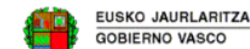
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Partners

Funders





41 Demonstration Sites of adaptive silviculture

Comparison of **alternative silvicultures** with **business as usual** to improve adaptation to climate change:

- Soil preparation
- Density management
- Species mixing
- Stand structure
- Border management
- Underfloor management
- Soil enrichment

