Forest Research

B4EST Case Study : Opportunities to develop Scots pine FRM in Scotland *(and England)*

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B4est

Scots pine in Scotland

- The only native conifer used in production forestry
- At the Atlantic margin of its native range
- National tree of Scotland – highly iconic and important habitat type known as the ‘Caledonian pinewoods’ (10% of the Scots pine area)
- Second commercial species (14% forest area) after Sitka spruce (40%)
- 0.4 million m3 harvested per year
- Main use: 52% OSB, 40% agricultural fencing
- ~10 million seedlings sold per year

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History of Scots pine FRM in Scotland

- 1700s – plantation forestry begins
- 1881 – “THE DETERIORATION OF SCOTCH FIR!” (McCorquodale, 1881)
- 1919 – Forestry Commission established. Seed import stops.
- 1920s – Provenance testing demonstrates home-site advantage
- 1940s – Tree breeding begins
- 1959 – “The Native Pinewoods of Scotland” is published – an ecological monograph beginning a renaissance
- 1980 – Biochemical markers characterise populations and ‘exclusion zones’ are set up
- 2000 – Breeding programme closes

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20th Century breeding programme

- Intended end use is construction timber
- Very intensive selections started 1949 in domestic plantations and native pinewoods
- 1065 selections tested in 30 half-sibling progeny test series (~110 sites)
- General breeding population of 226 parents reselected for **height** and **straightness** in 2002
- Top selections archived and the breeding programme was closed

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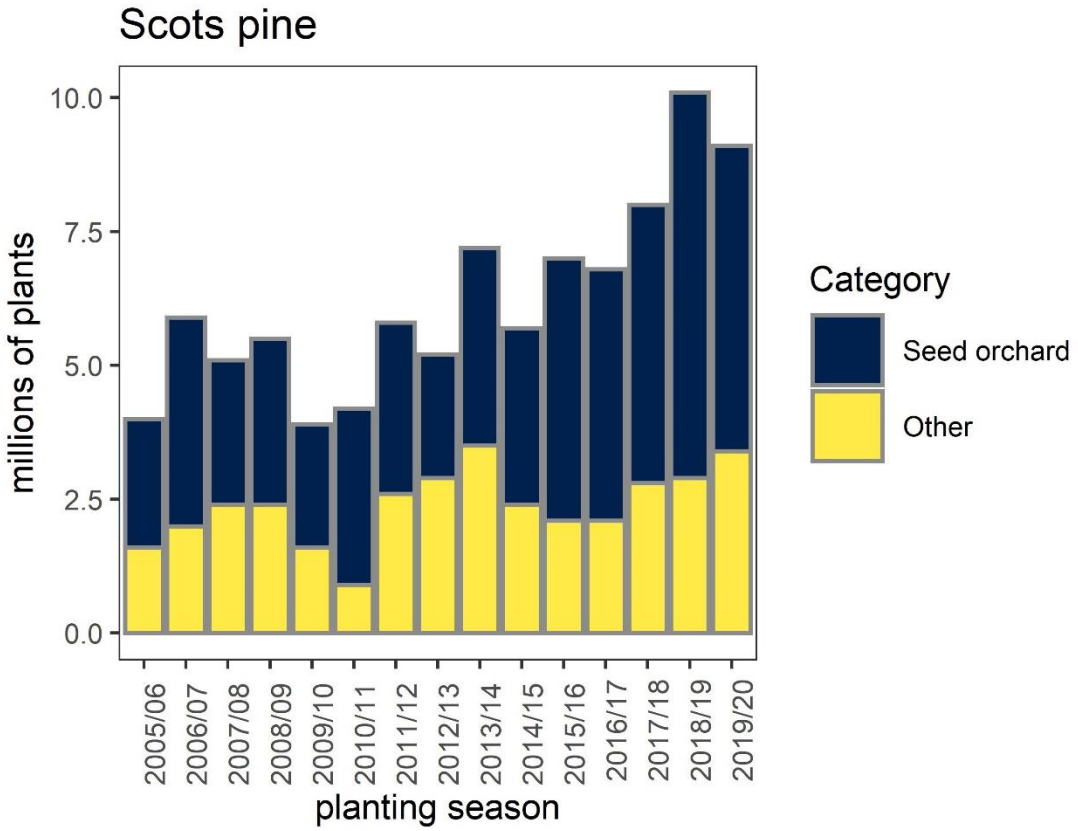
Deployment of improved FRM



Millions of seedlings supplied by British nurseries 2005-2020

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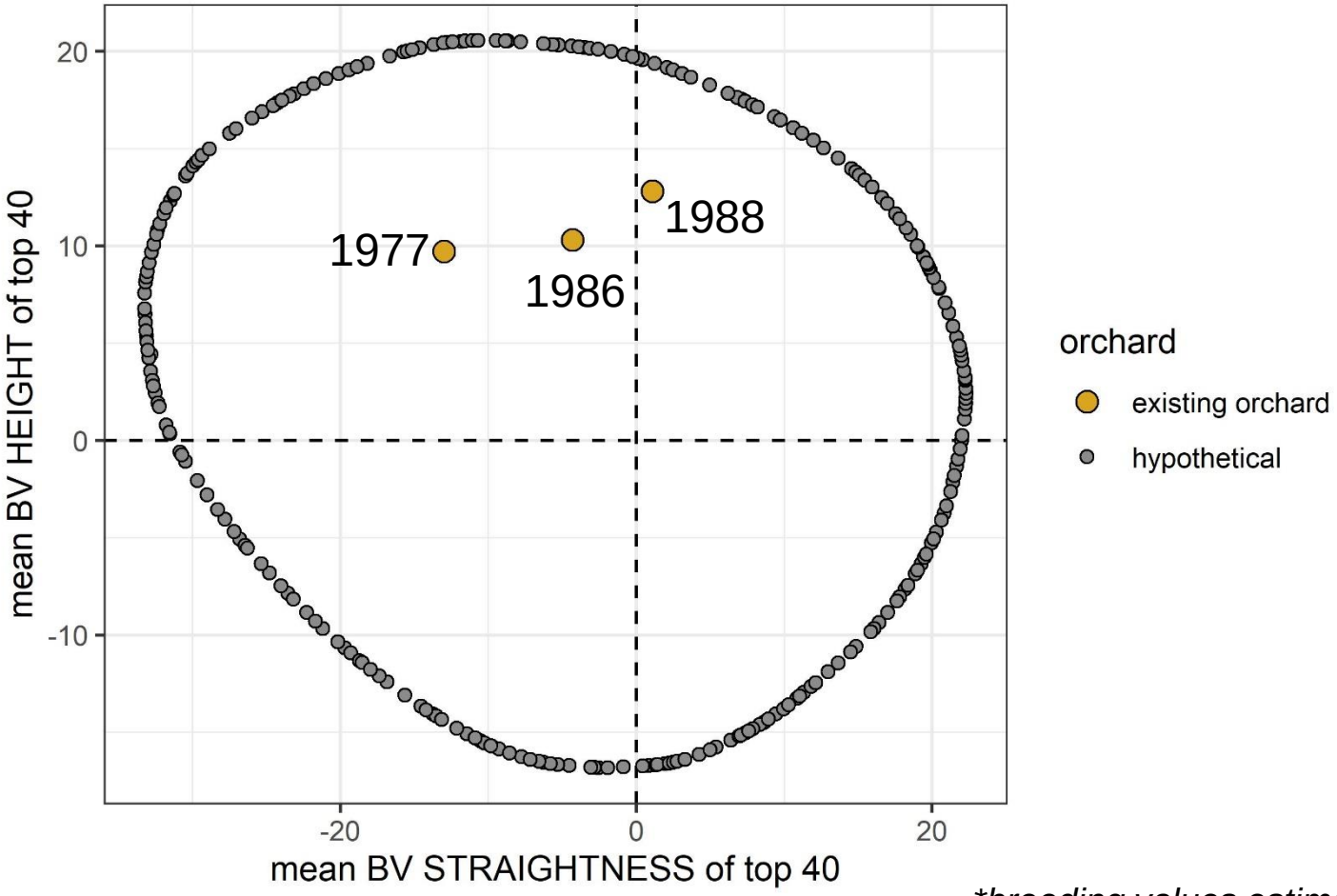
Deployment of improved FRM



**breeding values estimated 2002*

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Opportunities

- There is already room for improvement but…
- What has changed since then?
- What do people want?
- How would it pay off?
- What else have we learned since then?

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Opportunities

- There is already room for improvement but…
- What has changed since then? *Climate modelling*
- What do people want? *Stakeholder survey*
- How would it pay off? *Economic modelling*
- What else have we learned since then? *Ecological genetics and genomics*

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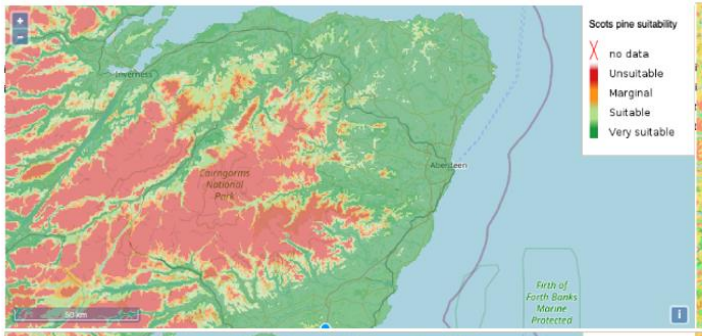
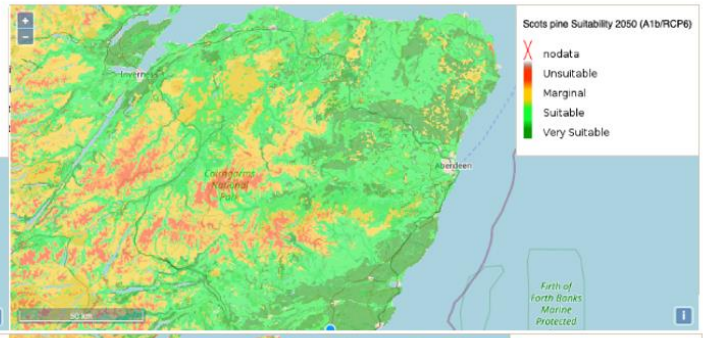
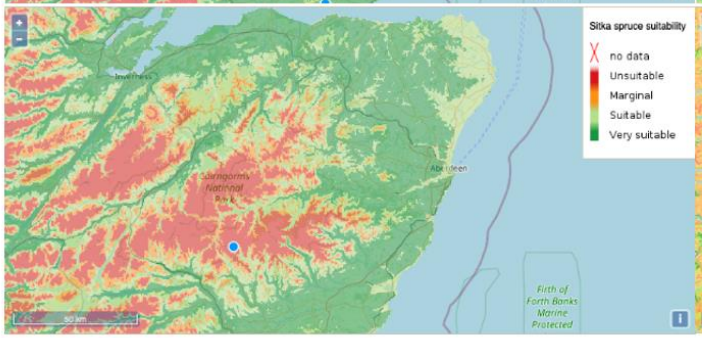
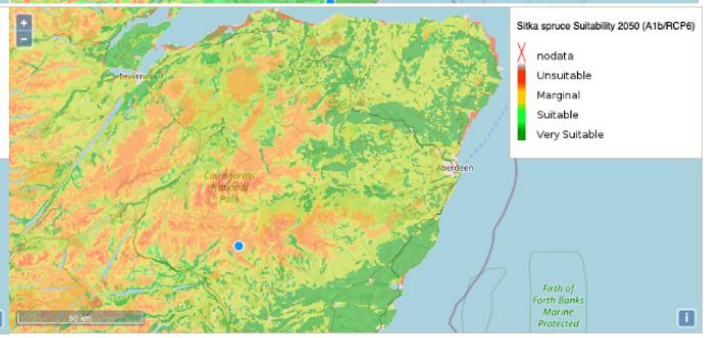
Climate resilience modelling

	Current	Predicted: 2050s
Scots pine		
Sitka spruce		

ESC (Ecological site classification) suitability

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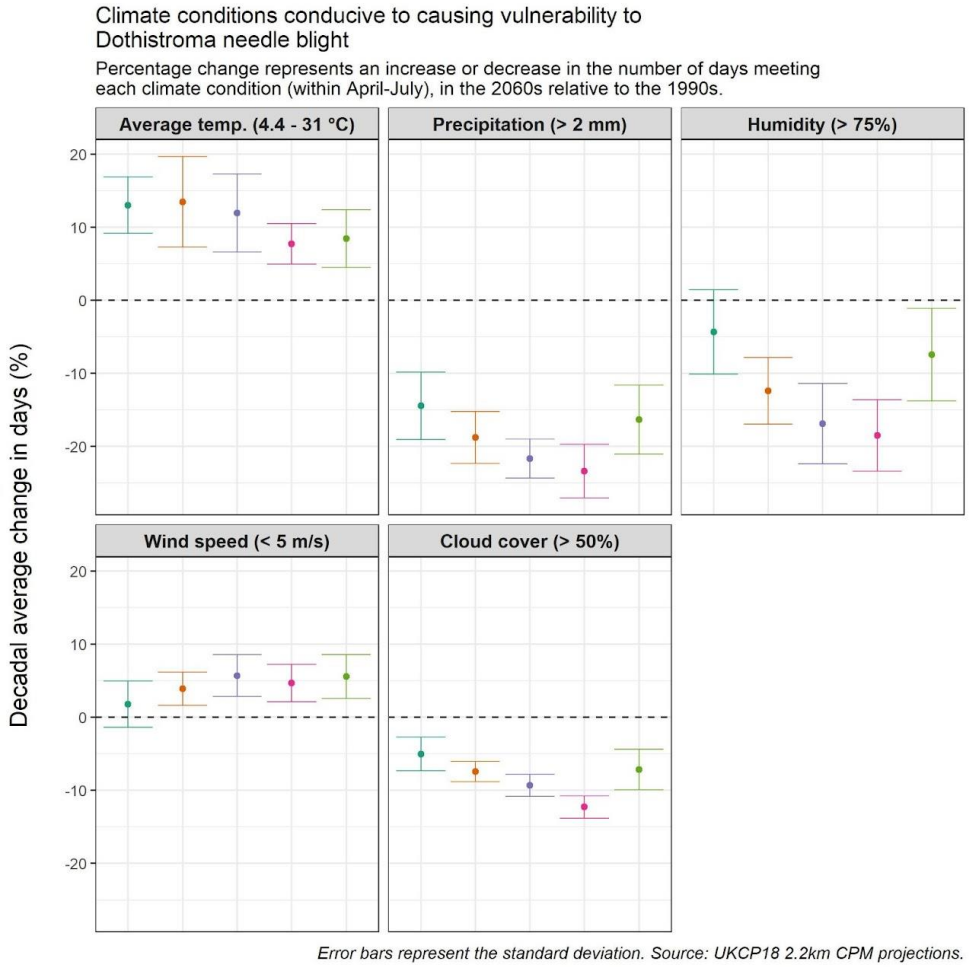
Disease resilience modelling

(*Dothistroma septosporum*)



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Stakeholder survey

- 45 responses
- 25 public sector, 15 private sector, 5 'other'

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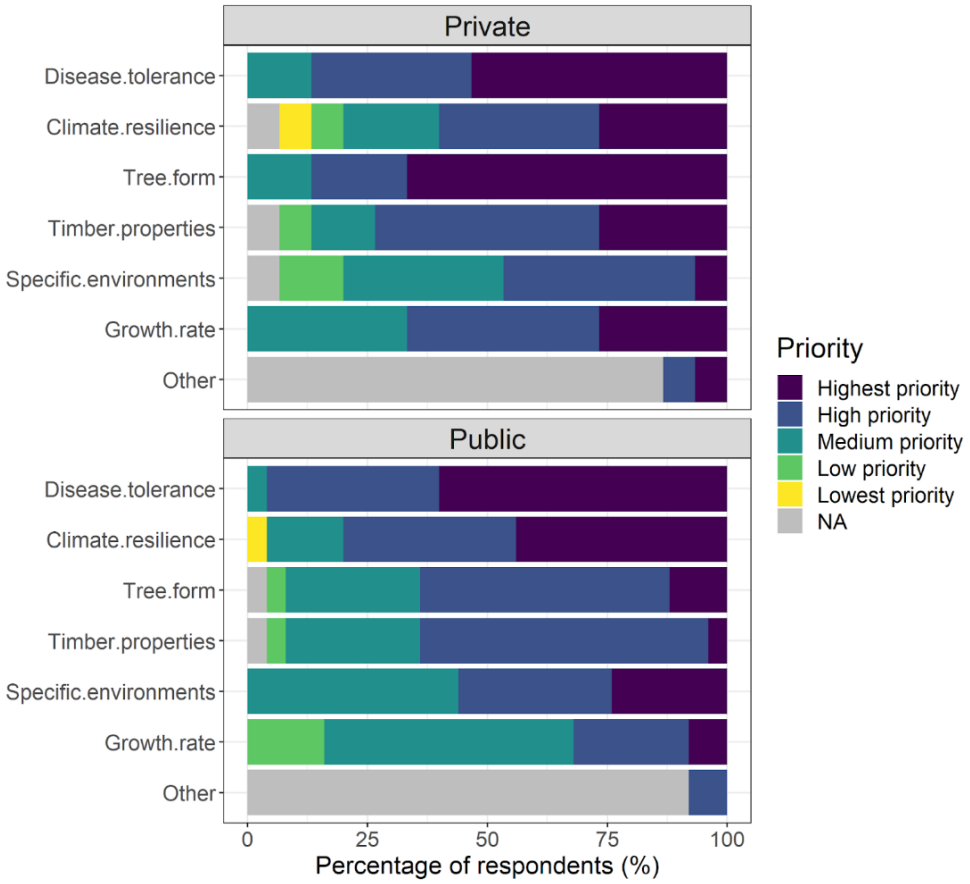
What should a breeding programme concentrate on?



- Both sectors – disease resilience
- Private sector – tree form *(branching, straightness)*
- Mediocre support for better growth rate
- Public sector interested in ‘climate resilience’ – private less so

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Majority agreed

- **"Scots pine will become more important under climate change"**
- **"The Scots pine breeding programme was stopped too early"**
- **"Improving Scots pine is in the public interest"**
- **"As long as we protect and encourage regeneration of the native pinewoods, we can plant improved material elsewhere"**

Majority disagreed

"The economics of Scots pine silviculture do not justify investment in tree breeding"

"Planting Scots pine threatens the genetic integrity of the native pinewoods"

"It is more important to match seed sources to current or future climates than to improve Scots pine"

"Improved Scots pine should only be planted if it is based on selections from native pinewoods"

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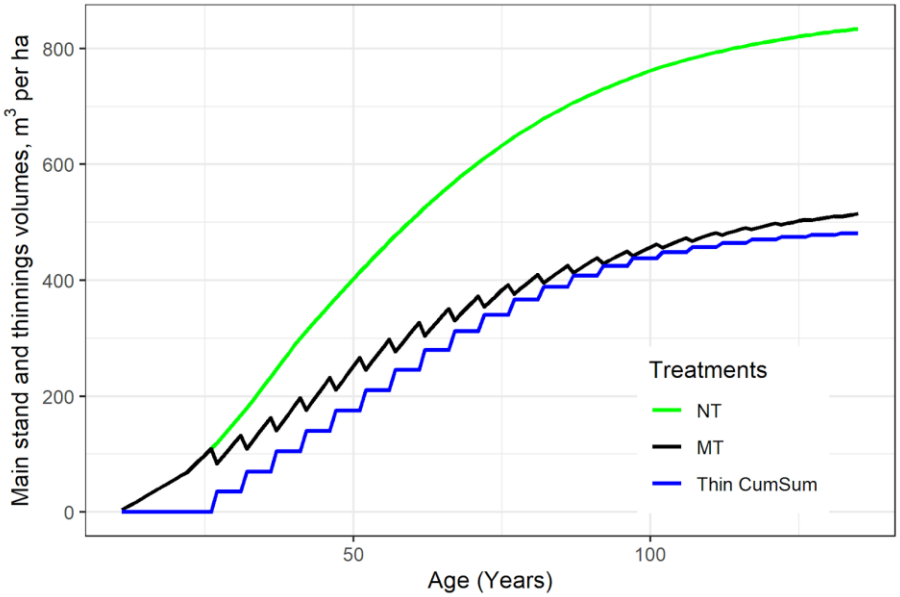
Economic model



Vadim Saraev

Scenario	Optimal rotation length (years)	NPV (£/ha)	Main stand volume (m^3/ha)	Thinnings volume (m^3/ha)
Base	50.8	**43.5**	265.2	140.0
+5%	50.7	411.2	304.8	161.0
+10%	45.8	788.6	300.1	136.5
+15%	45.8	**1,168.6**	334.7	152.3

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Economic modelling

- Options to finance tree improvement based on increase in net present value.
- Assumes genetic gains are split 50/50(!) between breeders and forest owners

Capital grant to planters

Pay more for the seedlings

Invest directly in breeding (e.g. via a levy)

Scenario	Annuity payment (per ha/yr-1)	Seedling cost	Scaled to area of pine in Scotland
Low (5% gain)	9.8	0.31	£1,509,117
Central (10% gain)	19.86	0.37	£3,058,074
High (15% gain)	29.99	0.43	£4,617,841

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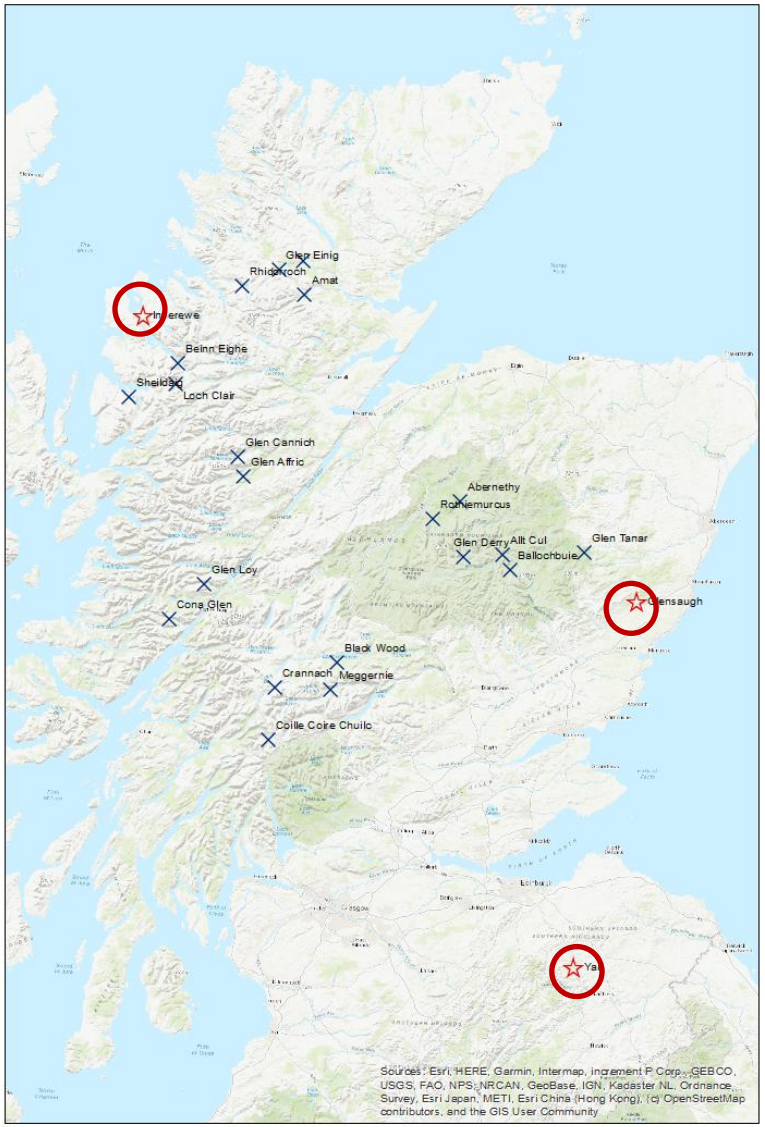
Native provenance-progeny trial

- 8 families from each of 21 populations of native Scots pine
- Planted at three sites: Inverewe (north-west), Glensaugh (east), Yair (south-east)
- Seed collected 2007, planted 2012
- Parents not selected for superiority – more or less random/natural/sufficient seed producing
- Assessment of many traits over several years (growth, phenology, endophytes, disease resistance)
- Centre for Ecology and Hydrology, James Hutton Institute, Forest Research



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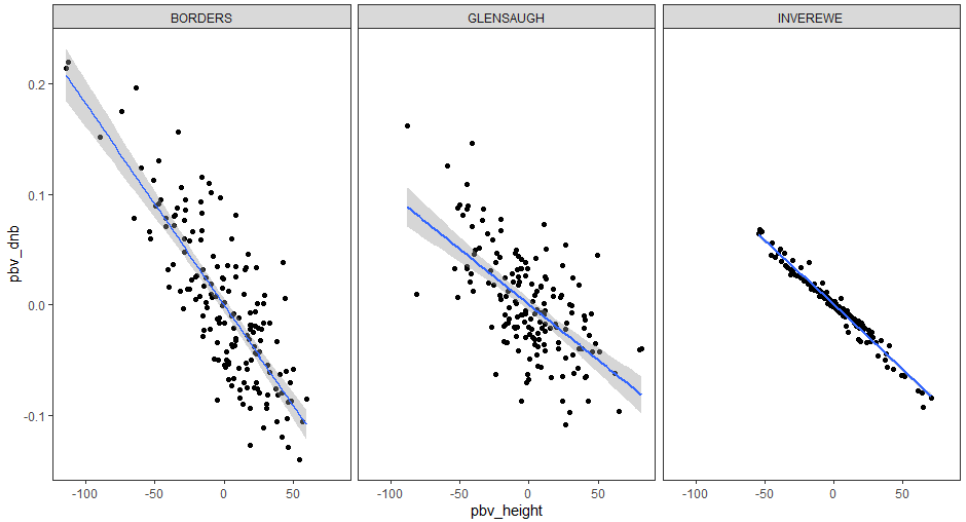
Native provenance-progeny trial

- Moderate-high heritability values for DNB response (0.3:0.6) and height (0.5:0.8) *but errors quite large*
- Stable performance of families across sites for both traits
- Strong and favourable negative genetic correlations between DNB susceptibility and height (-0.5 : -0.9)



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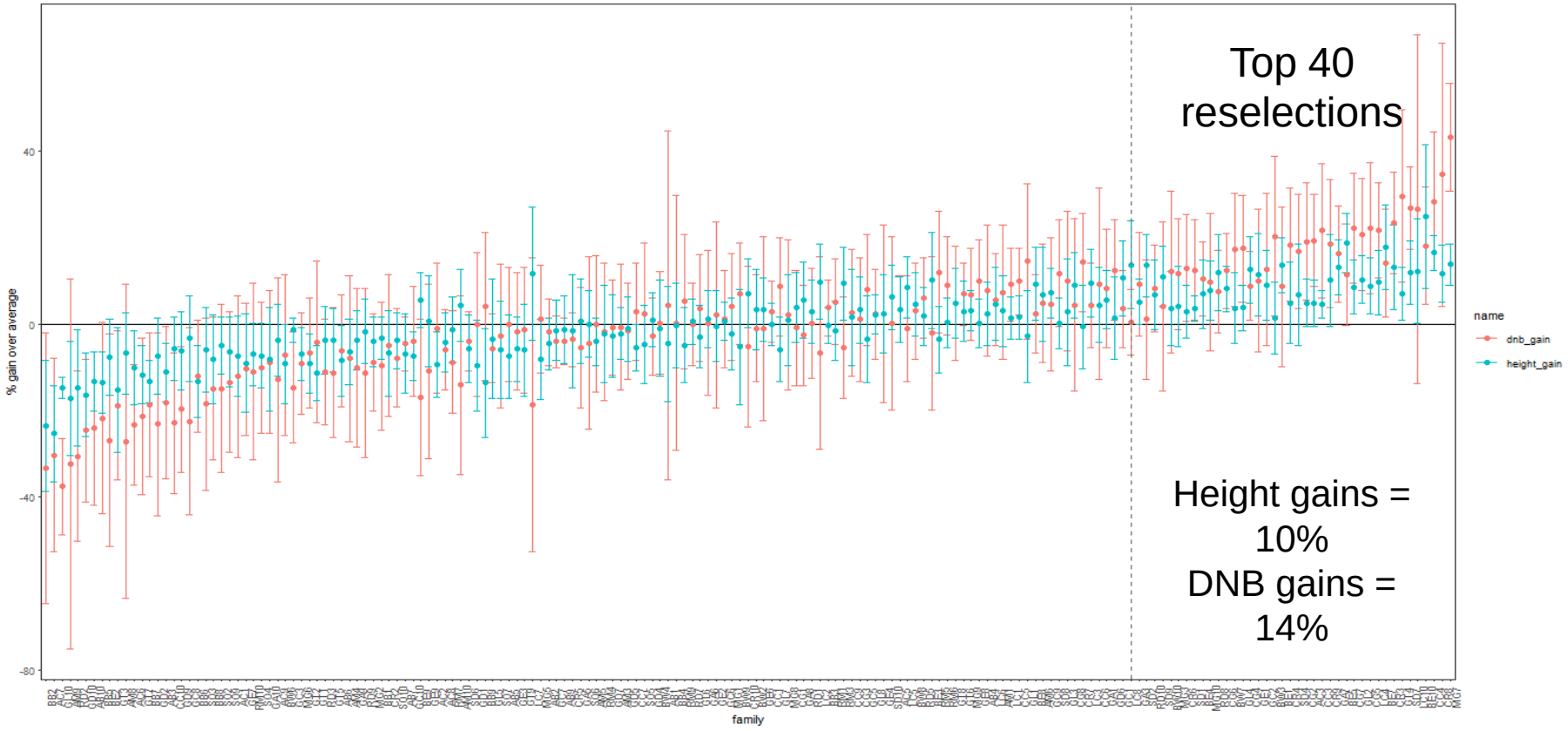
Genetic gains



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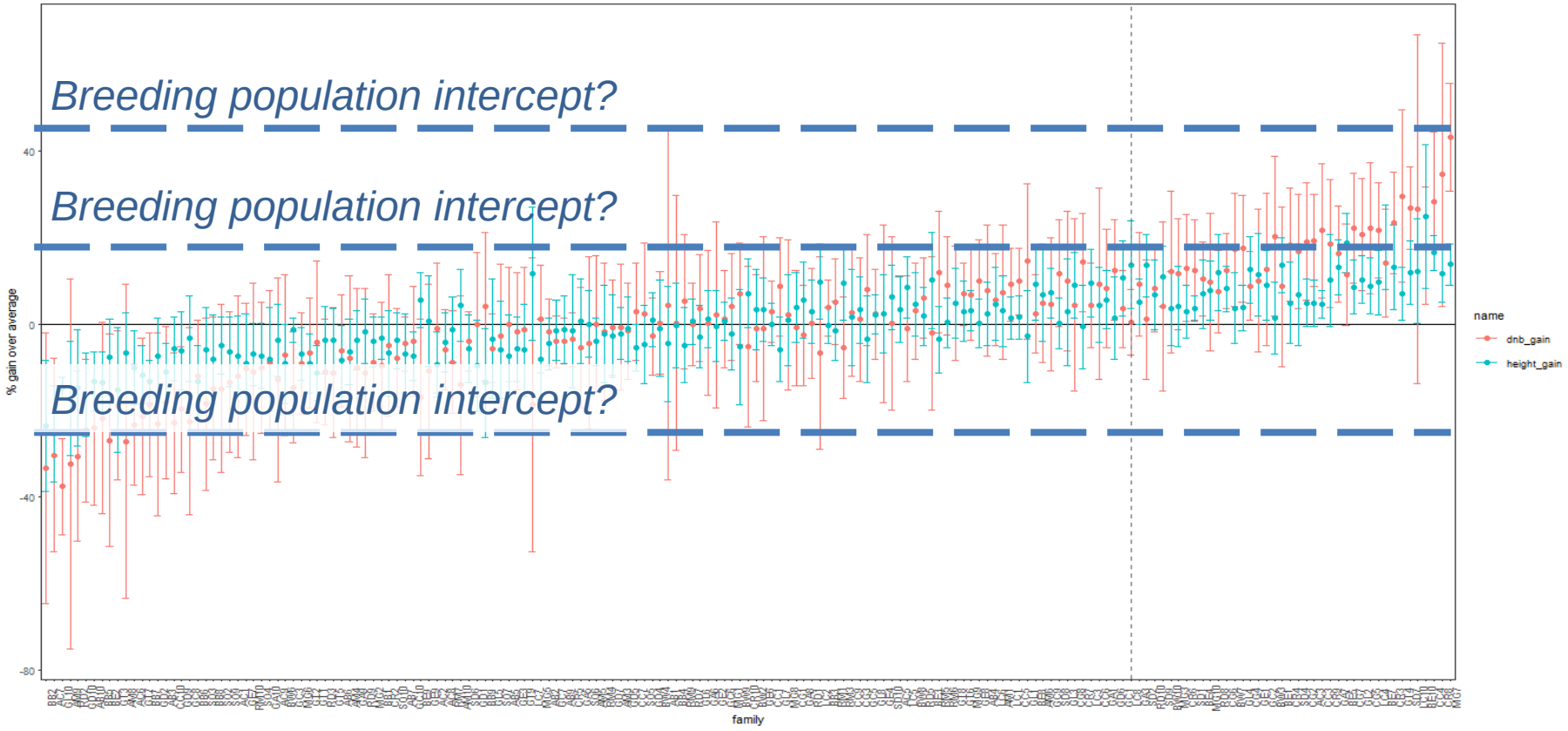
Genetic “gains”



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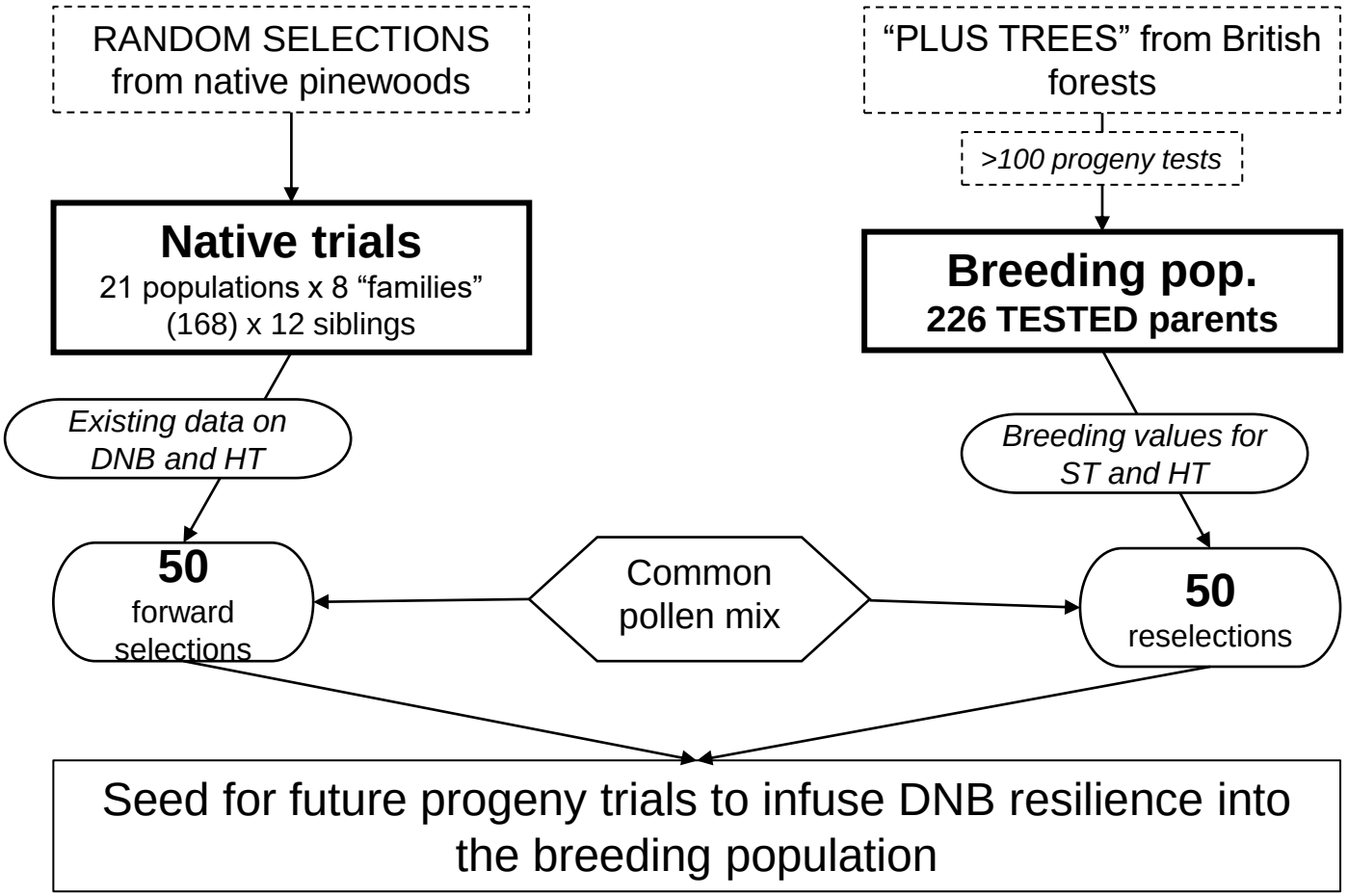
“Infusing *Dothistroma* needle blight resilience into the Scots pine breeding population”



Three year project, supported by: Department for Environment Food & Rural Affairs

funded via a new initiative called: Centre for Forest Protection

“Infusing *Dothistroma* needle blight resilience into the Scots pine breeding population”

WP2

50 BP
Reselections in WP1

DNB SCREENING

PARENTS: Various existing clone banks and seed orchards

PROGENY: Full-sibling tests planted in 1987

Methods for new progeny testing

Three year project, supported by: Department for Environment Food & Rural Affairs

funded via a new initiative called: Centre for Forest Protection

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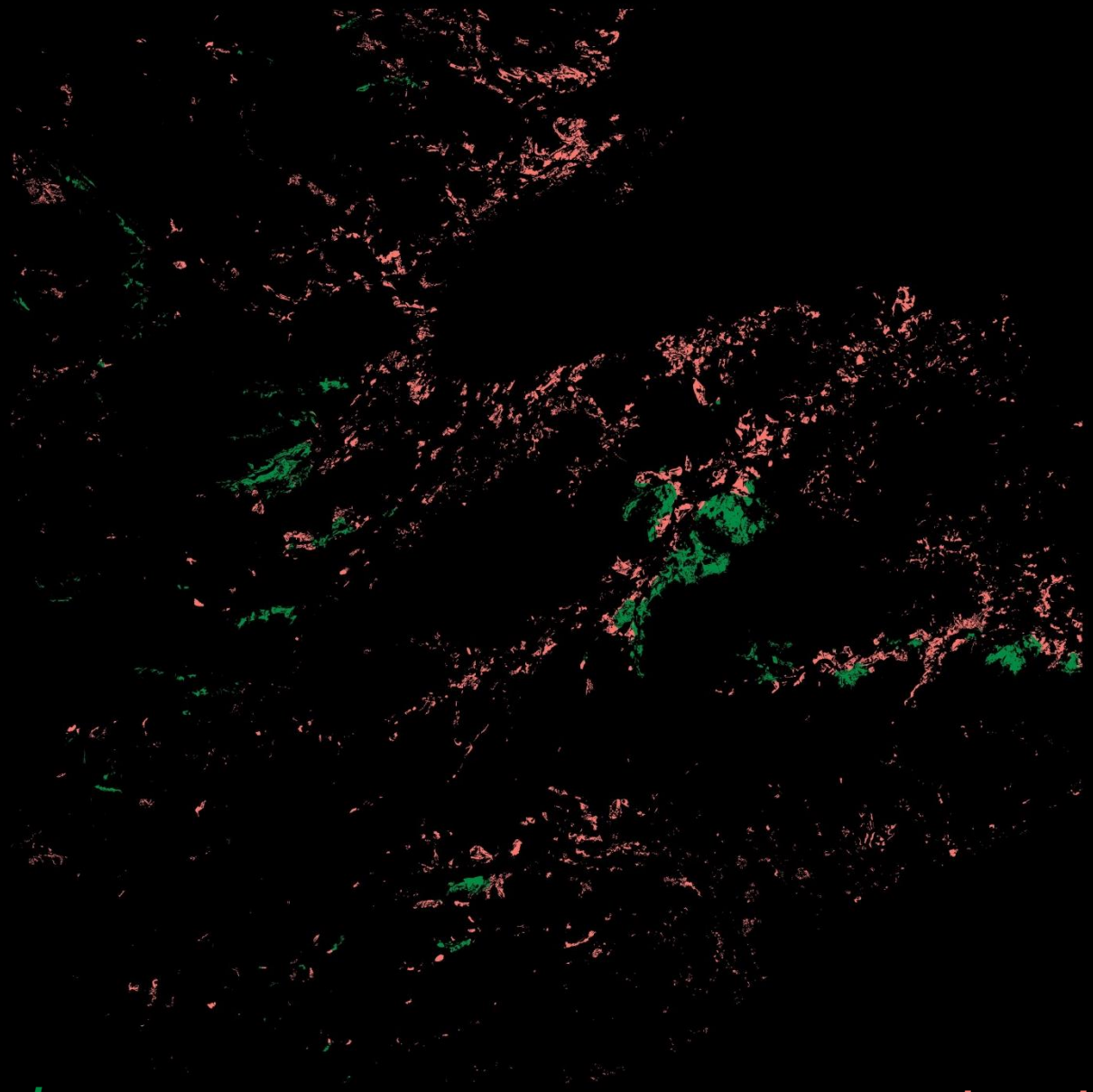
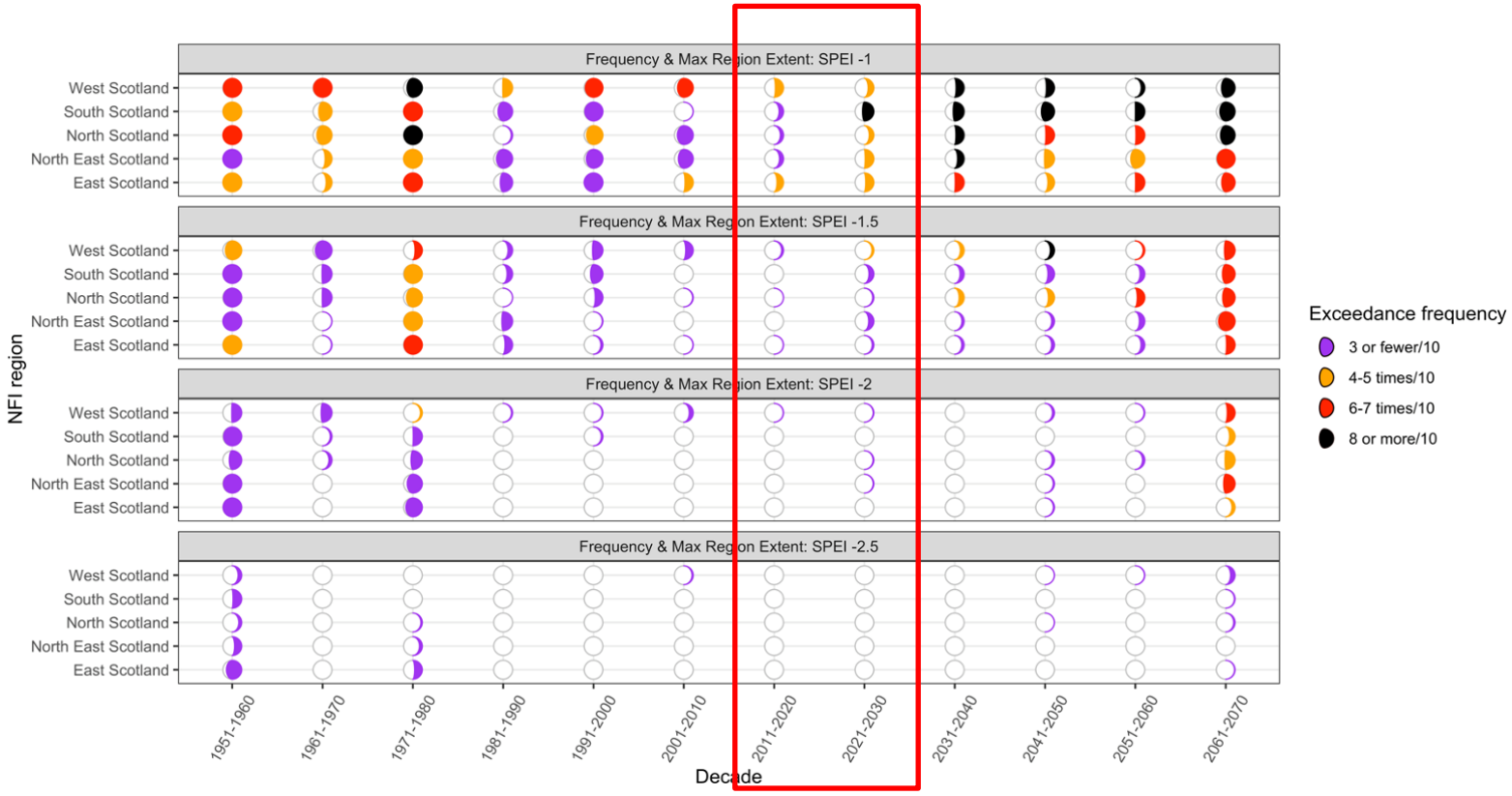


‘Caledonian’ pinewoods

Plantation origin pinewoods

Climate resilience modelling



SPEI Standardised precipitation and Evapotranspiration index

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