



An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine



FIRMLY ROOTED: Using Host Trees to Predict New Pest Invasions

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01

Forestry In Ireland

These goals can be
safeguarded through
proactive forestry
protection



**Commitment to 18% Forestry
Coverage by 2050 and Forest
Diversification**

Increased from 1% to 11.6%, 3rd lowest in EU 27.



**Diverse forestry facilitates a range
of services to humans and nature**

Supporting, Provisioning and Regulating.



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Risks to Forestry in Ireland

- Invasive species are becoming more likely to arrive and their origin more unpredictable.
- Ireland has a high protection status from invasive species.
- Two major invasive species have affected Irish forestry biodiversity:
 - Dutch Elm Disease
 - Ash Dieback

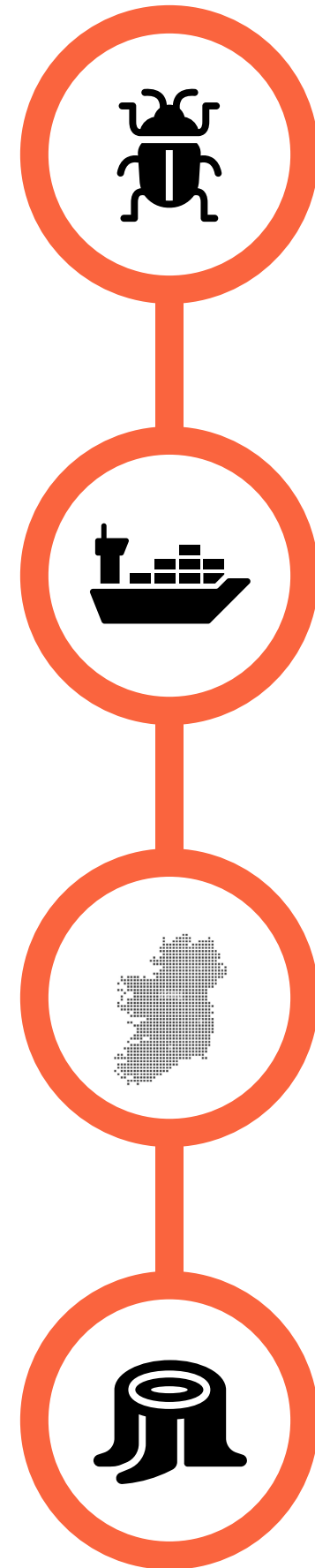
Photo Credit: Tony Grehan (2014)



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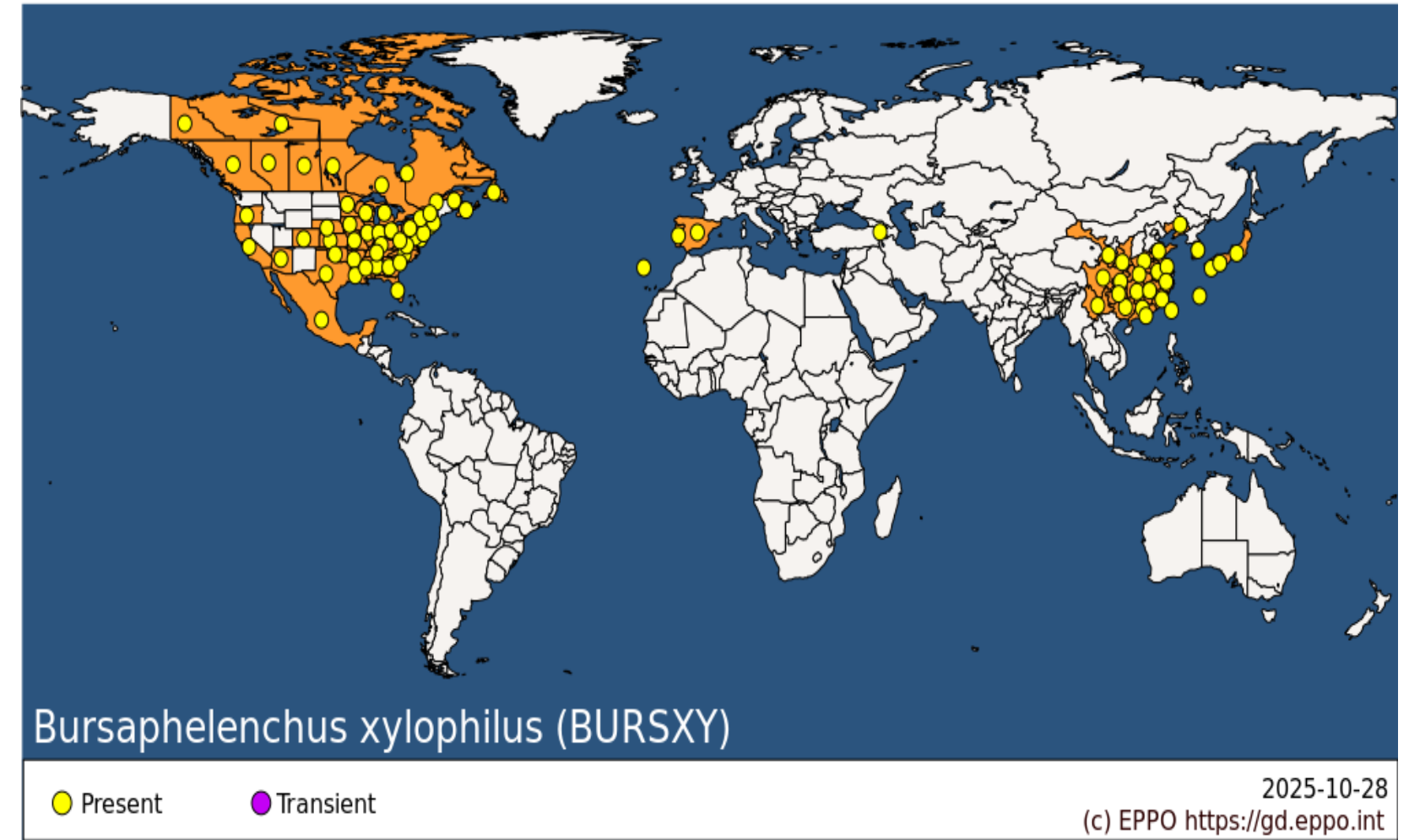
Horizon Scanning

- My research focused on risk of establishment
- How well is Ireland suited to the establishment of invasive forestry species?
- First pass to potential pests and follow up with other components of risk
- I began with using species distribution models





Pine Wood Nematode Species Distribution
(1 Record)



Pine Wood Nematode Global Distribution by Country

05

**Can host trees be used as a proxy to
determine relative pest suitability?**

Data Collection

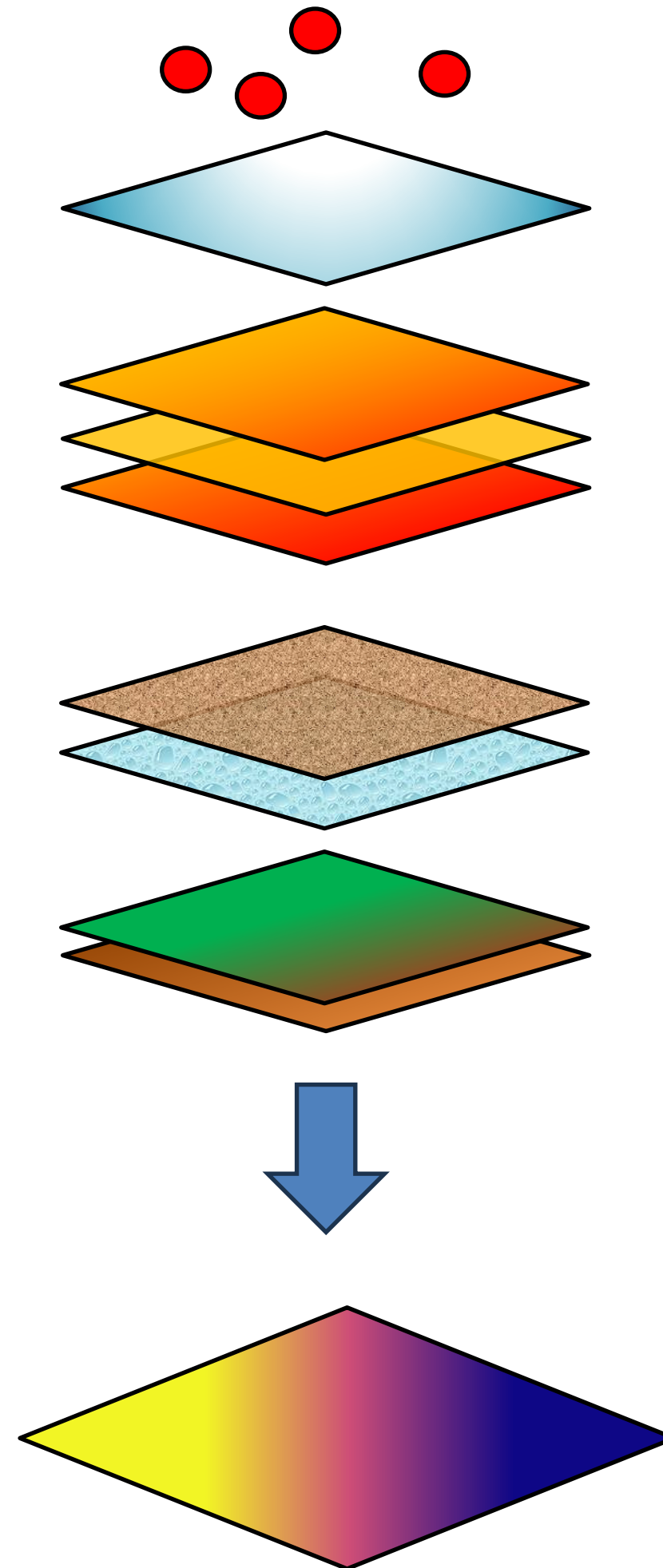
- All *Quercus* and *Pinus sp.* were collected from the EPPO Database
- Pests were scraped and location records were taken from GBIF
- Includes 220 pest species and 485 host species
- Environmental data taken from Bioclim and soilgrids.net



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Methodology

- Models were generated using a Boosted Regression Tree (BRT) algorithm.
- 220 pests were evaluated using 136 models.
- A minimum model performance threshold was set to ensure good quality predictions.



Host Records

Mean Diurnal Range

Mean Annual Temperature

Mean Temperature of CQ

Mean Temperature of DQ

Precipitation of DQ

Precipitation of WQ

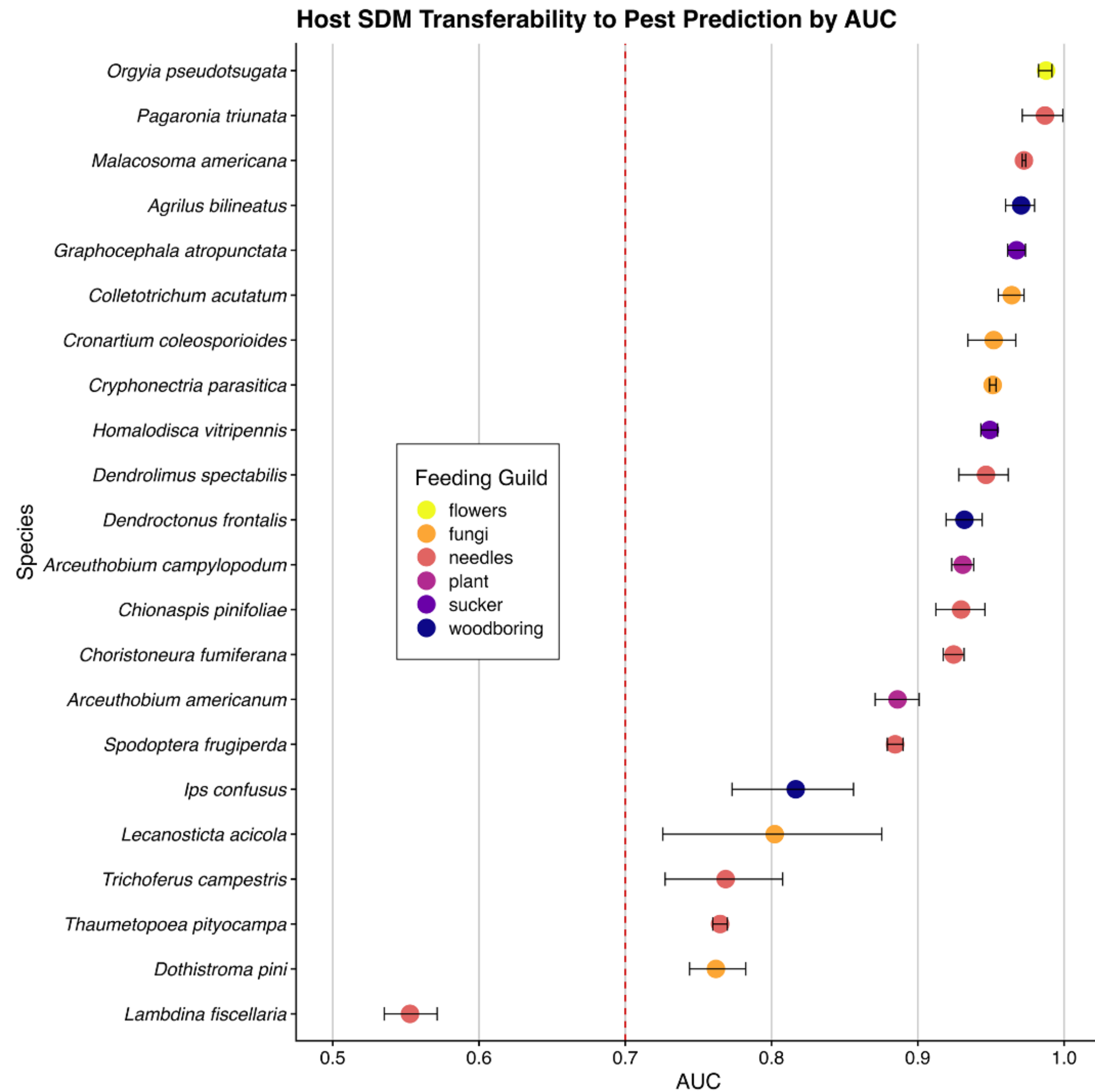
Soil pH

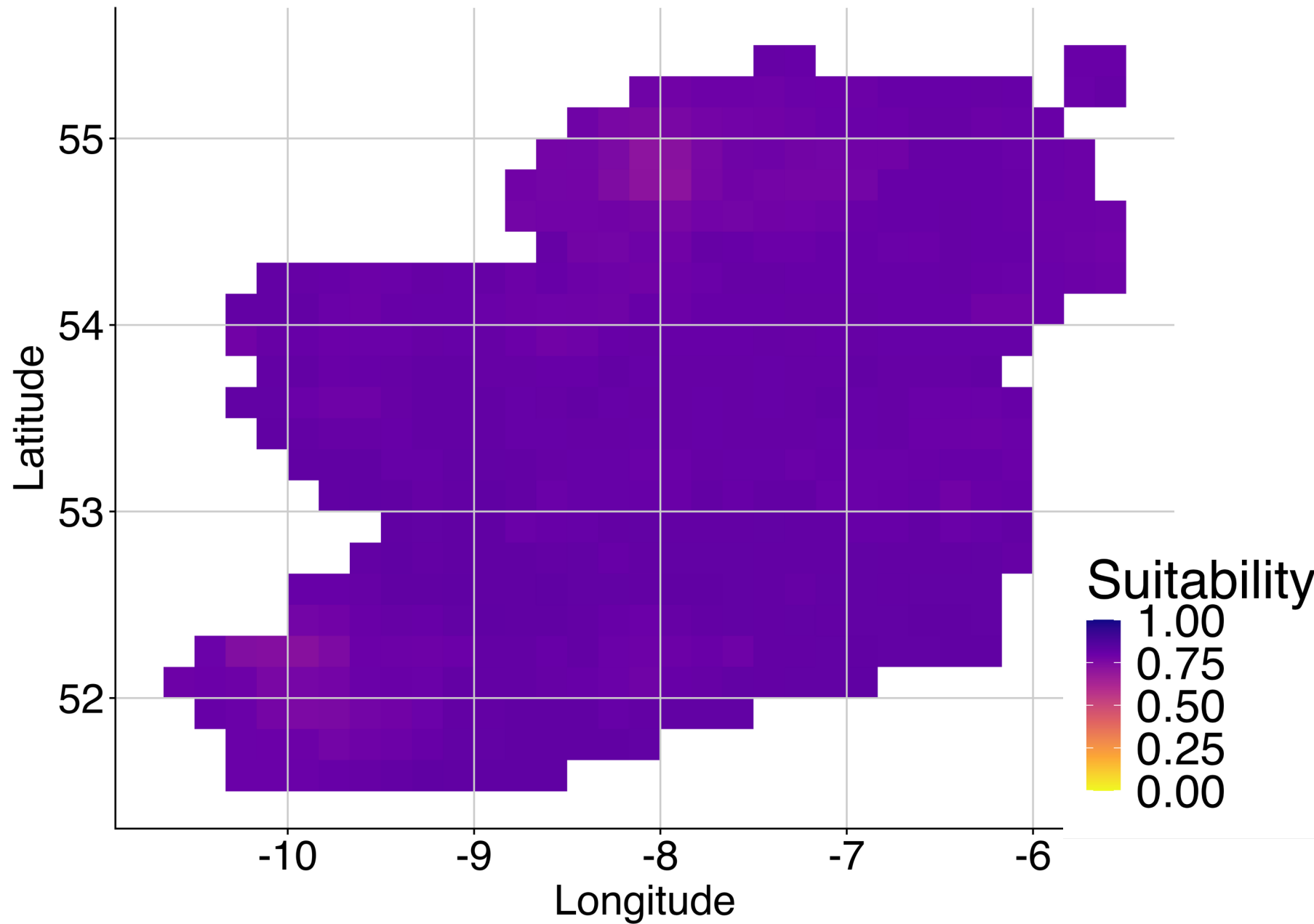
Soil Organic Carbon

Habitat Suitability
(0 to 1)

Proxy Validation

- Evaluated 22 (10%) of the total species used to see how well the host models predict pest presences.
- 22 pests picked based on minimum record cutoff (100 location records) for independent dataset.
- 21/22 pests predicted with an AUC of above 0.7
- A mean AUC 0.891 (SD = 0.106) as achieved with these predictions.





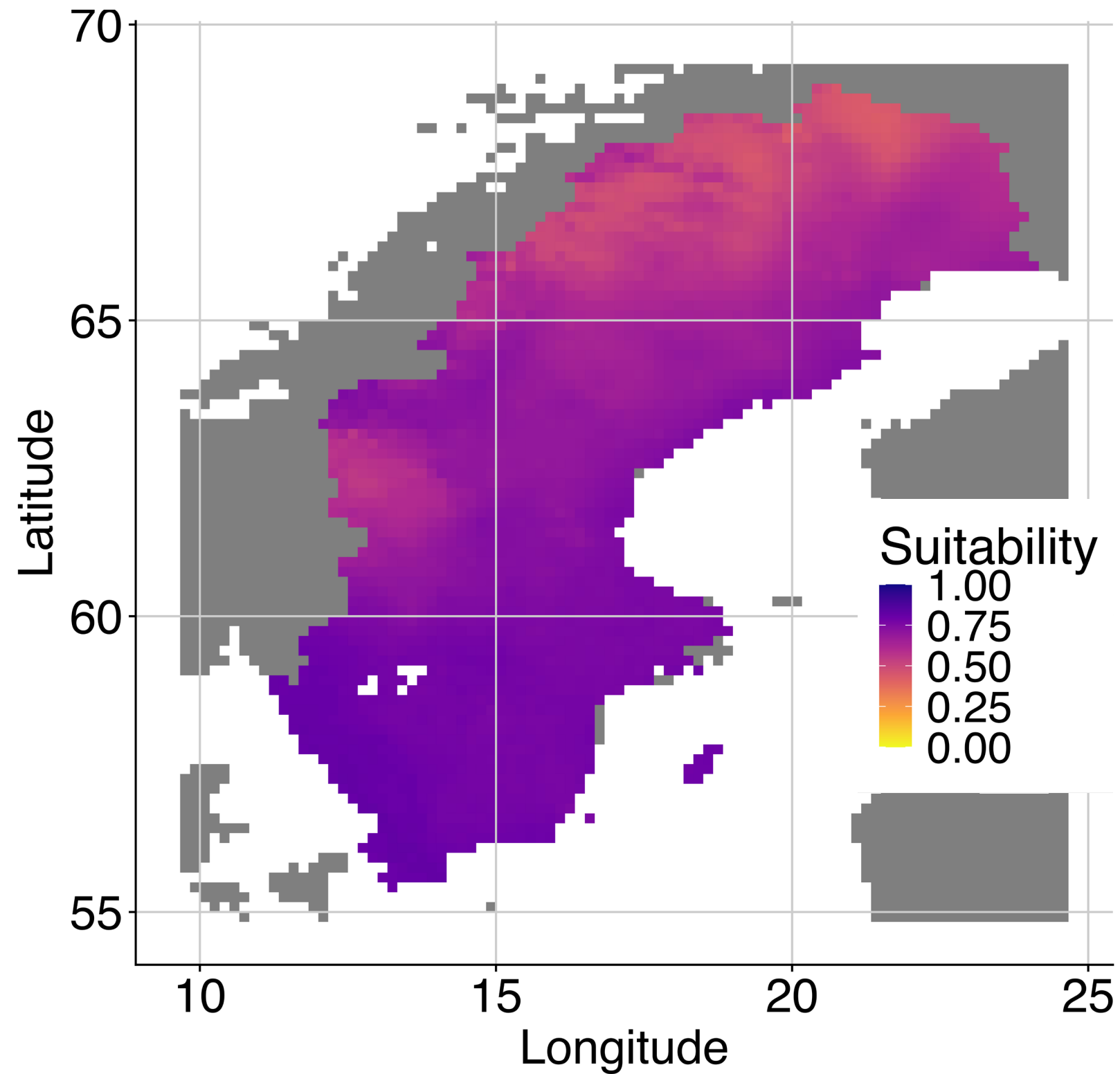
Mean Host Suitabilities for the island of Ireland

09

Results

Ireland's Climate is suitable to most oak and pine pests, based on host models

Median = 0.865, IQR = [0.824, 0.893]



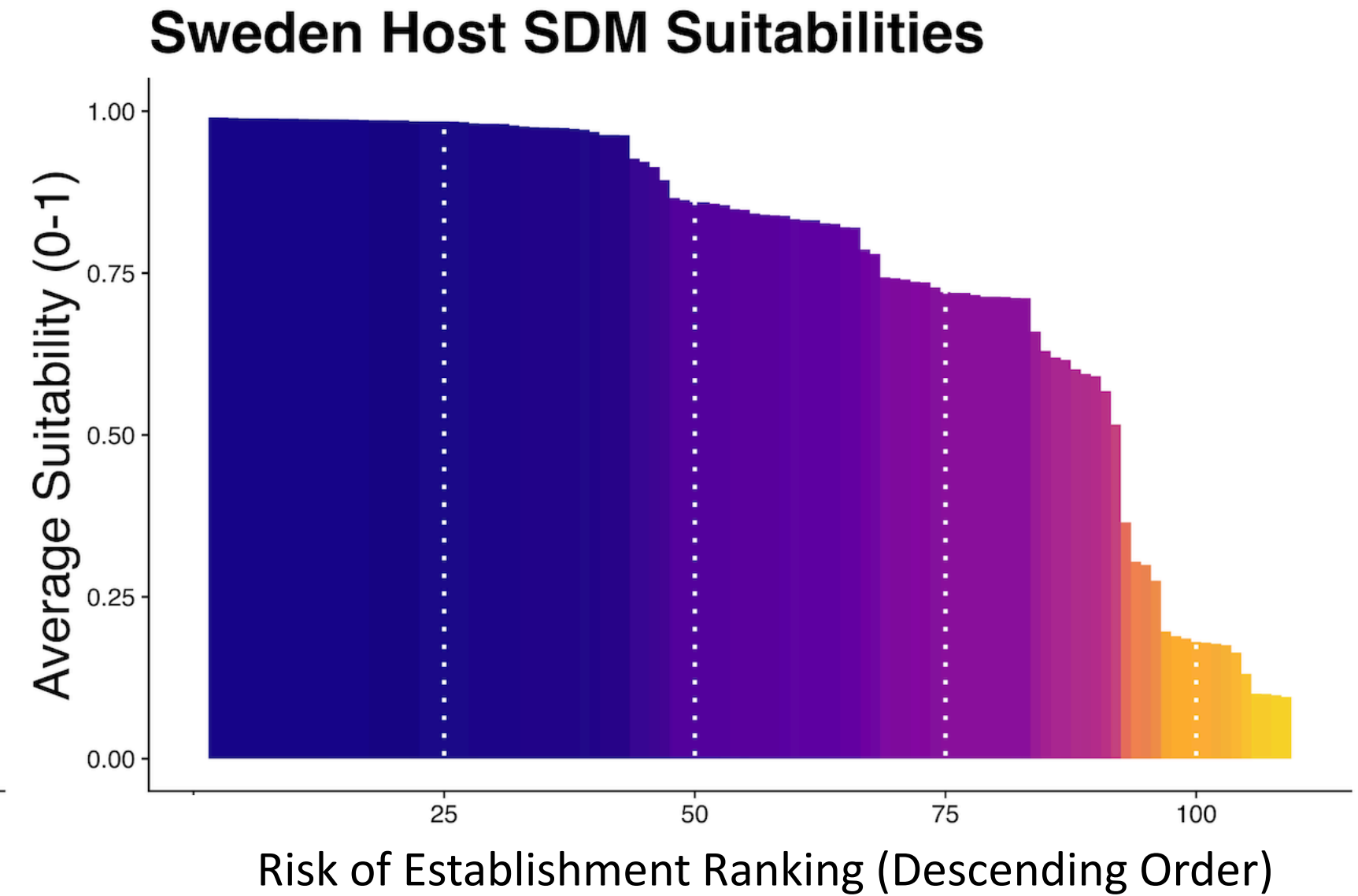
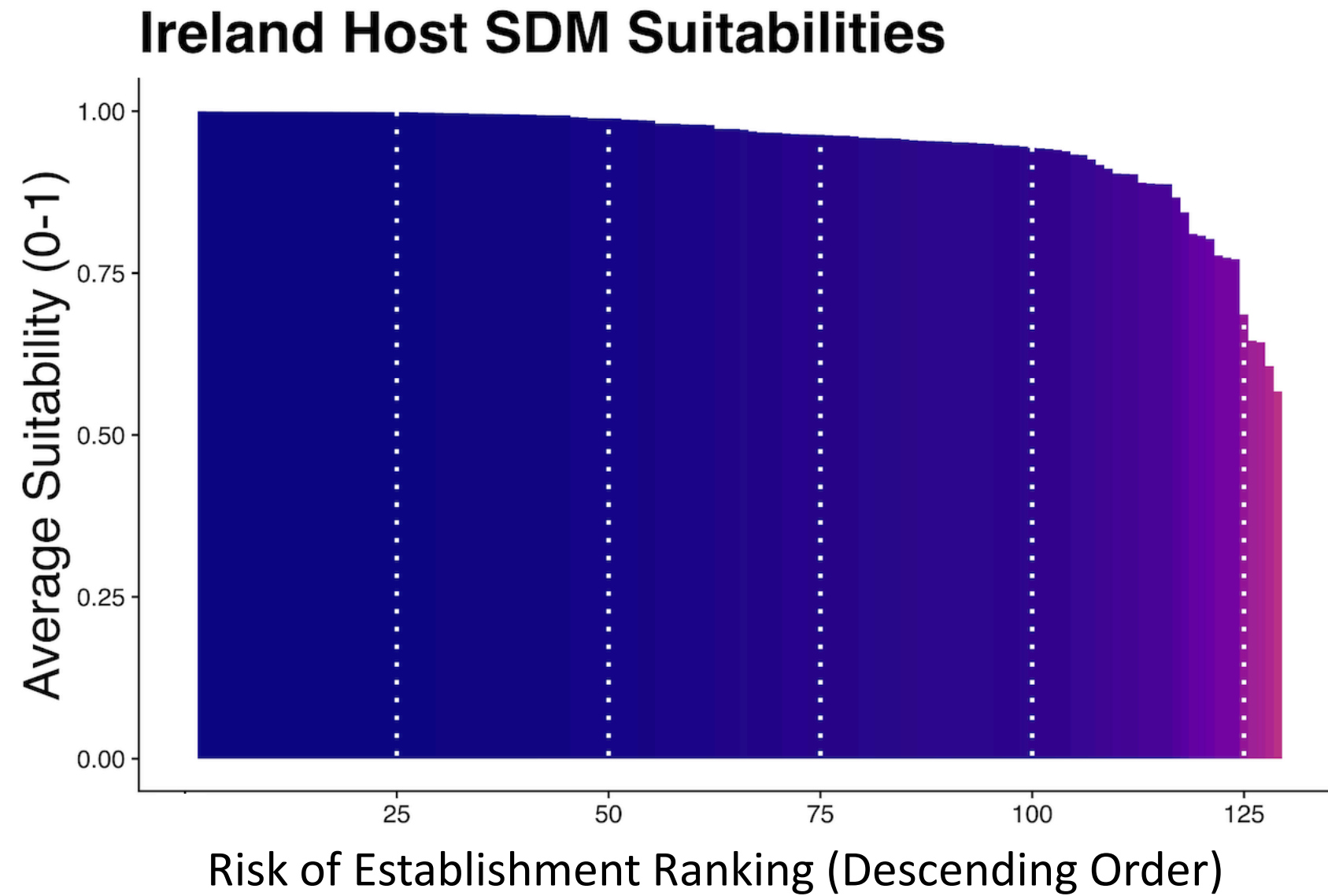
Mean Host Suitabilities for Sweden

09

Results

Sweden's Climate sees more variation in suitabilities than Ireland

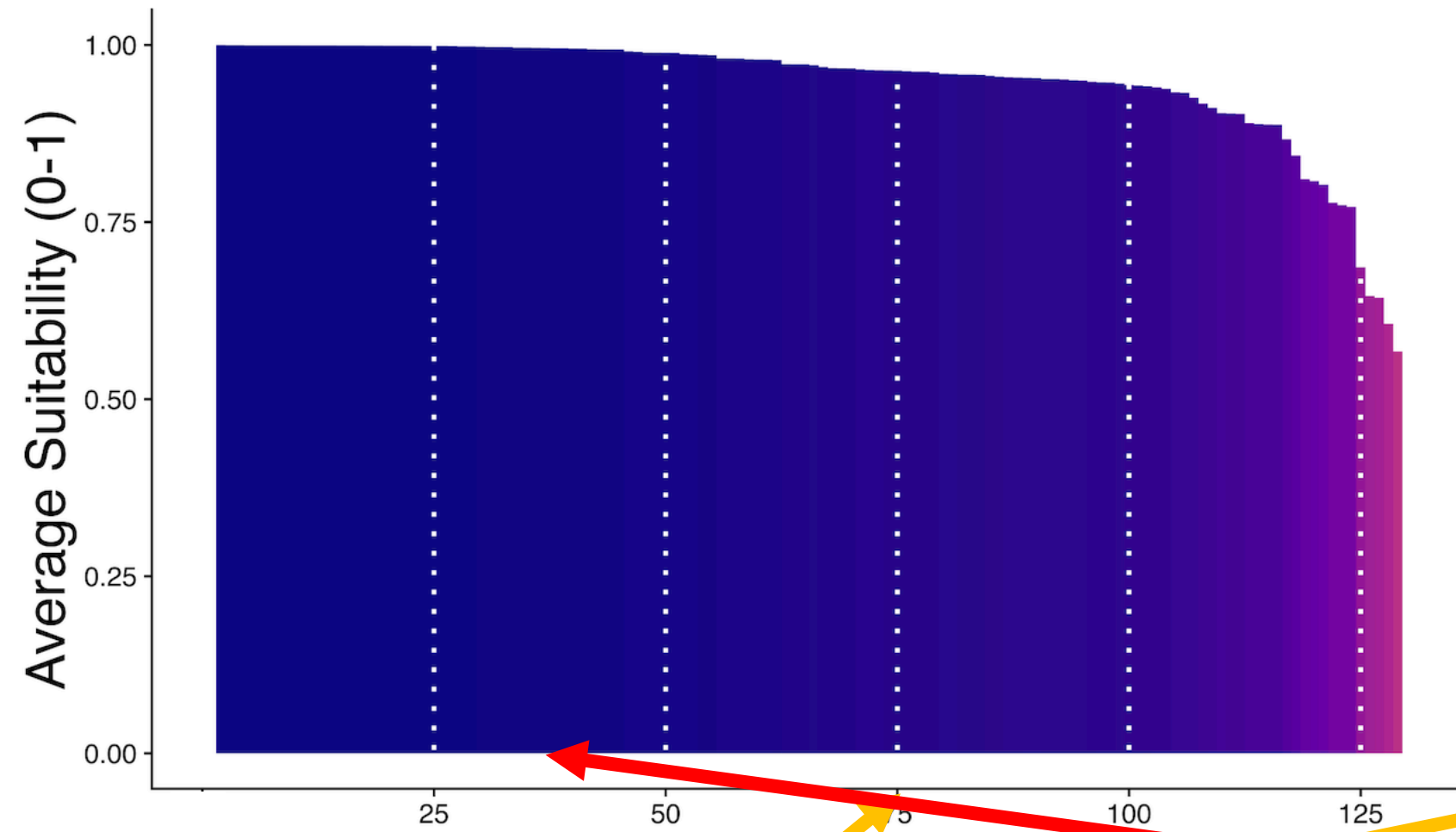
- Median = 0.857, IQR = [0.575,0.893]



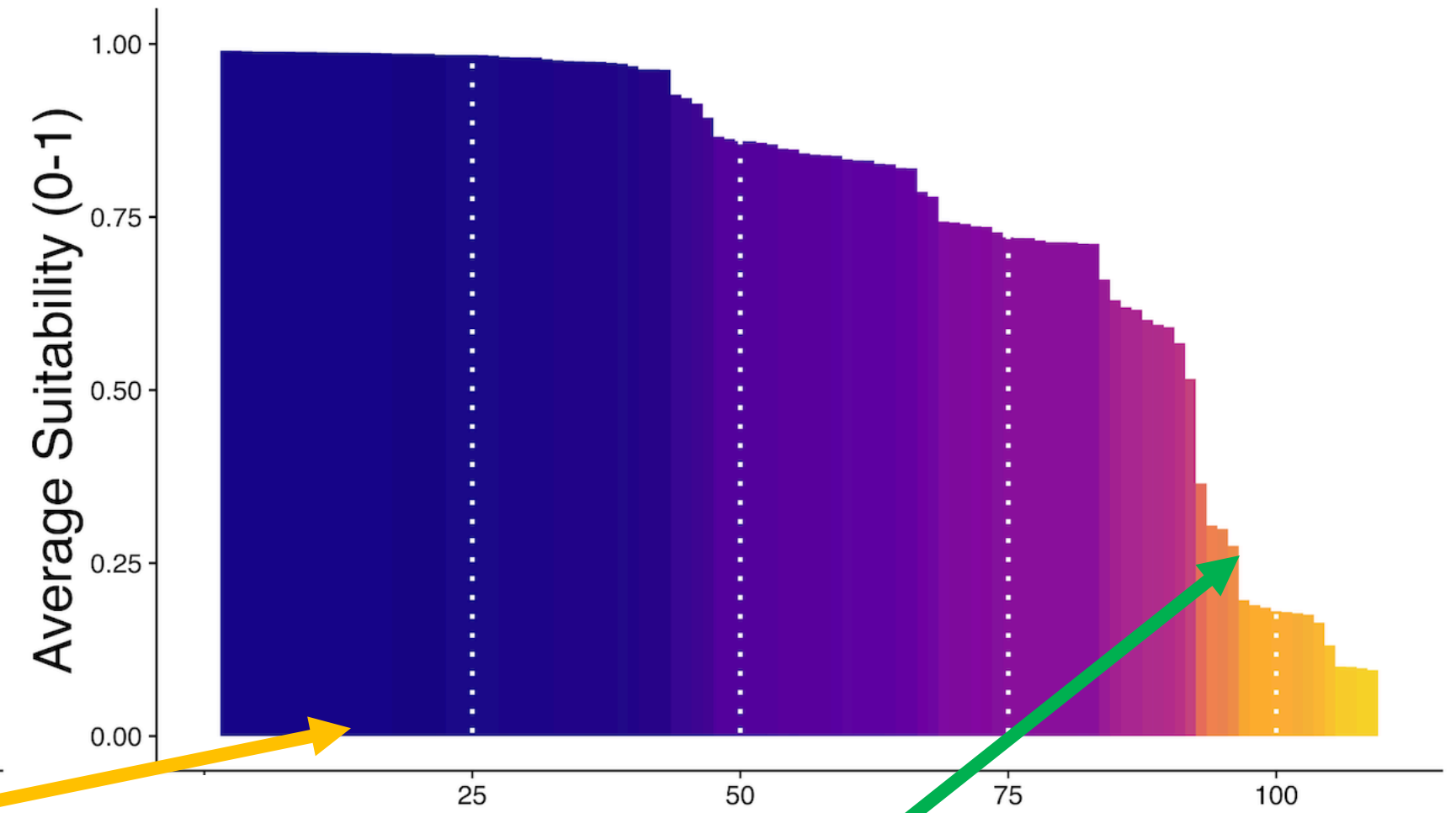
Comparison:

Comparing individual models per study area, the differences become a little bit clearer. There is a much greater variation in suitabilities in Sweden than in Ireland

Ireland Host SDM Suitabilities



Sweden Host SDM Suitabilities

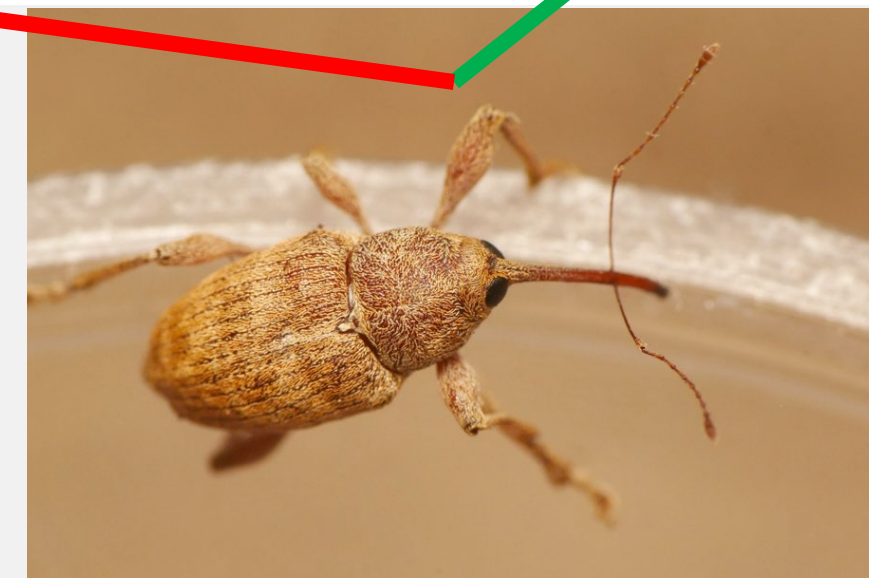


Risk of Establishment Ranking (Descending Order)

Risk of Establishment Ranking (Descending Order)



Oak Processionary Moth Caterpillars
Credit: Joeren Voogd



Curculio elephas (chestnut weevil)
Credit: Alexis Orion

Takeaways



This method can quantify relative risk with minimal pest data, provided hosts are available.



This method is unlikely to be appropriate for short-lived host species.



For Ireland, research should focus on introduction pathways and early detection.



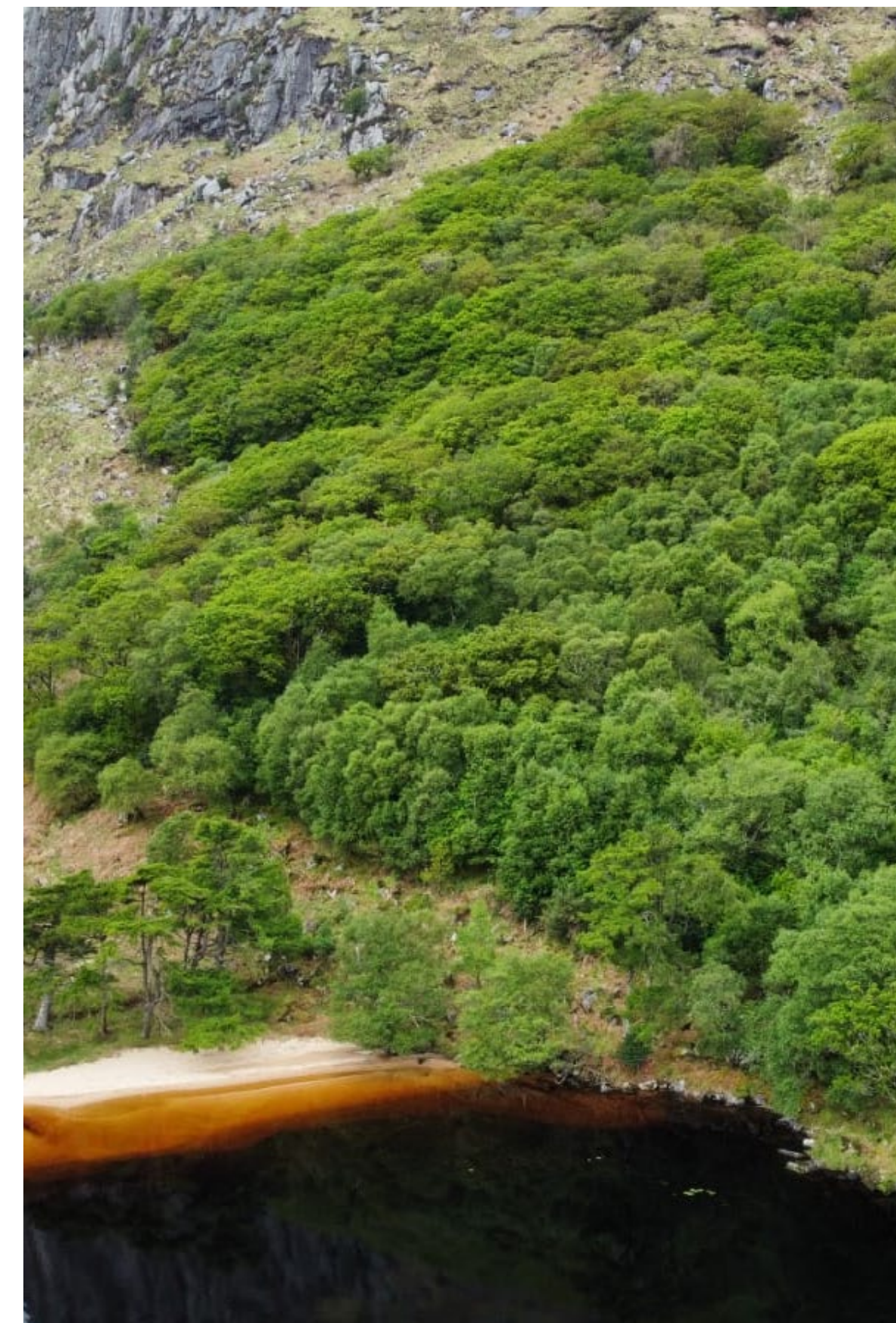
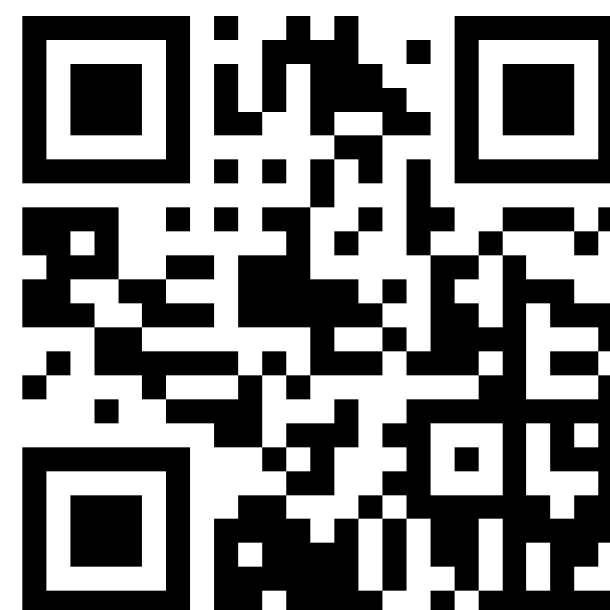
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Thank you!

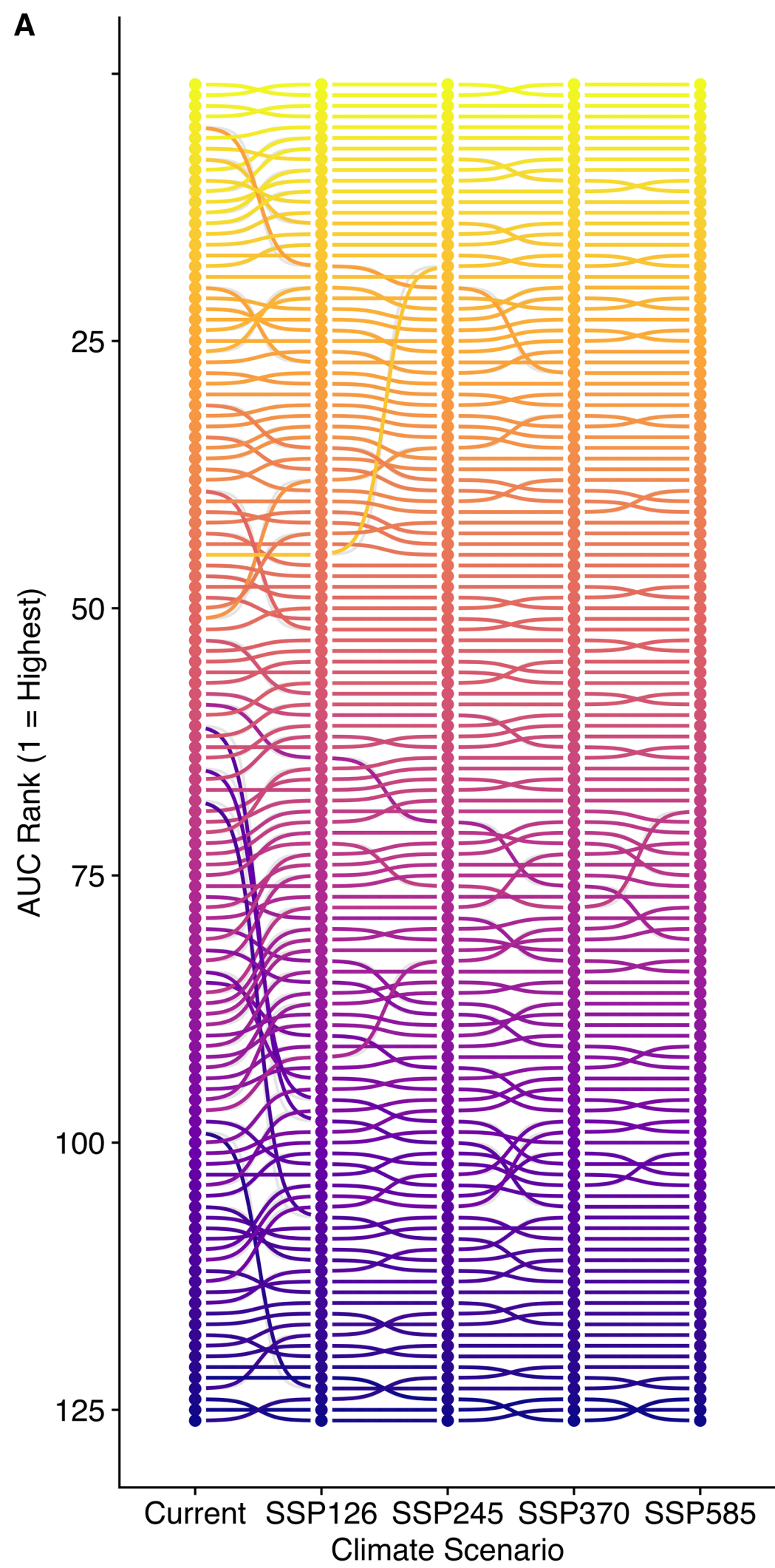
Do you have any questions?

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Relative Ranking

Species Records

- Host occurrence Data (Present/Absent)

Environmental Variables

- Annual Mean Temperature °C
- Mean Diurnal Range (hrs)
- Mean Temperature of the Driest Quarter (°C)
- Mean Temperature of the Coldest Quarter (°C)
- Precipitation of the Wettest Quarter (mm)
- Precipitation of the Driest Quarter (mm)

Soil Data

- Soil Organic Carbon (dg/kg)
- pH (pH*10)

Model Settings

- Boosted Regression Tree (BRT) Modelling Approach
- Spatial Block Cross Validation (5 Blocks)
- Area Under the Curve (AUC) and True Statistical Skill (TSS) Model Evaluation Metrics
- AUC = 0.7 and TSS = 0.6 Model Acceptance Threshold

Model Hyperparameters

- Number of Trees = 1000
- Interaction Depth = 3
- Shrinkage = 0.01
- Minimum number of records in a node = 100
- Bag Fraction = 0.5

EPPO Code	Scientific Name	Pest Type	Mean Suitability	Rank
CHAAFR	<i>Hymenoscyphus fraxineus</i>	Established ◀	0.925	1
PHYTRA	<i>Phytophthora ramorum</i>	Established ◀	0.884	2
RHAGPO	<i>Rhagoletis pomonella</i>	● EU	0.881	3
ERWIAM	<i>Erwinia amylovora</i>	Established ◀	0.877	4
CERAUL	<i>Ophiostoma ulmi</i>	Established ◀	0.873	5
AROMBU	<i>Aromia bungii</i>	● EU	0.869	6
ANOLCN	<i>Anoplophora chinensis</i>	Citrus ▶	0.861	7
BURSXY	<i>Bursaphelenchus xylophilus</i>	● EU	0.854	8
ARGPLE	<i>Thaumatotibia leucotreta</i>	Citrus ▶	0.839	9
ANOLGL	<i>Anoplophora glabripennis</i>	● EU	0.836	10
GUIGCI	<i>Phyllosticta citricarpa</i>	Citrus ▶	0.702	11
ANSTLU	<i>Anastrepha ludens</i>	Citrus ▶	0.241	12

