

2020_02: Phytophthora communities in UK nurseries: understanding the role of traits, biotic interactions and nursery management in pathogen invasions

Supervisor: Louise Barwell (loubar@ceh.ac.uk)

Department: UK Centre for Ecology and Hydrology / Biodiversity (Population Ecology Group)

(a) Motivation for the project

Imports of live plants into domestic nursery networks represent a direct pathway for pathogens to access, invade and establish in new biogeographic regions and hosts, with knock-on impacts for agriculture, forestry, tourism and biodiversity. Escape of plant pathogens into the wider environment is a significant risk because the ultimate destinations of traded plants include public and private gardens, forestry, and landscaping and restoration projects. In recent years novel *Phytophthora* pathogens arriving in the UK have had severe economic and ecological impacts in the ornamental and forestry (e.g. *P. ramorum*) sectors and the wider environment (e.g. *P. austrocedri*). Working with industry to improve the resilience of plants and trees to the risks from invasive pathogens, by analysing and predicting pathogen behaviour across sectors, is a target of the UK government's 25 year environment plan.

(b) Context and background

There are currently 49 *Phytophthora* species known to be present in the UK. Understanding how differences in UK nursery management practices affect the diversity of *Phytophthora* communities in nurseries is key to raising awareness of plant health issues among growers and informing guidelines for nursery plant health accreditation schemes.

Management practices with the potential to influence biosecurity include sourcing of imported plant material, water sources and usage, plant disposal, water run-off, growing media and raising plants off the ground. Linking these findings to disease outbreaks in the wider environment can also help to improve plant health surveillance by statutory bodies.

This project is hosted by the UK Centre for Ecology and Hydrology, in collaboration with Forest Research (FR) and the James Hutton Institute (JHI), and aligns with several aspects of the NERC remit by applying multi-species community modelling approaches to understand the drivers of *Phytophthora* diversity and community composition in nurseries and the surrounding wider environment (community ecology, environmental microbiology).

The model outputs have potential to raise awareness of plant health risks among growers, inform nursery accreditation schemes and target statutory plant health surveillance to enhance plant health biosecurity (environmental informatics, conservation ecology).

The student will develop skills for manipulating and integrating large, spatially explicit environmental datasets using the R language and statistical software, and will gain knowledge and experience of community modelling techniques to estimate risk factors (nursery management, pathogen traits, biotic interactions) for *Phytophthora* invasions.

The project aims to encourage the student to pursue a future career in environmental sciences by providing experience of the real-world applications of quantitative modelling skills in the context of plant health, through interactions with pathologists and social scientists at JHI and FR and their stakeholders to frame models.

(c) Objectives and methodology

We aim to quantify i) how nursery management practices, pathogen traits and biotic interactions influence the diversity and composition of *Phytophthora* communities in UK nurseries and ii) whether the local diversity of *Phytophthora* species in the wider environment is linked to that within nearby nurseries.

Previously, we have used Bayesian phylogenetic mixed effects models and latent variable models to analyse cross-species patterns of *Phytophthora* biogeography in relation to species traits and other risk factors for arrival, establishment and global impact.

We will encourage the student to explore these modelling frameworks alongside alternative approaches for capturing patterns of pathogen co-occurrence and shared responses to nursery management practices among *Phytophthora* species in relation to traits.

There is also scope to investigate metrics of biological, phylogenetic and functional diversity in relation to nursery management and to quantify similarity among *Phytophthora* communities in nurseries and the wider environment.

The data required for this project has already been collated during the THAPBI Phytothreats project meaning the student can quickly progress to data integration and development of models. The student will integrate data from the following sources:

- *Phytophthora* species data from meta-barcoding of over 1000 samples derived from detailed sampling of fifteen partner nurseries and statutory plant health inspections of 118 nurseries and garden centres (provided by FR and JHI).
- Nursery management data extracted from interview transcripts with nursery managers
- Species-level trait data for 179 *Phytophthora* species
- *Phytophthora* species survey data from a meta-barcoding survey in the wider environment

It is anticipated that the student will engage with the inter-disciplinary network of ecological modellers, pathologists, and social scientists from UKCEH, JHI and FR.

These collaborators have strong links to stakeholders in the policy, forestry and nursery sectors and can help the student to gain an understanding of the socio-economic and policy landscape in which the research is embedded and to interpret and explore the data and how it was collected.

There is scope for the student to co-develop hypotheses based on pathogen traits and nursery management practices to explain differences between *Phytophthora* communities in nurseries and the wider environment and to review and select appropriate community modelling frameworks to understand the role of management, traits and biotic interactions in *Phytophthora* invasions.

There is also the opportunity to contribute to stakeholder engagement activities planned for a parallel project funded by the Scottish Plant Health Centre, where the student may prepare materials for, or interact with some potential end-users of the *Phytophthora* community models developed during the project.

The student will also benefit from interaction with the scientists in Biodiversity and the Population Ecology group at UKCEH, that are conducting ongoing modelling projects on *Xylella fastidiosa*, Acute Oak Decline and *Phytophthora austrocedri*.

Project timeline

- Collation of relevant literature and background reading (week 1-3)
- Data exploration and co-development of hypotheses based on pathogen traits and nursery management practices, through engagement with FR and JHI (weeks 2 - 3)
- Data integration (week 4-5)
- Review and selection of community modelling approaches (weeks 5 - 6)
- Application of models and visualisation/reporting of model outputs (weeks 7 - 9)
- Interpretation of model results with support from pathologists at FR and JHI (week 10)

Project length: 10 weeks