Phd Advert

Mathematical modelling of pest invasion and spread in rural and urban woodlands

Supervisory team

Alex Best (School of Mathematical & Physical Sciences, University of Sheffield)
Jill Johnson (School of Mathematical & Physical Sciences, University of Sheffield)
Sam Grant (Plant Health, UK Govt Department for Environment, Food & Rural Affairs)

Project Description

Pests and diseases of trees such as ash dieback, oak processionary moth and emerald ash borer have significant impacts on the natural environment. They have large economic costs (ash dieback alone is predicted to ultimately cost the UK economy £15 billion), limit the availability of woodland for recreation and wellbeing, and impact climate change by reducing trees' ability to capture carbon. Management of disease and pest outbreaks in forests is often left to individual opinions of inspectors, and so it is crucial that we develop scientifically-evidenced management strategies to better control disease and pest spread. In particular, with ongoing climate change it is important to understand the differing dynamics, and therefore optimal management strategies, in urban vs rural woodlands. In this project you will develop mathematical models that can be used to understand and predict the spread of insect pests and advise on best practice for forest management, helping us to safeguard the biodiversity of our woodlands and mitigate climate change.

There is a rich history of mathematical models of disease, including their prominent role in understanding the COVID-19 pandemic. An important element of plant pests and diseases is that host individuals are usually fixed in their spatial location, with neighbour-to-neighbour spread dominating. Such spatially-explicit mathematical models are challenging to construct, but recent work in the field has successfully fitted spatial mathematical models to real data of disease spread. This opens the door to using these models to test different management and mitigation strategies and therefore advise forest managers on best practice.

The focus of the PhD project will be on developing mathematical and computational models, in the form of ordinary differential equations and individual-based stochastic models. The models will be focussed on case studies of Asian longhorn beetle and emerald ash borer, two insect pests of considerable importance in UK forestry. As well as developing and analysing the general epidemiological models, you will look to fit the models to real data of pest spread, and use these to determine crucial differences between infection dynamics in urban and rural woodlands. You will also use statistical approaches to quantify uncertainty in the predictions.

This is a collaborative project working with Defra (UK government Department for Environment, Food & Rural Affairs), who will provide relevant data and vital biological knowledge to help develop and interpret the models. You will also be hosted by Defra for a 3-6 month placement. The project would suit students either with a mathematics/statistics background who are keen to apply their skills to a real-world problem, or with a biology background who are keen to build more theoretical skills.

Applying and funding

You are strongly encouraged to first informally contact the primary supervisor, Alex Best (a.best@shef.ac.uk), to discuss the project. You will then need to apply via Sheffield's EPSRC Doctoral Landscape Award application portal - to be provided when available. You will have an initial interview with the supervisory team to determine your suitability for the project, and one student will be put forward as a preferred candidate. There is then a separate round for deciding funding for applicants across mathematics and statistics projects in Sheffield. It is likely that funding will only be available for Home applicants.