Tree Health and Plant Biosecurity Initiative

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New approaches for the early detection of tree health pests and pathogens

Led by Dr Rick Mumford, the Food & Environment Research Agency (Fera)
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The UK's forests, woods and trees are under threat from a growing number of pests and diseases. Many of these threats are alien which have been introduced to the UK from overseas. Some of the threats may reach the UK naturally by wind-borne spores. The alternative pathway of introduction is via human activity through trade such as moving infected plants or shipping infested timber. To improve the biosecurity of the UK and to protect plants and trees, better methods are needed for detecting pests and diseases. Early detection minimises damage by preventing an outbreak occurring or stopping it from spreading further. At present, trained inspectors are relied on to find these alien pests and pathogens, mainly through visual inspections of imported plants and products. Given the volume of inspections required, this task is difficult and the efficiency of detection is low. This project aims to provide better methods for detecting tree pests and pathogens, both moving through trade and the environment. It will look at new technologies for detecting changes in infected plants using either 'sniffer' technology to identify chemical changes in the air triggered by disease or imaging techniques that can detect changes beyond the range of human vision. The researchers will also look at developing new traps for capturing insects and DNA-based detection approaches to look for pathogens. This will allow the identification not only of known pathogens, but also new ones. In addition, the study will investigate using a "citizen science approach" in detection, identifying what type of end-users could be involved in the hunt for threats.

This project is a partnership between Fera, the Centre for Ecology & Hydrology, Forest Research, the James Hutton Institute, Rutherford Appleton Laboratories and the Universities of Aberdeen, Oxford, Exeter, Greenwich, Hertfordshire, St. Andrews and Worcester.

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Understanding Public Risk Concerns: An investigation into the social perception, interpretation and communication of tree health risks

Led by Dr Clive Potter, Imperial College London
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The surge in media coverage and increase in public concern about tree health in late 2012 following confirmation of the Chalara ash dieback fungus had arrived in the UK took many by surprise. Over a period of weeks, the threat to tree health from a number of pests and diseases became a major focus of public debate, drawing attention to the role that individuals and communities will need to play in the future prevention and management of tree disease outbreaks. The public response to ash dieback prompts deeper questions about the rapidly evolving nature of public risk understandings and the social and cultural factors which shape them. These need to be better understood if policy makers and risk managers are to engage with publics more effectively and build trust in platforms such as Defra's Plant Health Risk Register.This project will use a range of social science methods to compare public reaction and involvement with three recent tree disease outbreaks in the UK (ash dieback, ramorum blight and the oak processionary moth).

The study will explore how individuals encounter tree pests and diseases in different contexts and assess the role of media coverage and various forms of risk communication in raising awareness. The project will examine how concern has developed over time and identify the different "hazard sequences" that may have influenced perceptions and understandings of risk in these cases. The research will contribute to the policy evidence base by defining the nature of public concern about this important issue, drawing lessons for future risk communication and engagement.

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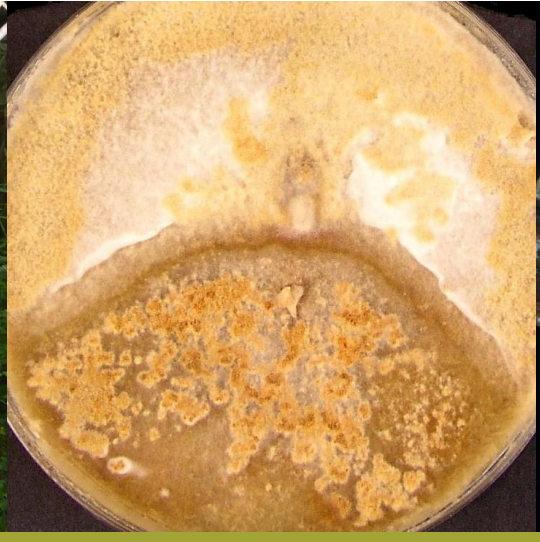


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Population structure and natural selection in the Chalara ash dieback fungus, *Hymenoscyphus pseudoalbidus*

Led by Professor James Brown, John Innes Centre
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Ash dieback (ADB), a devastating disease responsible for destroying vast numbers of ash trees in continental Europe and Scandinavia, is on the move. Caused by the fungus *Hymenoscyphus pseudoalbidus*, the disease was first identified in the UK in 2012 and has since been found at hundreds of sites throughout Britain and Ireland. It is likely that resistance to ash dieback will evolve in the UK ash population over time through natural selection. This poses an important challenge for forest scientists: to accelerate this process so that the UK's ash population can recover much more rapidly.

This project will investigate the ecological genetics of *H. pseudoalbidus* and its ability to evolve in response to natural selection. The researchers will look at the vegetative compatibility (VC) of the fungus, the system which allows fungi to distinguish between self and non-self, which could be manipulated to lessen the ash dieback epidemic. Variation in genetic diversity and pathogenicity of *H. pseudoalbidus* between populations and within trees will be explored, providing insights into the operation of natural selection on the fungus within its host. In addition, the study will look at the relationship between *H. pseudoalbidus* and the harmless *H. albidus*, a closely related fungus which is also found in the UK. By gaining vital information about the ash dieback fungus, the researchers hope to promote breeding and management of natural and commercial ash populations to control this aggressive disease.

This project is in partnership with Dr Joan Webber and Professor Clive Brasier at Forest Research, Alice Holt Research Station.

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Biological pest control of insect pests that threaten tree health

Led by Professor Tariq Butt, Swansea University
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A number of insects pose a threat to UK trees and plant biosecurity. The Tree Health and Plant Biosecurity Expert Taskforce set up by government recently recommended that the UK develops and implements ways to predict, monitor and control the spread of pests.

BIPESCO is an interdisciplinary project that will use botanicals and biocontrol with entomopathogenic fungi (EPF), fungi which kill or seriously disable insects, to kill and control insect pests that pose a threat to UK trees. BIPESCO will develop these natural alternatives to conventional chemical pesticides, of which usage is being severely restricted.

The aim of BIPESCO is to identify the strains of EPF that are most pathogenic to current and emergent pest species to utilise as efficient control, alongside botanicals that attract or repel target pests. The researchers will use botanicals to concentrate the pests and expose them to EPF and other agents in “lure and kill” and “stress and kill” strategies, increasing knowledge of the underlying mechanisms involved in control. BIPESCO’s outputs will offer environmentally friendly, sustainable methods of pest control, benefitting many sectors directly and indirectly.

This project is in partnership with Robert Weaver, Fera and Roger Moore, Forest Research.

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Identifying genomic resources against pests and pathogens in tree genera: a case study in *Fraxinus*

Led by Dr Richard Buggs, Queen Mary, University of London
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British ash trees are not only threatened by ash dieback (ADB), but also by the emerald ash borer (EAB) beetle which has killed tens of millions of trees in North America. In the long term, Britain needs ash trees that are resistant to both ash dieback and EAB. To achieve this, we need to study genes in the whole ash genus, which consists of about 50 species worldwide. Initial studies suggest that some of these species are resistant to either or both ADB and EAB due to co-evolution. This project will pioneer the application of a new method for finding the genes responsible for these traits. This works by building evolutionary trees for thousands of genes within the ash genus and examining how patterns of gene evolution fit with patterns of resistance to ADB and EAB. This evolutionary approach may allow us to identify the genes that may be involved in resistance.

For this method to work, accurate information is needed about the vulnerability of different ash species to ADB and EAB. To achieve this, the researchers will conduct an experiment in the USA looking at the susceptibility of ash species to EAB. A similar experiment will be carried out in the UK on clones of all the ash species available in British and Irish living collections. A social science study will complement the experimental work, discussing ways to enhance tree health in a manner that is socially and politically acceptable. If successful, these approaches can be used to tackle tree health issues in other tree species.

This project is in partnership with Dr Steve Lee, Forest Research and Dr Paul Jepson, University of Oxford.

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Modelling economic impact and strategies to increase resilience against tree disease outbreaks

Led by Dr Adam Kleczkowski, University of Stirling
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Forests in the UK are facing increasing pressures from pests and pathogens. An increase in the volume and global scale of trade, coupled with the evolution and adaptation of pests has led to new diseases and pests appearing in the UK at an increasing rate. The issue is not so much whether a new epidemic will emerge in the next years, but when and how it will happen.

In this project, an interdisciplinary team of mathematicians, forest ecologists and economists will work together to build a series of models to study the ways in which different management options can reduce risks and expected damages from a range of forest diseases. The models will generate information on the effects of these options on the supply of ecosystem services provided by forests such as carbon sequestration and storage, biodiversity, and recreation opportunities. Models will be combined with a "choice experiment" to measure the cost and benefit of management options. This experiment will be implemented with stakeholders, including members of the general public. The models will allow the researchers to assess which policy options offer best value for public money while reducing the risk of disease spread. In addition, the researchers will study the implications of uncertainty on the part of forest managers over the effects of their actions using a real options approach. The findings will be of use to forest managers, as well as government agencies and departments which are concerned with tree and plant diseases and forest management.

This project is in partnership with Professor Chris Gilligan, University of Cambridge and Professor John Healey, Bangor University.

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Promoting resilience of UK tree species to novel pests and pathogens: ecological and evolutionary solutions

Led by Dr Stephen Cavers, Natural Environment Research Council, Centre for Ecology and Hydrology
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Trees face a variety of challenges to their health from many different threats, often at the same time. To find a sustainable long-term strategy for keeping our trees healthy, the range of real and potential threats to tree health need to be considered, along with the trees' potential to adapt. This not only includes recognising important pests and pathogens, but also understanding how trees are adapted to their environment, how populations evolve and the impact of other pressures such as climate change and habitat fragmentation. These issues need to be understood in a physical, social and economic context so that workable management options can be identified.

Using the example of Scots pine, an important native tree species, this project will assess variation in three key threat species: Dothistroma needle blight, the pine-tree lappet moth and pine pitch canker. It will test variation in Scots pine's resistance to these threats and, using new and existing field trials, measure the extent to which Scots pine populations may be able to adapt. At the same time, by working with the public and with those who manage and use trees, the researchers hope to find ways to use the biological information to make change happen on the ground. Although Scots pine will be the case study species, the objective of the project is to create an experimental template and online resources for gathering similar information in other tree species. The researchers hope this can lay the groundwork for a comprehensive synthesis of information on all of the UK's important tree species, and help to improve the resilience of forests across the country.

This project is in partnership with the University of Aberdeen, The University of Edinburgh, SRUC, Royal Botanic Gardens, The James Hutton Institute and Forest Research.

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