Introduction

We write this newsletter not only to offer up to date information on our research project on early detection of tree pests and pathogens, but also to invite you to get involved. This project is pushing the boundaries not only of what science but of how we do science, with a genuine attempt to involve stakeholders more in technology development. The five different technology groups are at different stages of development and undertaking projects with different potential for your engagement. We hope you will at least find the newsletter contents interesting and possibly even be inspired to get involved in some way.

See below for the latest in how our technologies are developing!

Recent News

Dec 2015  Contributions to the European and Mediterranean Plant Protection Organization (EPPO) Conference: Angers, France

Nov 2015  Socio-technological Learning Lab: visit to APHA inspectors

Oct 2015  Learning Platform 2 in Edinburgh generates debate

Want to catch up?

Check out the Learning Platform 2 presentations and look out for the report on the website http://protectingtreehealth.org.uk/learning-platform-2.php
EPPO is an intergovernmental organization responsible for cooperation and harmonization in plant protection within the European and Mediterranean region. Under the International Plant Protection Convention (IPPC), EPPO is the regional plant protection organization (RPPO) for Europe. The 2015 conference in Angers, France, showcased the latest in diagnostic technologies.

Rick Mumford spoke about our integrated project, which is unique in Europe at present in its scope and ambition. Ian Adams offered updates on some of the latest technological work packages and Rehema White talked of our experiences with stakeholder engagement and the shift towards a more interactive and holistic form of science. A conference recommendation was made to consider social interactions more fully in the detection and diagnosis of harmful organisms in plants and seeds.

Background to this tree health project

The project “New approaches for the early detection of tree health pests and pathogens” runs from 2014 to 2017 and is funded through the LWEC (Living with Environmental Change) Tree Health and Plant Biosecurity Initiative. It is examining new technologies for detecting changes in plants and for detecting arrival of potential pests and pathogens, and exploring how these technologies can be developed better in partnership with practitioners involved in the use of technologies and industry representatives who may wish to take such technologies forward to commercial application. Technologies explored include:

- ‘sniffer’ technology to identify chemical changes in the air triggered by disease
- imaging techniques that can detect changes beyond the range of human vision
- new traps for detecting and capturing insects
- DNA-based detection approaches to seek established and emerging pests
Work Package 1: Socio-economic contexts

If we are to tackle tree pests and pathogens, it is essential that we work in partnership with others. This project thus has a team of social scientists assisting the natural and physical scientists to engage with stakeholders and at the same time exploring how we can most effectively do this. Can we produce better technologies if we talk to practitioners early on in the process? With whom should we engage and why? How will stakeholder engagement affect our Technology Readiness Levels?

Part of the legacy of this project will be the consolidation of a network of individuals and groups concerned with tree health, particularly early detection of tree pests and pathogens (a Learning Platform). This includes running Learning Platform workshops and Socio-Technological Learning Labs.

Mariella Marzano joined a group of social scientists in York in September to argue that we need to be specific in our stakeholder engagement efforts and yet also recognize serendipity and the importance of trust and relationships between scientists and others.

This team is also exploring the economics of technology development and implementation and is producing a bio-economic model. How much do we need to invest in technology and how much can this investment save the state and industries?

We are also considering the role of citizen science in defence of our trees. Involving citizens in monitoring tree health can engage expert enthusiasts. It can also engage other groups such as community and children, increasing awareness and enjoyment of our forests.

Finally, this group is reflecting on some more theoretical questions. Where is ‘the border’ in relation to the detection of tree pests and pathogens? How should we ‘do’ science? Who has responsibilities and interests in relation to forest disease management?

Where is ‘the border’ for early detection of tree pests and pathogens?
Work Package 2:
The use of volatile organic compounds for early detection

Technology for detecting volatile organic compounds (VOC) to find threats is used routinely at ports and by the military. VOCs can be characteristic for microorganisms, insects and plant diseases. We are using modern gas chromatography mass spectrometry (GC-MS) and ion mobility spectroscopy (IMS) technologies to detect VOCs produced by plant pests/pathogens and attacked/diseased plants whilst being shipped.

So far we have validated laboratory tests for a number of species and we are working to explore how we might make this technology more portable and how it might effectively be deployed.

We can envisage a device placed in a shipping container, but through interaction with plant inspectors we have recognised some of the logistical challenges to this approach. We are thus working to explore in more detail how they might be deployed, collected and analysed.
Work Package 3: Multispectral imaging and analysis for the detection of biotic and abiotic stress

Dothistroma needle blight is a fungal disease that affects pine trees within the UK; it is a controlled disease which organisations such as Fera, Forest Research and the Forestry Commission are trying to prevent moving throughout the UK. The work being carried out in this work package is developing spectral, particularly hyperspectral, techniques to aid inspectors in the early detection of diseased saplings involved in trade and in nurseries. By detecting diseased plants at this early stage it is hoped that we can prevent the disease moving into areas which are currently disease free while also managing areas where the diseased trees have been found.

Over the last few months we are continuing to building up a healthy and infected spectroscopic dataset which can be used for model building and evaluation. We have been collecting field samples from trees that have been identified by experts as: diseased, at risk and disease free. These samples are then taken back to the labs at RAL Space where spectroscopic measurements are taken. Once the spectra have been collected the samples are sent away Fera where the disease status of the needle samples are confirmed using genetic PCR analysis.

Alongside the building of a spectral dataset we have also been researching developments in hyperspectral imaging and have purchased a couple of XiSpec hyperspectral cameras that cover the visible wavelengths of light. These are very new cameras which use a mosaic of interference filters in front of a 2D CCD array to detect narrow band widths of light at specific wavelengths, current work has been focused on writing computer software to collect data from the cameras which we will use to test their capabilities. Future work will focus on calibration and integrating them with the models developed above to detect diseased and health specimens.
Work Package 4:

**Airborne spore trapping networks**

Spore trapping networks (STNs) are important in achieving increased, early, spatial and temporal surveillance of airborne pathogens (mainly spore-borne fungi). There is little existing national network to trap fungal spores. This project has been exploring methods of capturing and assessing spores in the laboratory and has now begun field tests. Cyclonic tests (see designed tested below) are allowing scientists to explore how best to trap spores.

The Woodland Trust partnered with us to better understand ash dieback. Machines were installed in its Londonthorpe Wood, near Grantham, to search for spores that cause the disease. The machines (see image) effectively suck in the air onto filters. These filters are then be analysed for the genetic signature of *Hymenoscyphus pseudoalbidus* - the fungal spore that causes ash dieback. The filters can even be on a timer so that the spores can be monitored at different times of the day. Other parts of the research include regular visits to other Woodland Trust woods affected by the disease – including Sleaford Wood, High Wood and Tattershall Carrs. The Woodland Trust is now urging the public to make sure they clean their shoes after leaving Londonthorpe Wood, as it can help prevent the spread of diseases.

The Trust has launched a new initiative encouraging people to become a ‘Guardian of the Woods’ to help look after their local woodland and wildlife. Find out more at: [www.woodlandtrust.org.uk/guardianofthewoods](http://www.woodlandtrust.org.uk/guardianofthewoods)

This partnership is an example of why it is important for us to engage stakeholders – we need to work with organisations such as the Woodland Trust to help reach out to communities, enhancing technology testing and simultaneously raising awareness of tree health issues.
Work Package 5:

Trapping of wood-boring beetle tree pests

During July, David Hall helped Fiona Jones (Animal and Plant Health Agency inspector) and Rob Weaver (FERA) set up pheromone traps for Asian longhorn beetle I (ALB) in the Paddock Wood area in Kent round the focus of the previous outbreak of this pest.

With Michael Pocock we initiated a pilot “Citizen Science” project using pheromone traps for monitoring for the presence of invasive longhorn beetles, so including ALB and citrus longhorn beetle. Nine volunteers were selected from 15 who responded to the request circulated by Michael, stretching from Warrington to Dorset, keen to test out the opportunities of using these traps as a survey method for live-trapping native longhorn beetles (as well as the invasive species). They were sent a panel trap and a multicomponent lure prepared at NRI. The latter included the pheromone and kairomone for ALB and three other pheromones that are known to attract a wide range of other Cerambycid beetles and they set them out during August. Fortunately no invasive longhorn beetles have been caught to date, but unfortunately no native longhorn beetles have been caught either. Although it has been calculated that ALB would be flying at this time if present, we probably started too late in the season for the indigenous Cerambycids, but we are now in a good position to make an early start next year. Pheromone lures could be a method for naturalists to record native longhorn beetles, but also serving as a network for the early detection of invasive longhorn beetles. Work has been initiated on collection of pheromone from citrus longhorn borer (CLB) with Rob Weaver at FERA. CLB is a potential invasive pest for the UK. It is related to ALB, but the pheromone has not yet been identified and will be a useful tool for detecting arrival of the pest.

Some of the work in this project was described at an invited presentation at a meeting “International Symposium on Biopesticides 2015” organised by Tariq Butt as part of the BIPESCO project which is also part of the THABI programme.
Work Package 6:

Development of non-targeted water surveillance methods

The genus Phytophthora exemplifies the weaknesses in the current plant health and detection protocols. New methods of testing this and other pathogens in water are being tested in this work package. There are 142 species of Phytophthora currently described but more are being found.

As scientists we need to support the inspection teams in APHA and Horticulture and Marketing Unit but it is important to stress that we are also here to support the 120 million plants for the planting industry (UK 2013 figures) It should be possible to test for pathogens in water run through plants in a nursery when in quarantine, for example.

This capacity would not only be useful to inspectors but also to nursery owners.

We have tested a simple hand held water pump through which water can be pushed. Genetic material retained by the filter can be sequenced and thus identified.

A Scottish Government study on streams identified 45 ‘species’ of Phytophthora in 4 upland and lowland burns. Many are new to science and some have only been reported to date in other countries. This research is providing a ‘baseline’ to help define what is ‘natural’.

Sampling
• Practical sampling regimes
• Equipment sterilisation
• Discussions with stakeholders

Sample processing
• Shipping and storage of used filters
• Dealing with sediment

Bioinformatics
• Rapid processing of data against ITS reference database
• Output per sample from which we can assess risk

Our valuable horticultural trade
Update on project activities

The first Learning Platform Workshop was held in York in 2014. It included a Dragons’ Den in which we sought input from ‘investors’ in the forestry, inspection, industry and other sectors. Sadly no money was committed! The second Learning Platform Workshop took place in Edinburgh at the end of October 2015. This included particular reflection on the Scottish policy context and on community woodlands and citizen science, a Pecha Kucha presentation of technologies and a carousel of technologies, with plenty of interaction by participants. We finished the day by visioning what we might like tree health protection to be in 10 years time. We all saw pre border tree health and checks as being key.

The project website is up and active. You can find more information on each of the work packages within the project at http://protectingtreehealth.org.uk

The Expert Advisory Panel (EAP) met in Edinburgh immediately after the Learning Platform Workshop. Different representatives commented on how they would like to be engaged and what they would like to see from the project. We also hope this panel will help us embed the results of the project in existing institutions and processes to ensure legacy.

Socio-technological Learning Labs (SLLs) have been planned, in which either open days within labs or visits to particular sites help scientists and stakeholders co-develop the direction of use of particular technologies. We were recently lucky enough to be hosted by the inspectors at Heathrow. We were shown the pragmatic reality of inspecting, and discussed how new technologies might increase rather than impede efficacy and efficiency. We all visited a storage and inspection facility near the airport and some of us went to see what happens on the docks at Southampton. Thanks to this group of inspectors for being so open about their processes and so open to new ideas!

Watch out for new events; we will be holding more SLLS in the new year and are already planning LP3 and a final conference.

Get involved! Ask to be placed on the email list

We want to know what you think! Please get in touch with the relevant contact below if you would like to know more about one of the technologies, about the social and economic aspects or about the project as a whole.

Rick.Mumford@fera.co.uk