



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

Rick Mumford

Tree health: our greatest current biosecurity challenge





NATURAL

TRADE



Import inspection: the frontline in plant biosecurity



Inspection is a real challenge



Inland surveillance is challenging too



Identifying
new
pathogens



Finding new
outbreaks



Speed of spotting
new problems



UK Tree Health & Plant Biosecurity Initiative



A joint initiative as part of the Living With Environmental Change (LWEC) Partnership, with the aim of bringing the widest possible research capacity and capability in the UK to focus on the area of tree health & associated plant biosecurity issues

Seven projects (worth ca. £7M) were funded and these started in 2014



The Scottish Government



Forestry Commission



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



Project lead: Rick Mumford (rick.mumford@fera.co.uk)

WORKPACKAGES:

1	2	3	4	5	6
Lead: Mariella Marzano, FR	Lead: Steve Woodward, Aberdeen	Lead: Hugh Mortimer, RAL	Lead: Neil Boonham, Fera	Lead: David Hall, NRI	Lead: David Cooke, JHI
Interdisciplinary approaches ('The Learning Platform')	Volatiles Detection	Multispectral Imaging	Spore trapping	Pest Trapping	Water surveillance

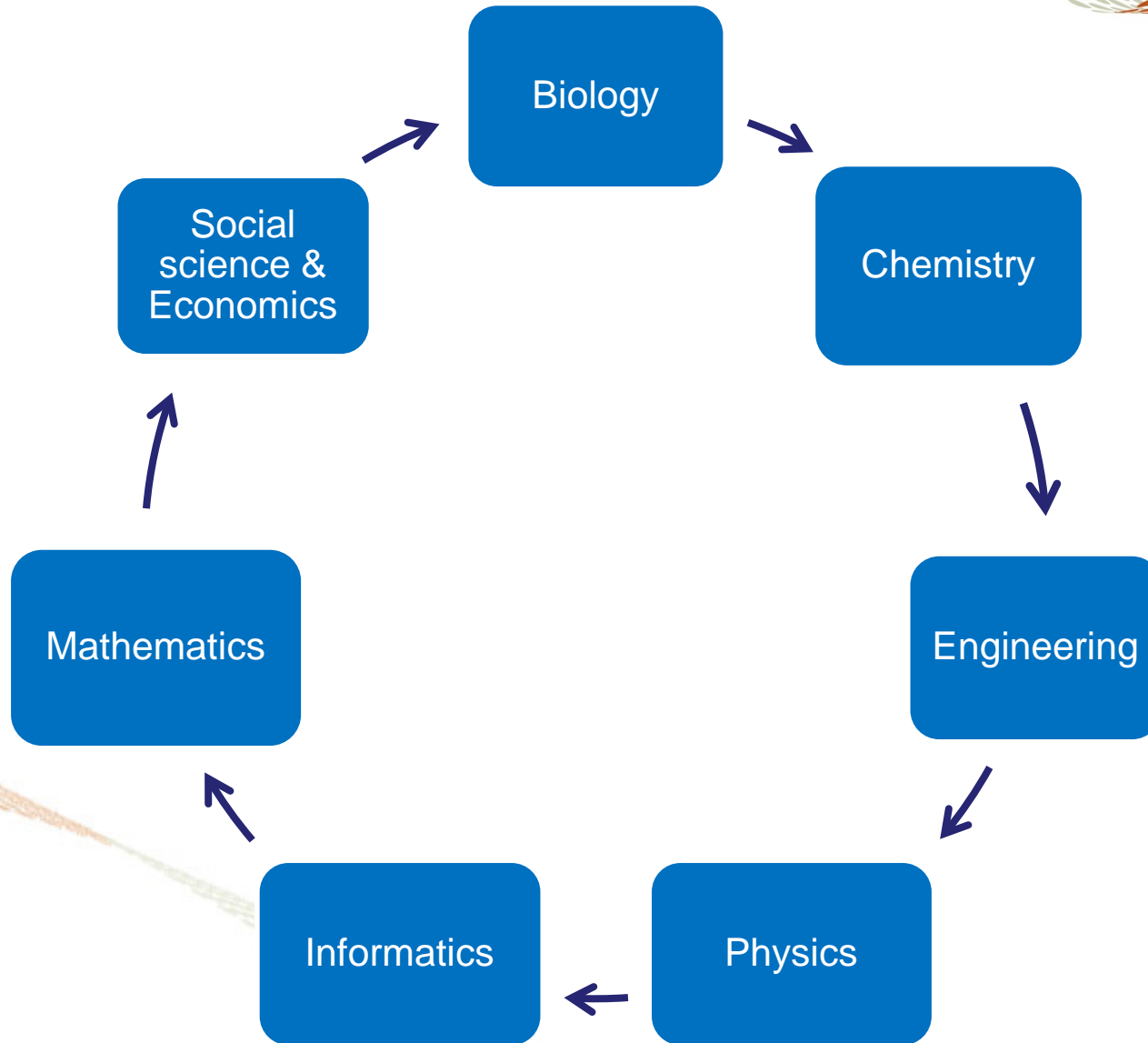


Key Objectives



1. Develop improved, cost-effective tools for the early detection, surveillance & monitoring of alien pests and pathogens of trees and other plants to improve the UK's biosecurity.
2. Exploit technical advances in fields such as genomics, bioinformatics, pest & disease detection, trapping and environmental sampling, including risk and social impact valuation to support the health and resilience of UK trees and woodlands.
3. Based on an interdisciplinary consortium bringing together natural science specialists in tree research and plant biosecurity with leading-edge scientists from the physical, engineering, social & economic science research communities to develop these tools.

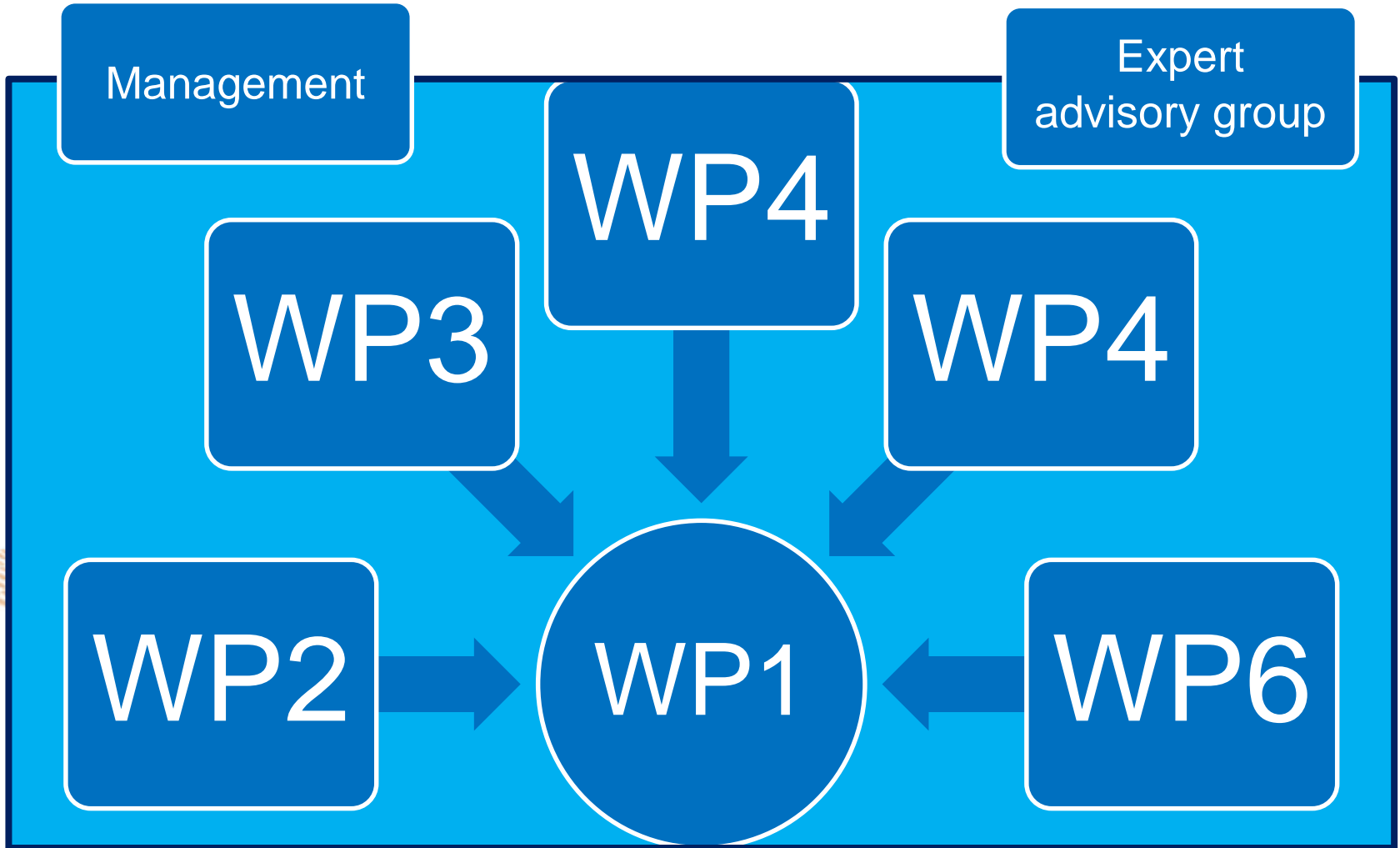
An interdisciplinary approach



Our approach

1. To ensure that the tools developed are fit-for-purpose in the real-world: offer a genuine cost-efficiency benefit, are deployed based on risk and that there is positive uptake by end-users
2. To create tools that can be used in a range of inspection contexts
3. To add to our national capabilities in plant health
4. Create generic tools that can be used beyond tree health surveillance and monitoring

Six work packages



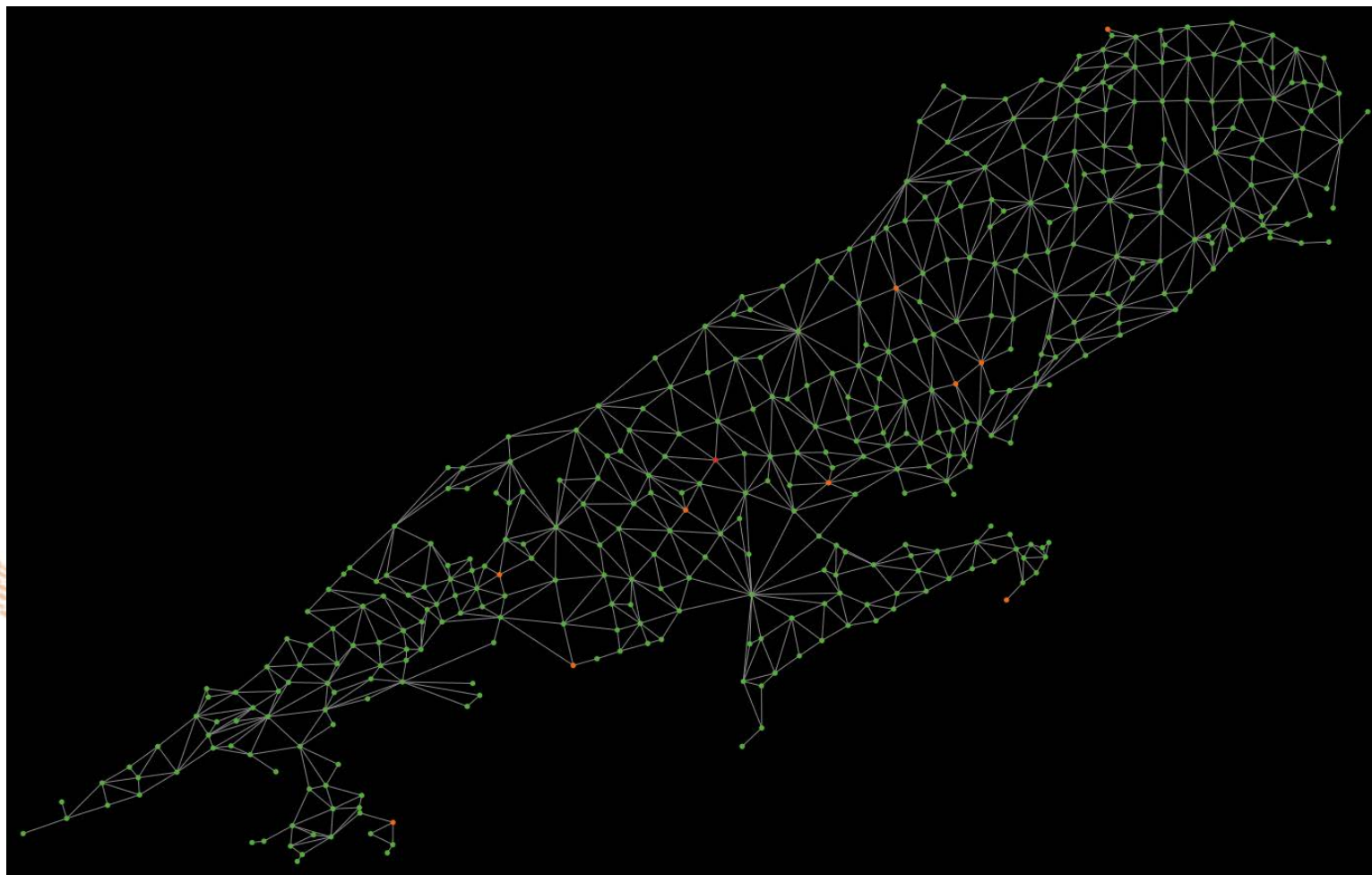
WP1: The use of an interdisciplinary approach to the effective deployment of detection technology ('The Learning Platform')

Partners: Marzano (FR), Jones/Crowe/Macarthur (Fera), White (St. Andrews), Pocock (CEH)

Promotes collaboration and shared learning to improve uptake of socio-technological innovation:

- **Stakeholder perspectives**
 - Stakeholder networks
 - Economic impacts, risk mapping & sampling strategies
- **Co-design of technologies**
 - Socio-technological learning labs (SLL)
 - Citizen science
- **Learning Platform**
 - Resource hub, 3 annual workshops

Network model of disease spread



Model Parameters

Disease Characteristics

Mean infections per infected tree per month
p-if 0.76
ctrl-pinf-mod 0.50
 Probability of infected tree dying per month
p-death 0.003

Model Run Controls

number months in simulation
num-ticks 720
 Number simulations in model run
num-sims 1

Monitoring Strategy

monitoring strategy
 static-monitoring
 random-checks
 monitor-if-behaves...
parcels-checked 10
ticks-per-parcel 5

Testing Accuracy

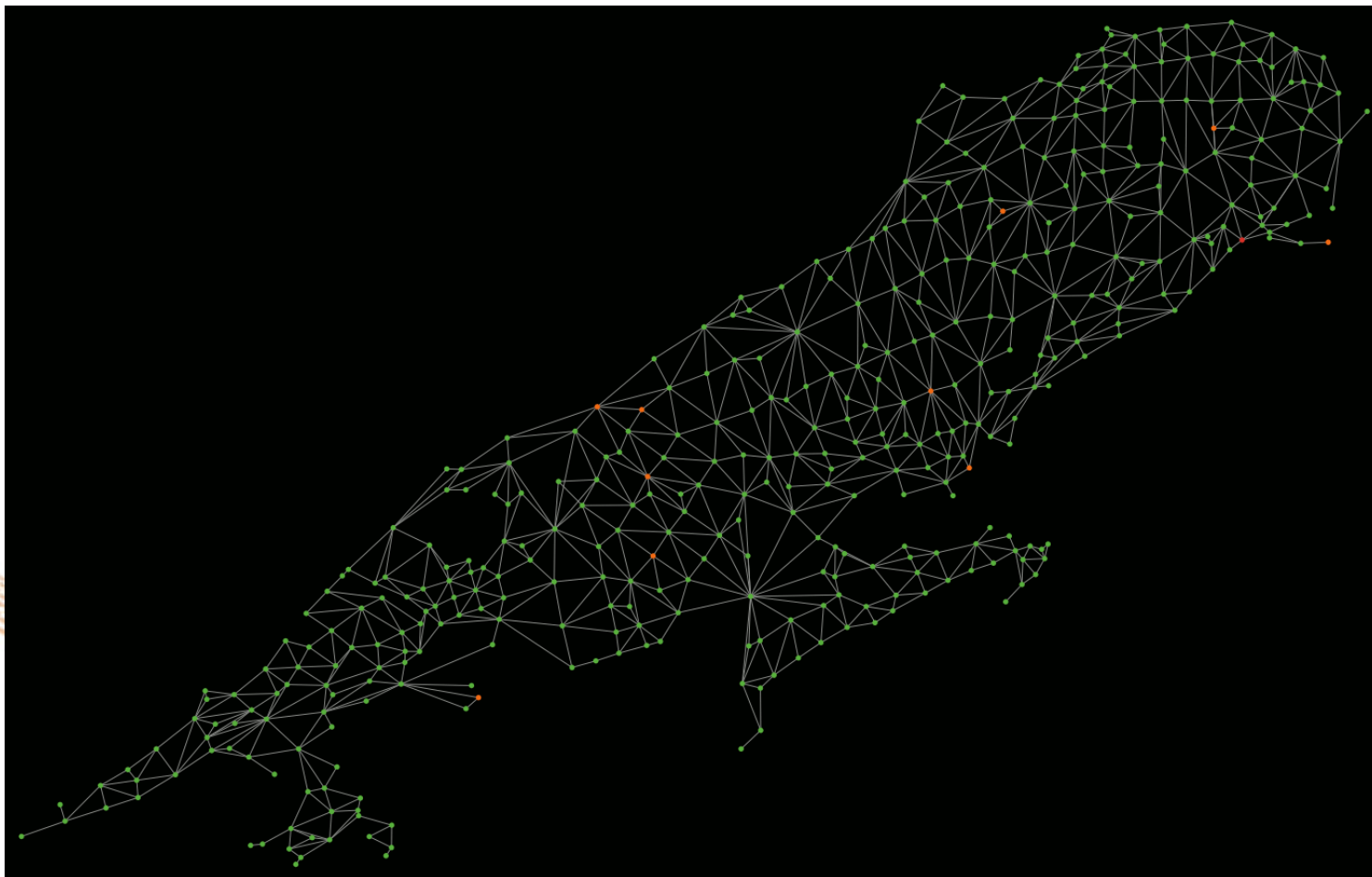
Test accuracy
true-positive 0.41
false-positive 0.005

Testing Threshold for Control

number of positive results to trigger control actions
pos-ctrl-threshold 5



Model Run



WP2: The use of volatile organic compounds for the early detection of pests and pathogens ('Volatiles Detection')

Partners: Woodward/Ebel (Aberdeen), Brown (FR), Preston (Oxford), Smiths Detection

Analytical chemistry approaches will be used to identify diagnostic volatile organic compounds produced by pests, pathogens and diseased hosts and to translate these onto commercial-available portable platforms for use by inspectors in the field

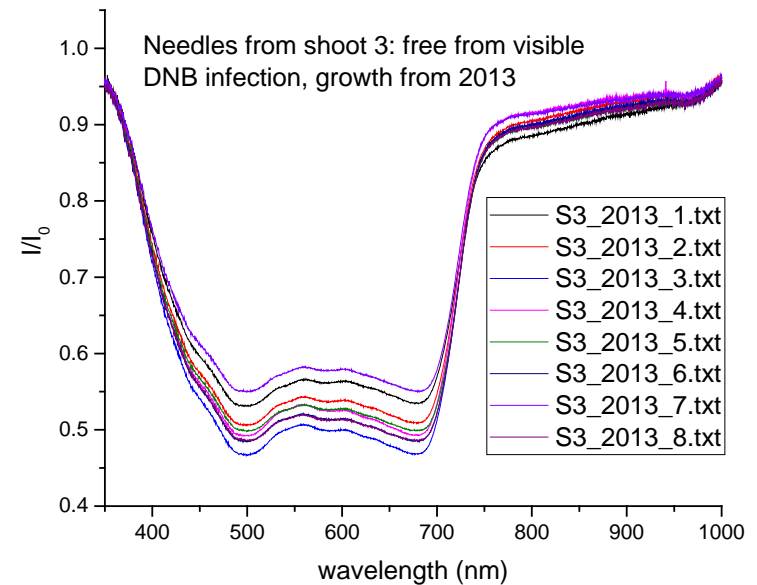
WP3: Multispectral imaging and analysis for the detection of biotic and abiotic stress ('Multispectral Imaging')

Partners: Mortimer/Hamilton (RAL), Woodhall (Fera), Tubby (FR)

Multispectral imaging will be used to identify markers for the early detection of biotic/abiotic stress in plants. A prototype bio-imaging camera will be constructed that can be used to validate this approach in the field.

Spectral database

- Model system:
 - Scots Pine
 - Red band needle blight
(*Dothistroma septosporum*)
- Continuing to build a spectral database
 - Field samples from around the UK
 - Seedlings grown in a controlled environment
- Used for model building and evaluation

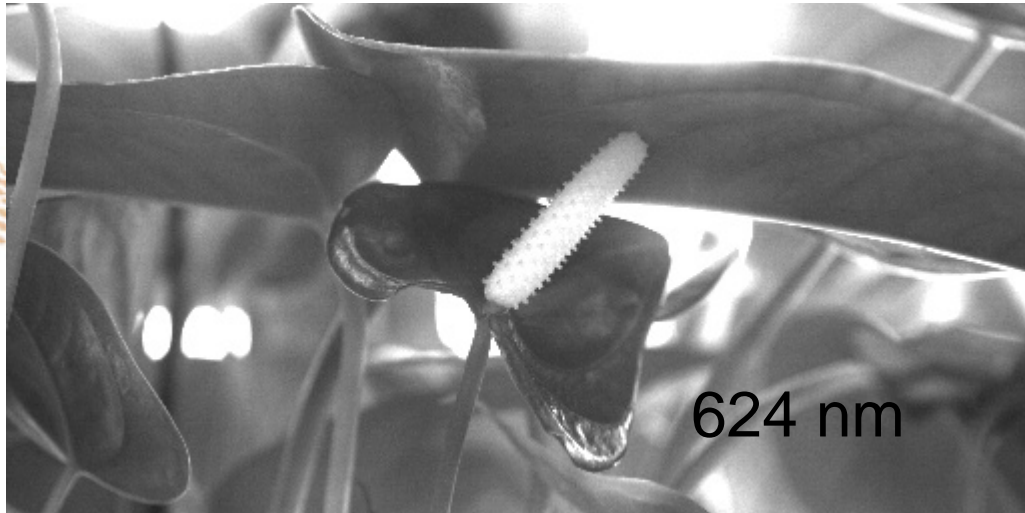
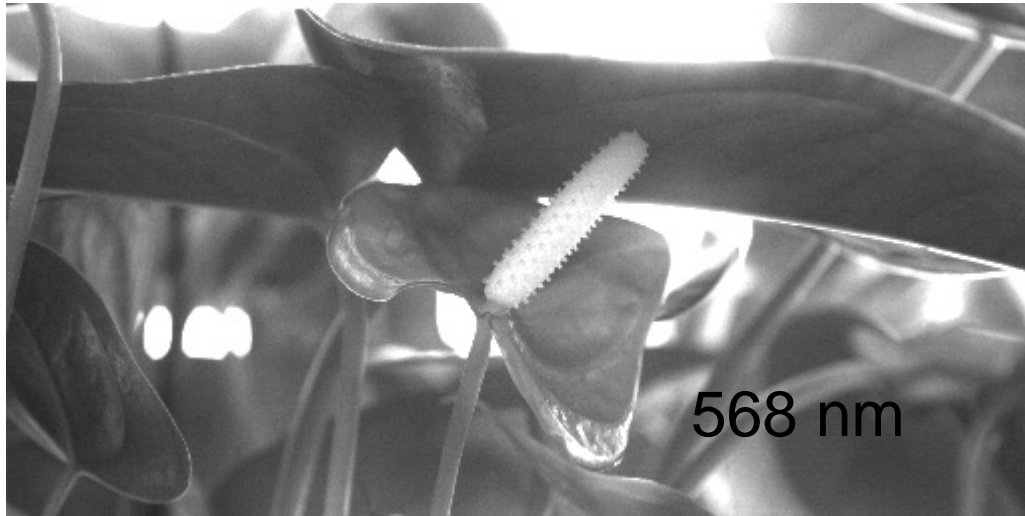


Prototype camera

- Purchased two different xiSpec hyperspectral cameras
- Small, light weight and can be mounted on a UAV or into a handheld device
- Sensitivity in the visible and part of the near infrared



Our hyperspectral data



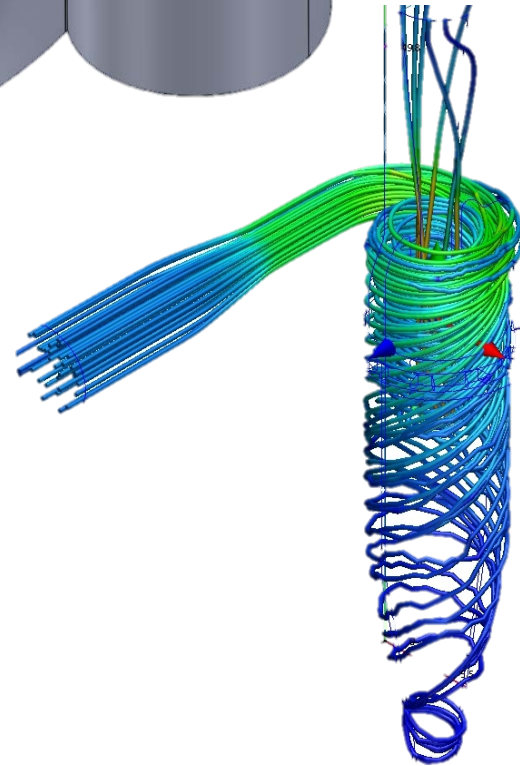
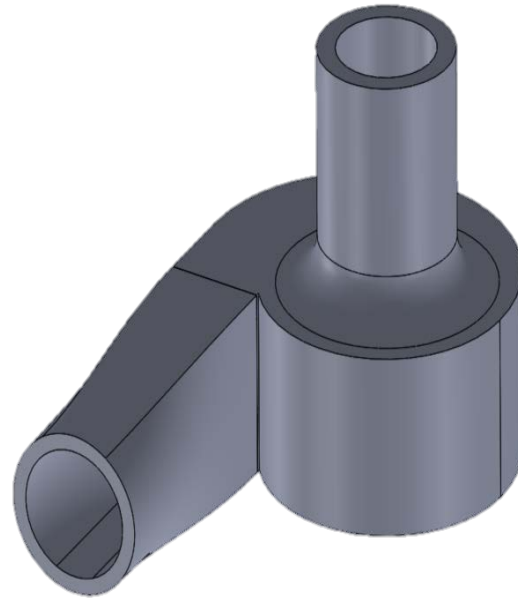
- Images from our 4x4 mosaic xiSpec camera using software written within RAL Space
- 16 images at wavelengths between 460 – 620 nm

WP4: Airborne spore trapping networks, understanding of spread & development of a distributed network ('Spore trapping')

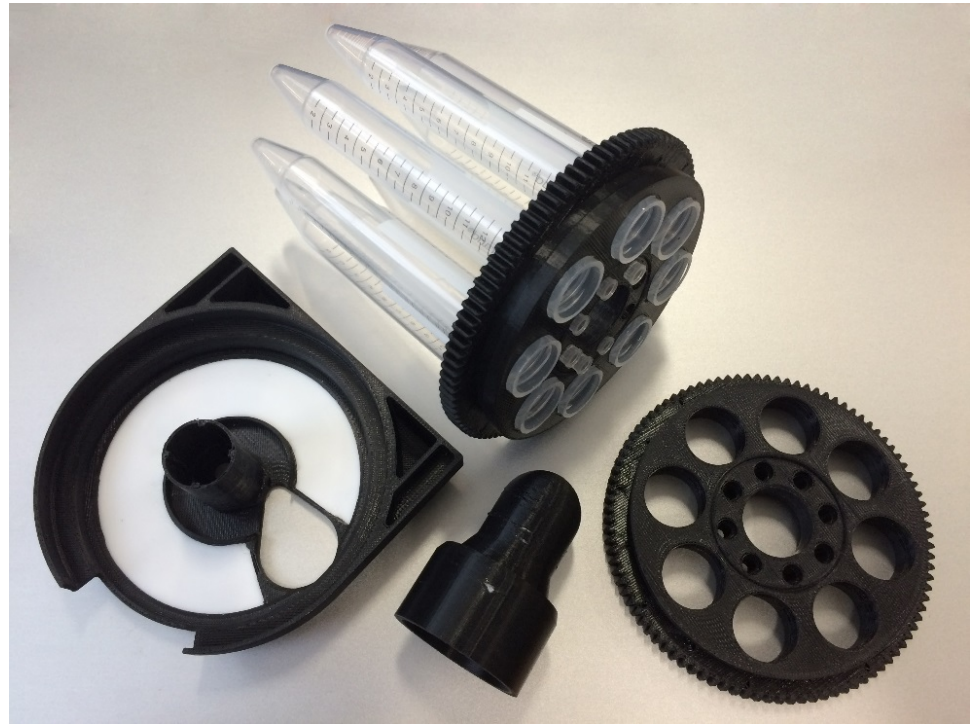
Partners: Boonham/Adams (Fera), Kennedy (Worcester), Tracey/Mclusky (Hertfordshire), Optisense

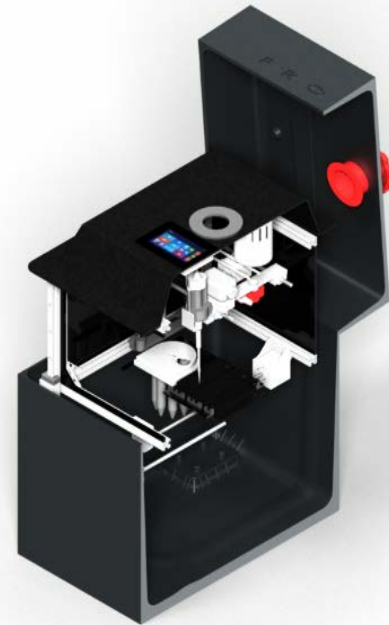
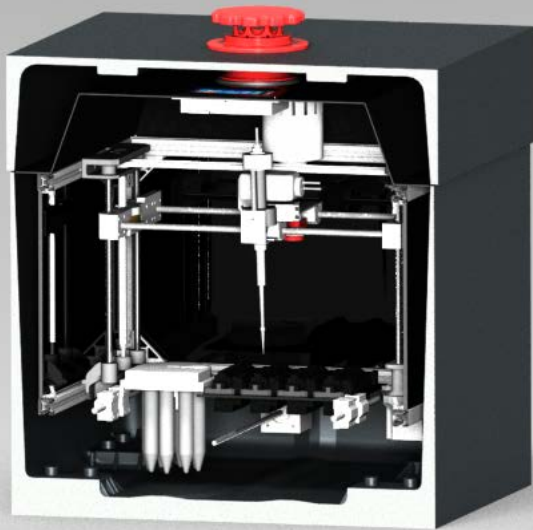
Develop mathematical models of spore movement and investigate metagenomics for broad-spectrum surveillance utilising existing monitoring networks e.g. pollen traps. In addition, a novel integrated cyclone-based trapping and molecular detection system will be developed and evaluated











WP 5: Novel approaches for the improved trapping of wood-boring beetle tree pests ('Pest Trapping')

Partners: Hall (Greenwich), Pocock (CEH)

Novel semio-chemical attractants will be identified for a range of wood-boring beetle pests, incorporated into traps designed for efficient detection and then deployed in a risk-based network



Pheromone trapping for longhorn beetles: a citizen science approach

- Developed a pheromone live-trap for use by volunteers
- Pheromone and kairomone for ALB: potential for early detection
- 3 other pheromones for many other longhorn beetles (Hanks & Millar 2012 Chemoecology)
- Can trap native longhorn beetles – biodiversity monitoring & motivating to volunteers

Early trial

- Traps provided to 10 volunteers, from across England, during August 2015
- No longhorn beetles were found, but will be repeated in June 2016

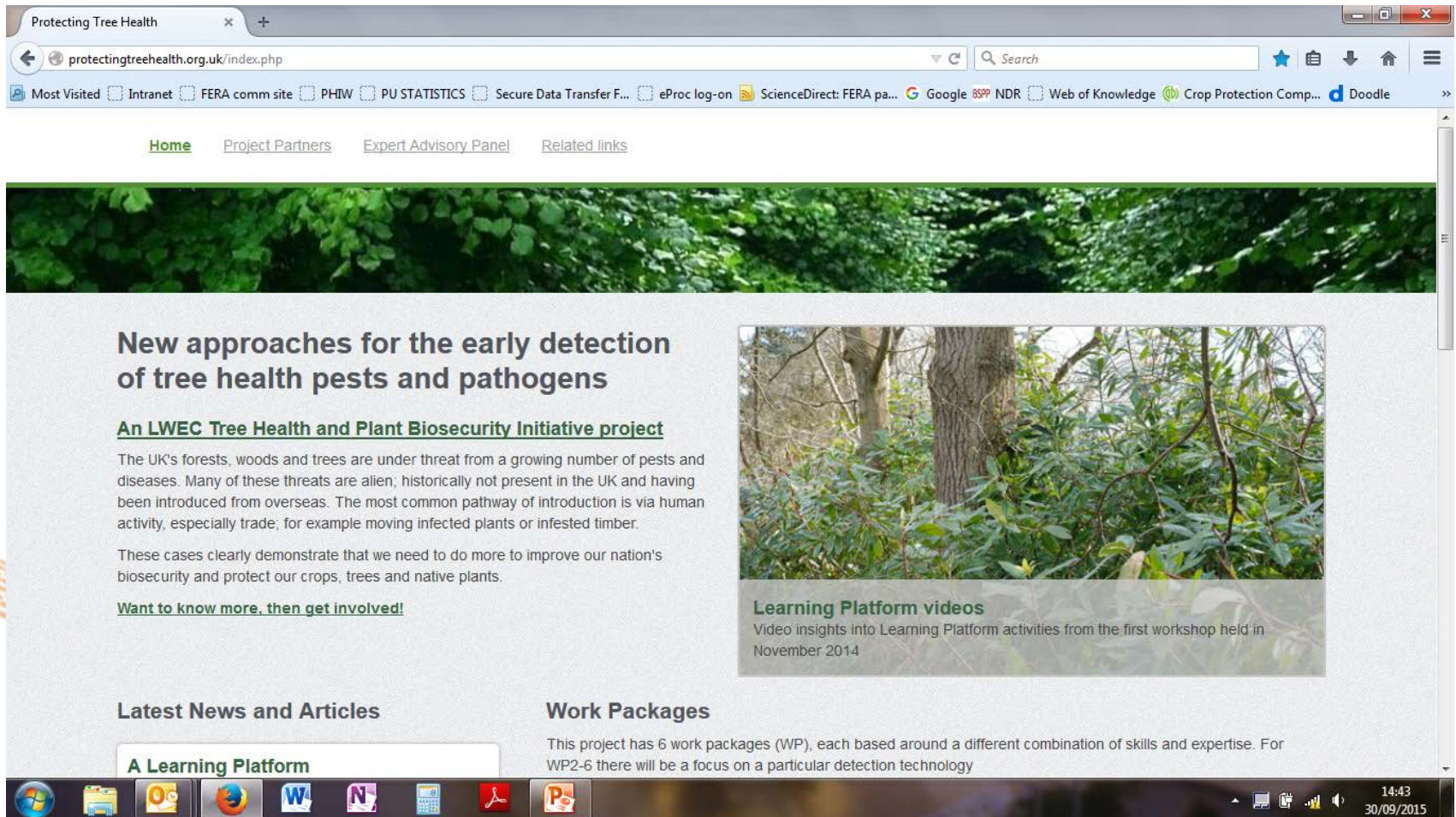


WP6: Development of non-targeted water surveillance methods for water-borne tree pathogens based on metagenomic approaches ('Water surveillance')

Partners: Cooke (JHI), Studholme (Exeter), Boonham (Fera)

Methods for sampling and rapid screening water for *Phytophthora* spp., including 'unknowns' will be developed and validated. This will combine high-throughput sequencing with a rapid bioinformatic pipeline

Project website:
<http://protectingtreehealth.org.uk/index.php>



The screenshot shows a web browser window with the URL protectingtreehealth.org.uk/index.php. The browser's address bar and search bar are visible. Below the browser window, the website's navigation menu includes links for [Home](#), [Project Partners](#), [Expert Advisory Panel](#), and [Related links](#). The main content area features a large green banner image of a forest. Below this, the main heading reads "New approaches for the early detection of tree health pests and pathogens". Underneath is a sub-heading: "An LWEC Tree Health and Plant Biosecurity Initiative project". The text explains that the UK's forests are under threat from pests and diseases, many of which are alien and introduced from overseas. It notes that the most common pathway is via human activity, especially trade. A call to action states: "These cases clearly demonstrate that we need to do more to improve our nation's biosecurity and protect our crops, trees and native plants." A link is provided: "Want to know more, then get involved!". To the right of the text is a video thumbnail showing a close-up of a tree branch with green leaves. Below the thumbnail is the text "Learning Platform videos" and "Video insights into Learning Platform activities from the first workshop held in November 2014". At the bottom of the page, there are two sections: "Latest News and Articles" with a sub-heading "A Learning Platform" and "Work Packages" with the text "This project has 6 work packages (WP), each based around a different combination of skills and expertise. For WP2-6 there will be a focus on a particular detection technology". The Windows taskbar is visible at the bottom of the screenshot, showing various application icons and the system clock displaying 14:43 on 30/09/2015.