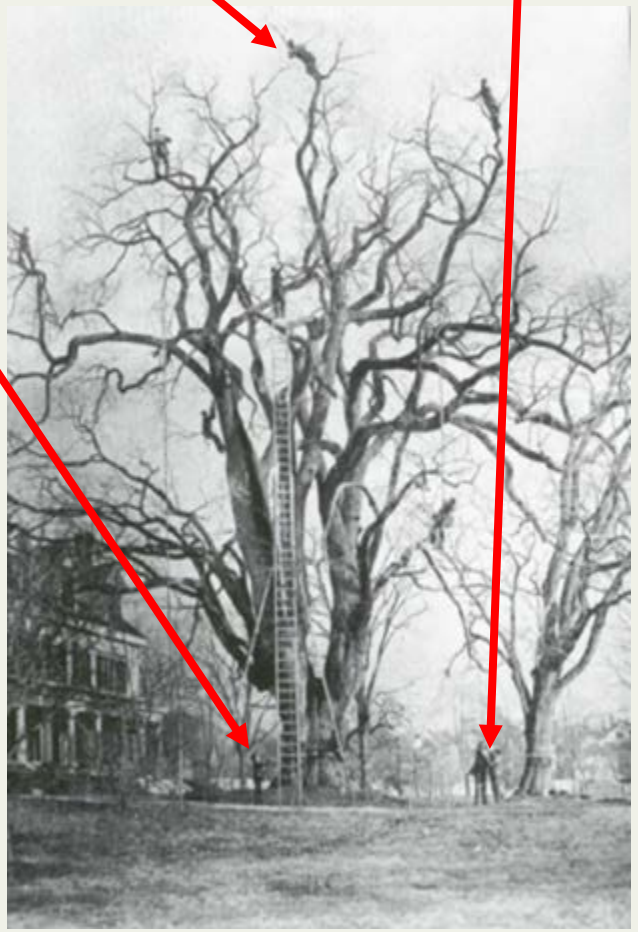
The risk analyst, the entomologist and the economist: a North American road trip to inform UK plant health research

Neil Audsley (Entomologist),
Glyn Jones (Env Economist)
Fera

Alan Macleod (Pest Risk Analyst)
Defra



Michigan State University
College of Agriculture & Natural Resources, Department of Forestry
28-29th August 2017

- Glyn
  - Who are we?
  - Why are we here?
  - What are we up to: socio-economics
- Alan
  - Risk Register
  - EAB
- Neil
  - What are we up to: entomology

The Road Trip

1. MSU – Deb McCullough
2. IPRRG
3. APHIS – Cape Cod
4. NYC parks service

Who are we?

- Fera (Glyn and Neil)
  - Former Government Executive Agency for plant health
  - Now 75% private, 25% Government owned
  - c500 scientists, 150 plant health
  - Plant health and agri-environment-food applied research
- Defra (Alan)
  - UK Government department with responsibility for plant health

Why are we here? The social amplification of risk?

"…seems capable of ending civilisation as we know it"

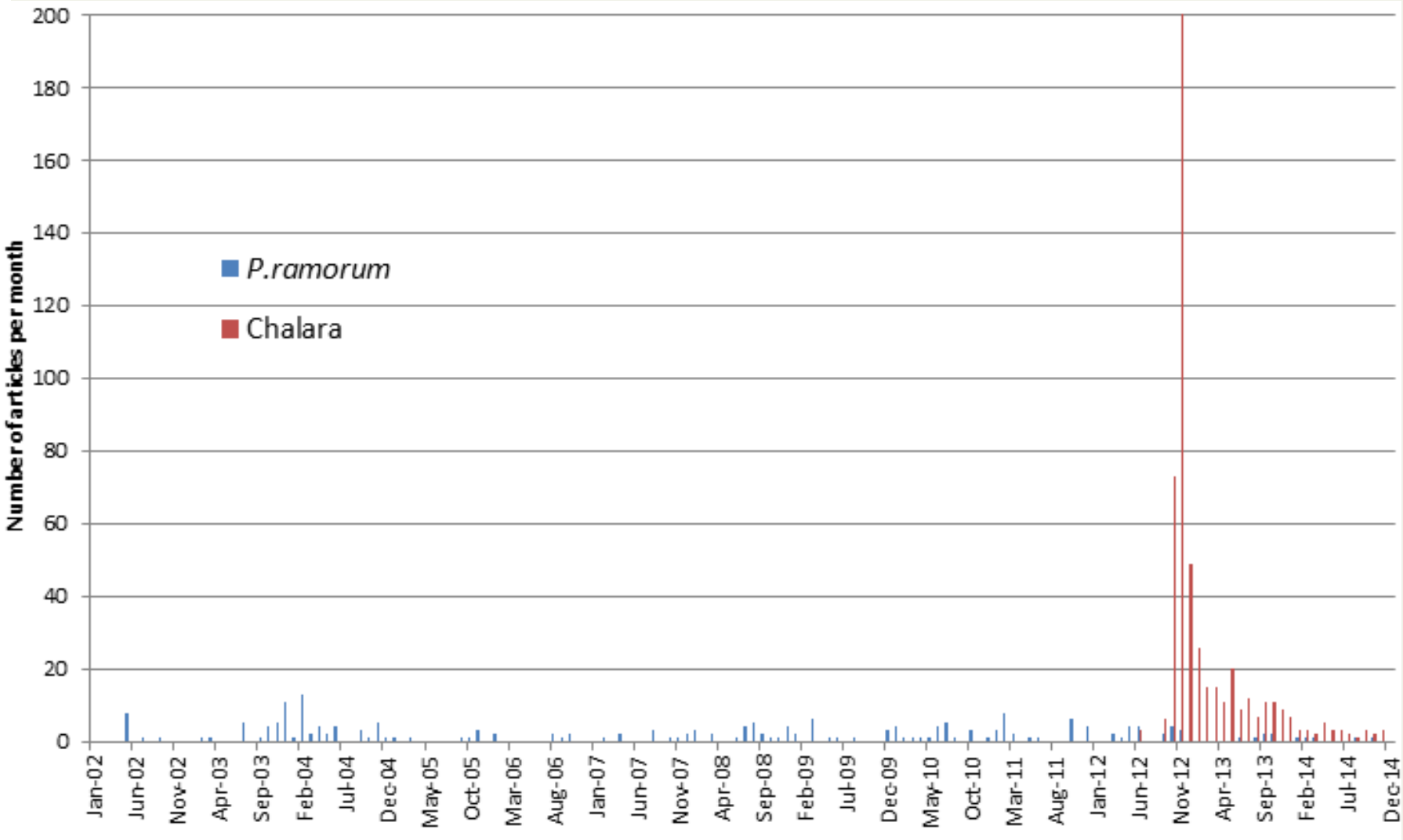
The Grower editorial, November 27th, 1986 - Western Flower Thrips)

"… this disease is sweeping the South of England. Think Ebola or AIDS …."

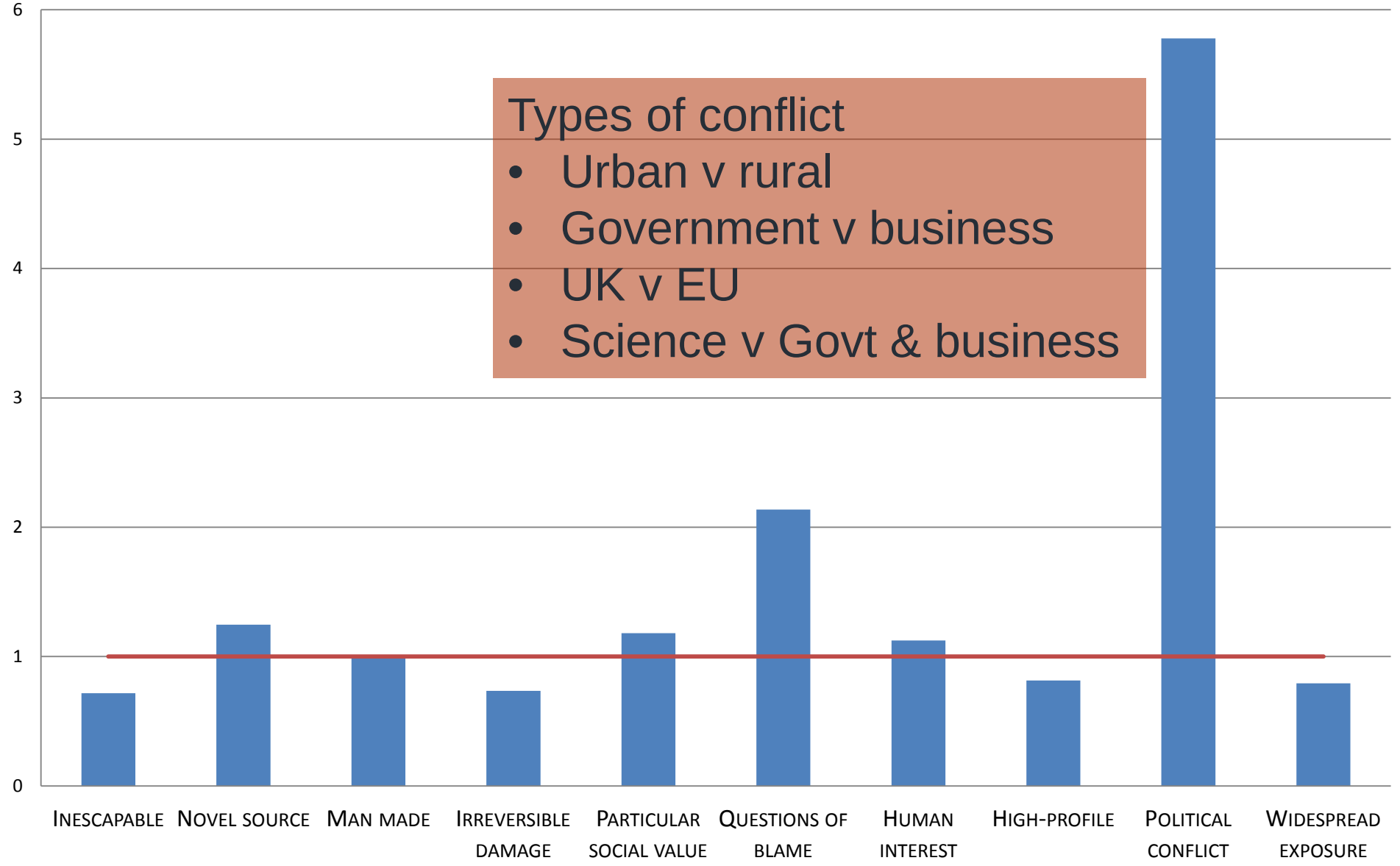
http://www.hortweek.com/national-collection-holder-warns-aquilega-downy-mildew-spreading/plant-health/article/1346972

A more recent example

P. ramorum v chalara: Number of newspaper articles



Chalara v *P.ramorum* intensity of Fright Factors and Media Triggers



Why are we here: media headlines

Mighty oaks will fall

Ash trees 'cannot be saved from deadly fungus'

The Government is in conflict with the natural world.

CATASHTROPHE!
ASHMAGEDDON!

If we lose the ash tree, we'll lose culture as well as nature

Telly Al 'a muppet'

Why are we here?

- What was done before pest X arrived?
  - Why pest X? Prioritising modelling, investment in detection, control etc? Contingency plans? Who was involved – when, why …?
- What was done when pest X arrived?
  - Put in place finely tuned plan, panic …..? How did the initial context define the response?
- How did the response to pest X evolve?
  - How move from eradication to contain to live-with-it? Science and non-science based influences?

Research: Future Proofing Plant Health

http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19496

- £5m programme of research 2014/15 – 2019/20
- Co-designed, commissioned and delivered in partnership with the Defra network

- Involves external expertise from universities, research institutes and SMEs
- Work packages led by science and policy/operations representatives

Some FPPH projects

- Review of Phytoplasmas
- *Xylella* diagnostics
- Risks from traded large trees
- Pathway analysis
- Horizon scanning – Twitter, text mining
- Co-design of detection technology
- Urban trees – local action plans
- Modelling pest outbreaks in urban/non-urban areas
- Cost and responsibility sharing
- Understanding the origins of a pest
- Remote sensing for host tree identification
- Assessing compliance for wood packaging treatment
- Stem injections in urban and high value trees
- Oriental Chestnut Gallwasp
- Multiplex lures & traps

Co-design: How good does detection technology have to be?

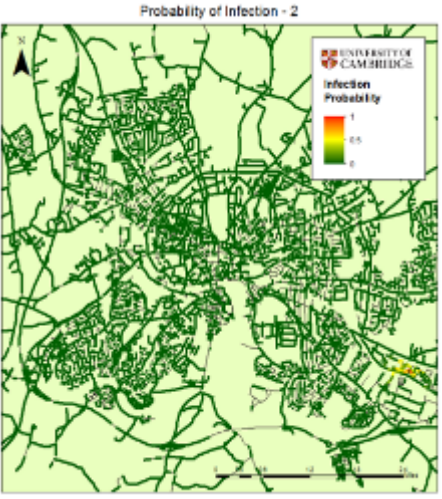
- Many technologies – looking for anything or something?
  - Eyeballs, in field technology, lab based
- Where should it be done? (Pre-border, at border, post-border)
- Who should do it?
  - Inspectors, diagnosticians, citizen scientists, stakeholders, others?
- How do we measure technology improvement?
  - Value of improving false positives/negatives?

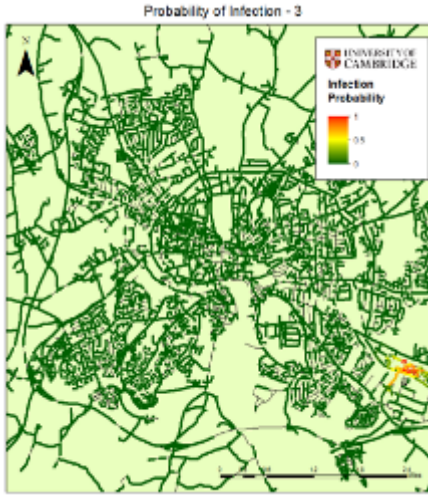
Urban trees: Ready …. for yesterdays battles?

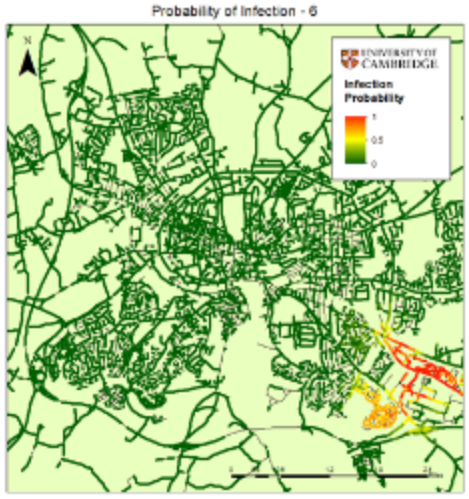
Pests and diseases	Plan	%
Ash Dieback (Hymenoscyphus fraxineus)	36	31
Oak processionary moth (Thaumetopoea processionea)	22	19
Dutch elm disease (Ophiostoma ulmi)	21	18
Horse chestnut leafminer (Cameraria ohridella)	21	18
Sudden oak death (Phytophthora ramorum)	16	13
Massaria/London Plane disease (Splanchnonema platani)	14	12
Acute oak decline	10	8
Red band needle blight (Dothistroma septosporum)	9	7
Sweet chestnut blight (Cryphonectria parasitica)	5	4
Oriental sweet chestnut gall wasp (Dryocosmus kuriphilus)	5	4
Great spruce bark beetle (Dendroctonus micans)	4	3
Asian longhorn beetle (Anoplophora glabripennis)	2	1
Citrus longhorn beetle (Anaplophora chinensis)	2	1
Emerald ash borer (Agrilus planipennis)	2	1

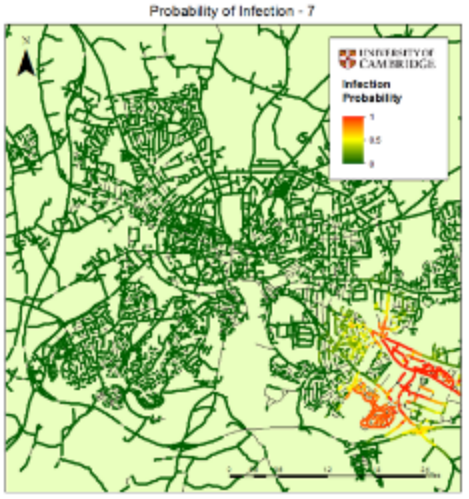
Urban trees: local management

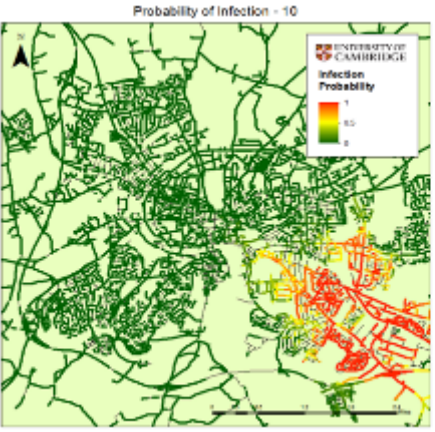
- Chalara action plans – an opportunity!
- How can PRAs inform “second tier” managers?
- Triage system to assess risks based on Risk Register
- Try to move from reactive pest-by-pest management to strategic management of tree resource
- Forward planning for structure of tree resource post chalara

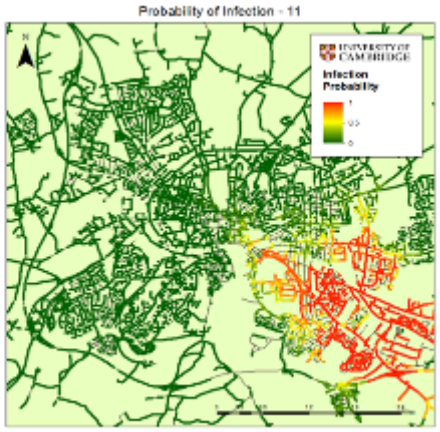


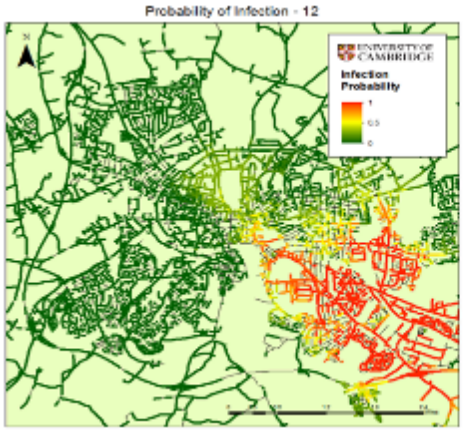


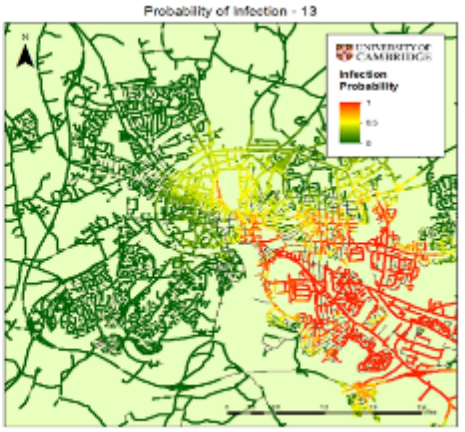


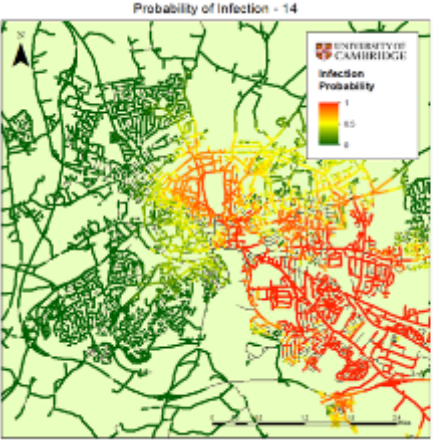


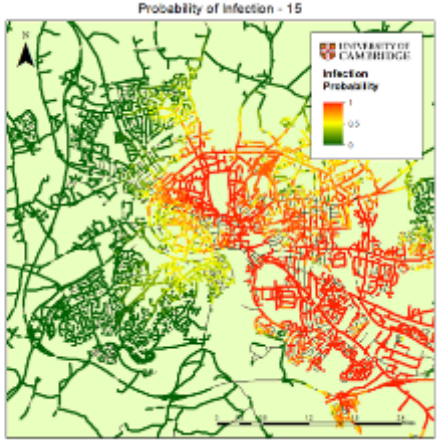






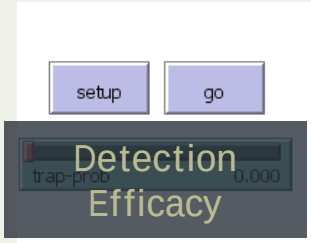


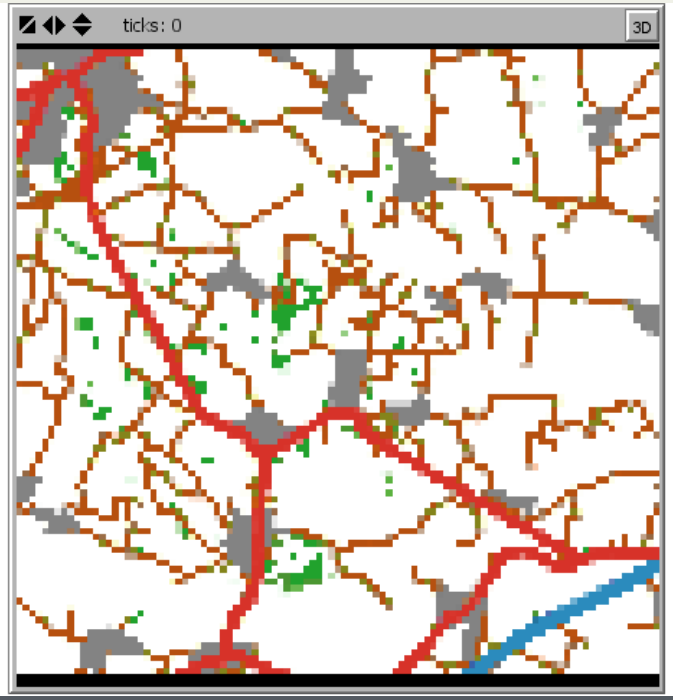


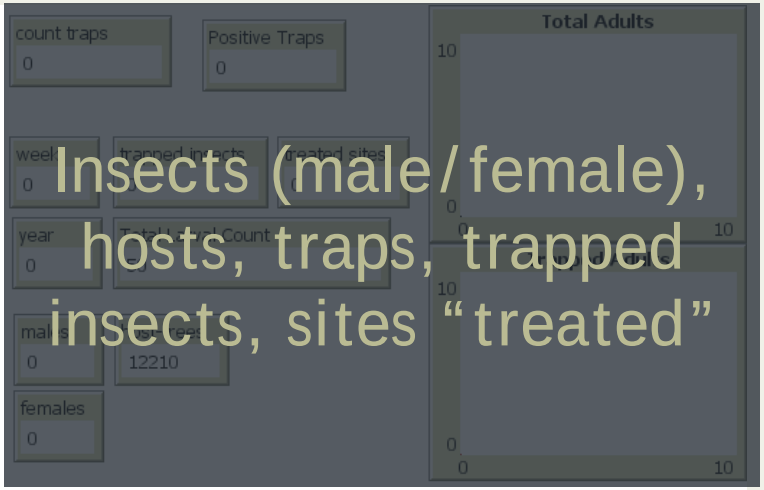


Modelling spread in urban settings (Cambridge University)

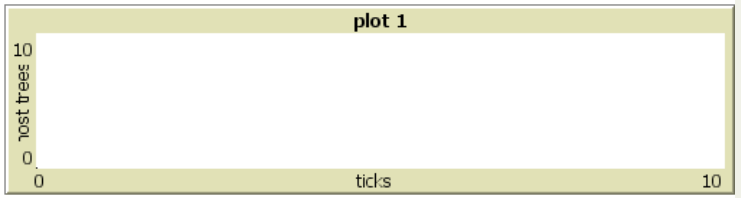
Modelling detection and control

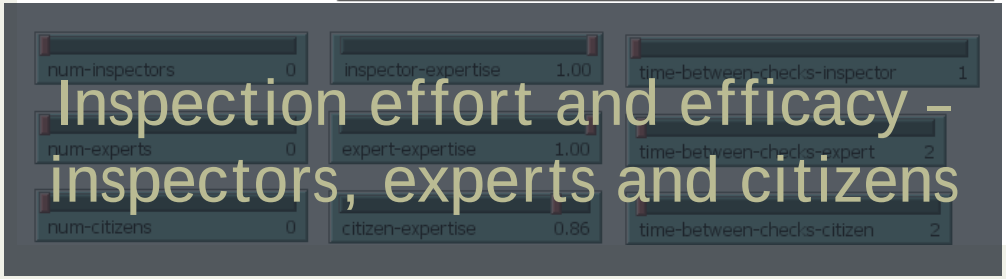






Insects (male/female), hosts, traps, trapped insects, sites "treated"





Inspection effort and efficacy – inspectors, experts and citizens

Traps

Injections: emamectin

Some things from the road trip thus far

- MSU communication and encouraging “second line” managers to move from reactive to proactive management
- IPRRG
  - Denys – can we apply to our urban modelling
  - Gabriel – application to trap placement
  - Justine – acceptance of model outputs by end users
  - Godshen – applicability to guide UK inspectors

Department for Environment Food & Rural Affairs

Identifying & prioritising pest risks - preparing for Emerald ash borer

Alan MacLeod, Plant Pest Risk Analyst, Defra

August 2017

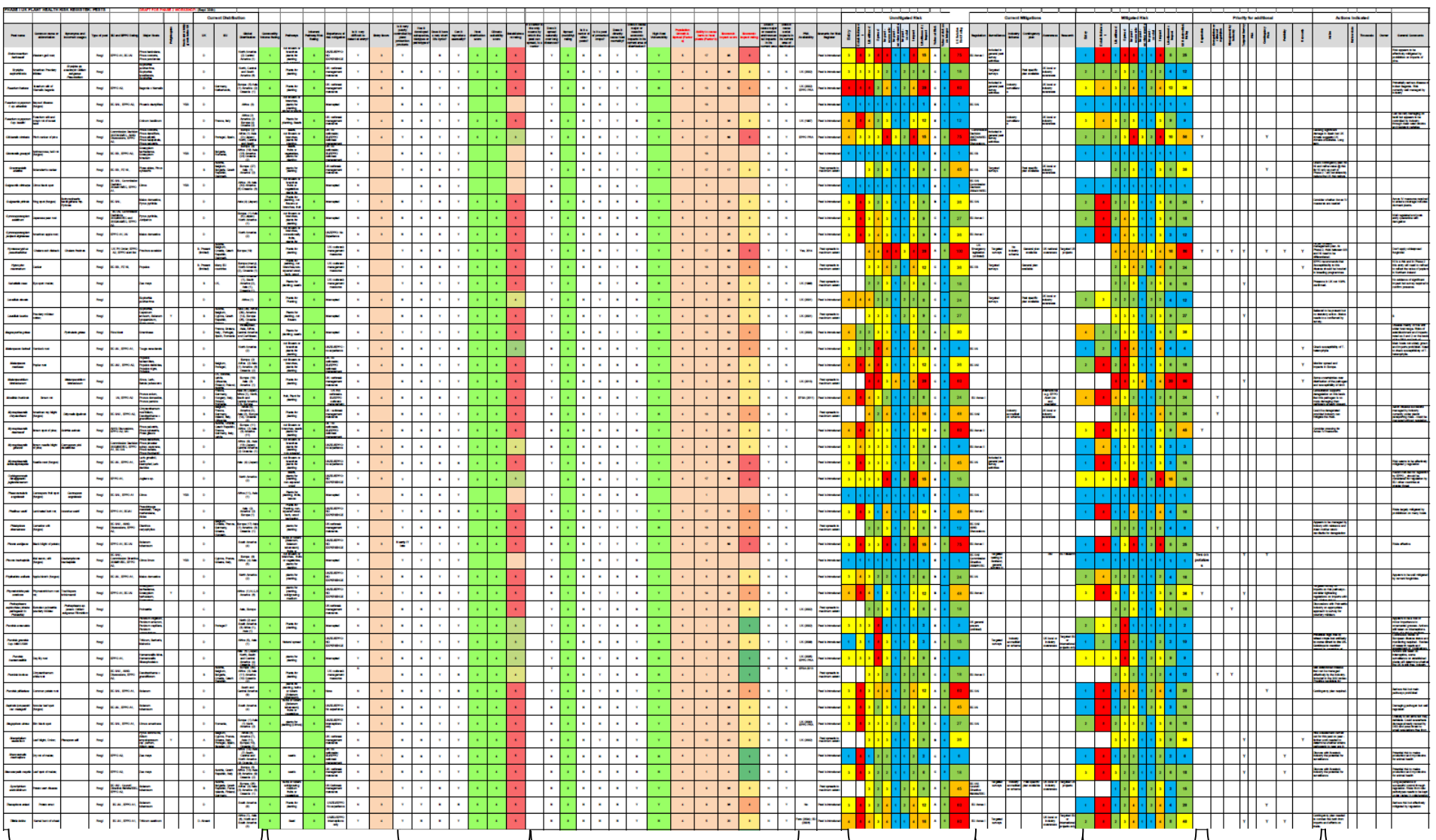
Forestry Commission England | NATURAL ENGLAND | Environment Agency

Risk register

- PH Risk Register is a means of identifying threats and prioritising actions
- Identifies the plant pests and pathogens that pose the greatest threat to UK crops, trees, gardens and ecosystems and records actions
- Uses ‘rules’ to rate the likelihood of a scenario (1-5), and the consequences of the scenario (1-5) and takes into account value of resources under threat (1-5)
- Risk is initially scored without mitigations, and then again assessed again with current mitigations in place
- Provides an agreed evidence based framework for decisions on priorities for actions by government and plant health stakeholders
- Register publically available at https://secure.fera.defra.gov.uk/phiw/riskRegister/

Ref: Baker *et al.* (2014) The UK Plant Health Risk Register: a tool for prioritizing actions. *EPPO Bulletin* 44: 187-194

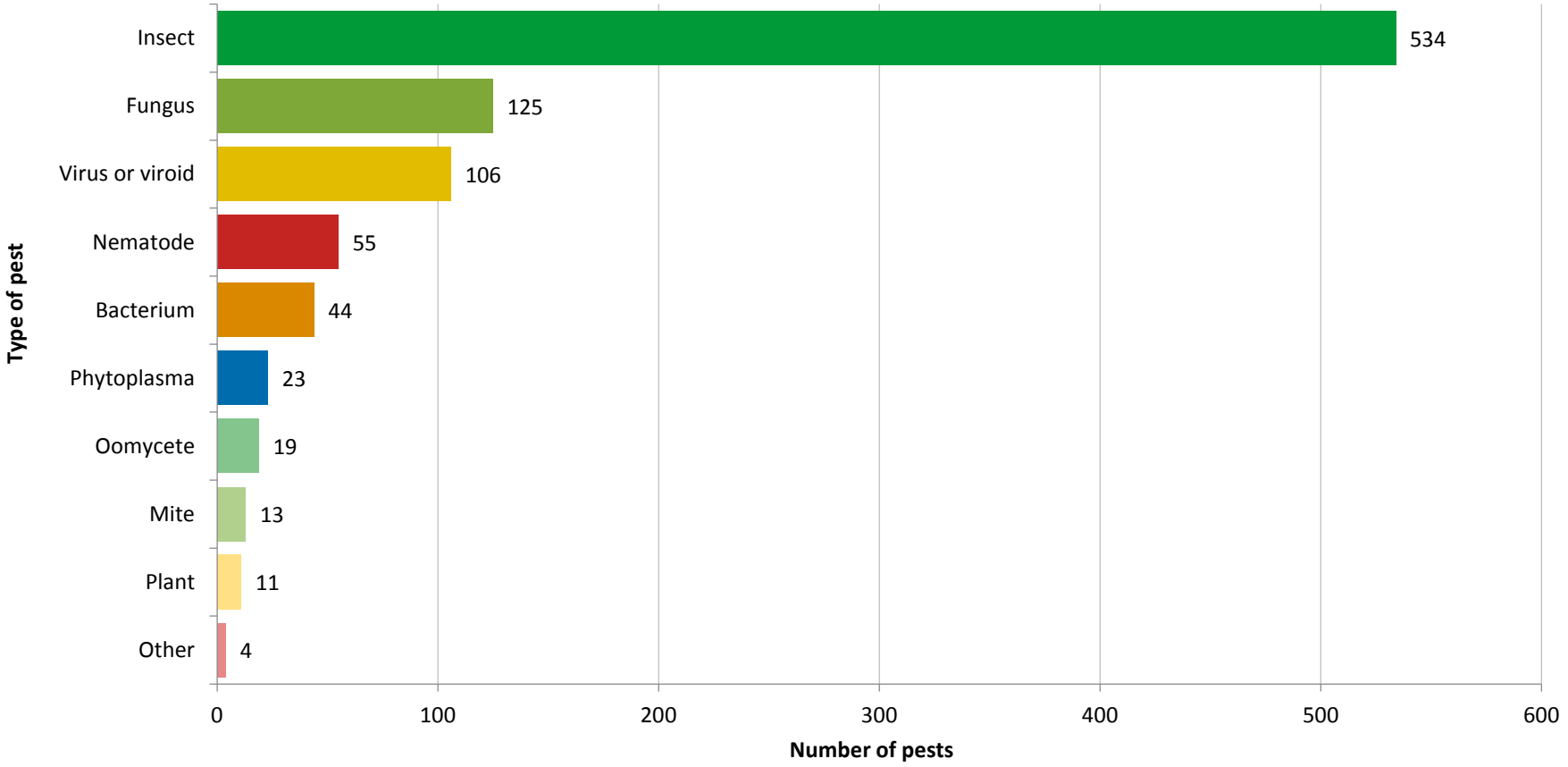
Risk Register spreadsheet



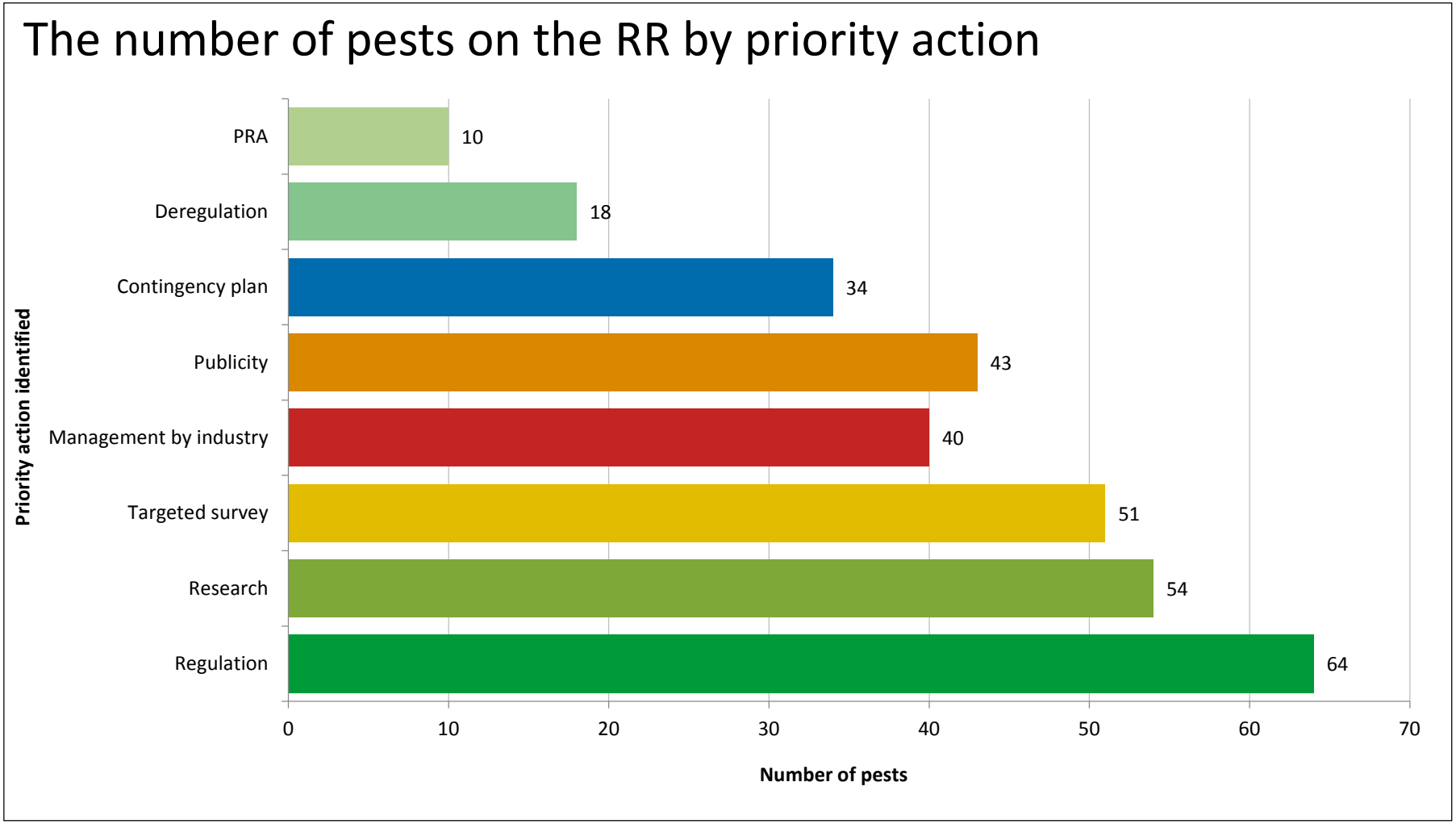
Basic biol info.
Entry
Establishment
Spread & Impacts
Scenario
Mitigations
Unmitigated Risk Ratings
Mitigated Risk Ratings
Actions
Comments

Insects dominate!

The number of pests on the RR by broad taxonomic category of pest

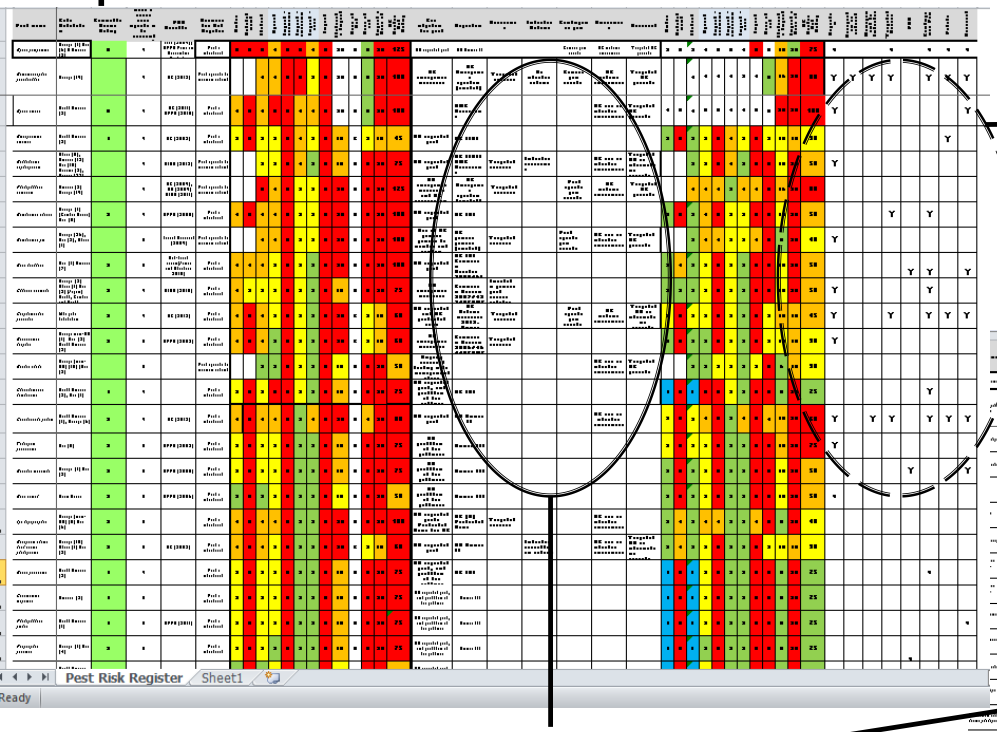


Priority actions identified



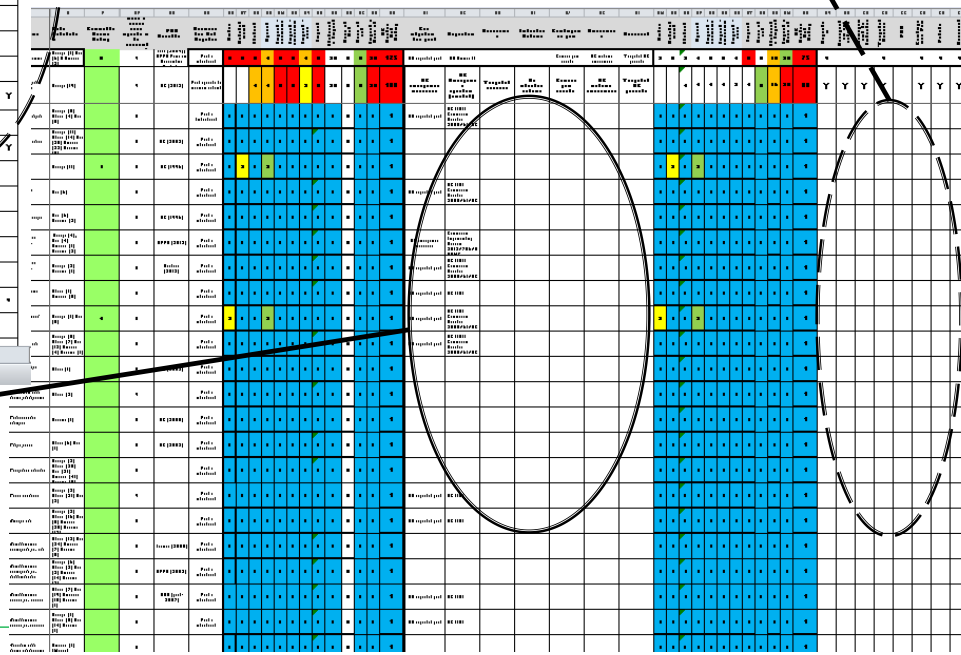
Most mitigations and additional actions for highest rated pests

Top



Additional actions

Bottom



Mitigations

Criticisms of risk registers

- Risk registers can lead to ritualistic decision-making (going through the motions)[1]
- Gives an illusion of control[2]
- Success often overstated (effectiveness of existing risk mitigation)[3]
- Management of register takes over from management of risks[1]

References

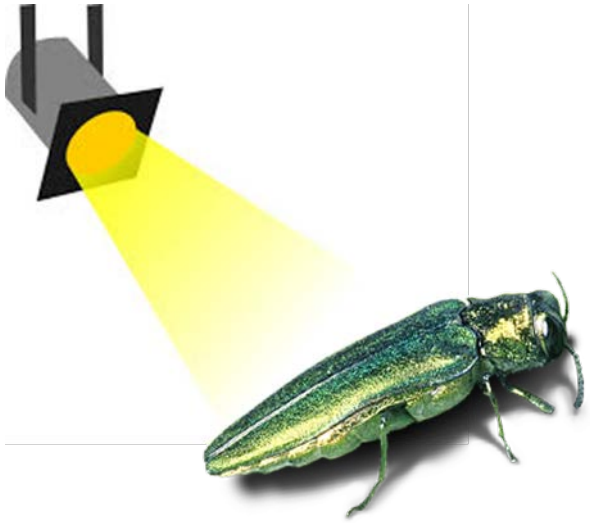
[1]Drummond (2011) An analysis of the risks of risk management. *J. Info. Tech.*, **26**, 259–267

[2] Lyytinen (2011) The urge to control and the control of illusions. *J. Info. Tech*., **26**, 268-270

[3] Budzier, A. (2011) The risk of risk registers. *J. Info. Tech.,* **26**, 274-276

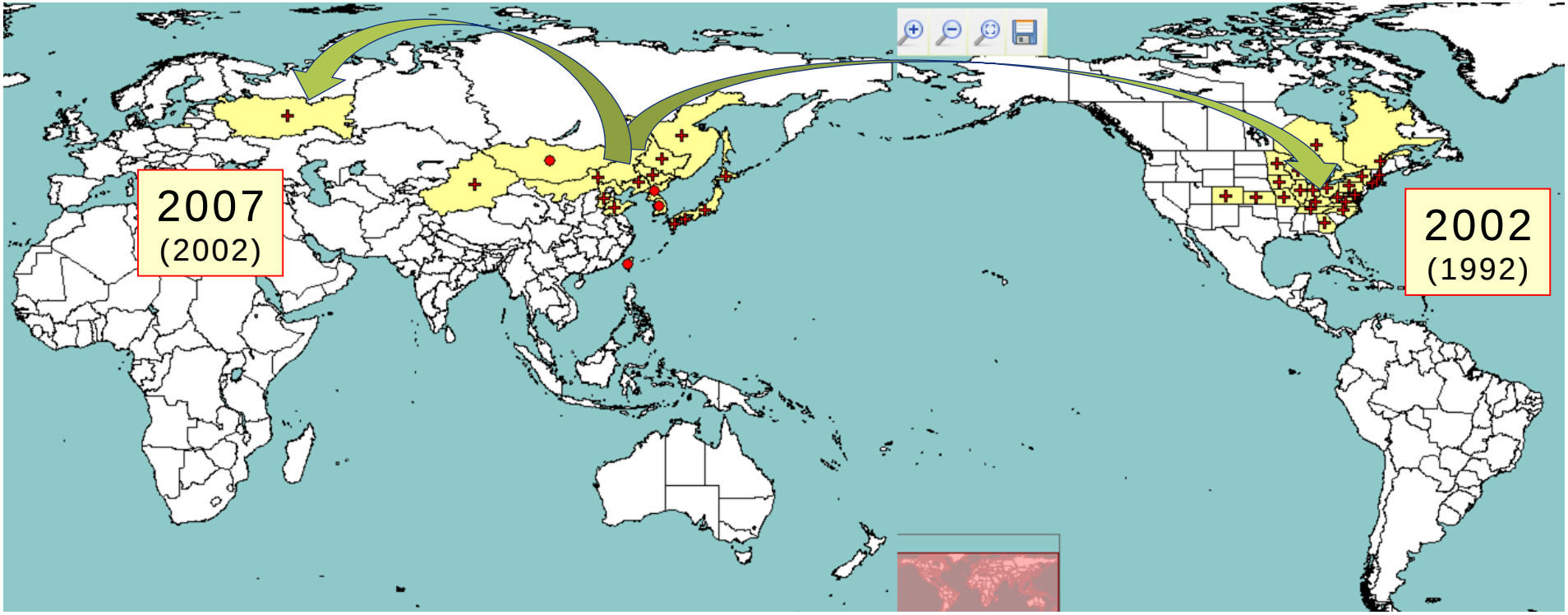
Risk register

- RR now an integral part of UK PH decision making
- 5 – 10 pests added each month
- Entries are reviewed / scores change in response to new information
- High on risk register is emerald ash borer



Agrilus planipennis

- Emerald ash borer
- Originates in Far-East Asia

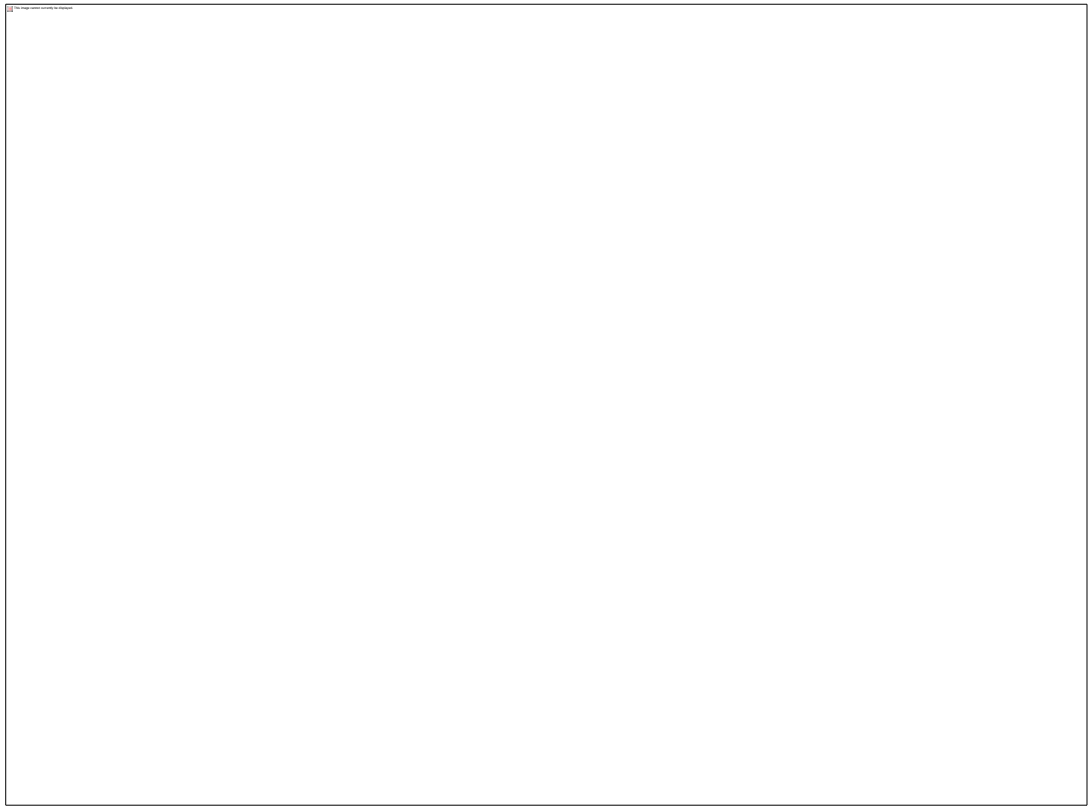


Agrilus planipennis in Russia

- Not regulated
- No management of outbreaks by NPPO
- No official surveys
- UK forest entomologist go to Russia

Gathering information from North America

- Scientific literature
- EAB workshop, Toronto June 2015
- EAB meeting Minnesota, July 2017



Spreading from Moscow

- Natural spread: strong flier (up to 20 km)
- But less than 800m if host available nearby
- Human assisted spread (firewood, wood, plants for planting)
- USA - combined spread estimated at 20km/year
- Russia - up to 40km/year

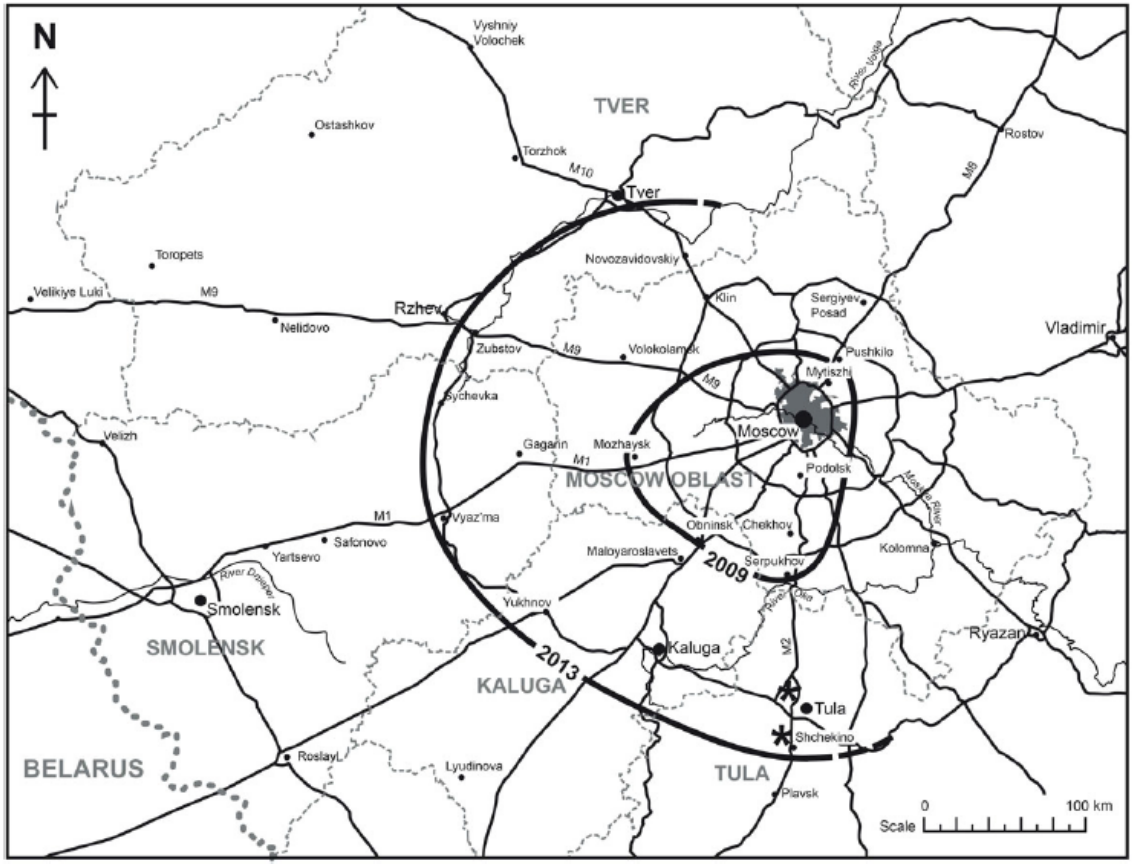
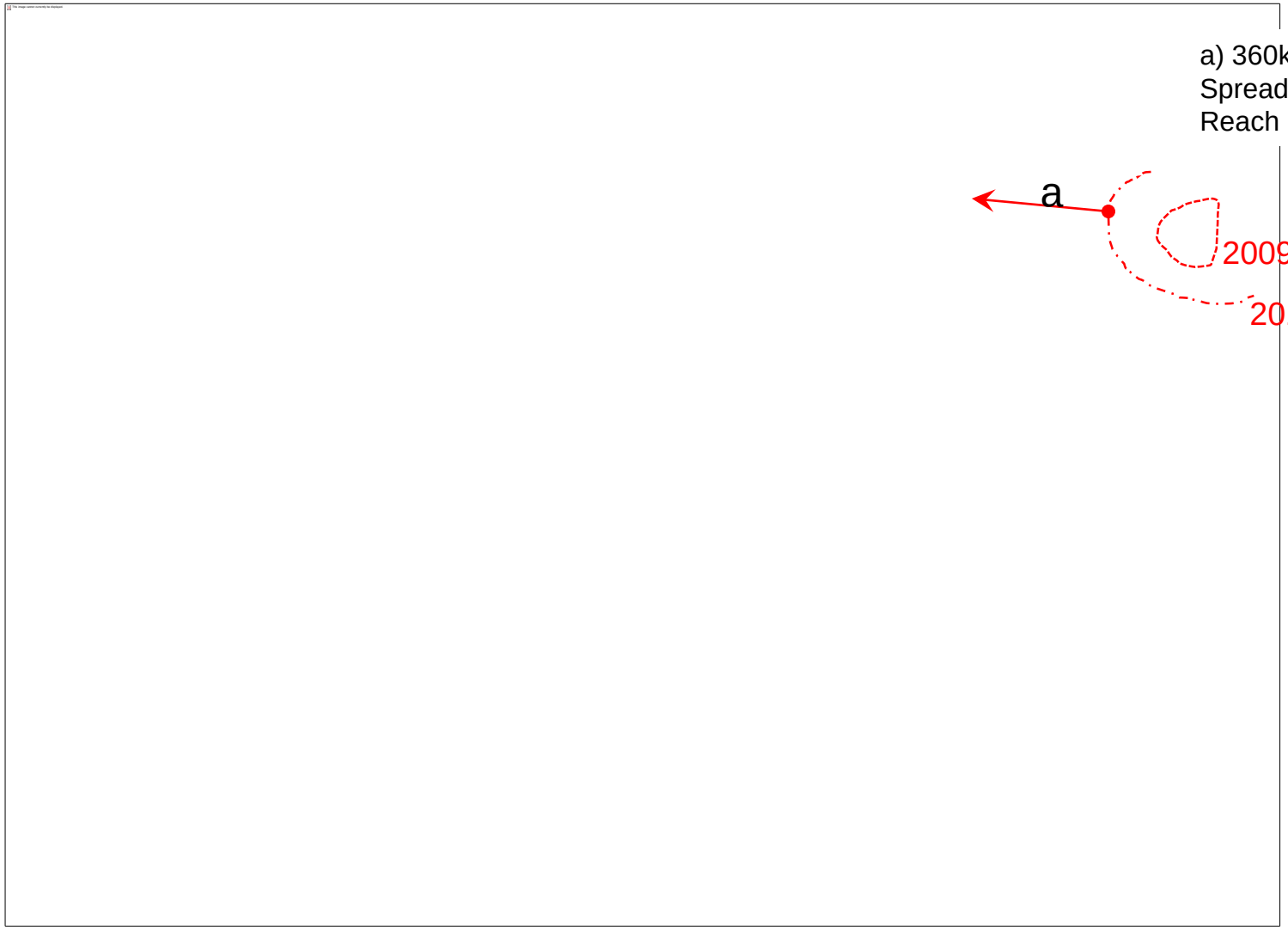


Figure 1 The distribution of *A. planipennis* in the Moscow region of Russia in 2009# and 2013, as indicated by the presence of damaged and dying ash trees. Star symbols mark the location of European ash *F. excelsior* in natural woodlands, which is mentioned in the text. #After Baranchikov *et al.* (2010).

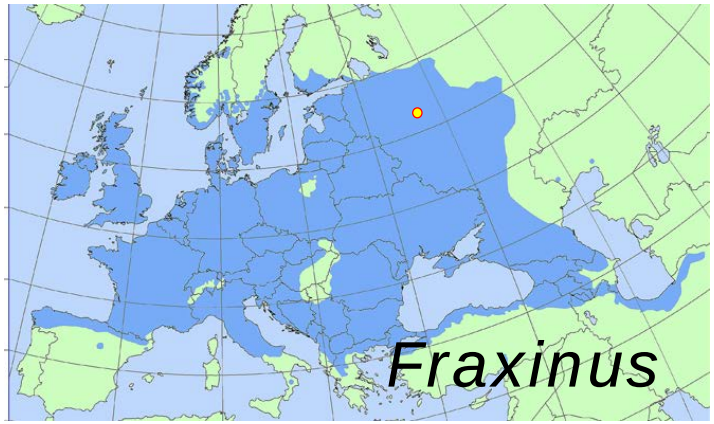
Source: Straw *et al.*,(2013) *Forestry*, **86** (5), 515-522

Spreading from Moscow

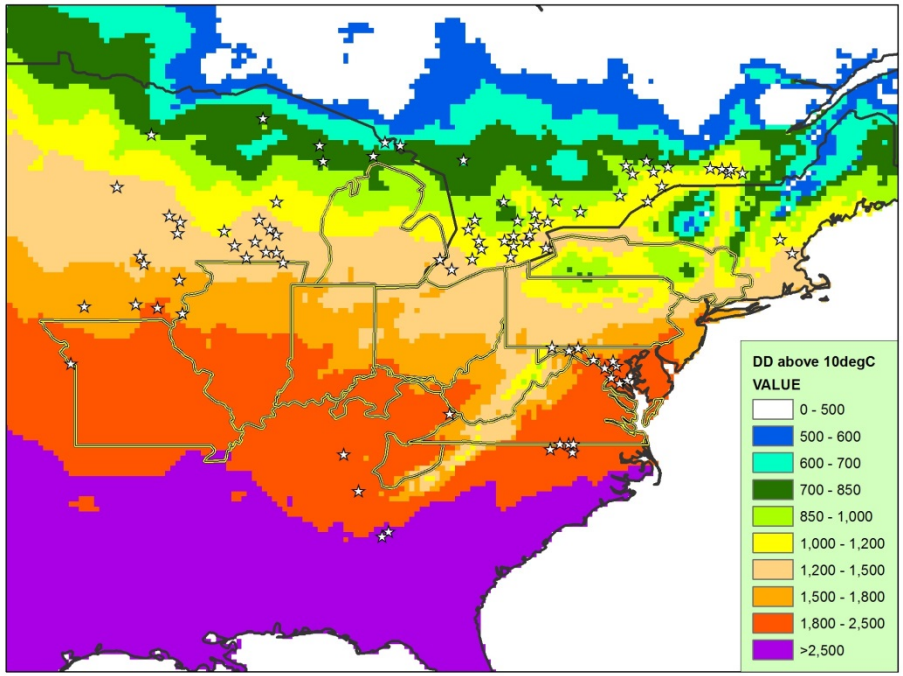


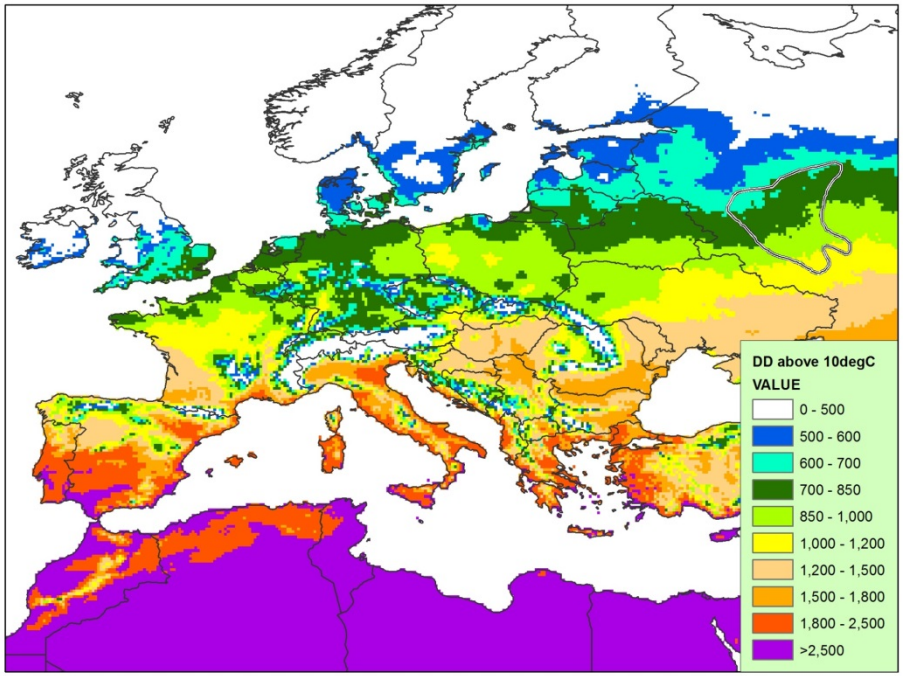
a) 360km
Spread @ 40km yr^{-1}
Reach EU border by 2022 ?

Establishment in EU



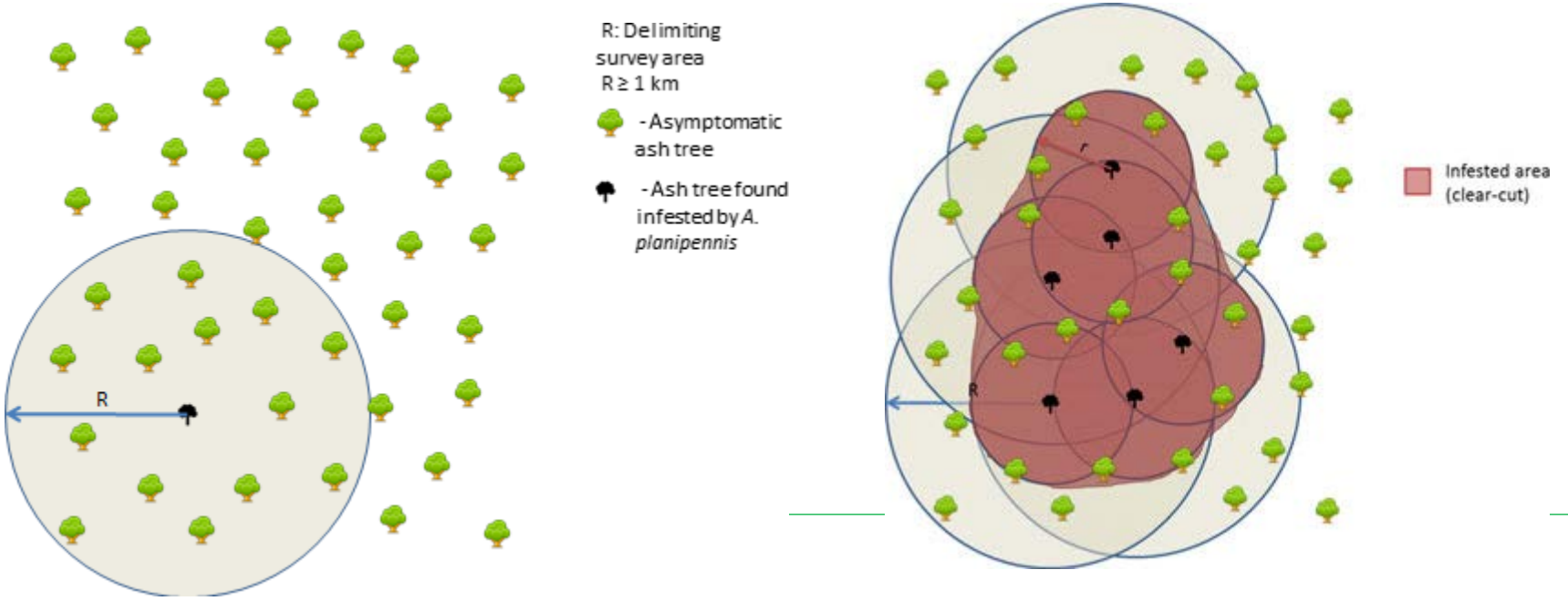
- *Fraxinus* widespread in Europe
- European *Fraxinus* species susceptible
- Similar temperatures / climates (North America & Europe)





Measures suggested for eradication

- Regulated area of at least 20 km radius around first finding of *A. planipennis* to prevent movement of infested material (wood including firewood, plants for planting, etc.) out of the regulated area
- Delimiting survey of at least 1 km radius based mainly on visual inspection
- Fell and destroy infested trees
- Fell all host (ash) trees in a radius of 100 m



Advice

- Use traps for early detection, don't wait for symptoms
- When detected, felling all hosts within 100m will not be enough*
  - Eggs laid up to 800m from tree of emergence,
  - Majority of eggs laid within 200m so felling has to at least double, but would still be behind the curve
- Use 'lethal trap trees' - inject pesticide into an ash, 7 days later girdle tree to stress it – draw in adults then progeny killed.
- Tree not killed and can be re-dosed in following years

** felling to 100m would actually encourage spread*

EAB Conclusions

- Eradication is very demanding
- Despite major efforts in North America *A. planipennis* is spreading
- In Russia *A. planipennis* is spreading (faster)
- It is crucial to prevent entry!

Preparing for invasive pests and diseases

- Early detection is vital to determine the introduction and spread of invasive pests and diseases

- Eradication requires the use of highly effective, primarily synthetic pesticides or destruction of plant material

- Once established few effective control and containment measures exist
  - ↓ availability of active ingredients driven by hazard-based EU legislation

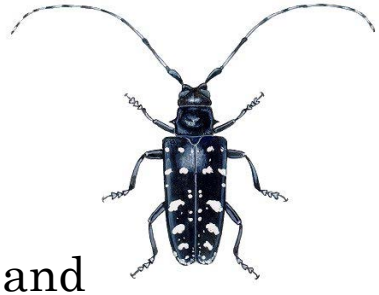
- Multifaceted approaches (IPM) rather than single control measures
  - These is a distinct absence of truly novel procedures

How do we evaluate management options?

- Establish quarantine laboratory cultures
- Use a similar native/established species in UK as proxy
- Field testing in region of origin or invasion
- Research visits to acquire knowledge

Current research

Pests identified from risk register or are a Defra priority



1. Improved detection of invasive xylophagous pests of trees

2. Evaluating the use of trunk injections for the control of pest and diseases in urban and high value trees:
   - Oak processionary moth; *Thaumetopoea processionea*
   - *Pseudomonas syringae pv. aesculi* (Psa) in Horse Chestnut Trees

3. Biological control of *Dryocosmus kuriphilus* (Oriental chestnut gall wasp)

4. Preparing for Emerald Ash Borer *Agrilus planipennis*

Multiplex Lures and Traps

Trapping during 2017 and 2018

black cross vein

black multi-funnel traps

Lures - 3 different blends of host tree volatiles and cerambycid pheromone components that are attractive for several species.

- No non-native species trapped to date
- Native species from families Cerambycidae, Scolytinae, Curculionidae and Ptinidae

Alain Roques. Forest Zoology – INRA
Gernot Hoch. Austrian Federal Forest Research and Training Centre
Antoon Loomans. Netherlands Food Safety Authority
Edmundo De Sousa, National Institute of Agrarian and Veterinary Research
Troy Kimoto. Canadian Food Inspection Agency

Aim: To provide better techniques for the improved detection of invasive xylophagous pests of trees using multiplex (multi-trap, multi lure blends) trapping

Focus on high-risk, high-threat wood-boring species, primarily cerambycids (longhorn beetles), but also buprestids (metallic wood borers) and scolytids (bark beetles)

Trap sites

High risk sites selected (e.g. ports, stone importers)

Traps placed within the site and in woodland close by

- The Humber estuary is the centre of forest products trade in Britain
- > one million tonnes of forest products enter UK via these ports on this estuary each year.

Trunk injections for the control of tree pests and diseases

- Delivers pesticides more effectively to improve efficacy
- Eliminates spray drift, soil contamination and run-off
- However, concerns in UK on impact on non-target organisms

Evaluating treatment and non-target impact

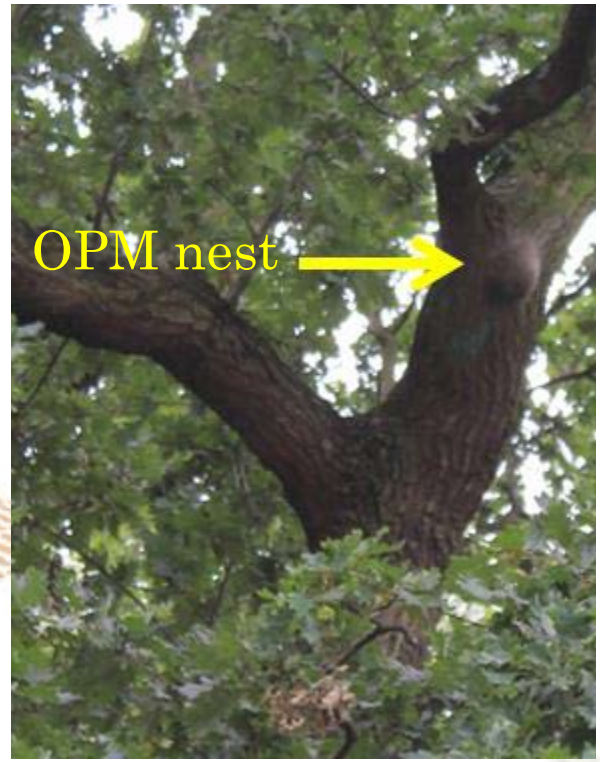
- Emamectin benzoate against oak processionary moth
- Allicin (extracted from garlic) against Horse chestnut bleeding canker and leaf miner

Oak processionary moth

Thaumetopoea processionea (OPM)

- Native to central and southern Europe, now established in northern Europe
- Found in London in 2006, could not be eradicated, has spread throughout London and its range is still expanding
- OPM caterpillars
  - Major defoliators of oak in Europe
  - Health risk: caterpillar hair cause skin irritation and allergic reactions
- Survey programme (pheromone traps) to map its spread
- Control
  - Nest removal
  - *Bacillus thurigiensis* (and Dimilin) to suppress populations to slow rate of spread and impact

Trunk injections of pesticide to control OPM in urban trees



An urban field site was selected to assess the:

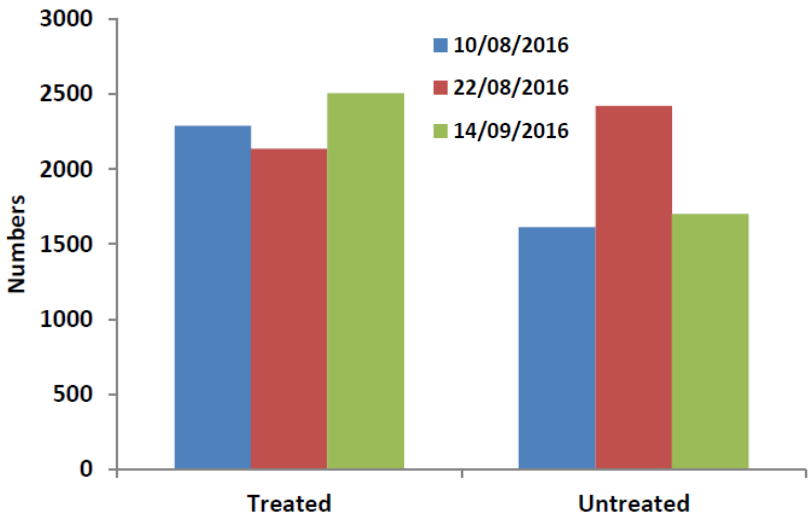
1. Efficacy of the emamectin benzoate (Revive®)
   - Trees treated in 2016
   - Trees surveyed in 2017 for OPM nests

2. Effect on oak tree invertebrate biodiversity
   - Samples collected using beating trays 1 week prior, 2 weeks and 1 month post treatment.

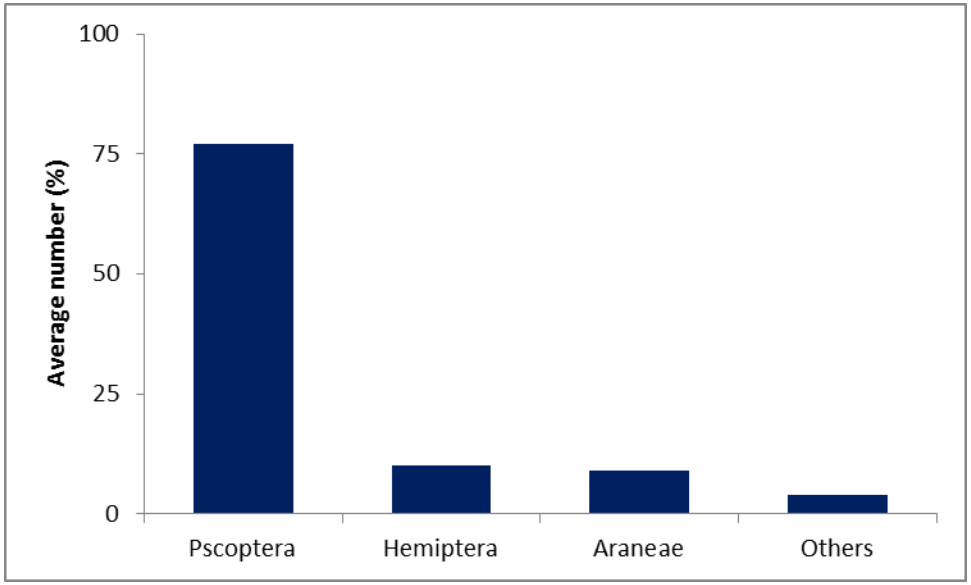
Invertebrate diversity

- 2017 - OPM larvae returned to some treated trees
- Over 20,000 invertebrates collected
- 15 different orders of Arthropoda

Total invertebrates collected



Major groups



Horse Chestnut trees


Injection of Psa


bleeding canker

- All trees infested with *Cameraria ohridella*
- Tree artificially infected by injecting a solution of *Pseudomonas syringae pv. aesculi* (Psa) (April 2016)
- 3-months post Psa injection trees injected with allicin
- Invertebrates collected using a beating tray
- Trees monitored in 2017 for symptoms of bleeding canker and *Cameraria ohridella*


Cameraria ohridella

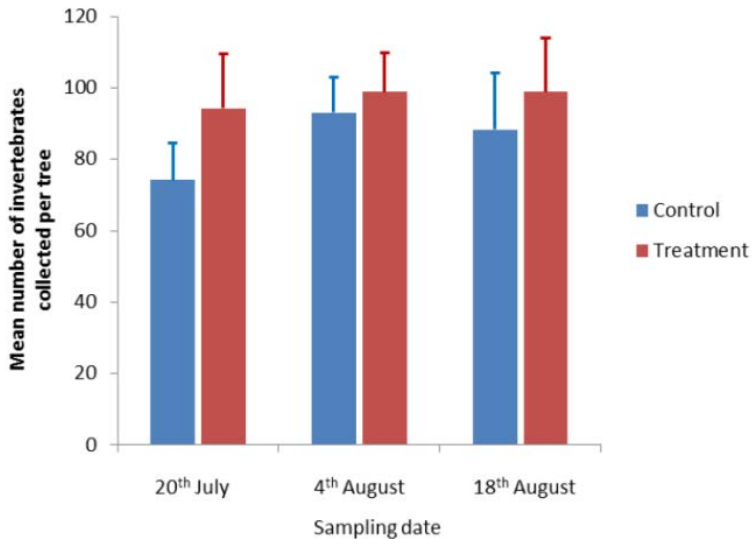
2017

- Psa infected trees showing no symptoms of disease
- All trees infested with *Cameraria ohridella*

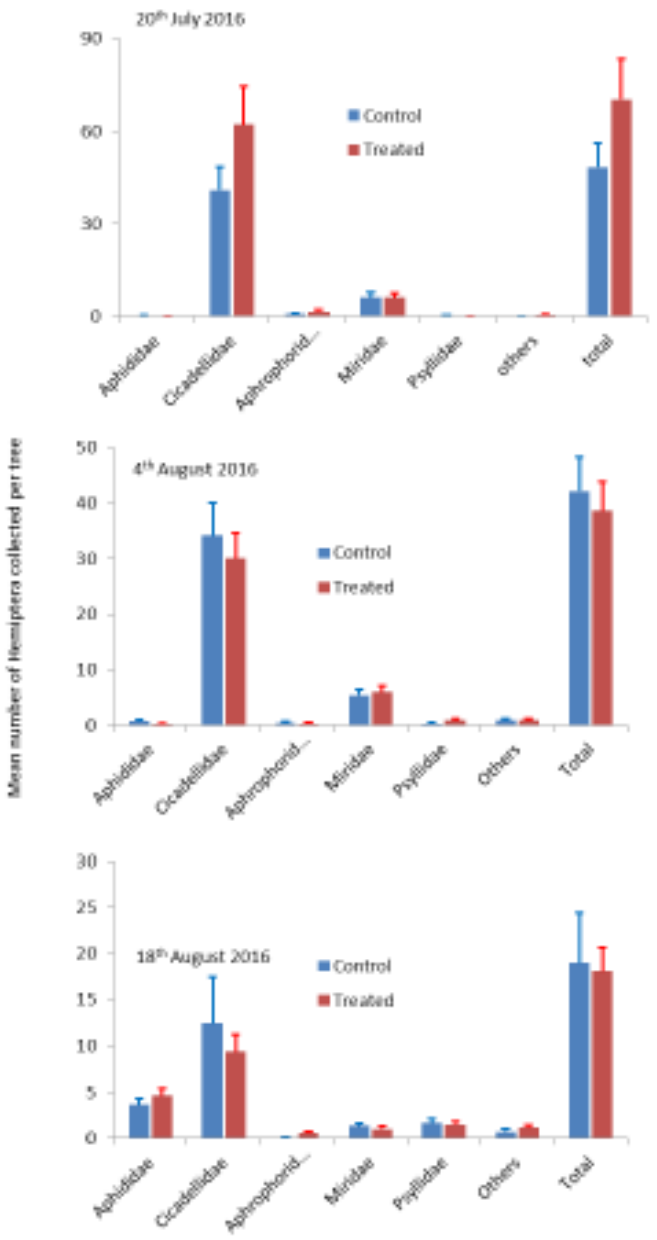
Non-target assessments

- Samples were collected 15 days prior, 1 day and 15 days post allicin treatment.
- 57-96% were insects, remainder arachnids
- 11 different orders of insects, predominantly hemipterans and psocopterans.
- Little impact on non-target species collected

Total invertebrates collected



Hemipterans collected



Oriental Chestnut Gall Wasp

The Oriental Chestnut Gall Wasp (*Dryocosmus kuriphilus*) induces galls on buds and leaves of Fagaceae, Castanea spp that damage young growing tissues.

An exotic parasitoid, *Torymus sinensis* has been (successfully) released in Japan, USA and Italy in a classical biological control programme achieving varying levels of chestnut gall wasp control.

OCGW was first detected in the UK in 2015, within Farningham wood, Kent (South-East England).

Now found in several locations in London and South-East England

Coppicing was undertaken to reduce OCGW populations – ineffective

Biological control using *T. sinensis* is the only effective control option

Oriental Chestnut Gall Wasp

2015 and 2016 ~ feasibility study on releasing *Torymus sinensis* in England

- A cost - benefit assessment of releasing *T. sinensis* to control OCGW.
- Investigate methods for the rearing and release of *T. sinensis.*

- Post release study in Italy:
  - *Torymus sinensis* emerged from 15 different oak galls, mainly *Andricus curvator* and *A. inflator*
  - confirms host-range expansion


BioControl (2015) 60:583–594
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Non-target host risk assessment for the parasitoid *Torymus sinensis*

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2017 – 2019

- Submit application for licence to release the non-native *Torymus sinensis* for the biological control of *Dryocosmus kuriphilus* in England

Emerald Ash Borer

A pest for which contingency plans should be drawn up so that immediate action can be taken should it occur in the UK.

Options for the UK:

- Prevent its introduction – unlikely?
- Eradication – initial detection is vital. Once dispersed eradication is impossible
- Management
  - Multifaceted approach and IPM to suppress EAB populations and slow dispersal
  - Chemical control (systemic pesticides e.g. emamectin benzoate)
  - Tree removal – can promote dispersal
  - Trap trees
  - Biological control (egg and larval parasitoids)
- Develop and implement a cohesive strategy involving most, if not all, of the components used in North America

Summary

- Multi lure traps being developed to monitor for wood boring beetles
- Tree injections using natural and conventional pesticides are being evaluated for pest and disease management in urban and high value trees
- The feasibility of a classical biological control programme using *Torymus sinensis* against *Dryocosmus kuriphilus* is being investigated
- Plans to prepare for the management of emerald ash borer once it arrives in the UK are in progress