Forest Research

How can we combat international movement of pests by trade?

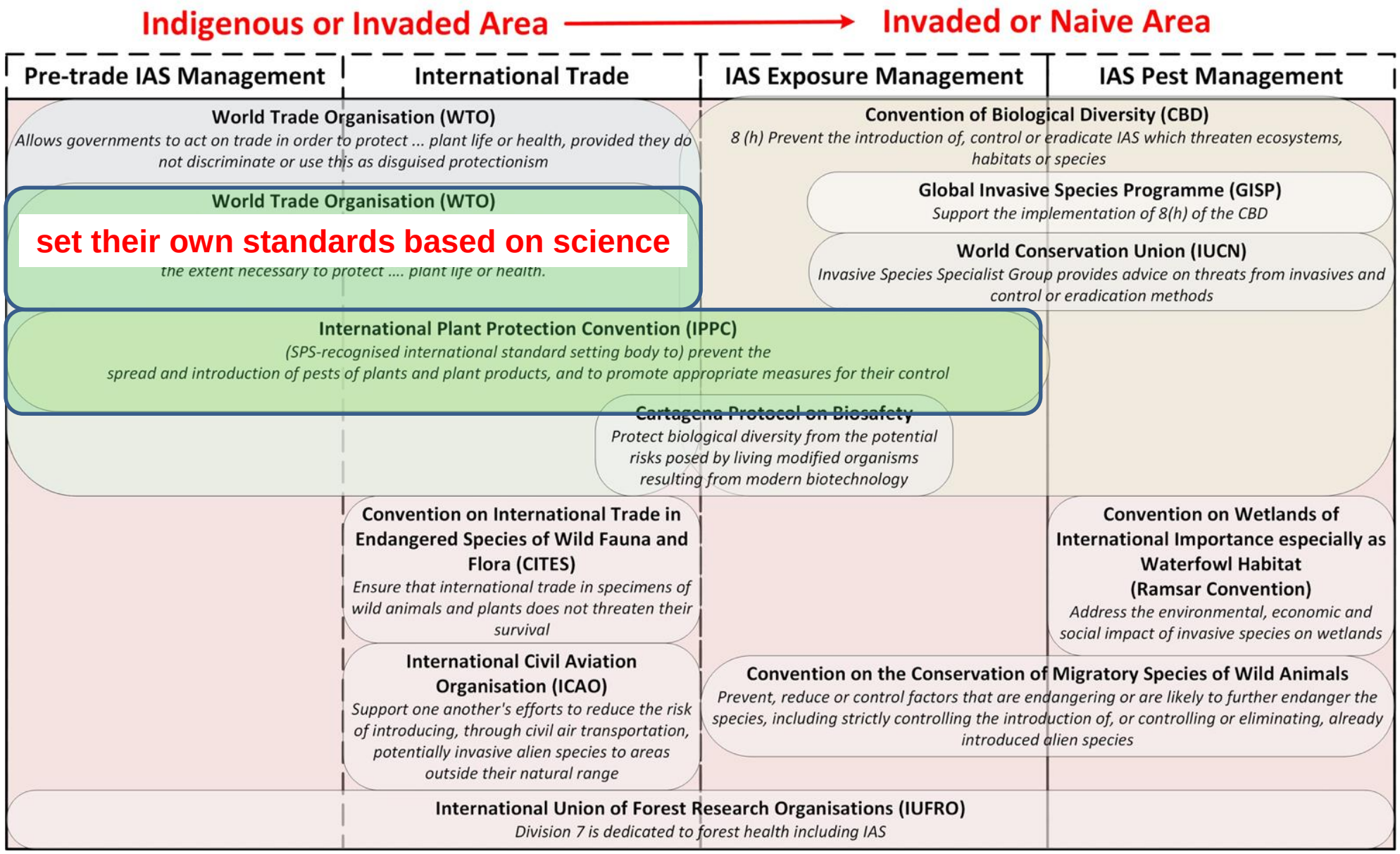
Professor Hugh Evans

Fellow of Forest Research, UK

Keeping forest pests out remains a very difficult problem!

- History of pest movements indicates that, despite international rules developed through the 20th and 21st centuries, new establishments continue
- A review by Mike Ormsby and Evan Brenton-Rule (Biol Invasions (2017) 19:3355–3364) provides a useful visual summary of the various global instruments developed to recognise and combat international movement of Invasive Alien Species (IAS)

Global instruments for managing IAS in forests: Ormsby & Brenton-Rule (2017)

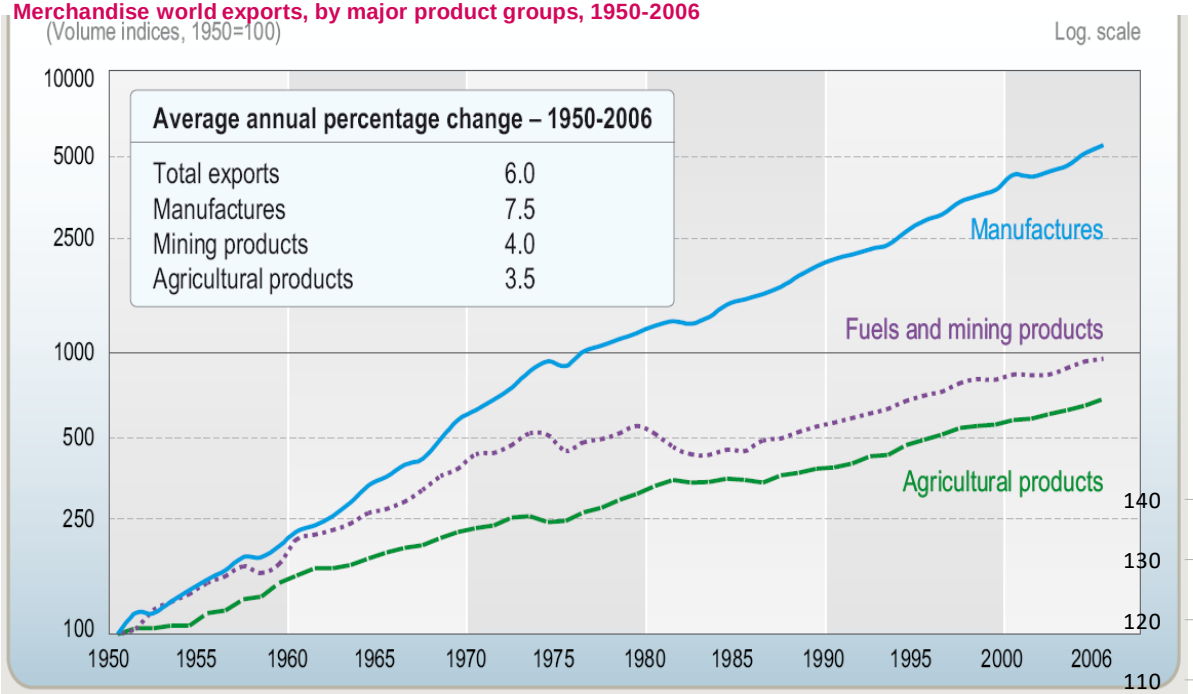


Global trade, climate change and international movement of forest pests: creating the ‘perfect storm’ for new damage to trees in new locations

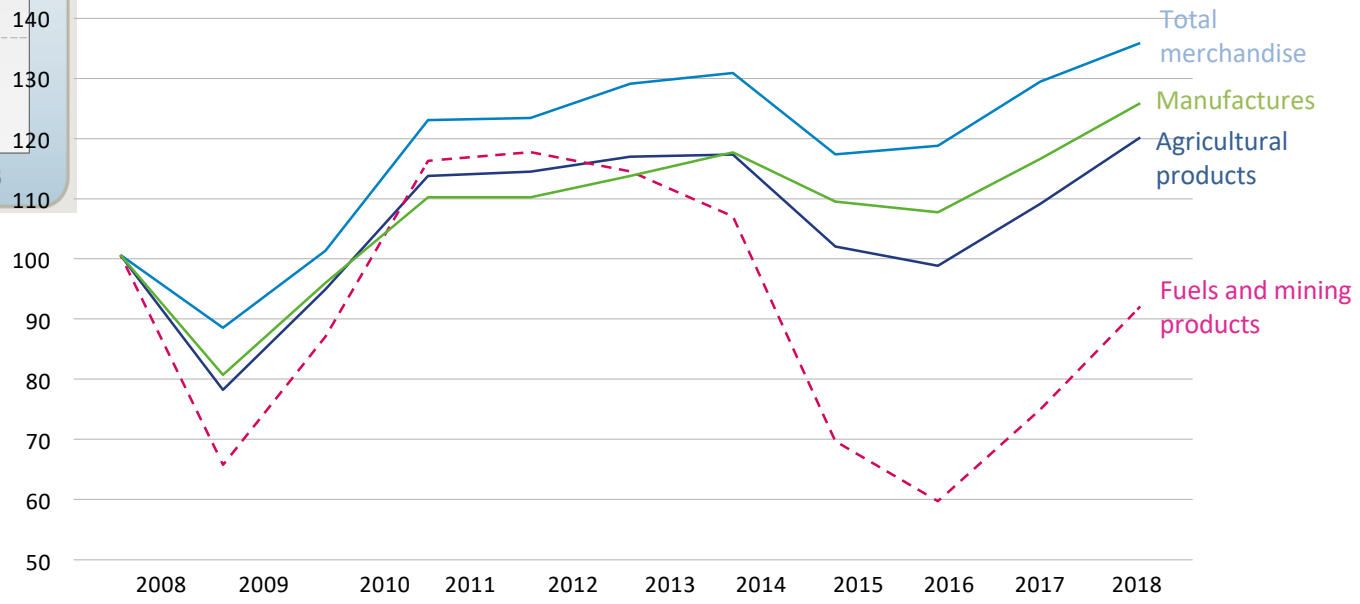
- **Opportunity** – global movement along pathways
- **Opportunity** – a range of exotic tree species as potential hosts after arrival
- **Opportunity** – climate change offers extended suitability for a wider range of species exploiting trees, but not all will benefit

Increasing global trade: opportunities for pests to move internationally

Merchandise world exports, by major product groups, 1950-2006

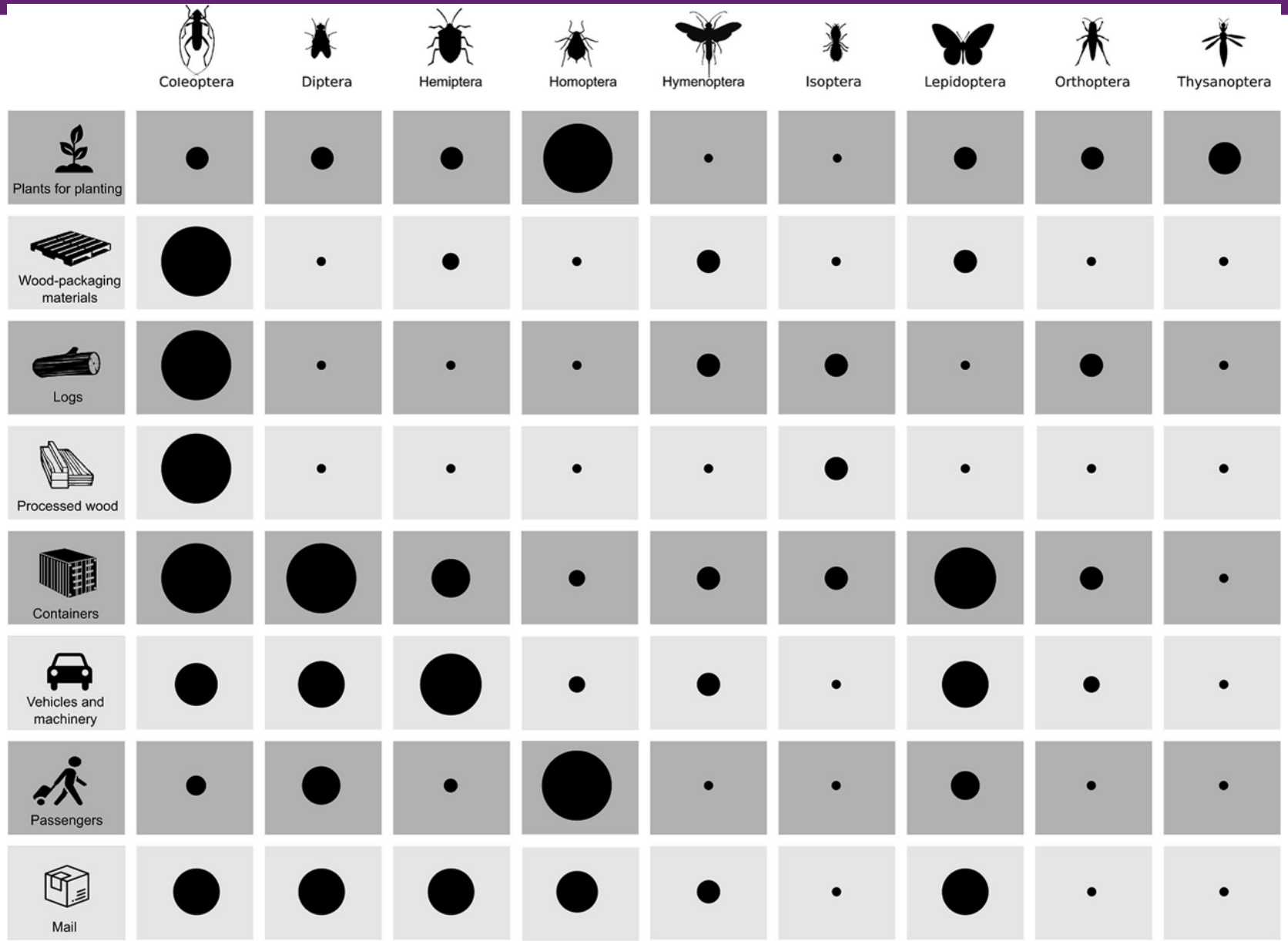


Merchandise world exports, by major product groups, 2008-2018
(Index 2008 = 100)



Pathways for international movement of pests: a key knowledge base

- There are many pathways for movement of a wide range of pests internationally
- An interesting recent analysis of global pest interceptions by Meurisse *et al* (Journal of Pest Science (2019) 92:13–27) summarised the relative densities of different orders of insects on each pathway; figure reproduced from their paper
- **Managing these pathways to minimise the risk of movement is not easy, despite the wide range of rules and procedures available**



Global trade cannot be inspected effectively

- Considering the volumes of global trade, the proportion of imports with wood present that can be inspected is extremely small
- This is made even more difficult because not all wood associated with trade can be identified for inspection at the points of entry
- Consequently, despite the wide range of 'rules' governing imports in relation to named pests, even a low level of inspection reveals a high level of pest importation

Importing country and commodities inspected (total number of interceptions) Data from Meurisse *et al*								
USA				Australia	Chile	EPPO (29 countries)		
All	Live plants	Wood	Airline baggage	Empty containers	WPM	All	Bonsai	Wood
1985-2001	2003-2010	1985-2001	1984-2000	1996	1995-1999	1995-2004		
577,343	17,758	7896	289,890	7426	1053	6734	281	478

Reducing the risks from invasive forest pests: Pest Risk Analysis (PRA)

- A structured procedure to assess the risks from pests and to develop mitigation measures to manage the threats
- Generally based on International Plant Protection Convention (IPPC) generic guidelines

Pest Risk Analysis (PRA)

- Outcome of PRA: normally production of a list of potentially dangerous pests
- Development of mitigation measures to keep the named pests out
- Contingency planning if a pest arrives
- These are partially effective
- BUT……

Failure of process: Pests move - globally
Most are not on lists!

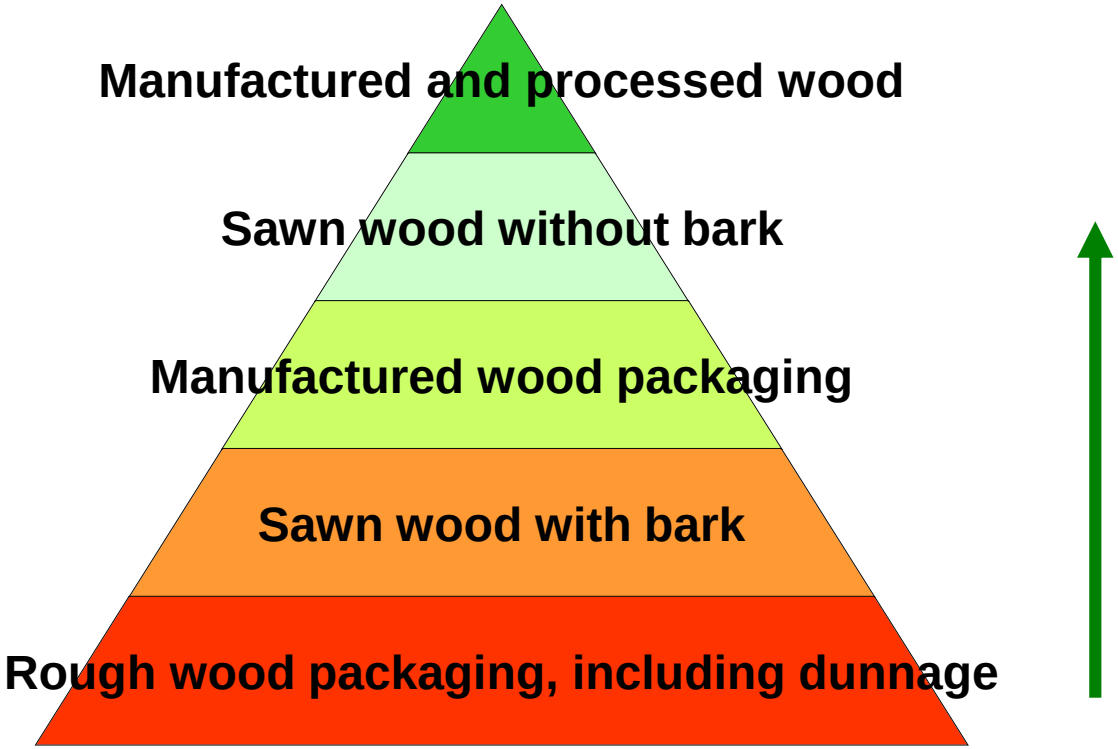
Lessons from failure of process

- Successful establishment of major pests not on lists before arrival in receiving country
  - *Anoplophora glabripennis*: USA, several EU countries. From Asia
  - *Agrilus planipennis*: USA, Russia. From Asia
  - *Megaplatypus mutatus*: Italy. From S America
  - *Dryocosmus kuriphilus*: USA, parts of Europe. From Asia
  - *Phytophthora ramorum*: USA, Europe. Origin unknown
  - *Phytophthora kernoviae*: Europe, NZ. Origin unknown
  - *Hymenoscyphus fraxineus*: Europe. From Asia?
  - *Xylella fastidiosa*: Parts of Europe. From the Americas
  - *Etc.*

Keeping as many pests out as possible.
Possible solution: manage the pathways generically

- The key aim – ***Manage once, remove many***
- Each pathway has a generic carrying potential for a range of pests
- Each process applied to the pathway has the potential to remove a range of pests with similar characteristics – a generic approach

Pathways: Risk profile of untreated wood



Manage once remove many?

Yes

Treatments (heat, fumigation, high temperature kiln drying, microwaves, etc.) remove most of the risk

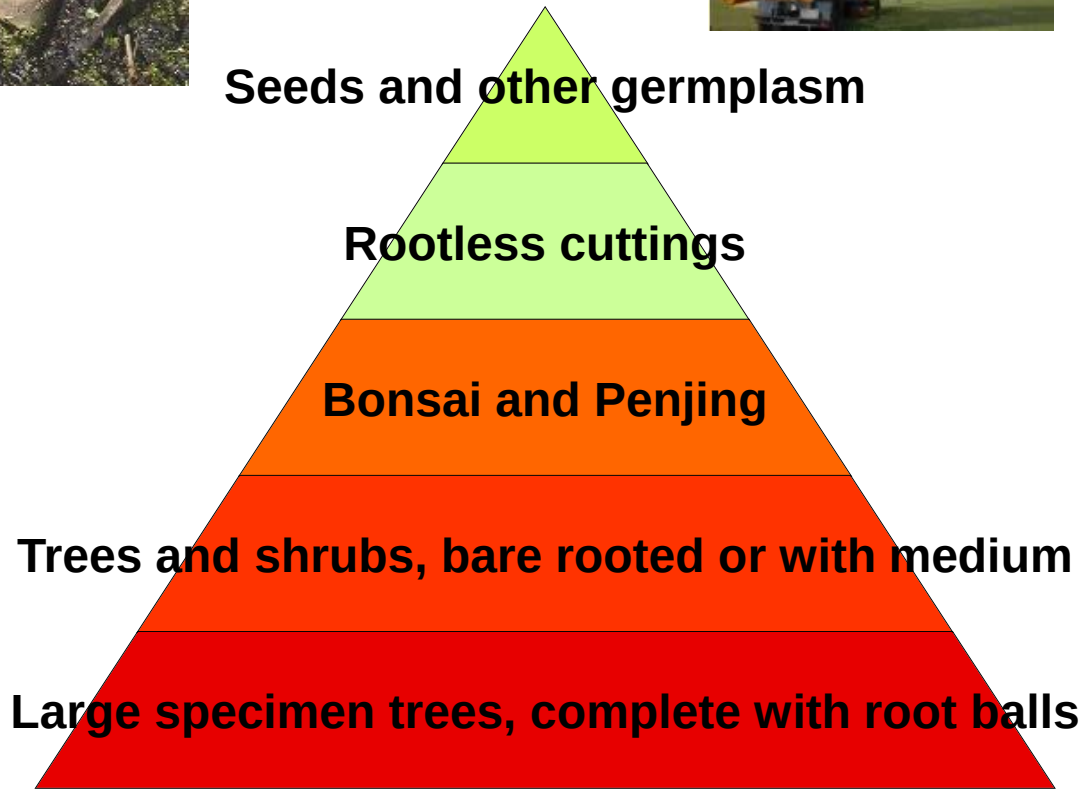
ISPM15 for wood packaging
An excellent example of a process-based solution to a previously highly dangerous pathway

Pathways: Risk profile of plants for planting

Manage once remove many?

Difficult

Direct treatment either not efficacious or not practical with increasing size of planting material



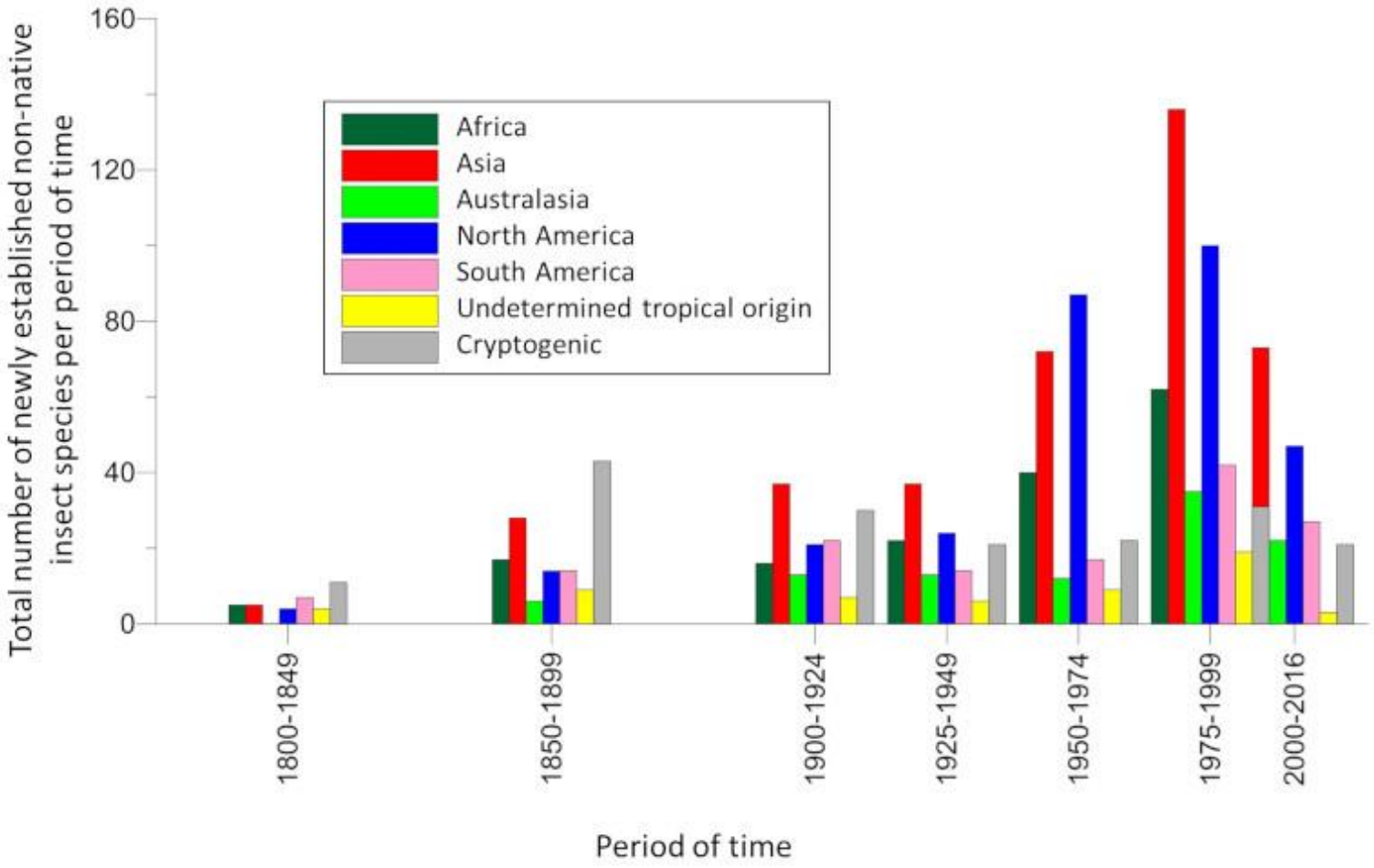
Living material plus soil/growing medium. There are too many unknowns – ***ecosystem in a pot****!*

For example ‘Place of production freedom from pests’: What do you list to be able to issue a phytosanitary certificate?

Prevention must remain the focus for reducing the threats from invasive forest pests; spending money on this pays dividends!

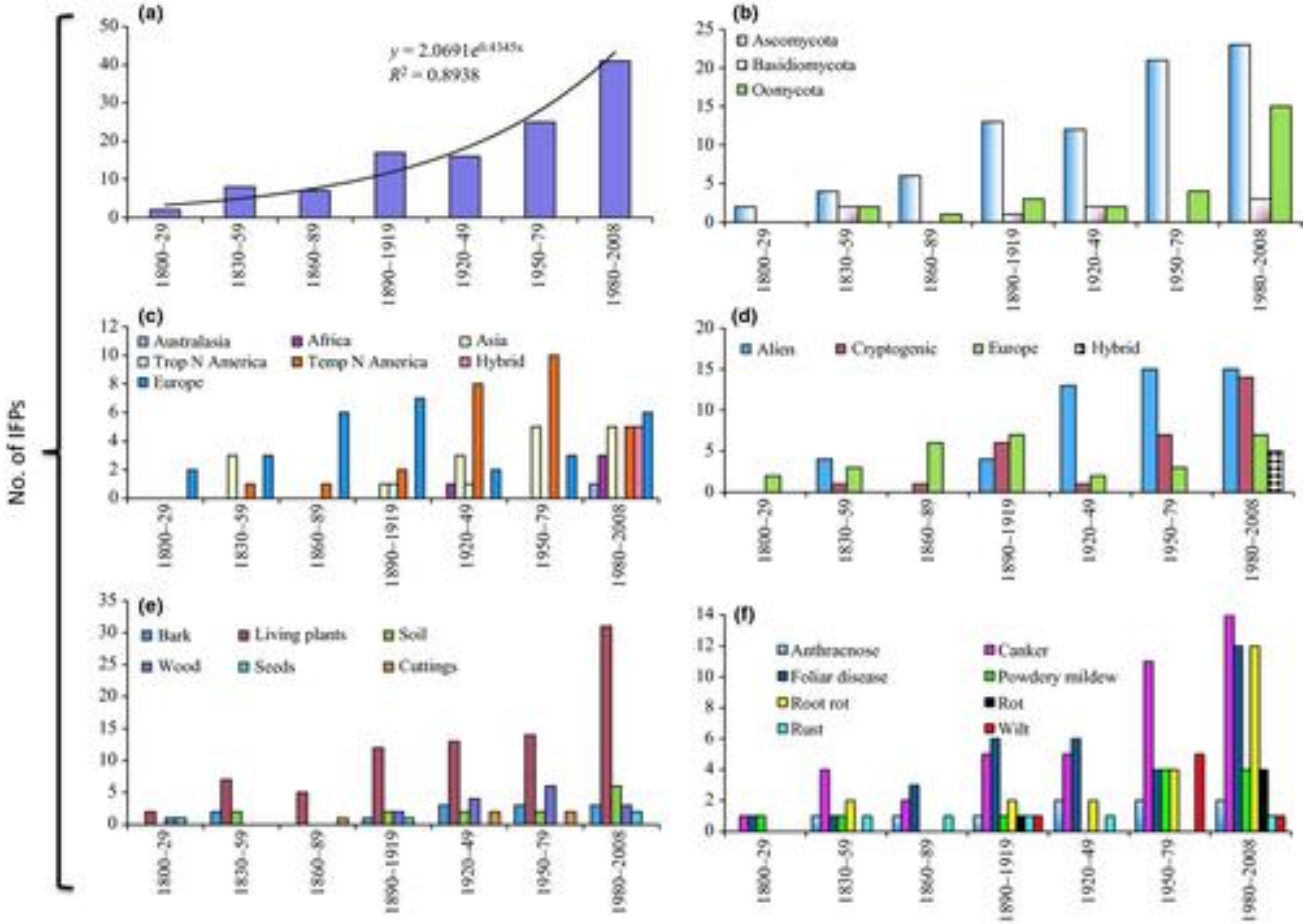
- For prevention, the emphasis must be on pathways and not on specific pests
- Application of one or more measures should aim to remove or prevent infestation by as many pests as possible; generic pest freedom
- A systems approach must account for both known and unknown pests that could move along the pathway

New insect establishments in Europe over time



ROQUES Alain, AUGER-ROZENBERG Marie-Anne (2019), Climate change and globalization, drivers of insect invasions, Encyclopedia of the Environment, [online ISSN 2555-0950] url : https://www.encyclopedie-environnement.org/en/life/climate-change-globalization-drivers-of-insect-invasions/

New pathogen establishments in Europe over time



Santini *et al* 2012 New Phytologist, Volume: 197, Issue: 1, Pages: 238-250, First published: 11 October 2012, DOI: (10.1111/j.1469-8137.2012.04364.x)

If prevention fails, the emphasis moves back from the pathway to the pest

- Early detection of pioneer populations of an invasive pest is key to management and for minimising impacts in the new environment.
- This poses the difficult question of how to survey for new pest infestations:
  - Pathway analysis for optimal surveillance has been developed for known pests (e.g. Yemshanov and colleagues for Asian longhorn beetle and emerald ash borer). This provides the basis for where to locate scarce survey resources for early detection.
- EFSA provides guidance and statistically valid protocols for survey, but not where to place the survey effort:
  - General survey guidelines
  - RiBESS+ manual available online (https://shiny-efsa.openanalytics.eu/)
  - Open access statistical tools include RiBESS+ and SAMPELATOR available online
- There is also guidance from EPPO as well as regulation from the EU. All have been pest-based up to now.

Sampling tools and management techniques

- A range of detection techniques available, such as pheromone traps, visual symptoms, etc., but all require a good knowledge of pest biology under the local climate and host tree conditions
- Detection of pests when there is no prior knowledge of their possible presence on pathways may require a generic surveillance approach such as multilures for bark and wood boring beetles, remote sensing, citizen science, etc
- Development of management regimes must include an early decision on whether eradication of a new infestation is feasible and, if not, what the longer term strategy will be
- Containment and 'living with the pest' are common options but require assessment of all available pest reduction tools:
  - Use of pesticides
  - Biological control
  - Silvicultural management

- PREPSYS project A-167 approved by Euphresco in July 2016 and had an official start date of 1 October 2016
- Partnership:
  - Forest Research - FR (UK): project coordinator Prof Chris Quine, science coordinator **Prof Hugh Evans** with Dr Mariella Marzano & Dr David Williams.
  - Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft - BFW (Austria): Dr Gernot Hoch and Ute Hoyer-Tomiczek
  - Department of Agriculture Food and the Marine - TEAGASC (Ireland): Dr Gerry Douglas and Dr Rachel Wisdom
  - Nederlandse Voedsel-en Warenautoriteit - NVWA (The Netherlands): Dr Antoon Loomans and Dr Martijn Schenk
  - United States Department of Agriculture, Animal and Plant Health Inspection Service – USDA APHIS: Dr Heike Meissner

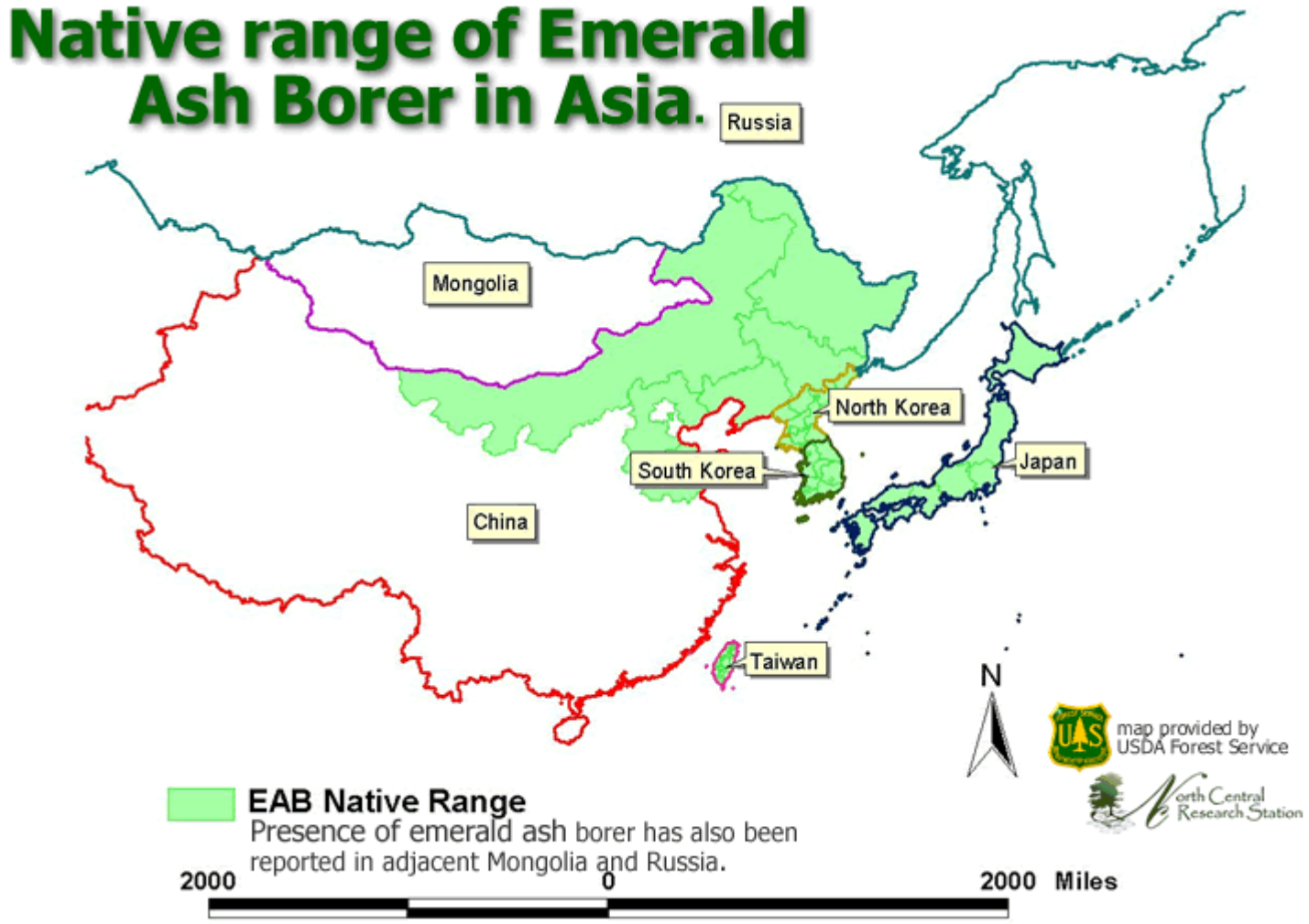
PREPSYS concentrates on two pests

- Formal title: *Risk-based strategies to prepare for and manage invasive tree borers*
- A UK Risk Register has been established for a very wide range of pests and pathogens (https://secure.fera.defra.gov.uk/phiw/riskRegister/)
- Among the >1000 organisms in the register, both emerald ash borer EAB (*Agrilus planipennis*) and bronze birch borer BBB (*Agrilus anxius*) are regarded as posing high risk to Europe

David Cappaert, Bugwood.org

Steven Katovich, USDA Forest Service, Bugwood.org

EAB – reasons to be concerned



Can we avoid this hindsight comment in Europe?

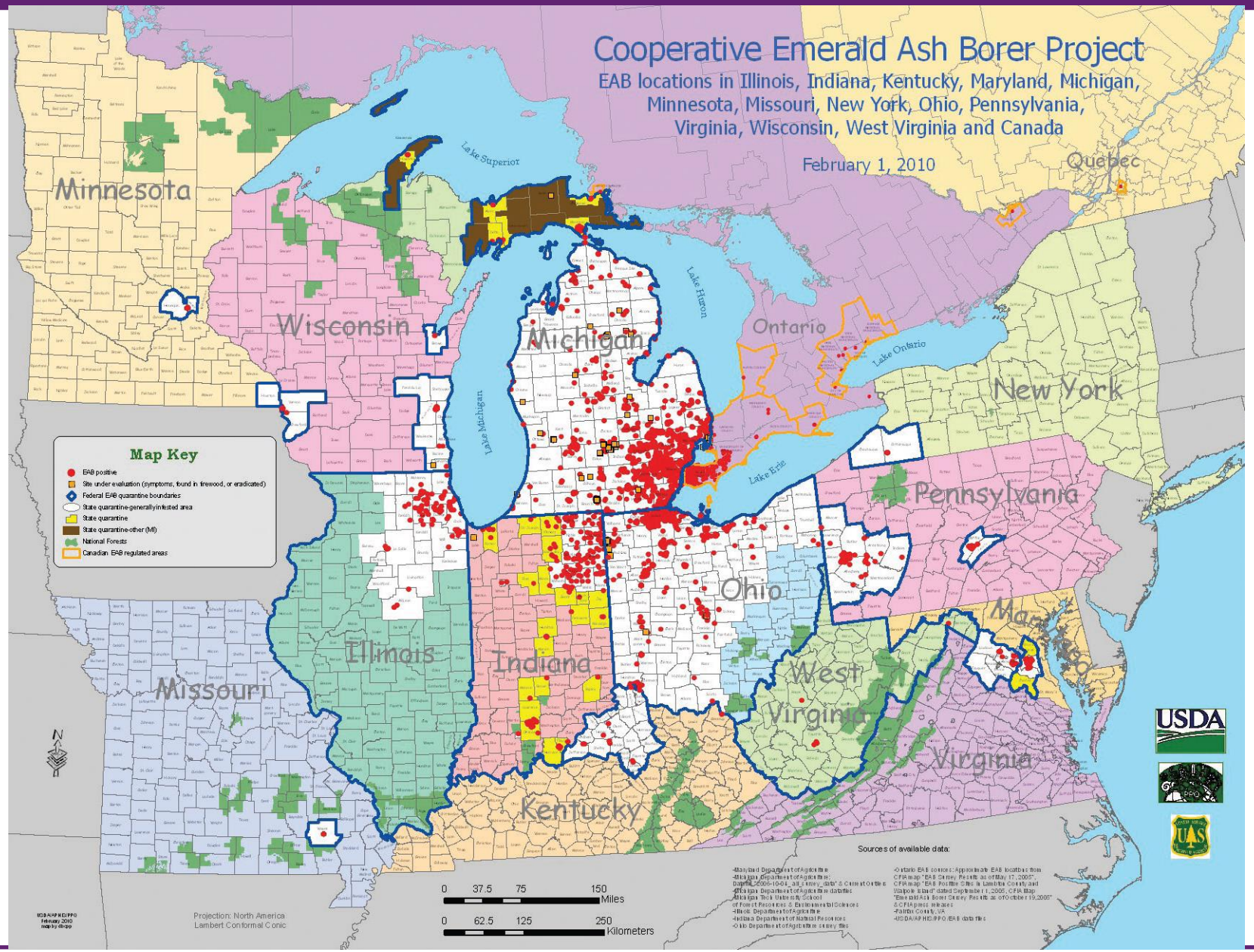
Quotes from press release:

"New research at Michigan State University shows that the uber-destructive emerald ash borer **arrived at least 10 years before it was first identified** in North America"

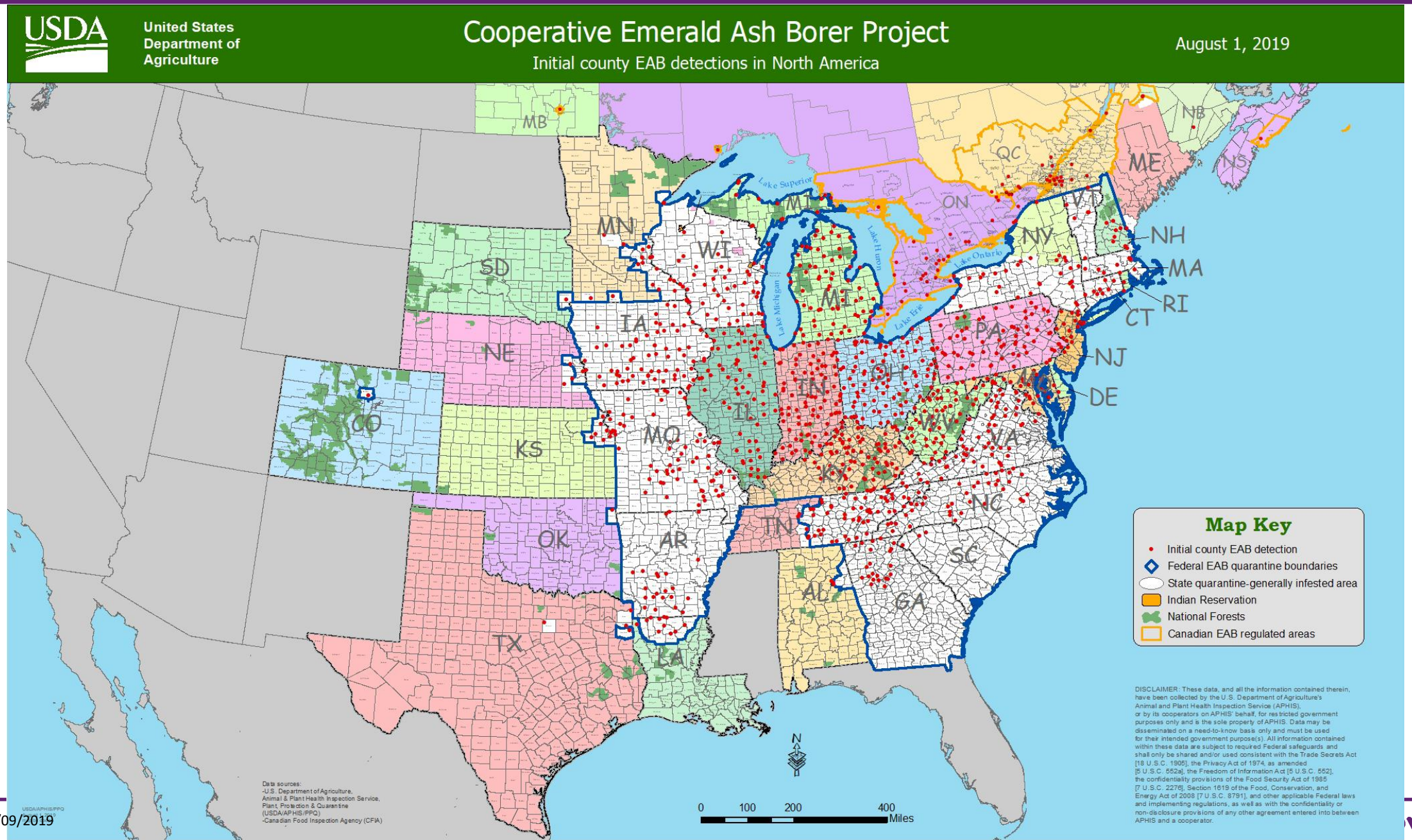
"EABs were feasting on ash trees in southeast Michigan by the early **1990s**, well before this pest was discovered in **2002**", said Deb McCullough, MSU professor of forest entomology.

Why are we not surprised!!

EAB – by 2010, spreading rapidly

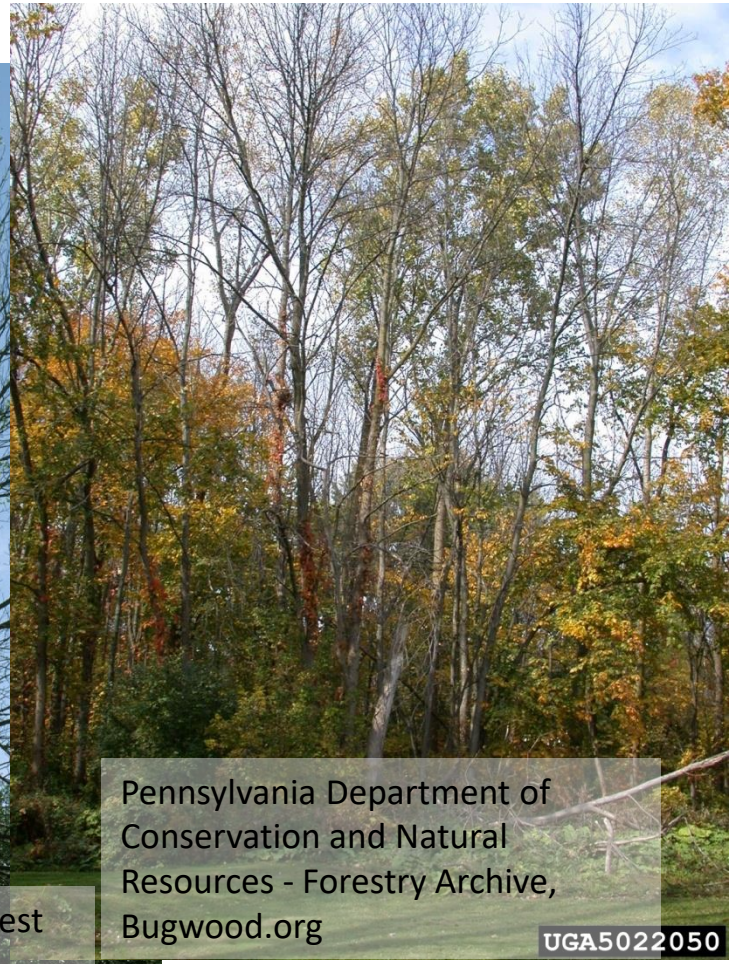


EAB – by 2019, accelerating. How much further?



Lessons learned: EAB is extremely destructive in North America

Initial thinning or yellowing of foliage (usually top of tree first) followed by tree death



Pathways for spread: how do the life stages move locally and 'long-distance'

- Larvae burrow through the bark after hatching and feed in the living cambium – sinuous tunnels.
- Four instars.
- Pre-pupae over winter.

EAB and BBB – characteristic signs; but too late!

Pupation takes place in the spring. Adults emerge through characteristic **D-shaped holes**, about 3 mm in diameter.

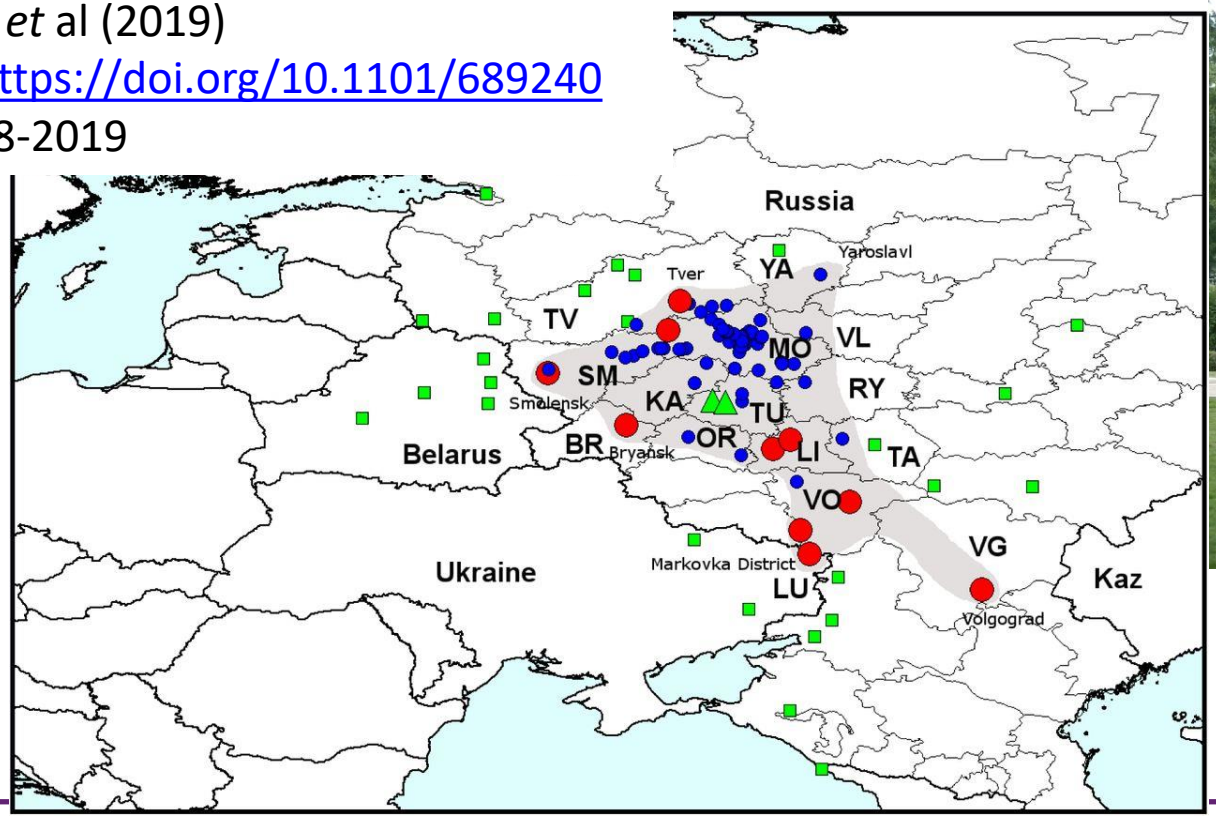
Debbie Miller, USDA Forest Service, Bugwood.org

EAB recent expansion in range: Russia and Ukraine

- Intensive surveys initiated in spring 2007 to assess the distribution of EAB in the Moscow region.
- EAB is distributed over the entire city, killing ash in parks and streets.
- Hundreds of dead trees felled but pest continues to spread; now >250 km west of Moscow.
- First evidence of mortality of *Fraxinus excelsior*.
- **No ecological barrier to further westward spread.**

Orolova-Bienkowskaja *et* al (2019)
bioRxiv 689240; doi: https://doi.org/10.1101/689240

● 2003-2017; ● 2018-2019



Agrilus anxius kills European birch even with low attack level

BBB poses a major threat to European birch woodlands

Trade in firewood and birch products represent potential pathways

European birch trees die quickly whereas native North American birches are rarely killed

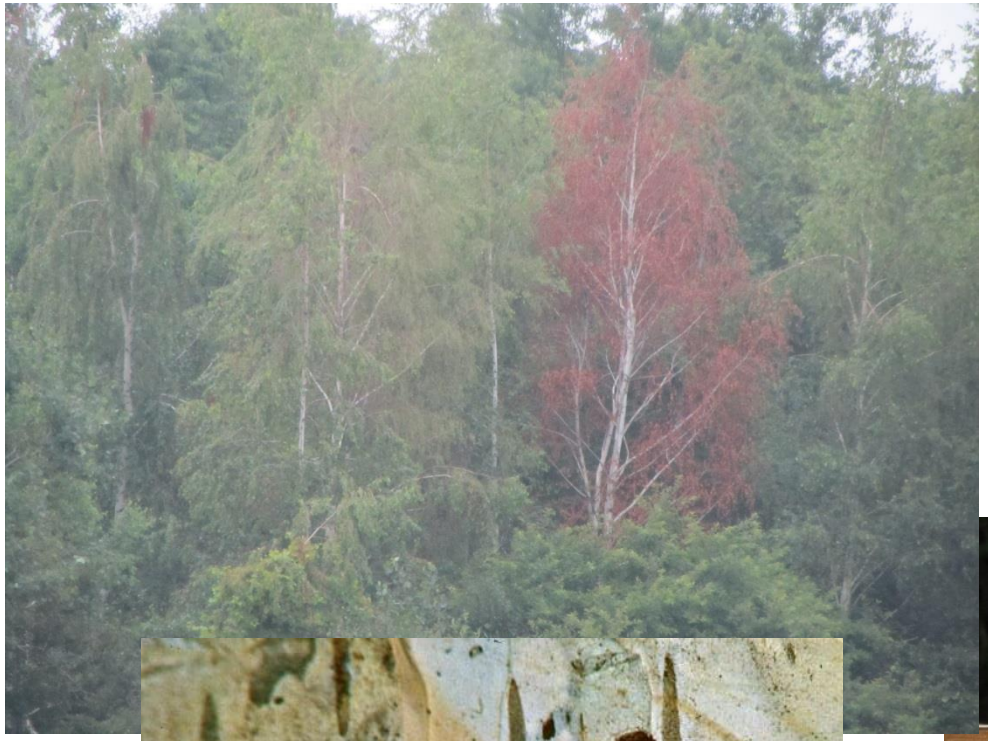
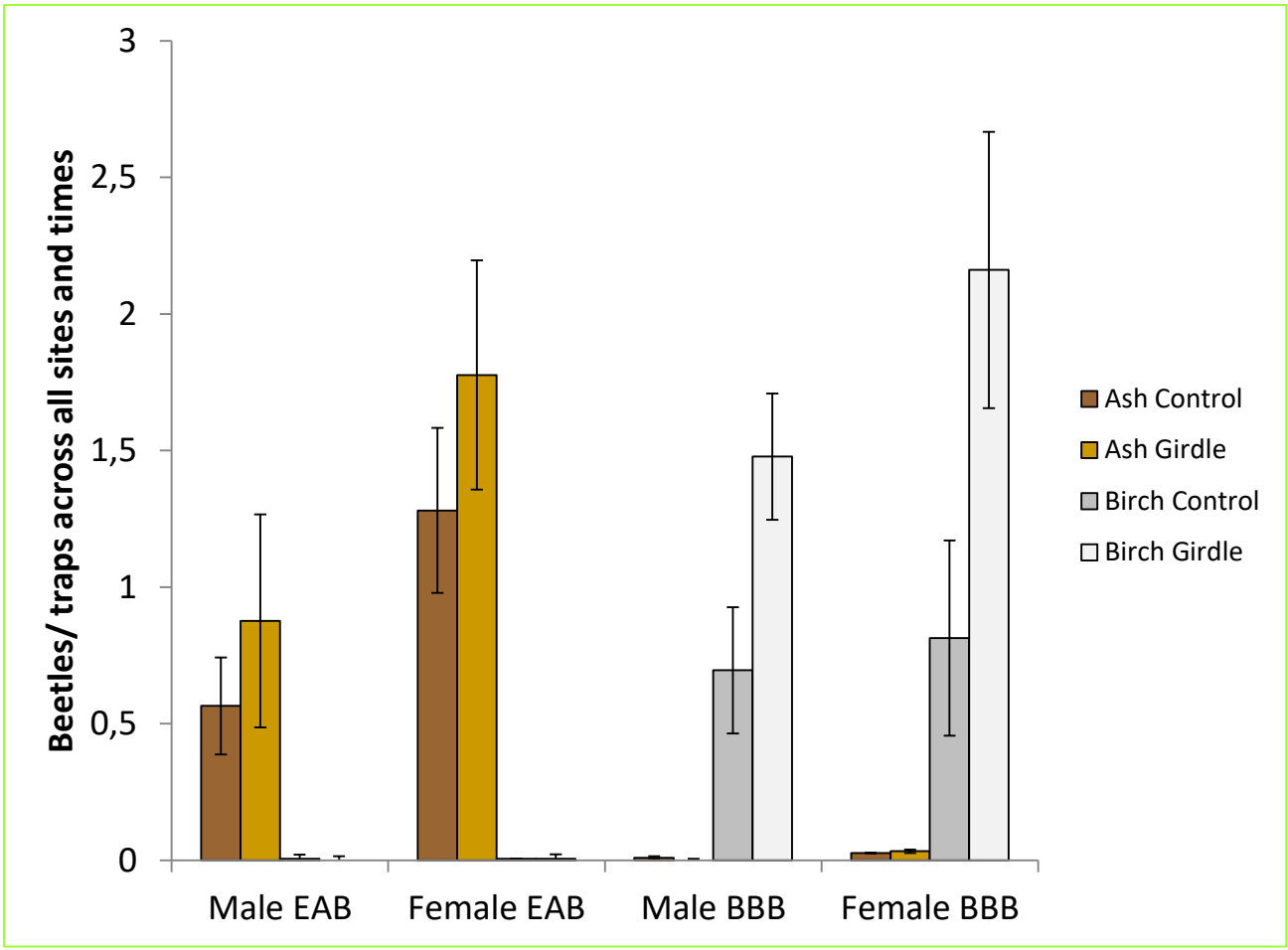


Photo by Steven Katovich, USDA Forest Service, Bugwood.org

Research with Claire Rutledge, Connecticut on lures for EAB and BBB

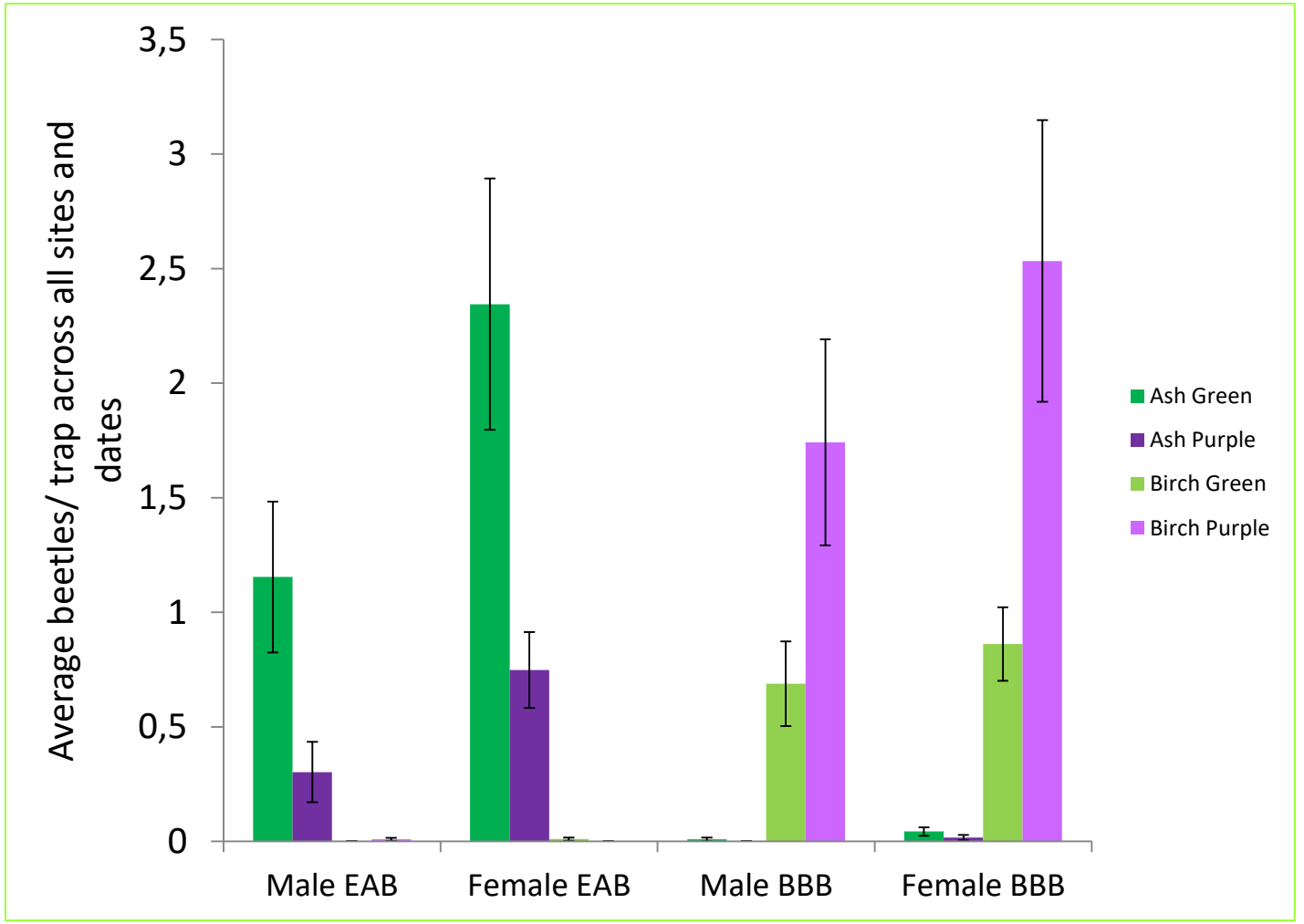
There were more BBB in traps on girdled trees than in traps on control trees. There was no difference for EAB, perhaps because most trees in the area are already infested with EAB.



EAB (male $F_{1,34}$ = 0.002, P = 0.963: female $F_{1,34}$= 1.496, P = 0.230)

BBB (male $F_{1.48}$= 14.41, P = 0.032: female F_{148} = 9.605, P = 0.003)

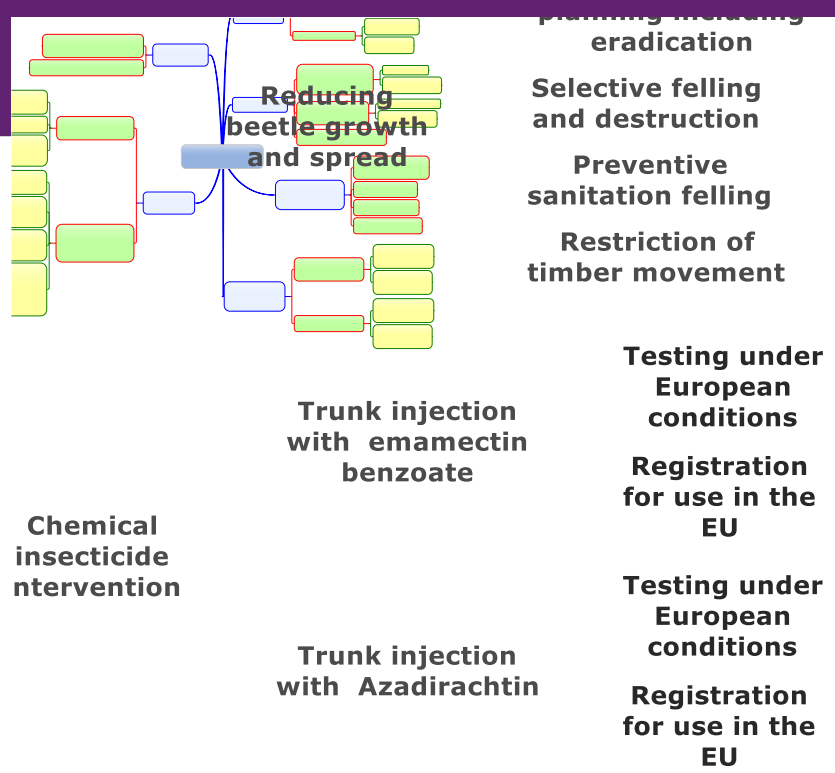
Response to trap types – EAB preferred green traps and BBB preferred purple traps



EAB $F_{1,34}$= 5.353, P = 0.027

BBB; $F_{1,54}$= 4.49, P = 0.039

- Fact-finding visits to Canada & USA in 2017 and to USA in 2018
- Very successful conference in Vienna in October, 2018
- Additional advances collaborative tests of lures with Claire Rutledge at CAES, USA in 2017 and 2018.
- North America is a key region for both EAB and BBB
- Many of the components of a potential Toolbox derive from work in North America and Russia



Information from the project

- Website: https://www.forestresearch.gov.uk/research/prepsys
- Vienna conference programme and presentations: https://bfw.ac.at/emeraldashborer
- Euphresco PREPSYS information: https://zenodo.org/record/1326235#.XXEwIjqP7IW
- Special issue of Forestry: An International Journal of Forest Research to be published in 2020 (17 papers)

Conclusions on threats to our forests from international movement of pests

- Pest lists have value, but many pests not on previous lists are moving and establishing globally
- Efforts are now concentrating on how to reduce risks generically so that both known and unknown pests are removed during a given process
- This has been done, through ISPM15, for a previously highly dangerous pathway – wood packaging

Conclusions

- A very difficult challenge is how to manage the greater complexity and pest-carrying capacity of **Plants for Planting**
- The process is to remove/prevent as many pests as possible through successful application of the *manage once remove many* concept
- Concerted international action is addressing this aim
- Education of end users is also important; if people want to buy instant mature trees, they contribute to the problem of moving pests internationally!

To sum up for dealing with the many organisms moving in international trade:

“as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know”.

Donald Rumsfeld

Thanks for your attention!

With thanks to the organisers for inviting me and to Defra for funding UK input to the PREPSYS project

See our website for further information:
www.forestresearch.gov.uk/prepsys