Improving knowledge, skills and capacity building to ensure plant health in more sustainable agricultural systems

Pre-emptive biological control and preparedness against priority biosecurity threats

Neil Audsley, Fera Science Ltd

EUROPEAN YEAR OF SKILLS

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3-11 June 2023

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Introduction

- Non-native invasive species threaten global biodiversity and food security
- Cause substantial economic costs (>US$100 billion annually)
- Approximately 480,000 non-native species have been introduced into different ecosystems worldwide
- Threat posed is increasing due to the globalisation of trade, tourism and climate change
- Measures have been introduced for prevention and early detection of invasive species
- However, management tends to be reactive once the pest arrives and an outbreak is discovered
- If eradication is unsuccessful, strategies switch to managing the risk by population suppression and slowing its spread

Spotted winged drosophila
© Fera Science Ltd

Emerald ash borer
© J. Stokes

Asian longhorned beetle

https://www.invasivespeciescentre.ca/invasive-species/meet-the-species/invasive-insects/asian-long-horned-beetle/

Japanese beetle

https://ipm.missouri.edu/pestmonitoring/jb/identification.cfm

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Classical biological control

- Deliberate introduction of a non-indigenous biological control agent (BCA)
- Over 6000 introductions of BCAs world-wide to control insect pests since the late 1800s
- Recognised as a key strategy to manage invasive insect pests

Torymus sinensis © C. Malumphy

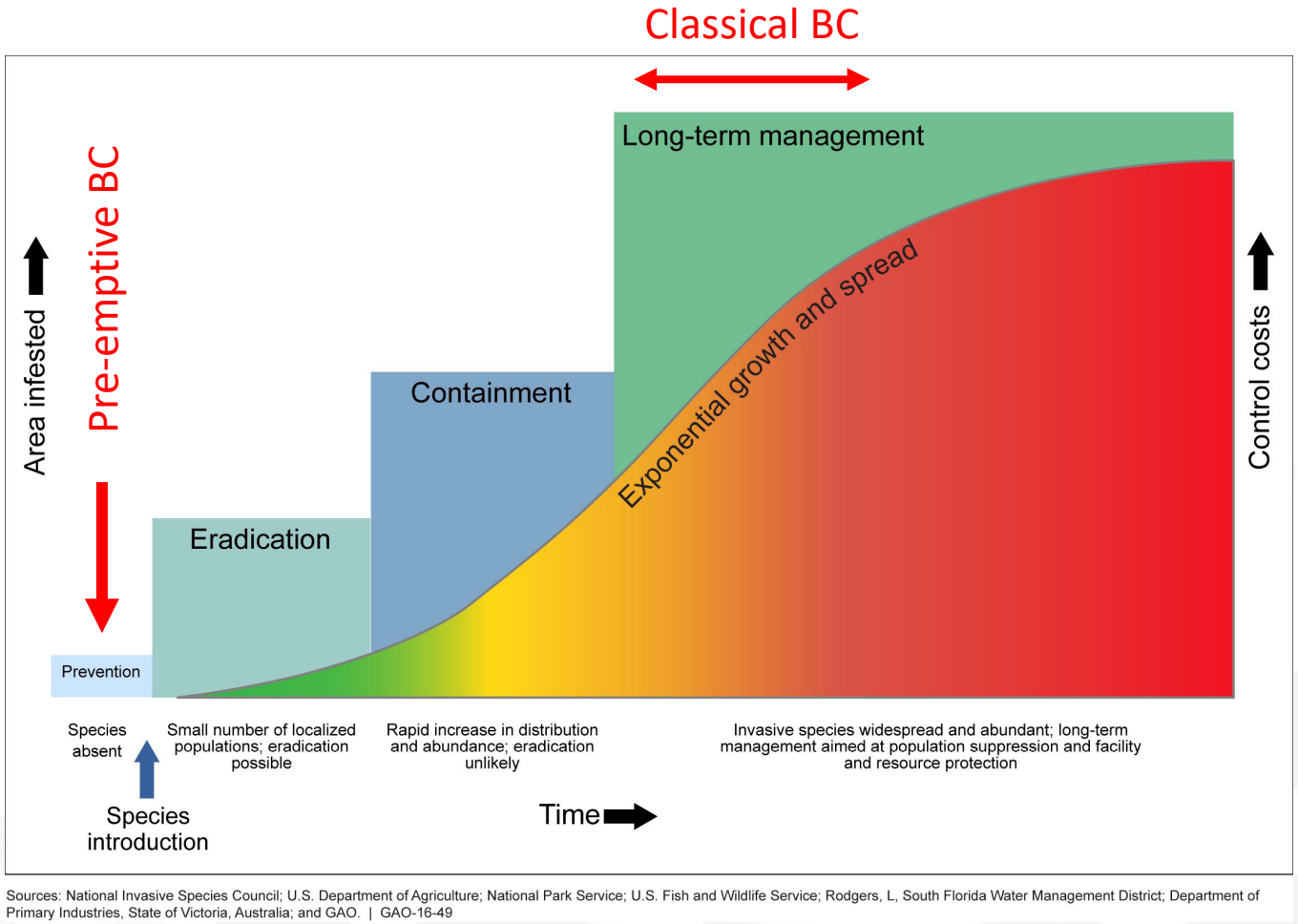
- Subject to regulatory measures including rigorous risk assessment and review process
- May take years before approval is granted allowing the pest population to build and spread
- Post-release evaluations are also needed to evaluate the establishment, spread and impact of the BCA release

Important to identify future risks and to prepare for managing those risks to help mitigate the impact that the establishment of an invasive species has on native ecosystems

Pre-emptive classical biological control

- A novel approach -usually wait for pest to arrive first.
- Effective preparedness for a potential invasion.
- Candidate BCAs screened and pre-approved before pest arrival.
- CBC could be started much earlier in the management programme

Invasion curve for invasive species



Sources: National Invasive Species Council; U.S. Department of Agriculture; National Park Service; U.S. Fish and Wildlife Service; Rodgers, L, South Florida Water Management District; Department of Primary Industries, State of Victoria, Australia; and GAO. | GAO-16-49

Pre-emptive biological control

Original thinking... applied

Importance of pre-emptive risk assessment recognised by the authorities in New Zealand and England

- The New Zealand Environmental Protection Authority has approved the conditional release of a parasitic wasp *Trissolcus japonicus* for the control of the brown marmorated stink bug *Halyomorpha halys*, in the event of the incursion and establishment of this pest.

BioControl (2019) 64:367–379
https://doi.org/10.1007/s10526-019-09949-x

Experimental assessment of the biosafety of *Trissolcus japonicus* in New Zealand, prior to the anticipated arrival of the invasive pest *Halyomorpha halys*

J. G. Charles · G. A. Avila · Kim A. Hoelmer · Sophie Hunt · Robin Gardner-Gee · Frances MacDonald · Vicky Davis

https://entomologytoday.org/2019/01/10/brown-marmorated-stink-bug-management-scientists-look-up/

- The Department for Environment, Food and Rural Affairs is funding work to prepare for the management of emerald ash borer *Agrilus planipennis* in advance of an incursion into Britain including preparing licence applications for the release of four exotic parasitic wasps for the classical biological control of this invasive beetle.

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Euphresco project

fera
Original thinking... applied

Preparedness in biological control of priority biosecurity threats

- 2-year project, June 2021-June 2023
- 17 partners from 12 countries (Europe – 10, Australia and New Zealand)
- Led by Fera Science Ltd (UK) and The New Zealand Institute for Plant & Food Research Limited

Neil Audsley Gonzalo Avila

Aim:

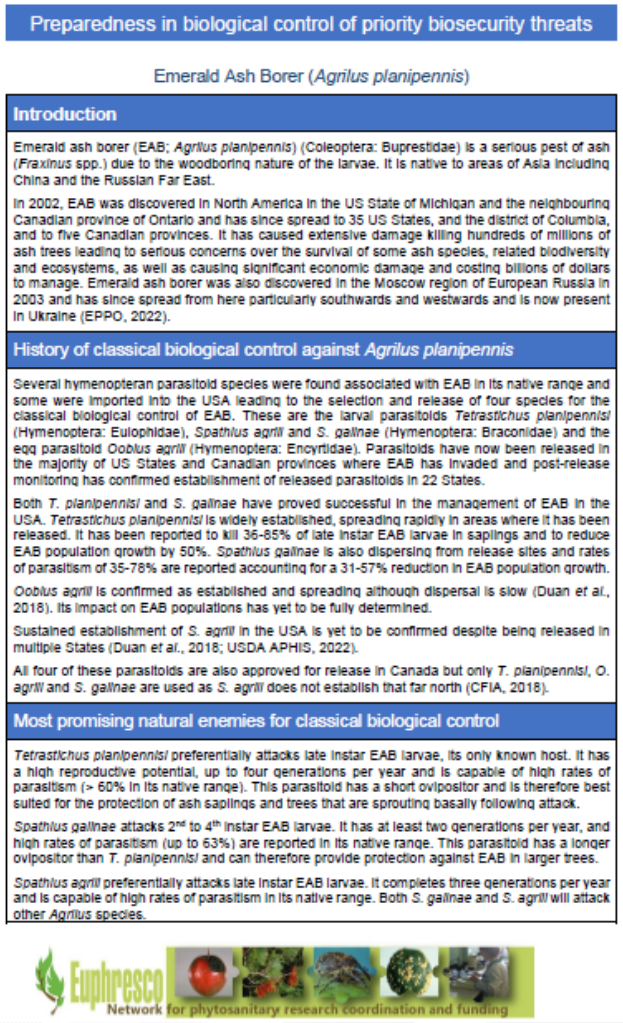
To establish a biological control network to share knowledge and information on priority biosecurity threats and BCAs to increase preparedness for incursions of invasive invertebrate species

Objectives:

1. Review priority pests and the potential for pre-emptive classical biological control options
2. Produce a standard to assess feasibility to conduct pre-emptive risk assessment for the introduction of BCAs
3. Establish a network and repository for the exchange of information

Fact sheets for priority pests

- Partners identified 74 priority pest risks (non-native species)
- Most significant pests selected
  - 12 Coleoptera
  - 6 Diptera
  - 5 Hemiptera
  - 8 Lepidoptera
- BCAs for priority pests selected for pre-emptive risk assessments



Preparedness in biological control of priority biosecurity threats

Emerald Ash Borer (*Agrilus planipennis*)

Introduction

Emerald ash borer (EAB; *Agrilus planipennis*) (Coleoptera: Buprestidae) is a serious pest of ash (*Fraxinus* spp.) due to the woodboring nature of the larvae. It is native to areas of Asia including China and the Russian Far East.

In 2002, EAB was discovered in North America in the US State of Michigan and the neighbouring Canadian province of Ontario and has since spread to 35 US States, and the district of Columbia, and to five Canadian provinces. It has caused extensive damage killing hundreds of millions of ash trees leading to serious concerns over the survival of some ash species, related biodiversity and ecosystems, as well as causing significant economic damage and costing billions of dollars to manage. Emerald ash borer was also discovered in the Moscow region of European Russia in 2003 and has since spread from here particularly southwards and westwards and is now present in Ukraine (EPPO, 2022).

History of classical biological control against *Agrilus planipennis*

Several hymenopteran parasitoid species were found associated with EAB in its native range and some were imported into the USA leading to the selection and release of four species for the classical biological control of EAB. These are the larval parasitoids *Tetrastichus planipennisi* (Hymenoptera: Eulophidae), *Spathius agrili* and *S. galinae* (Hymenoptera: Braconidae) and the egg parasitoid *Oobius agrili* (Hymenoptera: Encyrtidae). Parasitoids have now been released in the majority of US States and Canadian provinces where EAB has invaded and post-release monitoring has confirmed establishment of released parasitoids in 22 States.

Both *T. planipennisi* and *S. galinae* have proved successful in the management of EAB in the USA. *Tetrastichus planipennisi* is widely established, spreading rapidly in areas where it has been released. It has been reported to kill 36-85% of late instar EAB larvae in saplings and to reduce EAB population growth by 50%. *Spathius galinae* is also dispersing from release sites and rates of parasitism of 35-78% are reported accounting for a 31-57% reduction in EAB population growth.

Oobius agrili is confirmed as established and spreading although dispersal is slow (Duan *et al.*, 2018). Its impact on EAB populations has yet to be fully determined.

Sustained establishment of *S. agrili* in the USA is yet to be confirmed despite being released in multiple States (Duan *et al.*, 2018; USDA APHIS, 2022).

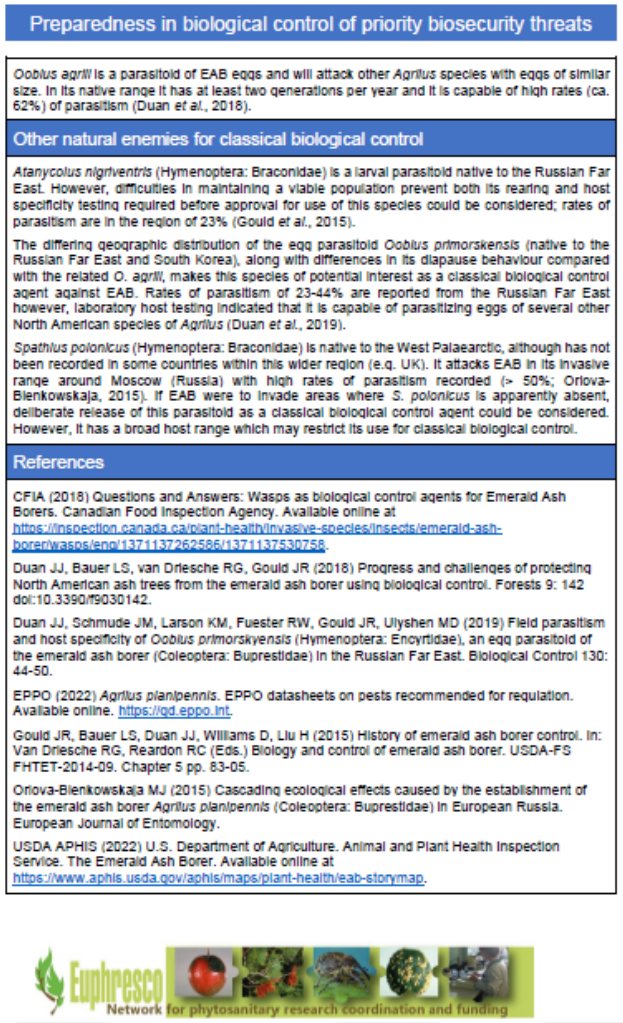
All four of these parasitoids are also approved for release in Canada but only *T. planipennisi*, *O. agrili* and *S. galinae* are used as *S. agrili* does not establish that far north (CFIA, 2018).

Most promising natural enemies for classical biological control

Tetrastichus planipennisi preferentially attacks late instar EAB larvae, its only known host. It has a high reproductive potential, up to four generations per year and is capable of high rates of parasitism (> 60% in its native range). This parasitoid has a short ovipositor and is therefore best suited for the protection of ash saplings and trees that are sprouting basally following attack.

Spathius galinae attacks 2nd to 4th instar EAB larvae. It has at least two generations per year, and high rates of parasitism (up to 63%) are reported in its native range. This parasitoid has a longer ovipositor than *T. planipennisi* and can therefore provide protection against EAB in larger trees.

Spathius agrili preferentially attacks late instar EAB larvae. It completes three generations per year and is capable of high rates of parasitism in its native range. Both *S. galinae* and *S. agrili* will attack other *Agrilus* species.



Preparedness in biological control of priority biosecurity threats

Oobius agrili is a parasitoid of EAB eggs and will attack other *Agrilus* species with eggs of similar size. In its native range it has at least two generations per year and it is capable of high rates (ca. 62%) of parasitism (Duan *et al.*, 2018).

Other natural enemies for classical biological control

Atanycolus nigriventris (Hymenoptera: Braconidae) is a larval parasitoid native to the Russian Far East. However, difficulties in maintaining a viable population prevent both its rearing and host specificity testing required before approval for use of this species could be considered; rates of parasitism are in the region of 23% (Gould *et al.*, 2015).

The differing geographic distribution of the egg parasitoid *Oobius primorskensis* (native to the Russian Far East and South Korea), along with differences in its diapause behaviour compared with the related *O. agrili*, makes this species of potential interest as a classical biological control agent against EAB. Rates of parasitism of 23-44% are reported from the Russian Far East however, laboratory host testing indicated that it is capable of parasitizing eggs of several other North American species of *Agrilus* (Duan *et al.*, 2019).

Spathius polonicus (Hymenoptera: Braconidae) is native to the West Palaearctic, although has not been recorded in some countries within this wider region (e.g. UK). It attacks EAB in its invasive range around Moscow (Russia) with high rates of parasitism recorded (> 50%; Orlova-Bienkowskaja, 2015). If EAB were to invade areas where *S. polonicus* is apparently absent, deliberate release of this parasitoid as a classical biological control agent could be considered. However, it has a broad host range which may restrict its use for classical biological control.

References

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Guidelines for pre-emptive risk assessment

Guidelines to assess the feasibility of starting pre-emptive risk assessment of classical biological control agents

Avila G, Caron V, Lesieur V, Seehausen L, ...

September 2022

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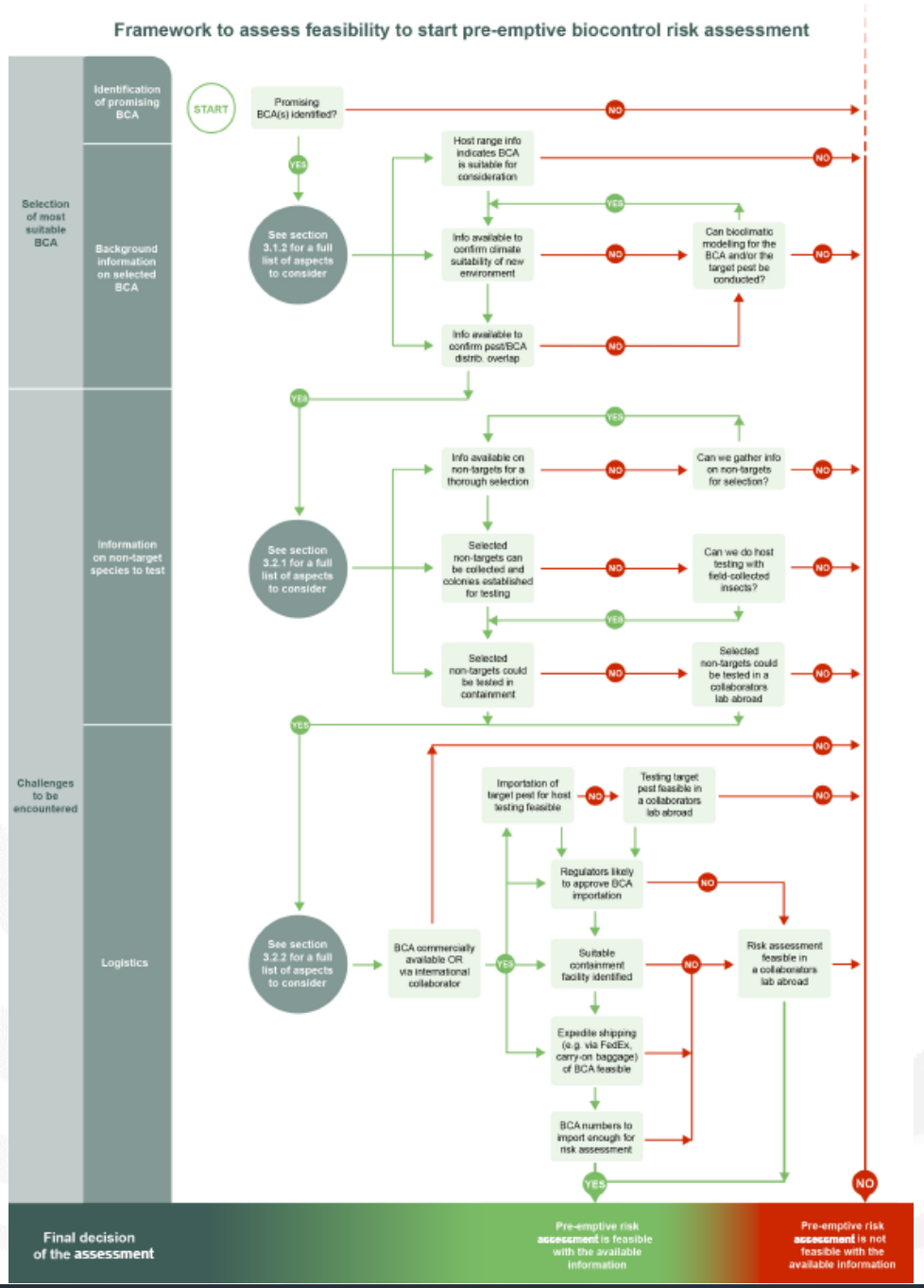
Decision framework



- Guidelines and decision framework to be published
- Will include examples of feasibility studies

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Feasibility to start pre-emptive biocontrol risk assessment

Two-lined chestnut borer *Agrilus bilineatus*

OUTCOME: pre-emptive risk assessment for *phasgonophora sulcata* not feasible with the available information.

Reasons for decision:

- Its univoltinism, solitary parasitism and delayed larval development will prevent the rearing of large numbers of *P. sulcata* which is an important consideration for mass rearing and release of a BCA.
- Climate modelling for *P. sulcate* required, but uncertainty whether sufficient data is available
- *P. sulcata* is not commercially available and currently no source of BCA to provide data for pre-emptive risk assessment

Potato psyllid *Bactericera cockerelli*

OUTCOME: Pre-emptive risk assessment for *Tamarixia triozae* is feasible with the available information.

- Recommended to complete the modelling studies to assess suitability of *T. triozae* to the UK climate before proceeding to pre-emptive risk assessment.

Biocontrol network

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fera Original thinking... applied

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