



# Ranking priority plant pests and diseases their preparedness activities

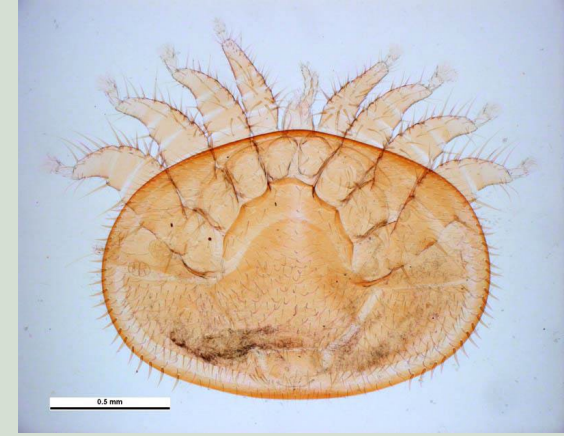
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# Current situation in Australia



- Plant pests: *any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products* (IPPC)
- Significant worldwide damages to biodiversity, food systems, and the economy
- **Australia faces increasing entry pressure from many plant pests and diseases**
  - Economy reliant on productive ecosystems (hosts) and global trade networks (dispersal)
  - Disturbed native ecosystems at risk from novel incursions
  - High climatic variability, including large swathes of temperate and Mediterranean climates
  - Global plant pests continue to rise with climate change and human-mediated dispersal
  - Exemplified by establishments of myrtle rust, fall armyworm, and varroa mite this century

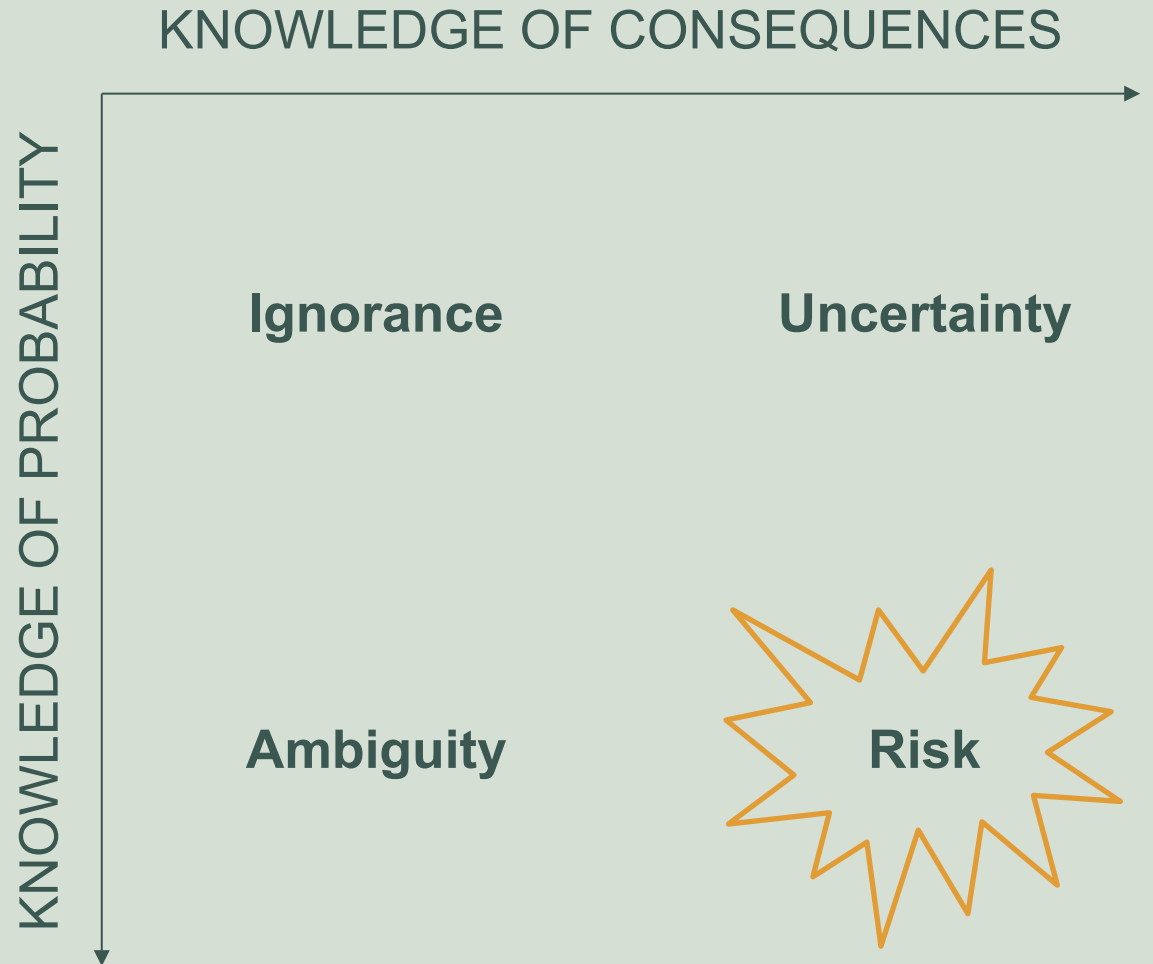
# Global pest risk analysis frameworks

- Global pest risk analysis (PRA) frameworks (ISPMs 2, 11, 21)
  - EPPO PRA scheme (European Union), NAPPPFAST and GIRAF (USA)
  - Australia - Weed Risk Assessment tool (Pheloung et al. 1999), Industry Biosecurity Plans, Exotic Environmental Pest List, National Priority Plant Pests and National Strategies
- **Implemented frameworks are based on expert knowledge elicitation (EKE) – but experts disagree!**
  - Major knowledge gaps in PRA
  - Liable to biases and risk-averse assessments
  - EKE cannot answer key questions



# Risk assessments

- *The relation between the estimated and true risk is unknown (Hulme, 2010).*
- **Interlinked quantitative models to rank priority plant pests and diseases**



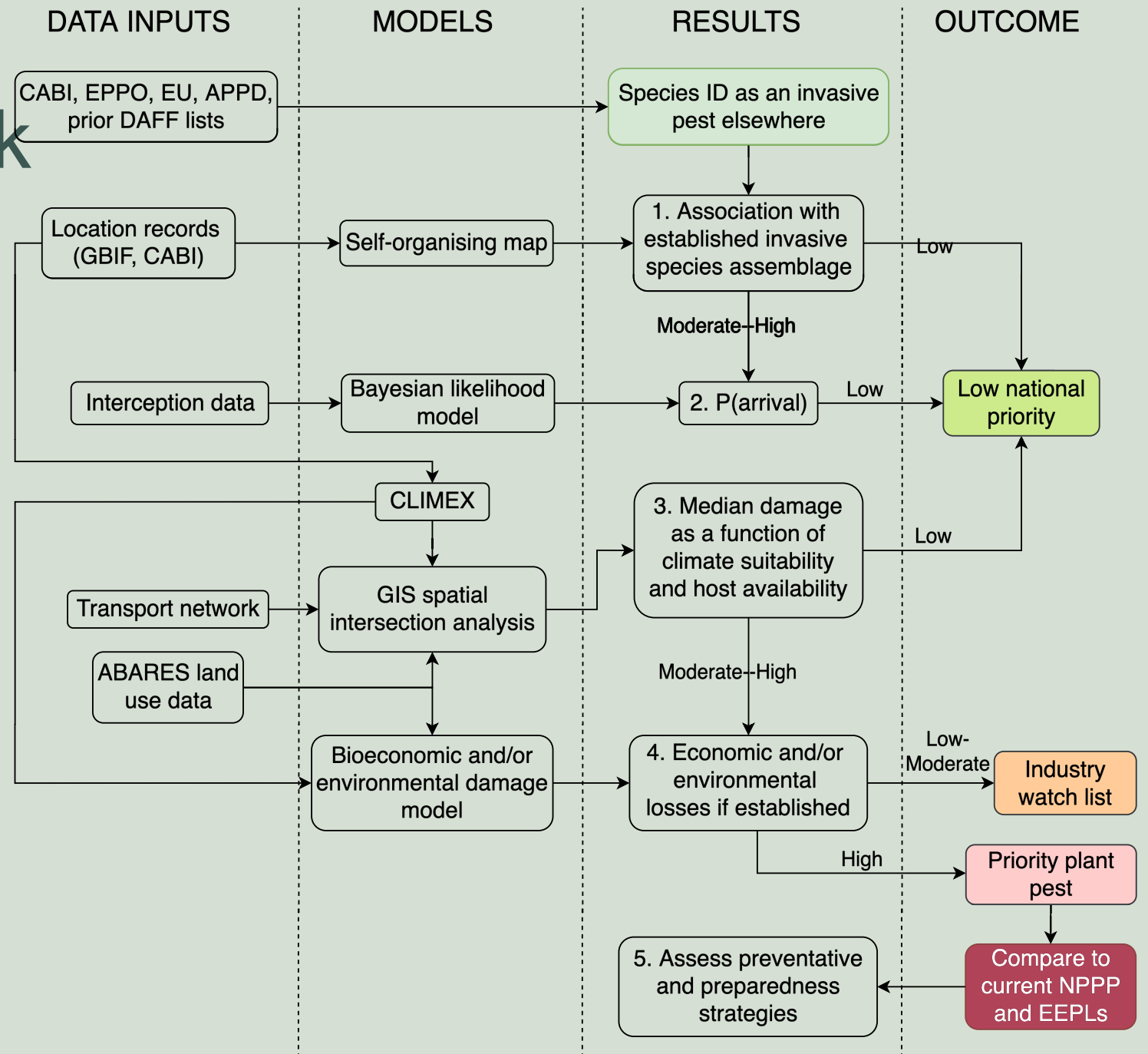
# Current PRA and risk mitigation and project purpose

*Screening: Is it an exotic plant pest?*

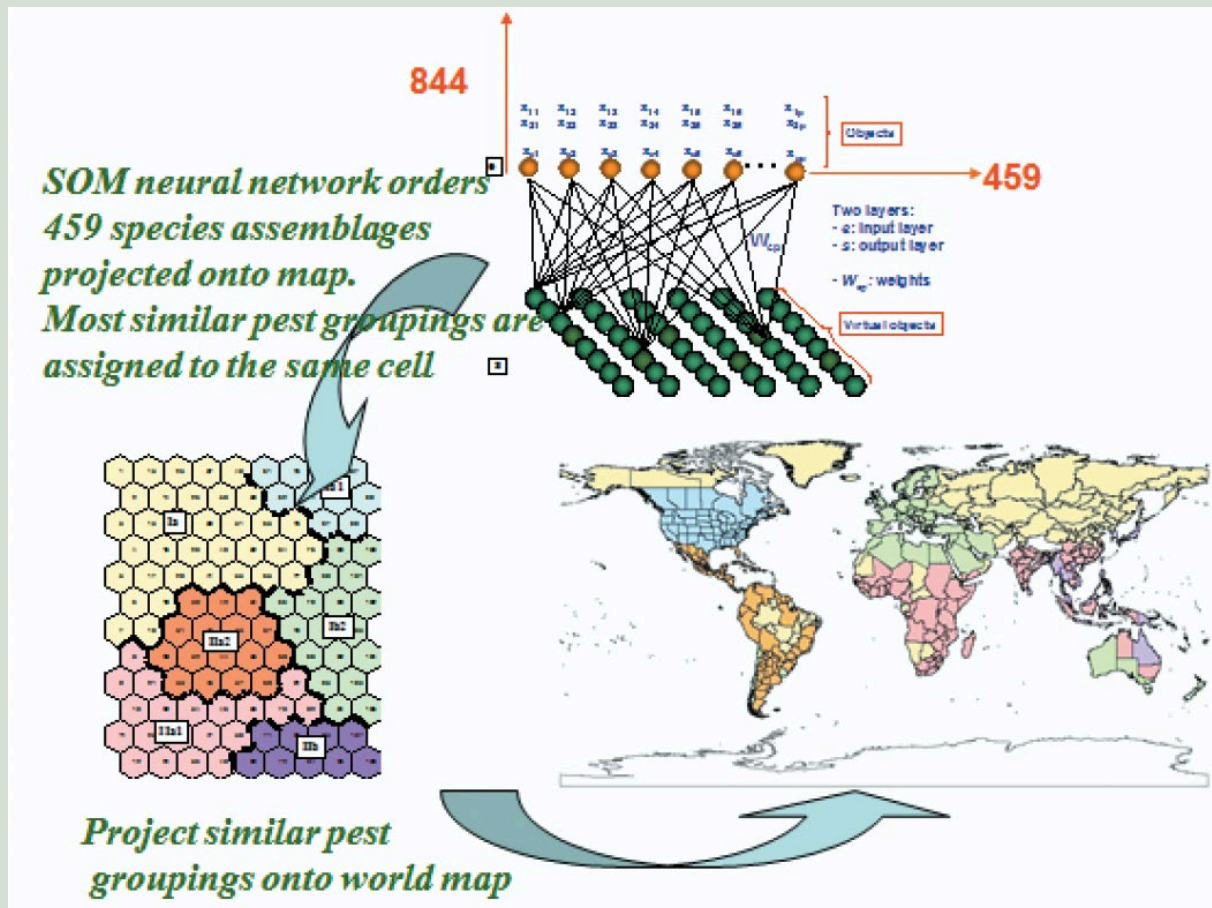
$$\begin{array}{l} \text{Risk =} \\ \text{Probability} \\ \times \\ \text{Consequence} \end{array} \left\{ \begin{array}{l} 1. \text{ Is the climate suitable for establishment of the pest?} \\ 2. \text{ How likely is the pest to arrive in a suitable area?} \\ 3. \text{ What would be the likely scale of economic impacts?} \end{array} \right.$$

# Project framework

- Interlinked models to rank priority plant pests and diseases
- Direct estimates of likelihood and consequences



# Association with established invasive pest assemblages



- Climate defines plant and insect distributions (Sutherst and Maywald, 1985) => Regions with similar pest assemblages have similar climates (Worner et al., 2013)
- Data from EPPO, CABI, GBIF
- Köppen-Geiger analysis to explicitly define pest assemblages by climate
- **Ranked climatic associations of thousands of pests on a macro scale for:**
  - Australia as a whole
  - **Climatic regions in Australia**

# P (Arrival)

- **Border interception data tell us what is found, not what isn't found!**
- Very little association between at-border interceptions and post-border detections (Caley et al., 2015)

- Model arrival rates based on uninformed priors of detection rates

- Number of arrivals of a given plant pest  $i$  in Australia defined as

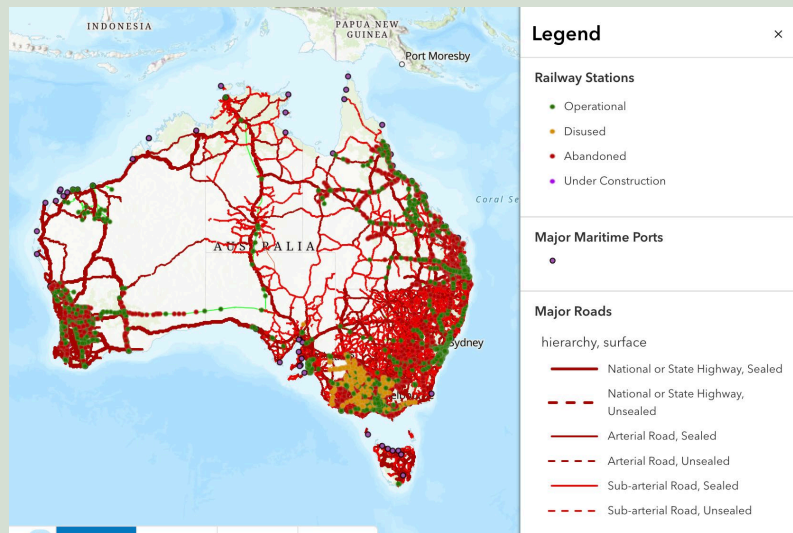
$$n \sim \text{Poisson}(\lambda_i \times p_i \times E_i)$$

- $\lambda_i$ : true arrival rate
  - Further log-scaled modelling of global baseline arrival, random effect for group (insect order, host type, or source region), species-specific predictors etc.
- $p_i$ :  $P(\text{detection})$
- $E_i$ : survey effort as no. inspections of relevant cargo over a time period

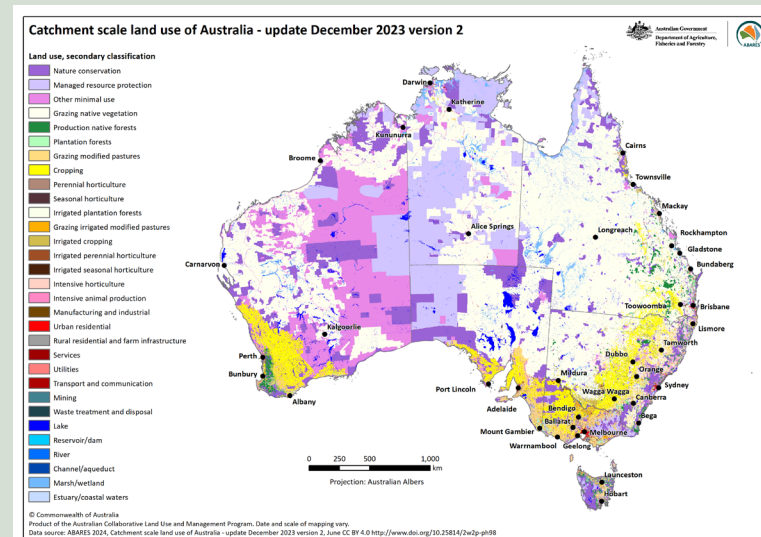
# Access to areas with suitable climate and hosts

## Spatially-specific pest establishment likelihood via GIS (Venette et al., 2010; Baker et al., 2012)

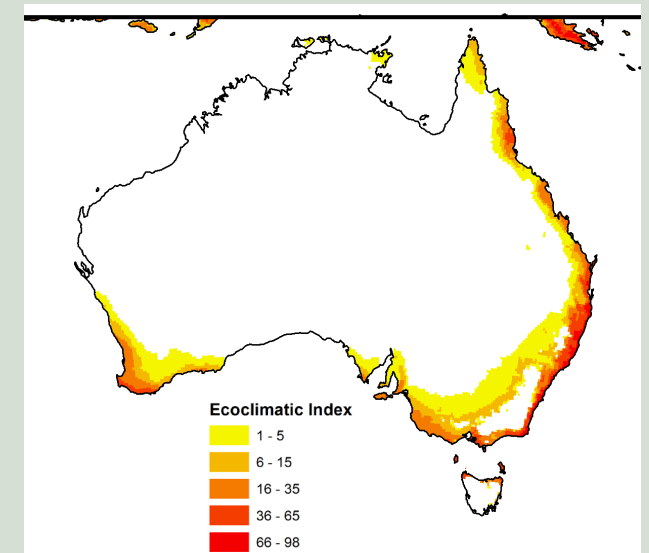
- Internal transport network x pest-specific natural dispersal capacity
- ABARES land use data of plant host availability
- Climate suitability (CLIMEX Ecoclimatic Index and Growth Index)



Australia's Transport Network, Digital Atlas Australia 2025



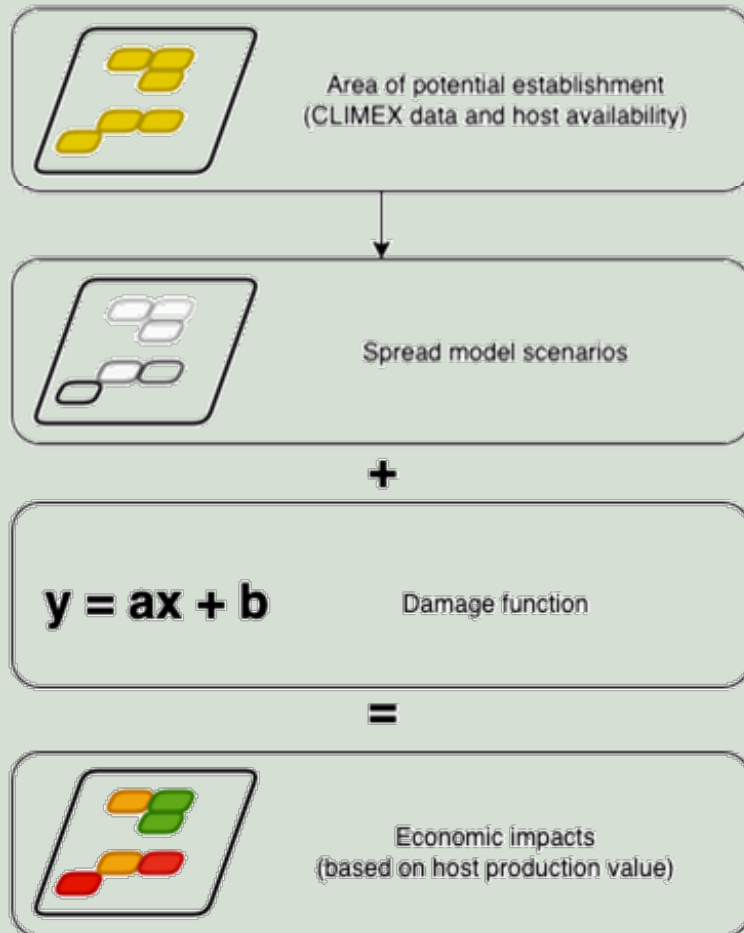
ABARES 2024



CLIMEX EI of *Austropuccinia psidii* sensu lato in Australia (Kriticos et al. 2013)

# Bioeconomic assessment of potential losses

## Bioeconomic spread and impact model



- Model spread rates (Kehlenbeck et al., 2012; Robinet et al., 2012) and host damage % (Kriticos et al., 2013) as a function of pest EI for case study species
- = **Estimates of best-case, median, and worst-case economic damages**

# Benefits

## **What the framework provides:**

- Start-to-end model framework for any pest, on any pathway, in any region
- Full framework can be deployed much more rapidly than traditional assessments
- Reproducible results with clear real-world evidence

## **Where to after?**

# Pest risk management options

## **We cannot realistically prevent pest entry forever.**

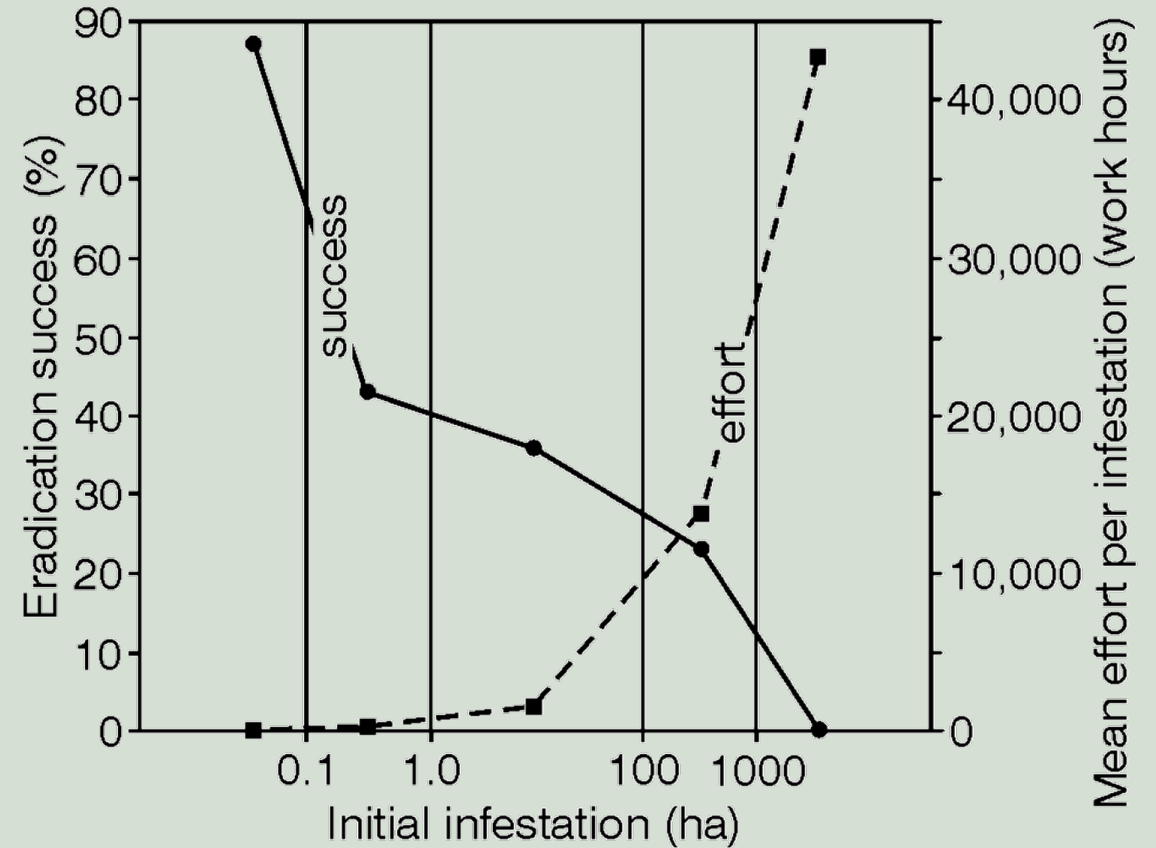
- Many established species were never detected at the border (Caley et al. 2015)
  - Detection and surveillance programs are useful but insufficient to prevent establishments
- Preparedness and management \$\$ must < potential \$\$ losses of doing nothing
  - Consideration of discount rates

## **So what do we do?**

- Assess and develop pre-emptive biological control options where possible
  - New Zealand development of BMSB biocontrol options
- Eradication only when criteria for life history, climate, and invaded area are met
- Define slow the spread strategies based on life history for rapid implementation

# Economic requirements for eradication

- Eradicate incursions of <1 ha
  - 1 in 3 successes of 1-1 000 ha
  - 1 in 4 successes >1 000 ha at exorbitant cost/ha
- **Success factors:**
  - Host specificity
  - Low genetic variation
  - Low climate suitability (~1 generation)
  - Little to no independent movement
  - Rapid and aggressive grower response
  - Small geographic area (islands)



When is eradication a realistic goal? (Rejmánek and Pitcairn 2002)



# Thank you!

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