# Wood borer & bark beetle risk analysis, surveillance costs & benefits

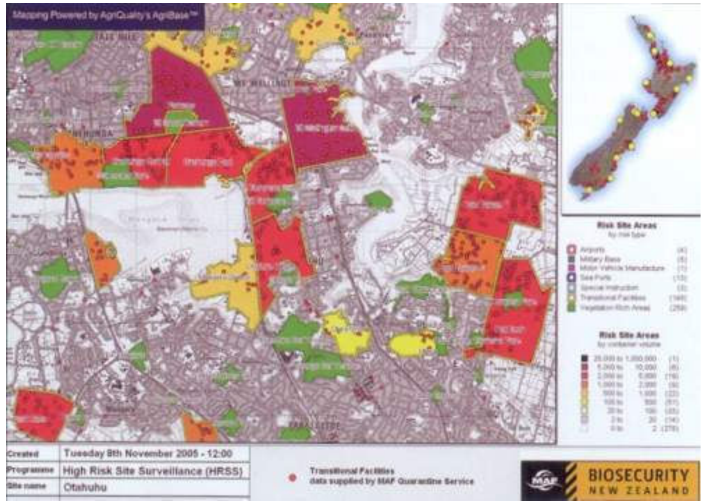
SCION
Next generation biomaterials

Ecki Brockerhoff and collaborators

FOA/MAFBNZ Forest Biosecurity Workshop, Rotorua, Feb. 2010

# NZ's Forest Health Surveillance

- Pest/disease surveillance
  & condition monitoring
  - Plots
  - Drive-through surveys
  - Aerial surveys




- High-risk site surveillance

- **2007: FOA commissioned review**
  (Andrew (Sandy) Liebhold / Brenda Callen)

# Liebhold & Callen FHS Review Findings

- “Overall, …**FHS system …well-conceived, valuable to NZ forest industry, well executed**.”
- “The **program deserves commendation** … …progressive approach to forest biosecurity … …**exceeds the sophistication level attained by forest health surveillance programs elsewhere in the world**.”
- Various <u>**recommendations**</u> …
- “A **network of attractant traps for detecting wood-boring insects should be implemented across NZ** on an operational basis. Ideally this network would consist of traps deployed **in high-risk locations coupled with traps in commercial forests**.”

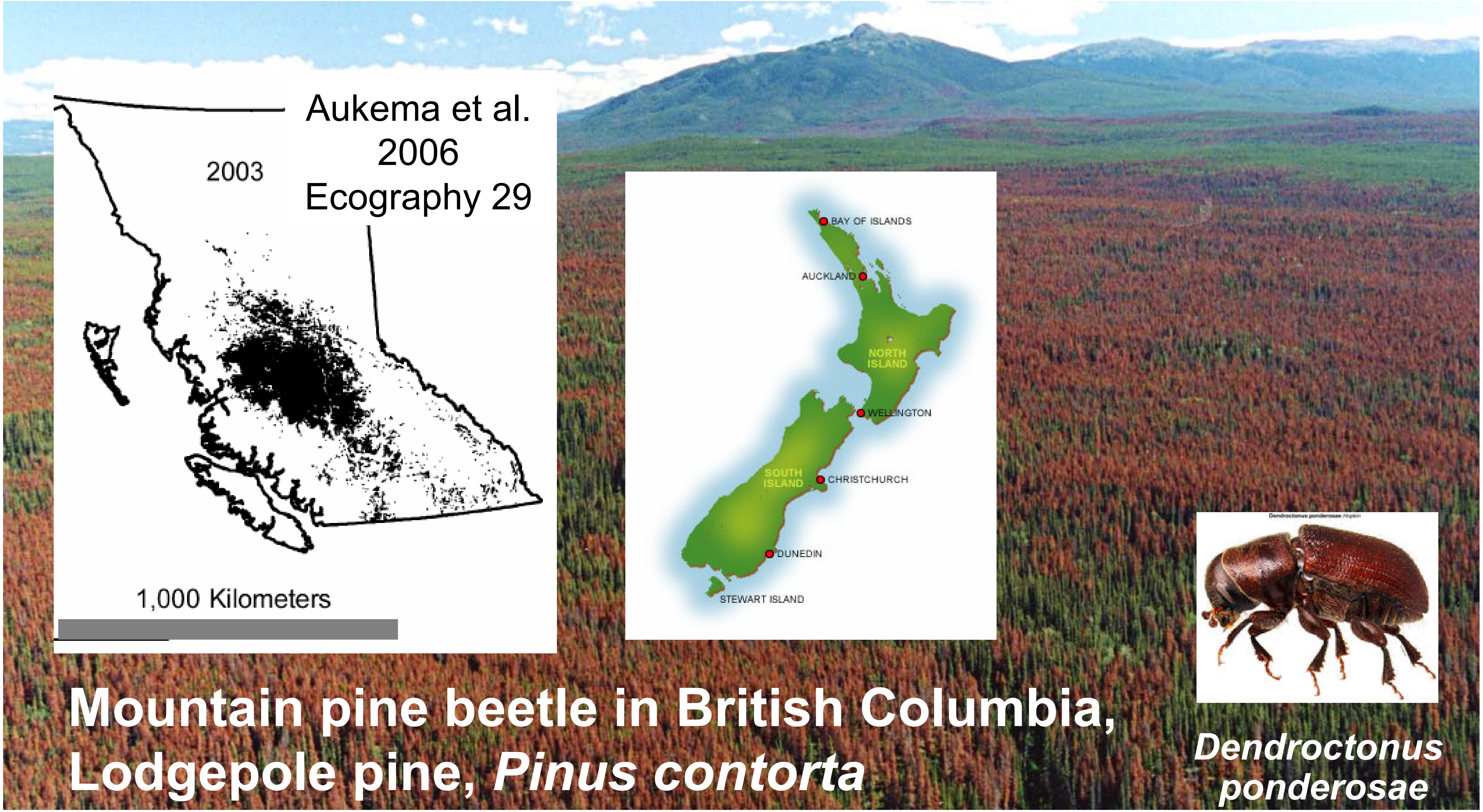
# Uncertainty:
## 1. Risks from bark beetles, wood borers?
## 2. Benefits of surveillance trapping?

- FBRC funded Scion to review Q. 1 & 2
- Report: “Wood borer and bark beetle risk analysis” (E.G. Brockerhoff, May 2009)

**Outline**:

- Risks overseas; historical incursions (NZ / World)
- Trapping in NZ / overseas
- Potential benefits of a trapping programme / costs
- Scope of a formal cost-benefit analysis

# Bark beetle pest risks



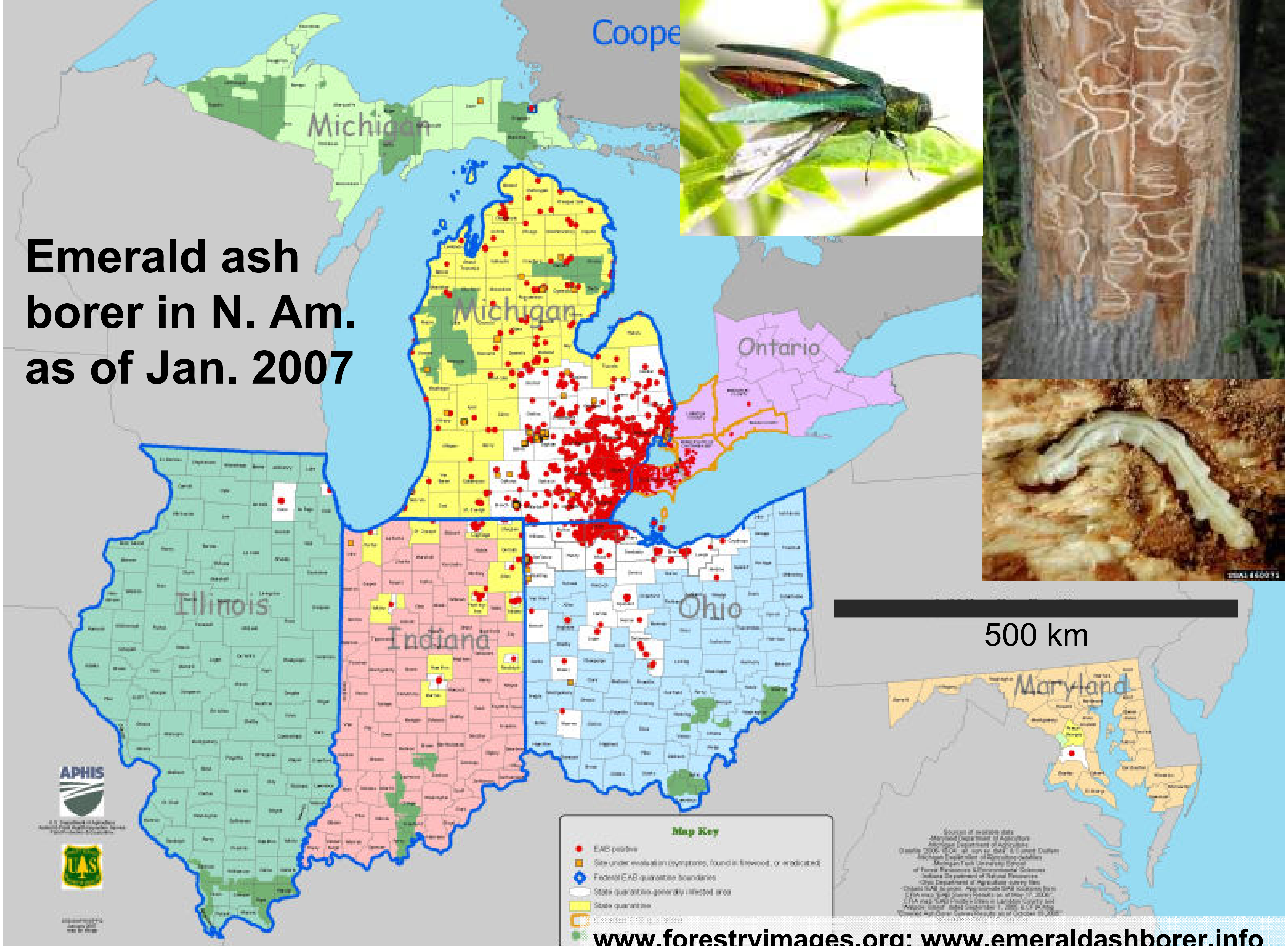

**Mountain pine beetle in British Columbia, Lodgepole pine, *Pinus contorta***

***Dendroctonus ponderosae***

Photo: www.mountainpinebeetle.com

# *Pine bark beetle* (*Ips sexdentatus*)
# Outbreak in *P. radiata* forests
# France (near Moleon)

# Emerald ash borer in N. Am. as of Jan. 2007

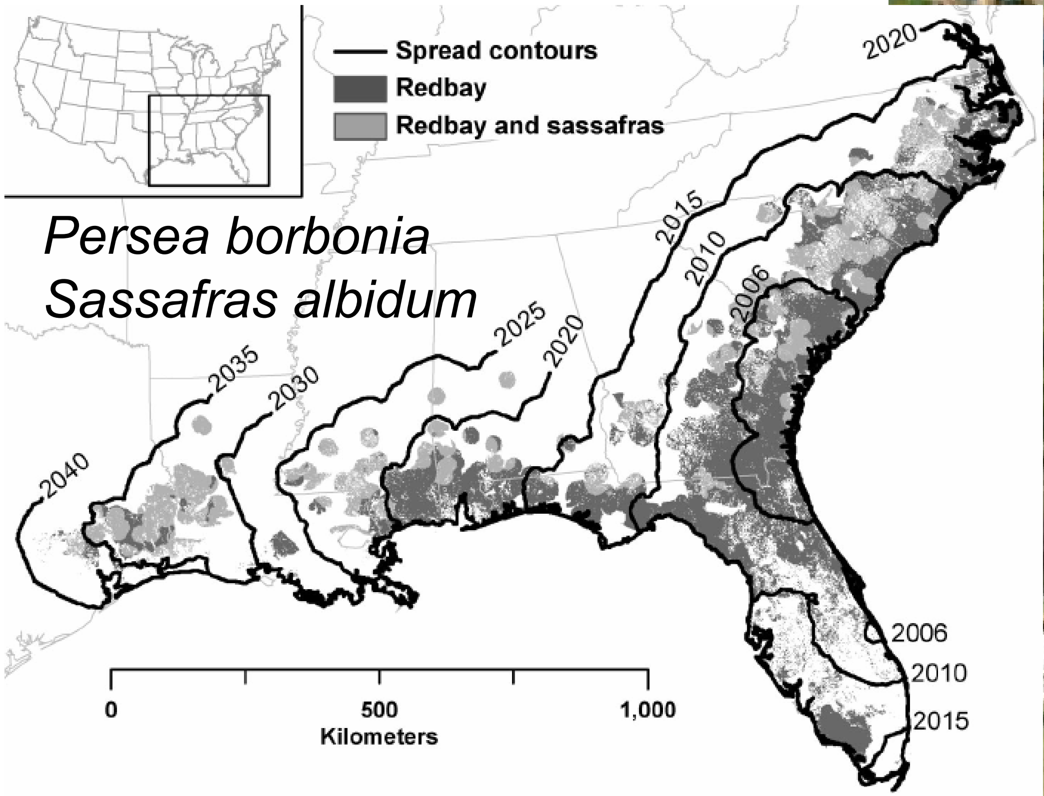



www.forestryimages.org; www.emeraldashborer.info

- As of 2007, > 20 million ash trees killed
- Ash is expected to be virtually eradicated in N. Am.

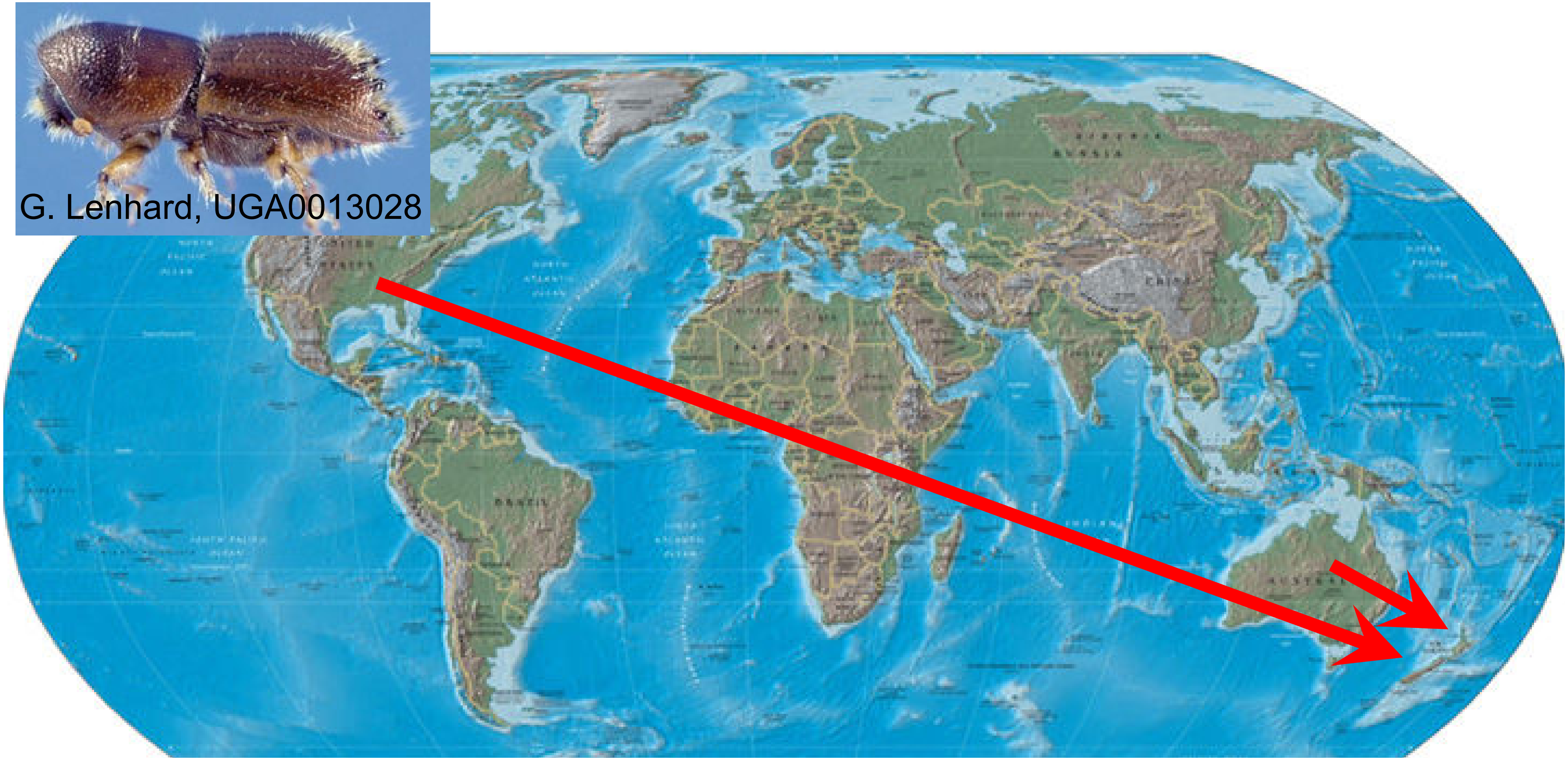
# Laurel wilt (2002-)

- *Xyleborus glabratus*
- *Raffaelea lauricola*
- Introduced from Asia
- Kills Lauraceae (redbay, sassafras, also avocado trees)




# *Ips grandicollis* on *P. radiata* in Australia

# > 48 border interceptions in NZ



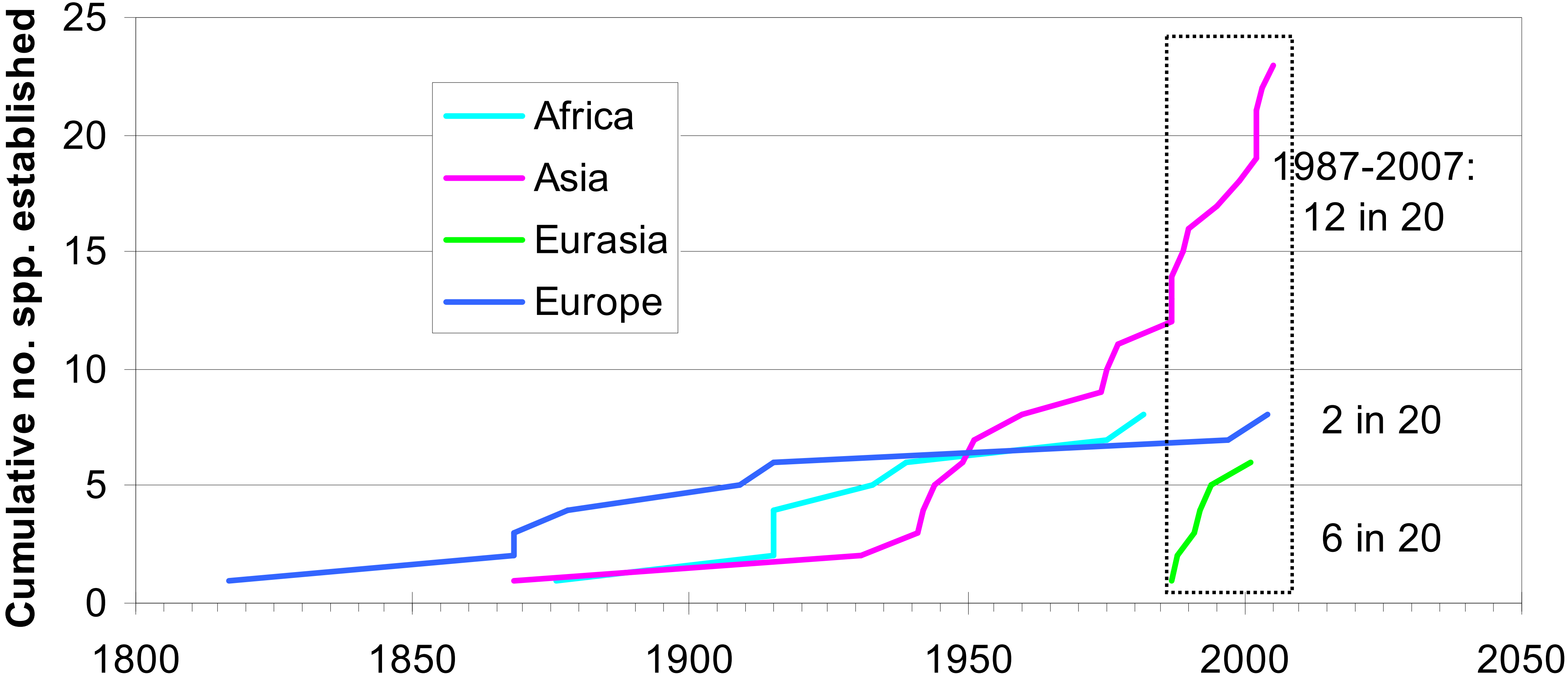

- **Introduced in Australia, behaviour ≠ in native region, kills pines**
- **Interceptions reveal arrivals from native and invaded areas**

# Examples of invaders (on pines / conifers)

| | | | |
|---|---|---|---|
| *Dendroctonus valens* | N. Am. | China (**1998**) | ***Pinus*** |
| *Ips calligraphus* | N. Am. | Philippines (?) | ***Pinus*** |
| *Ips grandicollis* | N. Am. | Australia (1943) | ***Pinus*** |
| *Orthotomicus erosus* | Eurasia | U.S. (**2002**), also Chile, S. Africa | ***Pinus*** |
| *Tomicus piniperda* | Eurasia | U.S. (1992), Canada (1993) | ***Pinus***, other Pinaceae |
| *Arhopalus rusticus* | Europe | Australia (**2000**?), Argentina (**2000**) | ***Pinus***, *Picea* |
| *Arhopalus syriacus* | Europe | Australia (1950s) | ***Pinus***, *Picea* |
| *Callidiellum rufipenne* | Asia | U.S. (1997), Italy (1980s?), Spain (?), Argentina (**2003**) | Cupressaceae, ***C. macrocarpa*** |
| *Hylotrupes bajulus* (European House Borer) | Eur. & N. Africa | Western Australia (**2004**), S. America, South Africa, Israel | ***Pinus***, *Picea, Abies*, other Pinaceae, Podocarpaceae, etc. (seasoned softwoods) |
| *Tetropium fuscum* | Europe | Canada (Nova Scotia) (**1999**) | *Picea*, ***Pinus***, other Pinaceae |
| *Sirex noctilio* | Europe | NZ, Australia (1952), S. Am., S. Africa, U.S. (**2004**) | ***Pinus***, *Pseudotsuga*, other Pinaceae |

# Establishment rate in U.S. of Scolytinae

## data from NCEAS WGs 1 & 2 (Brockerhoff, Haack)




Overall ca. 1 sp. per year since 1980s

# Types of damages caused by WBBB

- Tunneling in felled trees, attack of sawn timber
- Vectoring of sapstain, decay fungi
- Attack of live trees, potentially killing trees (MPB)
- Introduction & vectoring of pathogens (pitch canker)
- Direct costs through losses to pests
- Increased cost of trade (fumigation, phytosanitary…)
- Emergency response costs
- Increased pest management / forest management costs
- Research
- Cost of brown spruce longhorn beetle in Canada: Projected annual losses estimated at ca. \$3 - \$6 billion (CD), (Colautti et al., 2006, Biological Invasions)

# **Transport and arrival:** Border interceptions of wood borers, bark beetles, et al.

**<u>>9600 Border interceptions of WBBB</u>, 1948 to 2000 in NZ**

BUGS database (Scion / NZFRI):

Sp., shipmt. origin, date, logs/SWPM…

1505 Scolytinae intercpts., 103 spp.

<u>US PIN / Pest ID / AQIM databases</u> …

# Surveillance trapping in NZ

- **2002-2005**, nationwide
- For MAF (FR / Agriquality)
- At high risk sites (ports, airports, devanning sites…)
- Up to 580 traps p.a.

(*Brockerhoff et al. 2006 - FEM*)

**Lures:**

- Alpha-pinene + ethanol
- Frontalin + ethanol
- Ipsdienol
- Beta-pinene + ethanol

- Ongoing research (Scion)
- Other lures available for numerous other spp.

# Surveillance trapping overseas

United States
Department
of Agriculture

Forest Service

**Forest Health Protection**

May 2008

## Early Detection and Rapid Response for Non-Native Bark and Ambrosia Beetles

Robert Rabaglia, Donald Duerr,
Robert Acciavatti, and Iral Ragenovich

- Found one new species every year (2001-05)
- Similar programme also in Australia (see Brockerhoff 2009)

# Potential benefits/costs of trapping programme

- Benefits:
  - Greater sensitivity of traps would probably lead to an earlier detection than with conventional methods.
  - Early detection may enable more successful response (e.g., eradication or containment – recent *Xylosandrus crassiusculus* in Oregon, Jim LaBonte).
  - Avoidance of long-term pest management and other costs (e.g., trade, etc.; potentially millions of $$)

- Costs:
  - Costs of trapping and identification (ca. $100k-500k), depending on the scope and number of traps, etc.
  - Spent unnecessarily if no incursions!

## Scope of a formal cost-benefit analysis

- Detailed quantification of potential benefits and costs and estimation of probabilities using historical NZ and overseas data.
- With Scion economist, James Turner
- For details see FHRC proposal.

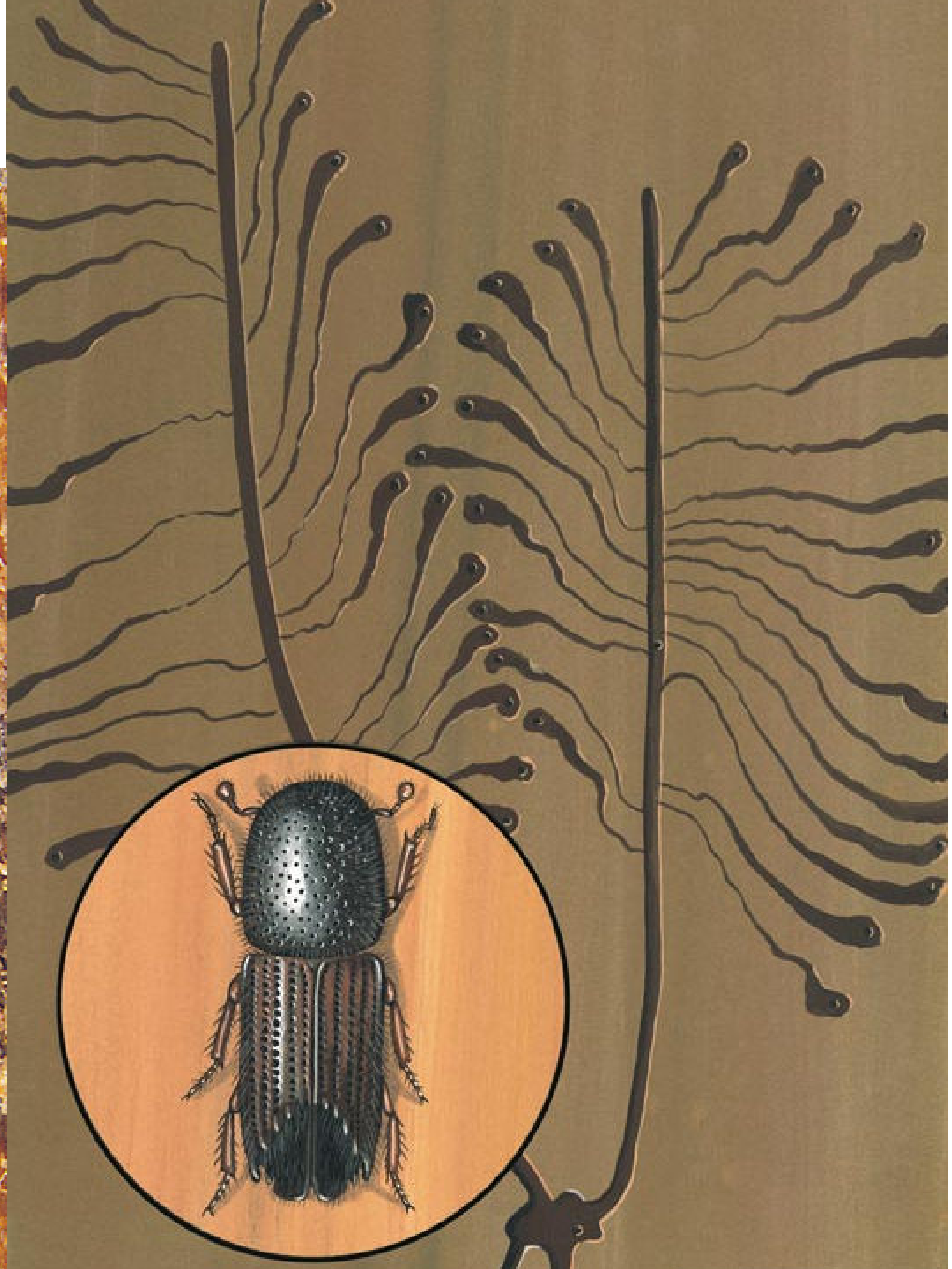

## Acknowledgements

- FBRC, FHRC, FRST
- John Bain, Lindsay Bulman, James Turner

For an extended version with more slides see …

Brockerhoff - Bark wood borer risk cost-benefit - FHRC Nov 2009.ppt

# Pine bark beetle, *Ips sexdentatus*

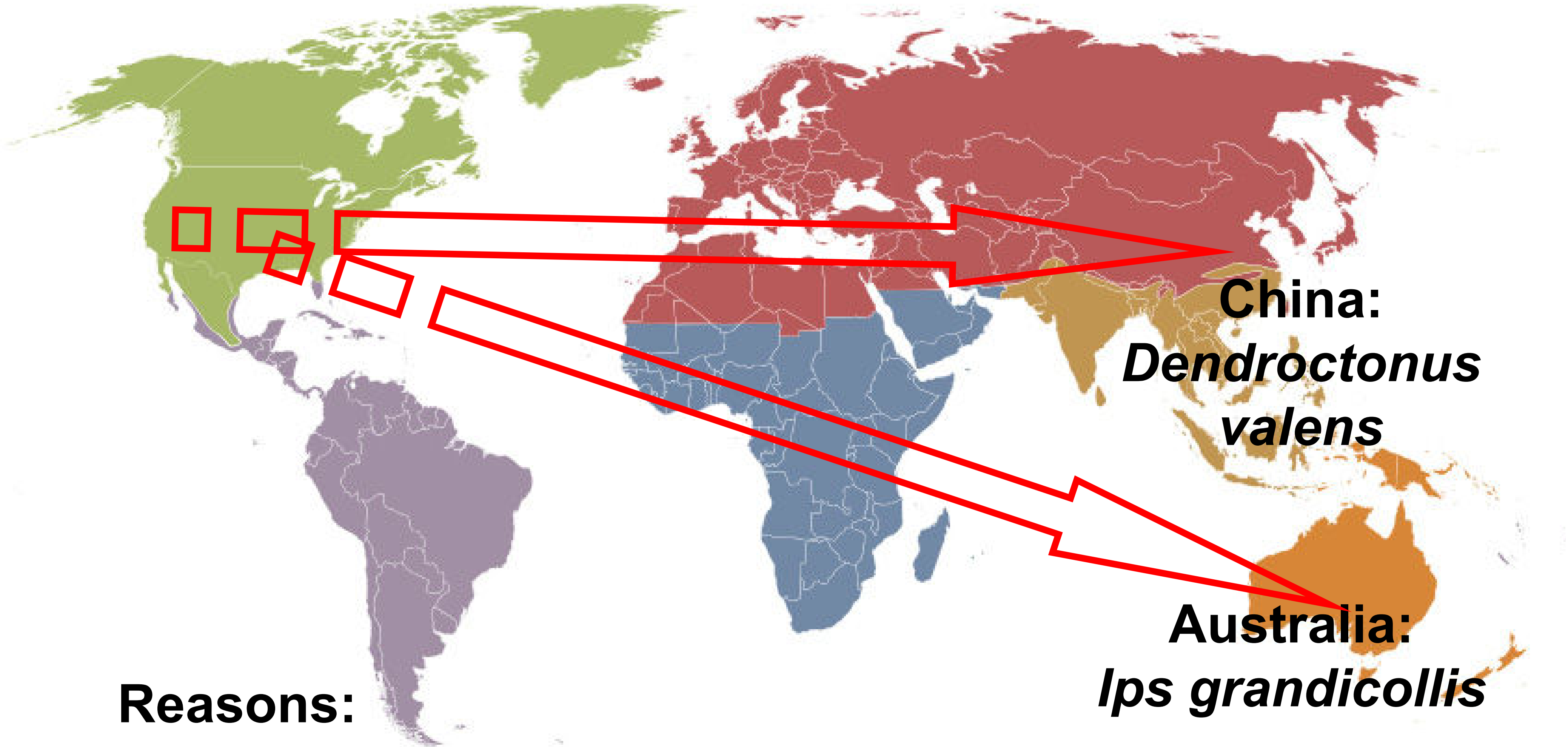


# Emerald ash borer in N. Am. (2002 - )


*Agrilus planipennis*
(Buprestidae)

Photos: Bob Haack (USDA-FS);
www.forestryimages.org; www.emeraldashborer.info

# Unexpected outcomes of invasions



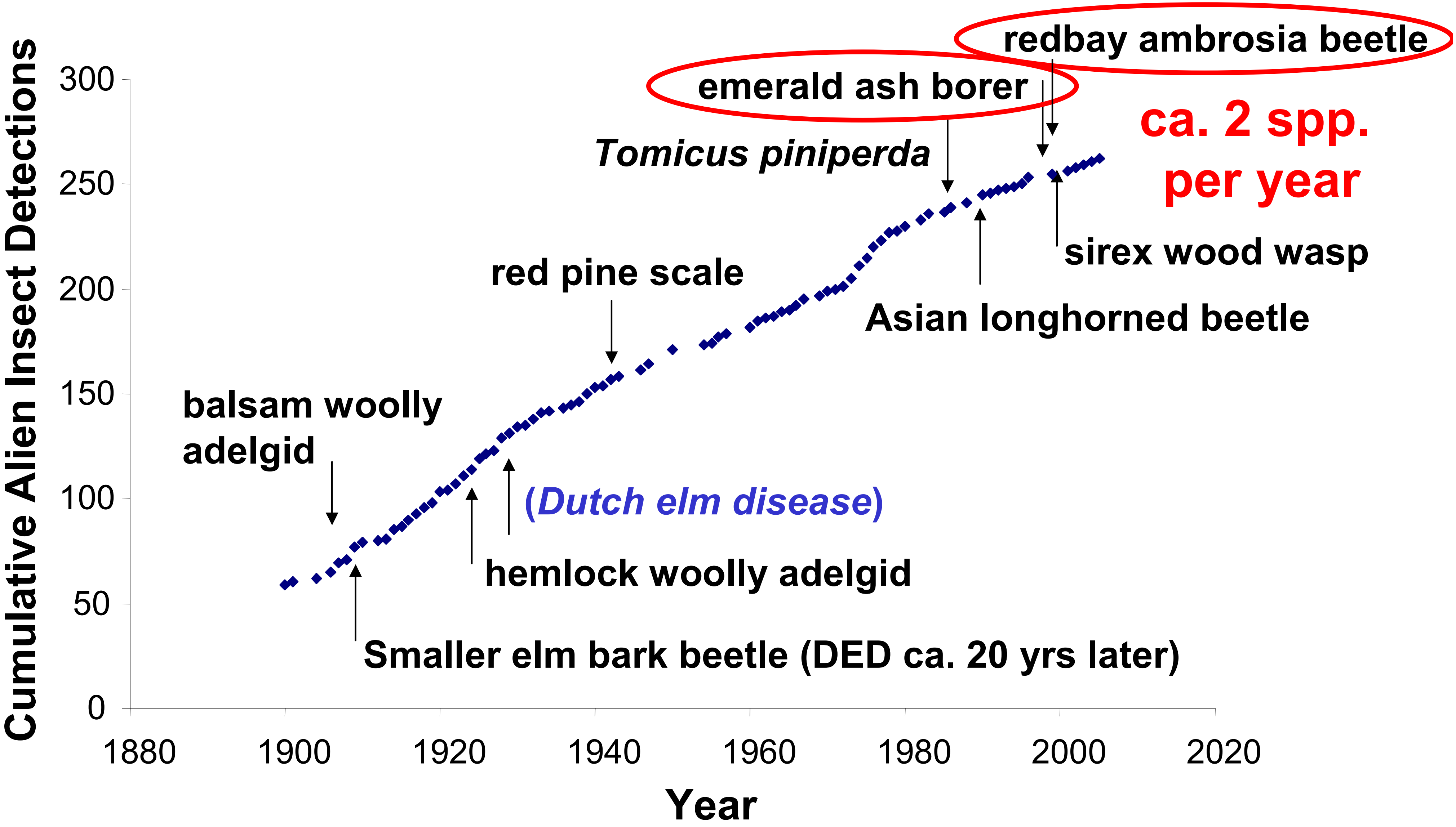

**Reasons:**

- Lack of resistance in ‘new association’
- Tree stress (e.g., suboptimal site conditions)

# Forest Insect Establishments - USA

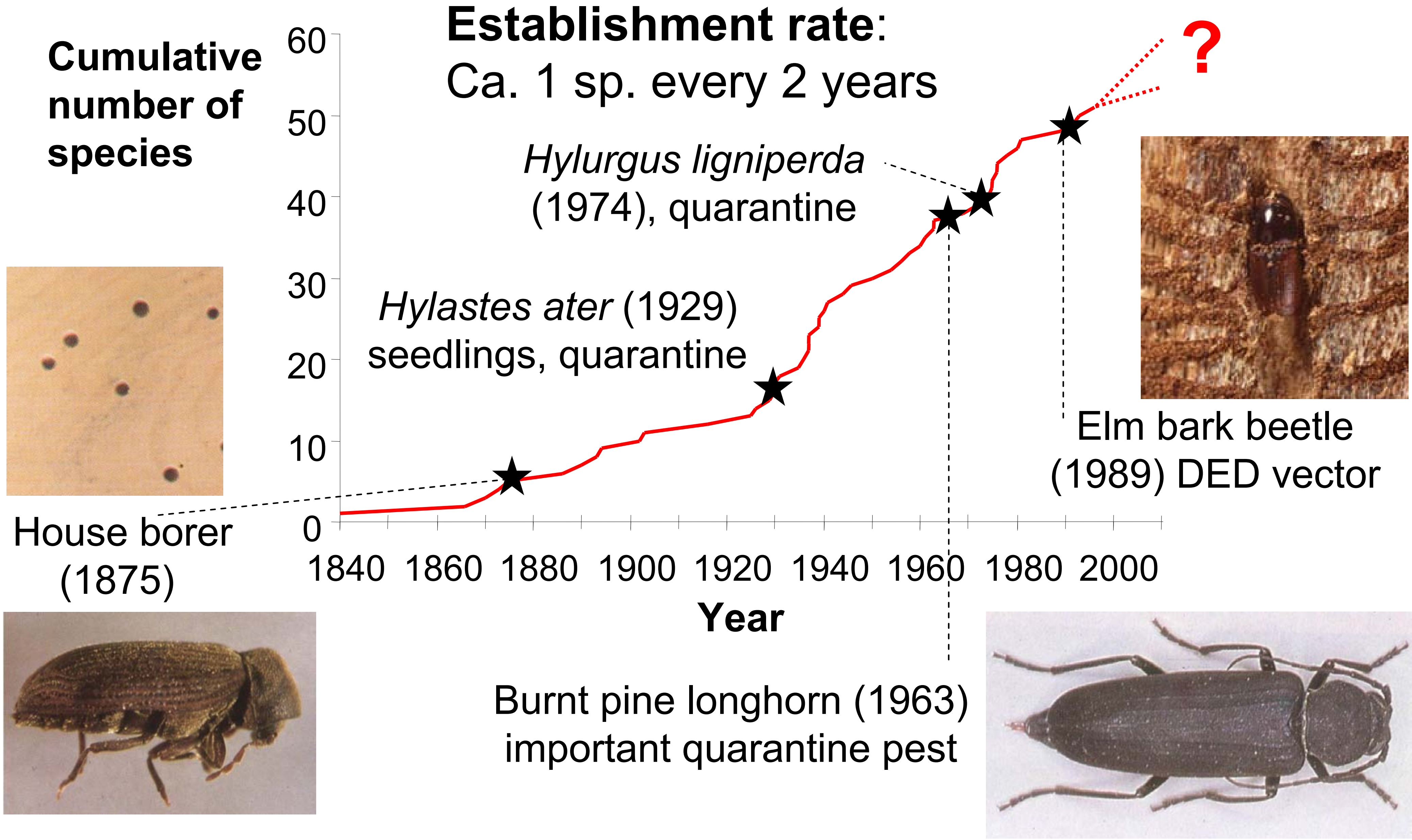
(NCEAS, UC SB, Trade & Invasive Species WG 1)

WG 1: J. Aukema, K. Britton, J. Englin, S. Frankel, R. Haight, T. Holmes, B. Leung, A. Liebhold, D. McCullough, T. Stohlgren, B. von Holle




Pre 1900: **gypsy moth**, **beech scale**, **larch casebearer**

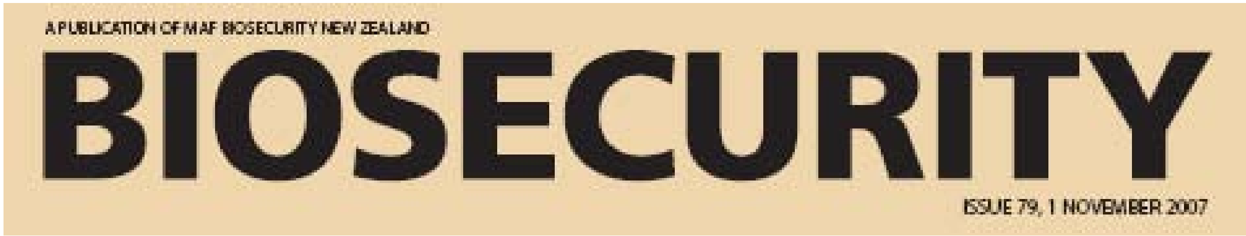
# Establishments of beetles attacking trees and shrubs in New Zealand (all guilds)




Source: Brockerhoff & Bain 2000 NZ Plant. Prot.

# Infested sofas…

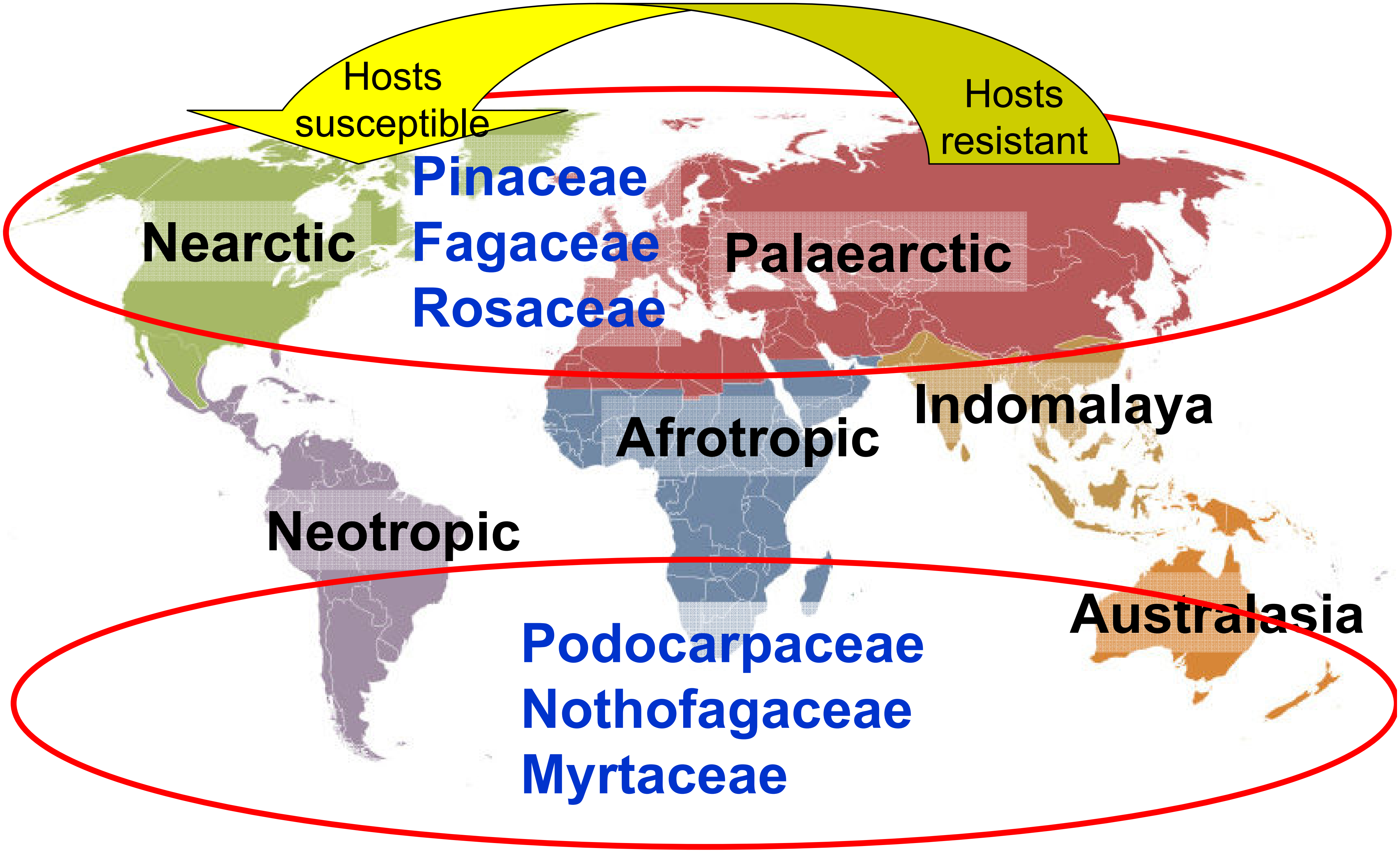
Thompson et al. (2007) Biosecurity 79
(NZ Ministry of Agriculture & Forestry)



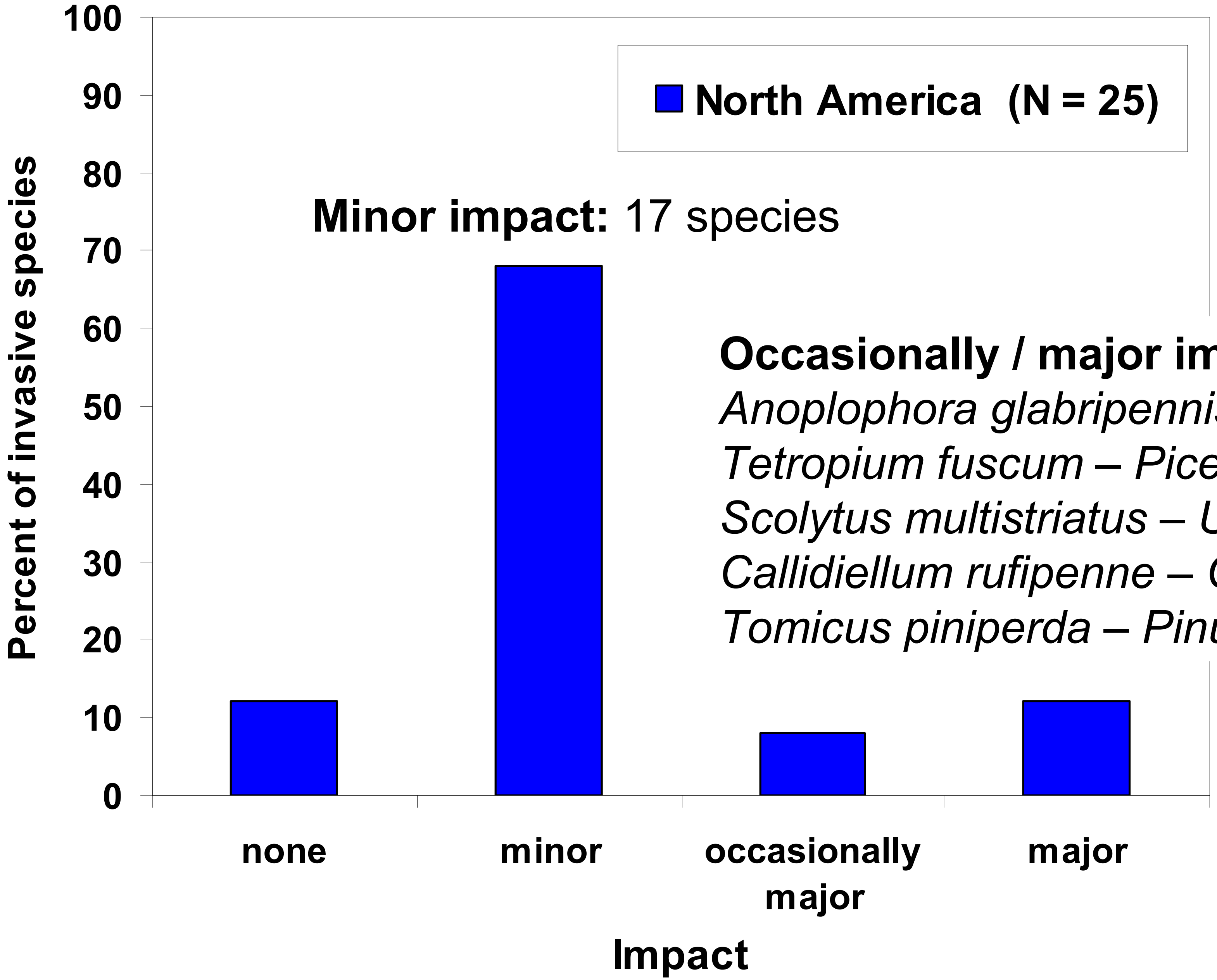

# Outline

- Wood borers and bark beetles
  - many invaders, some high impact (environmental / economic),
  - well-known group, known pathway (wood / wood packaging),
  - useful as 'case study' for mitigation of pathway
- Examples of high-impact invaders
- Explore historic patterns of forest insect invasions
- … within vs. between biogeographic regions / ecozones
- Propagule pressure, establishments, impacts on host plants
- Effects of phytosanitary policy to reduce future invasions

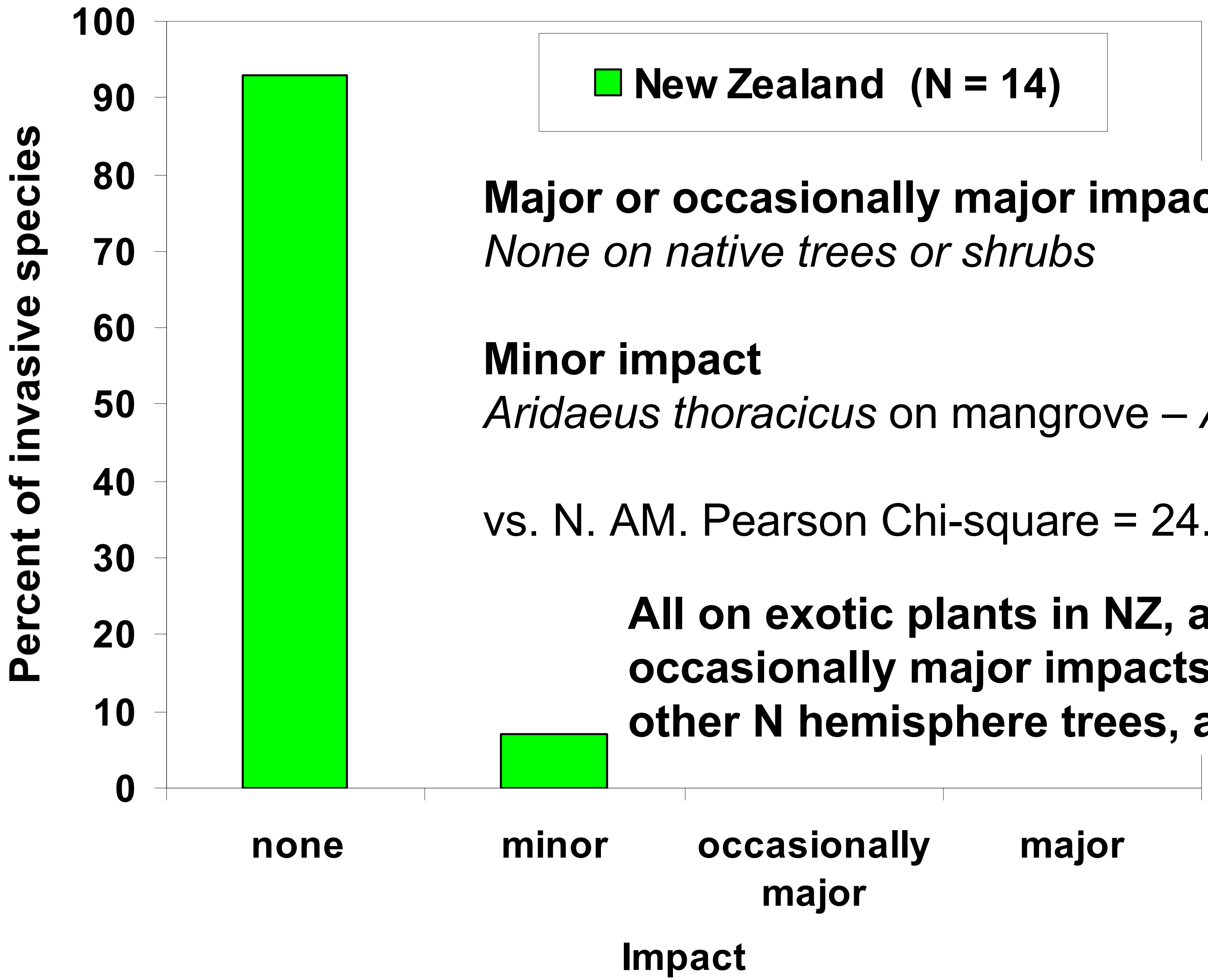
# Bioregions & prominent woody plant families



# Impact of introduced longhorn beetles and true bark beetles on native woody plants – North America




# Impact of introduced longhorn beetles and true bark beetles on native woody plants – New Zealand



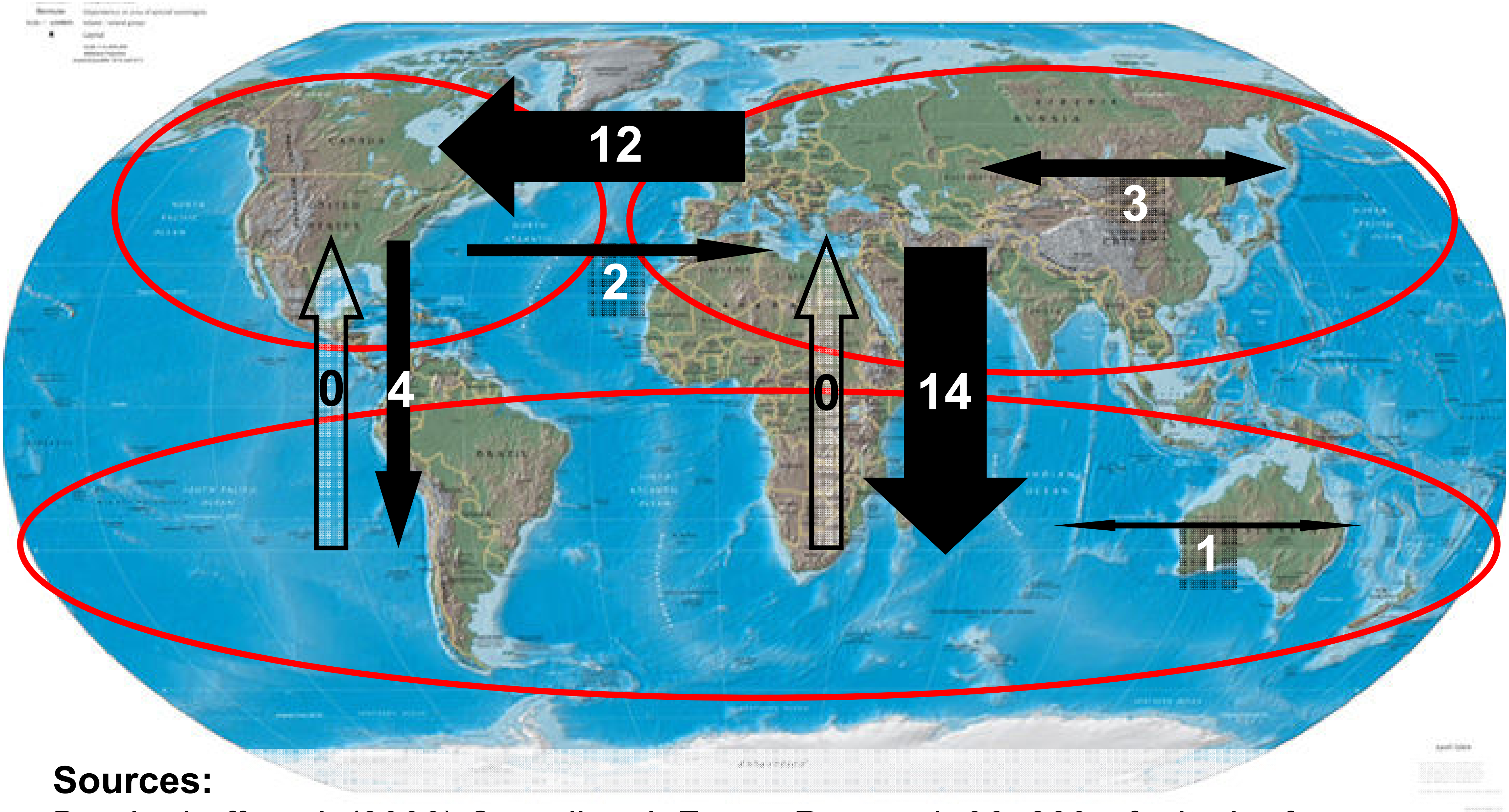

**Major or occasionally major impact – host:**
*None on native trees or shrubs*

**Minor impact**
*Aridaeus thoracicus* on mangrove – *Avicennia*

vs. N. AM. Pearson Chi-square = 24.3, $P<0.001$

**All on exotic plants in NZ, at least minor, occasionally major impacts (on pines, other N hemisphere trees, also eucalypts)**

# True bark beetle establishments & origins by region




**Sources:**

Brockerhoff et al. (2006) Canadian J. Forest Research 36, 289-  & cited references

Haack (2001) Integr. Pest Manage. Rev. 6

See also: Niemelä & Mattson (1996) Invasion of Nth American Forests by European phytophagous insects. Legacy of the European crucible? *Bioscience* 46

# NCEAS project: Trade & invasive forest spp.

## National Center for Ecological Analysis and Synthesis, UCSB

J. Aukema, K. Britton, E. Brockerhoff, J. Cavey, L. Garrett, R. Haack, F. Lowenstein, C. Marasas, A. Nuding, L. Olson, E. Sills, C. Speekmann, M. Springborn, J. Turner, C. Vieglais

**Objectives: model invasions**

1. Transport & Arrival – 2. Establishment – 3. Damages

- Mitigation: trade policy (costs, benefits)

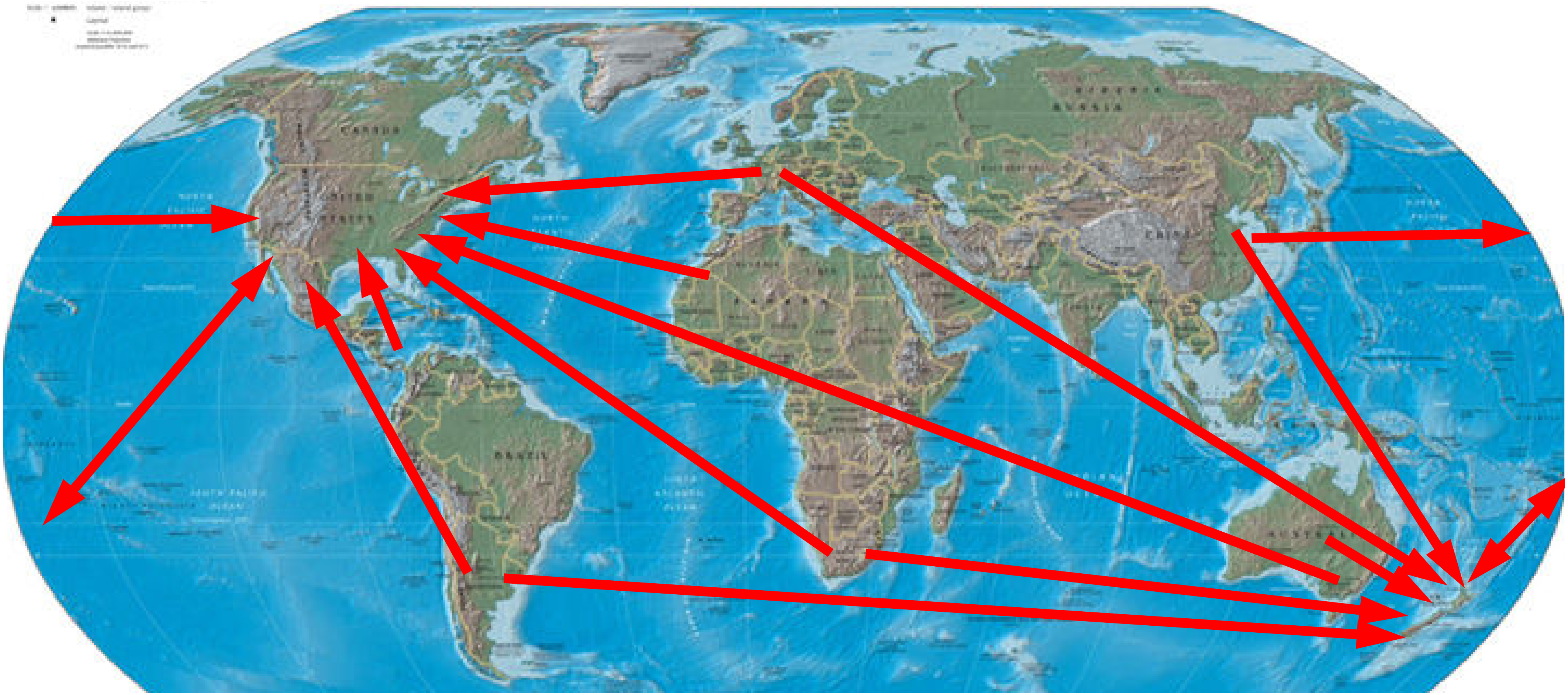
NCEAS

The Nature Conservancy

Protecting nature. Preserving life.™

# Border interceptions reflect world-wide movements

## (not just relevant to NZ or US)



NZ interceptions: 59 countries, all continents (except Antarctica)
US interceptions: 117 countries / islands, all continents
Representative of global human-assisted dispersal

## Using interception records to estimate arrival rate
## Aug. 05 - July 06 / pre-ISPM15

Agricultural Quarantine Inspection Monitoring (**AQIM**):
Random selection, positive & negative inspections recorded

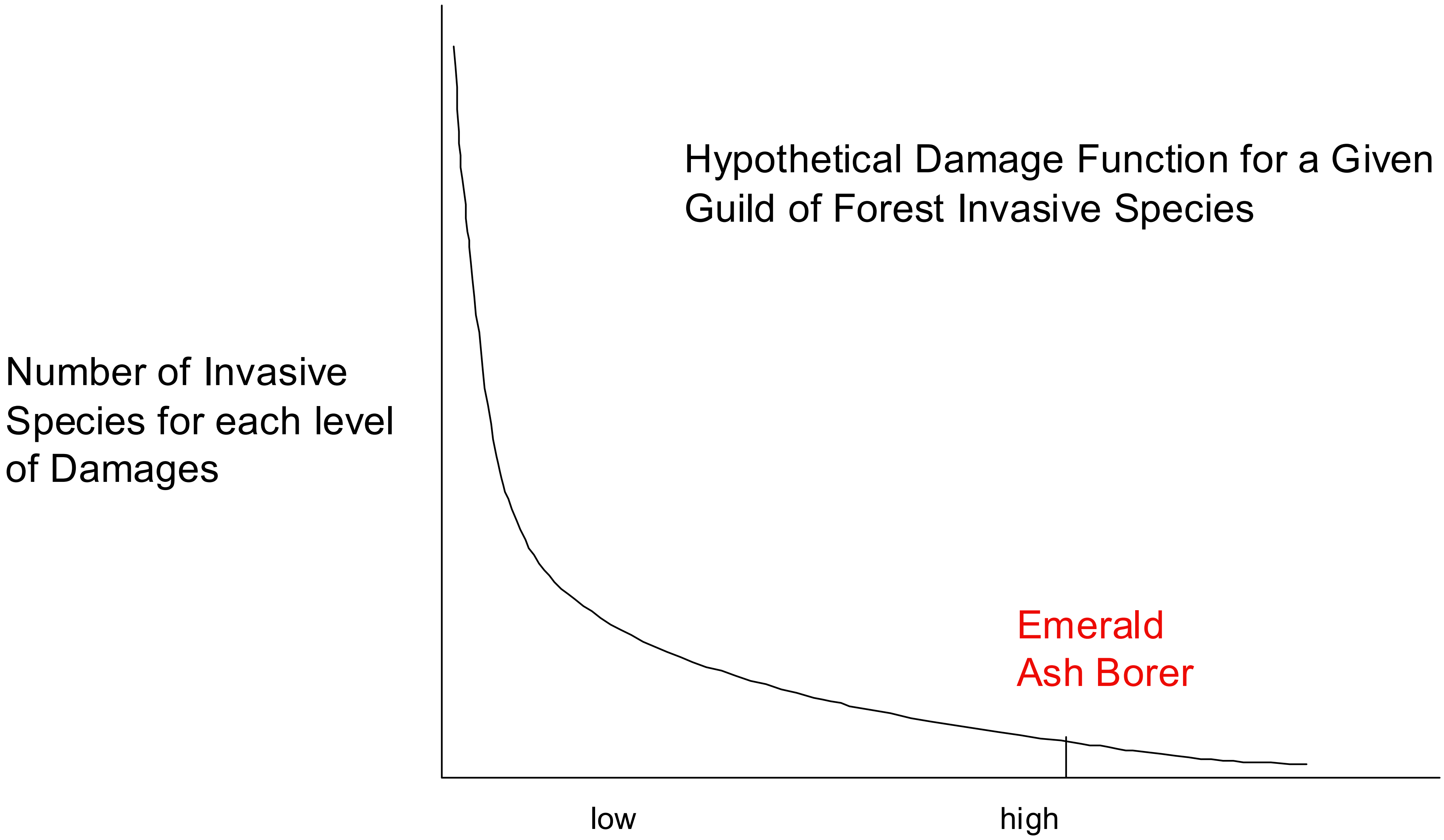
- AQIM inspections with WPM: 7,099 p.a.
- 1.5 interceptions per 1000 container with WPM (AQIM)
- Similar NZ data (ca. 1 interception per 1000 cont. – BNZ 2003)
- 703 interceptions (Pest ID, containers with WPM, Jan-Dec 06)
- Containers entering: ca. 22.4 million p.a. (US), 600 k (NZ)
- ca. 50% of containers containing WPM: ca. 11.2 million p.a.
- **US Total: 16,360 arrivals p.a.** (containers with WPM, AQIM)
- NZ Total: ca. 450 arrivals p.a. in containers

**Sea Container Review**

MAF Discussion Paper No: 35 **2003**

Prepared for MAF Biosecurity Authority, by the Border Management Group

# 3. Damage curve (wood borers, bark beetles)




(NCEAS WG 1)

# Mitigation: ISPM 15, Heat treatment efficacy

ISPM No. 15

APPROVED MEASURES ASSOCIATED WITH WOOD PACKAGING MATERIAL

**56°C, 30 minutes**

**Heat treatment (HT)**

Wood packaging material should be heated in accordance with a specific time-temperature schedule that achieves a minimum wood core temperature of 56°C for a minimum of 30 minutes[3].

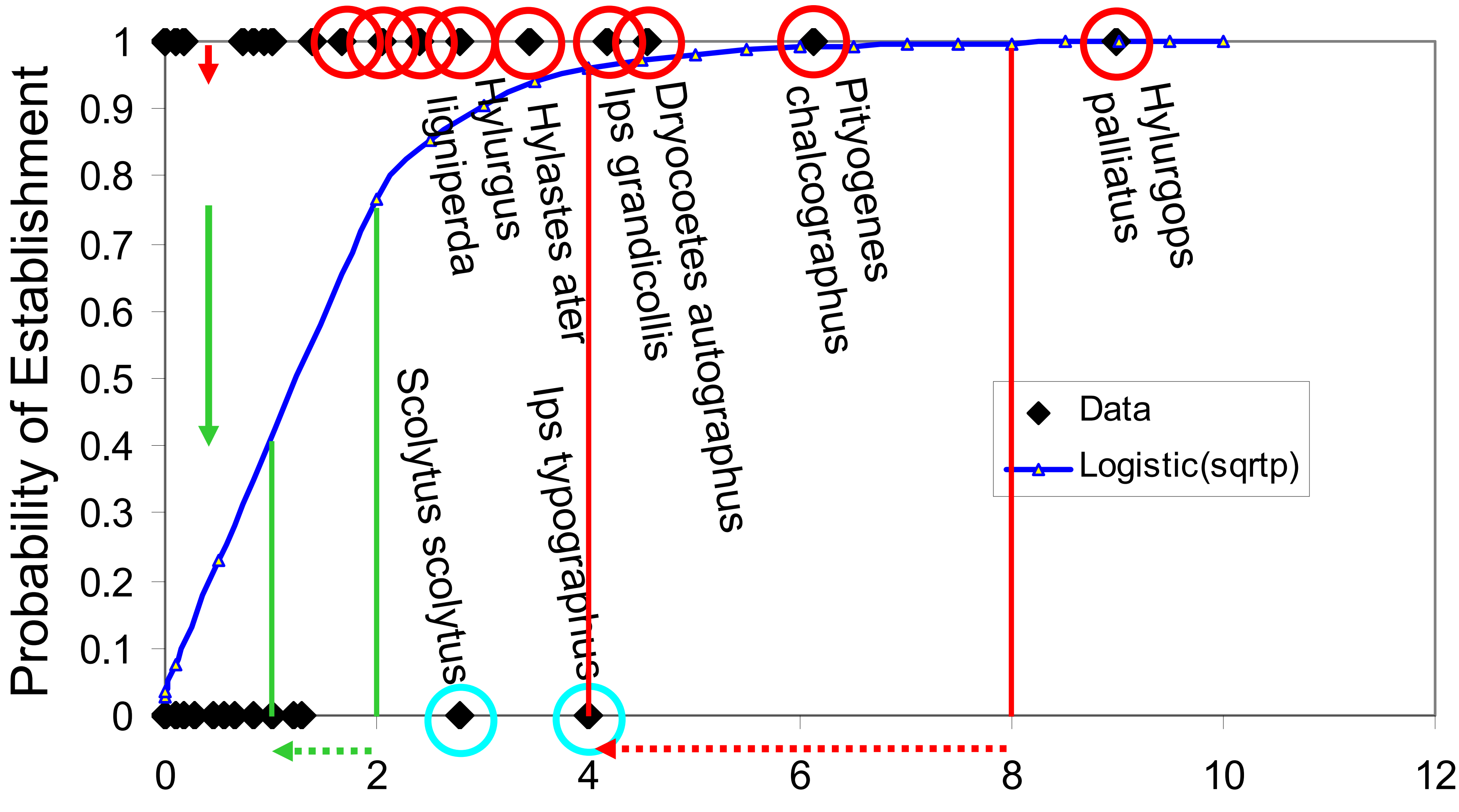
**CAUTION: Lab expmts show > 90% effectiveness, some spp. survive treatment, "cheating" (False sense of security)**

**ISPM No. 15**

***GUIDELINES FOR REGULATING WOOD PACKAGING MATERIAL IN INTERNATIONAL TRADE***

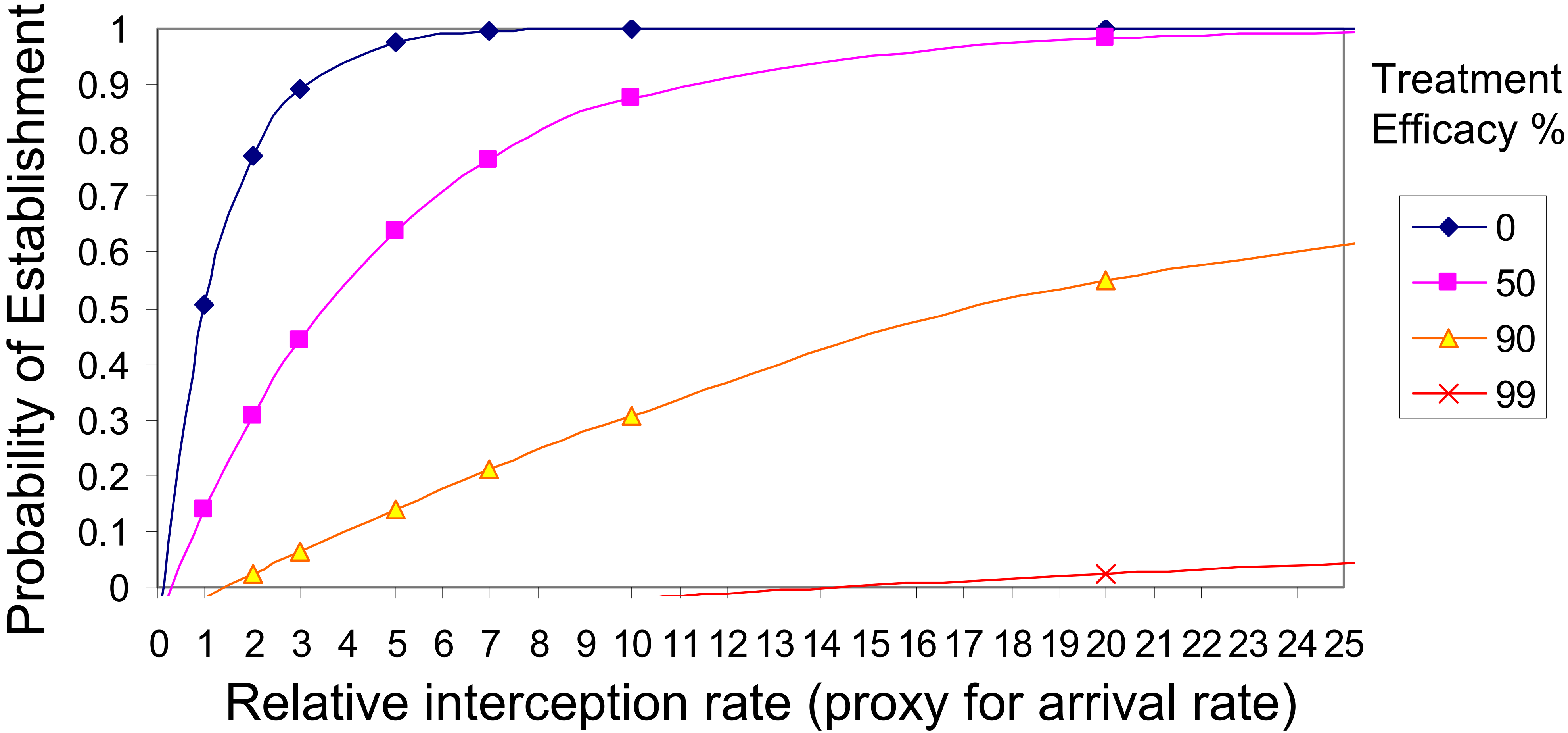
**(2002)**

# Model development: using NZ interceptions and establishments world-wide (more data)




Data from Brockerhoff et al. (2006) Canadian J. Forest Research 36

# Draft model: arrivals, establ. reduction (400 spp.)




Model 3, March 2009

Variation of (1-*E*) = exp(*a*×*n*)

# Conclusions

- WBBB useful system to study insect invasions & mitigation
- Border interception data critical – plea to record, pos. and neg.
- Greatest impacts on relatives of normal hosts
  (Palaearctic to Nearctic, E-Palaearctic to W-Palaearctic)
- Why? "New associations" – lack of resistance
  … and release from enemies (Torchin et al. 2003. Nature 421)
- North-South / S-N invasions rarely affect native plants
  … "Resistance" to herbivores from distant plants
- S. hemisphere plants most threatened by S. hem. insects, BUT
- N-S / S-N do affect exotics: enemy release, no resistance (?)
- **Why important?**
  - Better understanding of ecology of invasions
  - Better risk assessment, prediction & managemt. of threats …
  - Globalisation may intensify invader impacts

# Acknowledgements

**Contributors:**
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- NCEAS / Nature Conservancy
- FRST (Foundation for Research, Science & Technol.)
- MAF - Biosecurity NZ
- Forest Health Research Collaborative

NCEAS

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# Gondwanan flora - Distribution of *Nothofagus* *(southern beech), Nothofagaceae*