Leaning In: Is Proactive Biocontrol of Potential Invasive Pest Threats Feasible?

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A Few Things to Discuss

- The perennial threat posed by invasive pests
- What to do when incursions are detected?
- What is biocontrol?
- Is proactive biocontrol feasible?
  - Can you have a prescreened natural enemy “locked and loaded” prior to an identified pest threat establishing?
- Let’s consider a couple of potential invaders
  - Glassy-winged sharpshooter (GWSS)
  - Brown marmorated stink bug (BMSB)


AIR NEW ZEALAND

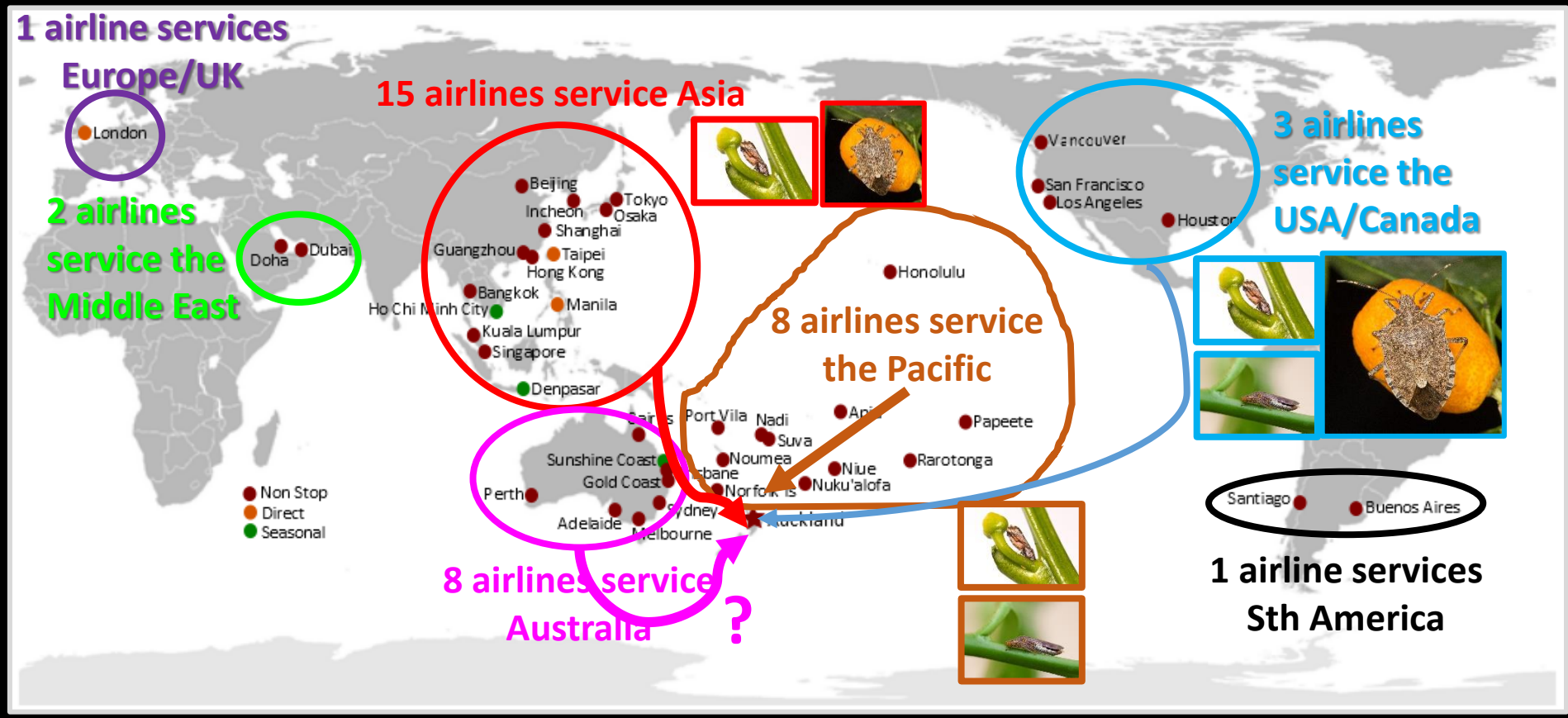
Incursion Pressure

- **Auckland International Airport summary statistics for May 2015 to May 2016**
  - **17,118,027 passengers were processed**
    - **~55% passengers (9,414,915) were international in origin**
    - **~45% passengers (7,703,112) were domestic in origin**
  - **71% of NZ air travel handled by AKL International Airport**
  - **156,407 aircraft movements**
    - **429 flights per day**
    - **45 flights per hour of airport operation**
    - **Most points of origin showing % increases in passengers coming to NZ**

https://en.wikipedia.org/wiki/Auckland_Air

Things Still Sneak In!

Destinations Served by Auckland Airport



30 International airlines service AKL

Some of these service more than one country (e.g., Emirates – Middle East, Thailand, and Australia)

https://en.wikipedia.org/wiki/Auckland_Airport

Global Flight Activity in 24 hrs

What to Do When an Incursion is Detected?

- There are many management options available when an invasive pest is detected
  - Do nothing
  - Increase geographic range of detection/monitoring programs
  - Containment and quarantines
  - Eradication
  - Develop management plans and learn to live with it
    - Classical biocontrol

Requires sustained funding and strong political/public support over a long period of time

What is Biocontrol?: A 101 Primer

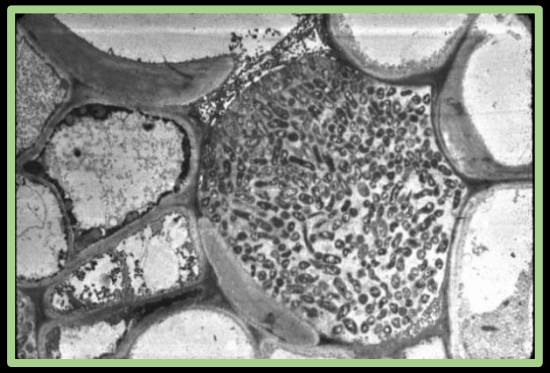
- Biocontrol is the intentional use by humans of natural enemies to reduce pest populations to less damaging levels
- Natural enemies fall into three broad categories
  - Host specificity may vary with natural enemy type
- Four types of biocontrol
  - Classical or introduction biocontrol
  - Inundative biocontrol
  - Augmentative biocontrol
  - Conservation biocontrol

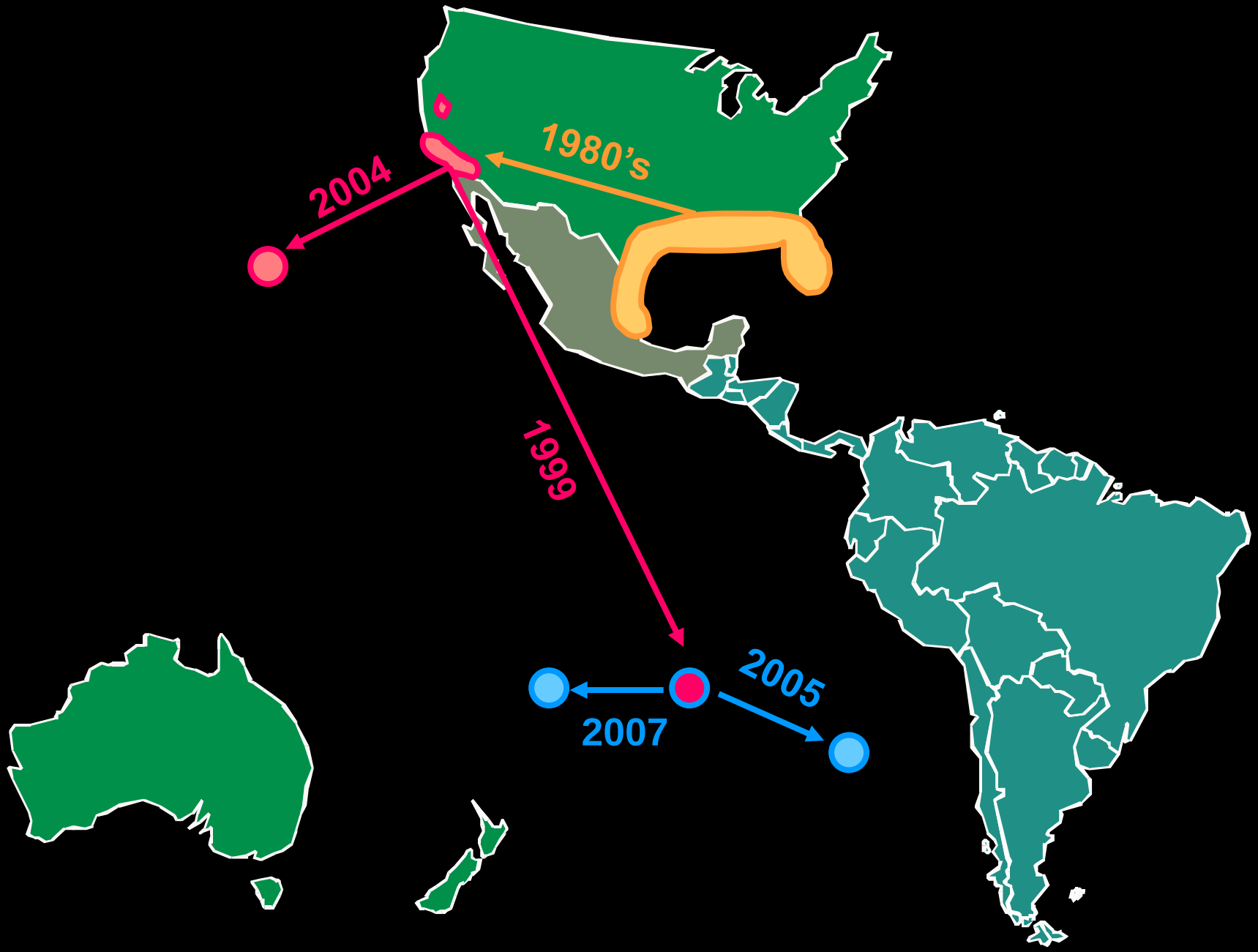
What is Classical Biocontrol?

- **The enemy release hypothesis**
  - **Invasive pests become pests because they escape the control of their natural enemies**
- **Classical biocontrol re-associates co-evolved host specific natural enemies from the pest's home range via introduction into the invaded range**
- **When successful spectacular and permanent pest control results**
- **Natural enemy introductions are strictly regulated in many countries**

Classical Biocontrol of GWSS

- GWSS notorious agricultural pest
- Vectors *Xylella fastidiosa*
  - Kills grapes, olives, oleander
- GWSS & *Xylella* exhibit high invasion potential
  - GWSS in Sth Pacific
  - *Xylella* in Taiwan, France/Corsica, Kosovo, Italy, & Mallorca (Spain)
- Highly efficacious and host specific natural enemies available

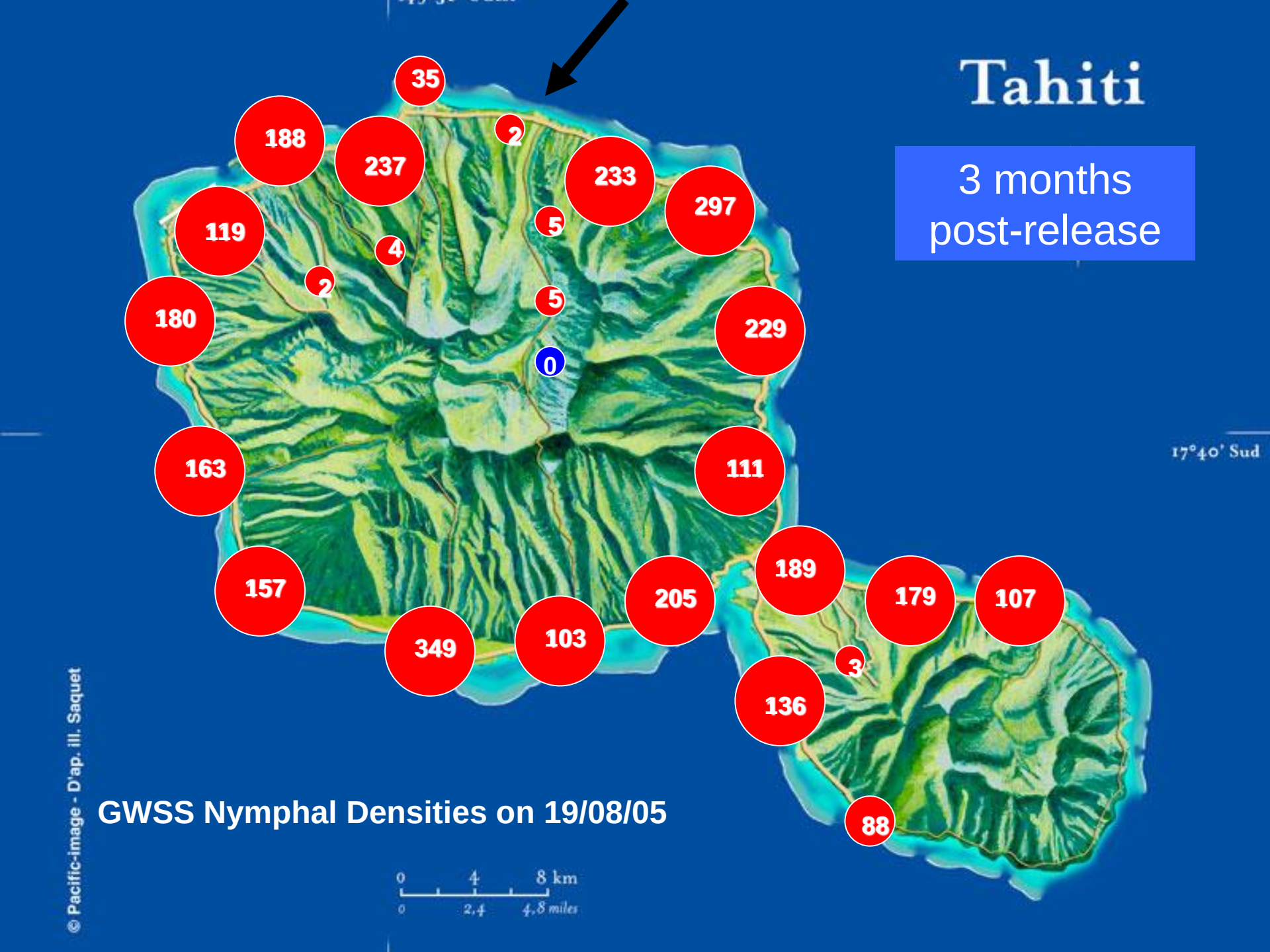



1980's
2004
1999
2005
2007

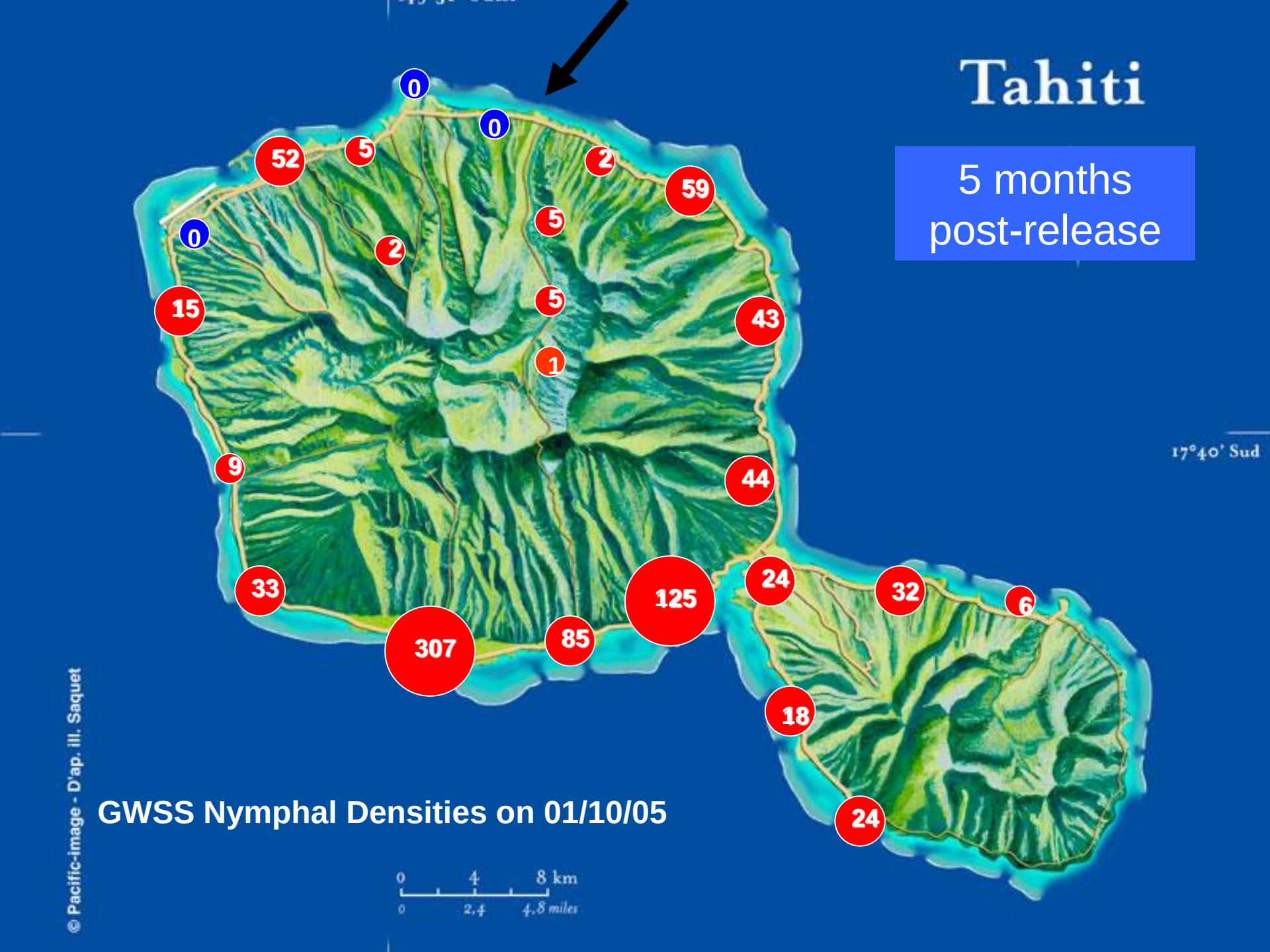
Tahiti

105
176
111
159
183
105
217
8
4
8
5
235
179
0
1
95
126
10
121
130
136
97
240
123
92
3
128
67

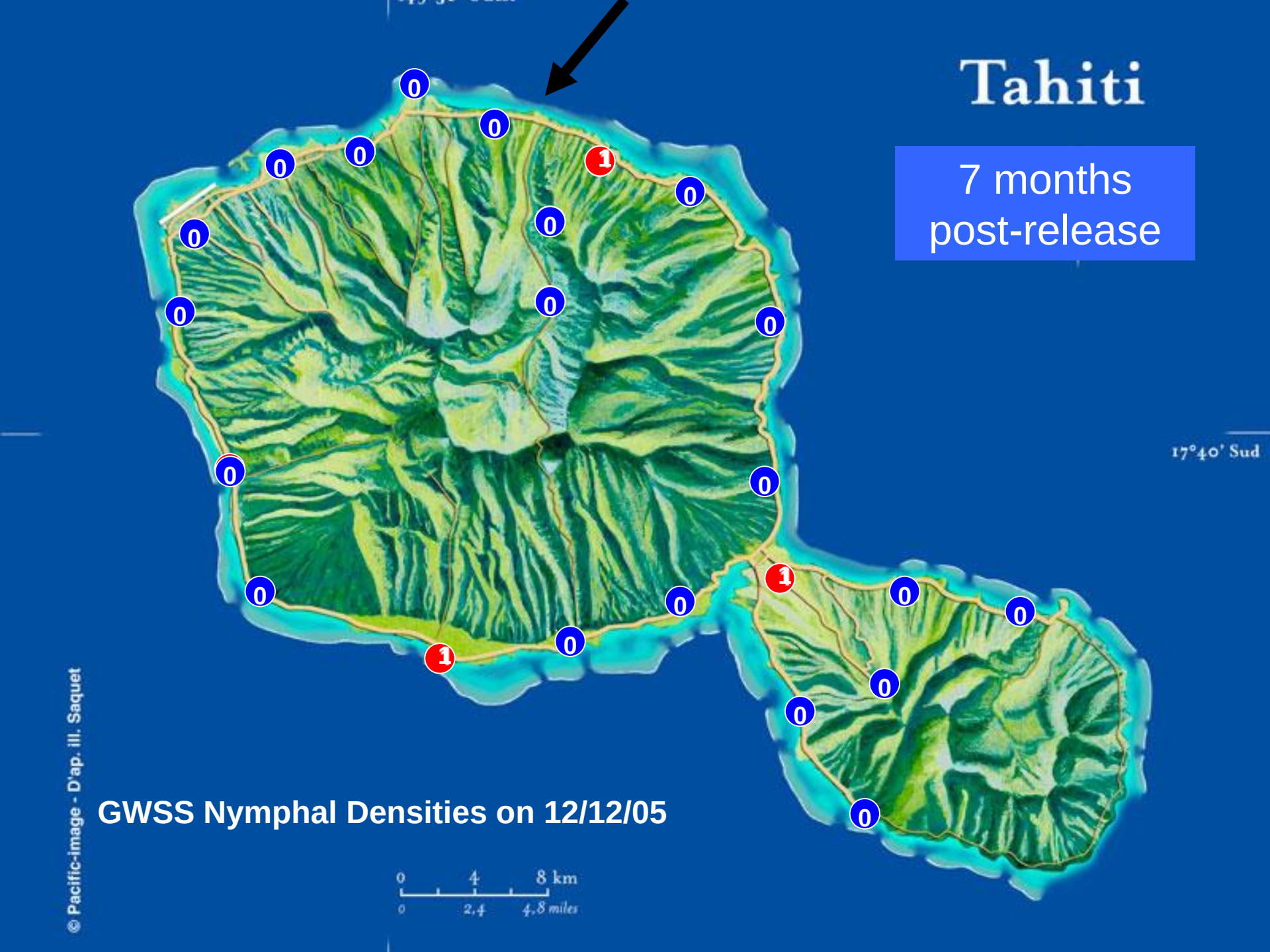
GWSS densities before release (parasitoid released May 2 2005)



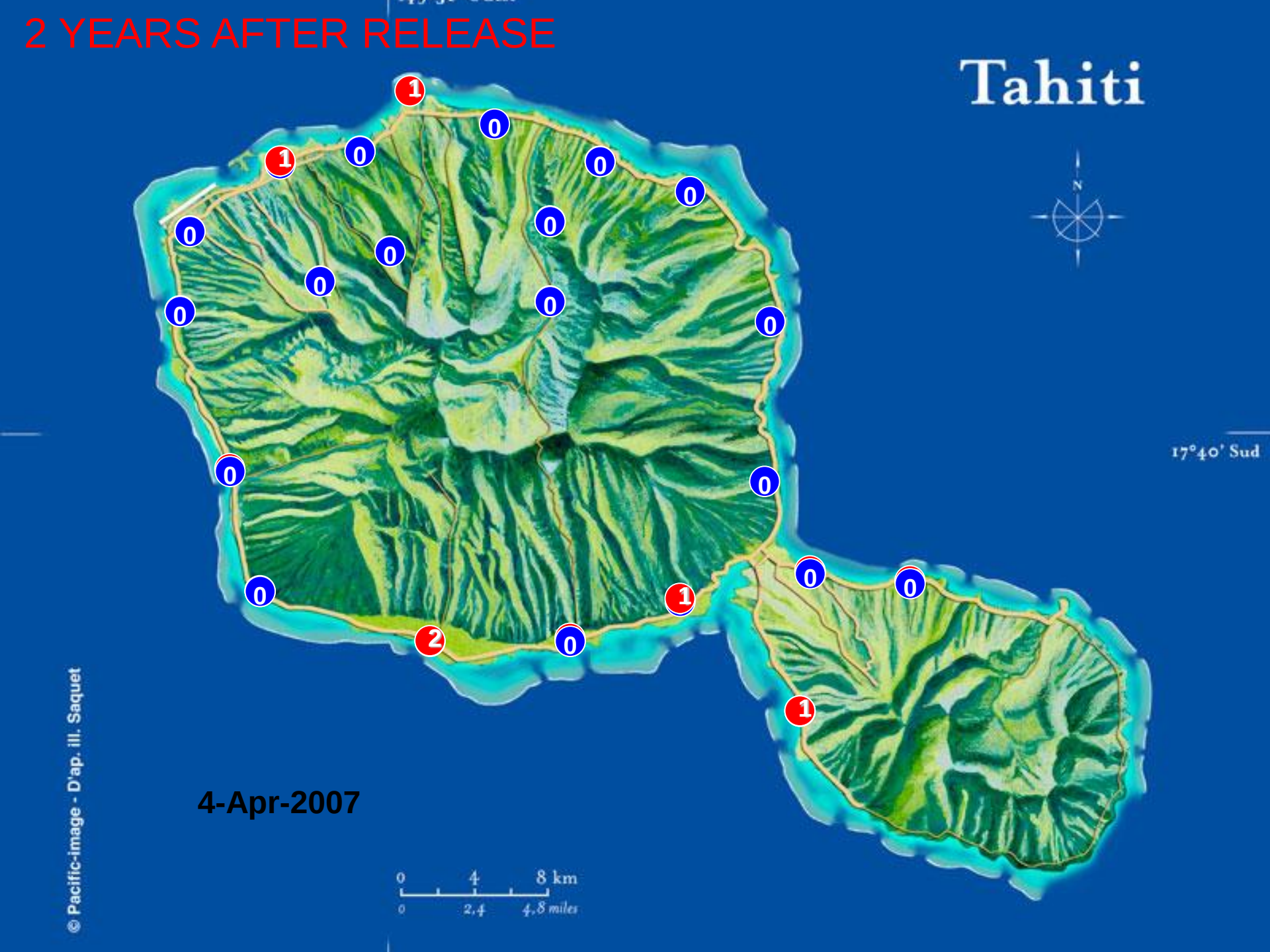
GWSS Nymphal Densities on 19/08/05

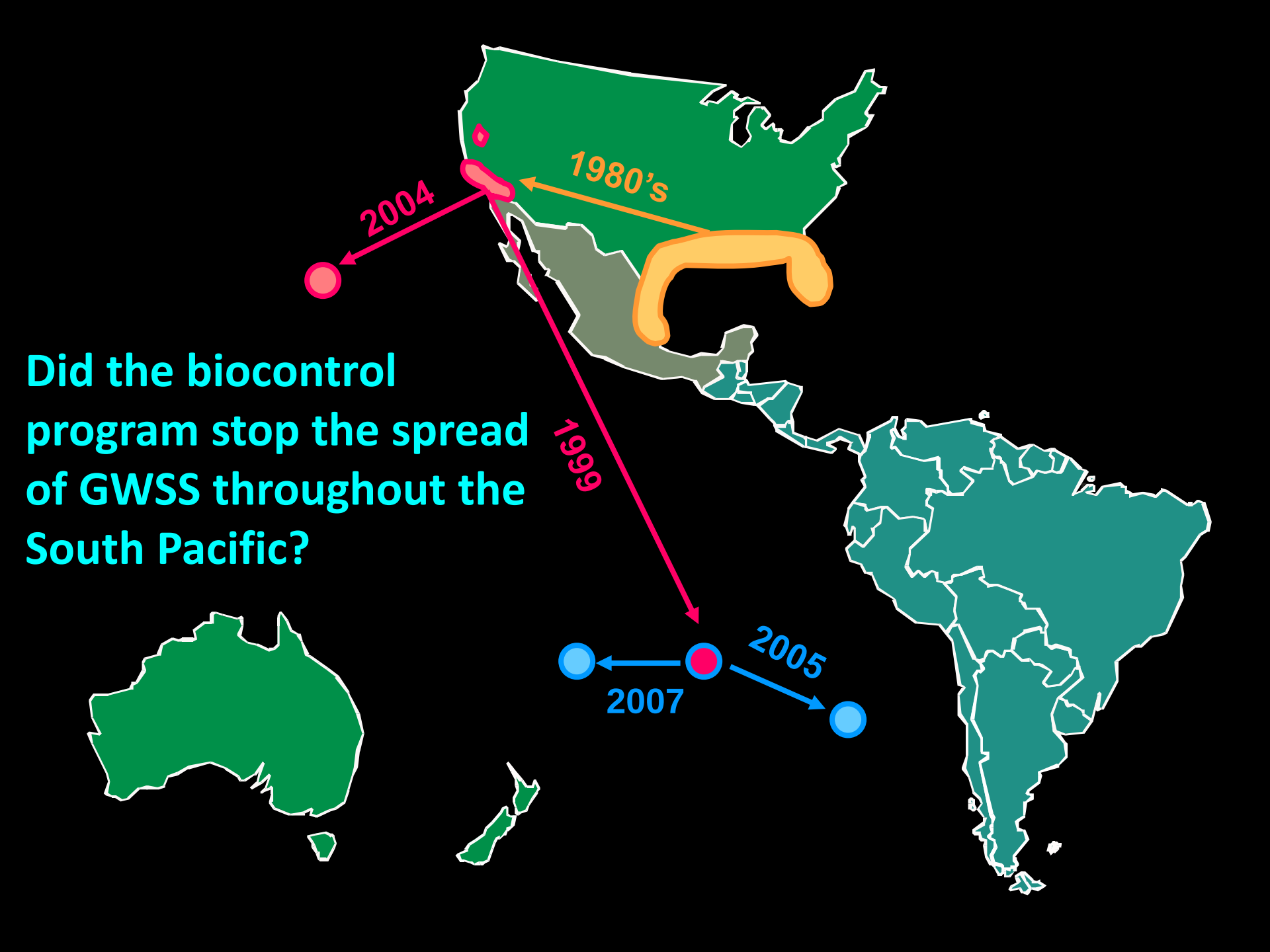


GWSS Nymphal Densities on 01/10/05

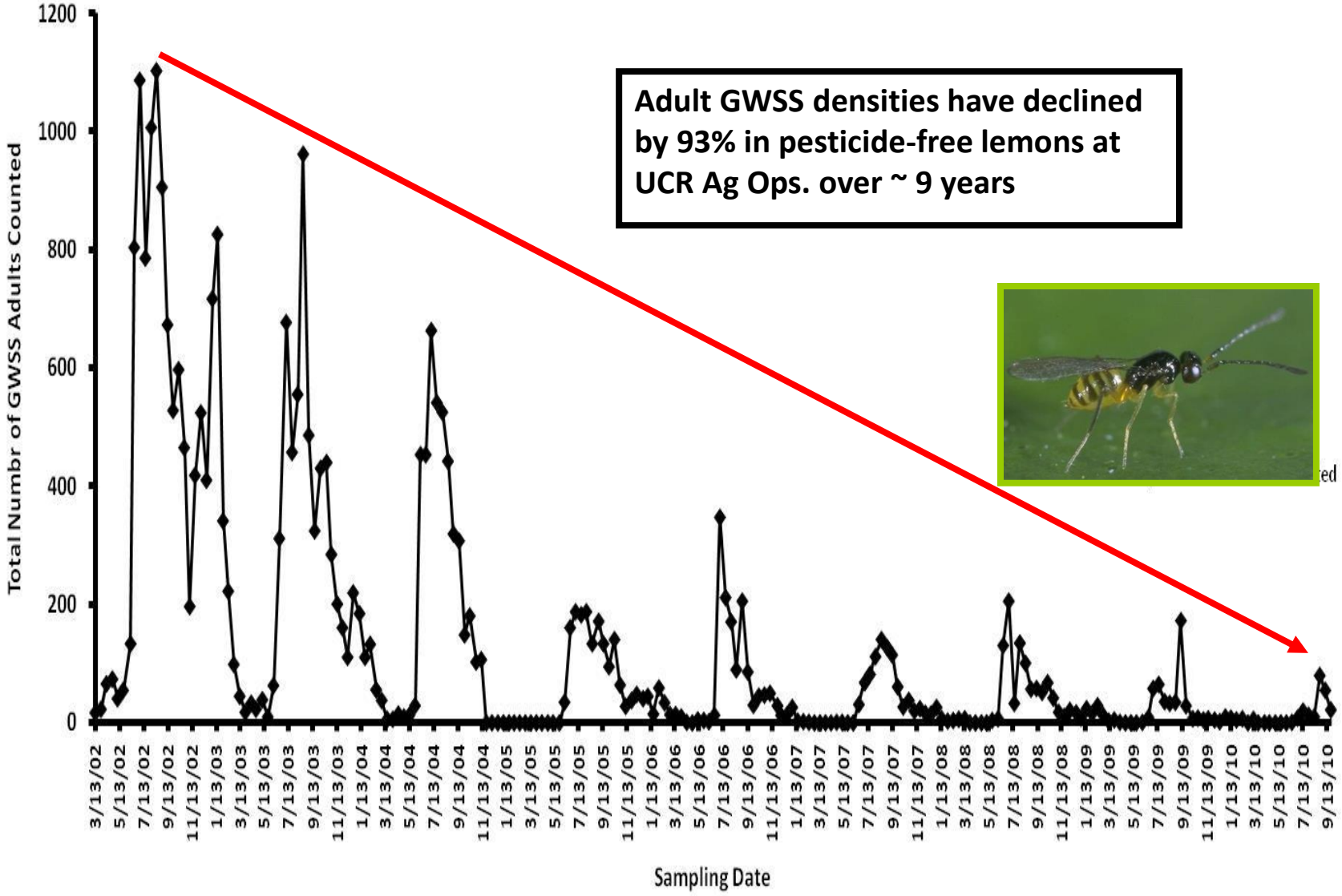


GWSS Nymphal Densities on 12/12/05


2 YEARS AFTER RELEASE
Tahiti
17°40' Sud
4-Apr-2007
0 4 8 km
0 2,4 4,8 miles
© Pacific-image - D'ap. ill. Saquet



Did the biocontrol program stop the spread of GWSS throughout the South Pacific?


Adult GWSS densities have declined by 93% in pesticide-free lemons at UCR Ag Ops. over ~ 9 years
Total Numbr of GWSS Adults Counted
1200
1000
800
600
400
200
0
3/13/02
5/13/02
7/13/02
9/13/02
11/13/02
1/13/03
3/13/03
5/13/03
7/13/03
9/13/03
11/13/03
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3/13/10
5/13/10
7/13/10
9/13/10
Sampling Date

What is the GWSS Risk to NZ & Australia?

- **Two research projects conducted at UCR have addressed this question:**
- **Anna Rathe's Ph.D. research at Charles Sturt University**
  - **GWSS will infest several genera/species of native Australian plants – egg to adult development observed**
  - **Probable that some native plants will host *Xylella***
  - ***G. ashmeadi* will attack GWSS eggs on native plants**
  - **GWSS can survive conditions simulating long distance transportation and reproduce!**
  - **Climate suitable in Australia for GWSS and *Xylella***
- **Landcare Research**
  - **102 native NZ plant species examined in SoCal**
    - **25% had evidence of GWSS breeding & parasitoid activity**
    - **72% tested positive for *Xylella***
    - **Climate is suitable in NZ for GWSS and probably *Xylella***

Is Proactive Biocontrol for GWSS Possible?

- **YES!**
- **Natural enemy of choice is *Gonatocerus ashmeadi***
  - **Recent taxonomic revision has moved *G. ashmeadi* to *Cosmocomoidea ashmeadi* (Huber 2015 Zootaxa)**
  - **Keep an eye open for these types of revisions!**
- **John Charles, Plant & Food Research, has reviewed proactive biocontrol for GWSS and concluded that *G. ashmeadi* poses negligible risk to non-target native NZ insects**
- **Should *G. ashmeadi* be "fast-tracked" and given an *a priori* "greenlight" for immediate release in NZ should breeding GWSS populations be found?**
- **Why bother with all this?**
  - **GWSS likely to be first found in urban areas**
  - **Eradication with pesticides unlikely**
  - **Suppress populations with natural enemies in urban centers may slow spread into agricultural areas and slow rate of spread of *Xylella***

How About Brown Marmorated Stink Bug?

- *Halyomorpha halys* is an invasive pest in the US
  - Native to China, Korea, Japan, and Taiwan
- Invaded the east coast of the US in 1998 (CA in ~ 2005)
  - Highly destructive pest
  - Feeds > 300 host plants
  - Attacks fruit, grapes, berry, row crops, & ornamentals
    - In 2010, it caused $32 million in loses to mid-Atlantic apple growers
    - Spray use increased 4 x
    - 2^{o} pests common now

BMSB Overwintering Aggregations

The BMSB Threat to Grape Producers

- **BMSB feeding damage to berries**
  - **Berry collapse and discoloration**
  - **Allows entry to pathogens**
  - **Attracts drosophilids, bees, wasps, beetles**
- **Feeding damage to raceme causes berry death or cluster abscission**
- **BMSB harvested in clusters a potential quarantine issue**
- **Pesticide applications likely for control**
  - **2^{o} pest outbreaks occur in east coast grapes (e.g., mealybugs that vector leaf roll viruses)**
- **Aggregations in processing plants likely – could contaminate packed grapes**

Other Commodities Are at Risk

High climate suitable areas at risk of invasion include latitudes between 30°-50° including northern Europe, northeastern North America, southern Australia and the North Island of New Zealand

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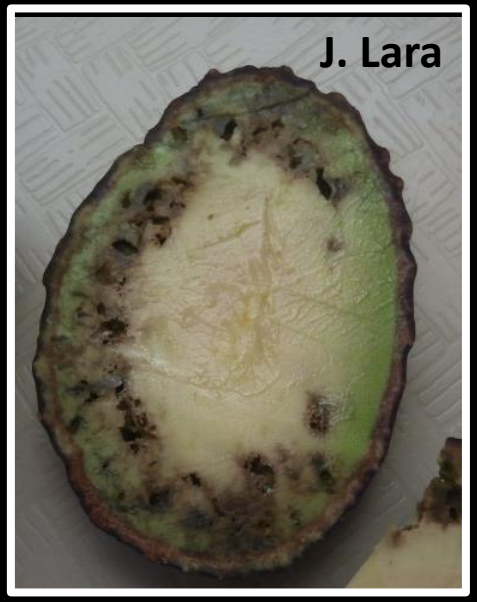

Classical Biocontrol of BMSB

- A major classical biocontrol program targeting BMSB is underway in the USA
- *Trissolcus japonicus* (Hymenoptera: Plagastridae)
  - Self-introduced into the NE and NW USA
- Egg parasitoid from Beijing (K. Hoelmer, USDA-BIIR)
- Parasitism rates in field collected BMSB egg masses was 50-80%
- Host range evaluated across the country (DE, OR, FL, MI, CA)
  - CA has a lot native pentatomids
  - One is an important predator
    - *Podisus maculiventris*
  - Host specificity testing demanding

Slide prepared by R. Lara UCR

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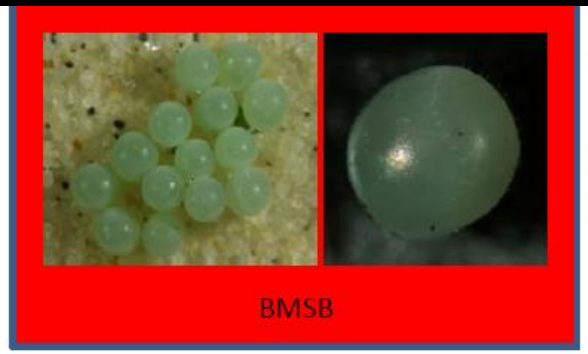
Banasa
dimiata & euchlora



BMSB

Brochymena
quadripustulata

Thyanta spp.

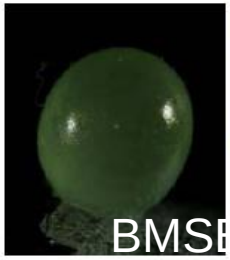

Chinavia
hilaris

Chlorochroa
sayi

Cosmopepla lintneriana

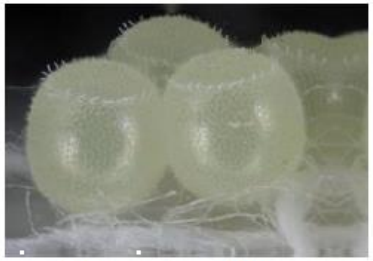
Murgantia histrionica

Trichopepla semivittata



BMSB

Edessa florida

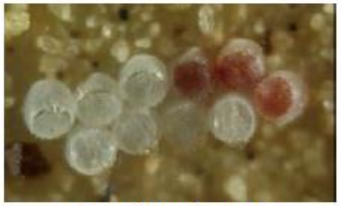


Euschistus servus

Holcosthetus limbolarius

Oebalus pugnax


Menecles insertus



Mormidea lugens

Podisus maculiventris

Stiretrus anchorago

C. Dieckhoff (USDA-ARS)

Is Proactive Biocontrol of BMSB in NZ Feasible?

- **Lab studies suggest *Trissolcus japonicus* is polyphagous**
  - **This natural enemy may have a broader than desired host range**
  - **Hard to disentangle the confounding effects of small test arenas and limited movement on potential host use in the field**
- **Pentatomoidea in NZ seems relatively small**
  - **16 species in three families (Lariviere 1995, Fauna of NZ)**
    - **Cydnidae, Acanthosomatidae, and Pentatomidae (BMSB family)**
    - **Some NZ pentatomids are exotic pests (e.g., *Nezara viridula*)**
    - **This may bode well for proactive BMSB biocontrol**
      - ***1 alpine endemic species at risk*, habitat/host may not be preferred by *T. japonicus***

Is There a Precedent for Proactive Biocontrol in NZ?

- Mmmmm, sort of, perhaps, not really??
- Weed biocontrol in NZ has taken advantage of overseas weed biocontrol programs
  - Used completed host specificity testing to streamline plant testing in NZ
    - Minimizes cost
    - Saves time
  - Speeds up significantly the acquisition of natural enemies
    - Don't need to conduct foreign exploration
- Similar concept available for insect pests in NZ?
  - Potato psyllid – recent approval for *Tamarixia triozae*
  - BMSB, GWSS, and ACP
    - Natural enemies identified and safety testing completed/underway
    - Significant history of use and non-target impact work

Time for Discussion ……