

Bugs without borders: unintended spread of introduced natural enemies

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Classical Biological Control

**Feasibility
Analysis**

**Demographics
and life cycle
analyses**

**Foreign
exploration**

**Host
specificity
testing**

**Predict
efficacy**

**Post release
evaluations**

Geographic region of interest

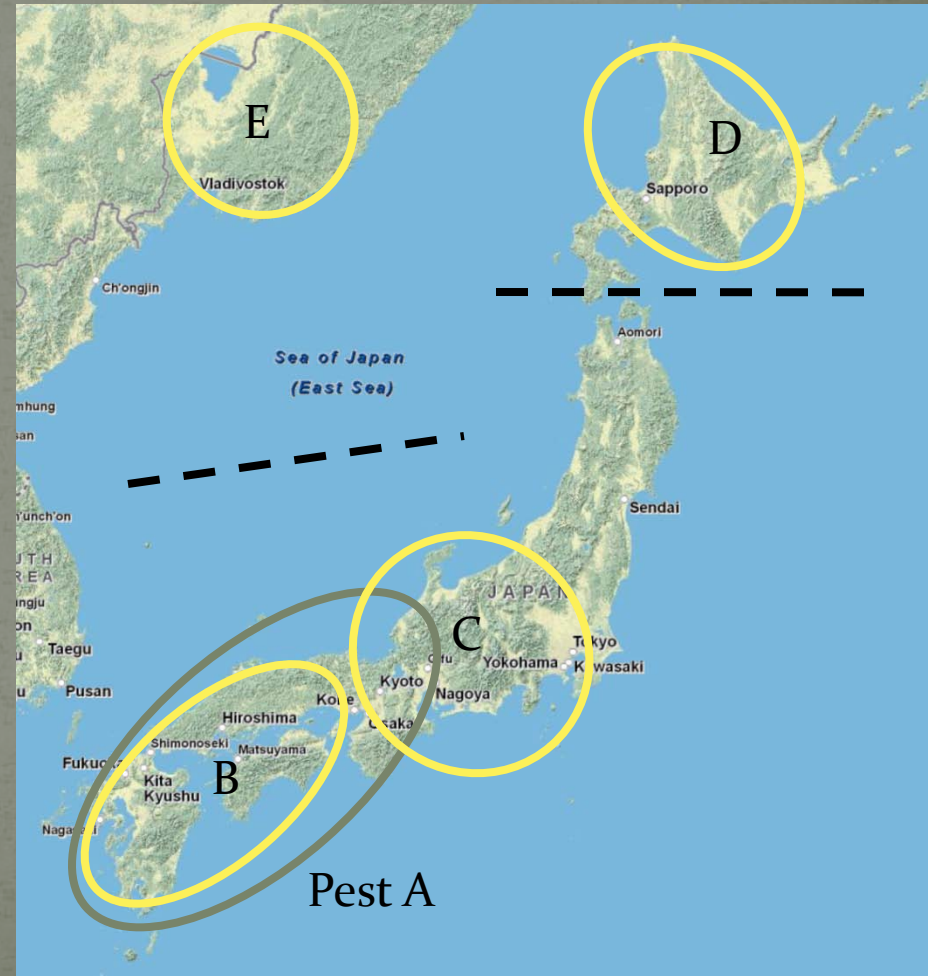
Geographic region

- Sympatric
- Physiological limitations
- Geographic barriers

		Host?
A	pest	Yes
B	native	No
C	native	No
D	native	Yes
E	native	Yes



To release or not to release,
that is the question



Geographic region of interest

Underlying assumption:
introduced agents will remain within the
identified boundaries that delineate the
program's geographic footprint.



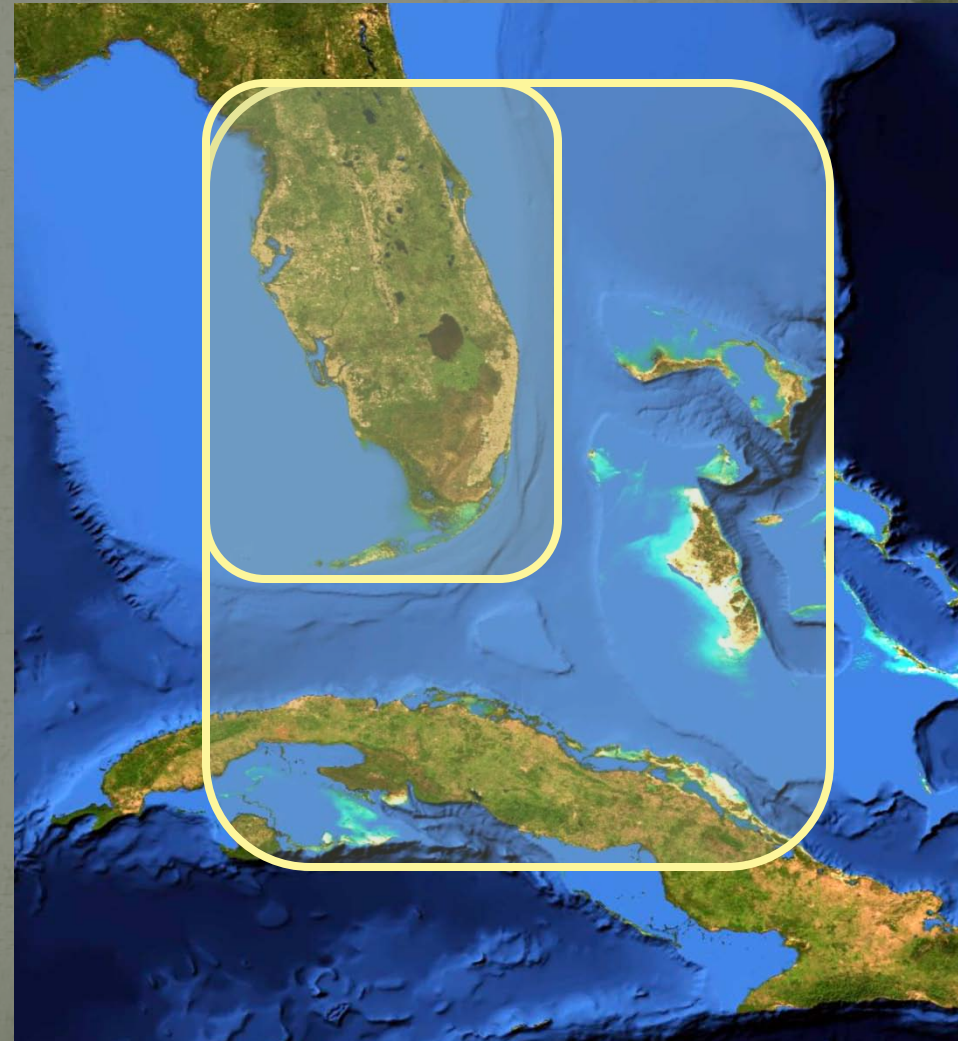
Test geographic assumption:
Melaleuca quinquenervia
in Florida, USA



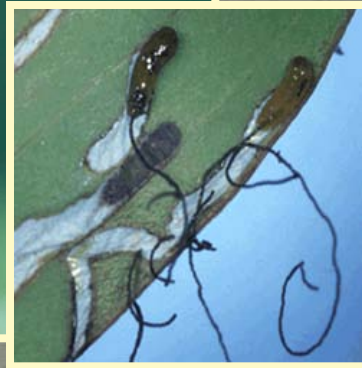


Geographic region of interest

- Biological control program: 1986
- Project footprint:
 - Florida
 - Bahamas (western)
 - Cuba (Zapata peninsula)
- 10 of 11 myrtaceous species in the Bahamas were tested
- Genus level specialists



Biological Control Agents



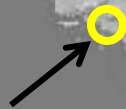
Melaleuca snout weevil
(*Oxyops vitiosa*)

Released 1997



Melaleuca psyllid
(*Boreioglycaspis melaleucae*)

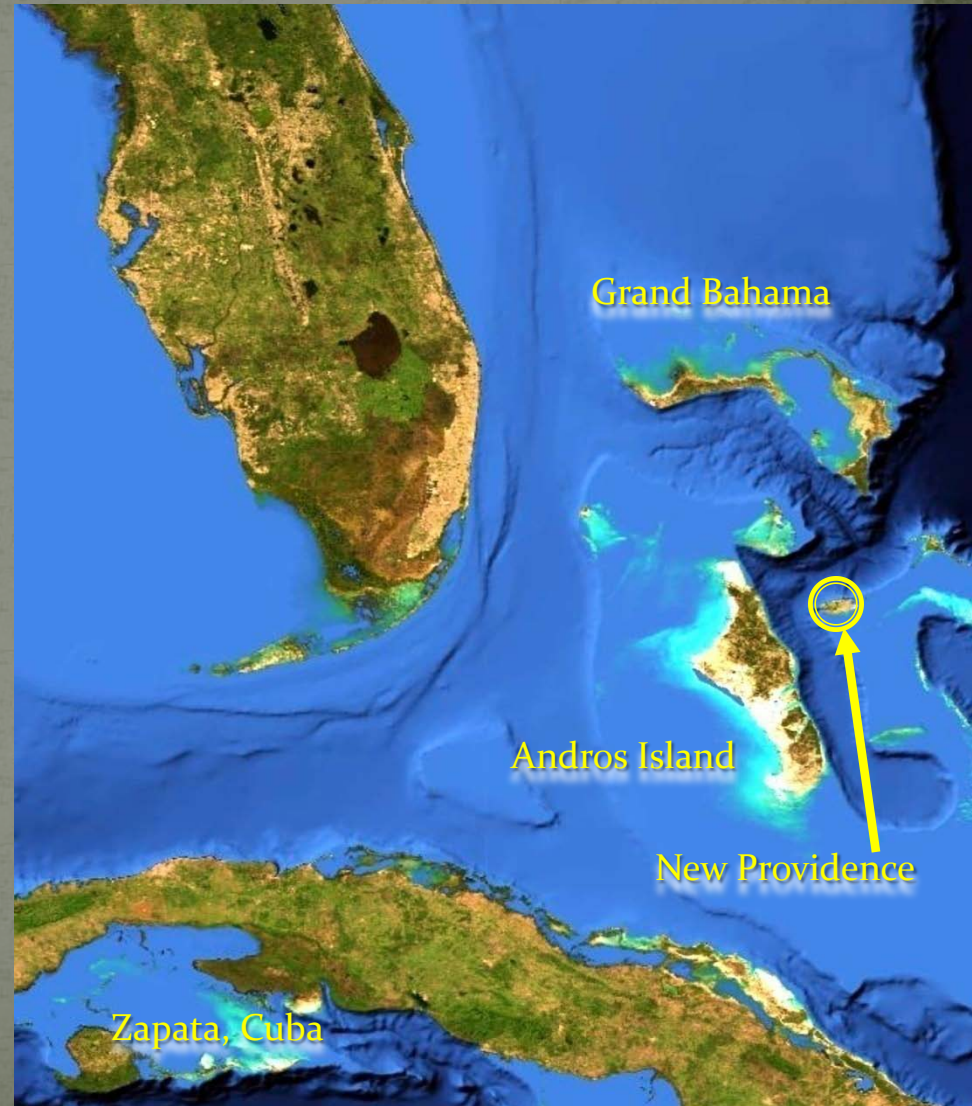
Released 2002



PIRATES of the CARIBBEAN

Bahamas and Cuba

- Hypothesis: Andros > Grand Bahama > New Providence
- Cuba: 2 sites
 - 2005 & 2007: No
- Grand Bahama: 20 sites
 - 2005 & 2007: No
- Andros Island: 8 sites
 - 2005 & 2007: No
- New Providence: 22 sites
 - 2005: no
 - 2007: Yes: weevil *O. vitiosa*



Dispersal pathways

- When
- from
- Flo
- How
- New
- Ne
- An
- Gra
- Zap
- Hurric

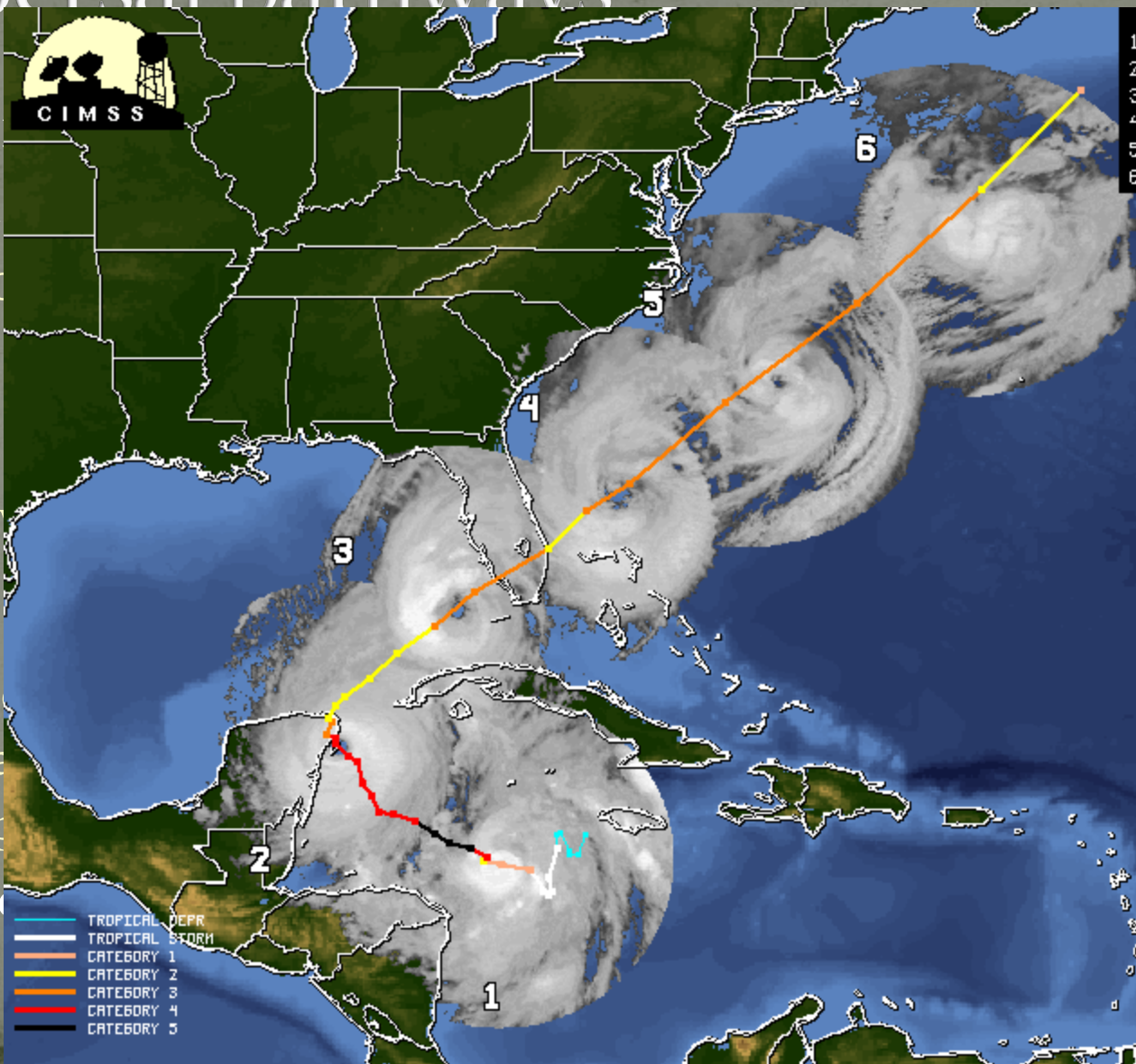


Image Index	
1:	2005OCT18/21: 15: 00UTC
2:	2005OCT21/17: 45: 00UTC
3:	2005OCT24/05: 15: 00UTC
4:	2005OCT24/19: 45: 00UTC
5:	2005OCT25/04: 15: 00UTC
6:	2005OCT25/13: 45: 00UTC

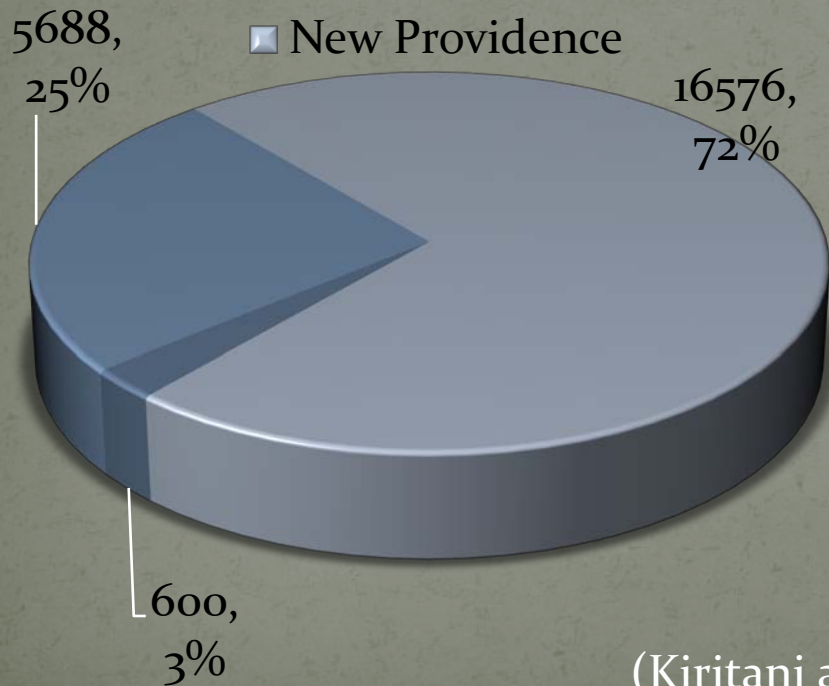
- TROPICAL DEPR
- TROPICAL STORM
- CATEGORY 1
- CATEGORY 2
- CATEGORY 3
- CATEGORY 4
- CATEGORY 5



Dispersal pathways

Air travel from south Florida to:

- Andros
- Grand Bahama
- New Providence



(Kiritani and Yamamura 2003)

- Most common invasion pathway is airline luggage and cargo
- Nearly 23,000 flights from Florida to 3 islands
- 166 ships from Miami & 52 from Ft. Lauderdale, all to New Providence
- Hitchhiked?

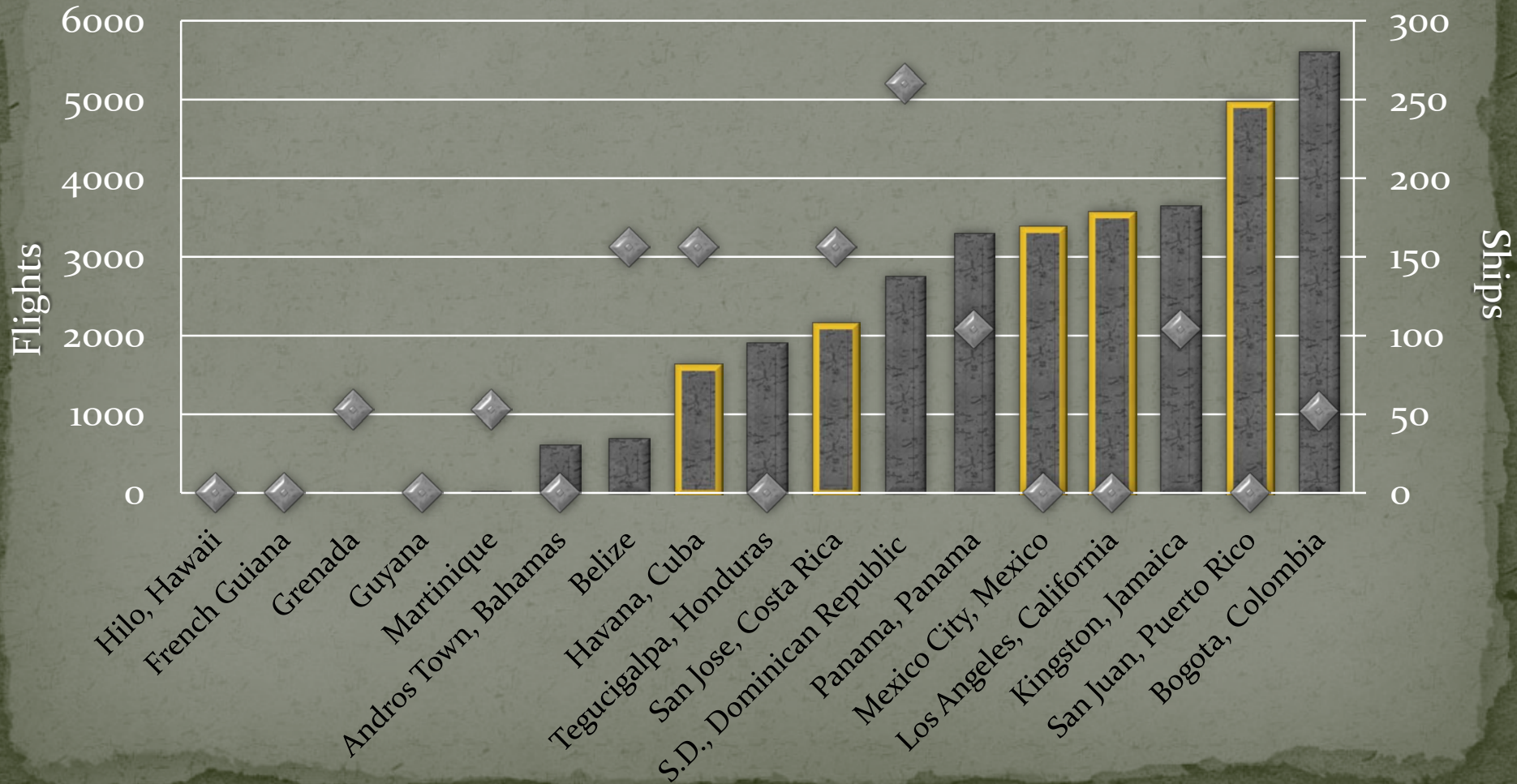


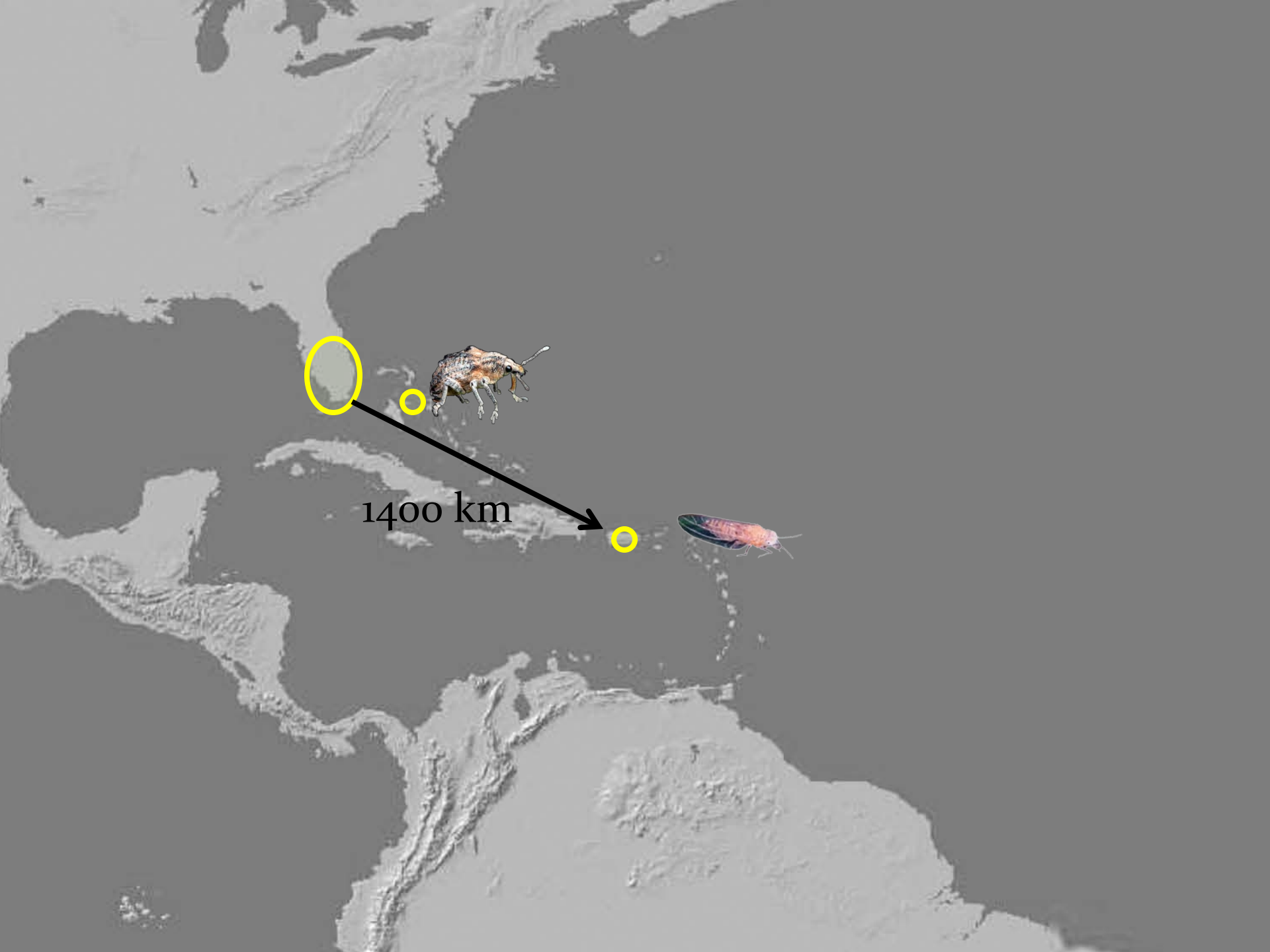
Flight and shipping data



Dispersal pathways

No. of direct flights and shipping tankers from south Florida to:





1400 km





3500 km



Unintended spread

- Implications
 - Fortuitous agent or unwelcome invader?
 - P.R. & Bahamas
 - Los Angeles, CA
 - Genus level specialists
 - No native *Melaleuca* in New World
 - no direct non-target damage
 - Unknown indirect non-target effects

Beauty or Beast?



Long range dispersers

- **Border crossings:**
- *Mogulones cruciger* (root weevil): released in Canada and dispersed south to US
- *Urophora quadrifasciata* (seed head fly): introduced in Canada and spread south to Arizona in US.
- *Eriophyes chondrillae* (eriophyid mite): introduced into US and spread north into Canada.
- *Puccinia chondrillina* (rust fungus): released in US but spread north into Canada.
- *Procecidochares utilis* (tephritid fly): released in India but dispersed to Nepal and China.

Long range dispersers

- **Barrier Breakers:**
- *Cactoblastis cactorum* (moth): released in the Caribbean (Nevis) and dispersed to Florida in 1989.
- *Aphytis lepidosaphes* (wasp): introduced into California for the control of a citrus scale but now occurs in Florida, Hawaii, Puerto Rico, Argentina, Turkey, Australia, etc.
- *Calycomyza lantanae* and *Ophiomyia lantanae* (agromyzid flies): released in Australia and now occur in Micronesia and Malaysia.
- *Dialectica scalariella* (moth): introduced into Australia for control of *Echium canalicans* but dispersed to New Zealand.
- *Longitarsus* sp.: not permitted for release in Australia due to permeability of geographic barriers.

Geographic region of interest

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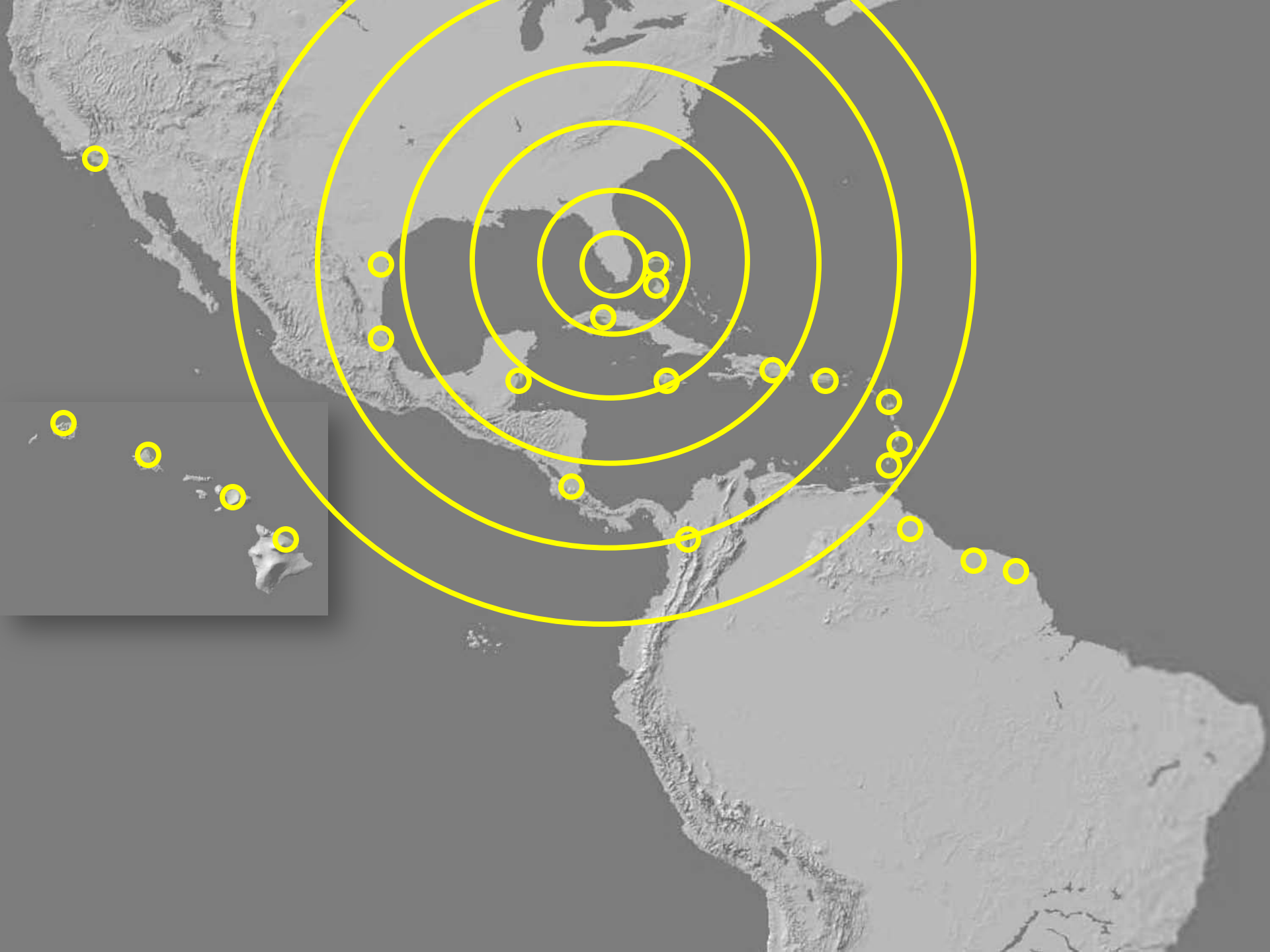
Aint no mountain high enough....

- Are there any geographic boundaries that limit an agent's spread?



Factors contributing to unintended spread

- Agent
 - High intrinsic reproductive potential
 - Good dispersers
 - Long lived adults (or eggs)
 - Estab. via small founding populations
 - Common families
- Pathways
 - Hub of trade or tourism
 - Prevailing winds or storms
 - “loose cannons”
 - Dynamic
- Recipient habitat
 - Widely distributed host
 - Climate similarity
(few examples of insects dispersing beyond physiological barriers)



Acknowledgements

- Lourdes Bernier: Puerto Rico
- Lucero Sevillano: Mexico
- Amy Ferriter: Hawaii and Cuba
- Melanie Williams: Bahamas
- Dana Price, John Goolsby: Texas, US
- Dan Clark: Costa Rica
- Ernita van Wyk: South Africa

