# Laurel wilt
## and the "other" ambrosia symbioses

**Jiri Hulcr**

UF UNIVERSITY of FLORIDA

# 1. Ambrosia beetles

**fungus farmers**

# 1. Ambrosia beetles

**fungus farmers**

# 1. Ambrosia beetles

**fungus farmers**

**1 mm —**

# 1. Ambrosia beetles

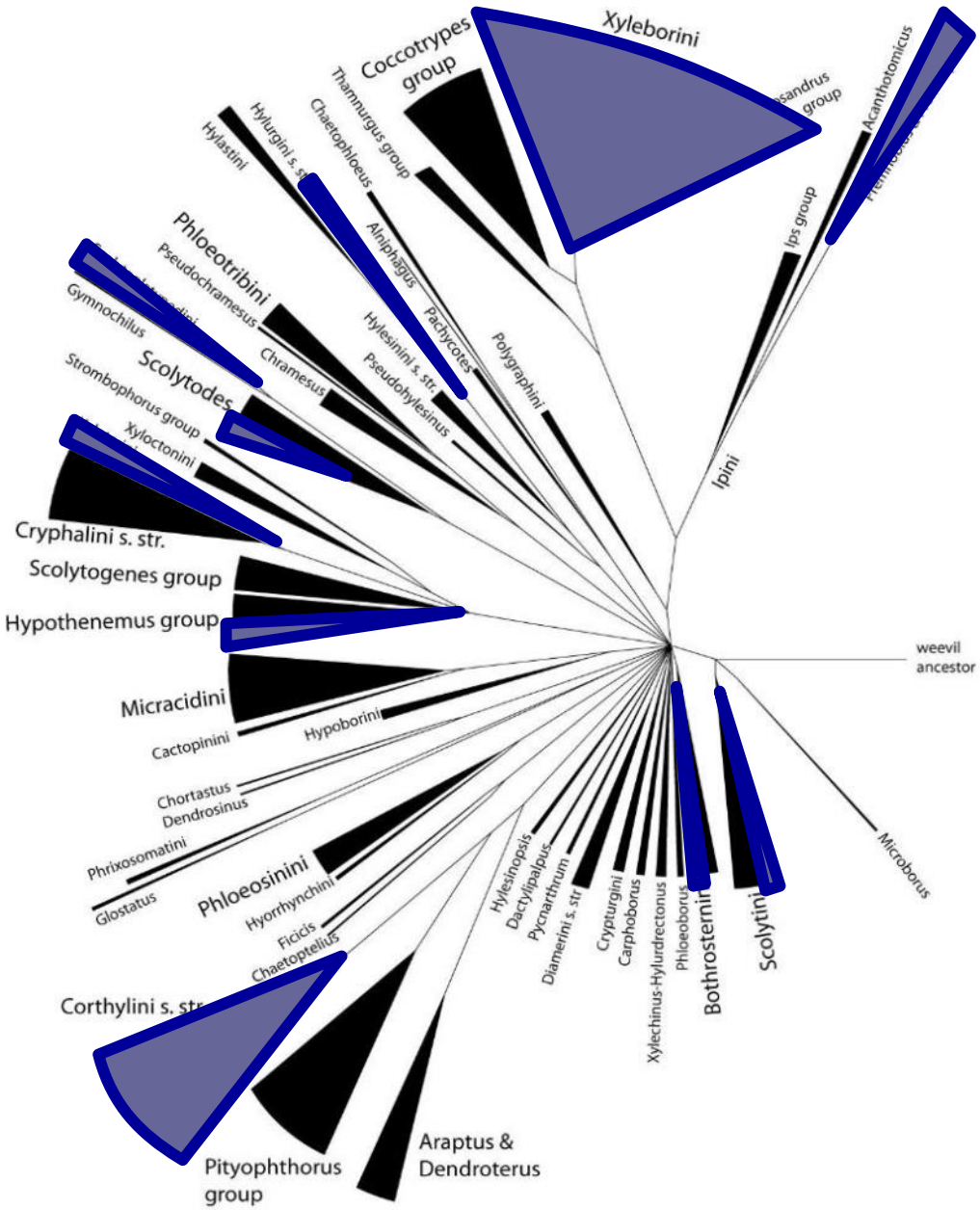
## fungus farmers

# 1. Ambrosia beetles

## fungus farmers

**11 origins of fungus farming**

**3,500 species mostly tropical**

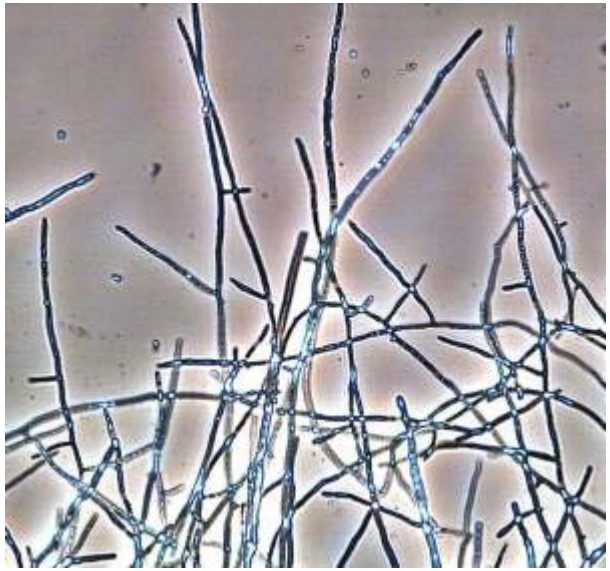



Bark beetle phylogeny

# 1. Ambrosia beetles

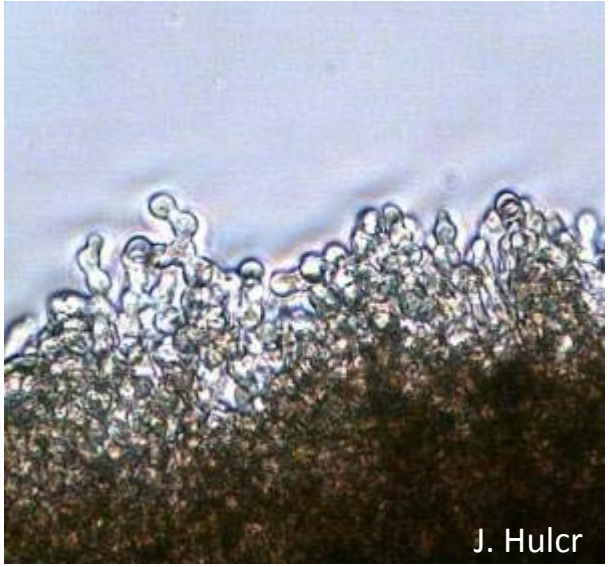
fungus farmers • **fungi**

**hyphae**



**in mycangium**

**garden**

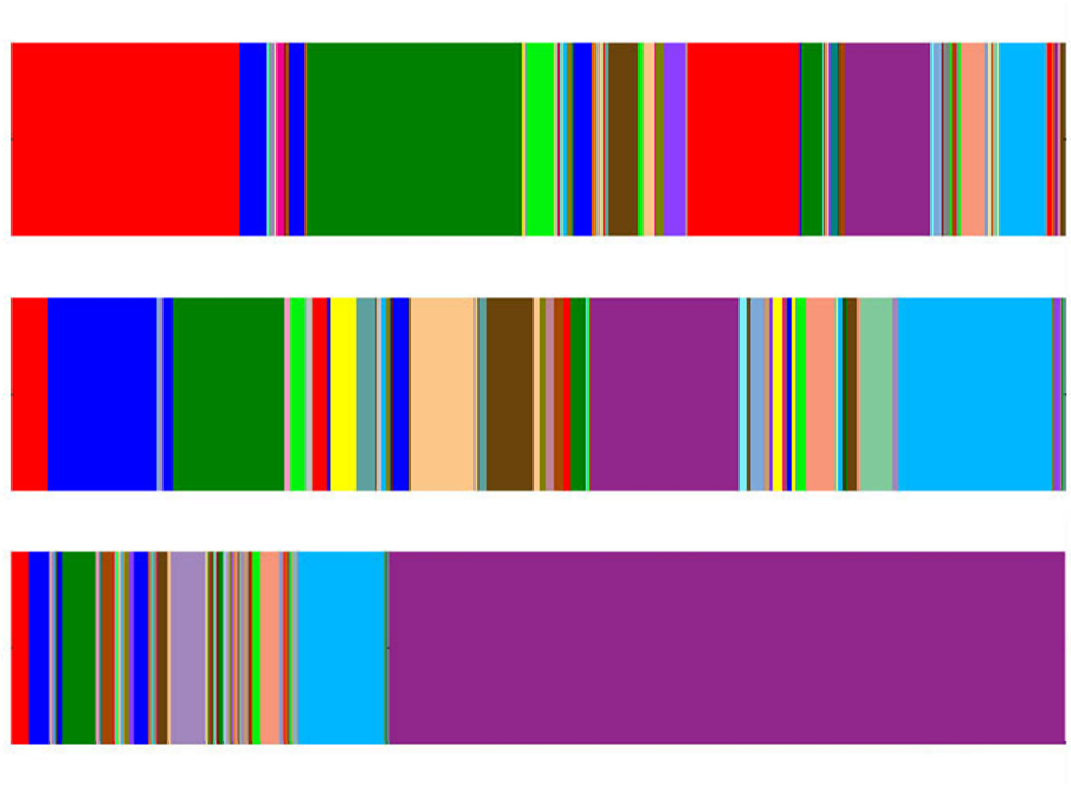


# 1. Ambrosia beetles

fungus farmers • fungi

*Xyleborus* spp.

*Xylosandrus*



Kostovcik et al. 2015

# 1. Ambrosia beetles

fungus farmers • **fungi**

**Literature:**

"… most ambrosia beetles are associated with Ophiostomatales (*Raffaelea*) or Microascales (*Ambrosiella*)…"

| | **ambrosia beetle genera** |
|---|---|
| Bothrosternini | 2 |
| *Camptocerus* (2 subgenera) | 2 |
| Corthylina | 10 |
| *Premnobius* clade | 2 |
| *Scolytodes unipunctatus* | 1 |
| Scolytoplatypodini | 2 |
| *Stylotentus* subgenus | 1 |
| *Sueus* | 1 |
| Xyleborini – elytral mycangium | 6 |
| Xyleborini – mandibular m. | 10 |
| Xyleborini – mesonotal m. | 5 |
| Xyleborini – unknown m. | 14 |
| Xyloterini | 3 |

**Fungi unknown in**

**72%**

**ambrosia beetle genera**

# 1. Ambrosia beetles

fungus farmers • **fungi**

**Literature:**

"… most ambrosia beetles are associated with Ophiostomatales (*Raffaelea*) or Microascales (*Ambrosiella*)…"

| ambrosia beetle genera | | # never studied |
|---|---|---|
| Bothrosternini | 2 | 0 |
| *Camptocerus* (2 subgenera) | 2 | 2 |
| Corthylina | 10 | 8 |
| *Premnobius* clade | 2 | 2 |
| *Scolytodes unipunctatus* | 1 | 0 |
| Scolytoplatypodini | 2 | 2 |
| *Stylotentus* subgenus | 1 | 1 |
| *Sueus* | 1 | 1 |
| Xyleborini – elytral mycangium | 6 | 5 |
| Xyleborini – mandibular m. | 10 | 6 |
| Xyleborini – mesonotal m. | 5 | 2 |
| Xyleborini – unknown m. | 14 | 13 |
| Xyloterini | 3 | 1 |

*Scolytodes* = ambrosial *Geosmithia*

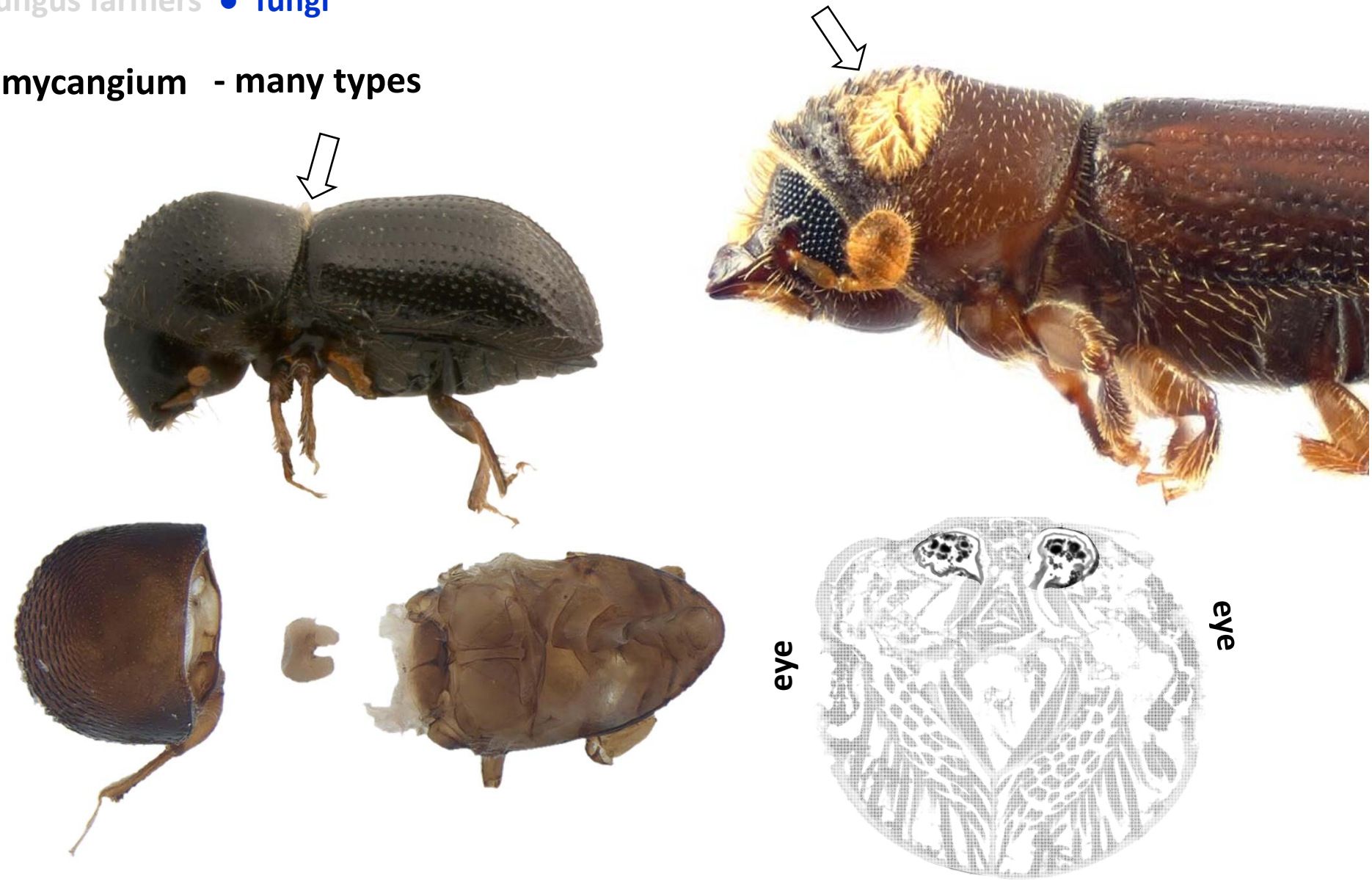
*Euwallacea* = ambrosial *Fusarium*

*Ambrosiodmus* = ambrosial polypore

# 1. Ambrosia beetles

fungus farmers • fungi

**mycangium - many types**



# 1. Ambrosia beetles

fungus farmers • fungi • **inbreeding**

# 1. Ambrosia beetles

fungus farmers • fungi • **inbreeding**

# 1. Ambrosia beetles

fungus farmers ● fungi ● inbreeding ● **host range**

**95% ambrosia beetles**

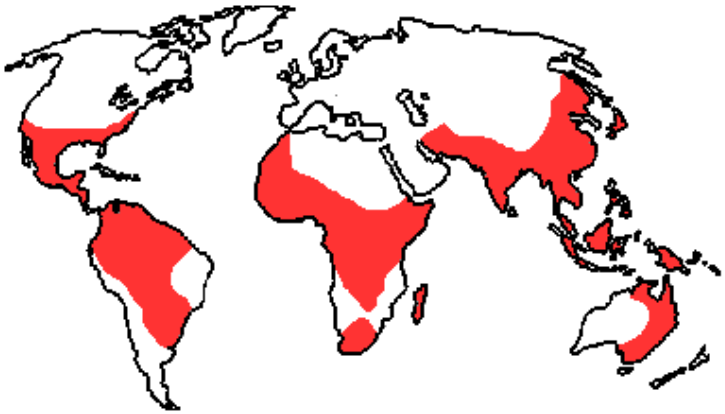
**no preference among tree species**

Hulcr *et al*. (2007b)

***But what about the remaining 5%?***

# 1. Ambrosia beetles

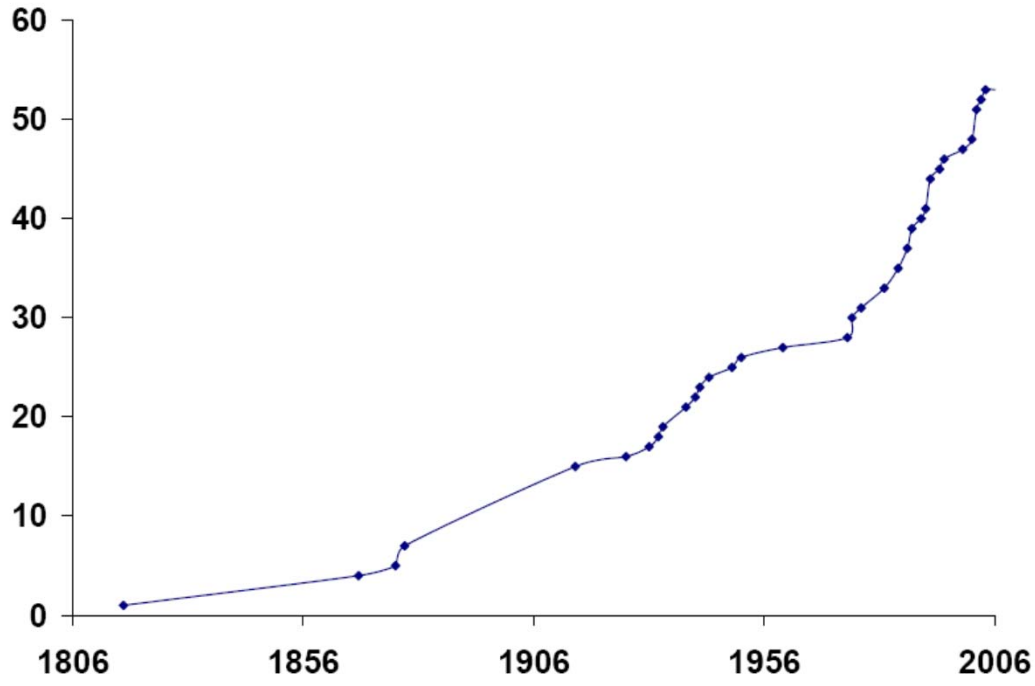
fungus farmers • fungi • inbreeding • host range • **global**



*Xyleborus affinis*

# 1. Ambrosia beetles

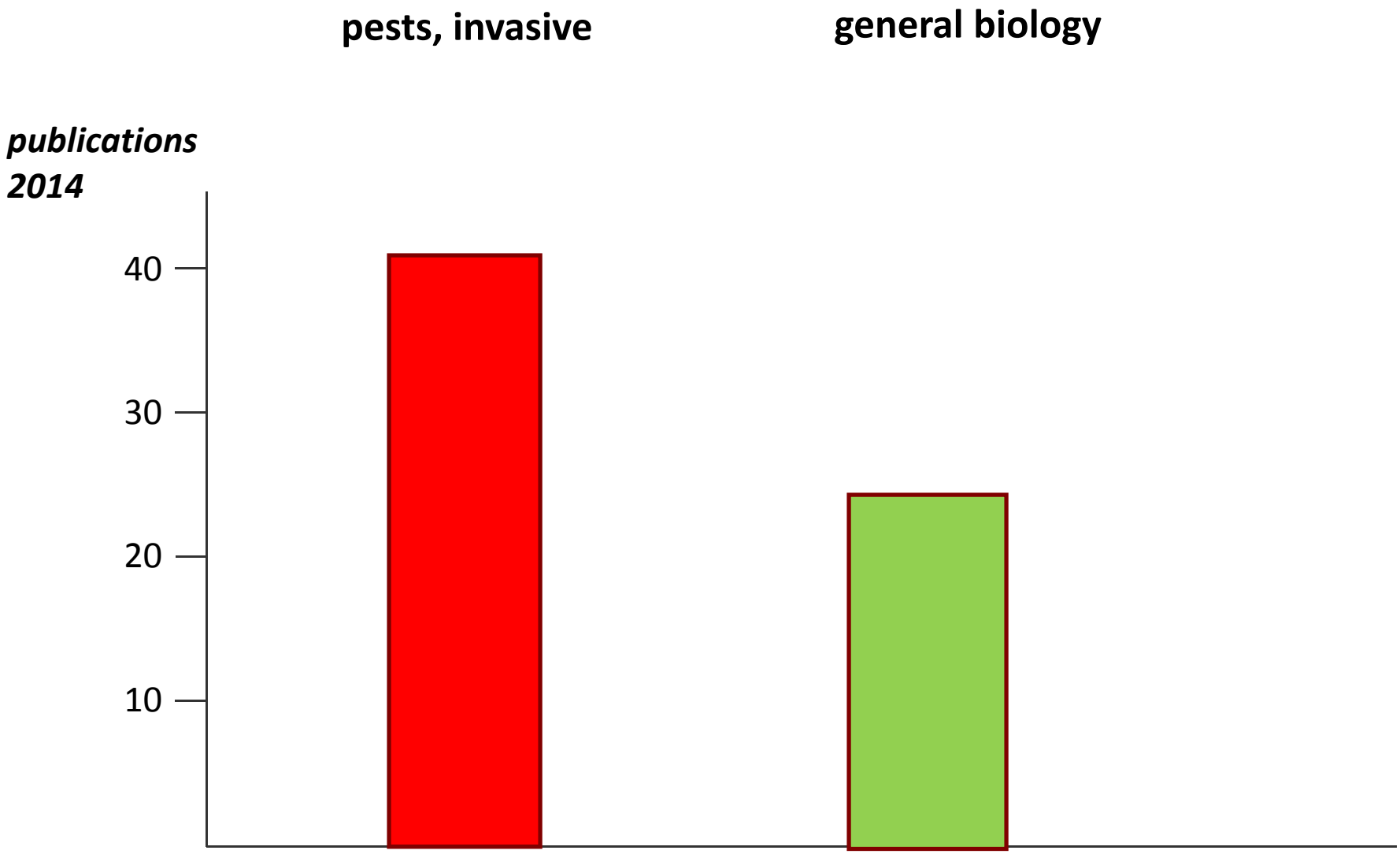
fungus farmers ● fungi ● inbreeding ● host range ● **global**




**Accumulation of exotic bark beetles in the US**

# 1. Ambrosia beetles

fungus farmers • fungi • inbreeding • host range • global • **pests**



# 1. Ambrosia beetles

fungus farmers • fungi • inbreeding • host range • global • **pests**

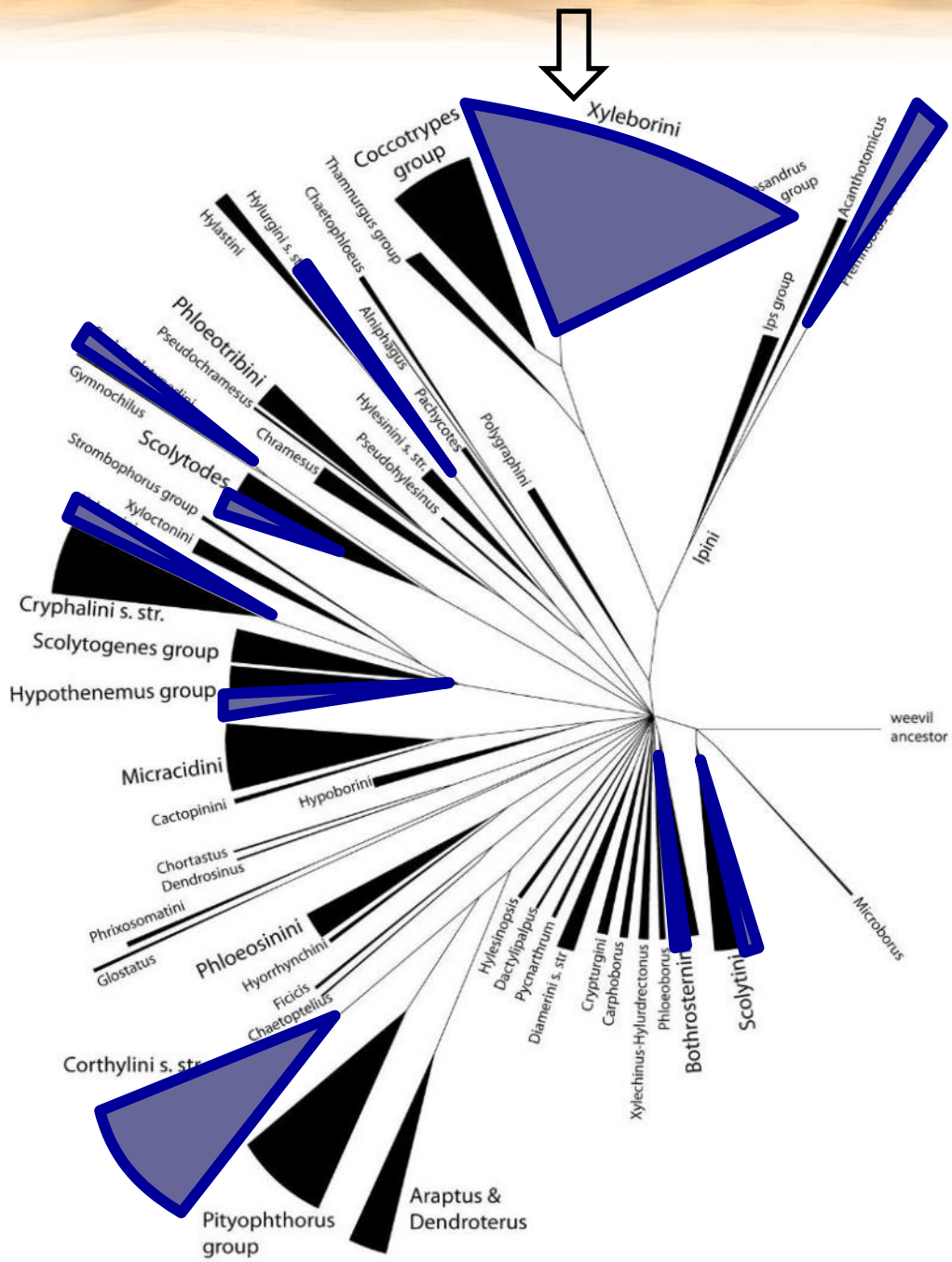
# 1. Ambrosia beetles

fungus farmers • fungi • inbreeding • host range • global • ~~pests~~

most are harmless

# 2. Xyleborus glabratus

**tribe: Xyleborini**



# 2. Xyleborus glabratus

**tribe: Xyleborini**

**family life: haplo-diploid inbreeder**

**boy**

*Kendra et al. 2013*

**girl**

# 2. Xyleborus glabratus

**tribe: Xyleborini**

**family life: haplo-diploid inbreeder**

**mycangium: pre-oral**

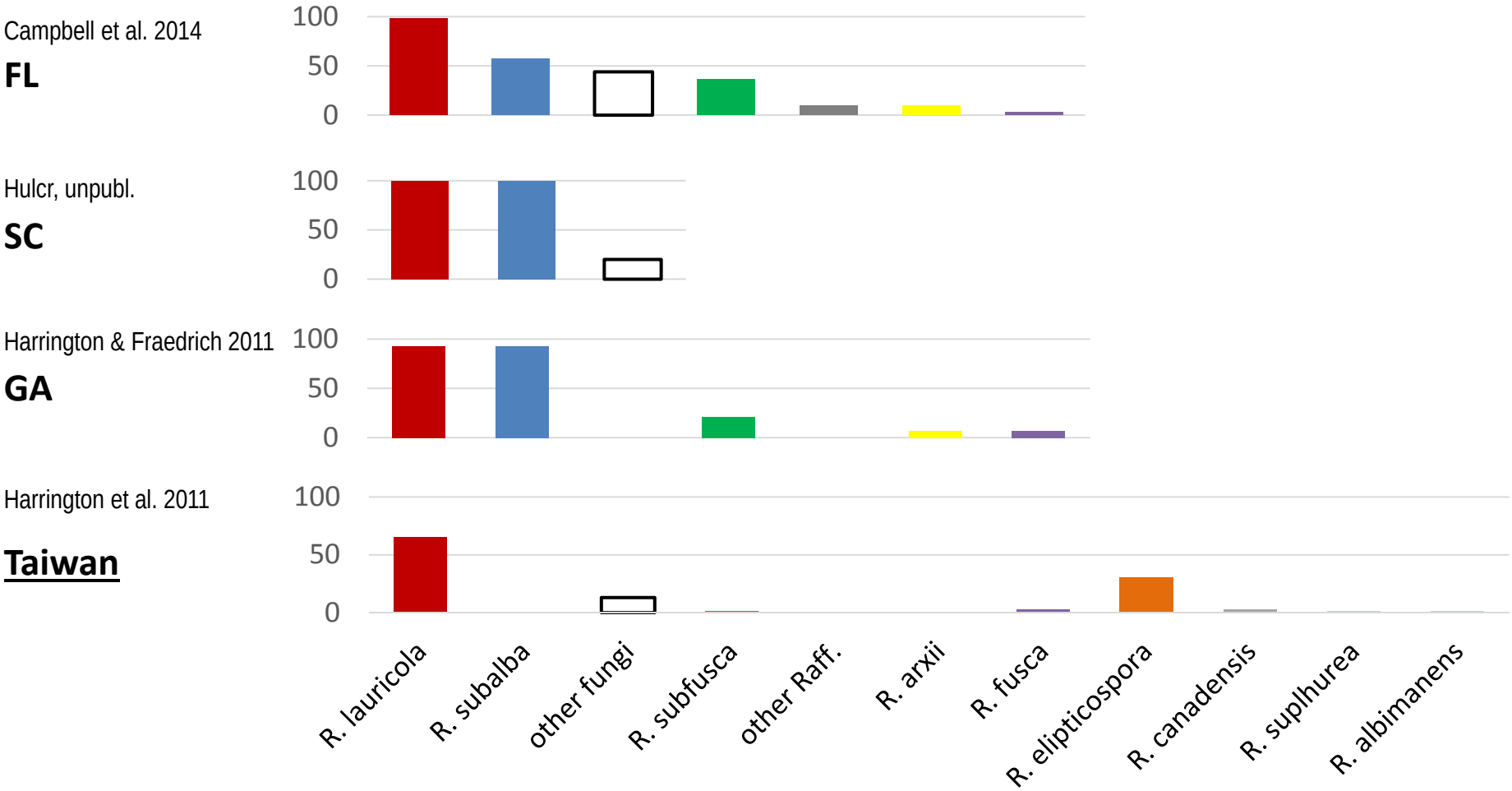
# 2. Xyleborus glabratus

**tribe: Xyleborini**

**family life: haplo-diploid inbreeder**

**mycangium: pre-oral**

**fungi**



# 2. Xyleborus glabratus

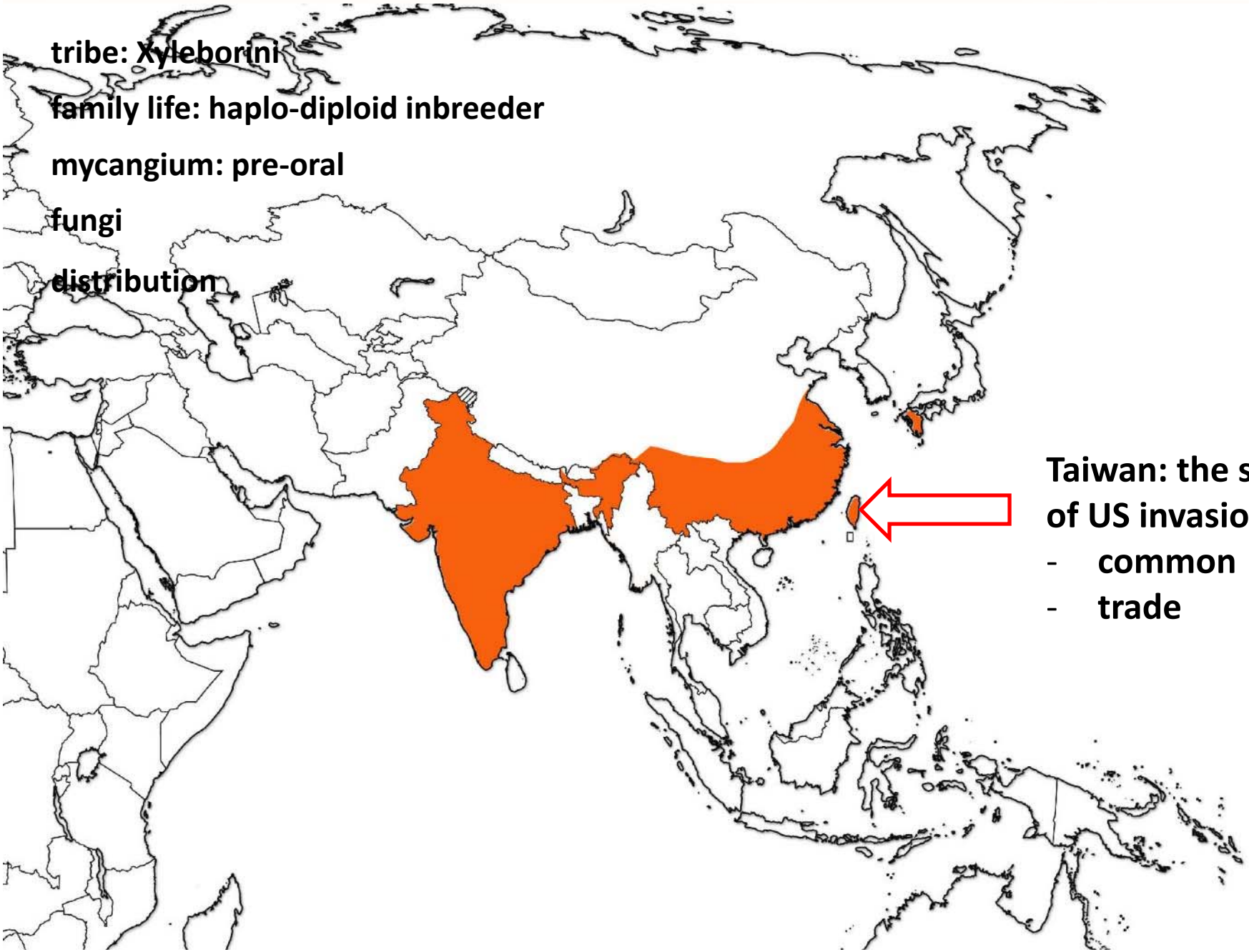
tribe: Xyleborini

family life: haplo-diploid inbreeder

mycangium: pre-oral

fungi

distribution



Taiwan: the source of US invasion!

- common
- trade

# 2. Xyleborus glabratus

**tribe: Xyleborini**

**family life: haplo-diploid inbreeder**

**mycangium: pre-oral**

**fungi**

**distribution**

**hosts**

**Lauraceae**

Dipterocarpaceae ?
Fagaceae ?
Pinaceae ?

} **Unreliable records**

**95% ambrosia beetles:**

**no preference among tree species.**

***But what about the remaining 5%?***

# 3. Tree killers

1) non-tree-killers

- 97% of species
- ALL native species in the US

# 3. Tree killers

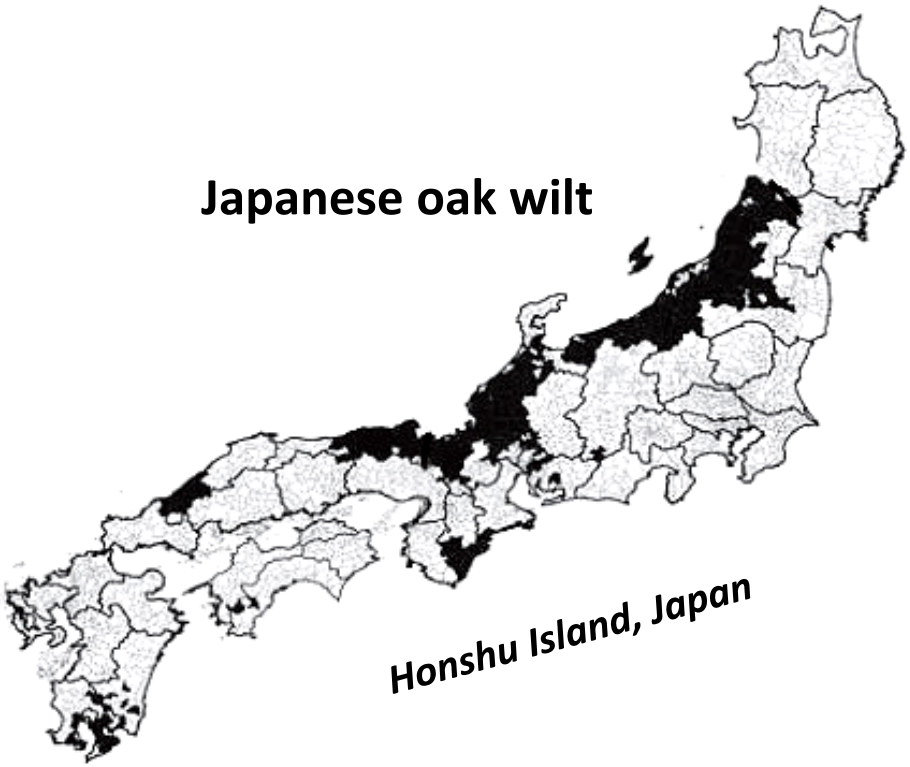
1) non-tree-killers

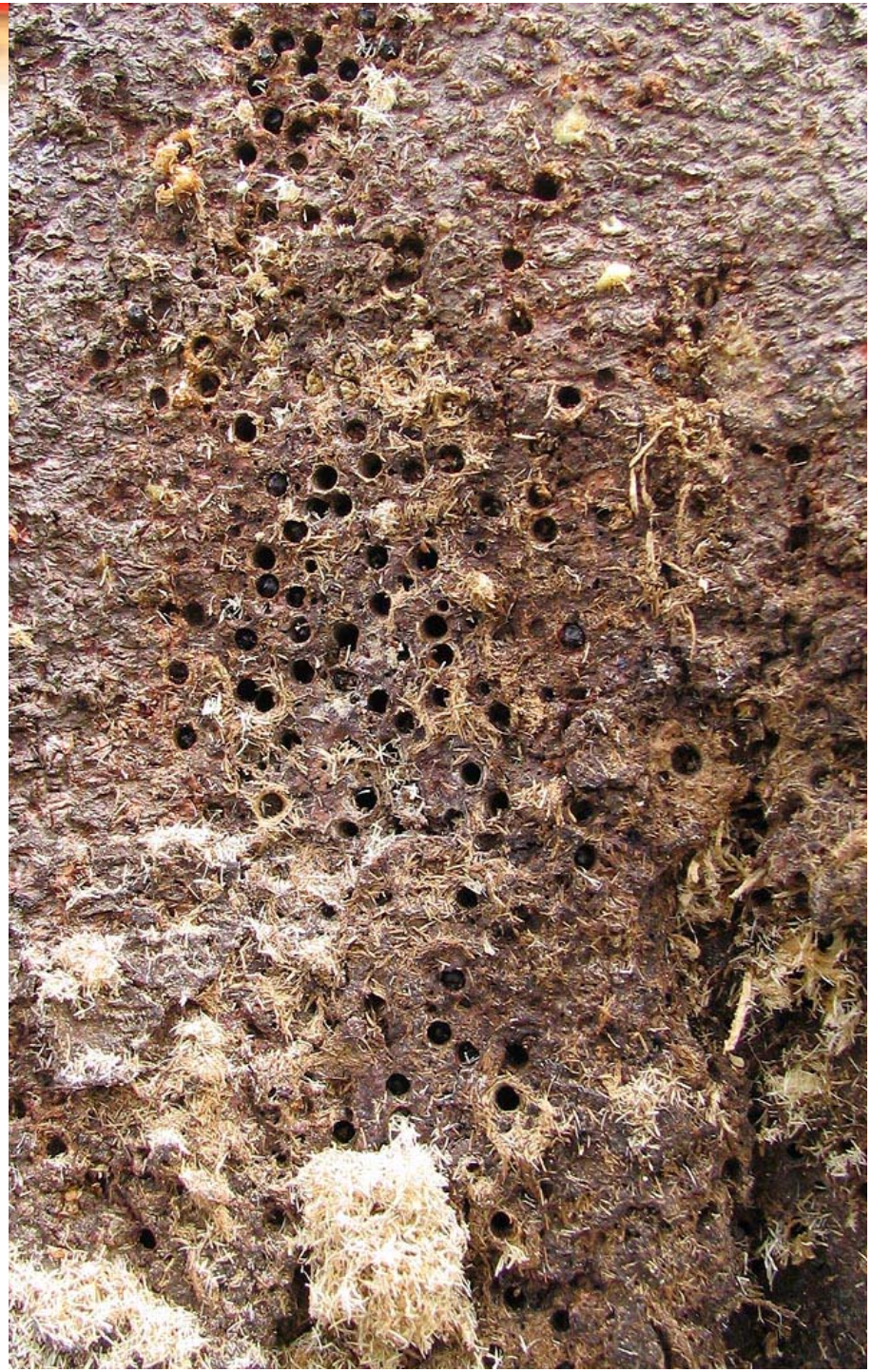
2) mass attack

(fungus only mildly pathogenic)

- *Platypus* spp.

Japanese oak wilt



# 3. Tree killers

1) non-tree-killers

2) mass attack

(fungus only mildly pathogenic) - *Euwallacea* aff. *fornicatus* + *Fusarium*

# 3. Tree killers

1) non-tree-killers

2) mass attack

(fungus only mildly pathogenic) - *Euwallacea* aff. *fornicatus*

# 3. Tree killers

1) non-tree-killers

2) mass attack

3) stressed trees

– excess of water

*Xylosandrus* spp.
*Theoborus*
*Euplatypus*
*etc…*

# 3. Tree killers

1) non-tree-killers

2) mass attack

3) stressed trees

– excess of water

– pathogen pre-infestation

*Euwallacea*
*Oxoplatypus*
*etc…*

# 3. Tree killers

1) non-tree-killers

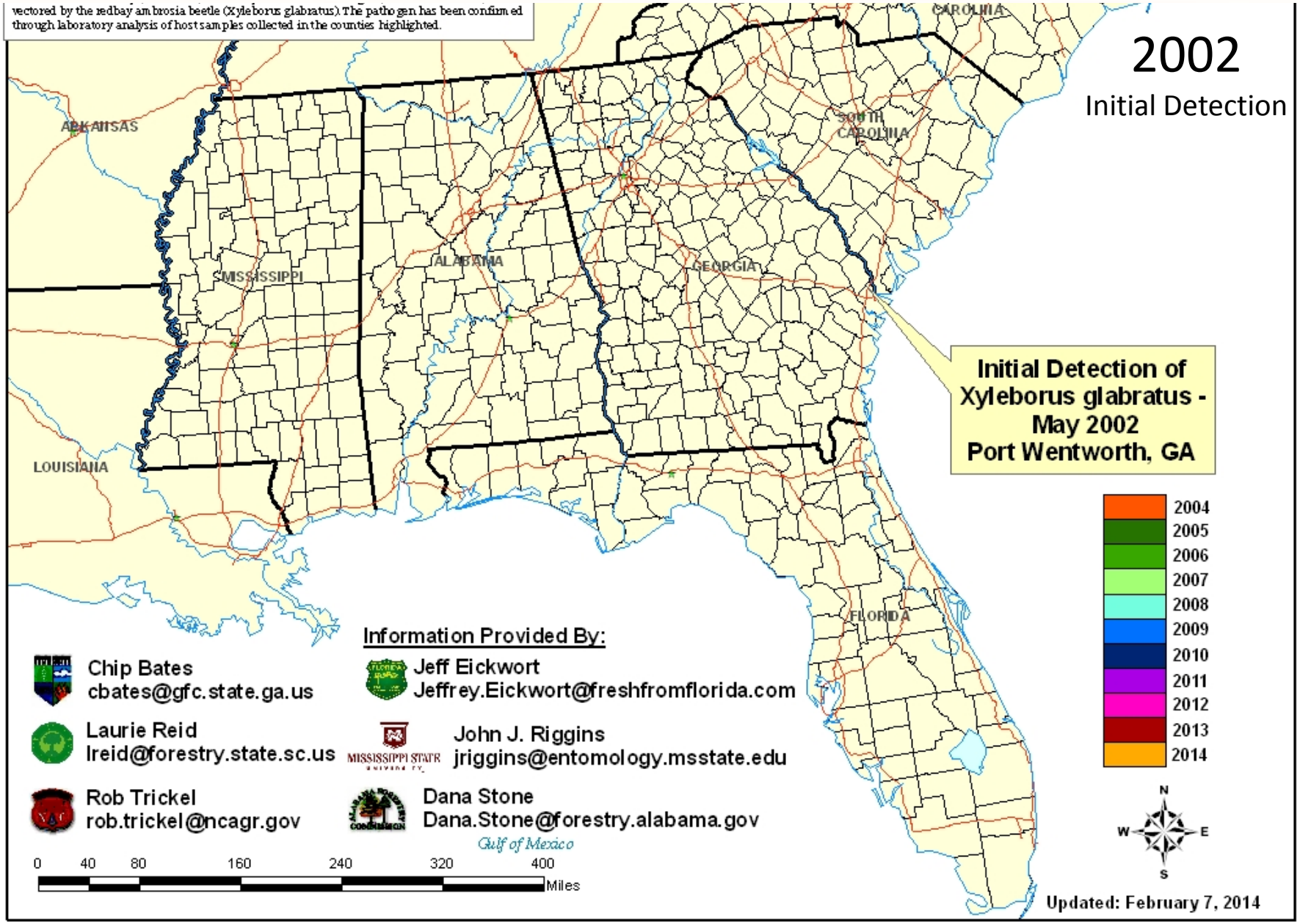
2) mass attack

3) stressed trees

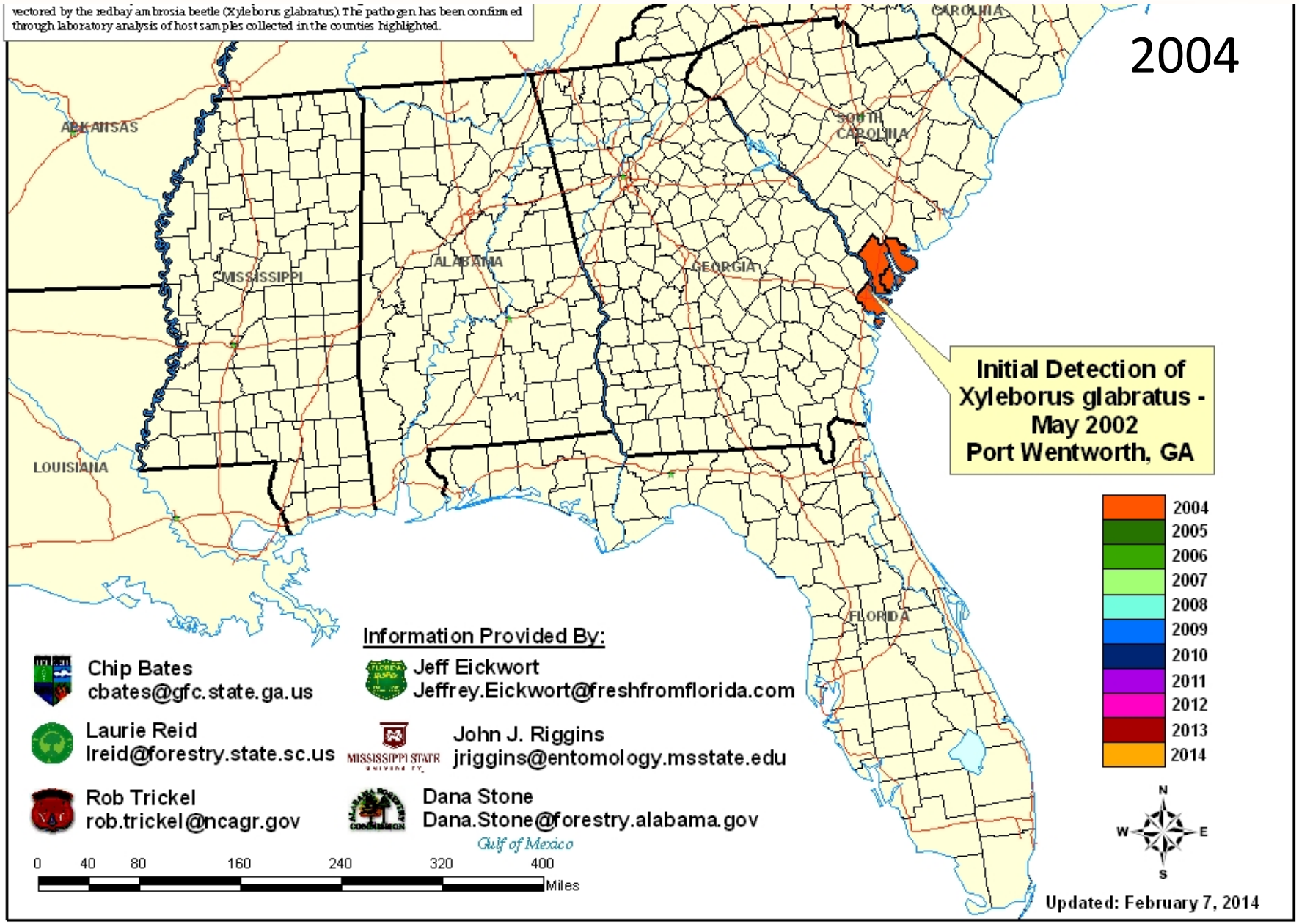
4) pathogenic symbiont - 1 case:

*Xyleborus glabratus*
*+ Raffaelea lauricola*

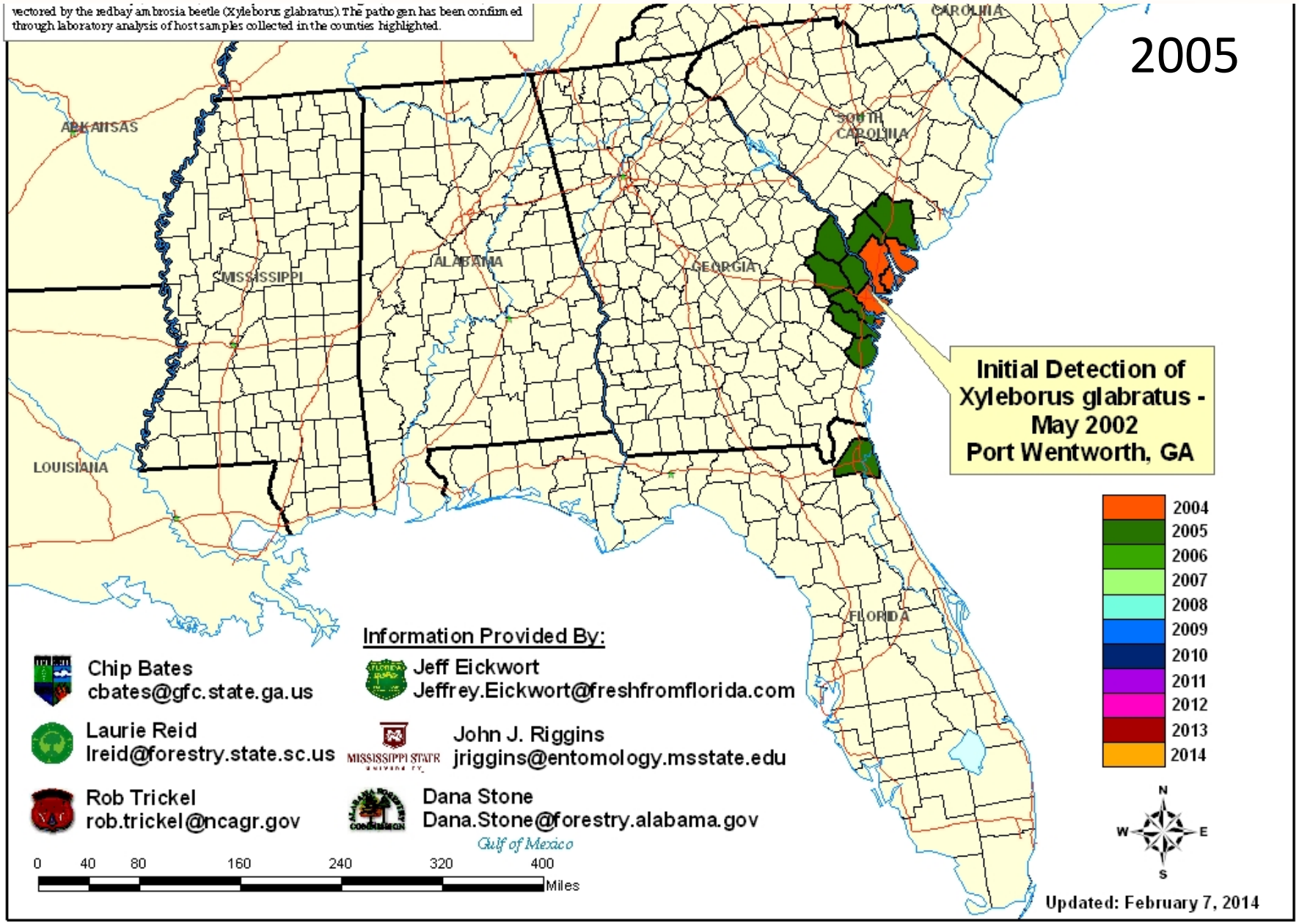
# 3. Tree killers



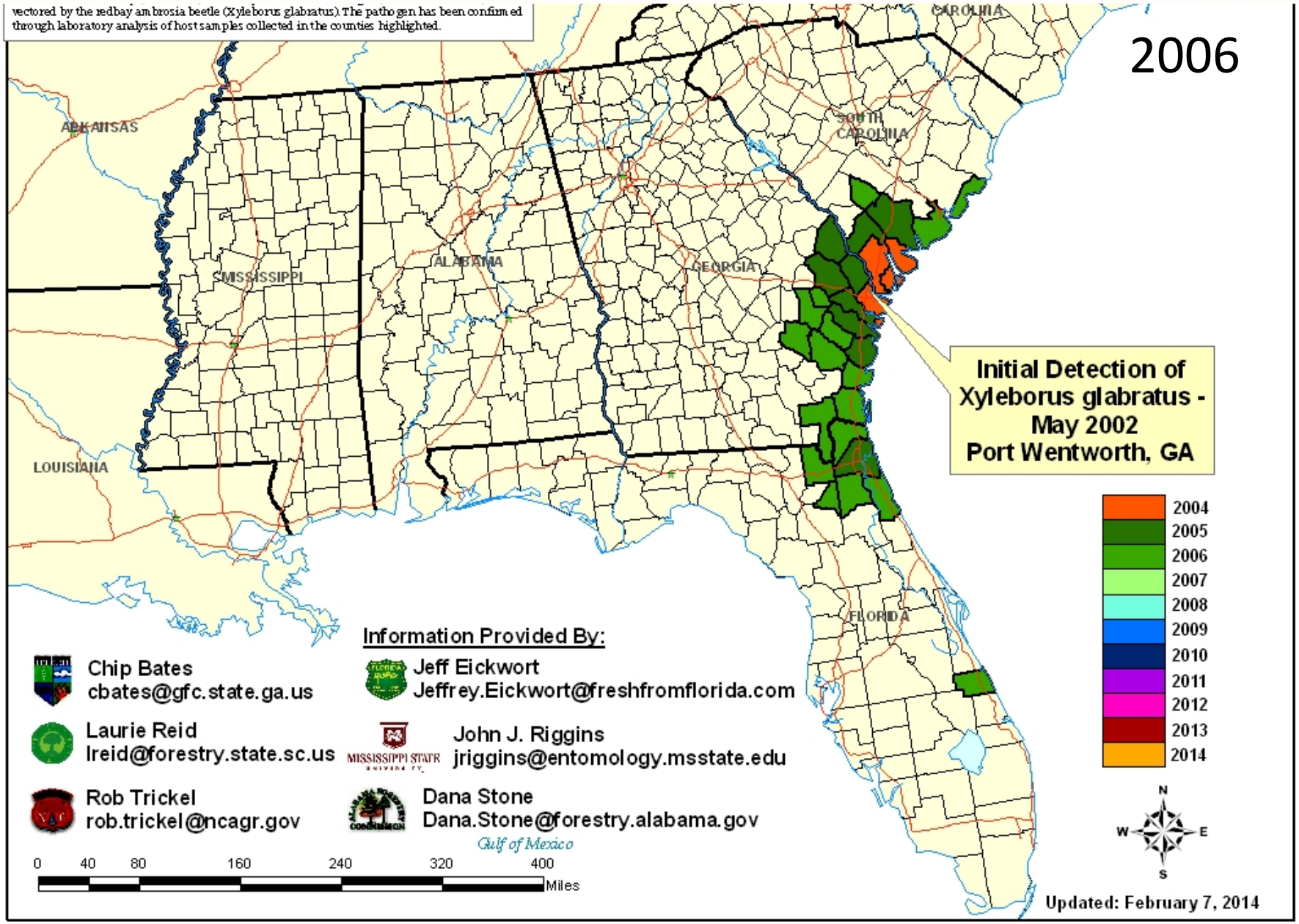
# 3. Tree killers



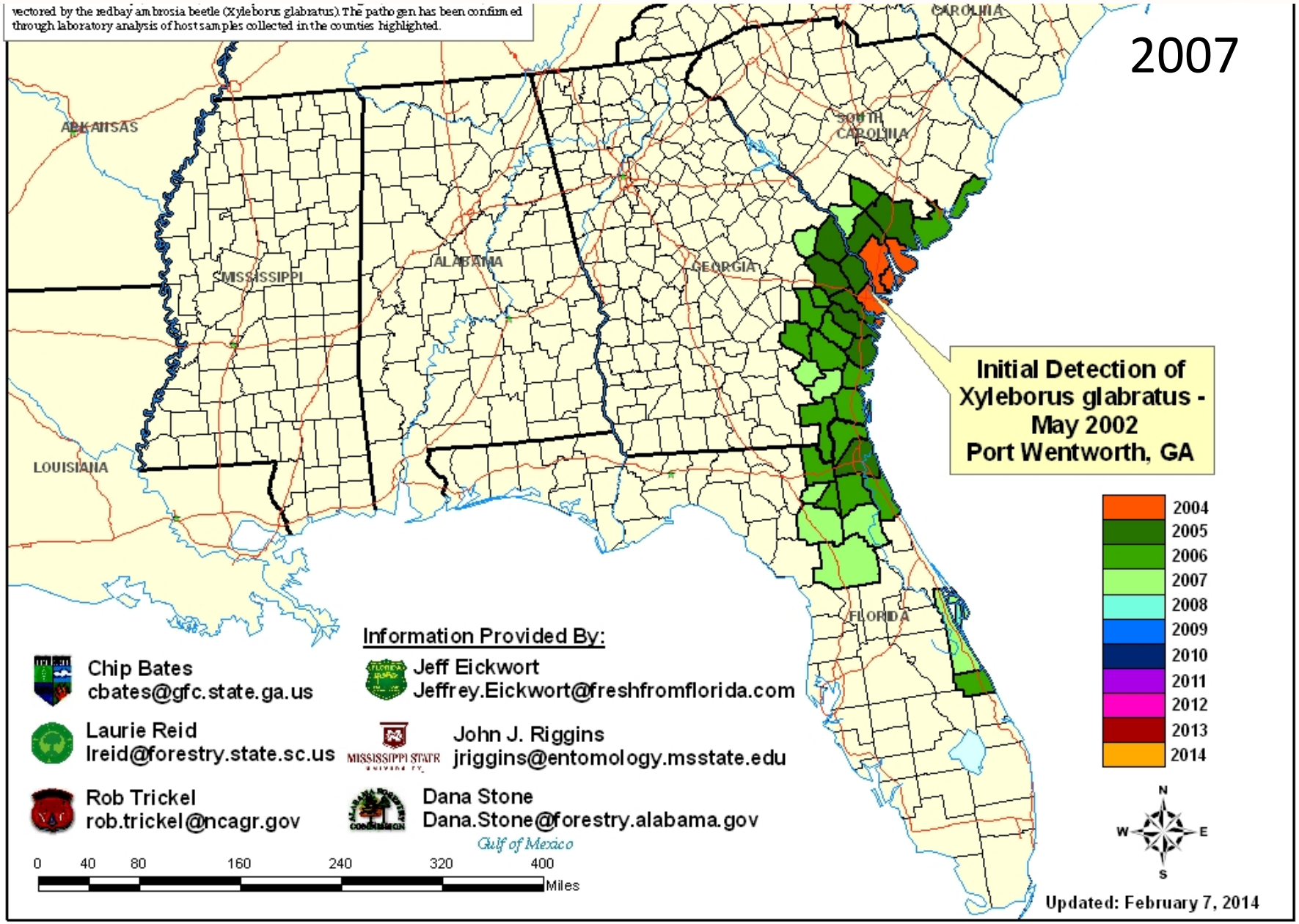
# 3. Tree killers



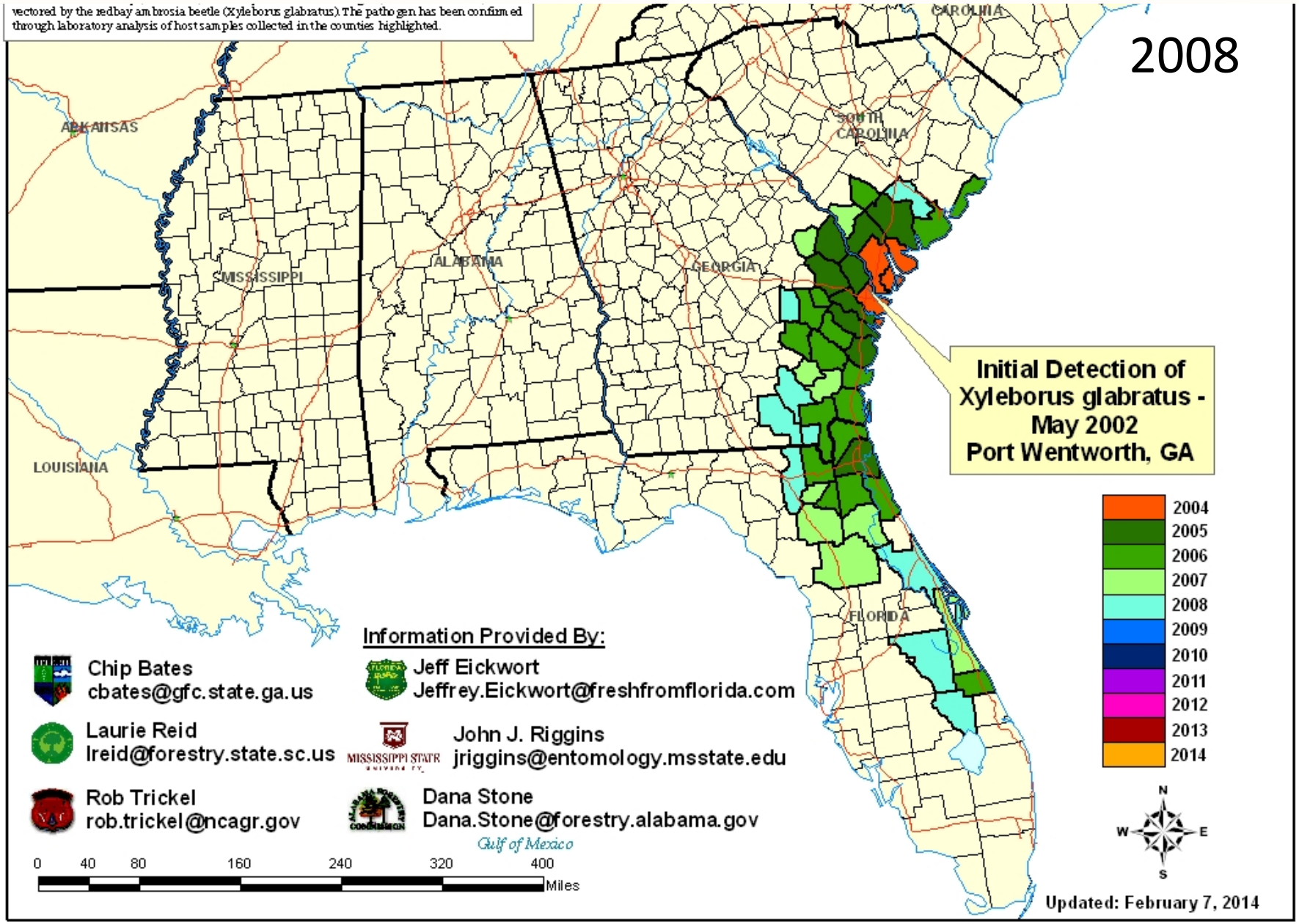
# 3. Tree killers



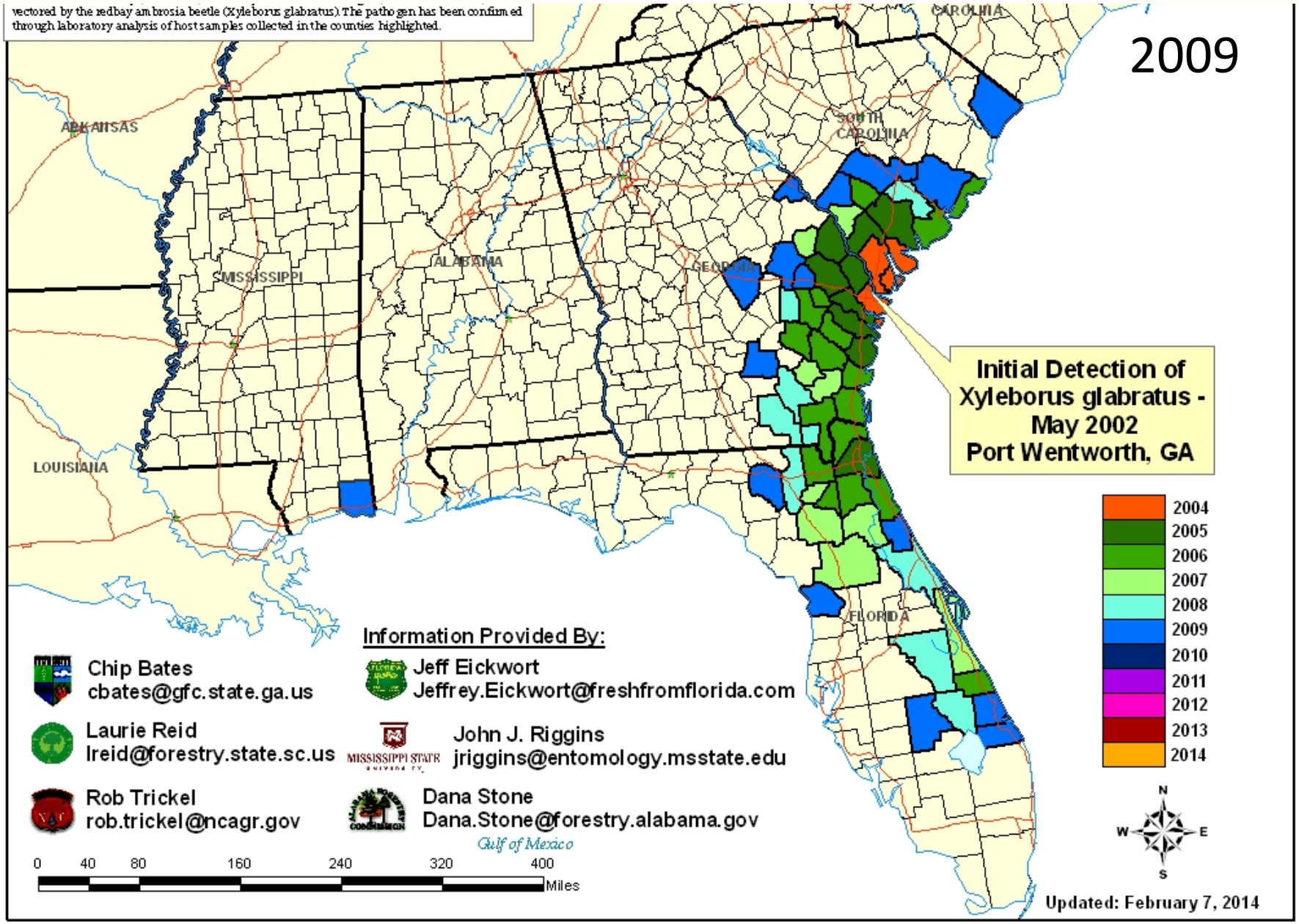
# 3. Tree killers



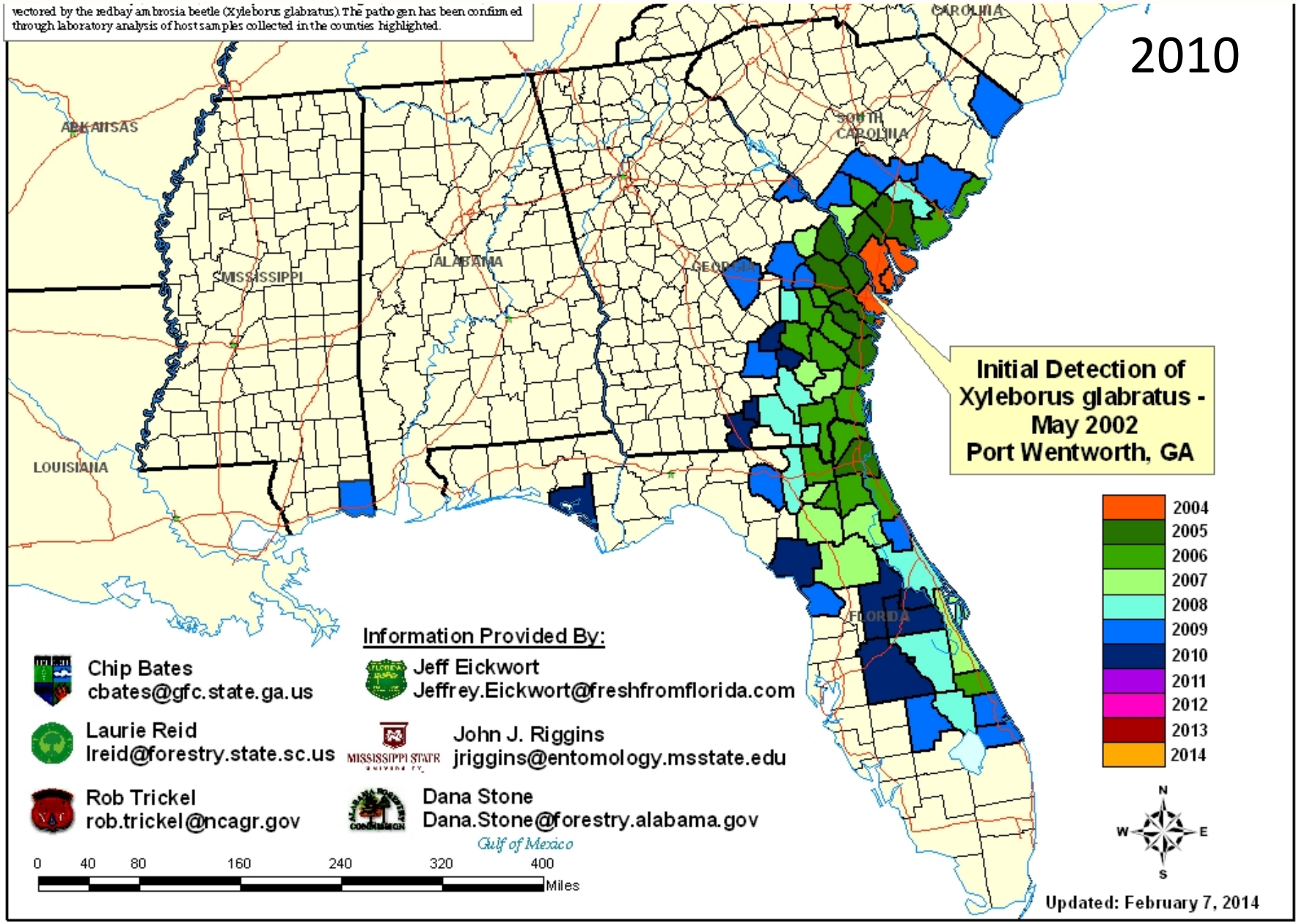
# 3. Tree killers



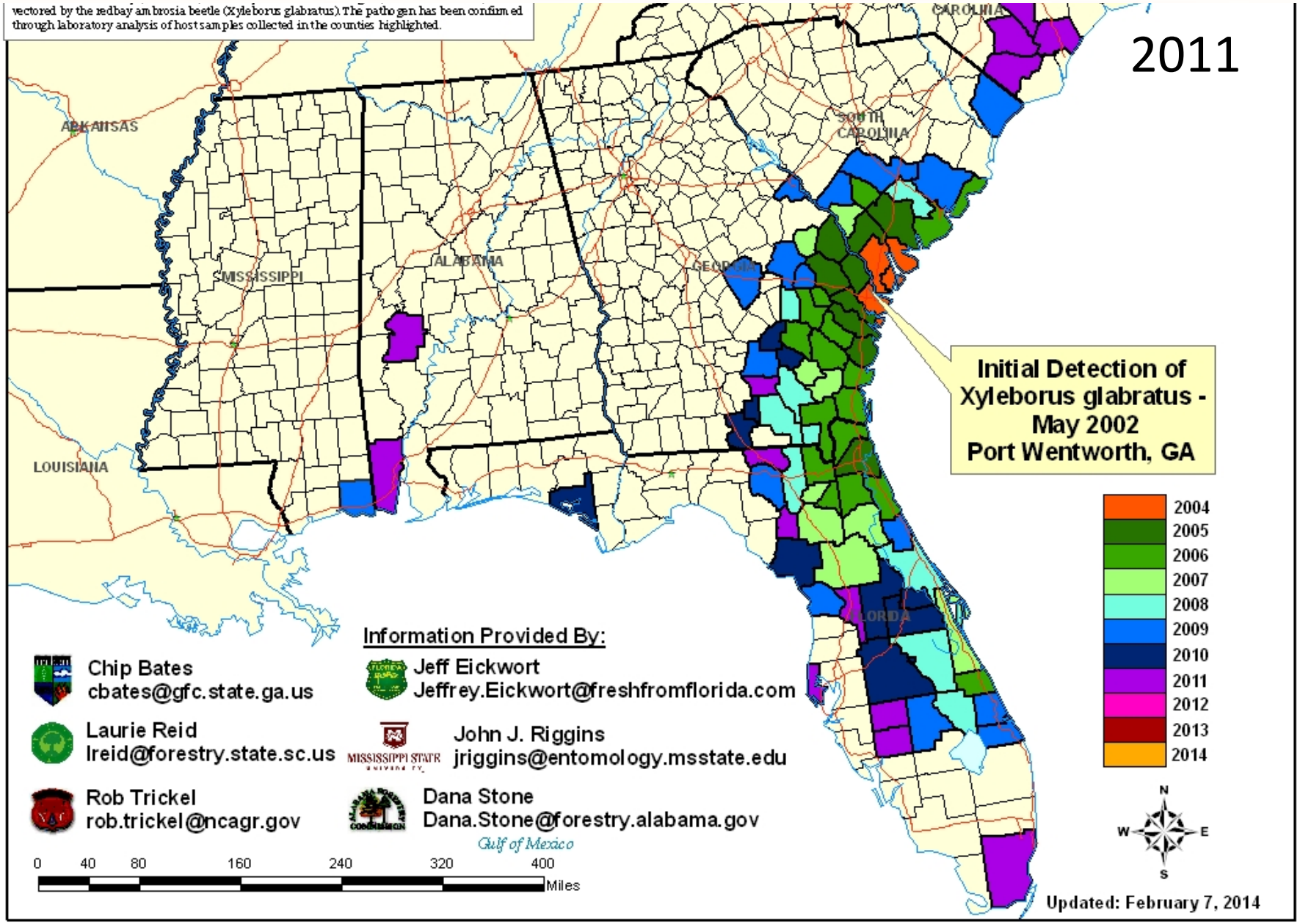
# 3. Tree killers



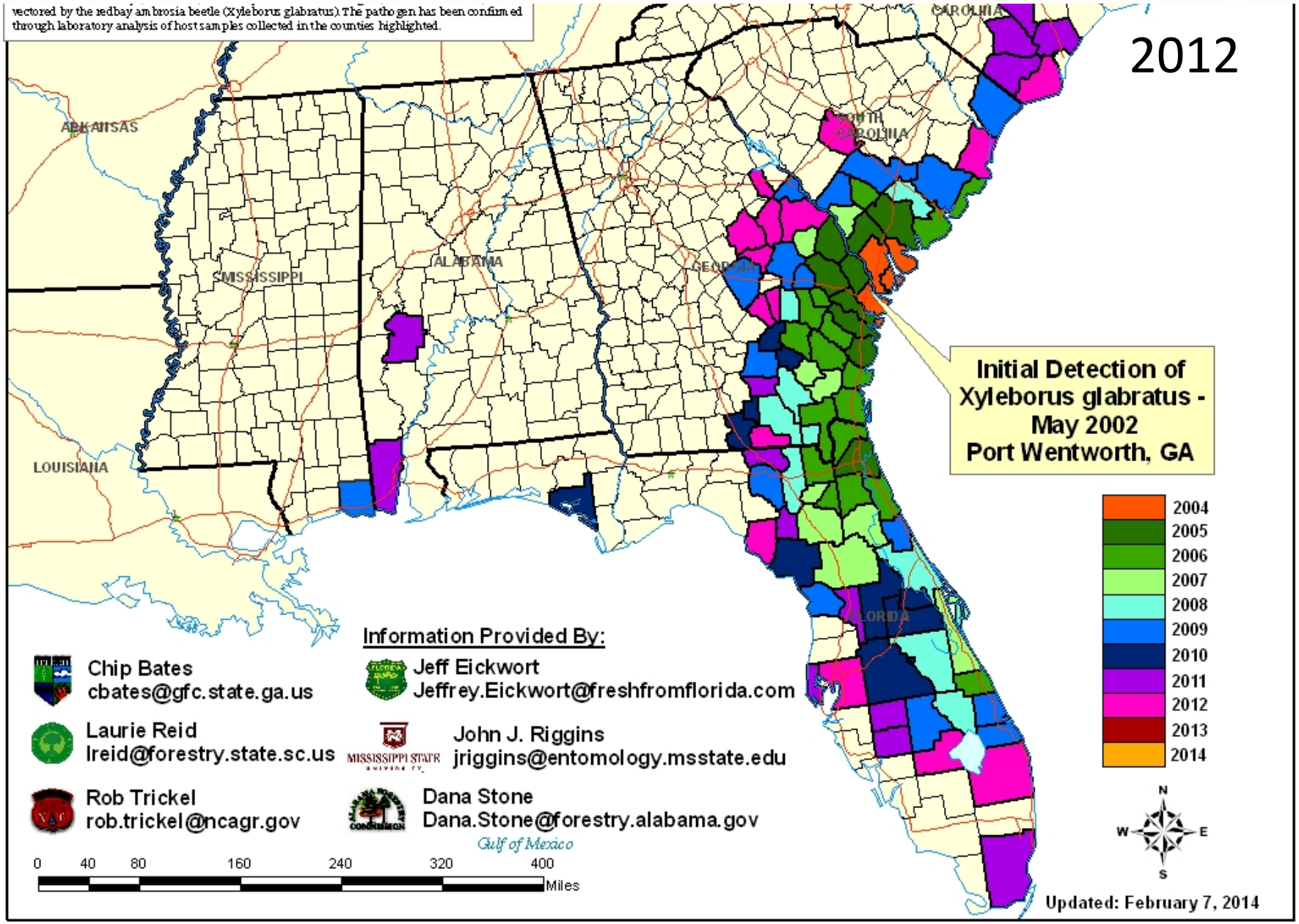
# 3. Tree killers



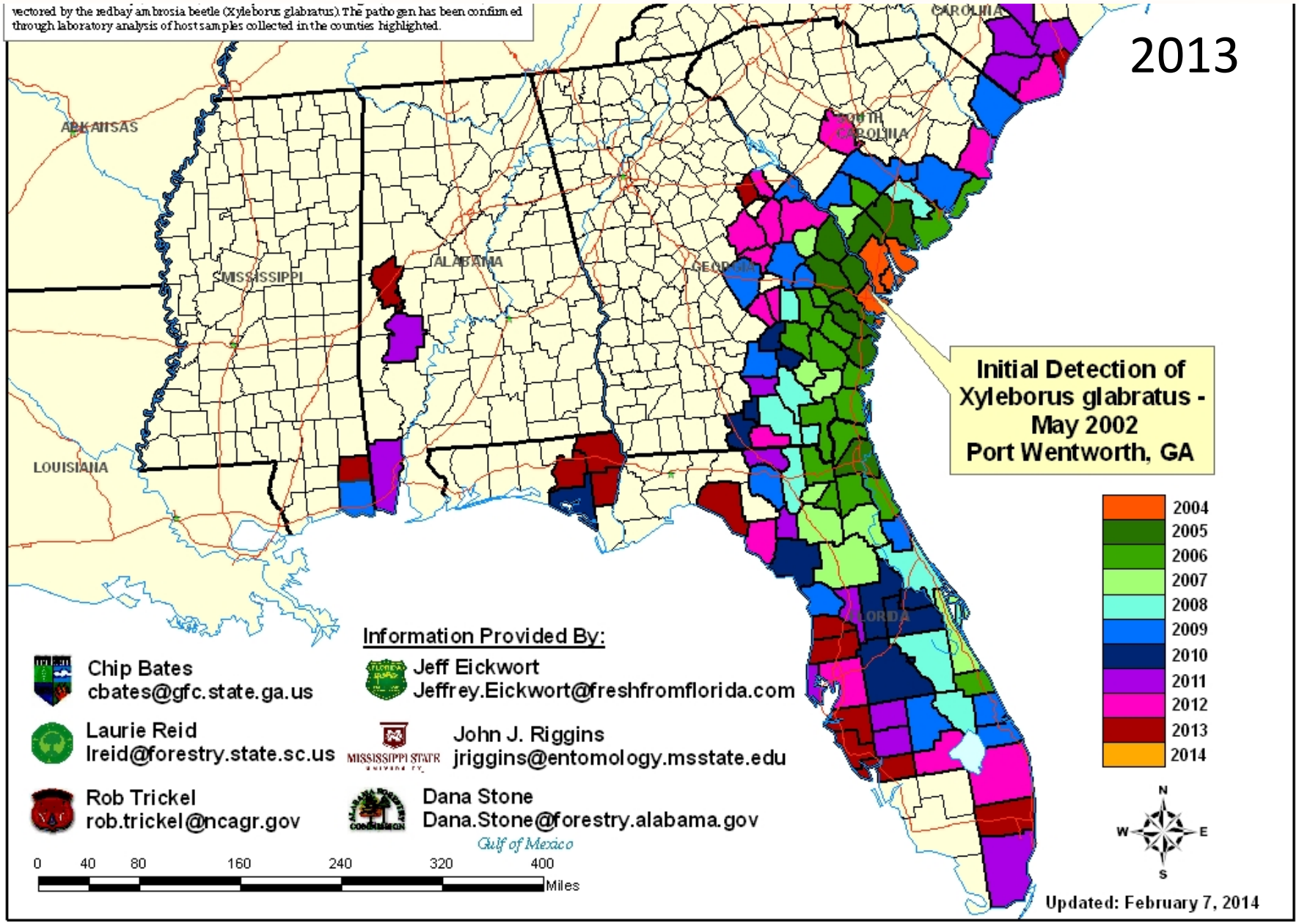
# 3. Tree killers



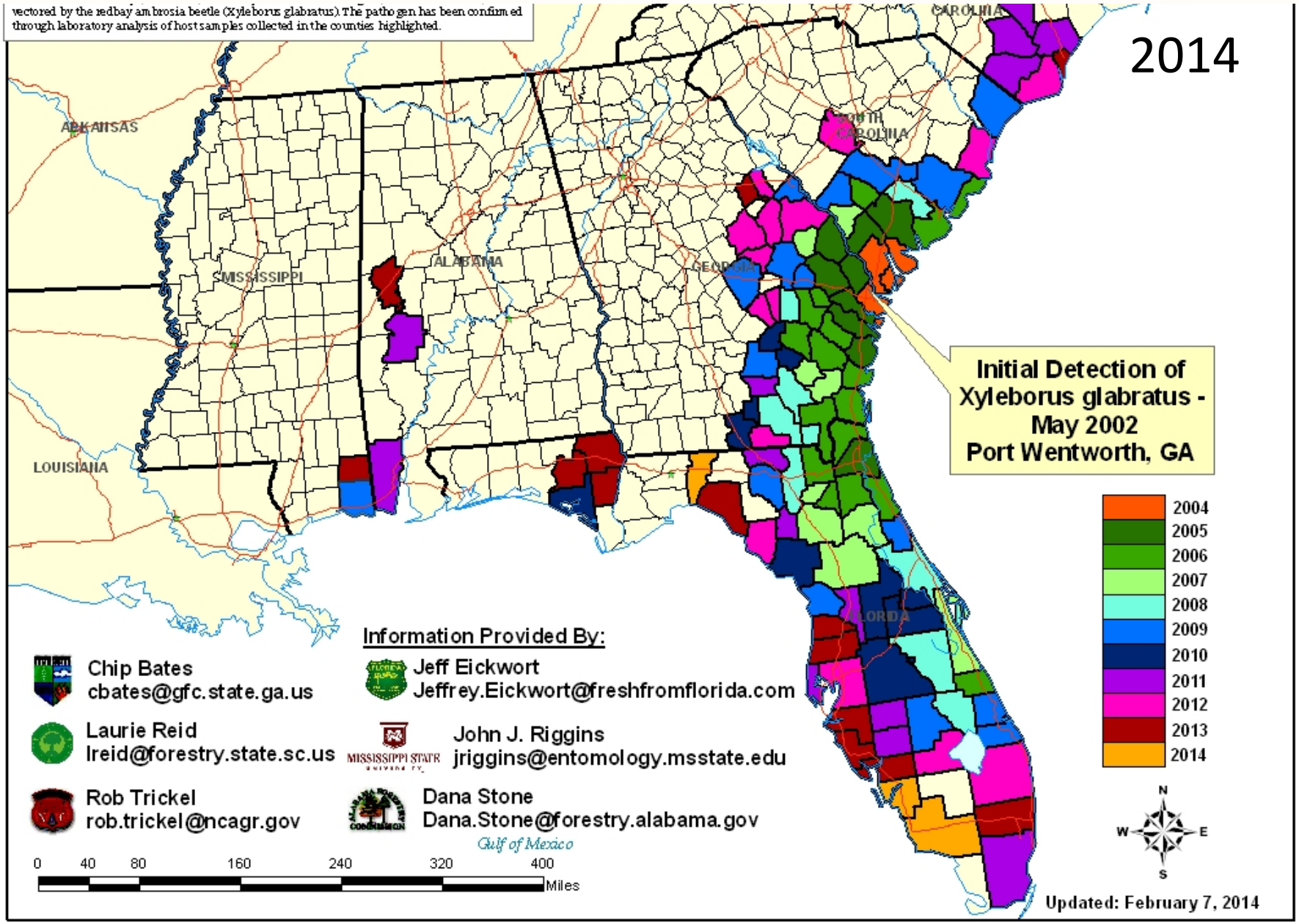
# 3. Tree killers



# 3. Tree killers



# 3. Tree killers



# 3. Tree killers

# 3. Tree killers

# We DO NOT know…

# We DO NOT know…

| ambrosia beetle genera | | # not studied |
|---|---|---|
| Bothrosternini | 2 | **0** |
| *Camptocerus* (2 subgenera) | 2 | **2** |
| Corthylina | 10 | **8** |
| *Premnobius* clade | 2 | **2** |
| *Scolytodes unipunctatus* | 1 | **0** |
| Scolytoplatypodini | 2 | **2** |
| *Stylotentus* subgenus | 1 | **1** |
| *Sueus* | 1 | **1** |
| Xyleborini – elytral mycangium | 6 | **5** |
| Xyleborini – mandibular m. | 10 | **6** |
| Xyleborini – mesonotal m. | 5 | **2** |
| Xyleborini – unknown m. | 14 | **13** |
| Xyloterini | 3 | **1** |

**Fungi unknown in**

**72%**

**ambrosia beetle genera**

# We DO NOT know…

| | ambrosia beetle genera | # not studied |
|---|---|---|
| Bothrosternini | 2 | **0** |
| *Camptocerus* (2 subgenera) | 2 | **2** |
| Corthylina | 10 | **8** |
| *Premnobius* clade | 2 | **2** |
| *Scolytodes unipunctatus* | 1 | **0** |
| Scolytoplatypodini | 2 | **2** |
| *Stylotentus* subgenus | 1 | **1** |
| *Sueus* | 1 | **1** |
| Xyleborini – elytral mycangium | 6 | **5** |
| Xyleborini – mandibular m. | 10 | **6** |
| Xyleborini – mesonotal m. | 5 | **2** |
| Xyleborini – unknown m. | 14 | **13** |
| Xyloterini | 3 | **1** |

**Fungi unknown in**

**72%**

**ambrosia beetle genera**

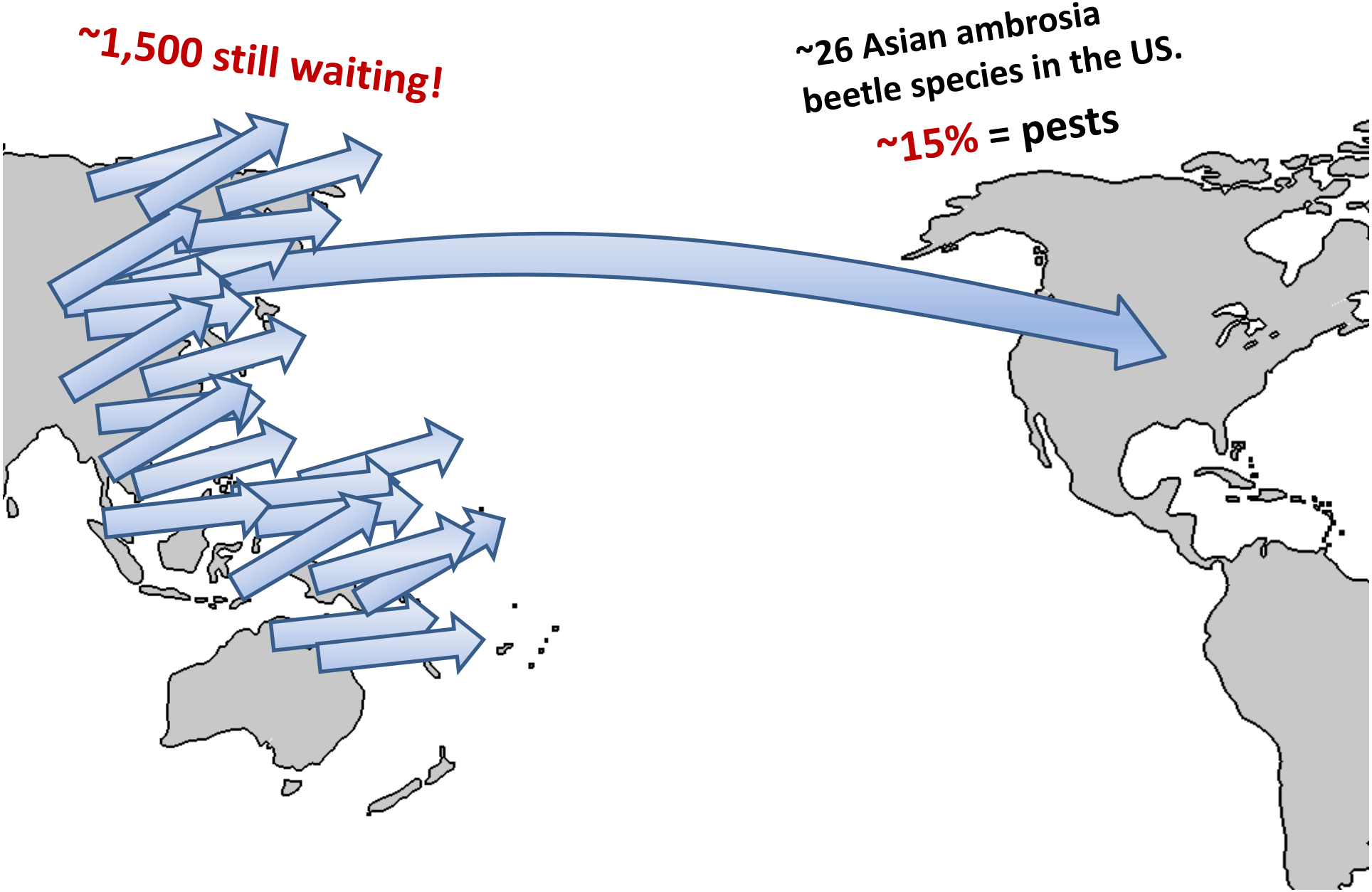
**?**

**…another *Raffaelea lauricola*?**

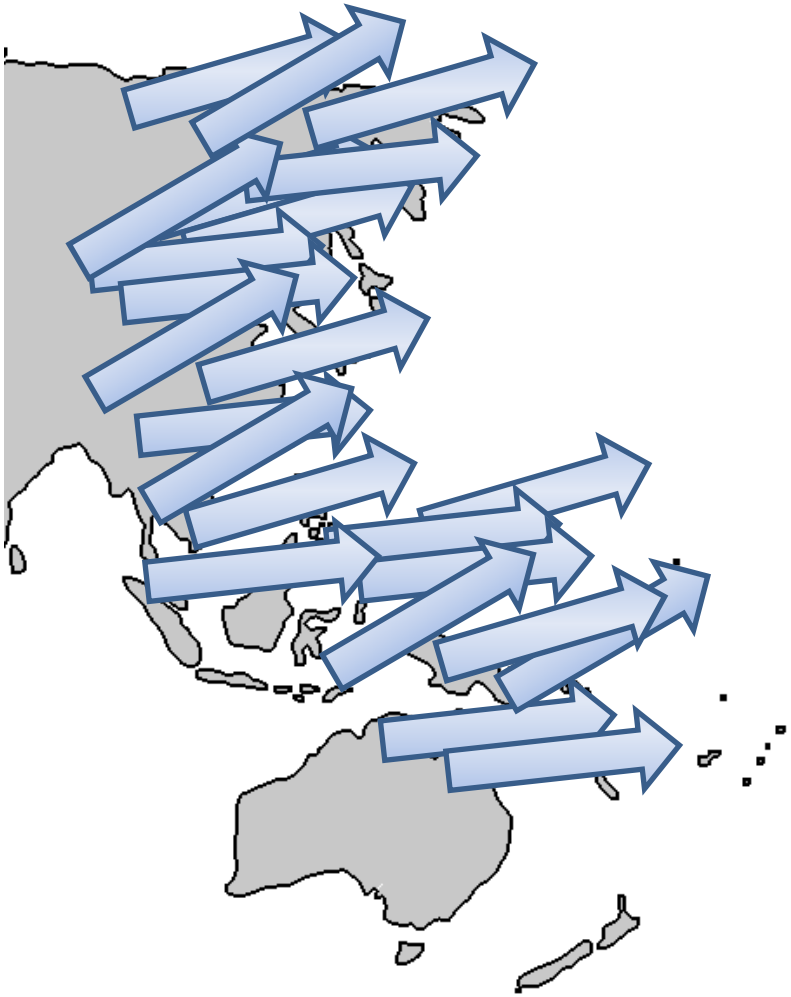
**…another *Ophiostoma ulmi*?**

**…pathogenic *Fusarium*, *Geosmithia*?**

# We DO NOT know…



# We DO NOT know…



**Will some attack our pines?**

**…our oaks?**

**…our sequoias?**

# We DO NOT know…

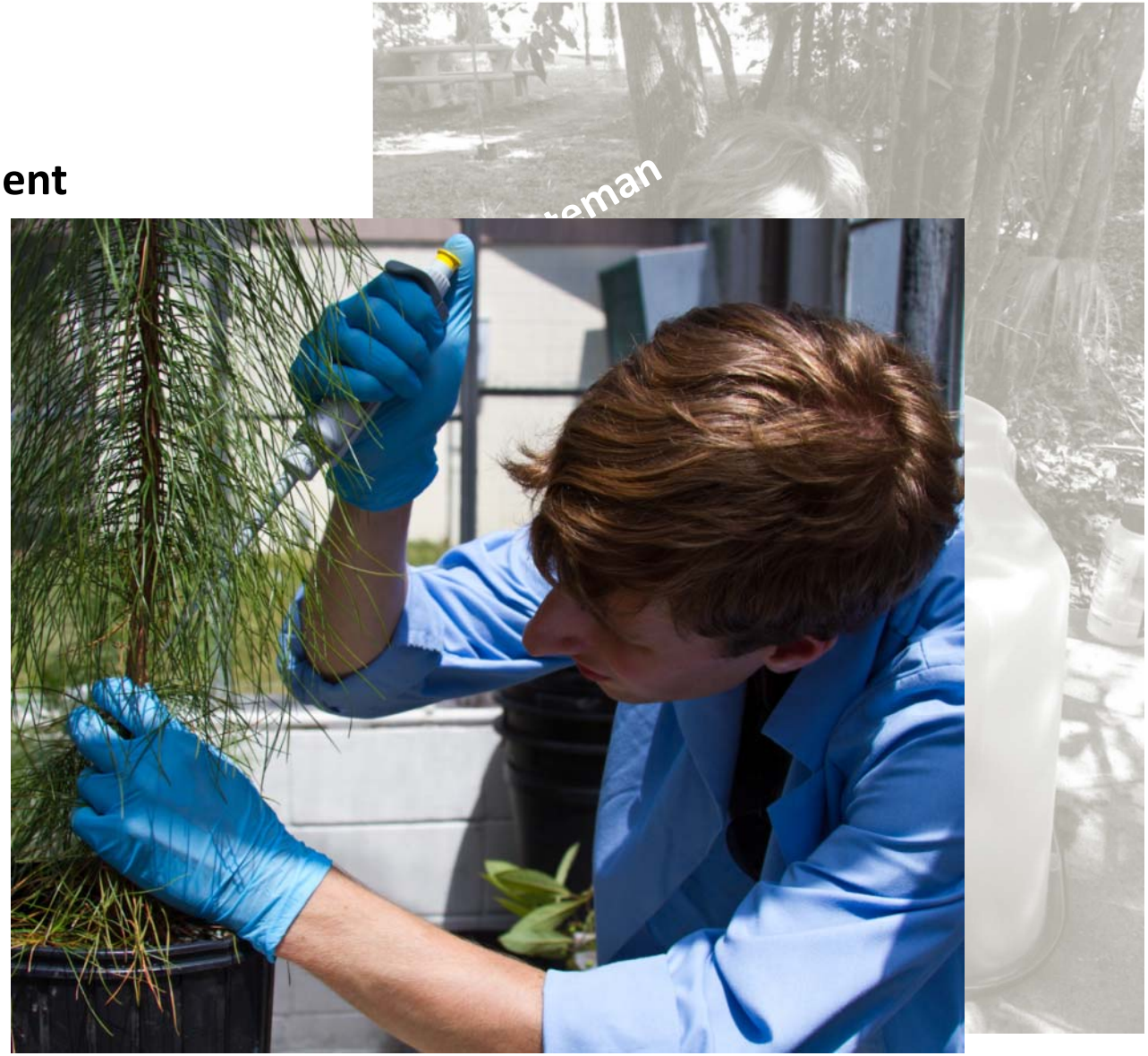
## *Imagine…*

**Pre-invasion assessment of overseas species**

# We DO NOT know…

## *Imagine…*

**Pre-invasion assessment of potential pests**



# We DO NOT know…

## *Imagine…*

| beetle | country | fungus | OK | mild | virulent |
|---|---|---|---|---|---|
| ***Xyleborus pinicola*** | Thailand | *Rafaelea* sp. | OK | | |
| ***Ips acuminatus*** | China | Ophiostomatales sp. | OK | | |
| | | *Ophiostoma ips* | | mild | |
| ***Tomicus minor*** | China | *Geosmithia* | | | |
| ***Webbia pabo*** | China | [illegible] | [illegible] | | |
| | | [illegible]? | OK | | |
| ***Cyclorhipidion fuki*** | | [illegible]*stoma* 2 7736 | OK | | |
| ***Cyrtog*** | [illegible]ina | *Ophiostoma* 3 7690 | OK | | |
| | | *Ascomycete* sp. 7694 | OK | | |
| ***Polygra*** [illegible] ***sp.*** | China | *Ceratocystiopsis* 7744 | OK | | |
| ***Dendroctonus micans*** | Czech Republic | *Pesotum* sp. | ? | | |
| | | *Leptographium* sp. | ? | | |
| ***Platypus koryoensis*** | Korea | *Raffaelea* sp. | ? | | |
| | | *Ambrosiozyma* sp. | ? | | |
| ***Platypus quercivorus*** | Japan | *Raffaelea quercivora* | ? | | |
| ***Orthotomicus erosus*** | Israel | *Leptographium* sp. | ? | | |

**No systemic pathogen!**

# We DO NOT know…

*Could we have predicted laurel wilt?*

**YES!**


Laurel wilt!

# We DO NOT know…

***Could we have predicted laurel wilt?***

**YES!**

- **Beetle interested in living trees**
- **Fungus pathogenic**

↳ **Candidates for pre-invasion assessment**

↳ **In 2004, we would have known!**

# We DO NOT know…

*Could we have predicted laurel wilt?*

**YES!**

**With:**

- **pre-invasion assessment**
- **$upport**
- **political advocacy**

**We can prevent the next one…**

# Thank you!


USDA Forest Service – Forest Health Protection

USDA Forest Service – Southern Research Station

USDA Farm Bill section 10007

National Science Foundation

Florida Forest Service

UNIVERSITY OF FLORIDA IFAS