



# Laurel wilt and the “other” ambrosia symbioses

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FLORIDA

# 1. Ambrosia beetles

fungus farmers



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fungus farmers



# 1. Ambrosia beetles

fungus farmers



1 mm —

# 1. Ambrosia beetles

fungus farmers

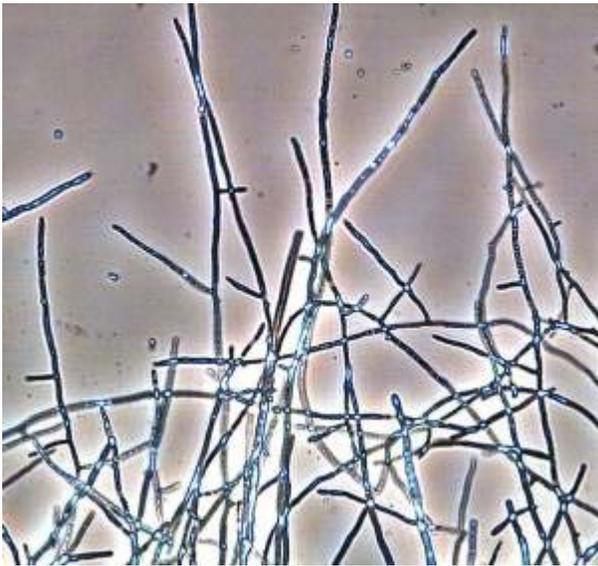




# 1. Ambrosia beetles

fungus farmers • fungi

hyphae



in mycangium



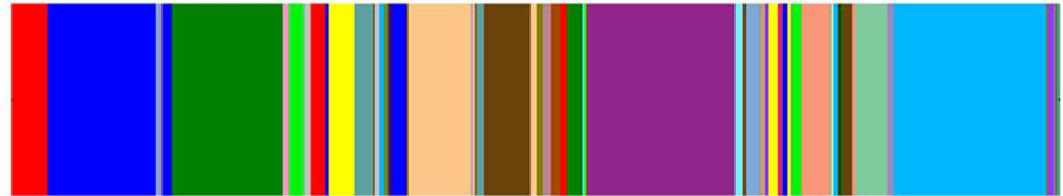
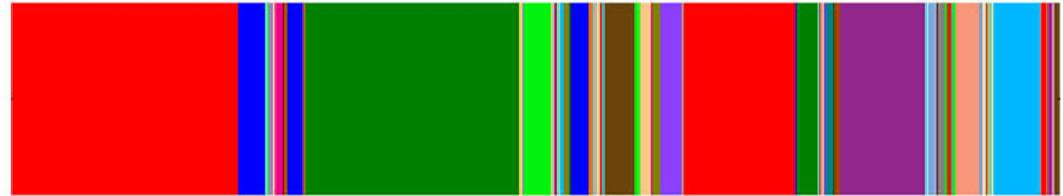
garden



# 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
<i>Camptocerus</i> (2 subgenera)	2
Corthylina	10
<i>Premnobius</i> clade	2
<i>Scolytodes unipunctatus</i>	1
Scolytoplatypodini	2
<i>Stylotentus</i> subgenus	1
<i>Sueus</i>	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:

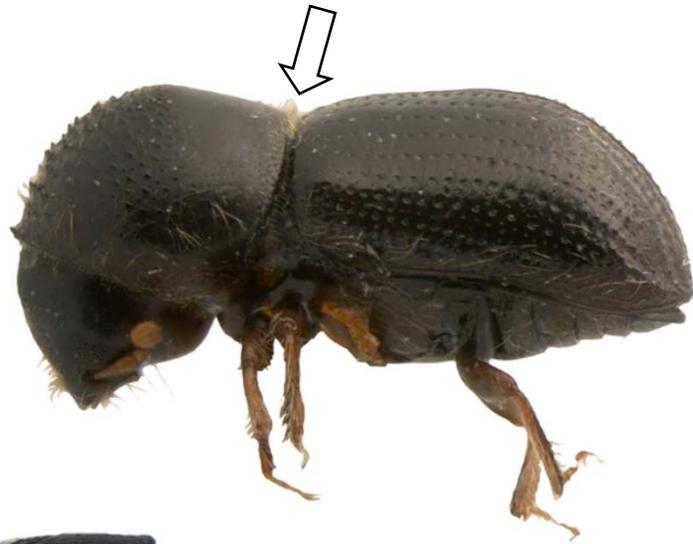
“... most ambrosia beetles are associated with Ophiostomatales (*Raffaelea*) or Microascales (*Ambrosiella*)...”

<u>ambrosia beetle genera</u>		<u># never studied</u>	
Bothrosternini	2	0	
<i>Camptocerus</i> (2 subgenera)	2	2	
Corthylinea	10	8	
<i>Premnobius</i> clade	2	2	
<i>Scolytodes unipunctatus</i>	1	0	<i>Scolytodes</i> = ambrosial <i>Geosmithia</i>
Scolytoplatypodini	2	2	
<i>Stylotenus</i> subgenus	1	1	
<i>Sueus</i>	1	1	
Xyleborini – elytral mycangium	6	5	<i>Euwallacea</i> = ambrosial <i>Fusarium</i>
Xyleborini – mandibular m.	10	6	
Xyleborini – mesonotal m.	5	2	
Xyleborini – unknown m.	14	13	
Xyloterini	3	1	<i>Ambrosiodmus</i> = 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**

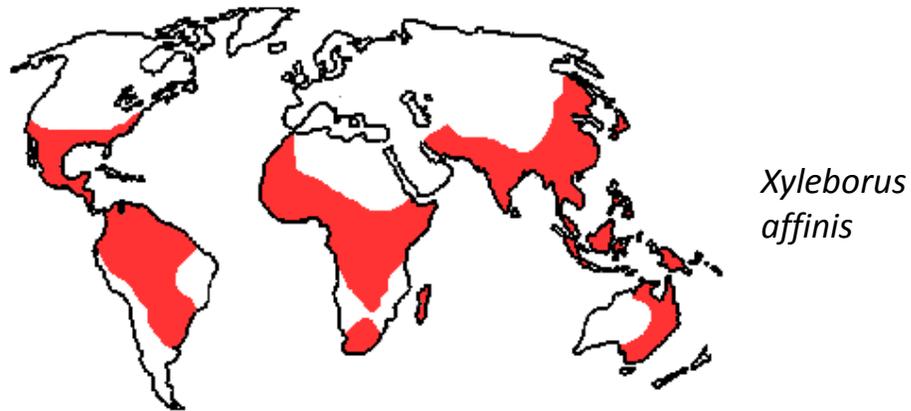
**no preference among tree species**

Hulcr *et al.* (2007b)

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

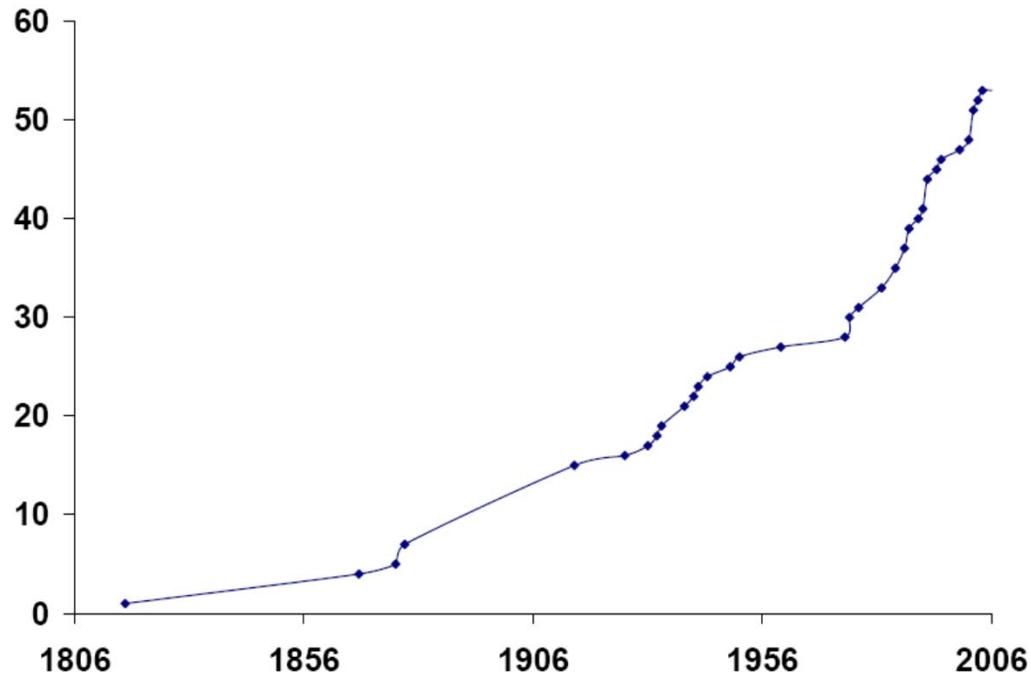
# 1. Ambrosia beetles

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



# 1. Ambrosia beetles

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



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

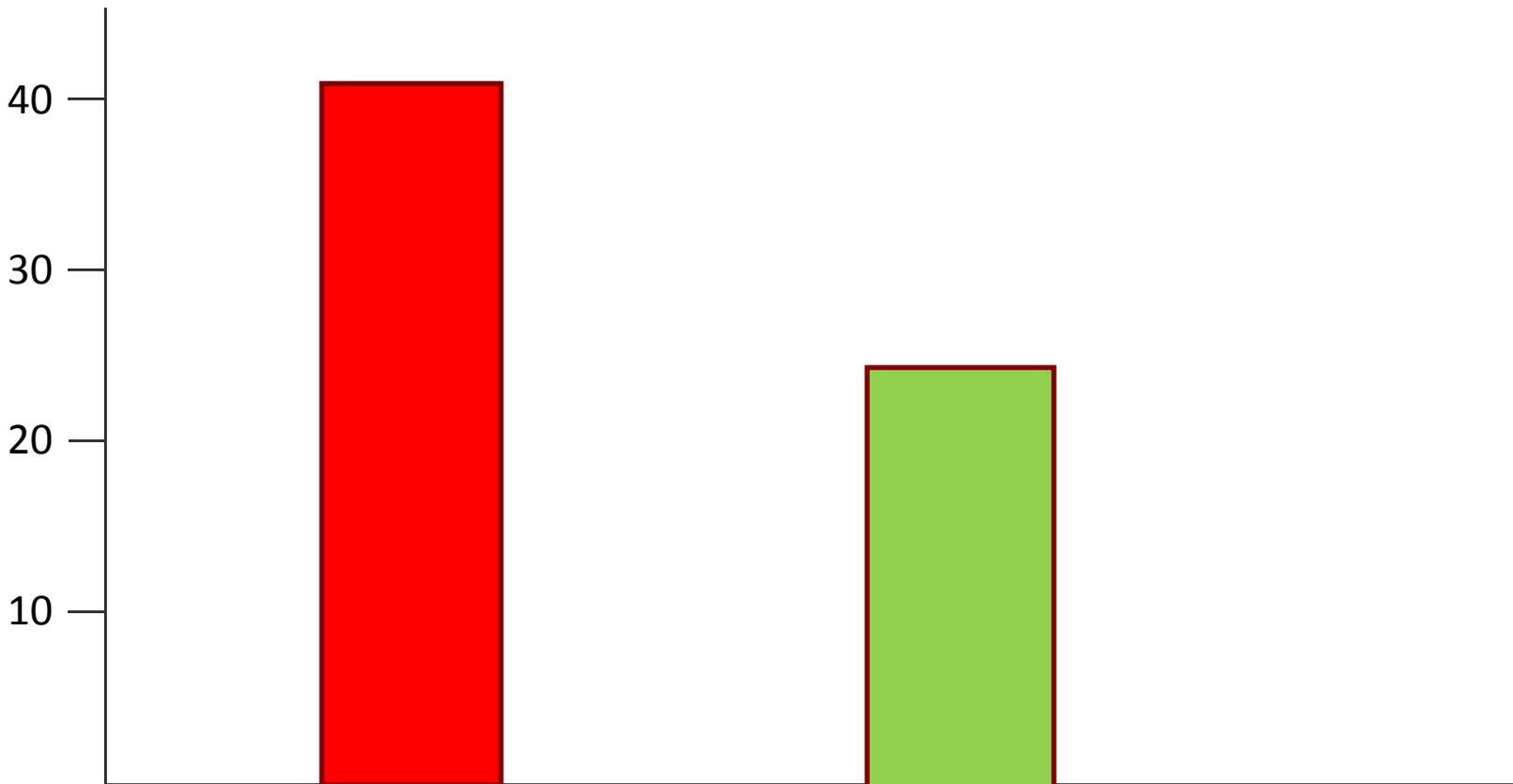
# 1. Ambrosia beetles

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

pests, invasive

general biology

*publications*  
2014



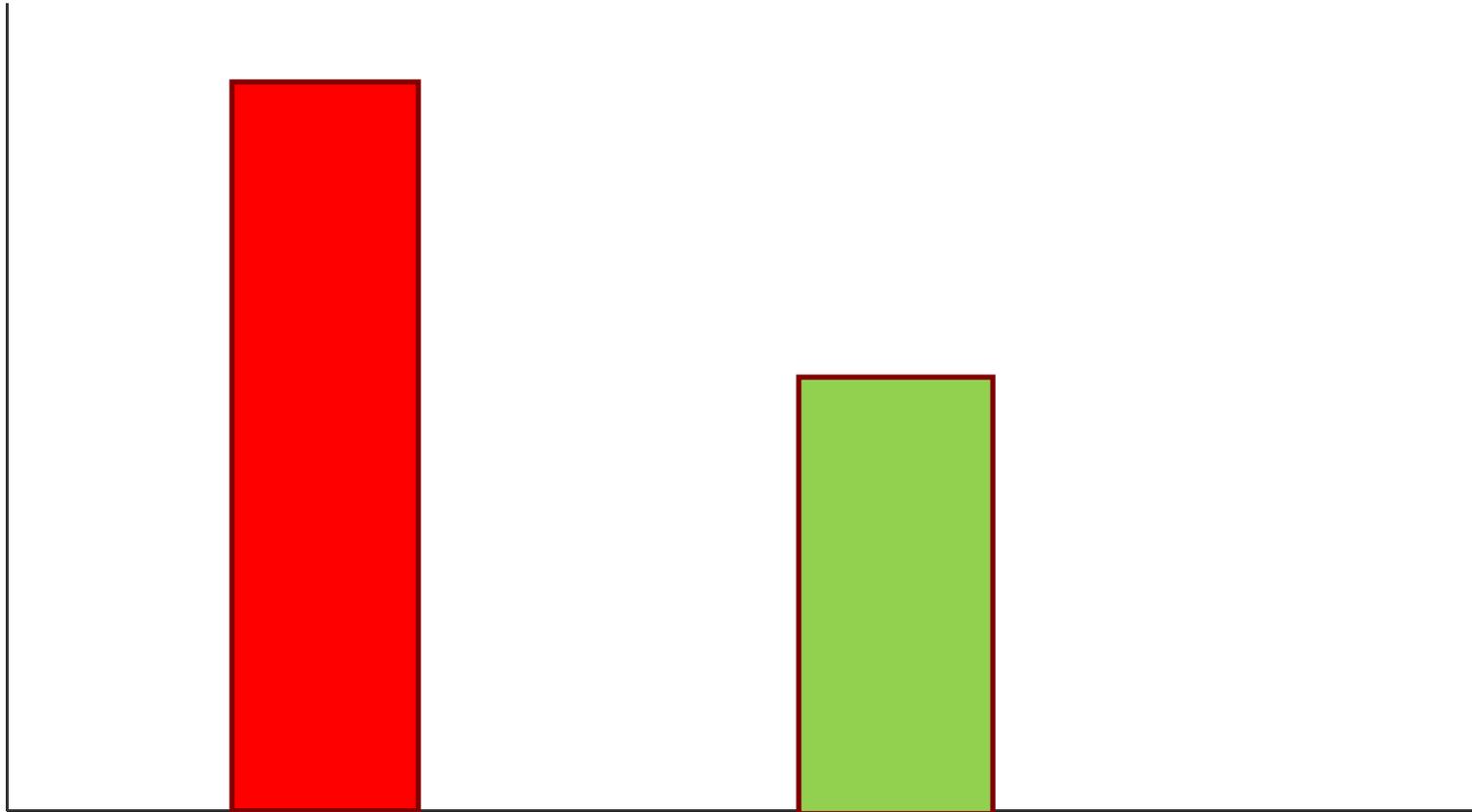
# 1. Ambrosia beetles

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

tree killers

dead wood colonizers

*species  
diversity*



# 1. Ambrosia beetles

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

most are  
harmless

tree killers

dead wood colonizers

*species  
diversity*

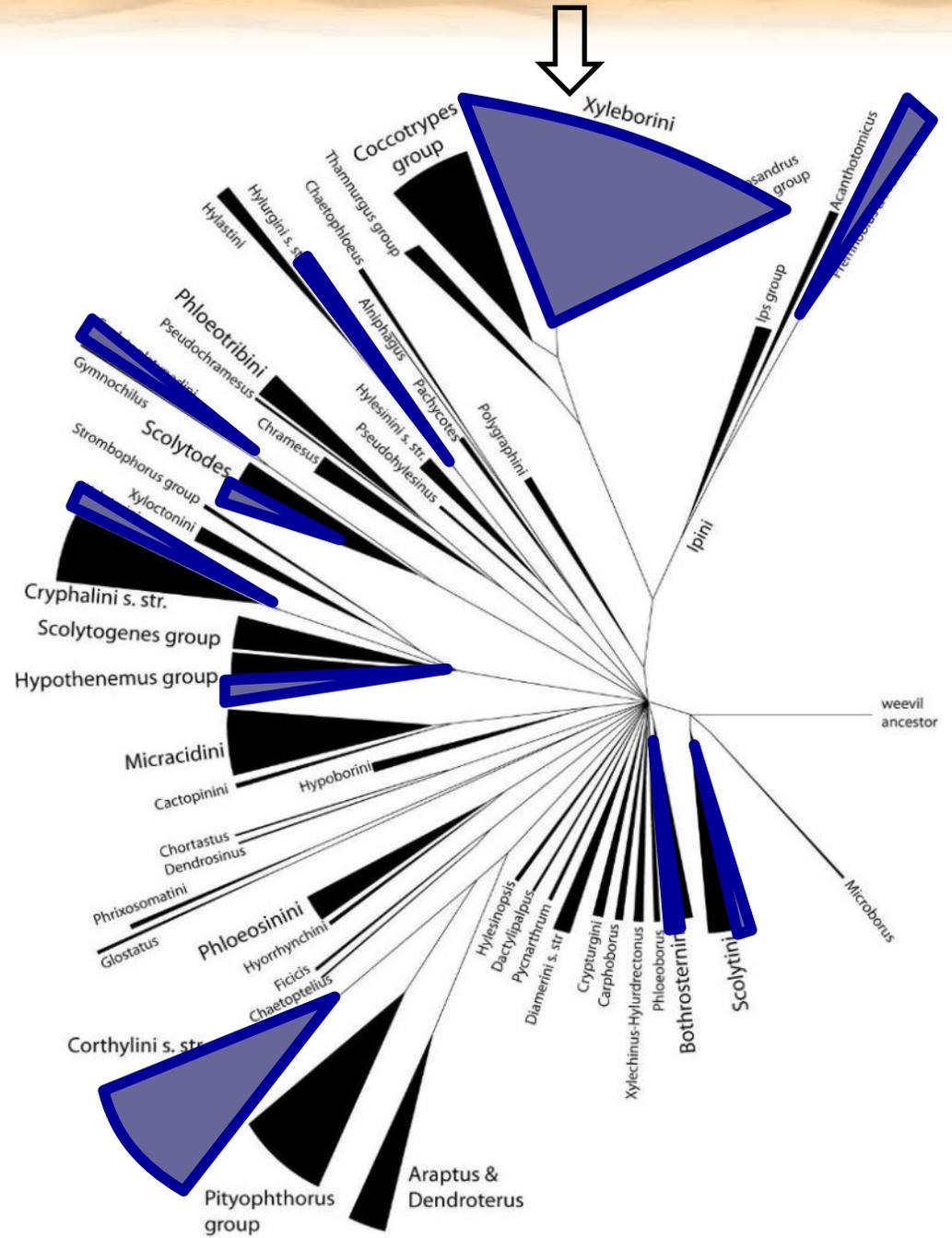
<10

3,500



## 2. Xyleborus glabratus

tribe: Xyleborini

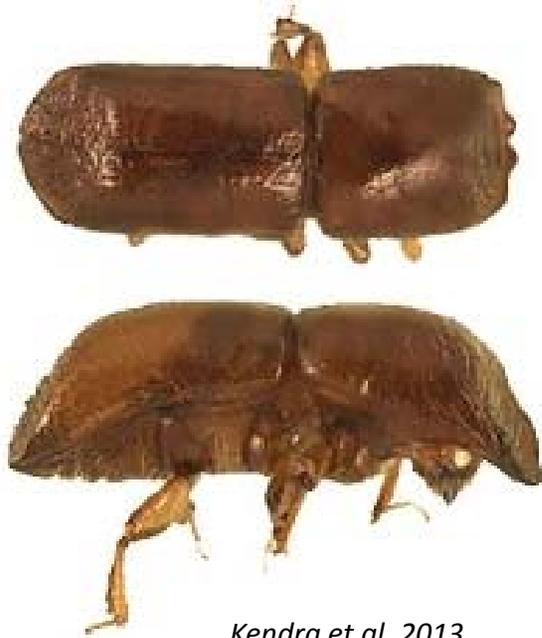


## 2. *Xyleborus glabratus*

tribe: Xyleborini

family life: haplo-diploid inbreeder

boy



girl



## 2. *Xyleborus glabratus*

tribe: Xyleborini

family life: haplo-diploid inbreeder

mycangium: pre-oral



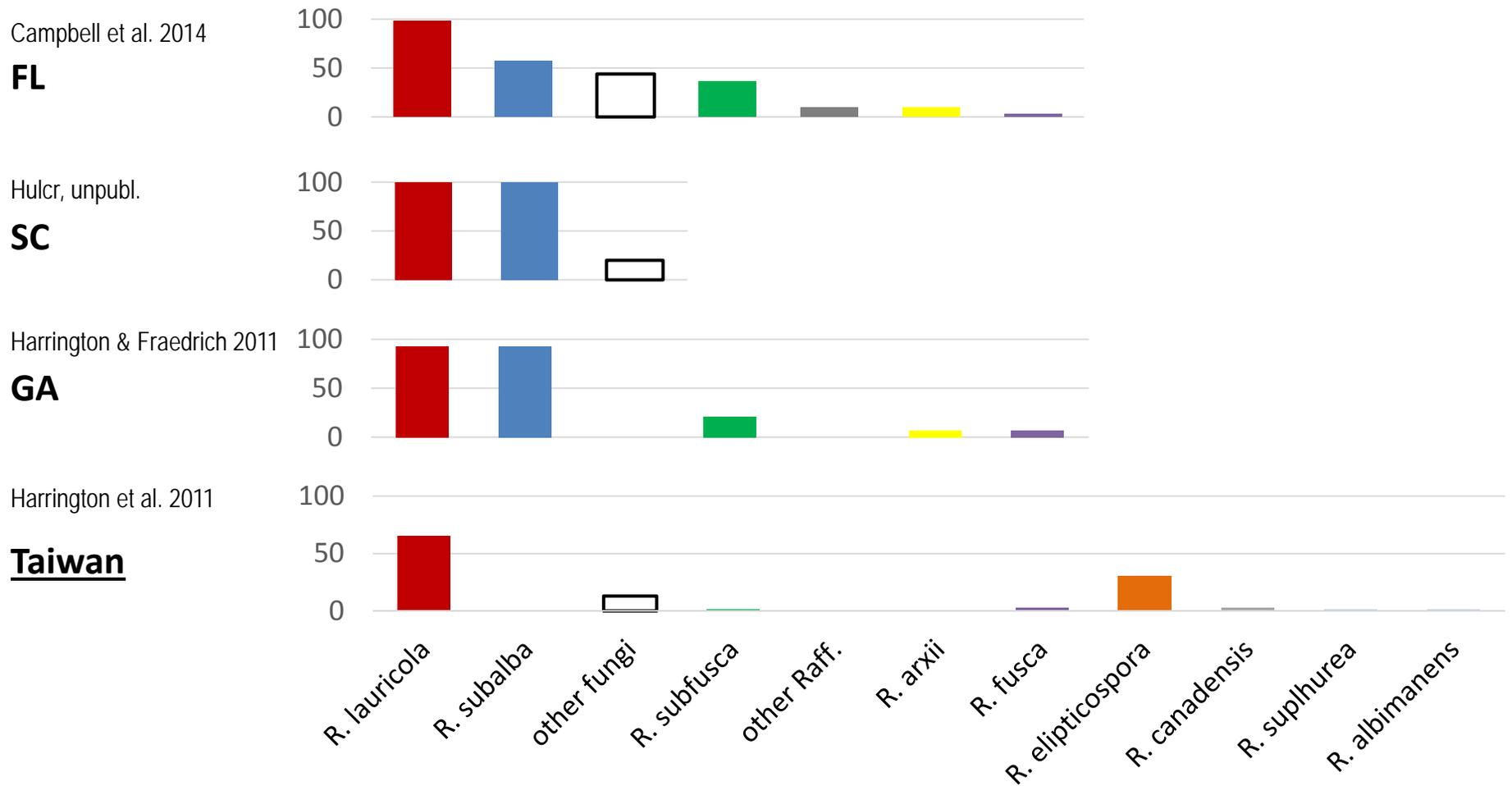
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tribe: Xyleborini

family life: haplo-diploid inbreeder

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fungi



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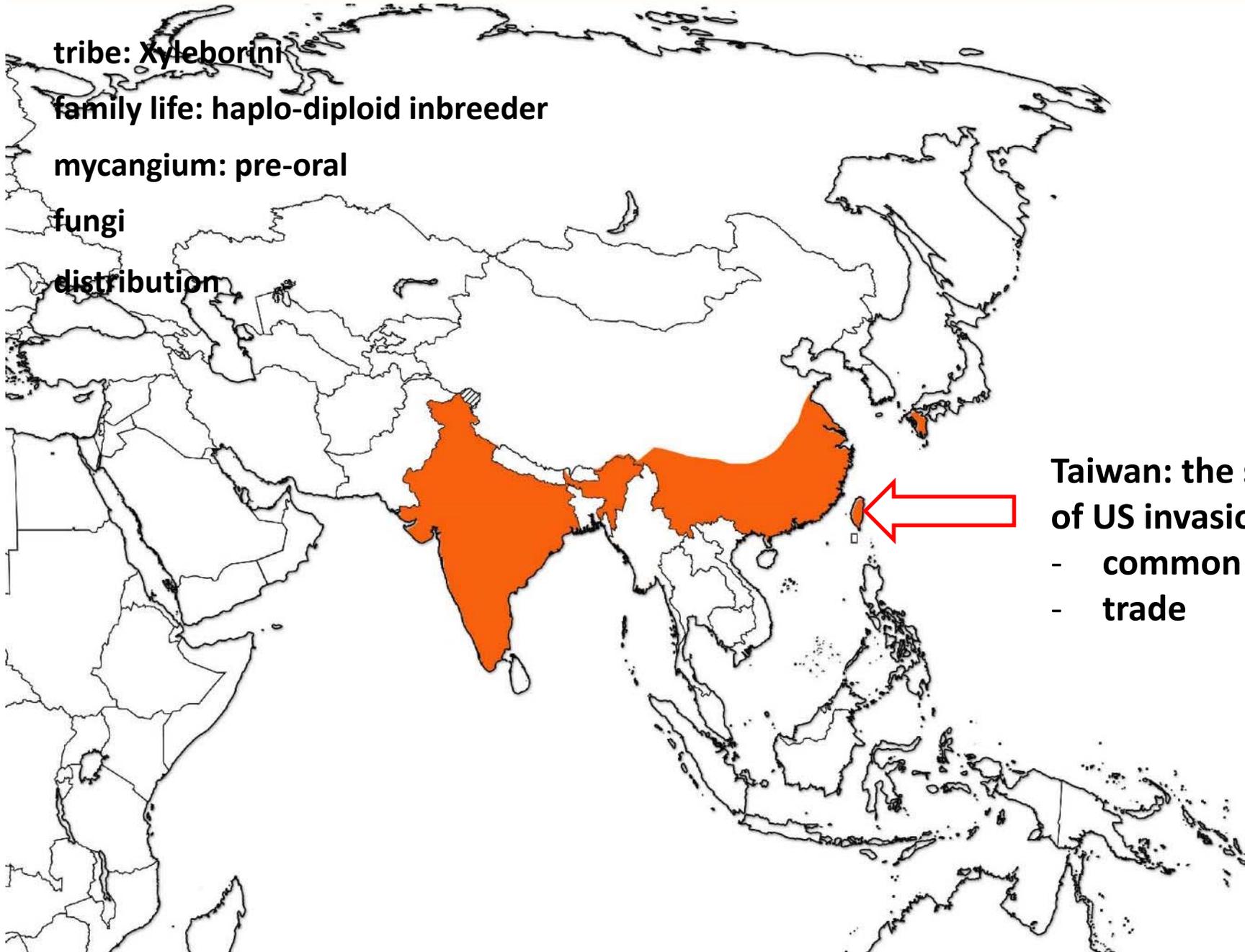
tribe: Xyleborini

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



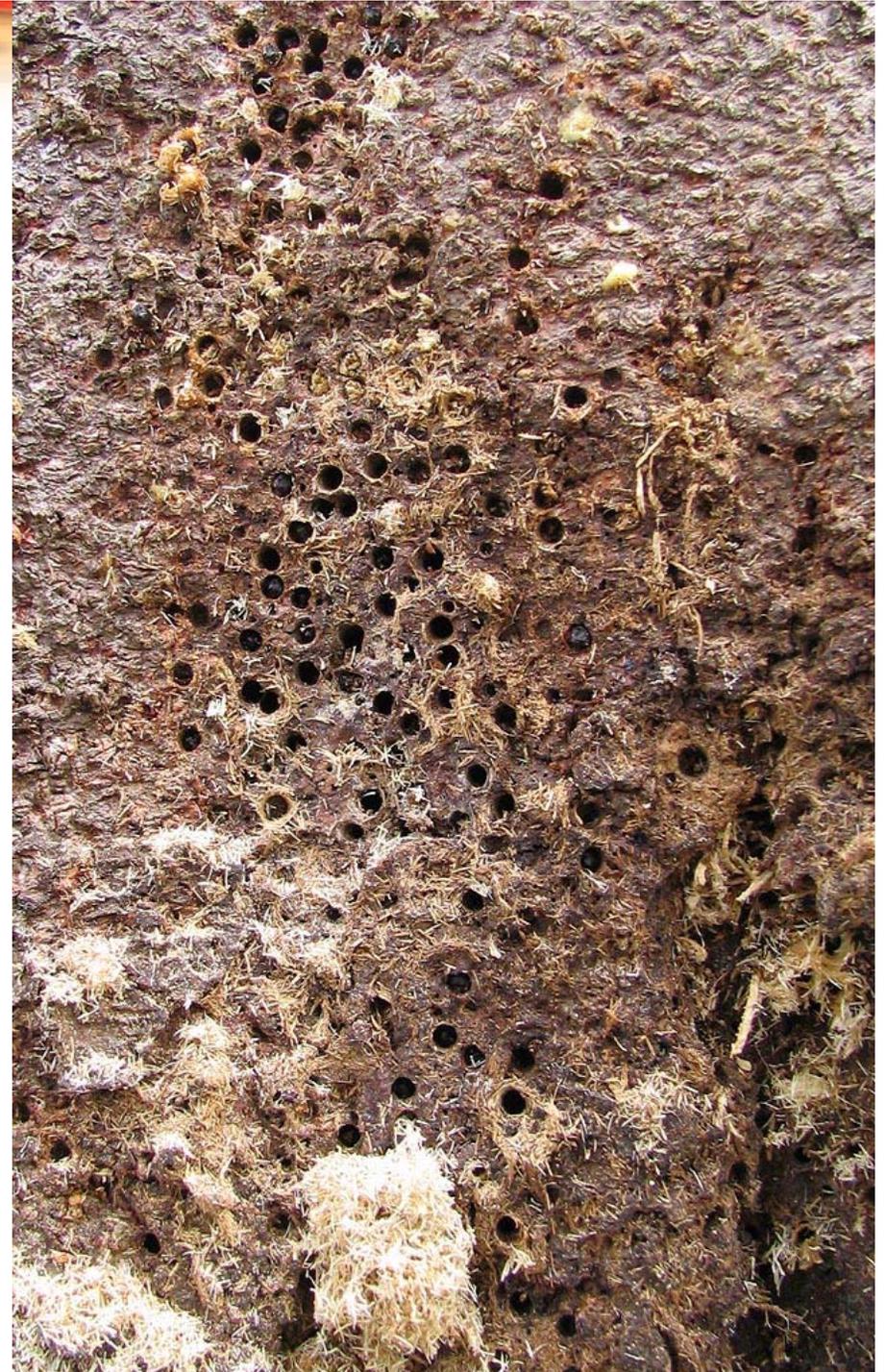
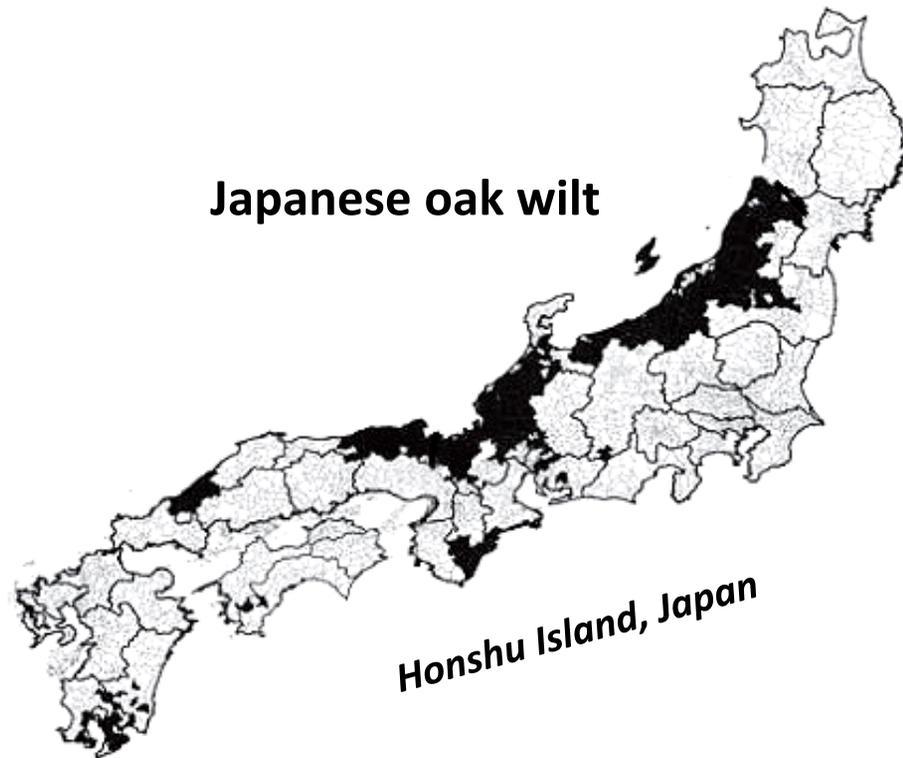
### 3. Tree killers

1) non-tree-killers

2) mass attack

(fungus only mildly pathogenic)

- *Platypus* spp.



### 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*

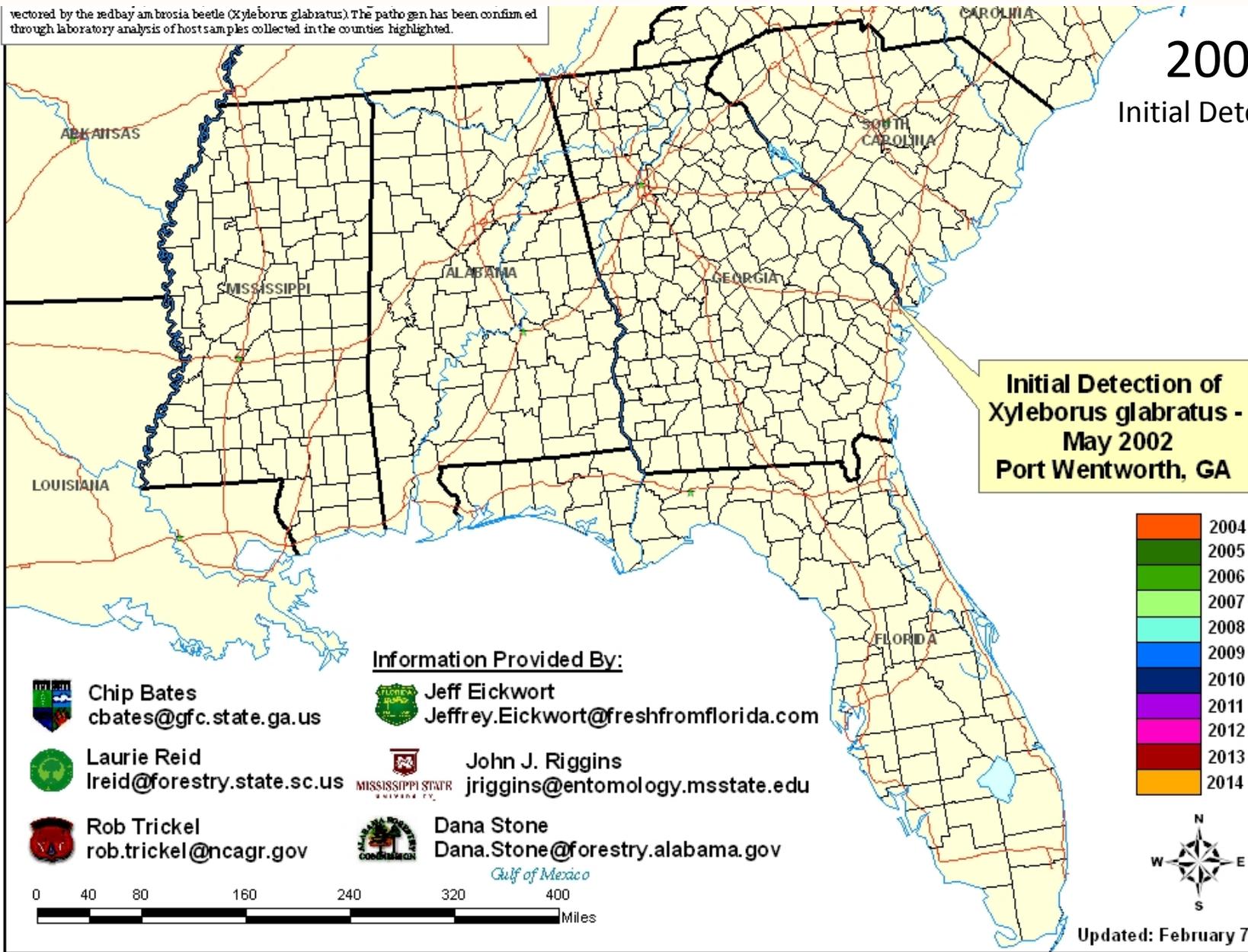


# 3. Tree killers

vectored by the redbay ambrosia beetle (*Xyleborus glabratus*). The pathogen has been confirmed through laboratory analysis of host samples collected in the counties highlighted.

2002

Initial Detection



Initial Detection of *Xyleborus glabratus* - May 2002 Port Wentworth, GA

- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014

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Gulf of Mexico

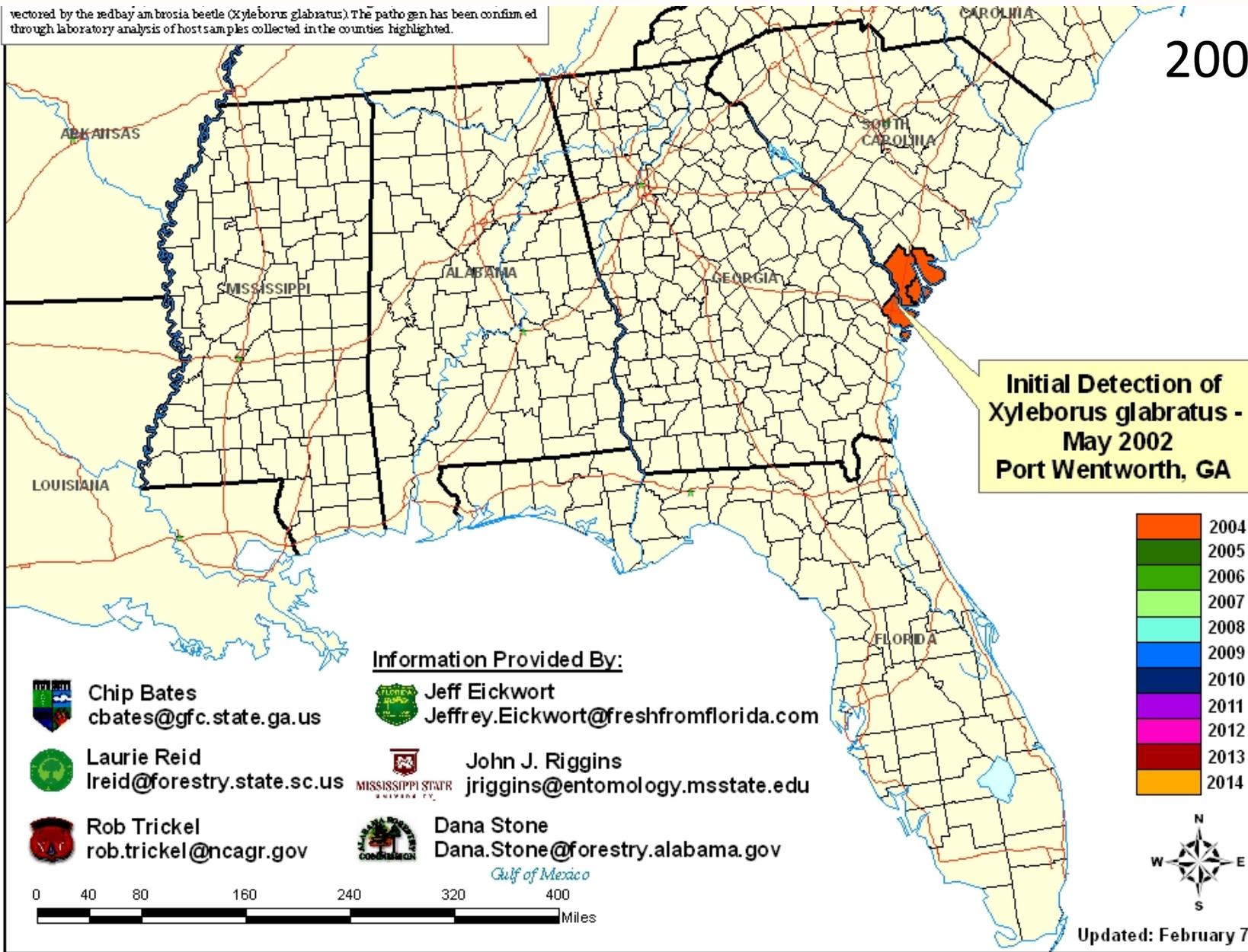


Updated: February 7, 2014

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2004



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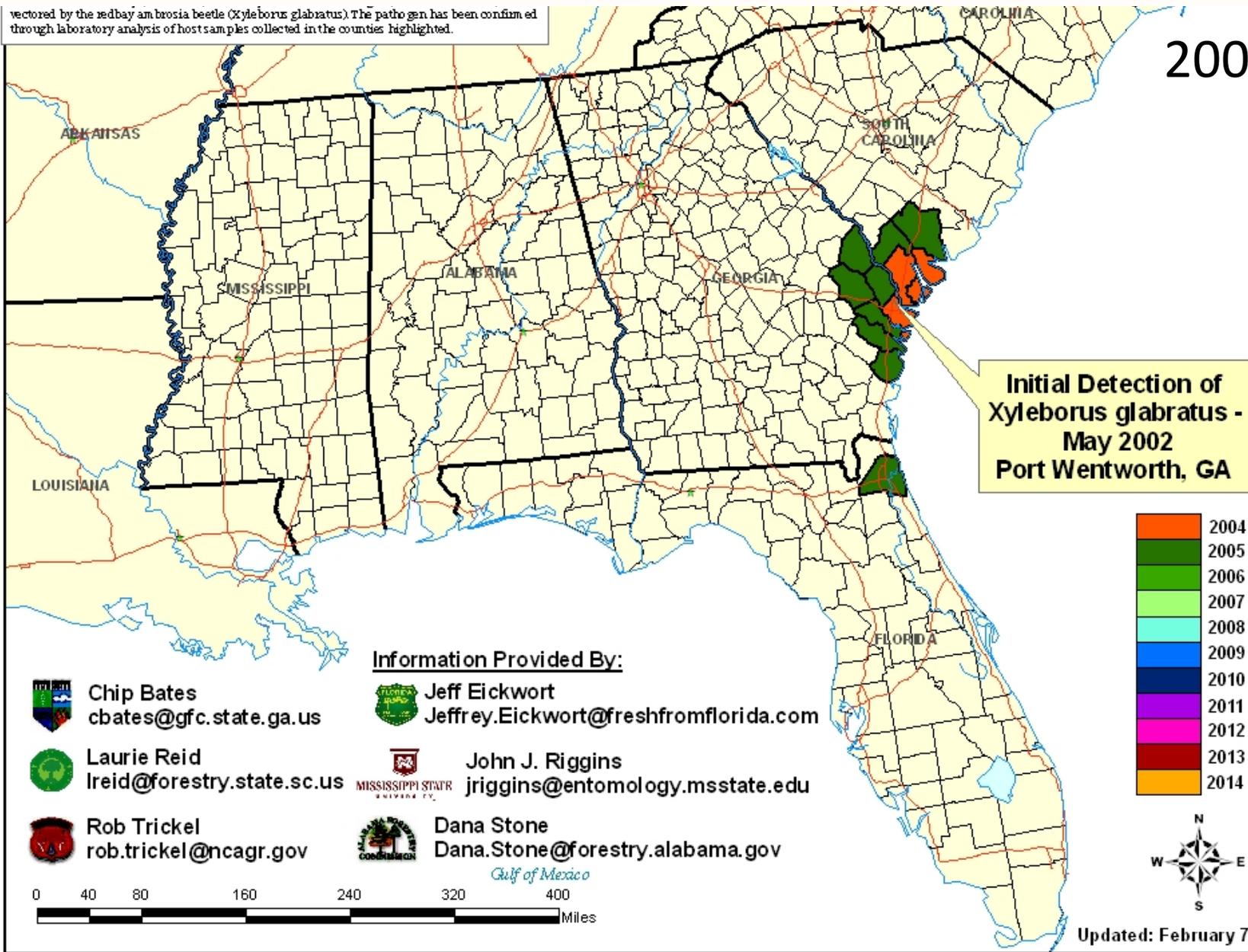


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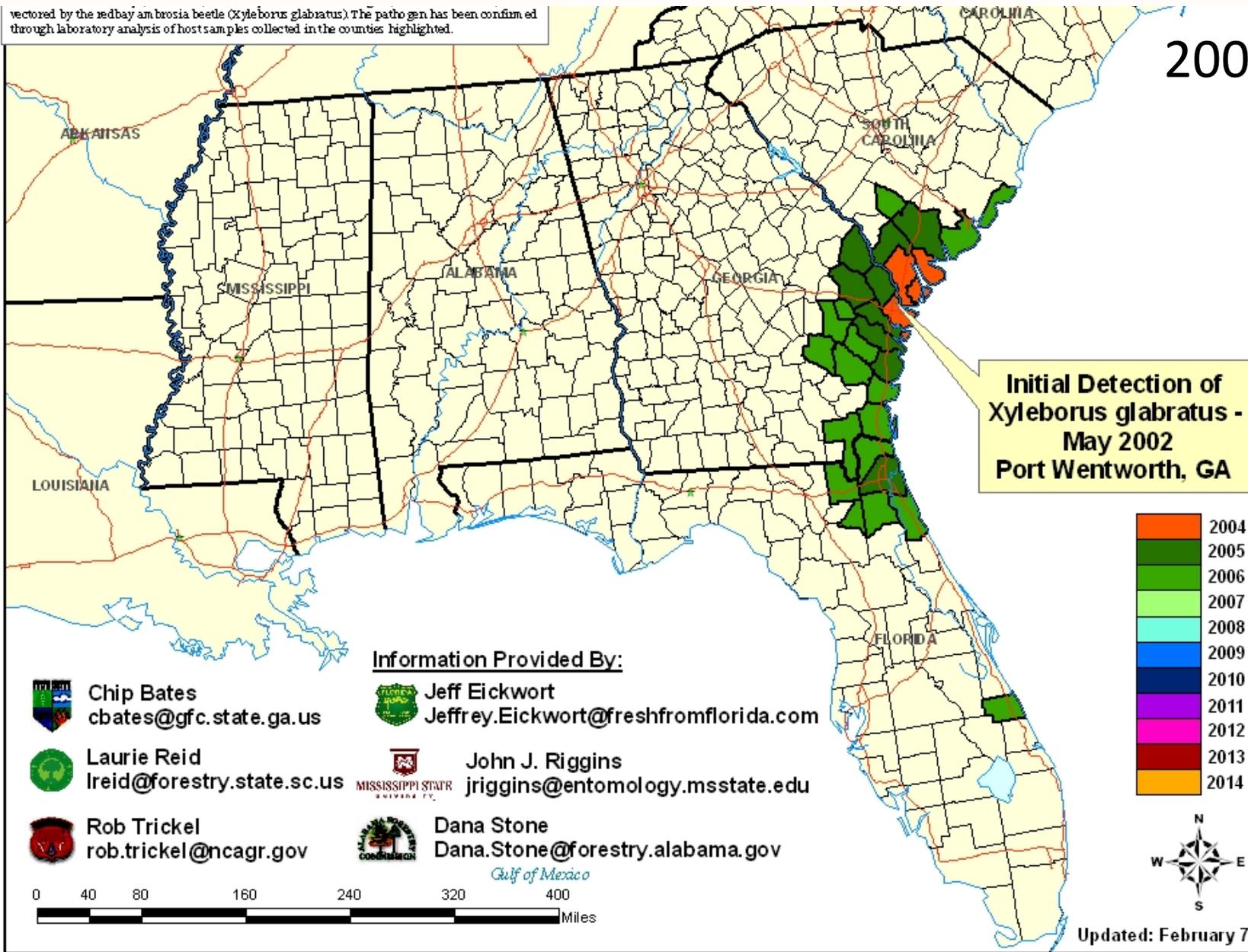


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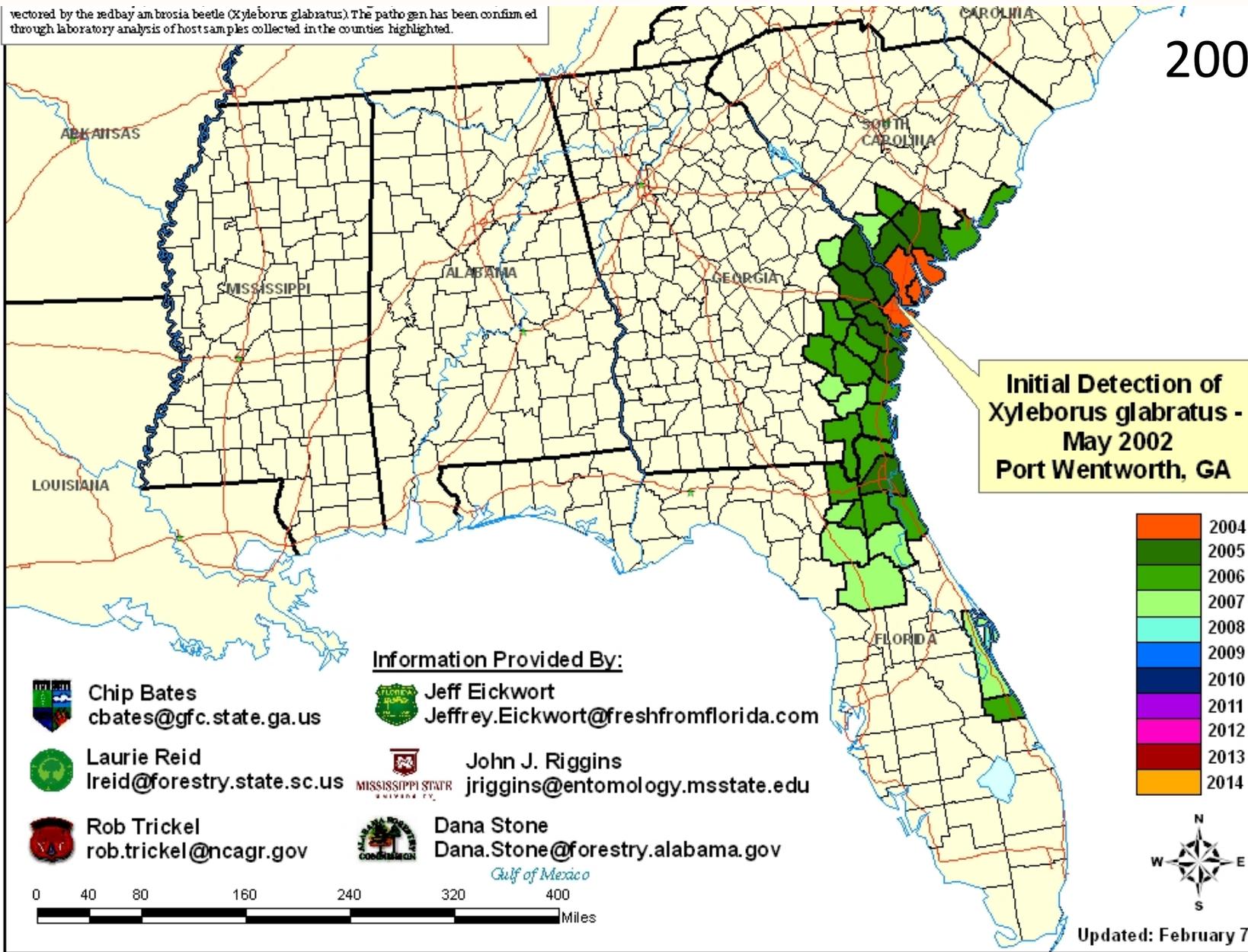


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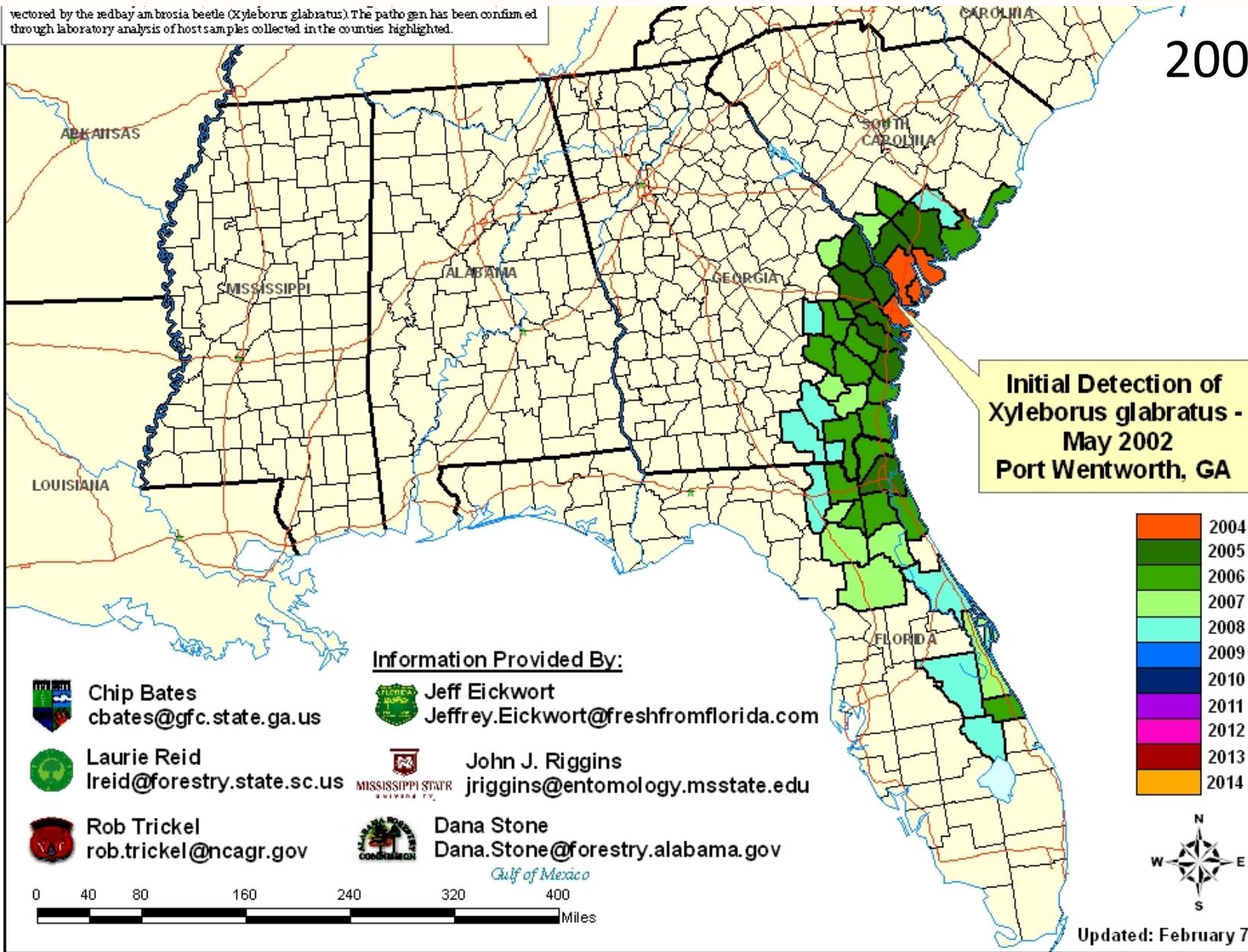
2007



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2008



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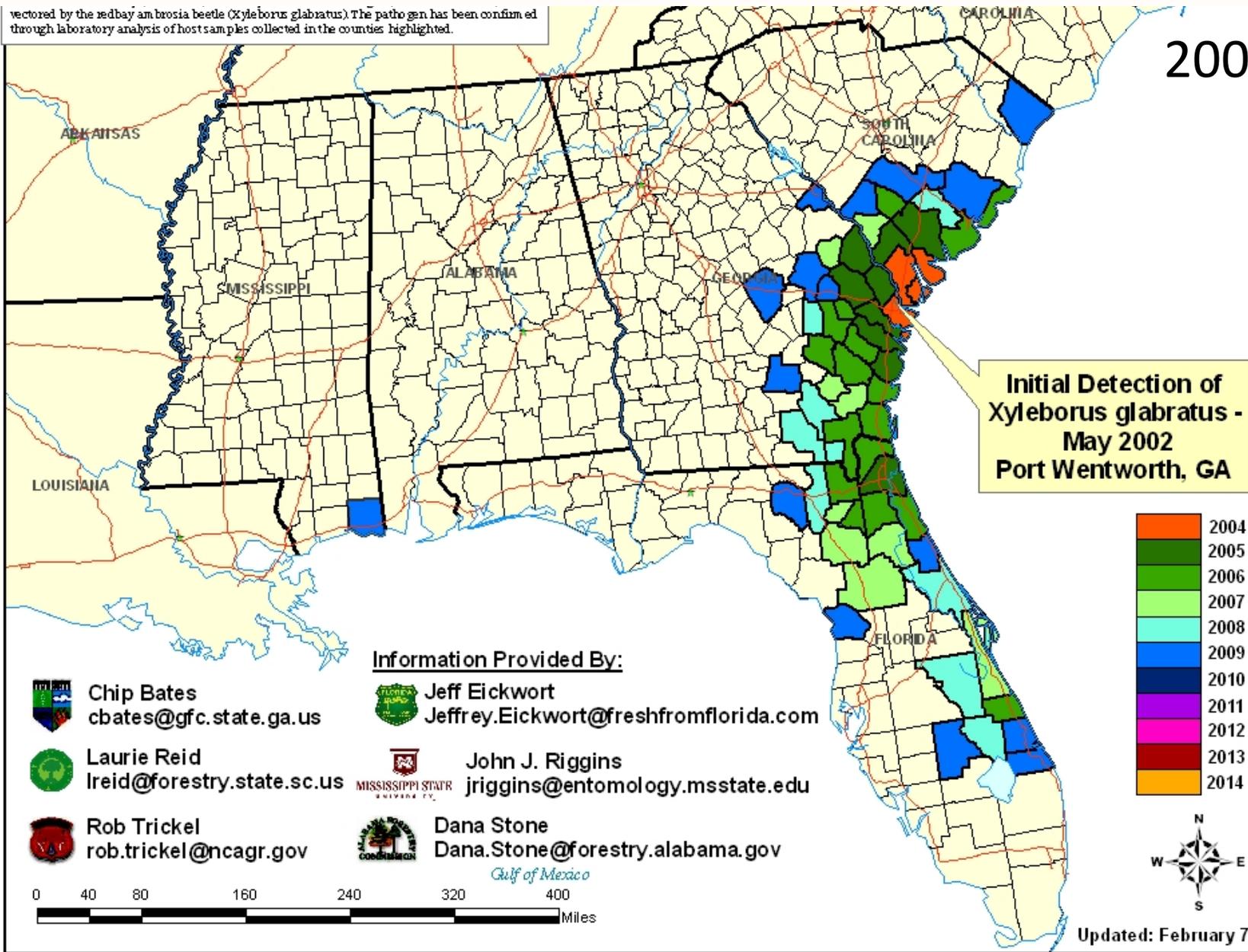


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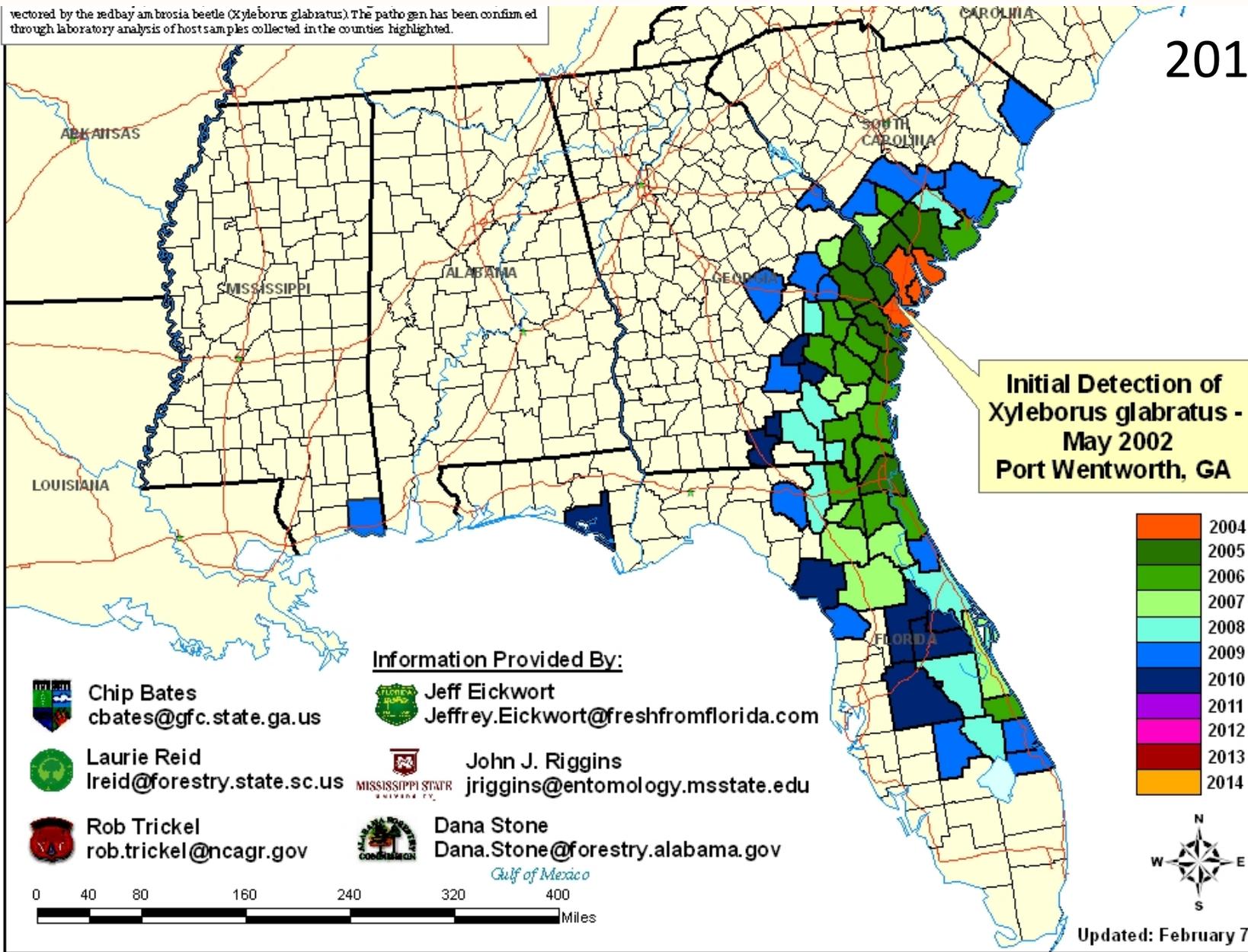


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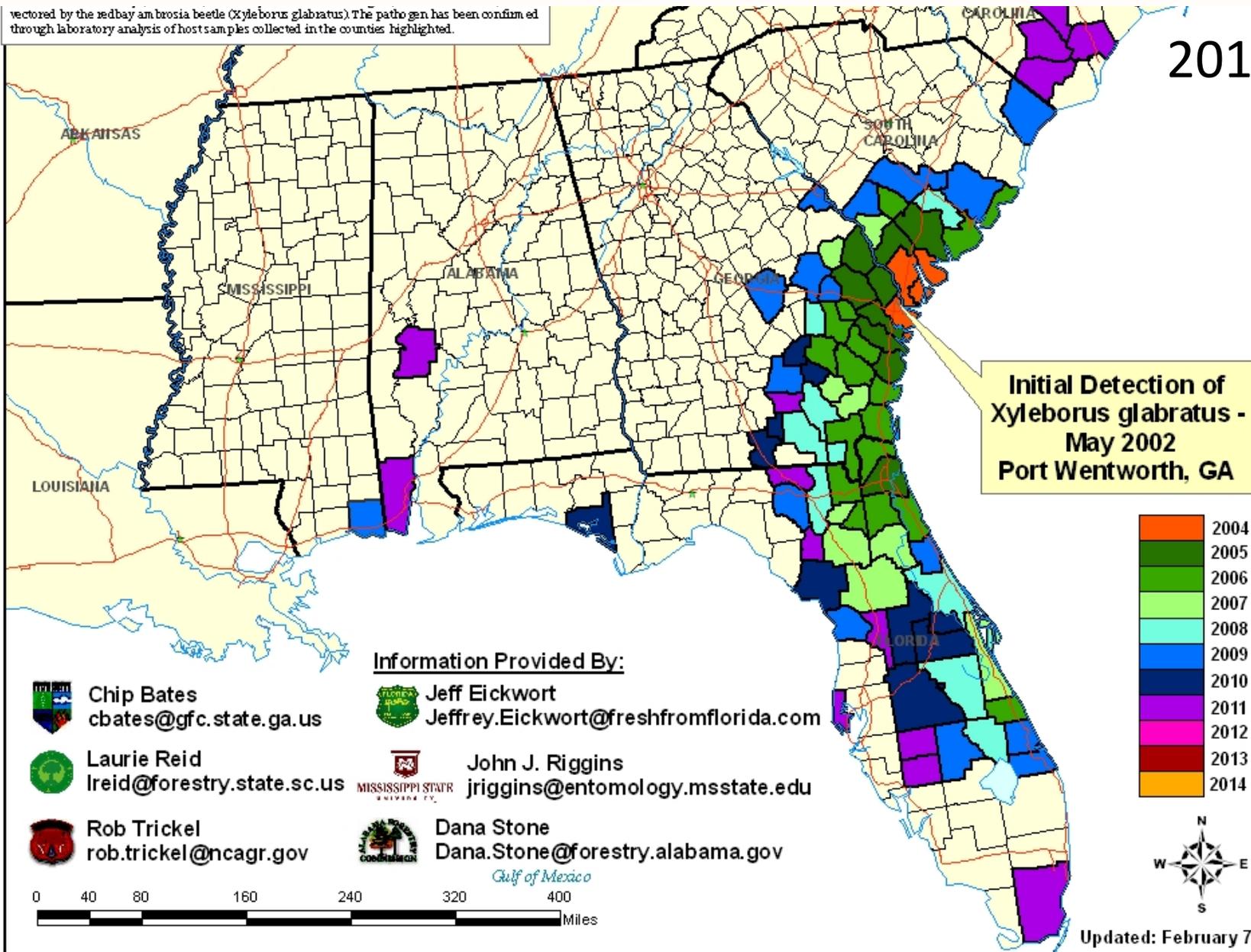


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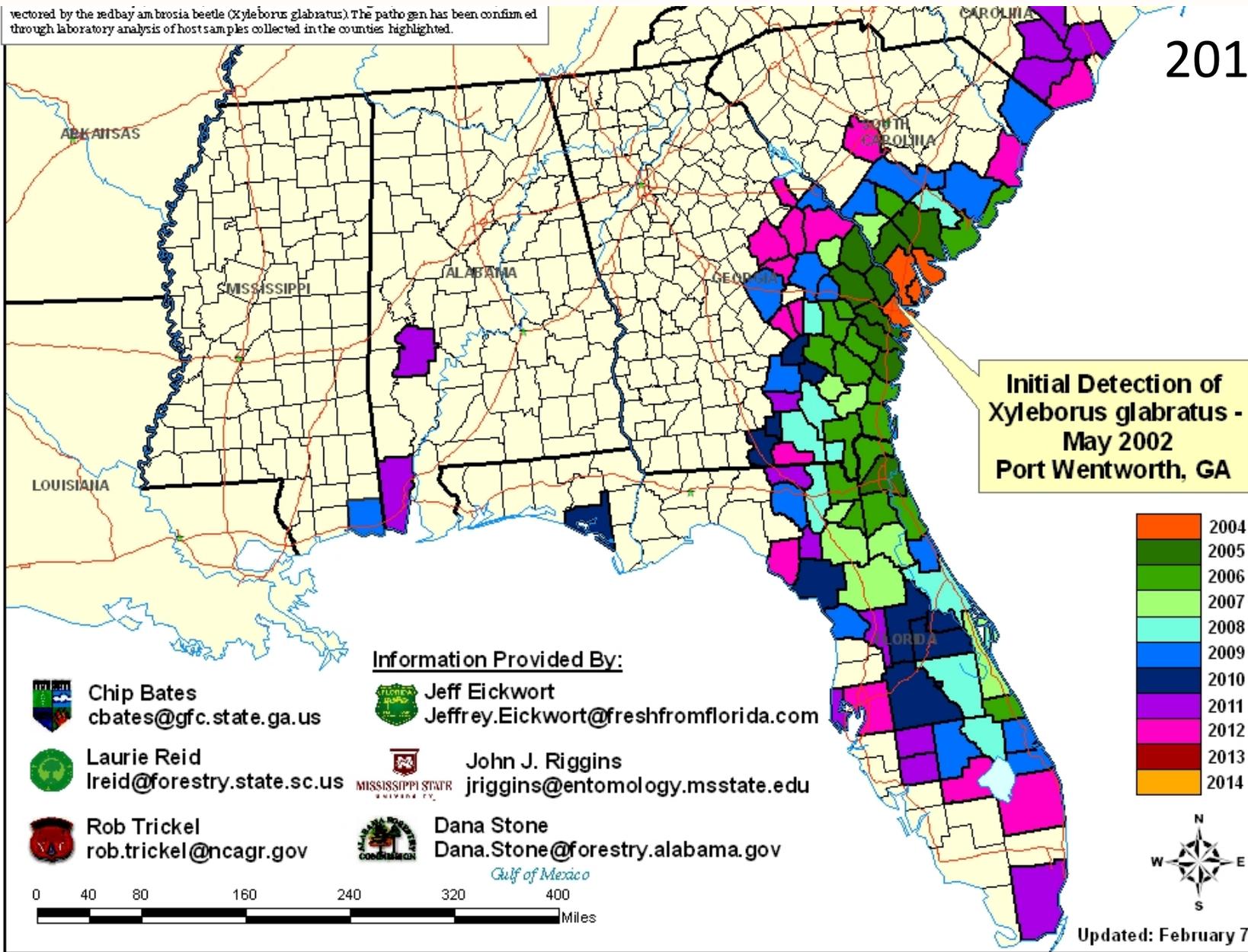
2011



# 3. Tree killers

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2012



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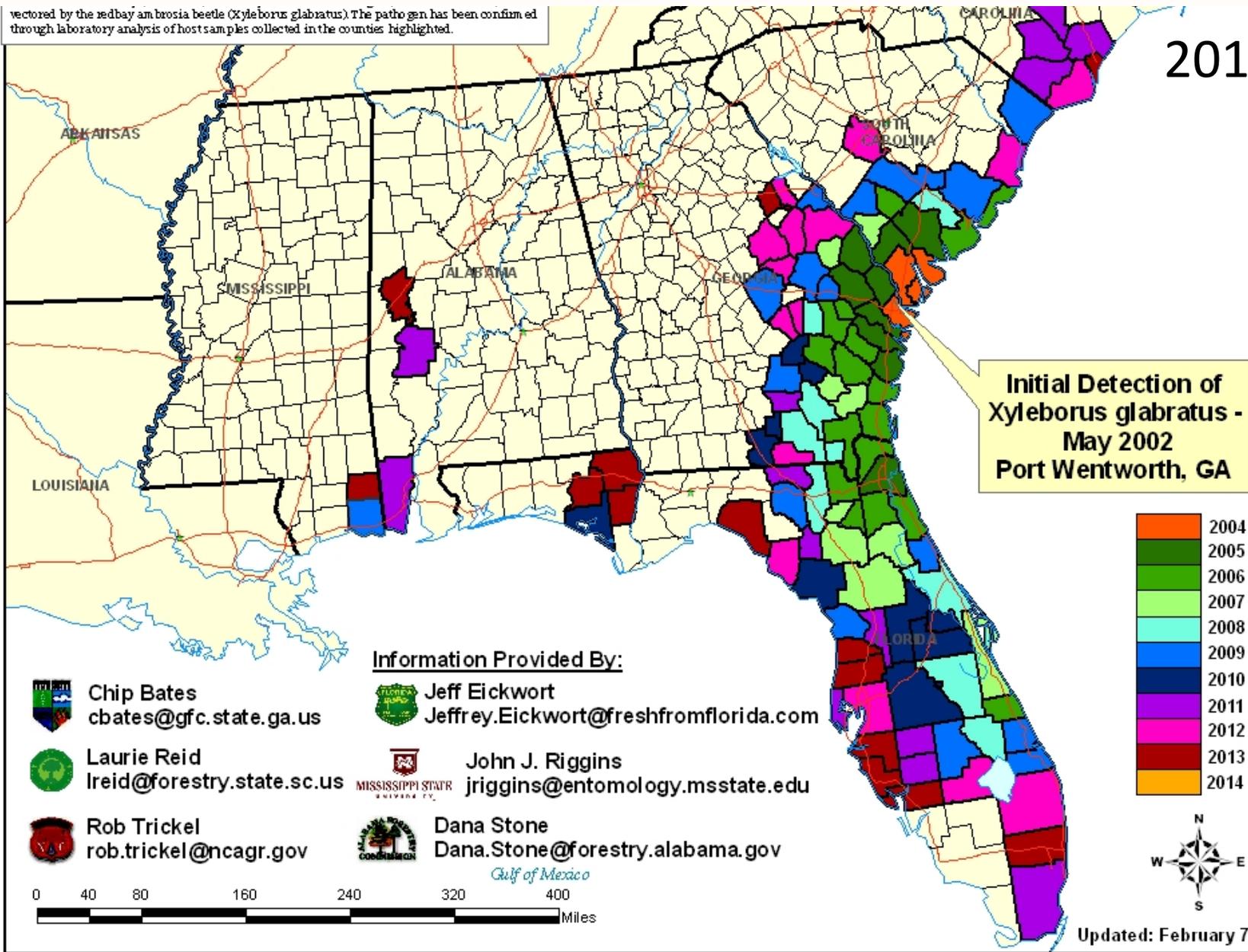


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2013



Initial Detection of *Xyleborus glabratus* - May 2002 Port Wentworth, GA

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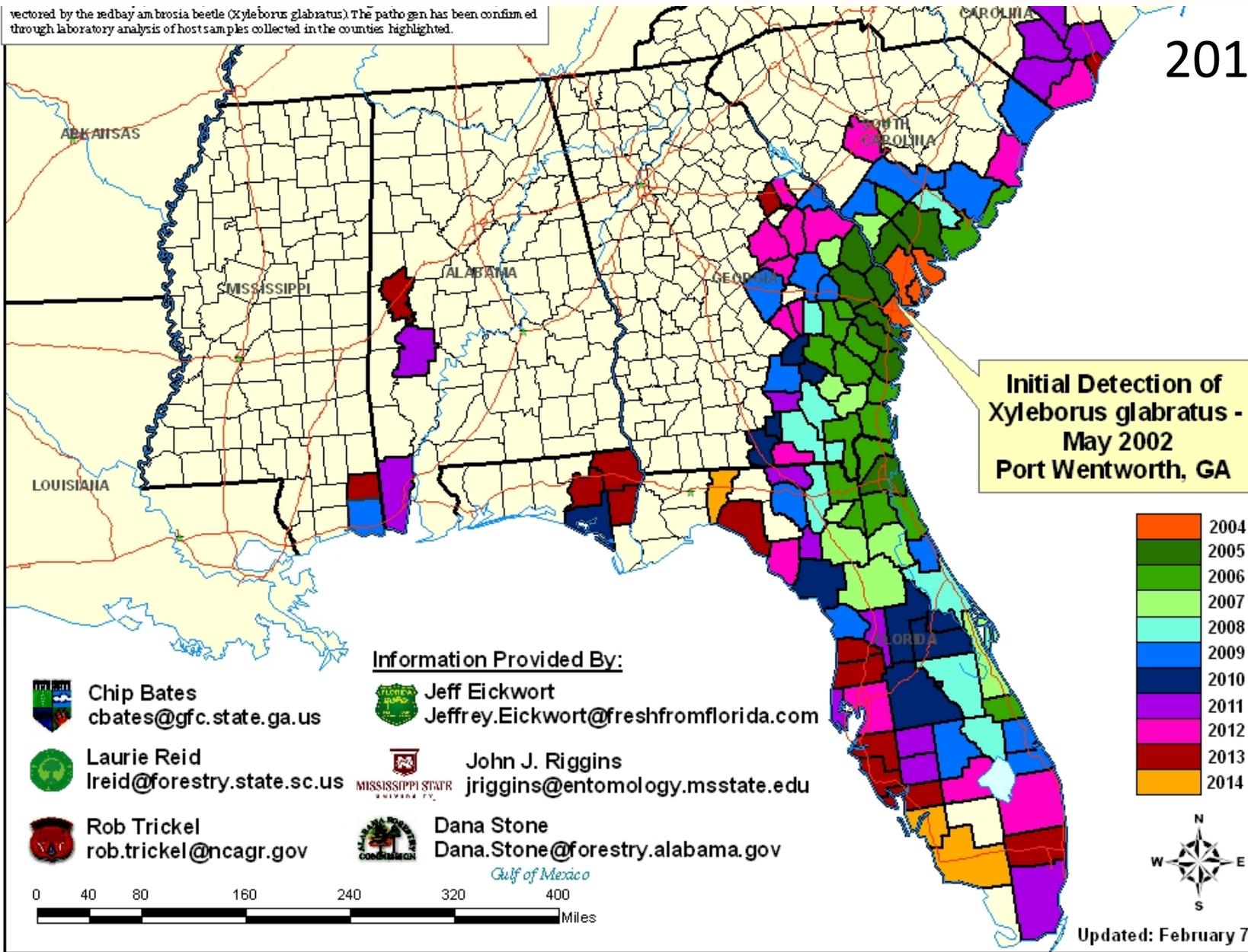


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2014



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Updated: February 7, 2014

### 3. Tree killers

avocado orchards in  
South Florida, 2014





### **3. Tree killers**



**We DO NOT know...**

# We DO NOT know...

<u>ambrosia beetle genera</u>		<u># not studied</u>
Bothrosternini	2	0
<i>Camptocerus</i> (2 subgenera)	2	2
Corthylina	10	8
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<i>Scolytodes unipunctatus</i>	1	0
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Xyloterini	3	1

Fungi unknown in  
**72%**  
ambrosia beetle genera

?

...another *Raffaelea lauricola*?

...another *Ophiostoma ulmi*?

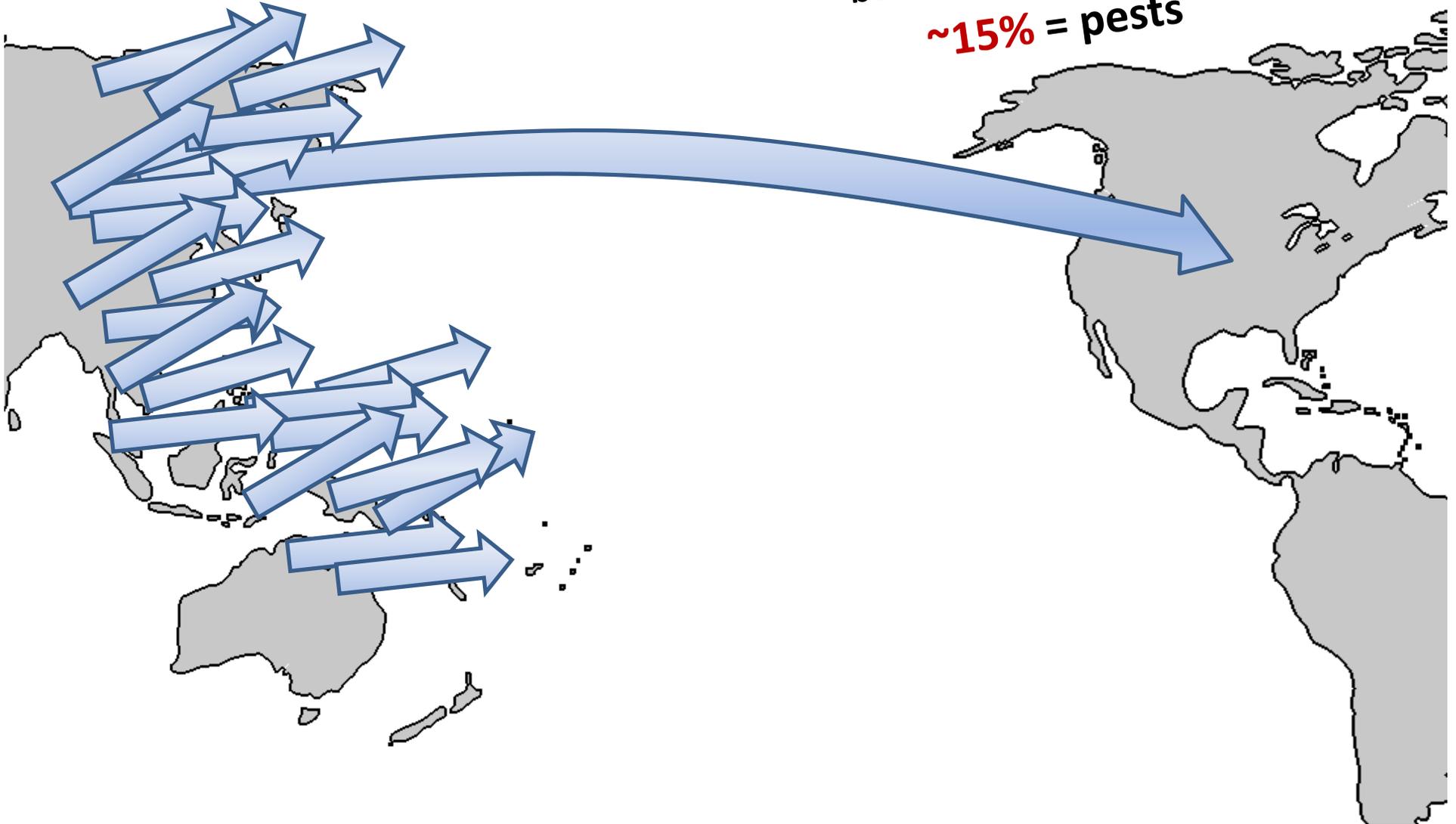
...pathogenic *Fusarium*, *Geosmithia*?

# We DO NOT know...

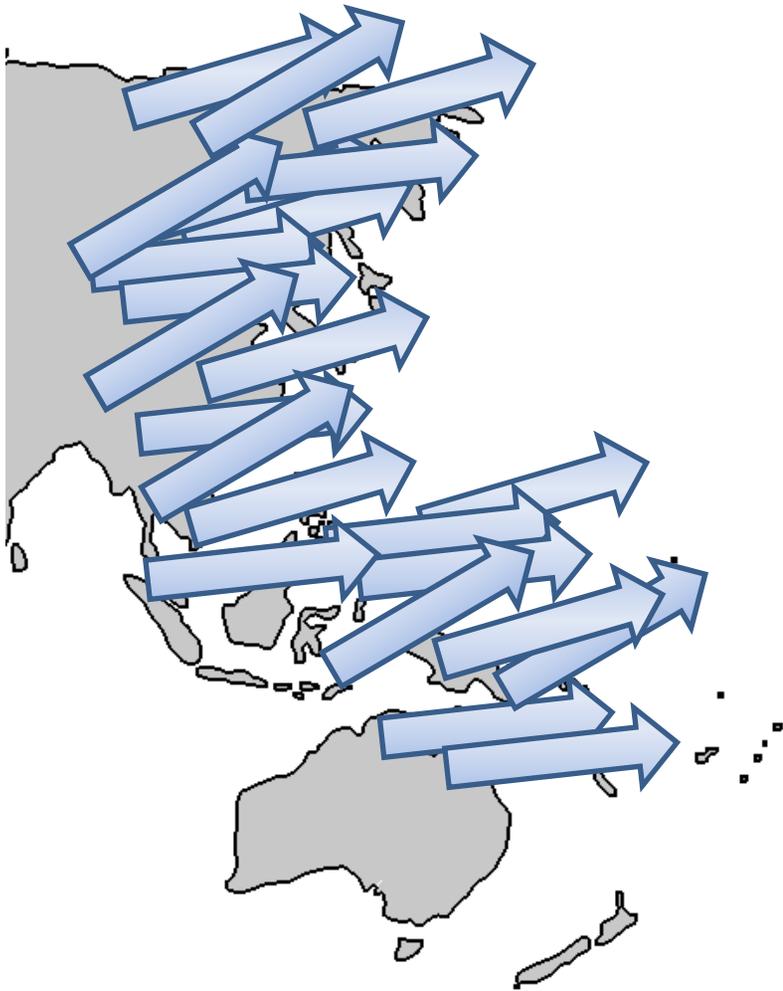
**~1,500 still waiting!**

~26 Asian ambrosia  
beetle species in the US.

**~15% = pests**



# 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
<i>Xyleborus pinicola</i>	Thailand	<i>Raffaelea</i> sp.	OK		
<i>Ips acuminatus</i>	China	<i>Ophiostomatales</i> sp. <i>Ophiostoma ips</i>	OK	mild	
<i>Tomicus minor</i>	China	<i>Geosmithia</i>			
<i>Webbia pabo</i>	China	<i>Ophiostoma</i>	OK		
<i>Cyclorhipidion fuki</i>		<i>Ophiostoma</i> 2 7736	OK		
<i>Cyrtog</i>	China	<i>Ophiostoma</i> 3 7690	OK		
<i>Polygra</i> sp.	China	<i>Ascomycete</i> sp. 7694	OK		
<i>Polygra</i> sp.	China	<i>Ceratocystiopsis</i> 7744	OK		
<i>Dendroctonus micans</i>	Czech Republic	<i>Pesotum</i> sp. <i>Leptographium</i> sp.		?	
<i>Platypus koryoensis</i>	Korea	<i>Raffaelea</i> sp. <i>Ambrosiozyma</i> sp.		?	
<i>Platypus quercivorus</i>	Japan	<i>Raffaelea quercivora</i>		?	
<i>Orthotomicus erosus</i>	Israel	<i>Leptographium</i> sp.		?	

**No systemic pathogen!**

**We DO NOT know...**

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

**YES!**



**Taiwan, March 2015**

**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**

