

Laurel Wilt: a New Forest Disease in Florida

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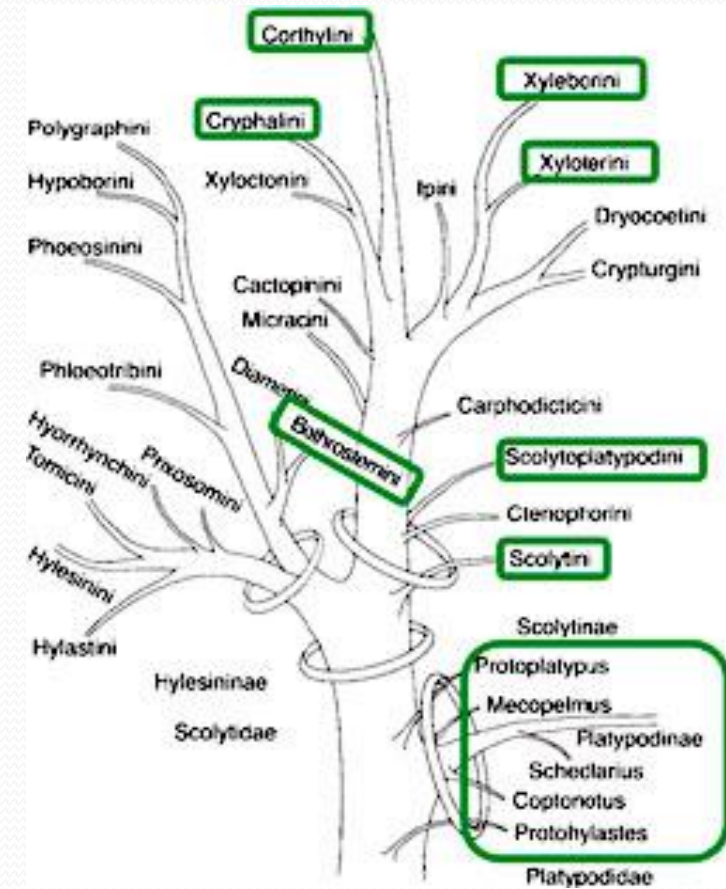
The History

- 2002 – Previously undetected ambrosia beetle species caught in Early Detection Rapid Response (EDRR) traps near Port Wentworth, GA (Savannah area).
 - Identified as an Asian species, *Xyleborus glabratus*.
 - Assigned a “low risk” rating (ambrosia beetles = not usually a big deal).



Backing up – what is an ambrosia beetle?

- In weevil family (Curculionidae), closely related to bark beetles
- Very diverse, ~3,000 species in two subfamilies
- Defined more by behavior than taxonomy
- Fungus farmers!



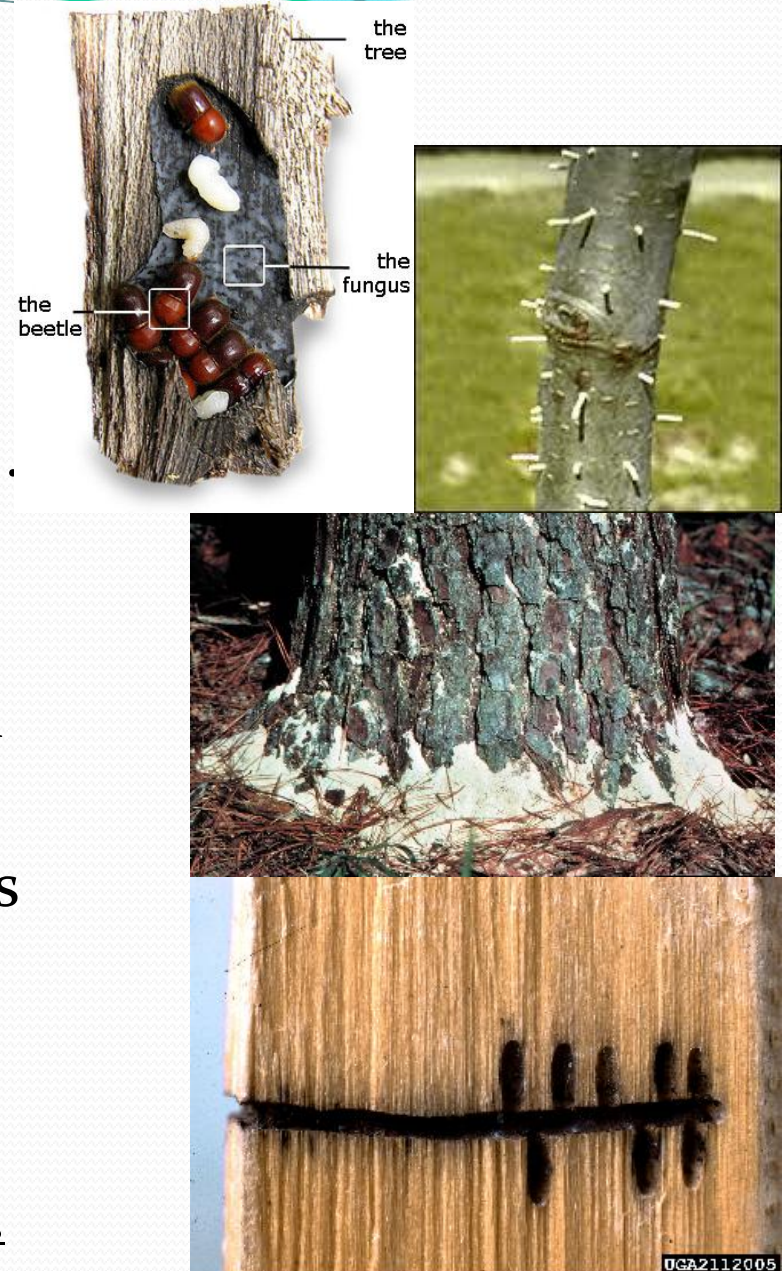
Ambrosia beetles, cont'd.

By definition:

- Don't eat the tree.
- Carry fungi with them, often in specialized structures (mycangia).
- Burrow into the wood of the tree, create tunnels ("galleries").
- Inoculate tree with fungus, which infects the wood.
- Eat fungus that grows on the walls of the galleries.

(An evolutionary derivation from bark beetle fungal symbiosis)

Not usually killers of healthy trees.



Redbay Ambrosia Beetle (*Xyleborus glabratus*)

- Native to Asia (India, Bangladesh, Japan, Myanmar, Taiwan)
- Reported Asian hosts
 - Lauraceae (*Lindera*, *Litsea*, *Phoebe*)
 - Dipterocarpaceae (*Shorea*)
 - Fagaceae (*Lithocarpus*)
 - Fabaceae (*Leucaena*)

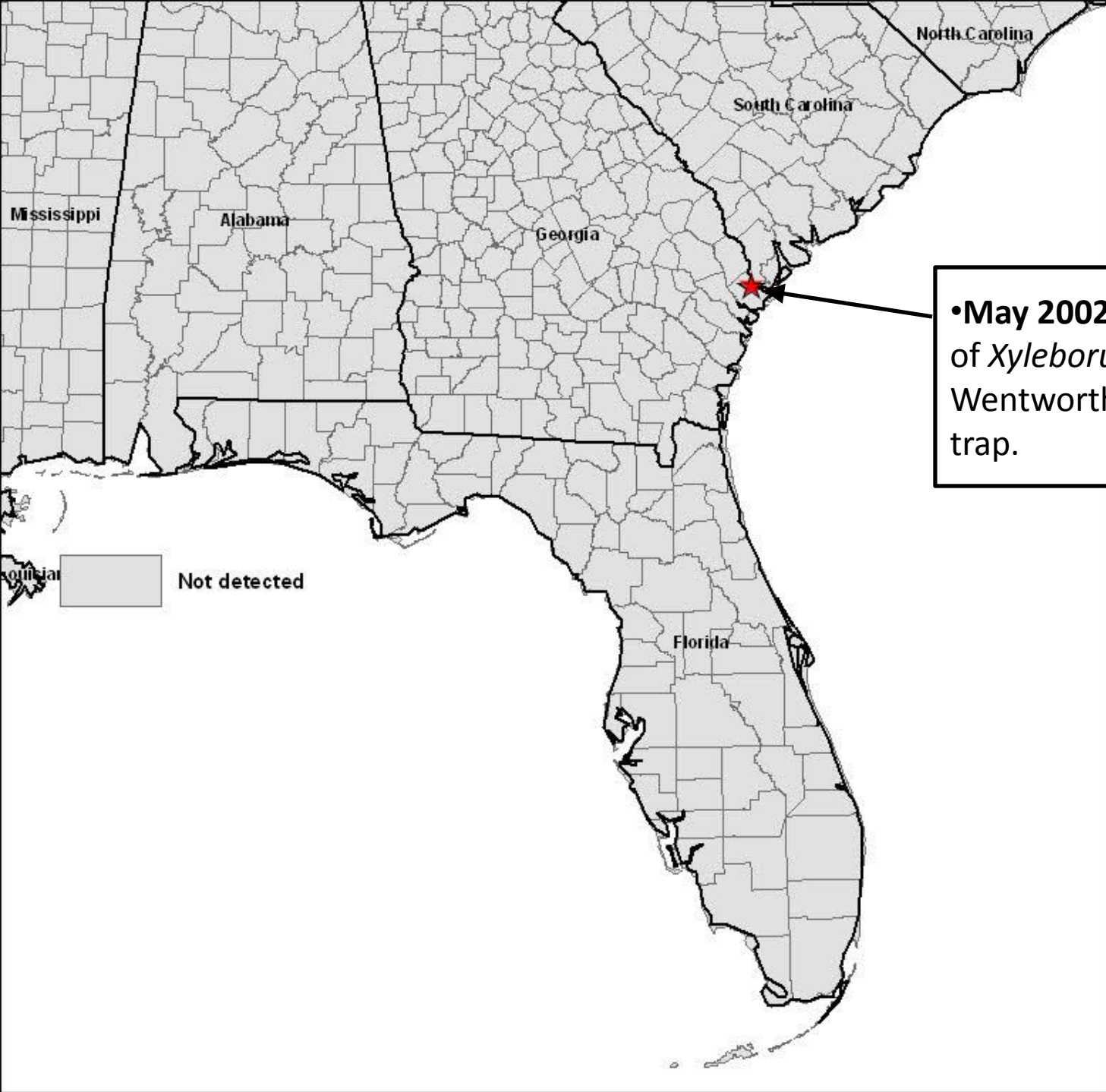


R.J. Rabaglia et al. 2006. Ann. Entomol. Soc. Am. 99(6):1034-1056.

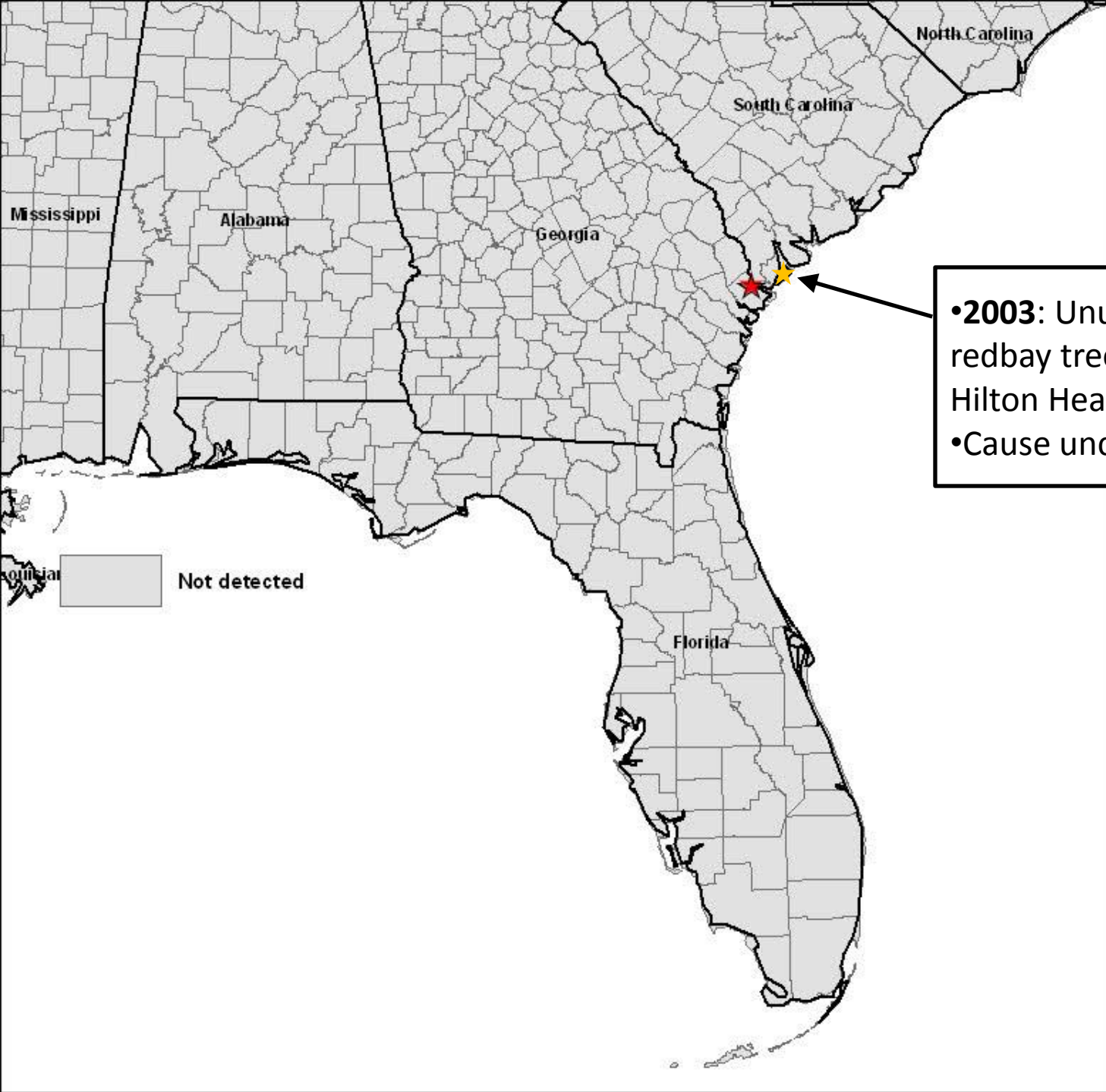
The redbay ambrosia beetle (*Xyleborus glabratus*)



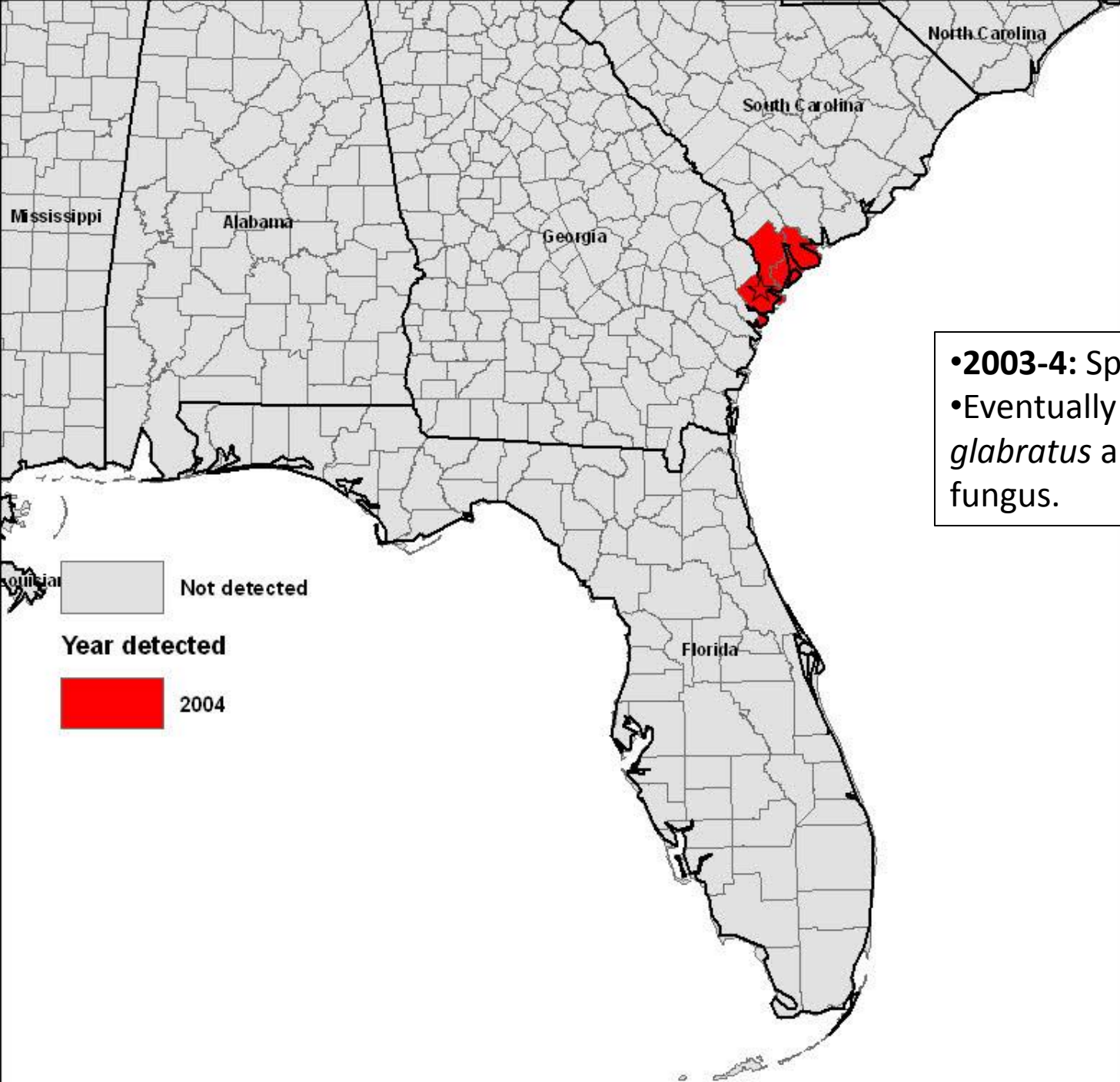
A.E. Mayfield



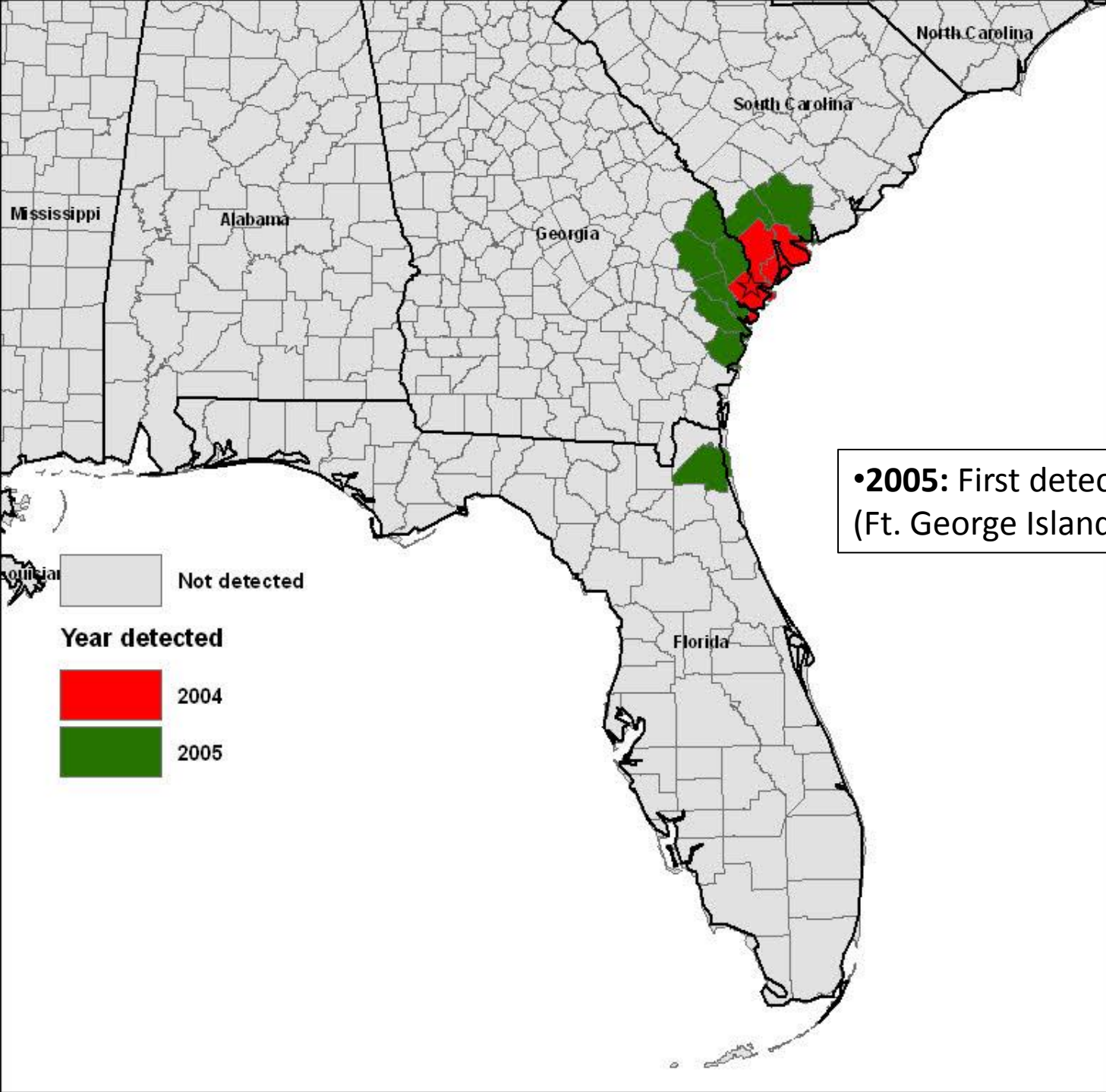
•**May 2002:** Initial detection of *Xyleborus glabratus* in Port Wentworth, GA monitoring trap.

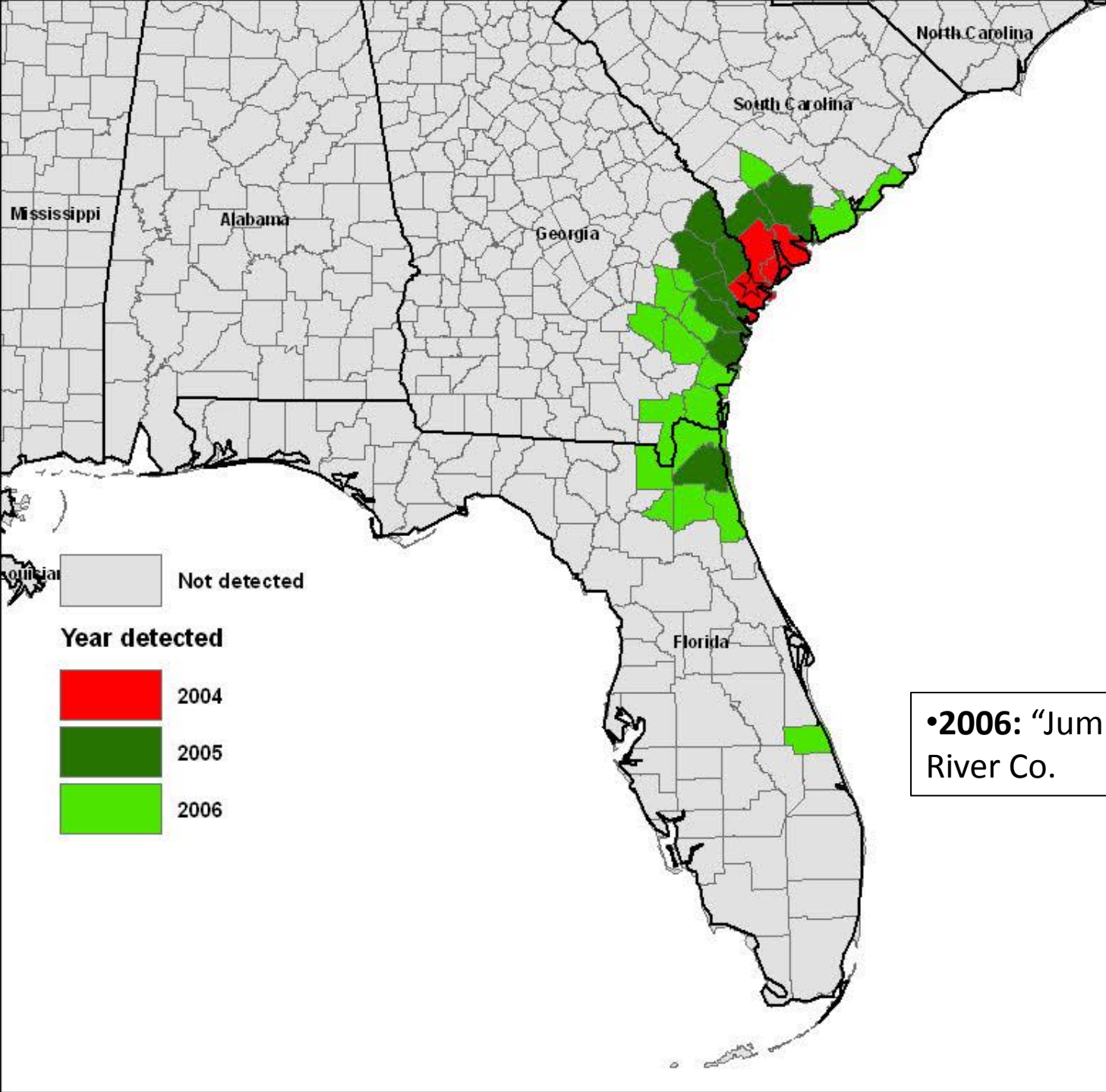


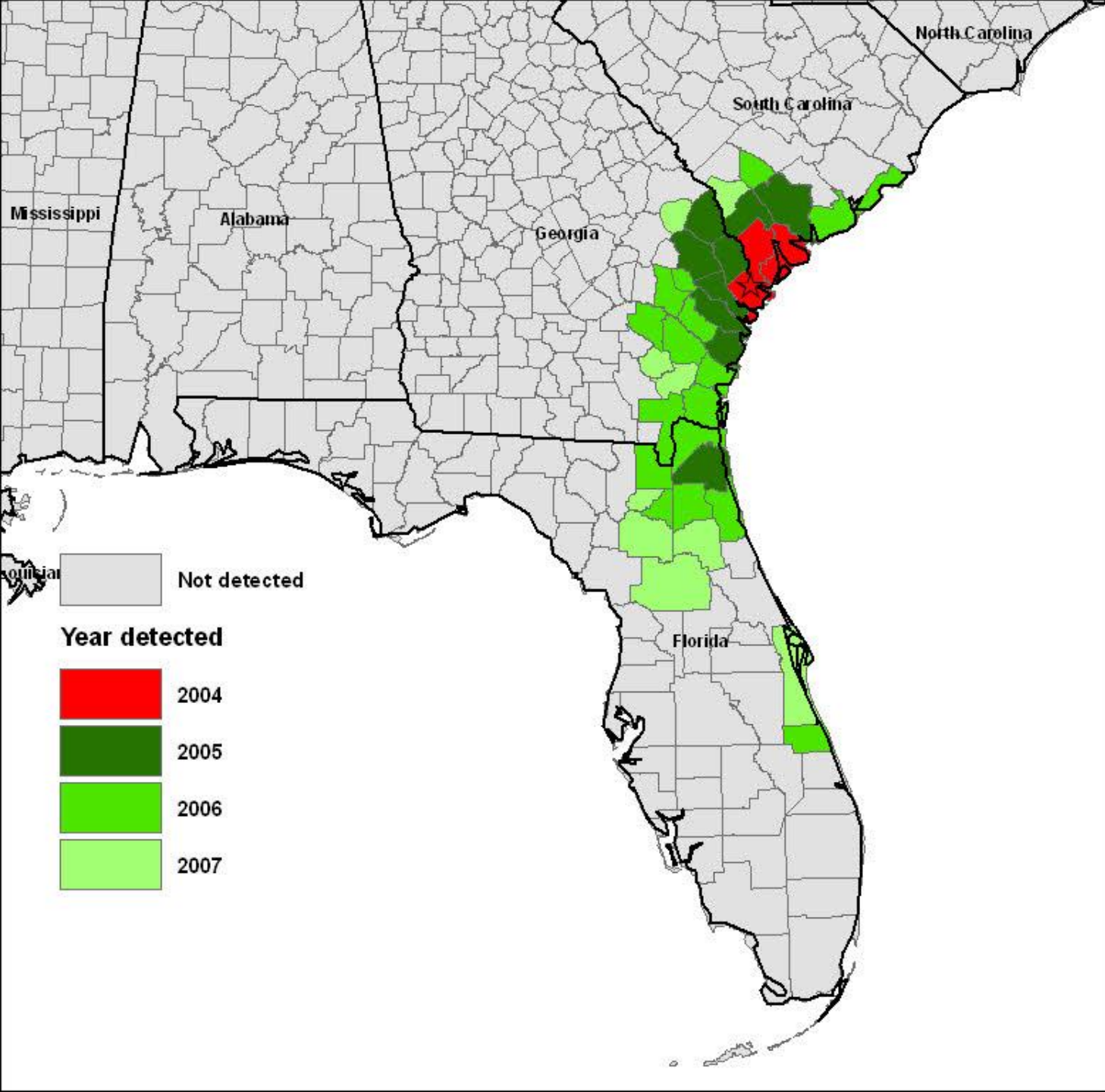
- 2003:** Unusual mortality of redbay trees reported on Hilton Head Island, SC
- Cause uncertain (drought?)

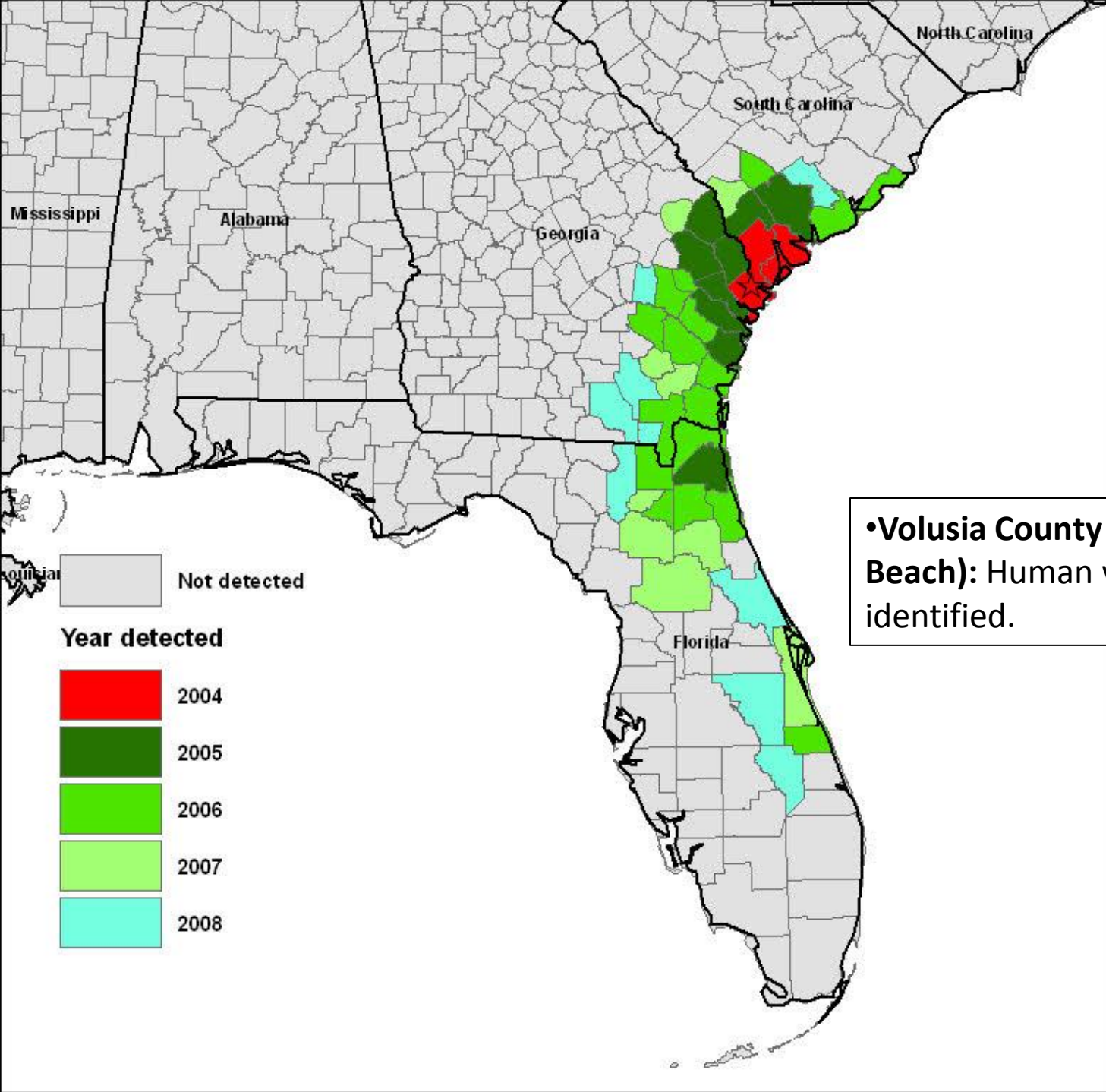


- **2003-4:** Spreads into SC & GA
- Eventually associated with *X. glabratus* and an unidentified fungus.

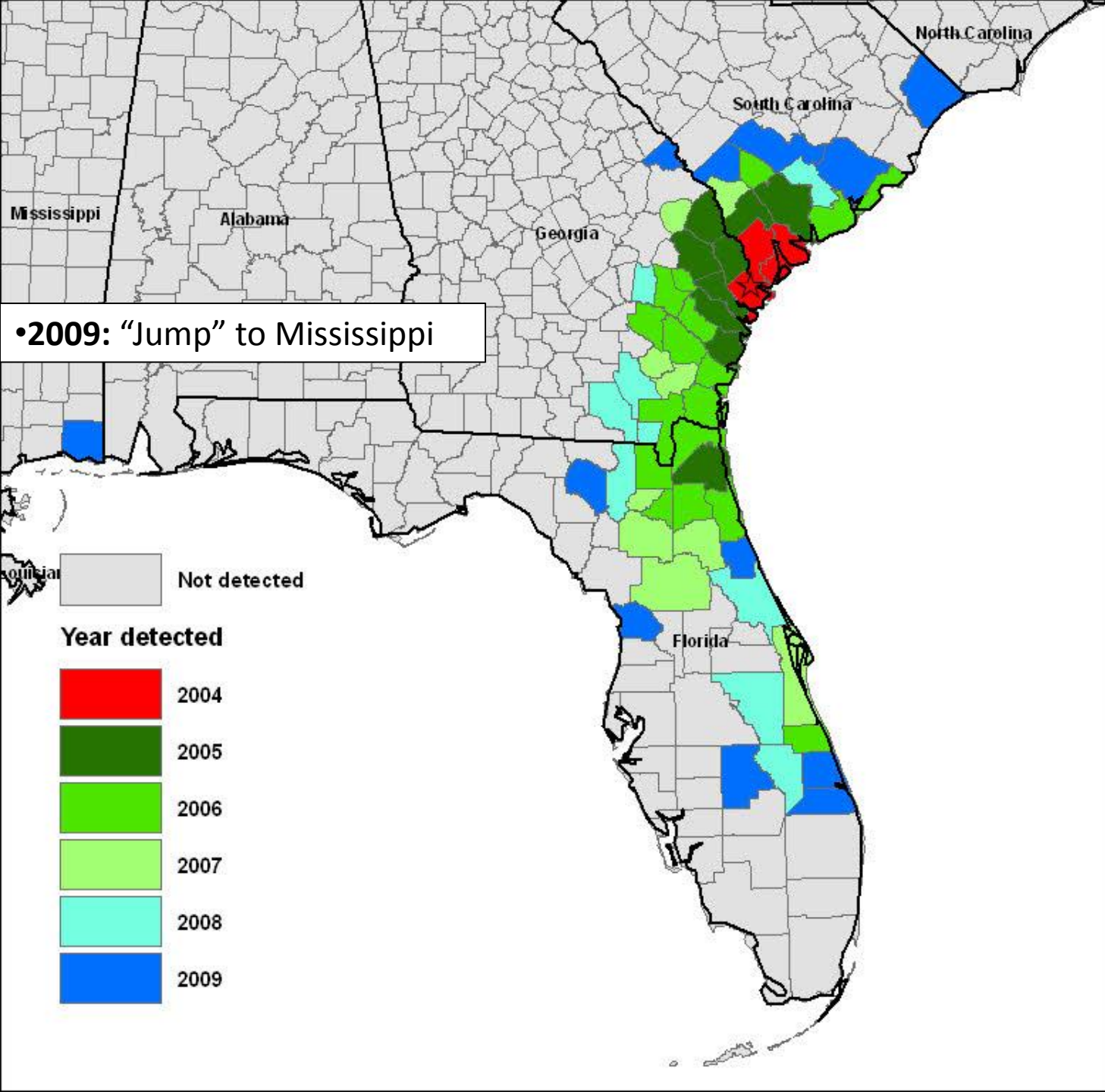


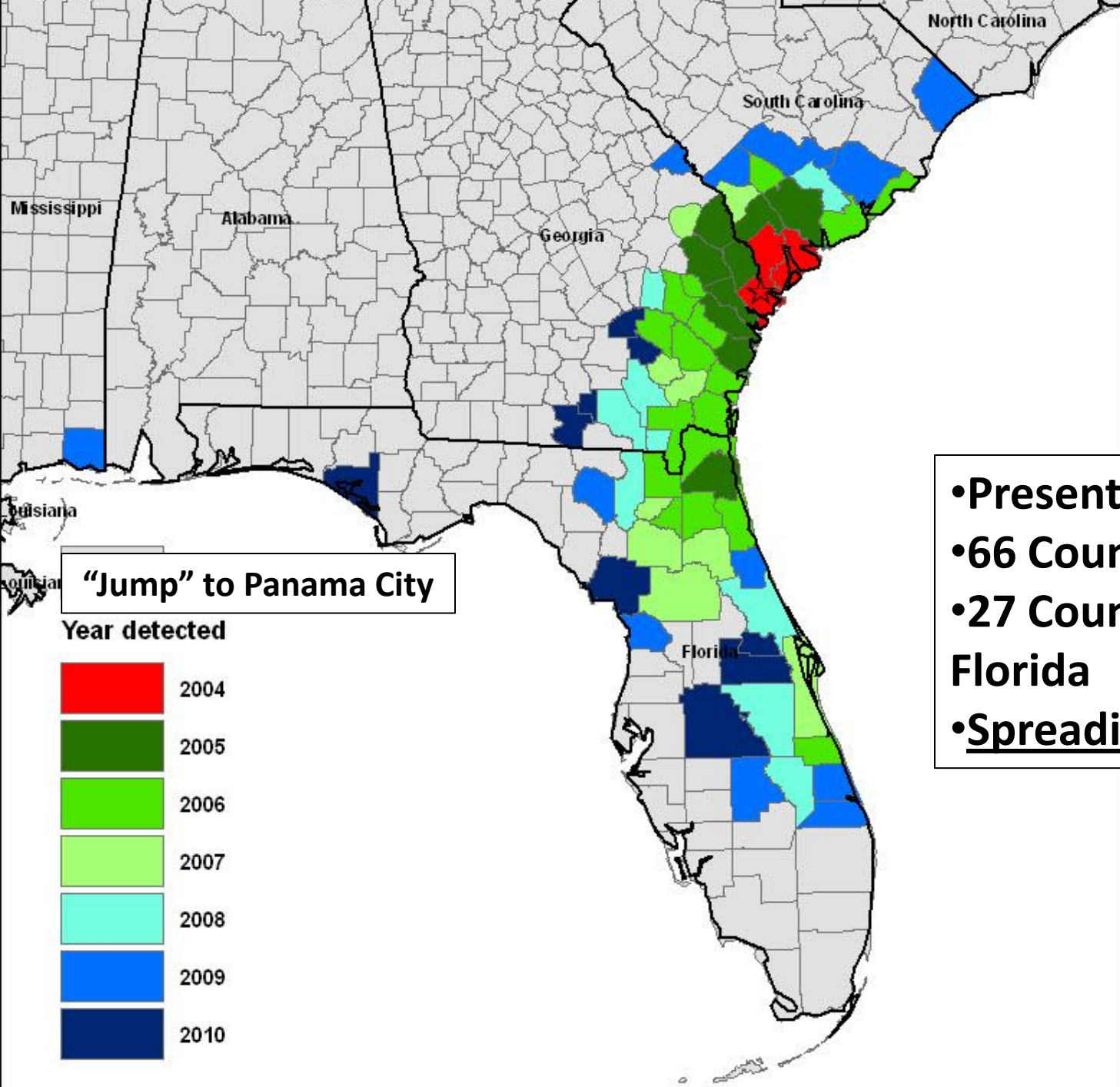






•Volusia County (Daytona Beach): Human vector identified.





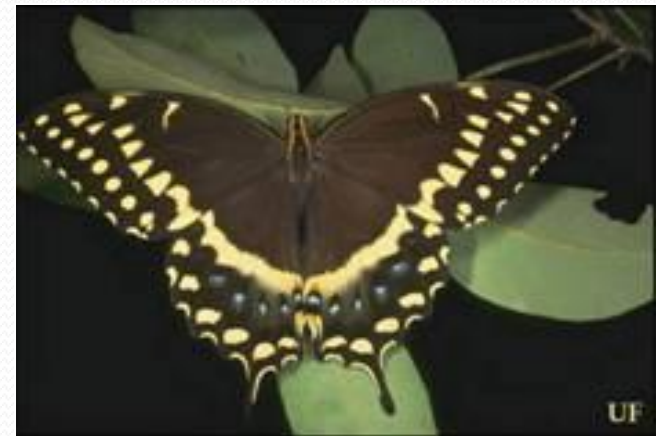
Primary host:

Redbay (*Persea borbonia*)

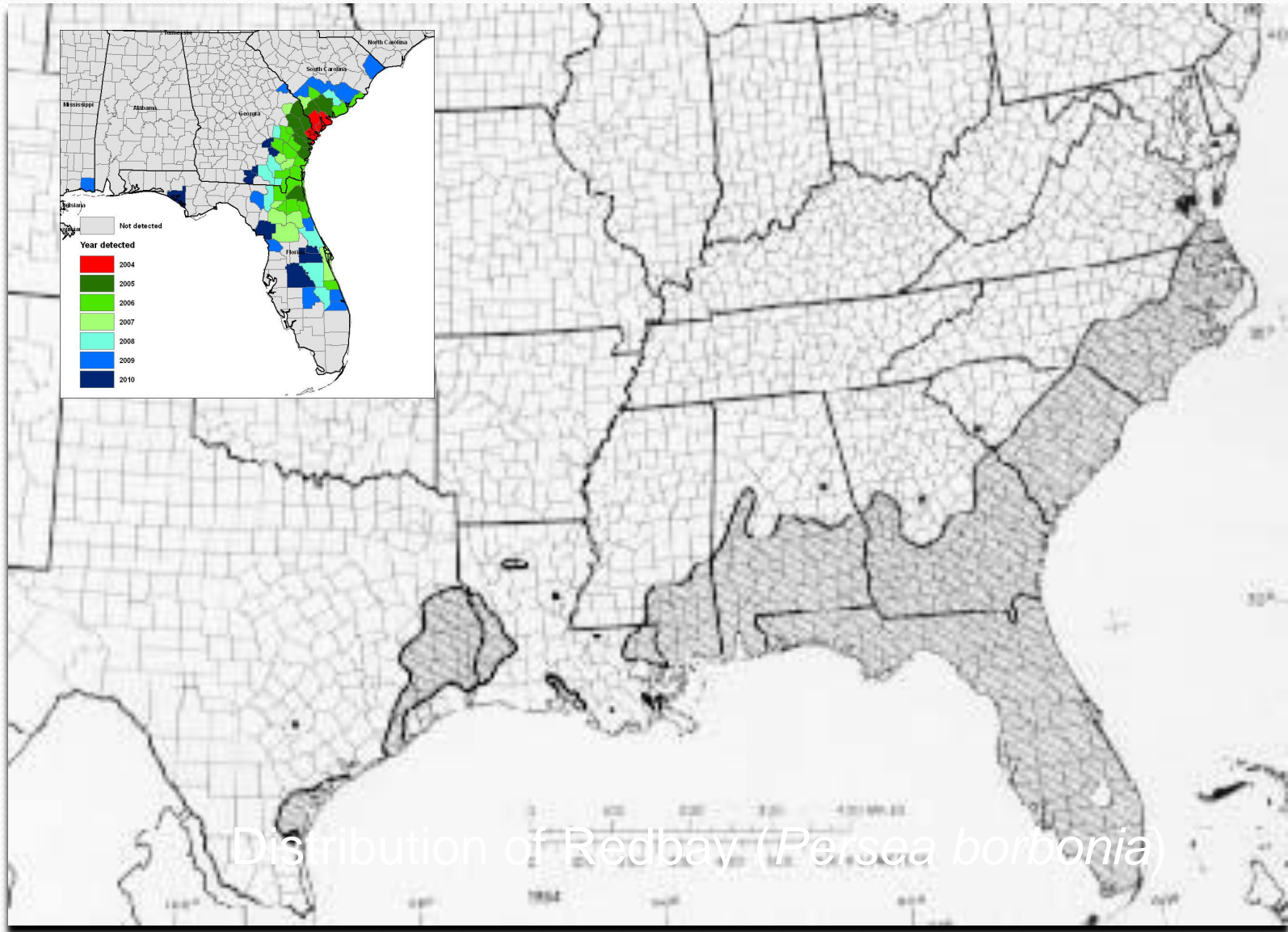
“*sensu lato*”

Family: Lauraceae

- Aromatic, broadleaved, evergreen of SE coastal plain
- Other closely-related “bay” species or varieties (swamp bay, silk bay)
- Wide habitat variety
- Cultural value: culinary, cabinetry, woodturning
- Fruits utilized by variety of wildlife
- *Persea* bays are only host of Palamedes swallowtail butterfly larvae



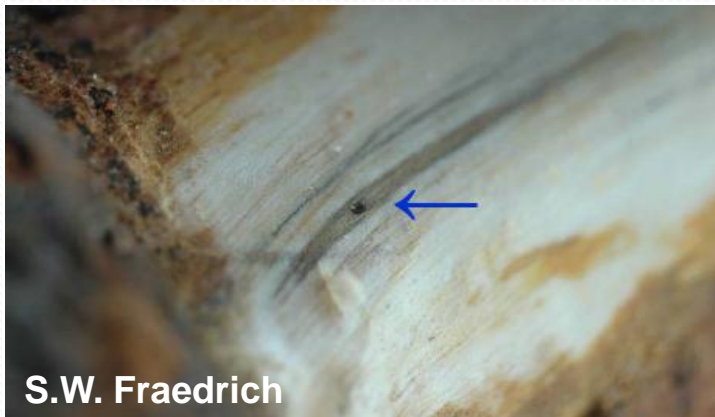
Distribution of redbay (*Persea borbonia* L.)



Distribution of Redbay (*Persea borbonia*)

Laurel Wilt: Symptoms

- Initial beetle hits:
 - Happen on healthy trees
 - Cryptic, difficult to find
 - May not be successful breeding attempts, but serve to inoculate the host
- Initial sign of infection:
 - drooping and discoloration of leaves



Laurel Wilt: Symptoms



September 2005



Same tree, May 2006

Eventually crown wilts with a reddish to purplish brown discoloration. Dead leaves tend to remain a year or more.

Symptoms: dark discoloration in sapwood



Symptoms

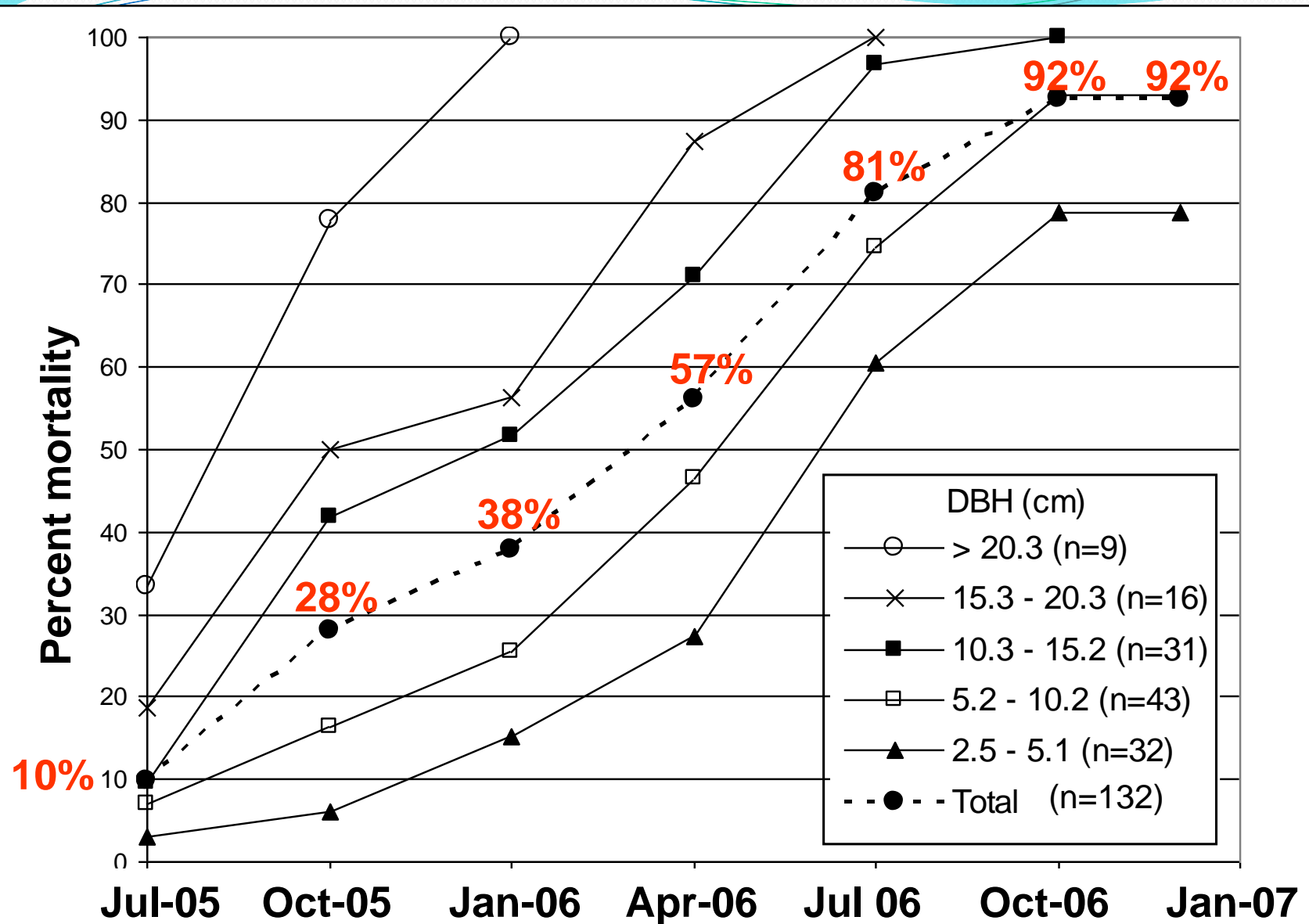
- Sawdust tubes: result of attacks by
 - *X. glabratus*
 - other ambrosia beetles
- Occurs after tree wilts & dies
- Female *X. glabratus* emerge to attack and infect new hosts







Redbay mortality curve at Ft. George Island, FL



Impact

- Nearly all mature redbays dead in areas affected 3-5 yrs
- Redbay seedlings, sprouts <1" diameter are still abundant
- Shade trees in residential neighborhoods parks = costly removals





S.W. Fraedrich

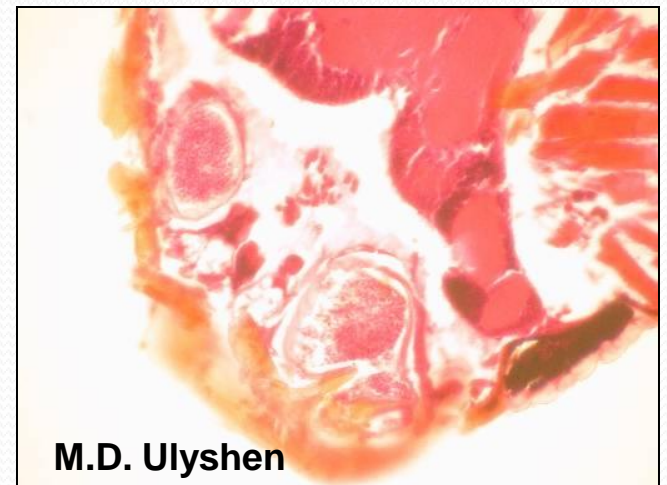
Redbay at the Horton House on Jekyll Island, GA (November, 2006)

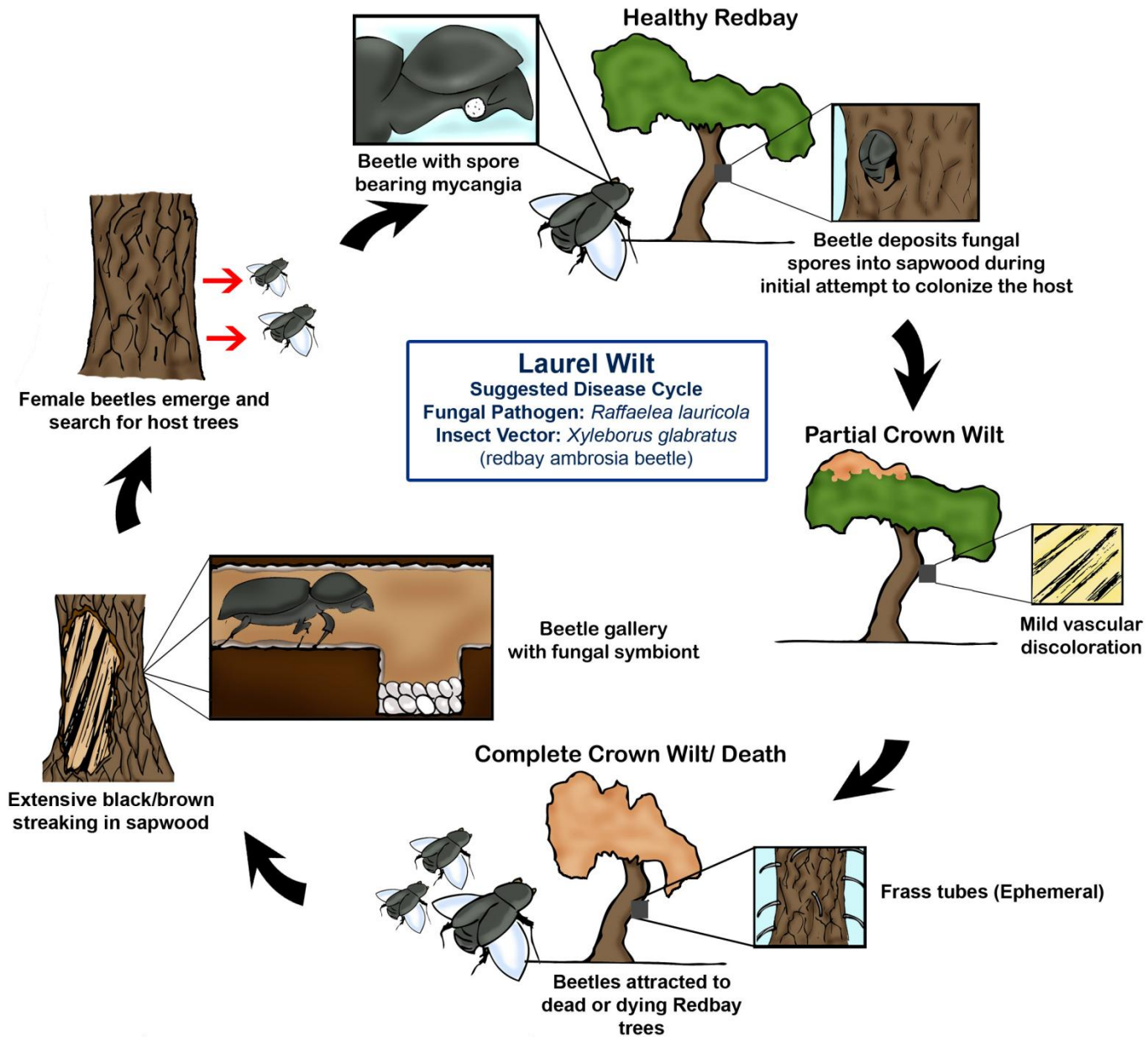


Horton House on Jekyll Island, GA (December, 2007)
Photo credit: William Kauffman (USDA APHIS)

Laurel Wilt pathogen (*Raffaelea lauricola*)

- Previously undescribed species
- Transmitted to host during attack of female RAB on stems, branches
 - Spores carried in mandibular mycangia
- Plugs xylem and discolours the sapwood of host





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Haplodiploid mating scheme = “Extreme inbreeders”

- Females fly & infest new trees
- Lay eggs
- Unfertilized eggs with $\frac{1}{2}$ the chromosomes (haploid) = males (flightless).
- Fertilized eggs = females
- Females mate with males, emerge to infest new trees

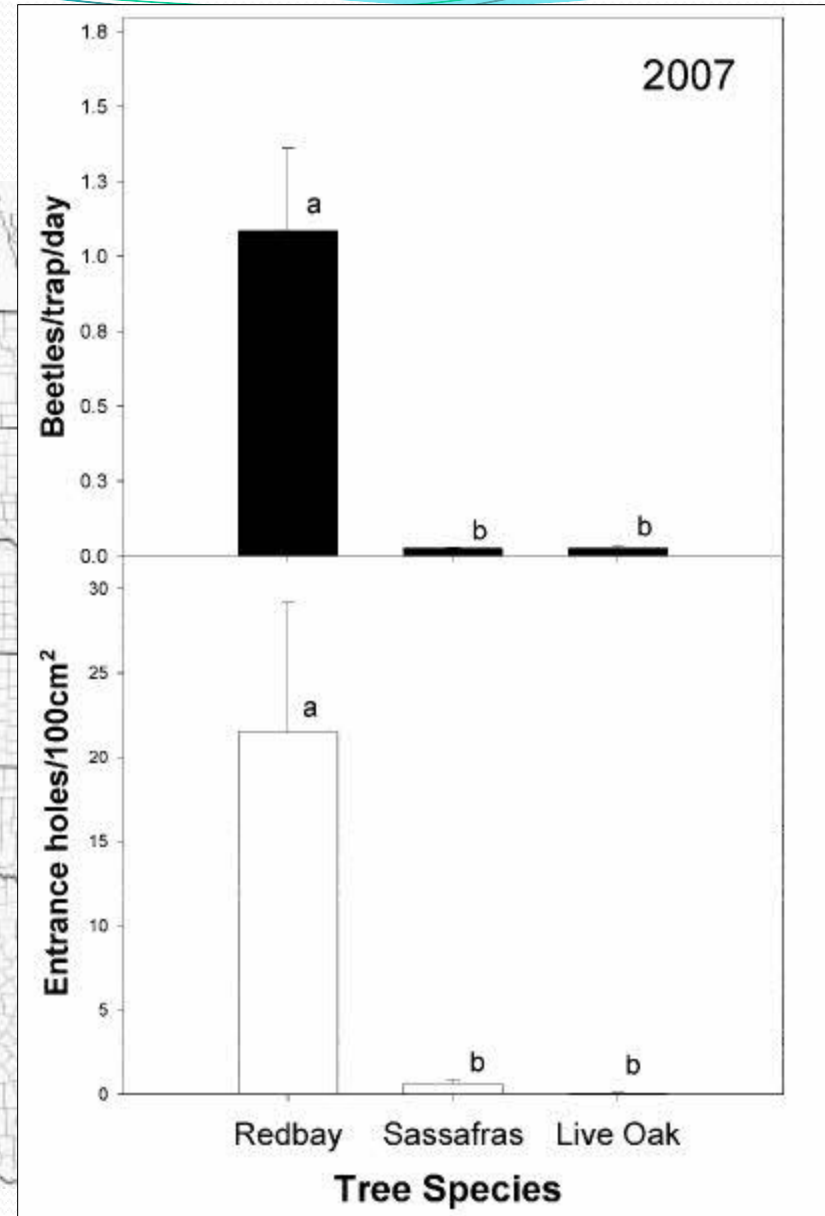
Very easy to start new populations!

Other **known** and potential hosts: Florida trees in the Lauraceae

- **Redbay**
 - *Persea borbonia*
- **Swamp bay**
 - *Persea palustris*
- **Silk bay**
 - *Persea humilis*
- **Avocado**
 - *Persea americana*
- **Sassafras**
 - *Sassafras albidum*
- **Pondspice**
 - *Litsea aestivalis*
- **Northern Spicebush**
 - *Lindera benzoin*
- **S. Spicebush (pondberry)**
 - *Lindera melissifolia*
- **Lancewood**
 - *Ocotea coriacea*
- **Love vine, Devil's gut**
 - *Cassytha filiformis*
- **Pepperleaf sweetwood**
 - *Licaria triandra*
- **Camphor tree**
 - *Cinnamomum camphora*

Sassafrass?

- Known host, very large distribution
- Hit hard where laurel wilt is found
- We don't know how far LW will spread through its range.
- May not be very attractive to the beetle.



savetheguac.com



Avocado Monitoring at Ft. George Island 2006-2007

- “Ground Zero” for FL
- 16 avocados planted Jul-Oct 2006
 - Cvs: 4 ‘Day’, 12 ‘Donnie’
 - 2-6 cm base caliper
- RAB and *Raffaelea* sp. recovered from 2 dying ‘Donnie’ plants
- Stress?



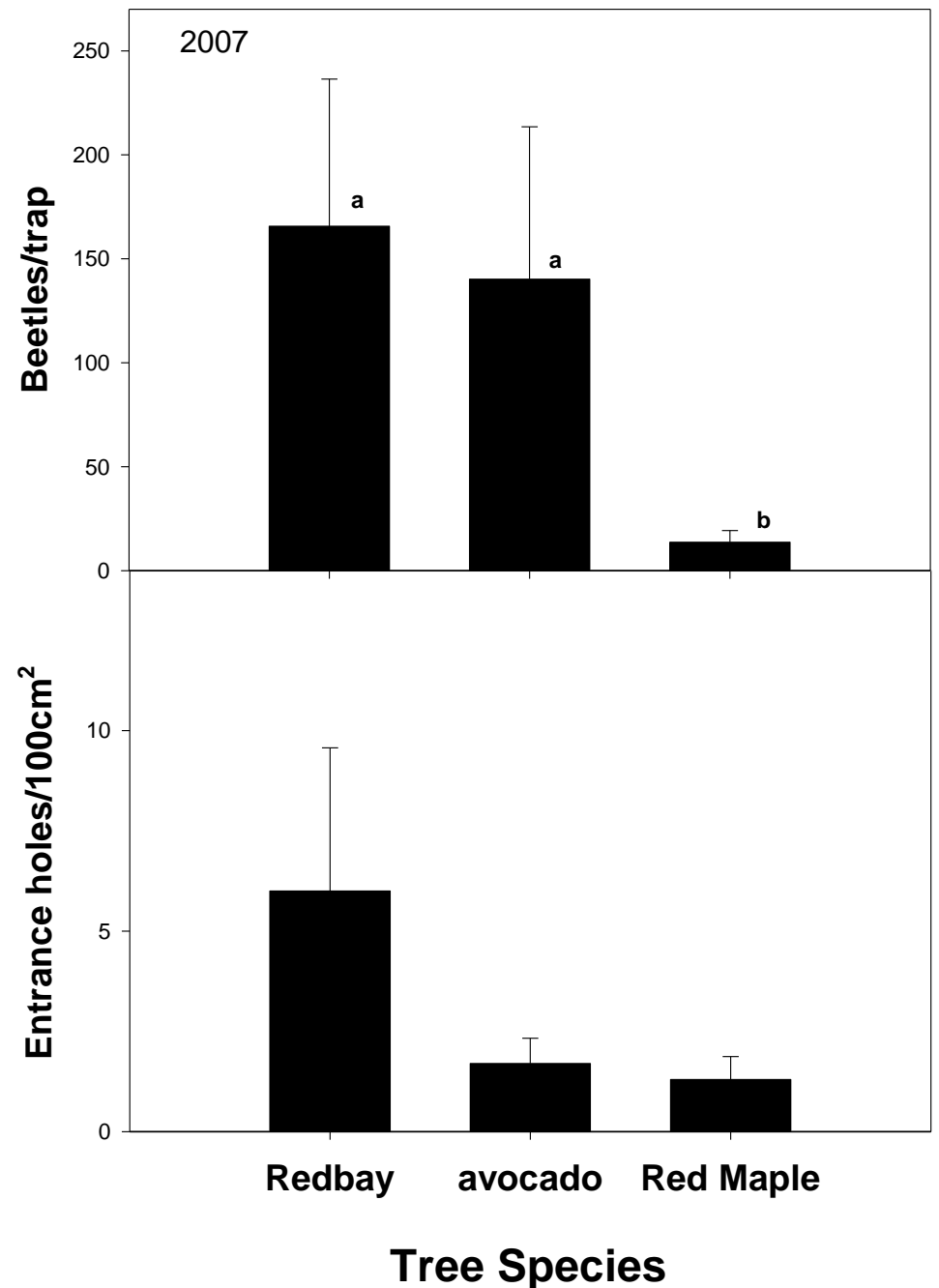


Laurel Wilt in Avocado, Jacksonville, FL
(Sept. 2007)

RAB Trapping and Host Attraction

Avocado bolts were as attractive as redbay, but had few beetle entrance holes (questionable for brood development)

Hanula, J.L, Mayfield, A.E. III, Fraedrich, S.W., and Rabaglia, R.J. 2008 (J. Econ. Entomol.)



Avocado cultivar susceptibility

- No-choice experiments with avocado varieties (Hass, Simmonds, Monroe, Winter Mexican, Catalina), plus redbay and live oak.
- Beetles bored into all species/cultivars except live oak within 5 days
- Only redbay and Simmonds avocado wilted and died
 - All other cultivars remained externally asymptomatic
- *R. lauricola* recovered from stained xylem samples of redbay and all avocado except Haas
- UF researchers continuing to evaluate cultivars



Host Susceptibility – Field Detections

- *X. glabratus* and *Raffaelea* sp. recovered from:
 - redbay (*Persea borbonia* - sensu lato)
 - sassafras (*Sassafras albidum*)
 - avocado (*Persea americana*)
- *Raffaelea* sp. also recovered from:
 - pondspice (*Litsea aestivalis*)
 - State threatened / endangered lists
 - pondberry (*Lindera melissifolia*)
 - Federal endangered list
 - camphor tree (*Cinnamomum camphora*)



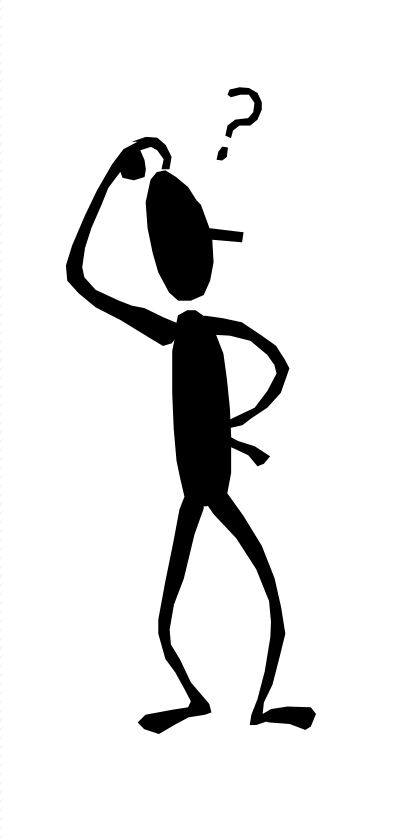
Host Susceptibility – Inoculation Studies

S.W. Fraedrich et al. 2008. Plant Disease 92: 215-224

- Growth chamber inoculations with laurel wilt fungus produce wilt symptoms in:
 - Redbay, sassafras, avocado
 - Spicebush (*Lindera benzoin*)
 - California bay laurel (*Umbellularia californica*)
- Tested hosts outside Laurel family not affected



Management Possibilities



Laurel Wilt Management Possibilities

- Discourage / restrict / prohibit movement of infested wood and plants
 - **FL legislation has passed!**
- Sanitation (if pursued very early and diligently?)
- Pesticides for 'high value' trees (?)
 - **Fungicide injection treatment**

PEST ALERT

**DON'T TRANSPORT
REDBAY FIREWOOD**

Non-native insects, diseases and invasive plants are major threats to our nation's forests. Of current concern in Florida is the accidental introduction of the **Redbay Ambrosia Beetle and its associated fungus from Asia**. This beetle is killing redbay trees at an alarming rate, and related trees like sassafras are also at risk. This exotic tree-killing pest can spread to new areas through the movement of infested wood.

- Please do not bring redbay firewood from places outside the local area.
- If you have already brought redbay firewood from somewhere else, burn all of it thoroughly.



Dying redbays



Redbay ambrosia beetle

Actual length 2 mm.



Ambrosia beetle sawdust



Tree killed by redbay ambrosia beetle and lethal fungus

Florida Department of Agriculture and Consumer Services, Division of Forestry
CHARLES H. BRONSON, Commissioner · MICHAEL C. LONG, Director · www.fl-dof.com



New Florida Law: FAC Rule Chapter 5B-65, Firewood and Unprocessed Wood Products

- Passed August 2010
- Prohibits import & movement of firewood & other unprocessed wood products (including yard waste, etc.)
- Permits granted for properly treated wood (kiln/heat, fumigation, etc.)
- Exemptions:
 - Within-state movement < 50 miles
 - Certified cut Christmas trees
 - Processed mulch or wood chips for cooking (w/ appropriate certificates).
 - Primary & secondary forest products for transport to mills & plants

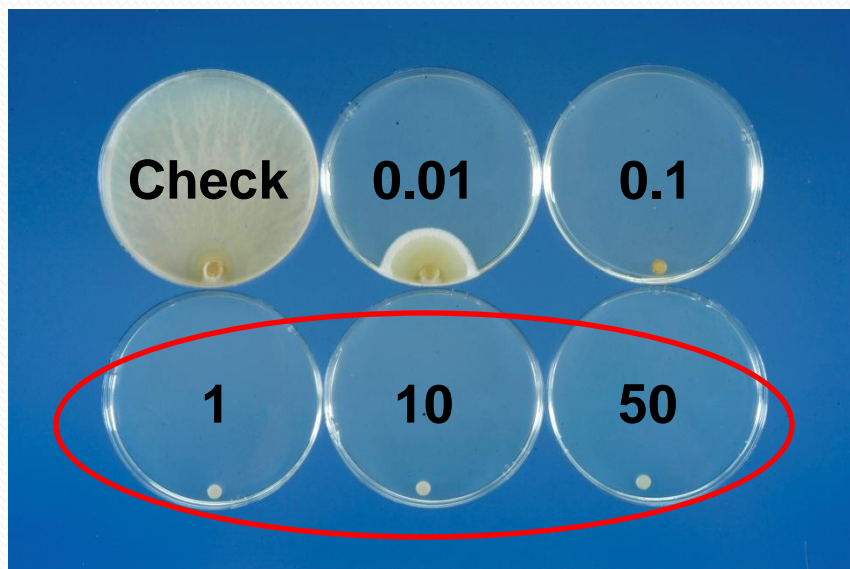


Effect of propiconazole on laurel wilt disease development in redbay trees and on the pathogen *in vitro*

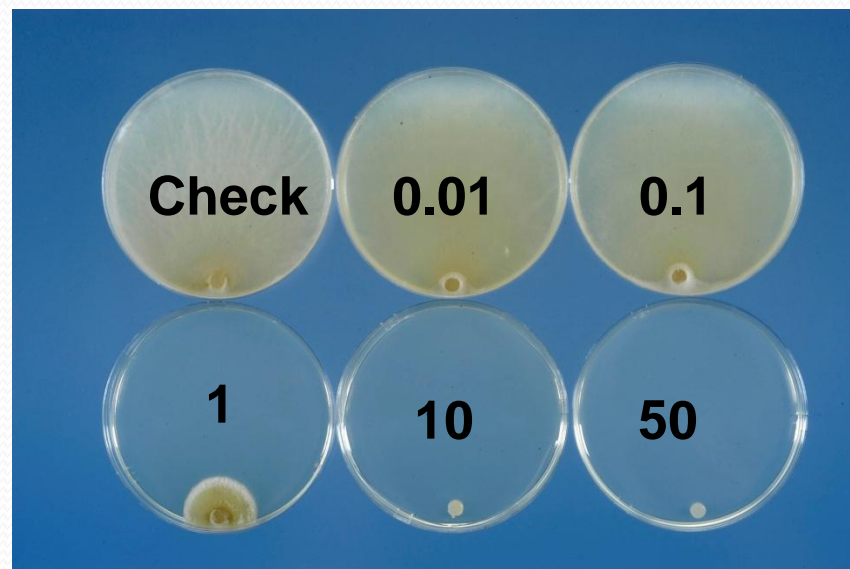
Mayfield, A.E. III, Barnard, E.L., Smith J.A, Bernick, S. and Eickwort, J.M. 2008.
(Arboriculture & Urban Forestry)

1. Inhibition *in vitro*: Determine minimum effective concentrations (MEC) at which fungicides inhibit *R. lauricola* growth
2. Fungicide injections: Determine whether root-flare injections of propiconazole help prevent laurel wilt in mature redbays
3. Fungicide bioassay: Determine if propiconazole is retained in xylem up to 7.5 months later

1. In-vitro Tests of Fungicides on growth of *Raffaelea* sp.



Propiconazole
(Concentration, ppm)



Thiabendazole
(Concentration, ppm)

* Plugs transferred to fresh agar; fungus dead on Propiconazole 1-50 ppm

2. Fungicide Injection Field Trial



- Root-flare injections of propiconazole (Alamo®)
- 20 ml product in 0.3 L water per inch DBH
- *Raffaelea* sp. inoculum plug inserted at BH 2-3 weeks post injection



2. Fungicide Injection Field Trial

Tree Injection Treatment	Tree Inoculation Treatment ^{†††}	No. of trees	DBH (cm)	
			Mean (SE)	Range
Propiconazole [†]	<i>R. lauricola</i> plug	10	23.8 (1.7)	16.8 - 35.8
None	<i>R. lauricola</i> plug	10	24.8 (2.0)	16.8 - 39.4
None	Clean agar plug	5	15.1 (0.3)	14.2 - 16.0
Propiconazole ^{††}	None	7	23.4 (1.6)	16.5 - 29.2

[†] Trees injected Mar 28 – Apr 5, 2007.

^{††} Two trees injected Mar 30 – Apr 5, 2007; five trees injected Jun 27-28, 2007. These trees were used and evaluated in the bioassay trial only.

^{†††} Trees inoculated April 19, 2007.

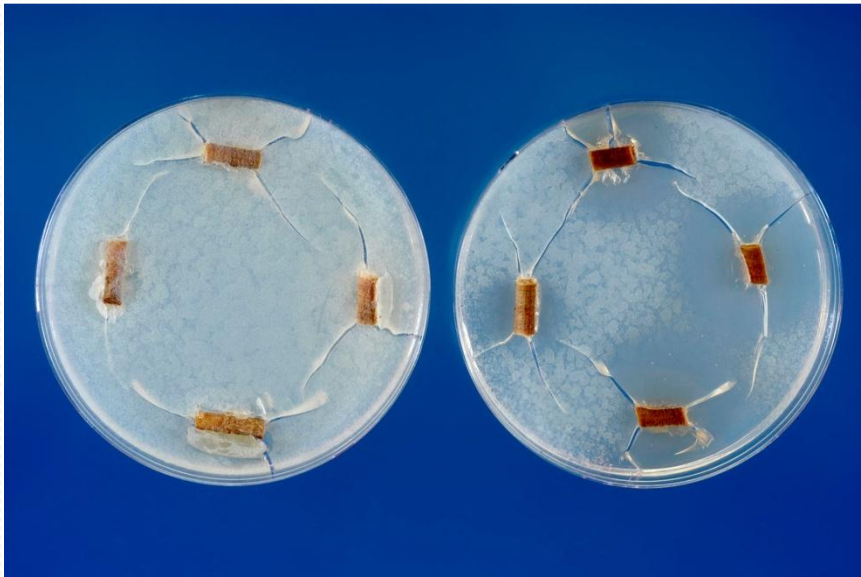
Fungicide Injection Field Trial

Percentage of redbays with greater than 1/3 crown wilt, from time of pathogen inoculation:

Weeks post inoculation	Treated (n=10) Fungicide (+) Pathogen (+)	Control (n=10) Fungicide (-) Pathogen (+)	Clean plugs (n=5) Fungicide (-) Pathogen (-)
6 weeks	0%	30%	0%
9 weeks	0%	70%	0%
12.5 weeks	0%	90%	0%
30 weeks	0%	90%	0%
1 year	0%	90%	0%
2 years	10%	90%	60%
3 years	50%	100%	100%

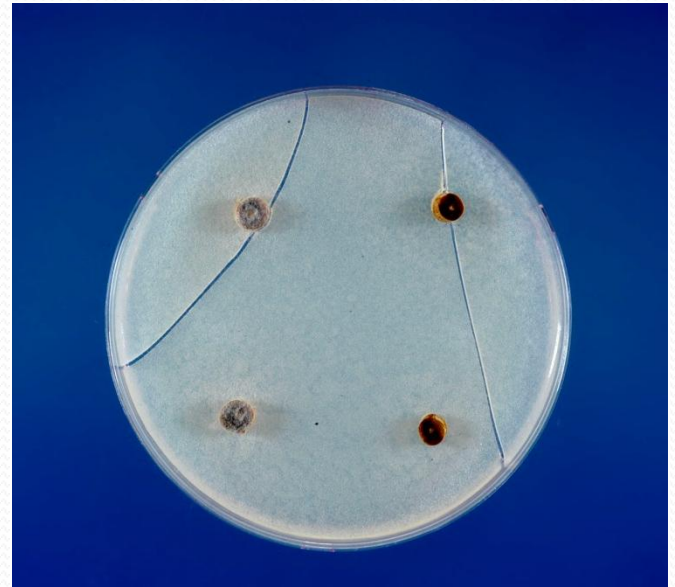
3. Fungicide Bioassay

Plugs from main stem
(4 per tree)



- Evidence of inhibition in 16 of 17 treated trees
- Usually in 3-4 samples/tree
- Inhibition zones in agar more frequent in trees injected most recently

Outer branch discs
(6 per tree)



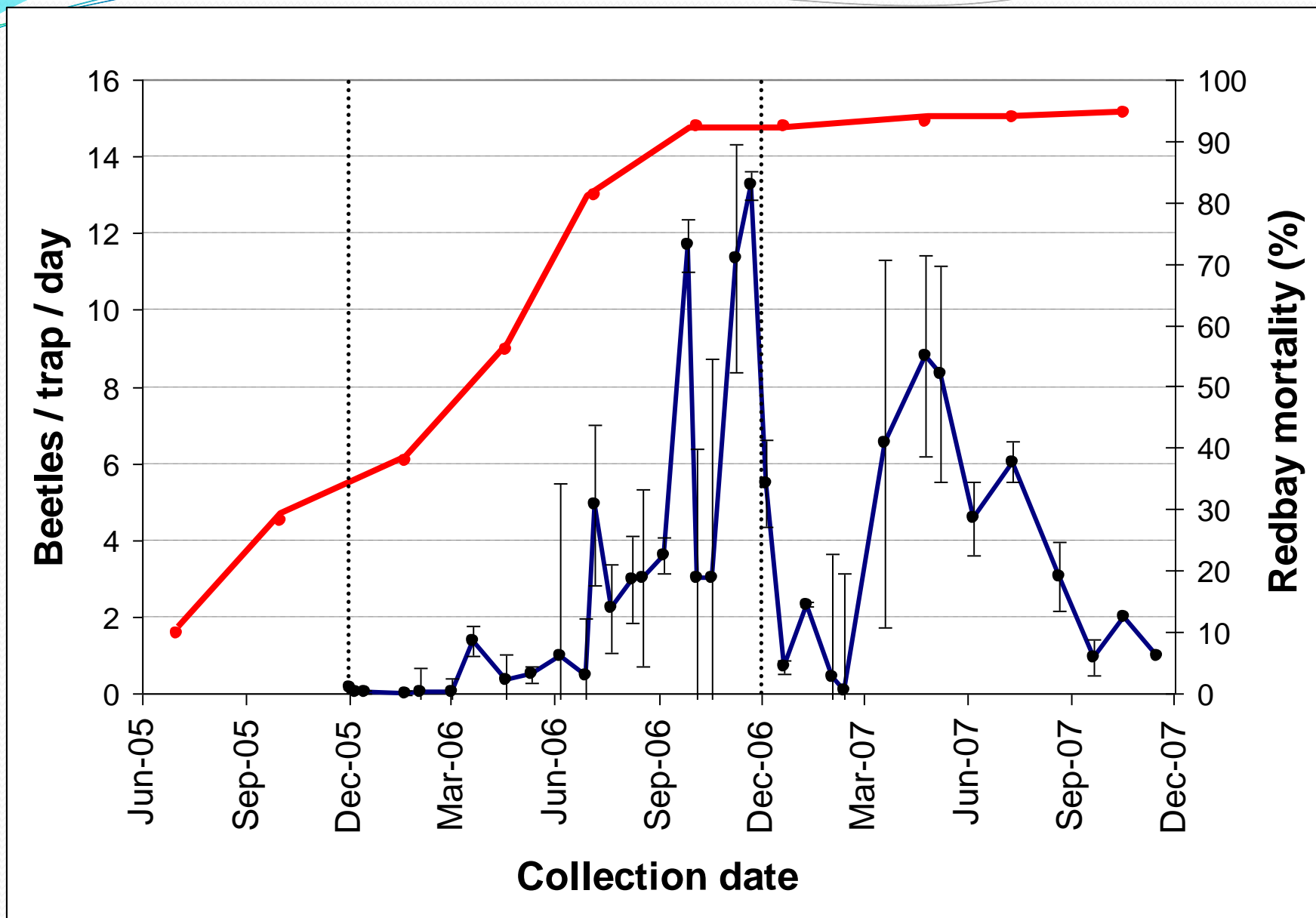
- Evidence of inhibition in 9 of 17 treated trees
- Usually in 1-2 samples/tree
- No inhibition zones in agar

Laurel Wilt Management Possibilities (continued)

- Development of resistant trees
- Collection and conservation of redbay seed
- Improve lures to “trap out” low beetle populations in the aftermath of mature redbay devastation



Redbay ambrosia beetle flight activity, Ft. George Island, FL



My opinion...

- The future of redbay looks bleak.
- Stopping movement of wood
 - May preserve some isolated populations
 - Prevent spread to new hosts outside of redbay range (California, Central & South America)
- These exotic introductions need to be prevented



2010 EDRR trapping

Xylosandrus amputatus

- New continental record
- Orlando, Jacksonville and Gainesville trap collections
- Early detection, what response?

