

The interactions of *Xyleborus glabratus* and *Raffaelea lauricola* with species in the family Lauraceae in the southeastern United States

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Iowa State University, Ames, IA



Laurel Wilt, Hunting Island State Park

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Tracy Hawkins, US Forest Service, SRS

Wood Johnson, US Forest Service, SRS

Roger Menard, US Forest Service, SRS

Laurie Reid, South Carolina Forestry Commission

Andy Boone, South Carolina Forestry Commission

James Johnson, Georgia Forestry Commission

Chip Bates, Georgia Forestry Commission

Scott Cameron, Georgia Forestry Commission

Jeff Eickwort, Florida Division of Forestry

Dana Stone, Alabama Forestry Commission

Rob Trickel, North Carolina Forest Service

Wood Johnson, US Forest Service, FHP

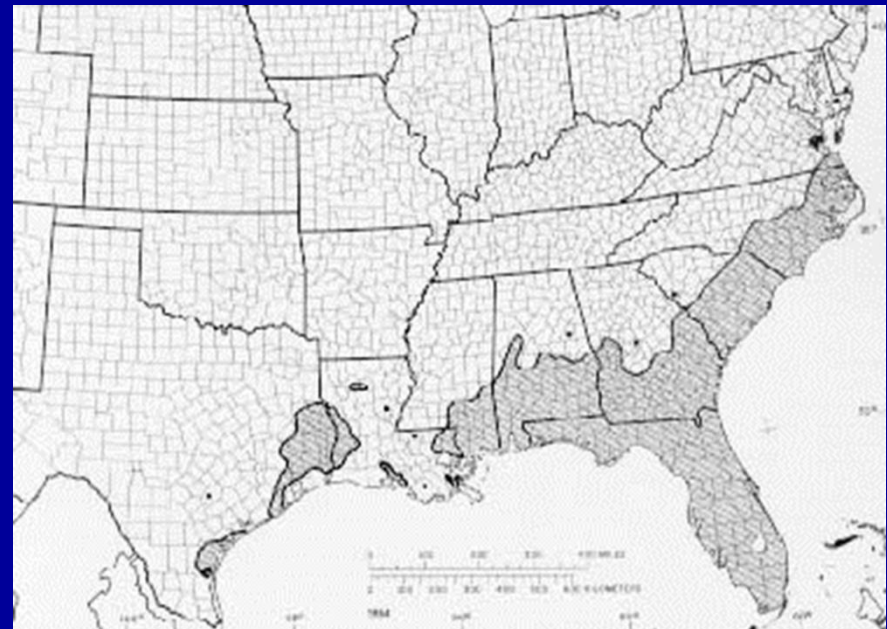
Roger Menard, US Forest Service, FHP

Redbay (*Persea borbonia*)

- Family Lauraceae
- Common tree in the maritime forests
- Small to medium size tree (up to 60 ft height)
- Attractive, aromatic tree; horticultural value
- Minor use hardwood
- Value to wildlife (e.g. deer use it for browse; songbirds and turkeys feed on fruit; host for the Palamedes swallowtail)

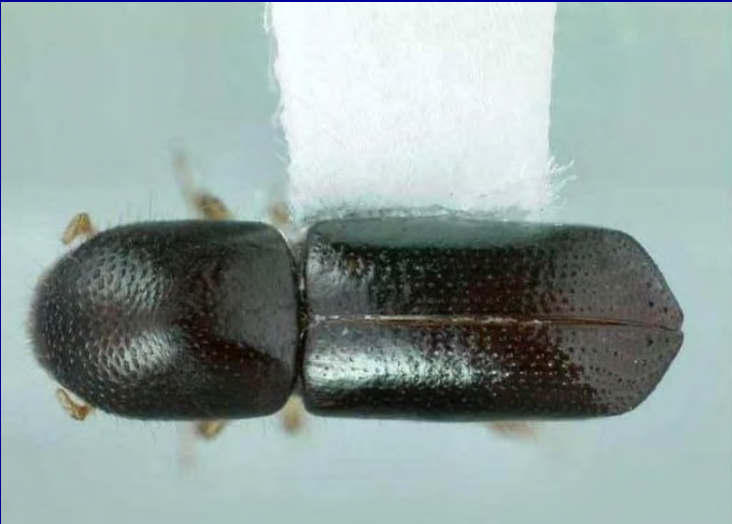


Redbay at the Horton House, Jekyll Island, GA (2006)



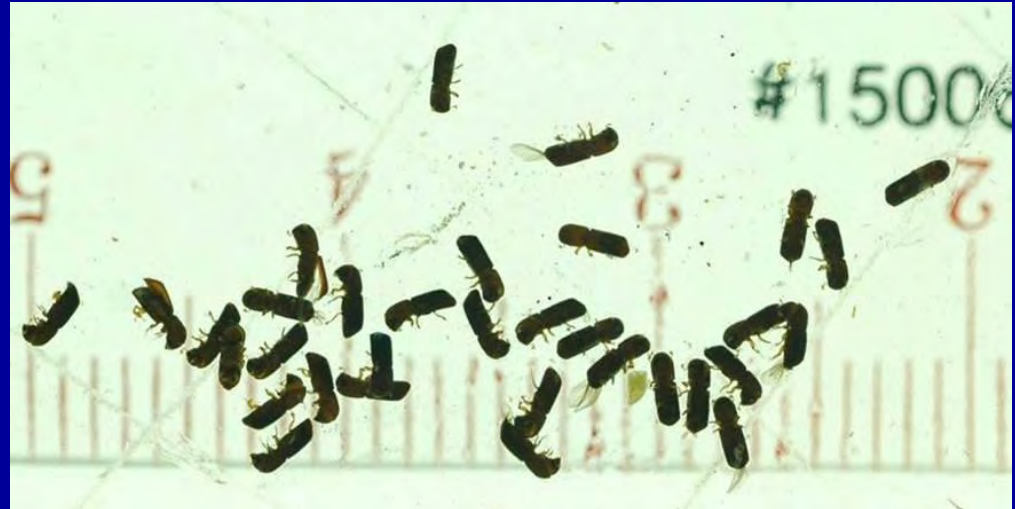
Range of red bay (*Persea borbonia*)

The redbay ambrosia beetle: *Xyleborus glabratus*



Mike Thomas (Florida Division of Agriculture)

- Ambrosia beetle – small – about 2mm length
- Native range: India, Japan, Taiwan, China
- Hosts in Asia: Members of the Lauraceae
Asian spicebush (*Lindera latifolia*);
yellow litsea (*Litsea elongata*)

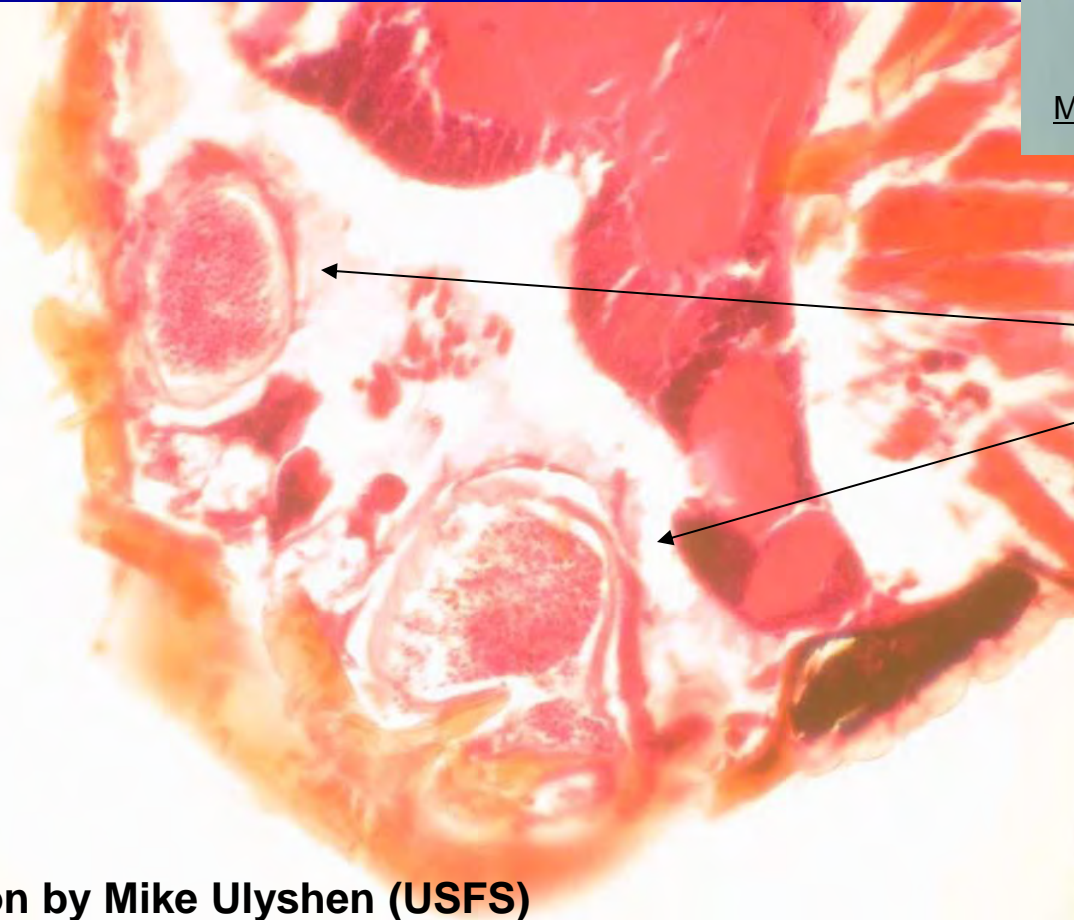


***Xyleborus glabratus*
carries *Raffaelea lauricola*,
its fungal symbionts, in
mandibular mycangia.**



Mike Thomas (Florida Division of Plant Industries)

**Mandibular
Mycangia**



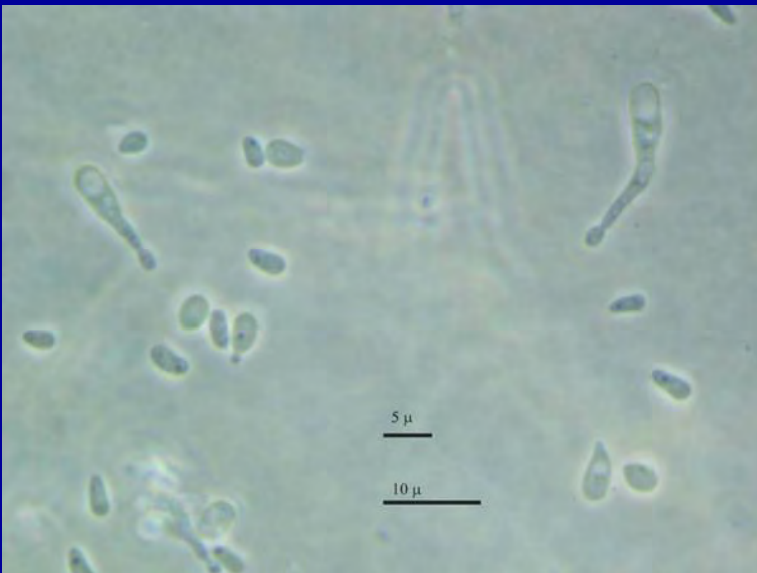
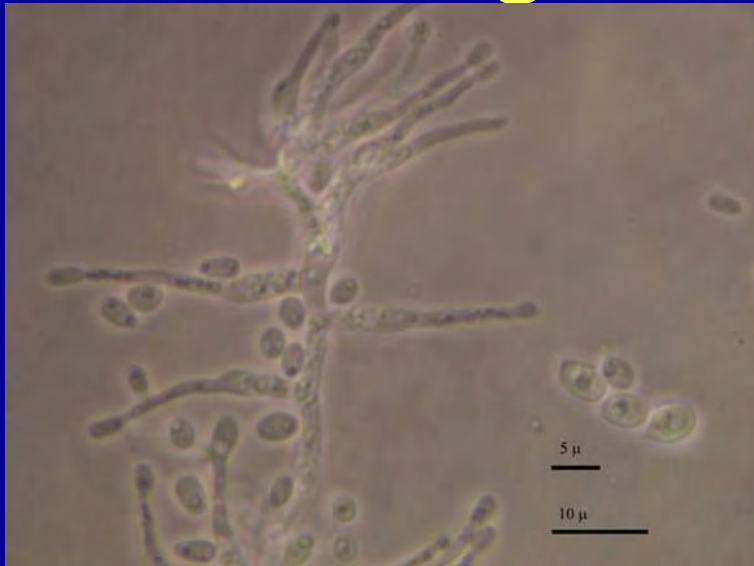
Section by Mike Ulyshen (USFS)

Raffaelea lauricola – the causal agent of laurel wilt

Previous undescribed fungal species.

Mycangia symbiont of *Xyleborus glabratus*

The fungus is similar to the Dutch elm disease pathogen



Laurel wilt is a vascular wilt disease of redbay and other members of the Lauraceae

Disease symptoms



Laurel Wilt



Hunting Island State Park, SC; April, 2007



Fort George Island, FL (October, 2005)



Jesup, Georgia (October, 2006)



Photo credit: James Johnson, GFC)

Claxton, Georgia (“Shock and Awe” site), 2009

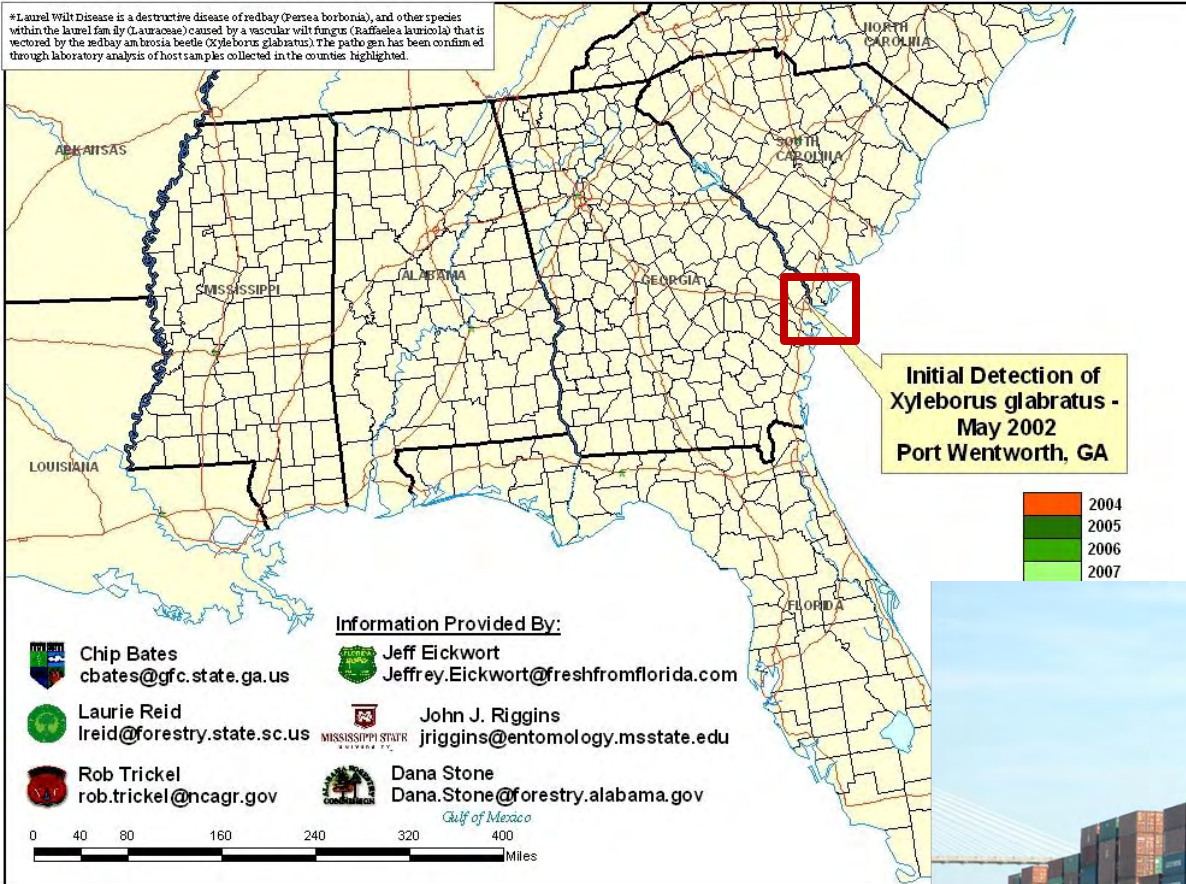


Jekyll Island, Georgia

Xyleborus glabratus found near Savannah, GA, May, 2002

Distribution of Counties with Laurel Wilt Disease* by year of Initial Detection

*Laurel Wilt Disease is a destructive disease of redbay (*Pernis borbonica*), and other species within the laurel family (*Lauraceae*) caused by a vascular wilt fungus (*Raffaelea lauricola*) that is vectored by the redbay ambrosia beetle (*Xyleborus glabratus*). The pathogen has been confirmed through laboratory analysis of host samples collected in the counties highlighted.

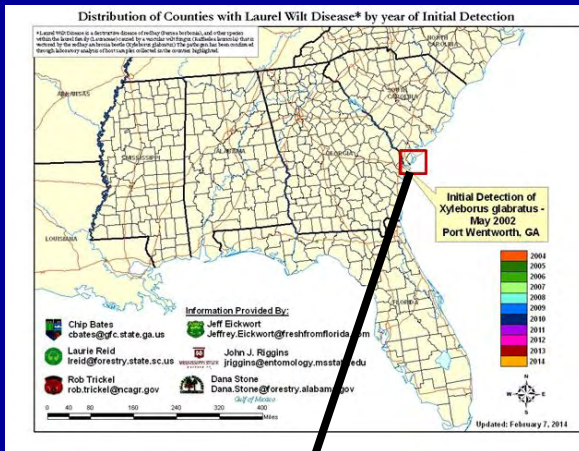


Beetle trap; Early Detection & Rapid Response Program

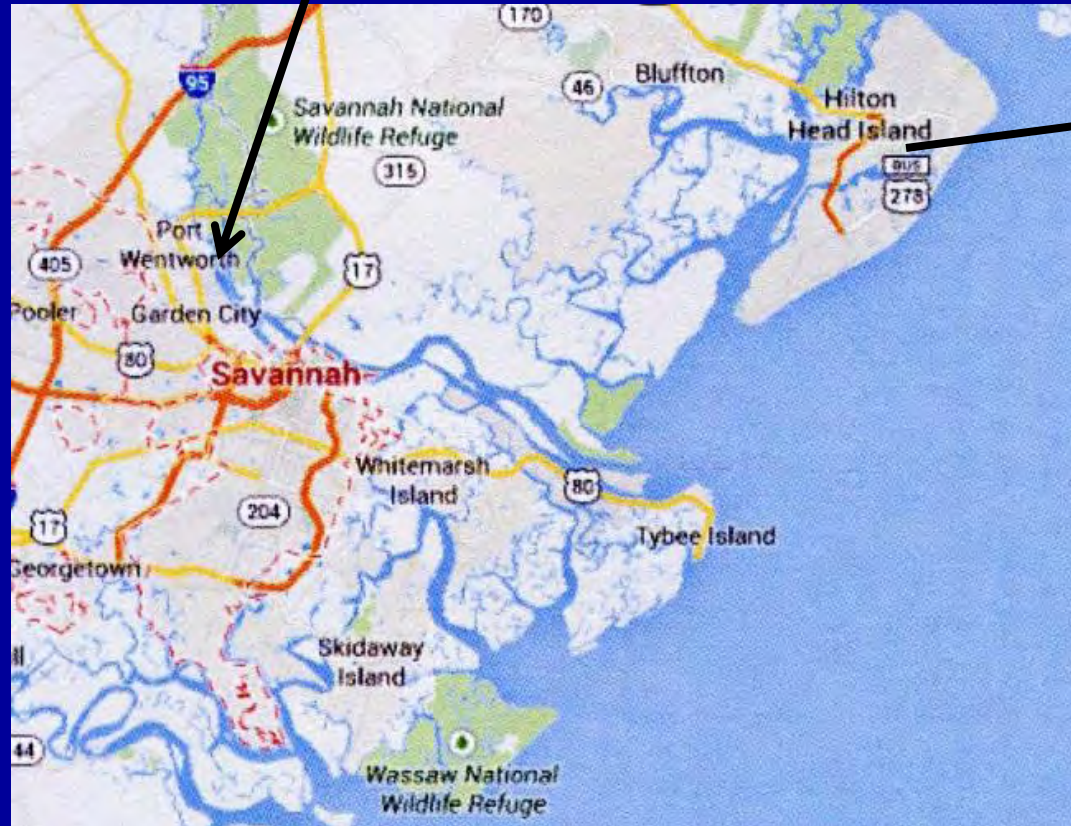


Savannah, Georgia

County map of States in southeastern USA



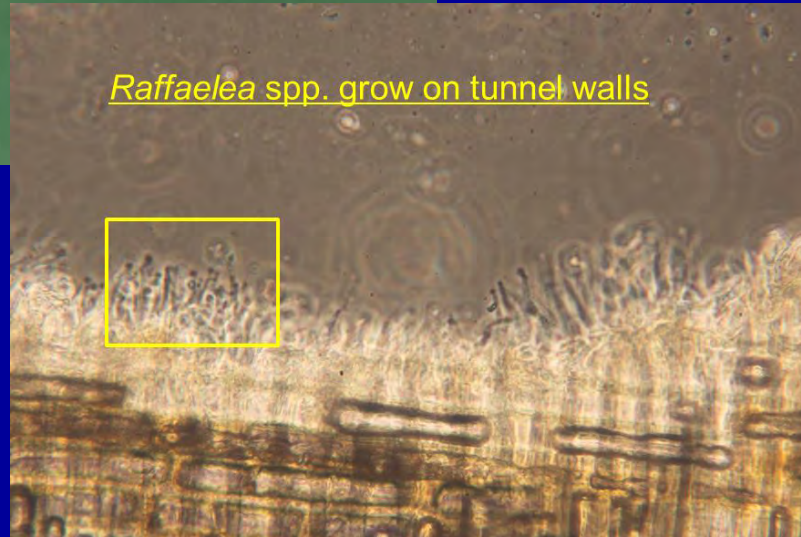
Initial Spread of the Redbay Ambrosia Beetle and Laurel Wilt



Fall, 2003 – First reports of red bay mortality in newspapers around Hilton Head Island

May, 2002 – Initial discovery of *Xyleborus glabratus* in the United States at Port Wentworth, GA.

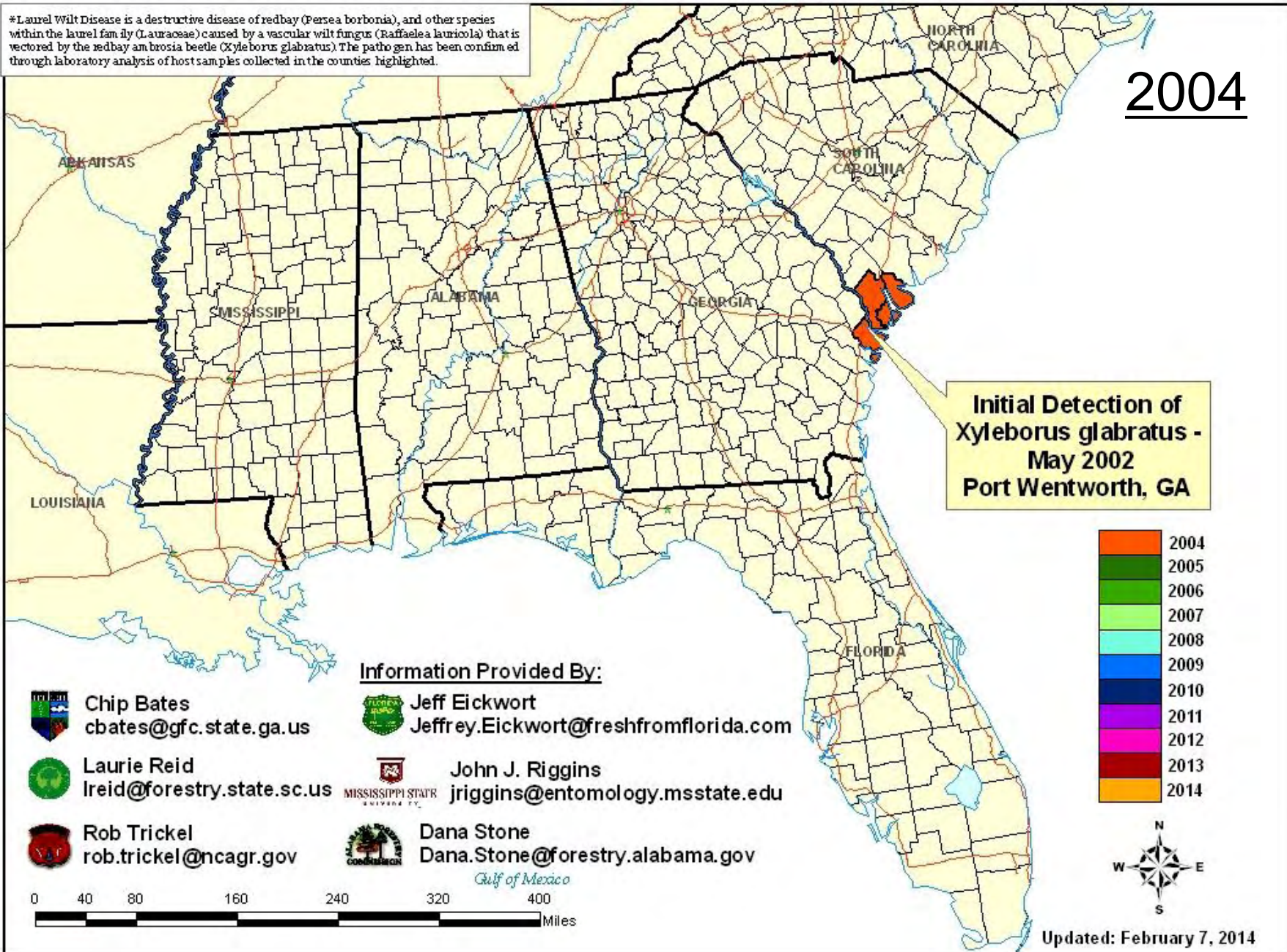
Investigations begin on the cause of redbay mortality – November, 2004



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2004



**Initial Detection of
Xyleborus glabratus -
May 2022
Port Wentworth, GA**

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

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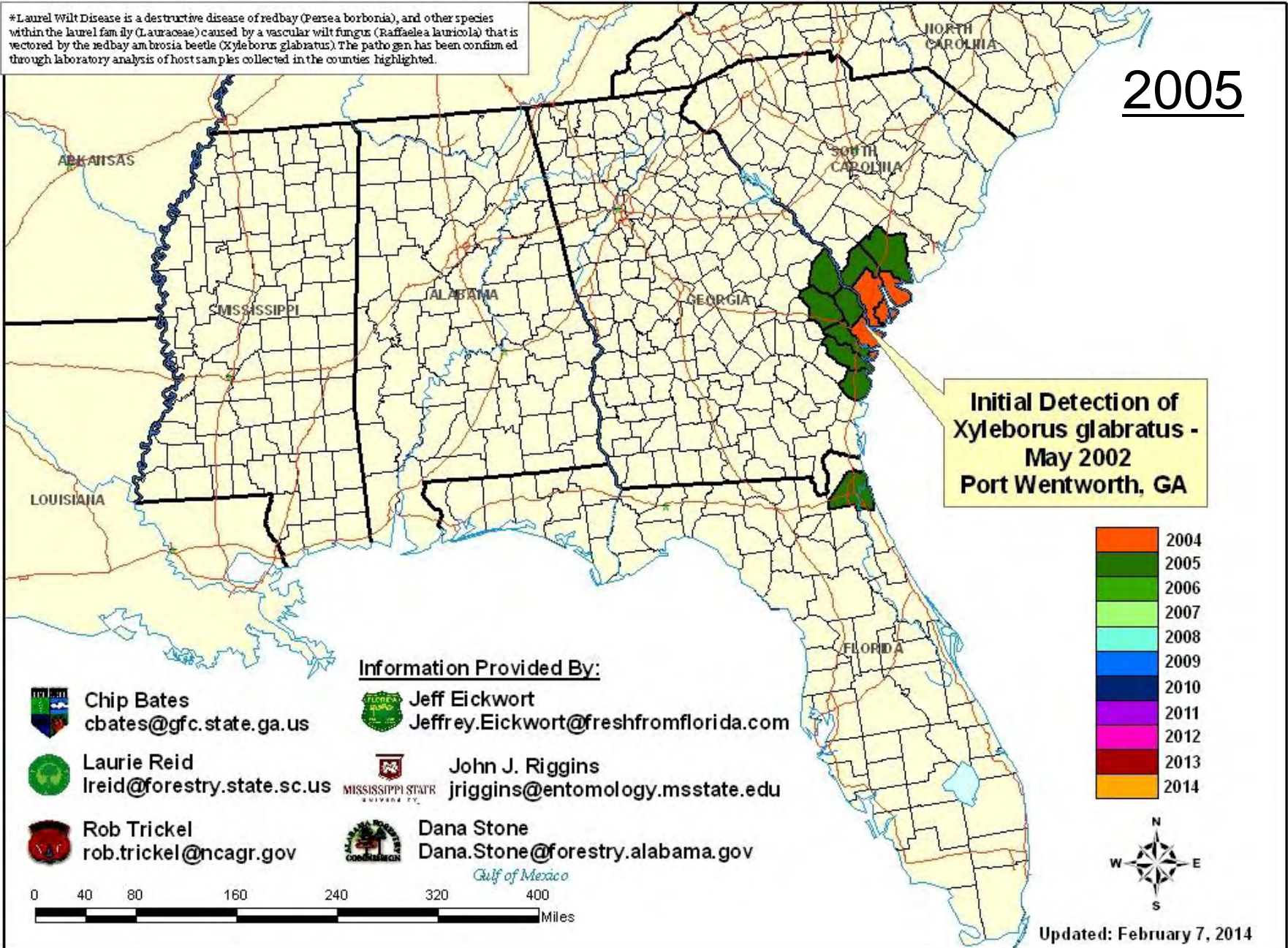


Updated: February 7, 2014

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Gulf of Mexico

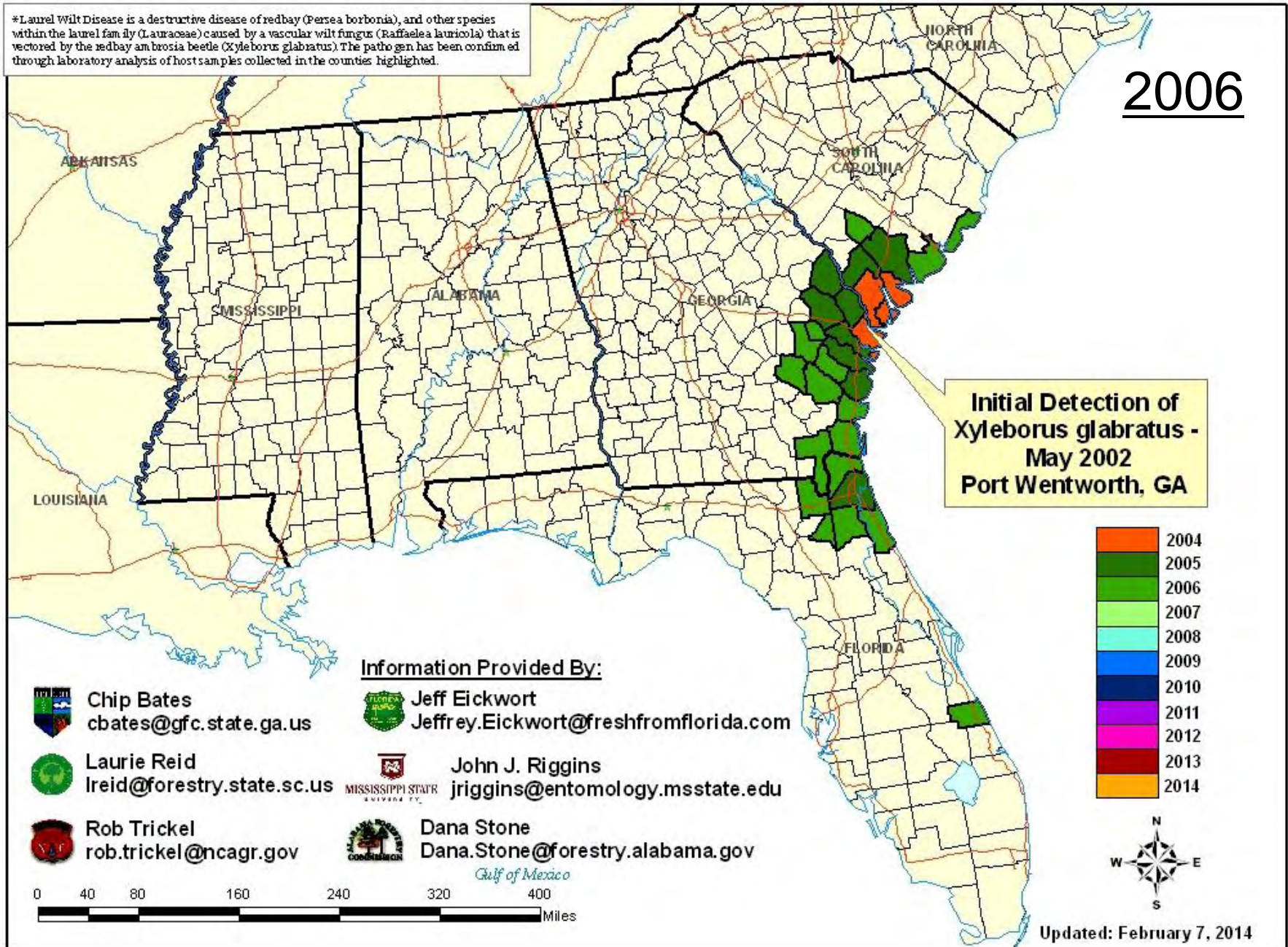


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2006



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Xyleborus glabratus -
May 2002
Port Wentworth, GA**

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-  2014



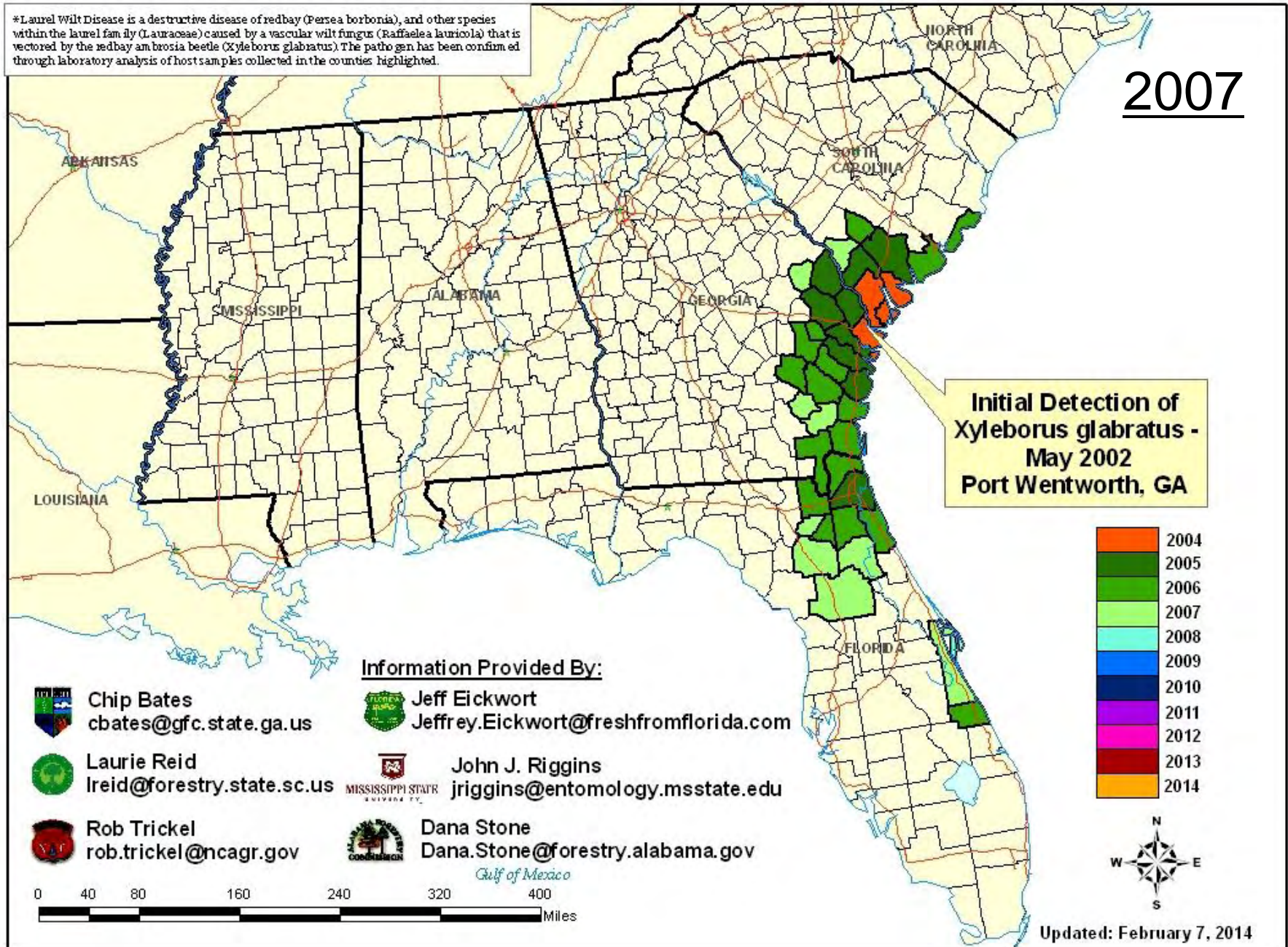
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2007



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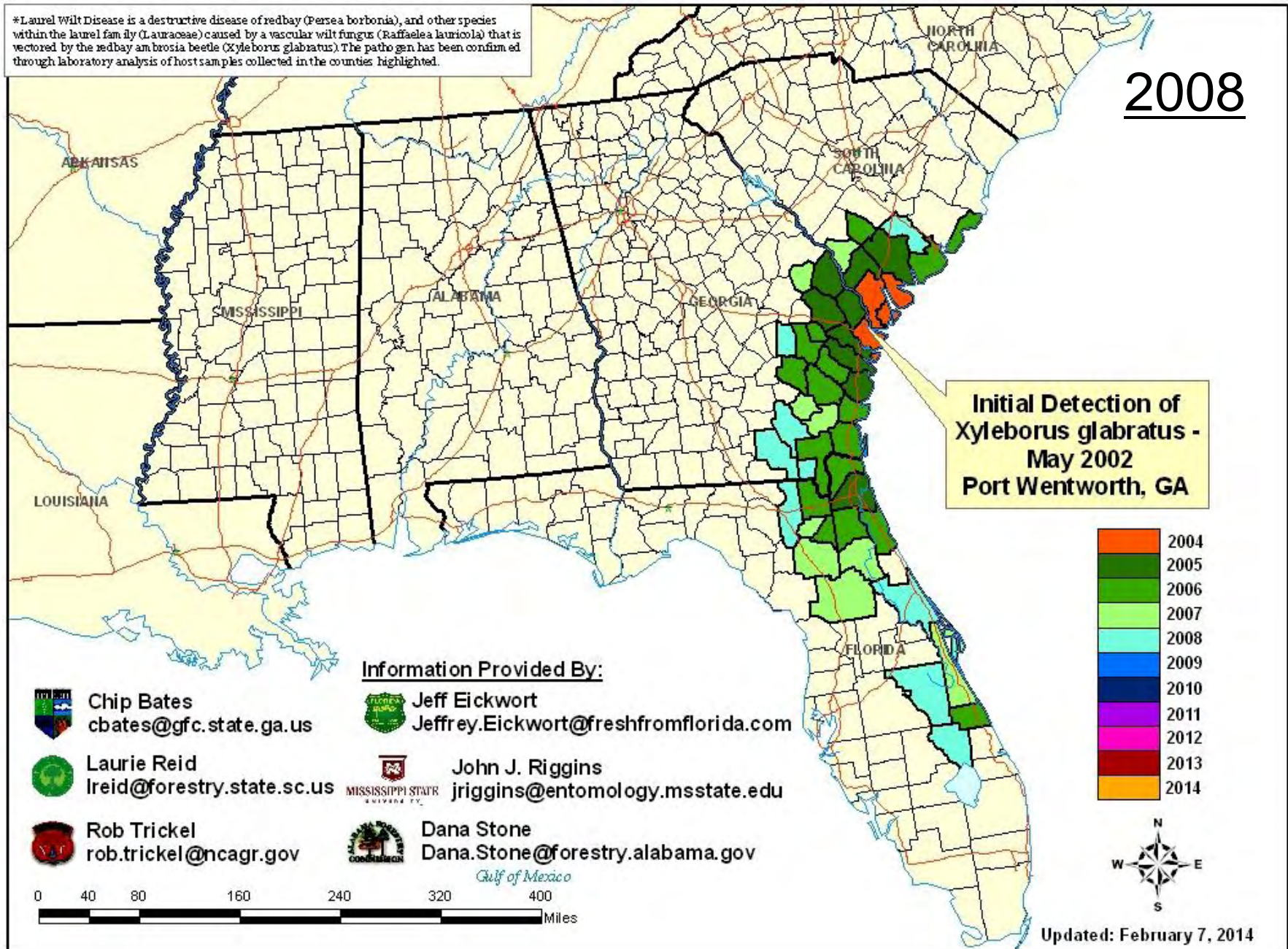


Gulf of Mexico

Distribution of Counties with Laurel Wilt Disease* by year of Initial Detection

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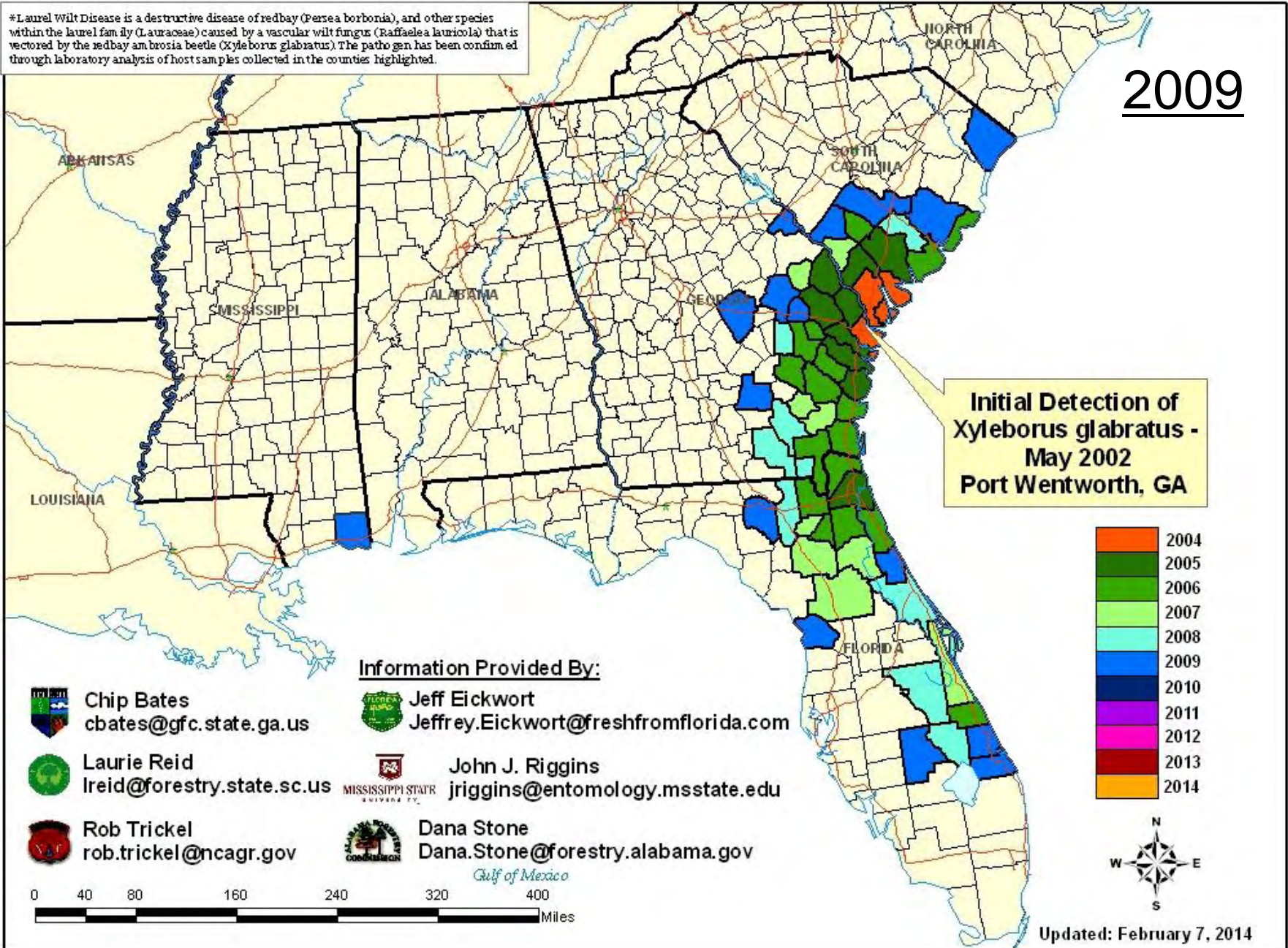
2008



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2009



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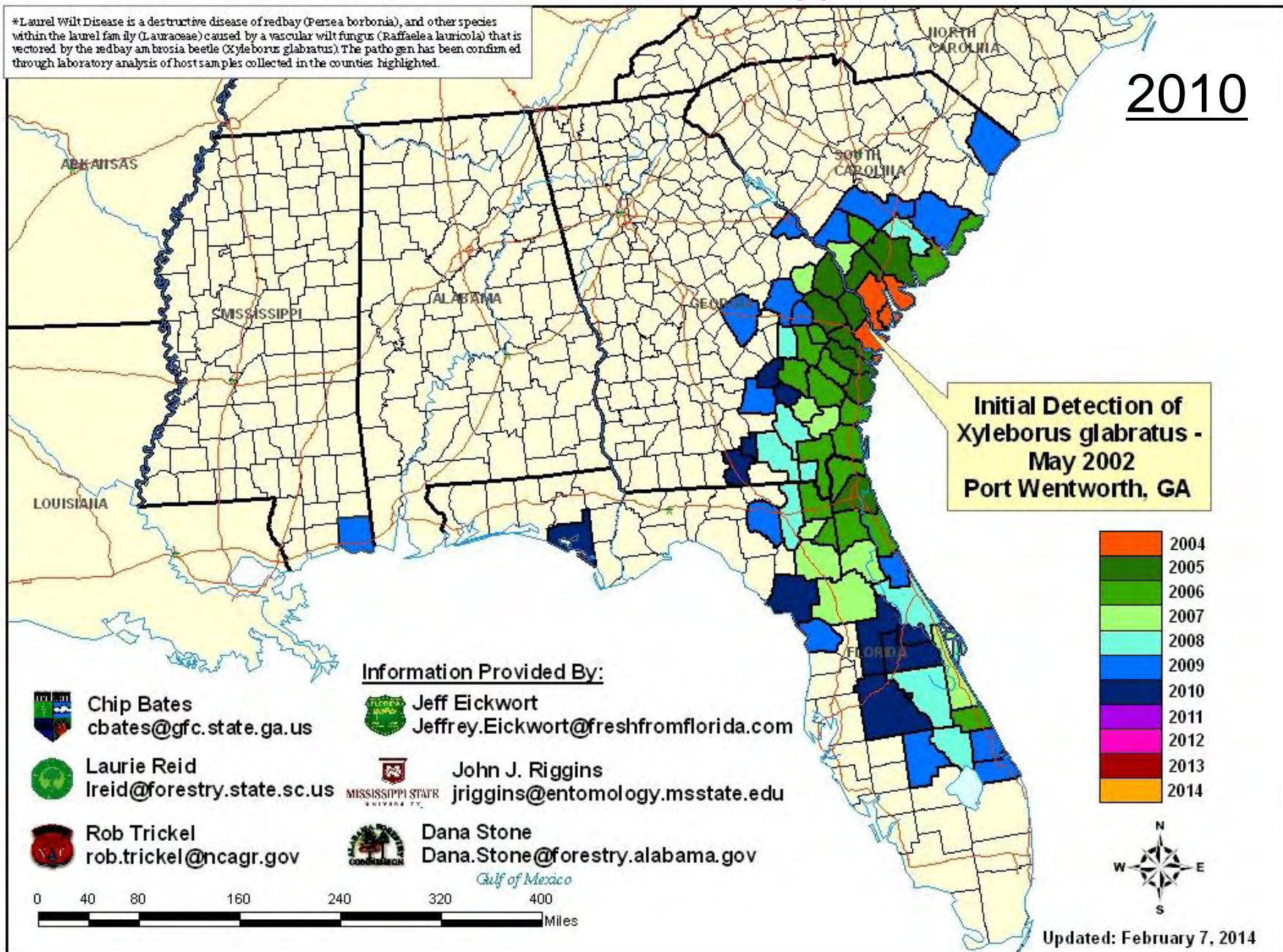


Gulf of Mexico

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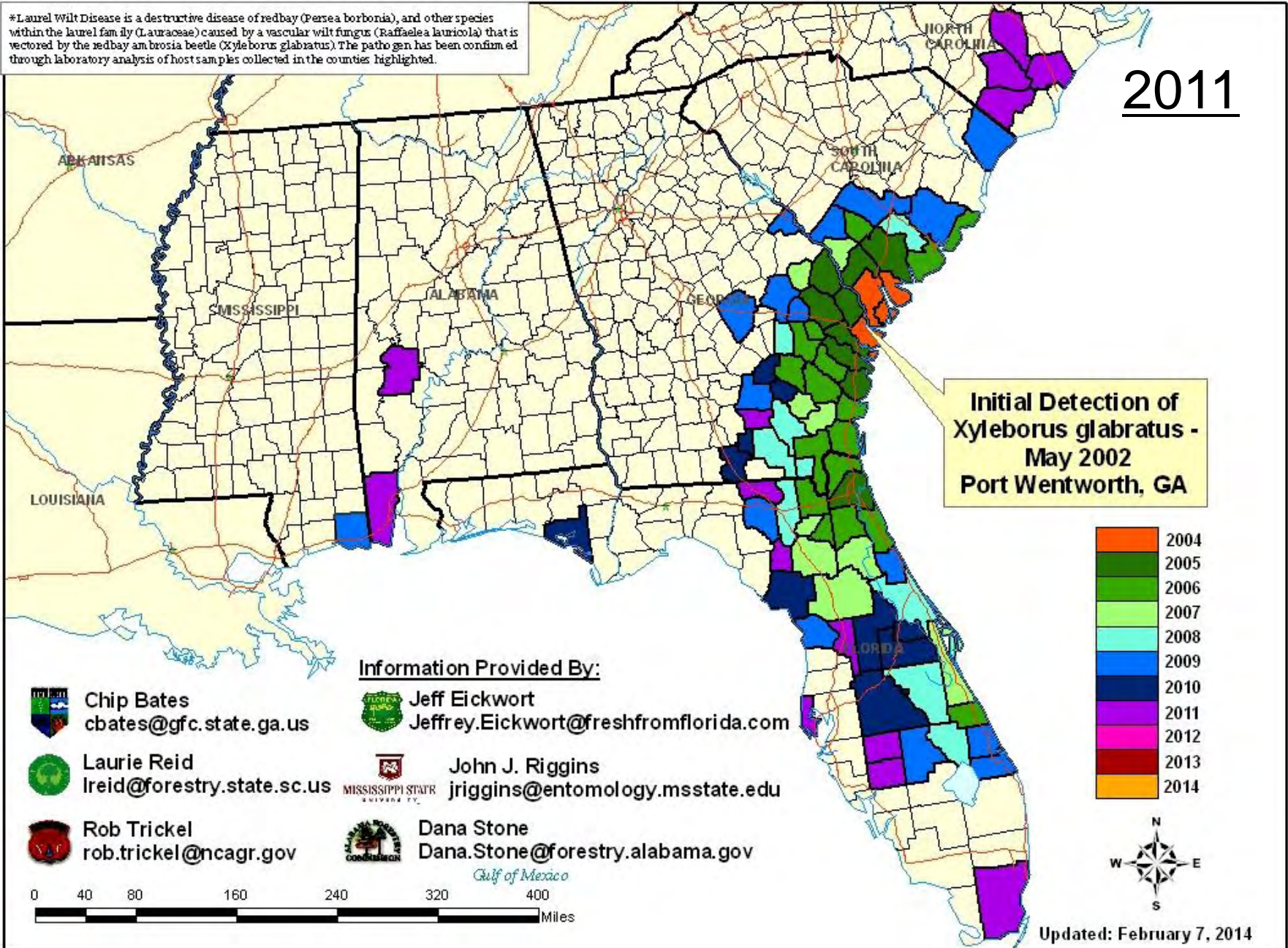
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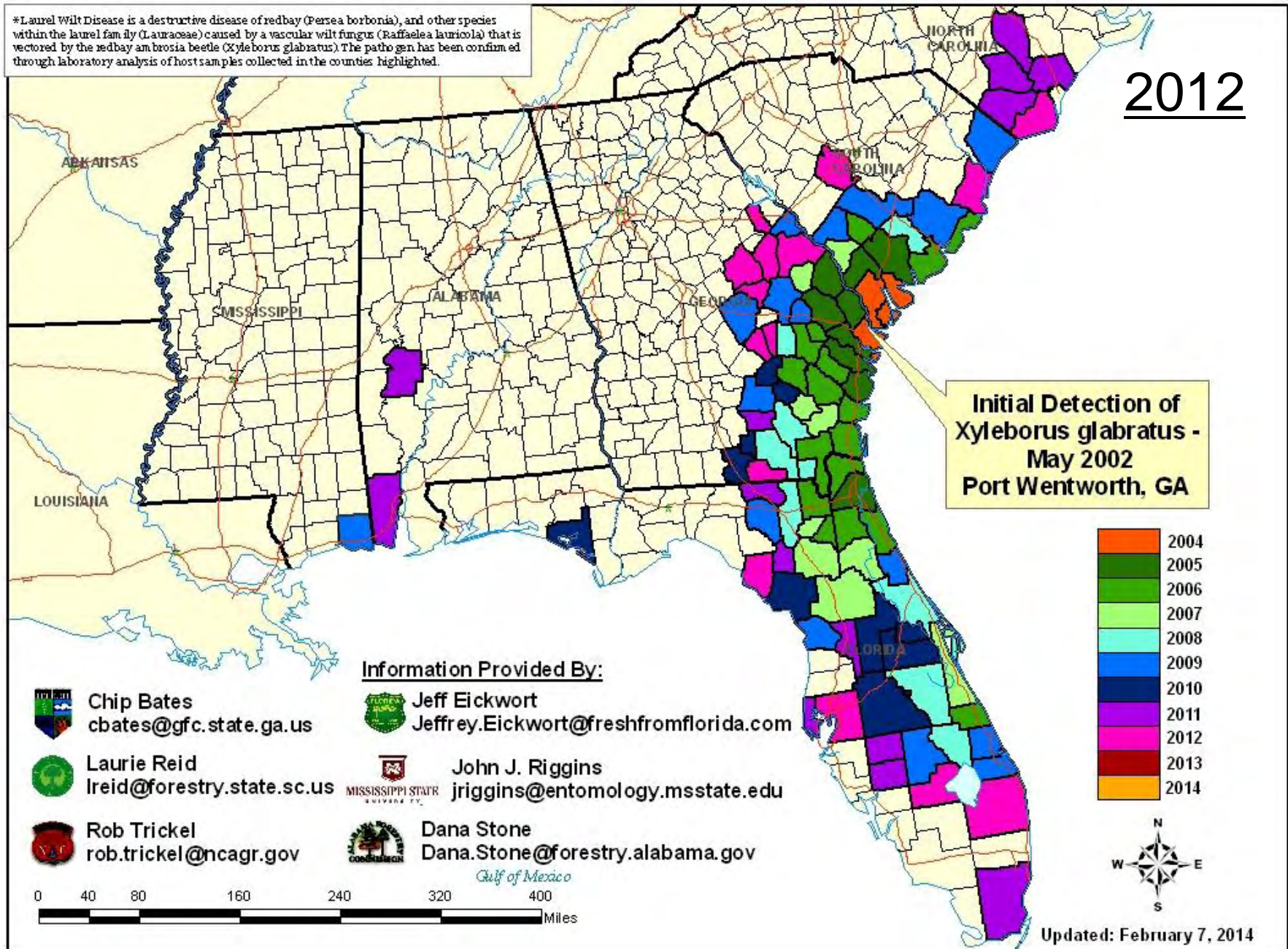
2011



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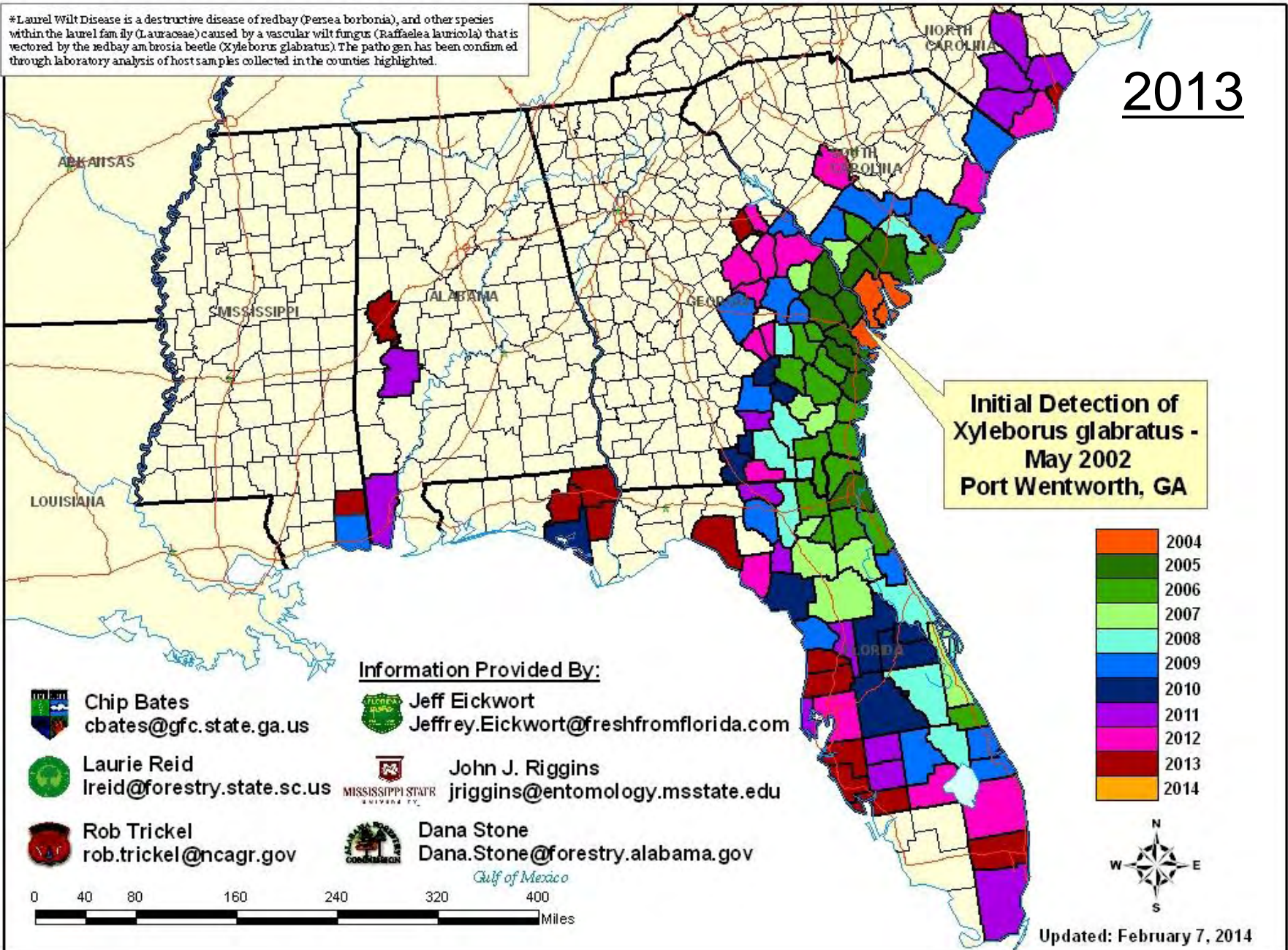
2012



Distribution of Counties with Laurel Wilt Disease* by year of Initial Detection

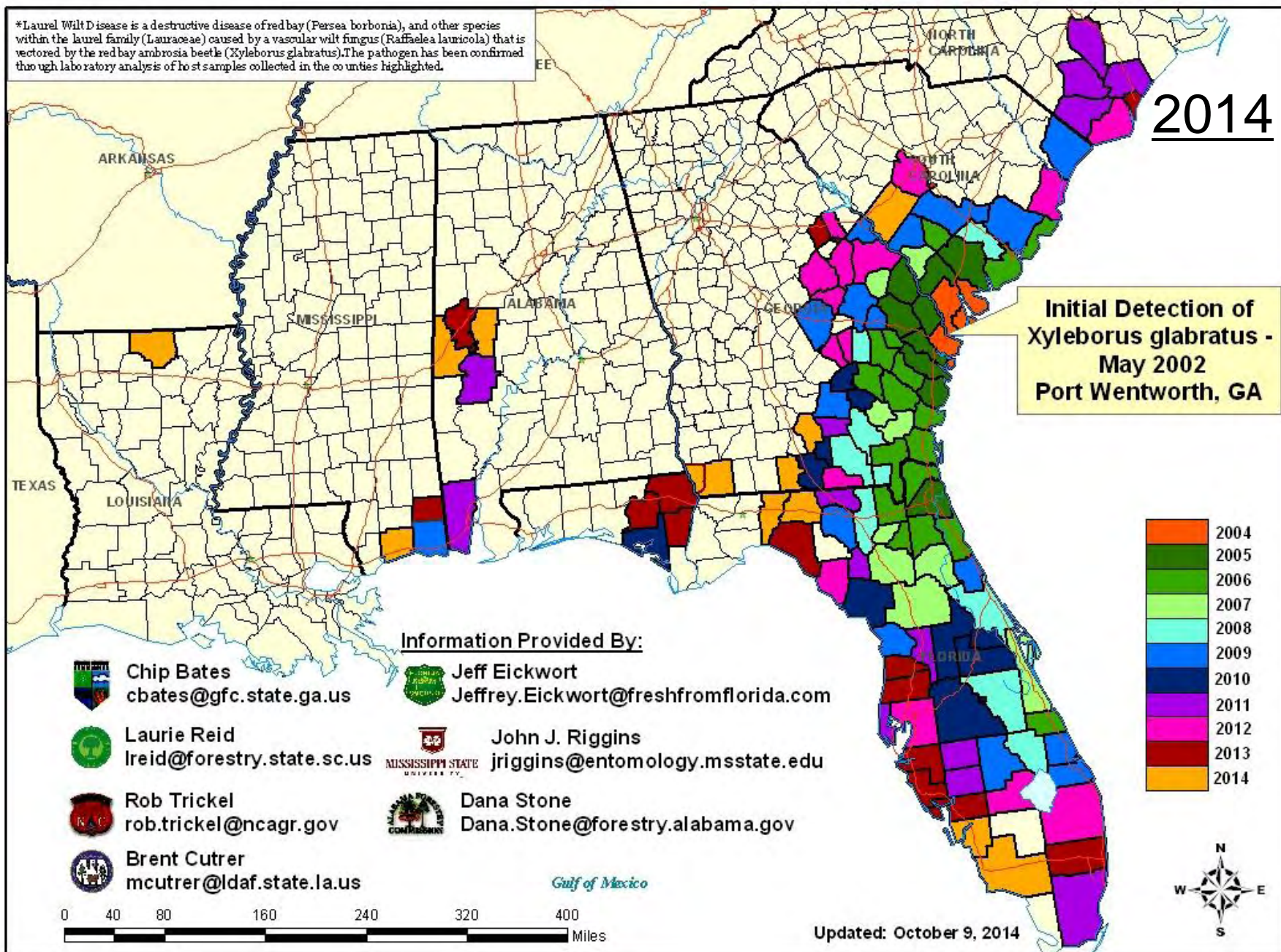
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2013



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Laurel wilt development: Tree infection and movement of the fungus



Xylem discoloration and beetle entrance hole at base of tree in early stages of the disease

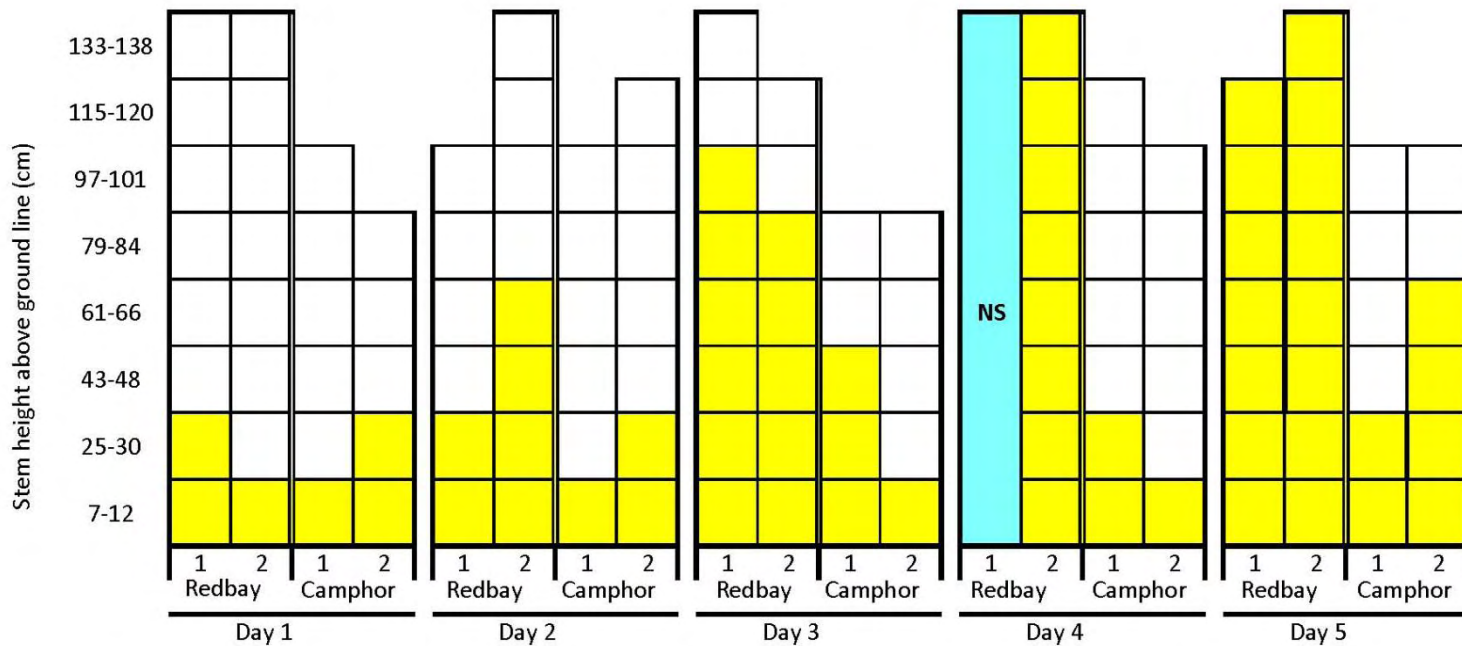


Loss of turgor in leaves of some branches as disease progresses



Aborted beetle tunnel

Raffaelea lauricola moves rapidly in the xylem of redbay



- All saplings inoculated with *R. lauricola* at 7 cm above ground level.
- Areas colored yellow indicate stem sections positive for *R. lauricola*

Source: Fraedrich, S. W., T. C Harrington and G. S. Best. 2014. *Xyleborus glabratus* attacks and systemic infections by *Raffaelea lauricola* associated with dieback of camphortree (*Cinnamomum camphora*) in the southeastern United States. Forest Pathology, online@ <http://onlinelibrary.wiley.com/doi/10.1111/efp.12124/pdf>

Laurel wilt development: Trees begin to wilt



Foliage beginning to wilt and becoming brown throughout tree



Xylem discoloration increasingly noticeable and beetle attacks increasing but still somewhat rare.

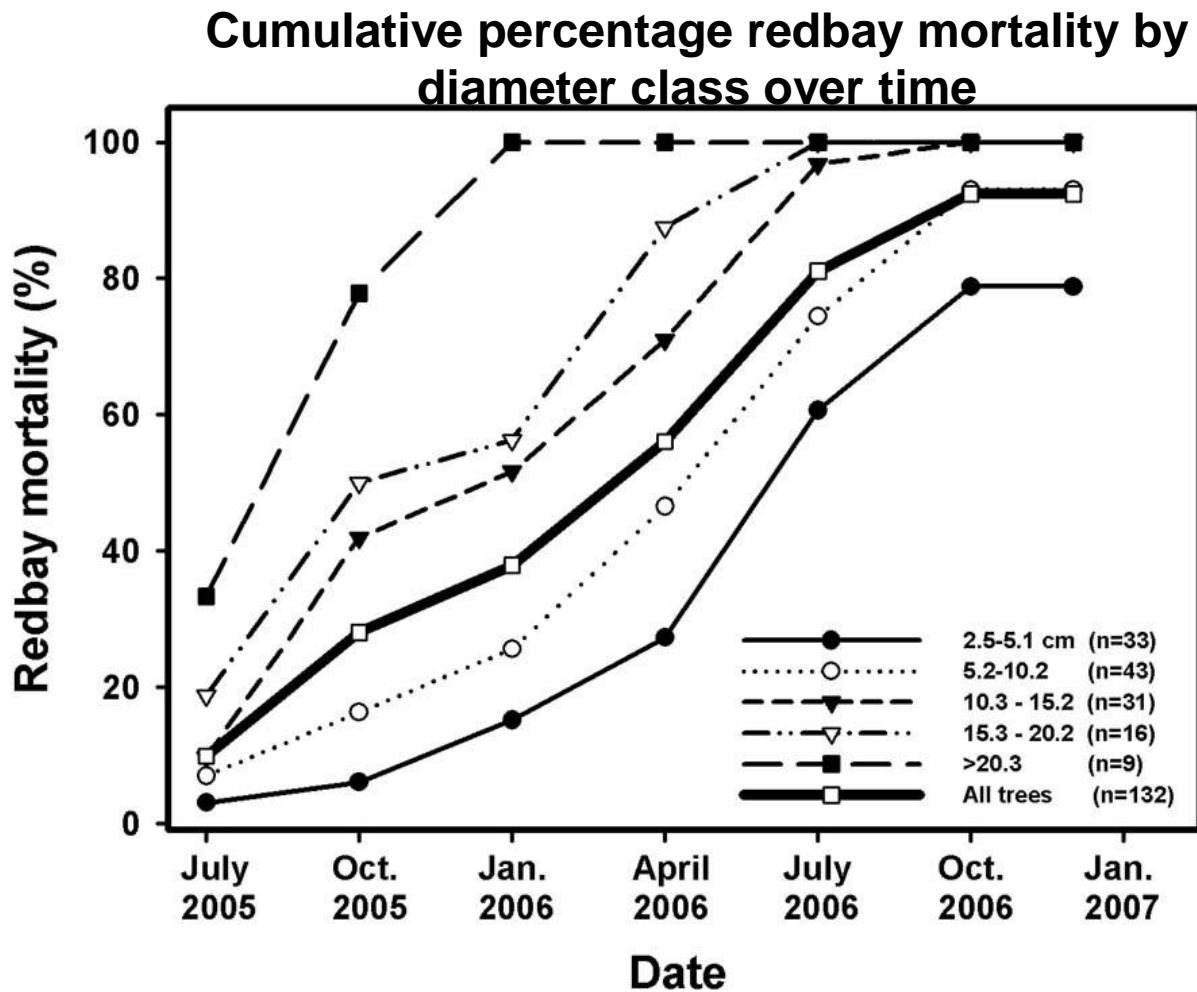


Stem cross section of xylem discoloration.

Laurel Wilt Development: Tree Mortality and Utilization by *Xyleborus glabratus* for Brood



Larger diameter trees are killed first by laurel wilt

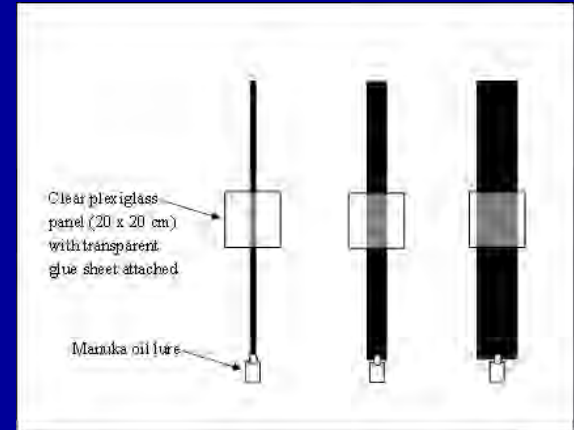


** Only 1 of 222 redbay less than 2.5 cm diameter had wilt

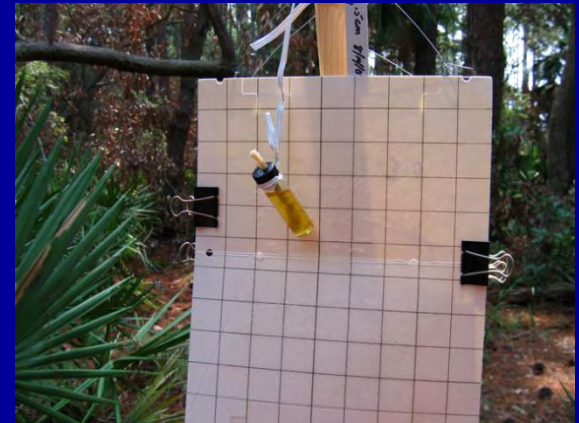
Source: Fraedrich, S. W., T. C. Harrington, R. J. Rabaglia, M. D. Ulyshen, A. E. Mayfield, J. L. Hanula, J. M. Eickwort, and D. R. Miller. 2008. A fungal symbiont of the redbay ambrosia beetle causes a lethal wilt in redbay and other Lauraceae in the southeastern United States. *Plant Dis.* 92:215-224.

Host Finding by *Xyleborus glabratus*

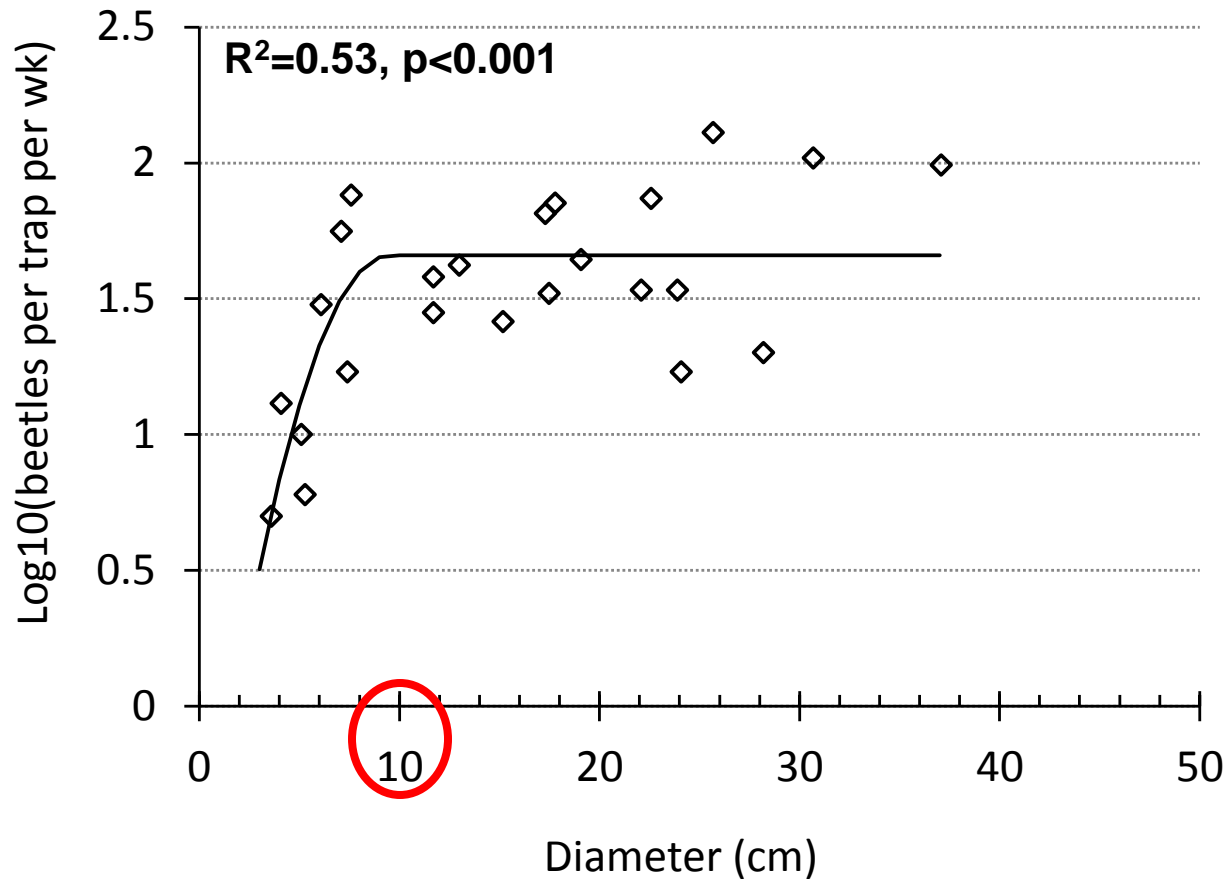
- Visual cues -
tree diameter size



- Olfactory cues -
host tree volatiles

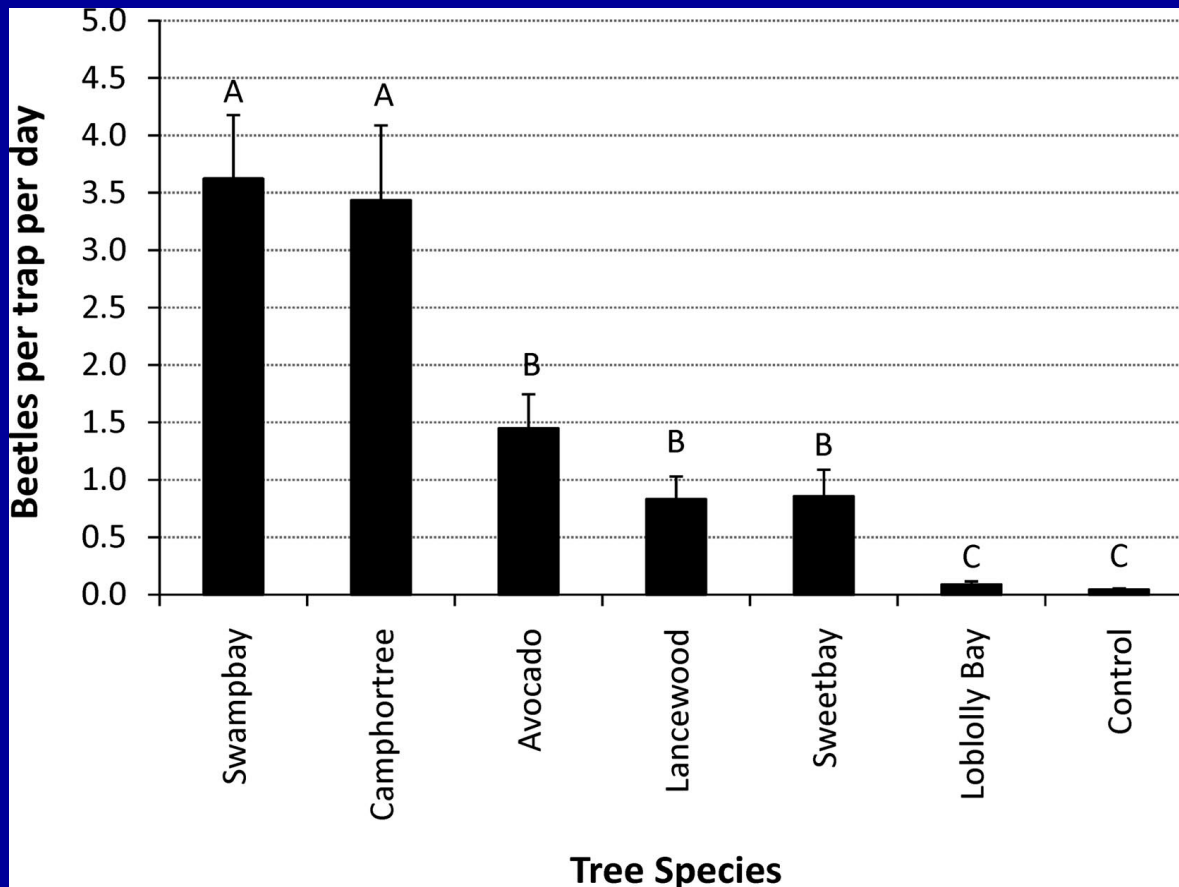


Visual Cues - Relationship between stem diameter and beetle attractions using standing non-host pines



Source: Mayfield, A. E. and C. Brownie. 2013. The Redbay Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae) Uses Stem Silhouette Diameter as a Visual Host-Finding Cue. Environmental Entomology 42:743-750.

Olfactory cues: *Xyleborus glabratus* attraction to various tree species



Source: Mayfield, A. E. and **J. L. Hanula**. 2012. Effect of Tree Species and End Seal on Attractiveness and Utility of Cut Bolts to the Redbay Ambrosia Beetle and Granulate Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae). *Journal of Economic Entomology* 105, no. 2:461-470

Will small diameter trees, stump spouts and seedling regeneration survive??



Seedling regeneration – Jekyll Island, GA



Surviving 4" dbh red bay
Hunting Island, SC

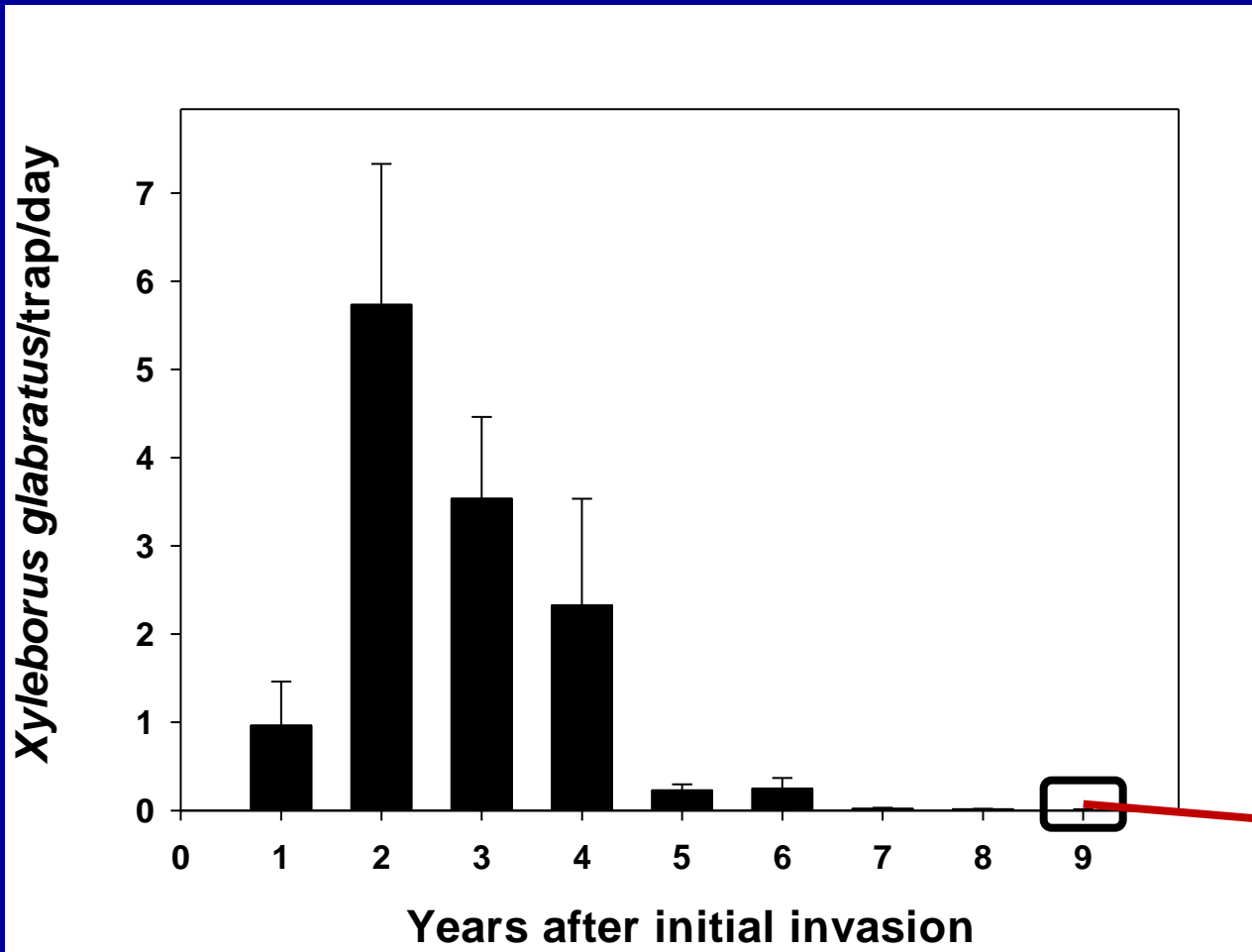


Healthy stump sprout;
Hunting Island, SC (June, 2012)



Wilted stump sprout;
Jekyll Island, GA (June, 2012)

Population trends of *Xyleborus glabratus* on sites with laurel wilt

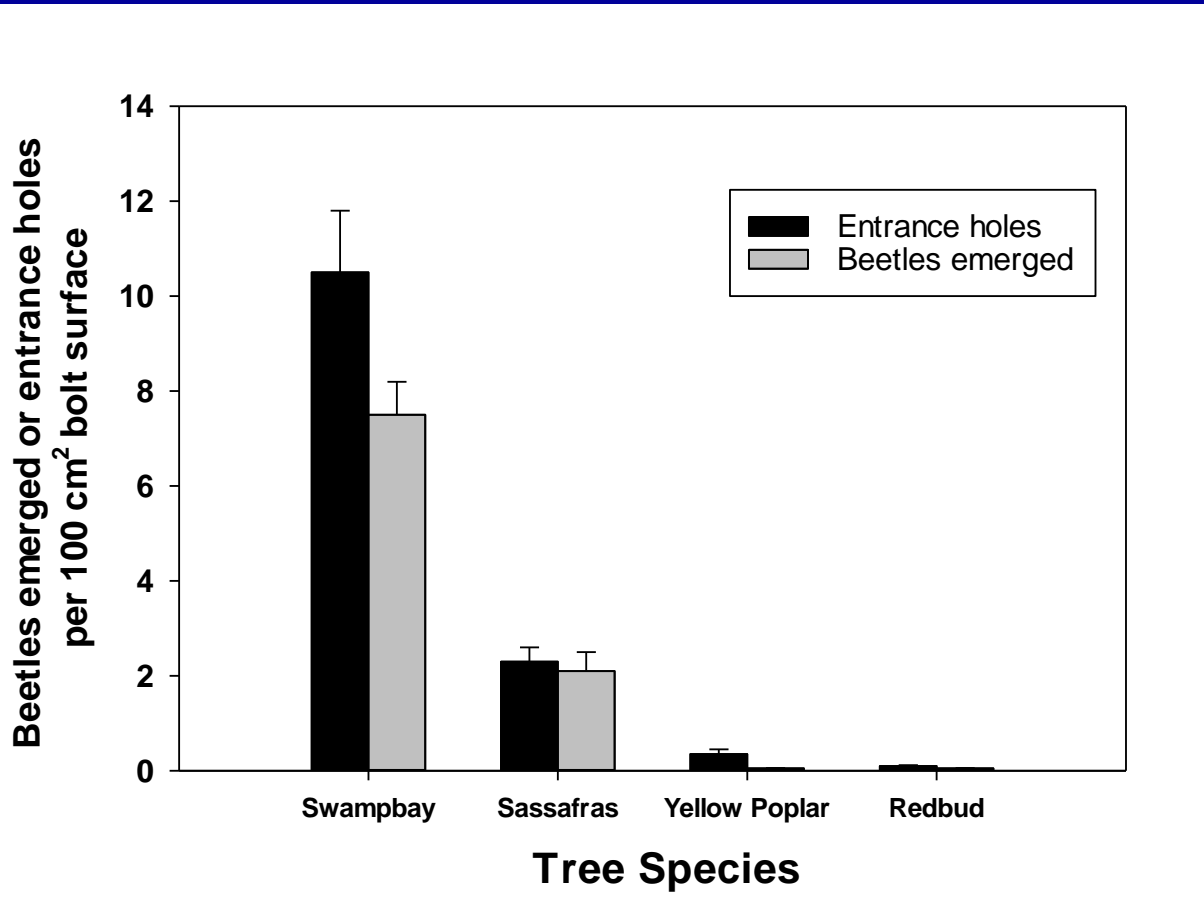


Sticky traps with manuka oil lure

0.01 Xg/trap/day

Source: Maner, M. L., J. L. Hanula, and S. Horn. 2014. Population Trends of the Redbay Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae): Does Utilization of Small Diameter Redbay Trees Allow Populations to Persist? Florida Entomologist 97:208-216.

Studies examining beetle attacks and beetle emergence typically use bolts from healthy trees



Redbay bolt

Source: Mayfield, A. E. and *J. L. Hanula*. 2012. Effect of Tree Species and End Seal on Attractiveness and Utility of Cut Bolts to the Redbay Ambrosia Beetle and Granulate Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae). *Journal of Economic Entomology* 105, no. 2:461-470

Is beetle production greater in bolts from trees with laurel wilt than bolts from healthy trees?

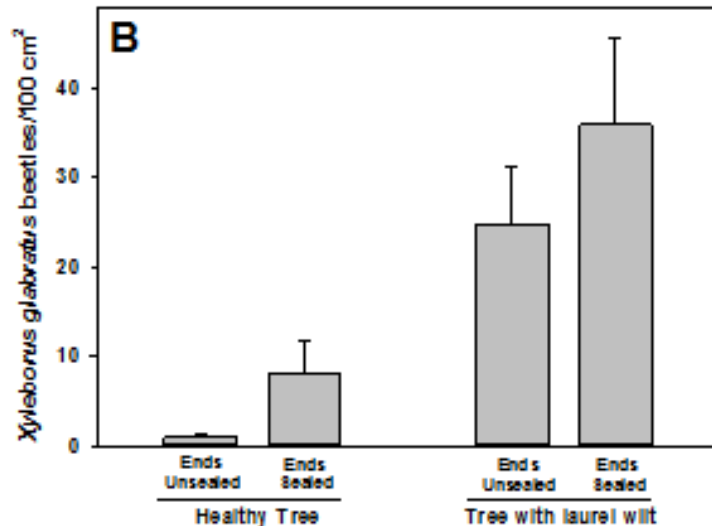
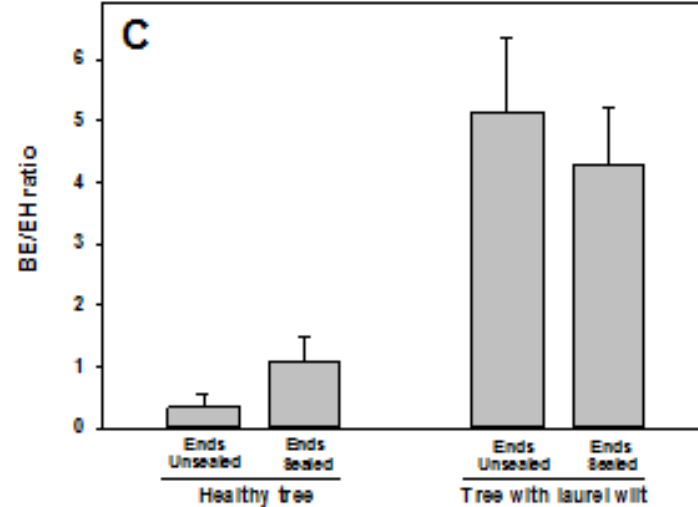
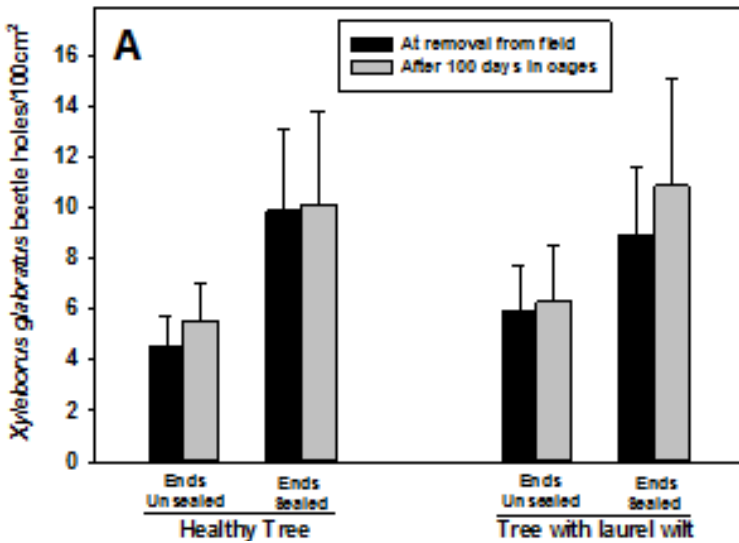
Treatments

- Bolts from healthy tree/ends not waxed
- Bolts from healthy tree/ends with paraffin wax
- Bolts from tree in early stages of wilt / ends not waxed
- Bolts from tree in early stages of wilt / ends with paraffin wax



****Manuka oil lures attached to all bolts**

Results: Beetle brood production in bolts from healthy trees and those with laurel wilt



- Bolts from trees with laurel wilt tend to produce more brood than bolts from healthy trees
- Bolts with ends waxed with paraffin produced more brood than those with unwaxed ends

Sassafras (*Sassafras albidum*)



Rennes ParcOberthur

Sassafras with root sprouts



Chip Morrison

Sassafras albidum

- Family Lauraceae
- Deciduous species
- Minor use hardwood with good wood properties
- Ecologically important
- Occurs as scattered trees in many forest types in the eastern USA

Sassafras (*Sassafras albidum*)



Pathogenicity tests

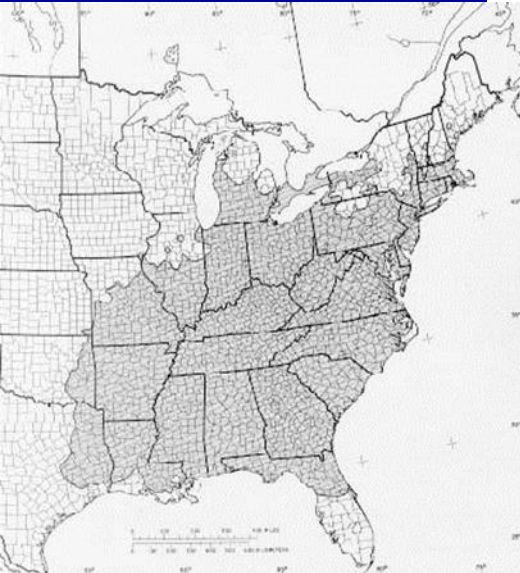
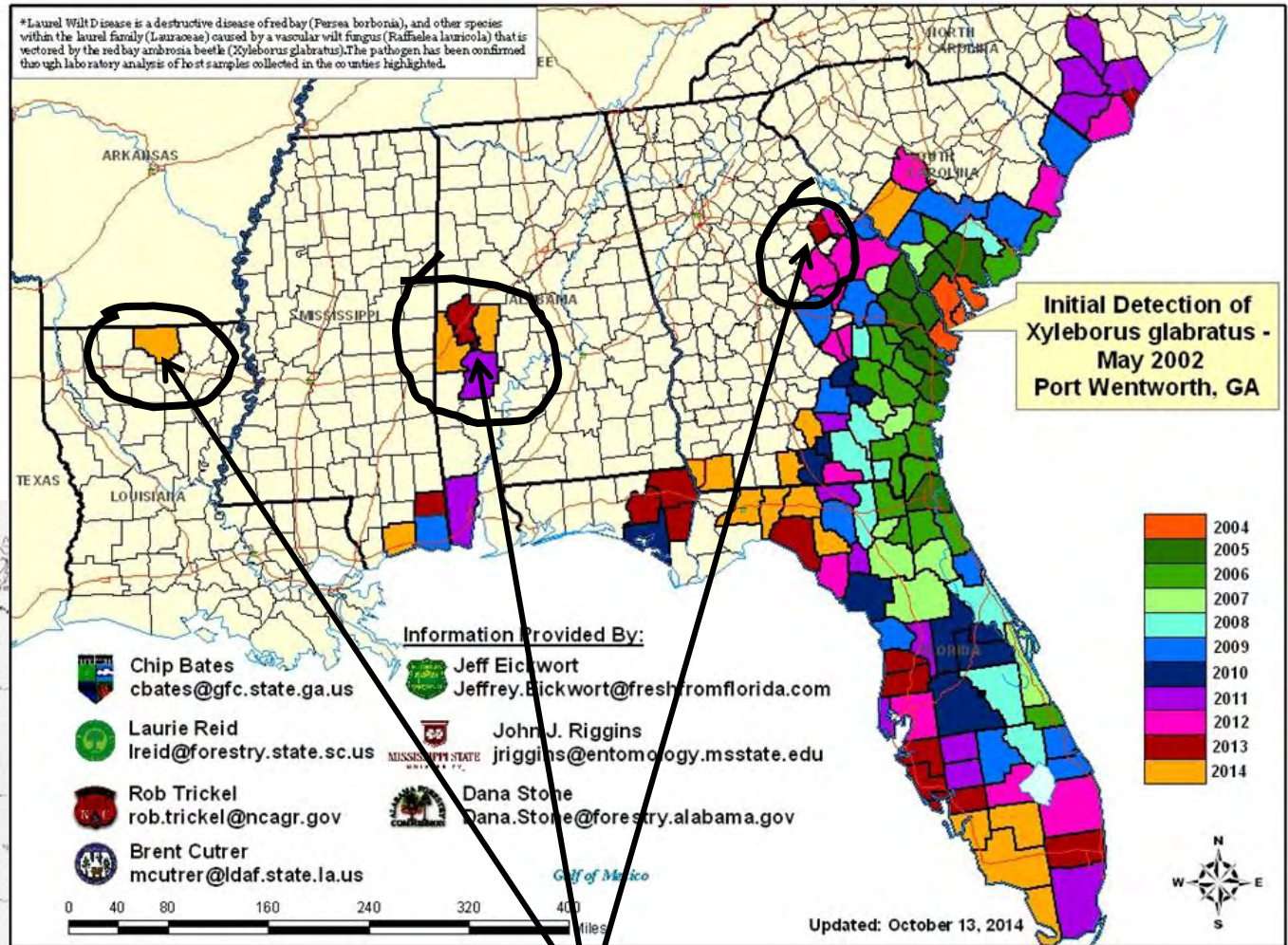
- Highly susceptible to laurel wilt
- Initially thought to be not very attractive to *X. glabratus*; this is now questionable
- Also, initially thought not be a good brood host; additional research is needed



Laurel wilt in sassafras; Wrightsville, Georgia, May, 2014

Sassafras – species range and occurrence of laurel wilt

Distribution of Counties with Laurel Wilt Disease* by year of Initial Detection



Range of sassafras

Laurel wilt occurring on sassafras, no redbay present

Pondberry

(Lindera melissifolia)



Pondberry, Clio, GA

- Family Lauraceae
- Endangered Species
- Rare - occurs as isolated populations in the SE USA
- Small understory shrub
- Highly clonal

Pondberry



Pondberry inoculated
with *R. lauricola*

Control

- Highly susceptible to laurel wilt disease in inoculation studies
- Rarely attacked in natural environment because of small size
- Not a good brood host for *X. glabratus*
- When infected, fungus can move rapidly through rhizome to other plants

Pondspice

Litsea aestivalis



Pondspice, Lady's Island, SC

- Family Lauraceae
- Threatened species
- Large shrub
- Occurs in coastal plains where redbay also common.

Pondspice

- Highly susceptible to disease
- Disease primarily observed in natural areas where redbay is also present
- Probably not a good reproductive host for *Xyleborus glabratus*



Pondspice with laurel wilt, Clyo GA, July, 2006



Pondspice - inoculation studies

Camphortree **(*Cinnamomum camphora*)**

- **Member of the Lauraceae**
- **Native to Southeast Asia**
- **At one time cultivated in the United States**
- **Regarded as an invasive species in many coastal areas of the southeastern USA**



Camphortree on the coast of Georgia

Laurel wilt – Association of *X. glabratus* and *R. lauricola* with camphortree



Shoot dieback in camphortree caused by *R. lauricola*; Half Moon, Georgia; June, 2007



Dieback in camphortree, St. Simons Island, Georgia; July, 2014

Susceptibility of camphortree to wilt/dieback caused by *R. lauricola*



Single inoculations
on stem



Multiple inoculations
on stem



Field inoculations
currently underway

Source: Fraedrich, S. W., T. C Harrington and G. S. Best. 2014. *Xyleborus glabratus* attacks and systemic infections by *Raffaelea lauricola* associated with dieback of camphortree (*Cinnamomum camphora*) in the southeastern United States. Forest Pathology, online@ <http://onlinelibrary.wiley.com/doi/10.1111/efp.12124/pdf>

Laurel wilt – Association of *X. glabratus* and *R. lauricola* with camphortree



Discoloration associated with *R. lauricola* infection



Discoloration associated *X. glabratus* attack and *R. lauricola* infection



Dead *X. glabratus* beetle in old, undeveloped tunnel

California bay laurel (*Umbellularia californica*)

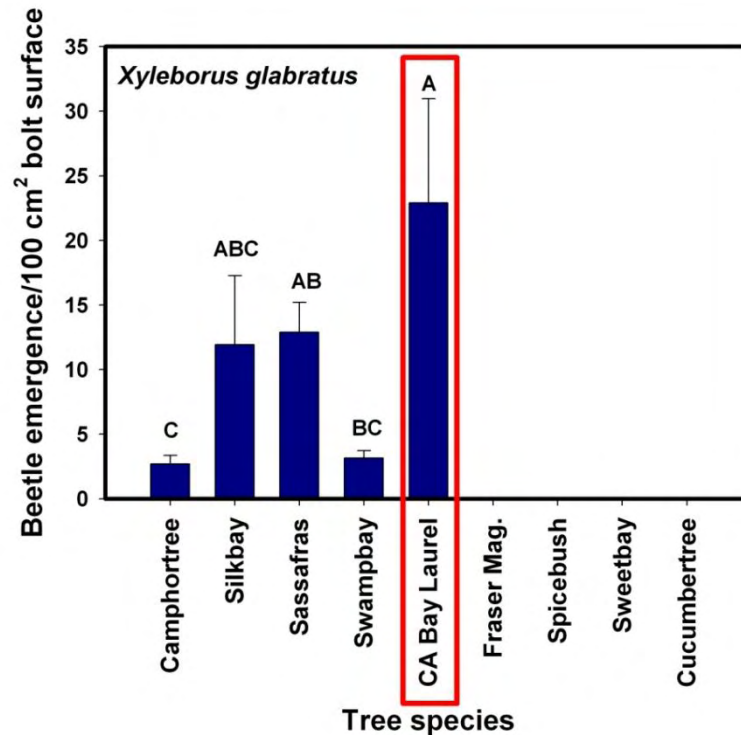
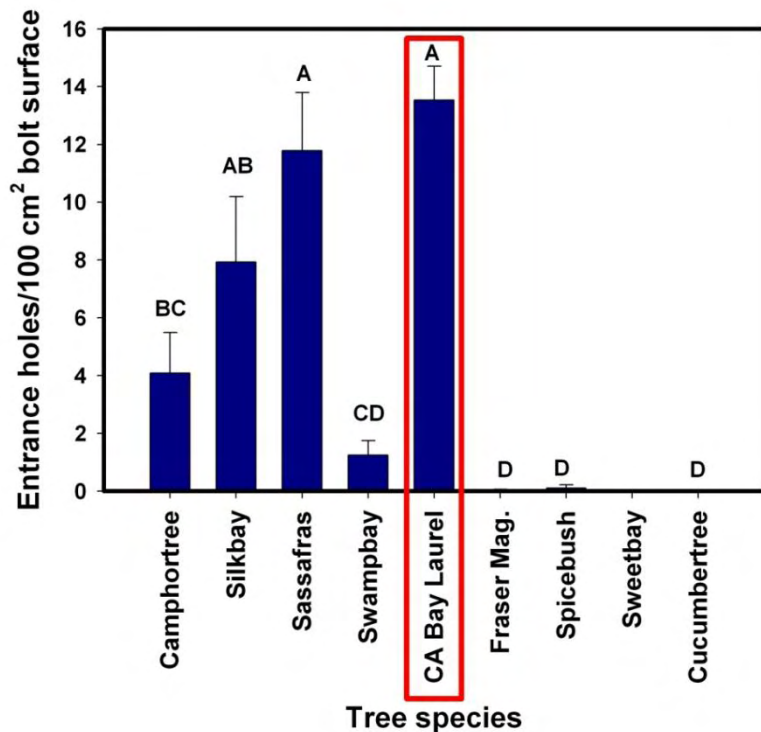
- Family Lauraceae
- **Forests of California and Oregon**



Range of California bay laurel

Susceptible to laurel wilt

Xyleborus glabratus attacks and produces brood in California Bay Laurel



From: Mayfield, A. E., M. Mackenzie, P. G. Cannon, S. W. Oak, S. Horn, J. Hwang, and P. E. Kendra. 2013. Suitability of California bay laurel and other species as hosts for the non-native redbay ambrosia beetle and granulate ambrosia beetle. *Agricultural and Forest Entomology* 15:227-235.

For more information on laurel wilt:

www.fs.fed.us/r8/foresthealth/laurelwilt

www.srs.fs.usda.gov/pubs

www.public.iastate.edu/~tcharrin/



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



**The Horton House on Jekyll Island, GA
(June, 2008)**

Public needs to be aware of the potential problem

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

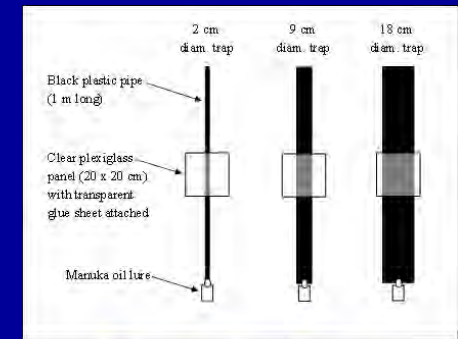
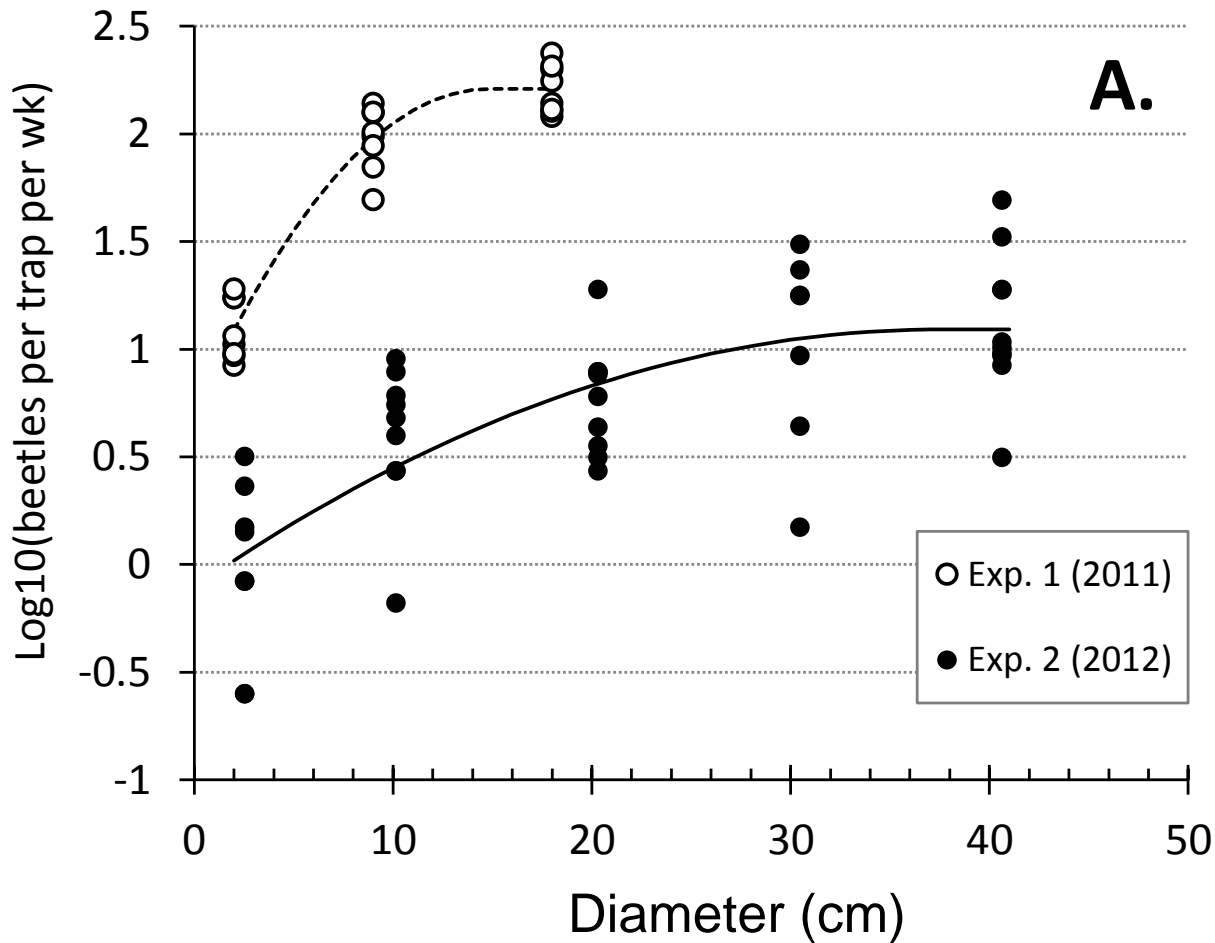


Tree killed by redbay ambrosia beetle and lethal fungus

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



Xyleborus glabratus is visually attracted to larger diameter stems

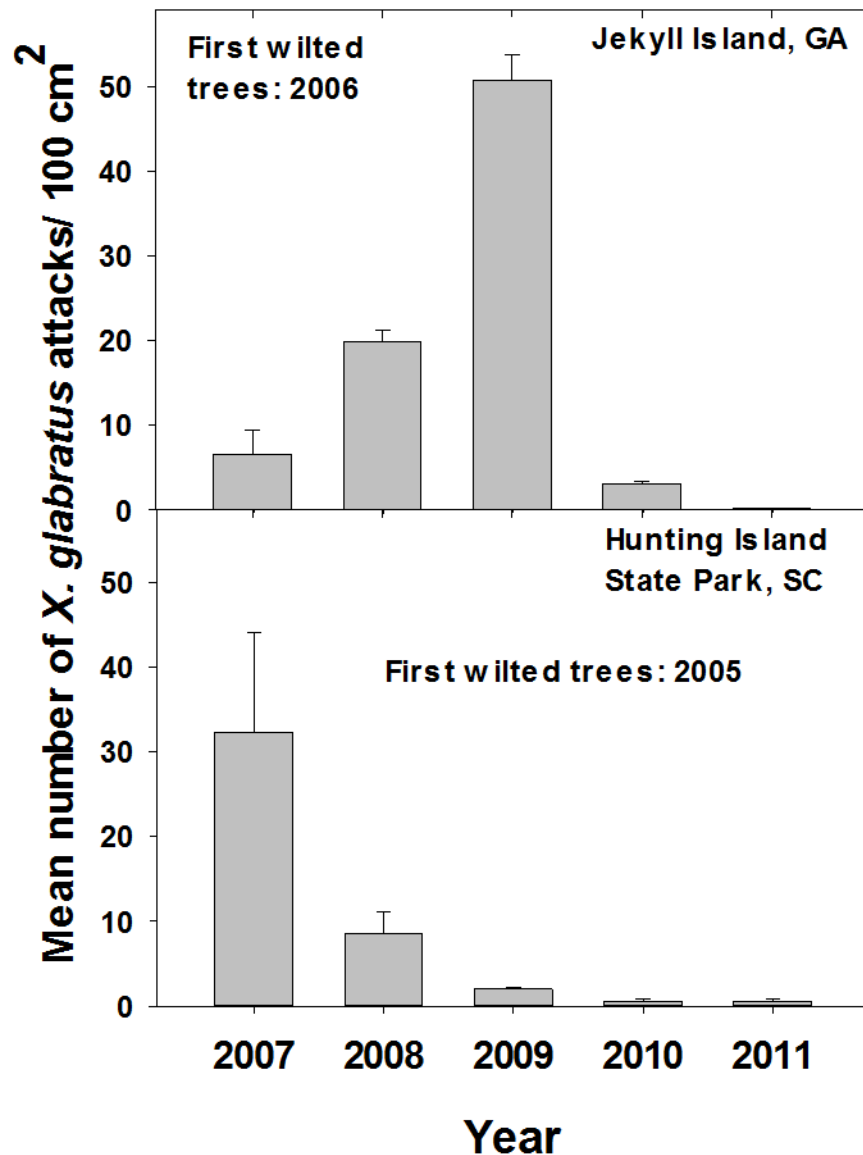


Silhouette effect



Source: Mayfield, A. E. and C. Brownie. 2013. The Redbay Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae) Uses Stem Silhouette Diameter as a Visual Host-Finding Cue. Environmental Entomology 42:743-750.

Xyleborus glabratus attack rates on redbay bolts



Redbay bolt used to assess *X. glabratus* attacks

Source: Maner, M. L., J. L. Hanula, and S. Horn. 2014. Population Trends of the Redbay Ambrosia Beetle (Coleoptera: Curculionidae: Scolytinae): Does Utilization of Small Diameter Redbay Trees Allow Populations to Persist? Florida Entomologist 97:208-216.

Prevention: What are the potential pathways for *Xyleborus glabratus* and *Raffaelea lauricola* to gain entry into Mexico/Central America?



Savannah, Georgia

Xyleborus glabratus beetles per trap per day

