

Laurel Wilt

A threat to Lauraceous plants in North America and beyond



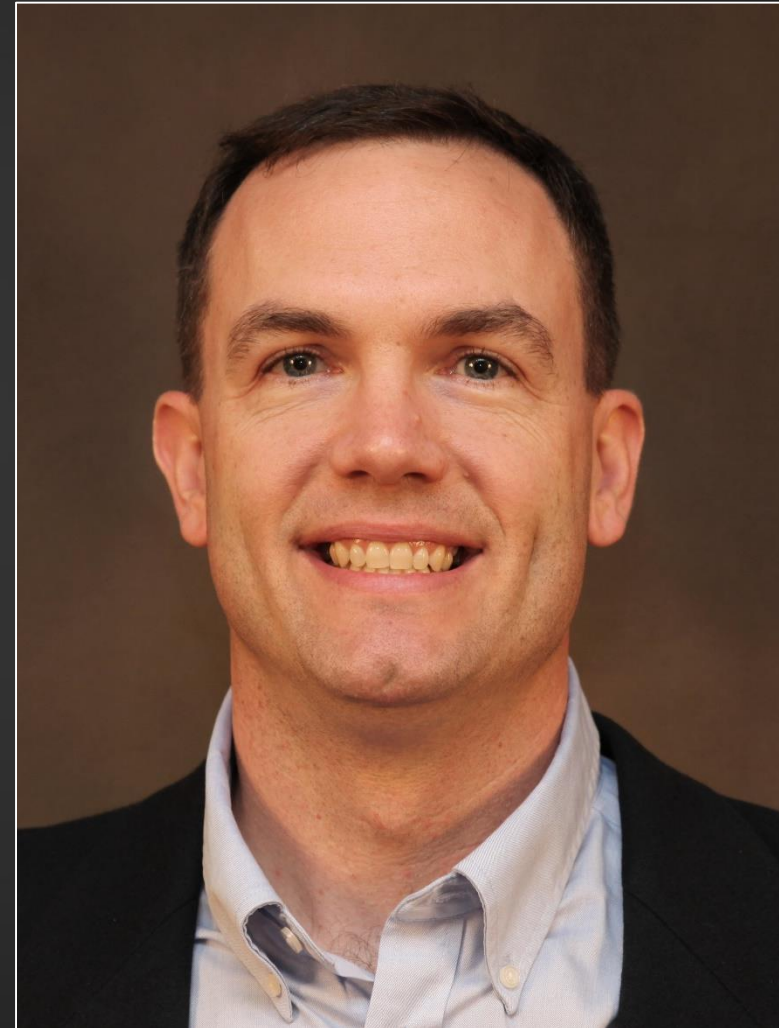
Albert "Bud" Mayfield
USDA Forest Service
Southern Research Station

Southern Regional Extension Forestry Webinar, 8 April 2020

Alfred E. Neuman



Albert E. Mayfield



What is the Laurel Family (Lauraceae)?

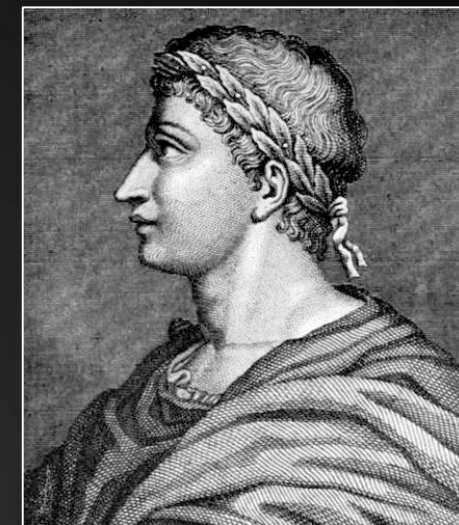
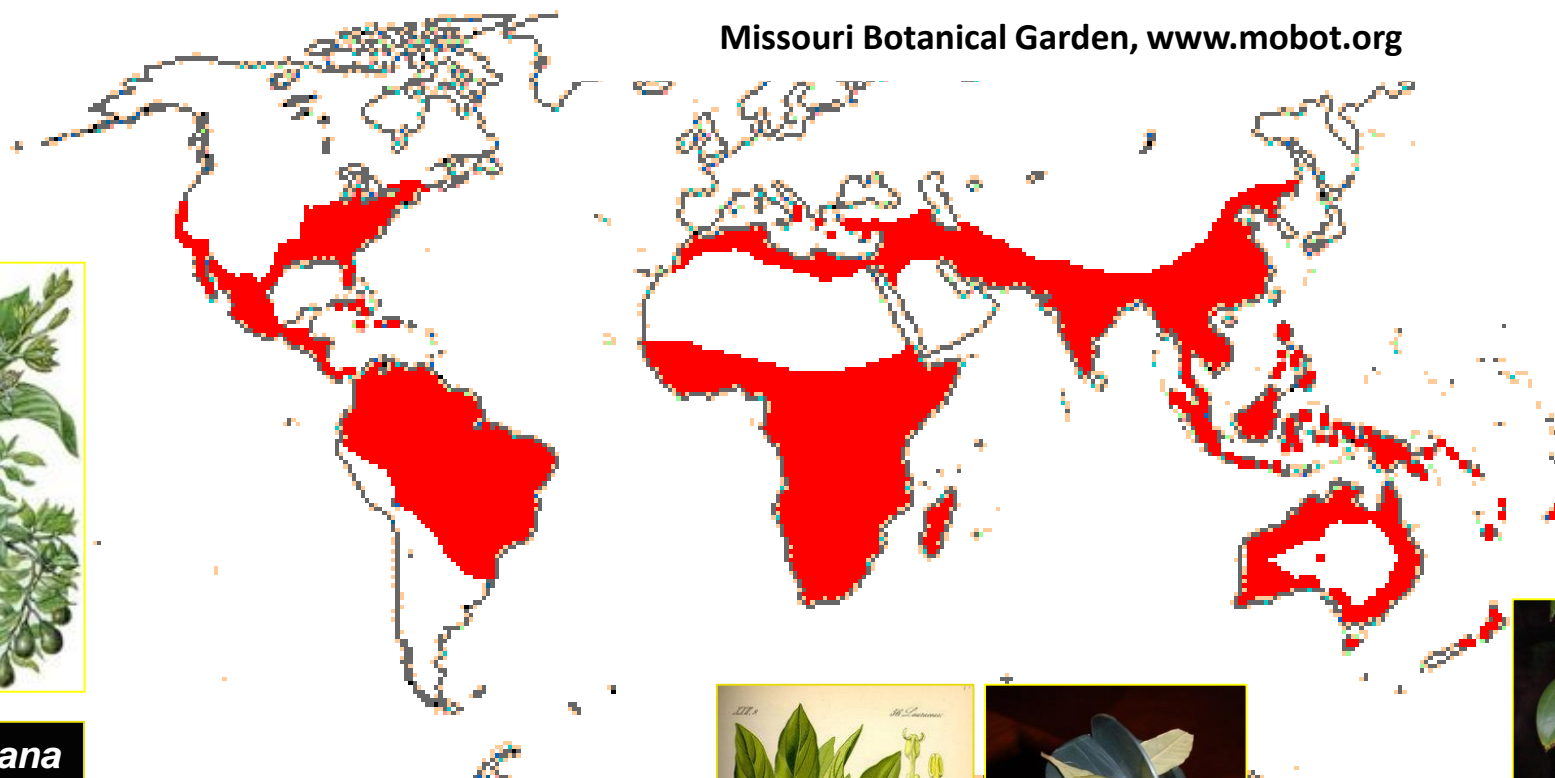
Laurel Family: Lauraceae

Missouri Botanical Garden, www.mobot.org



Persea americana

- 55 genera, >2000 species worldwide
- Aromatic oils
- Economic, cultural, medicinal, and ecological importance



Laurel wreath



Laurus nobilis



Cinnamomum verum

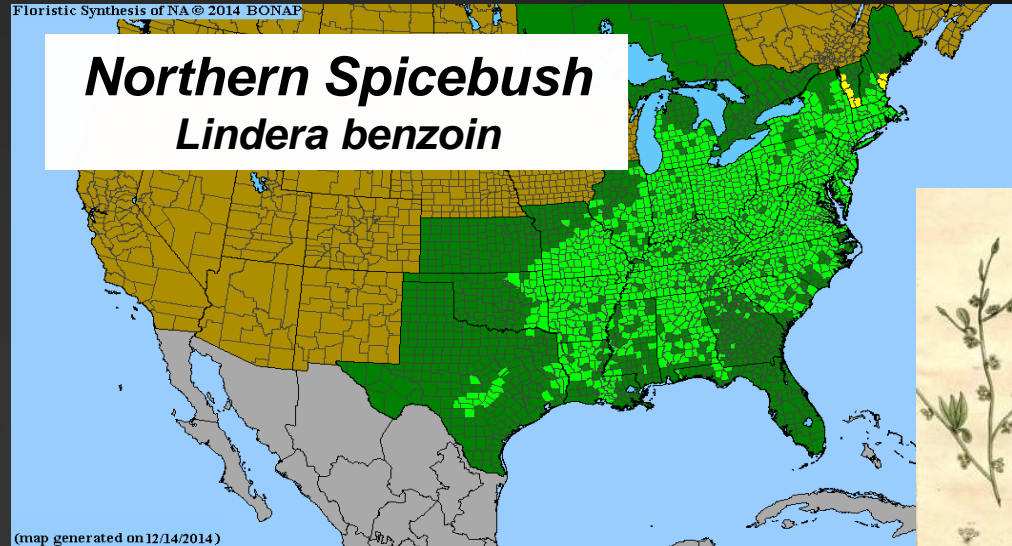


Major species of Lauraceae in North America

Sassafras
Sassafras albidum



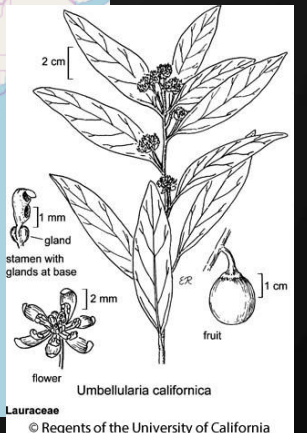
Northern Spicebush
Lindera benzoin



Redbay
Persea americana



California Bay Laurel
Umbellularia californica



Lauraceae
© Regents of the University of California

Laurel Family: Lauraceae



Laurisilva of
Madeira

UNESCO World
Natural Heritage Site

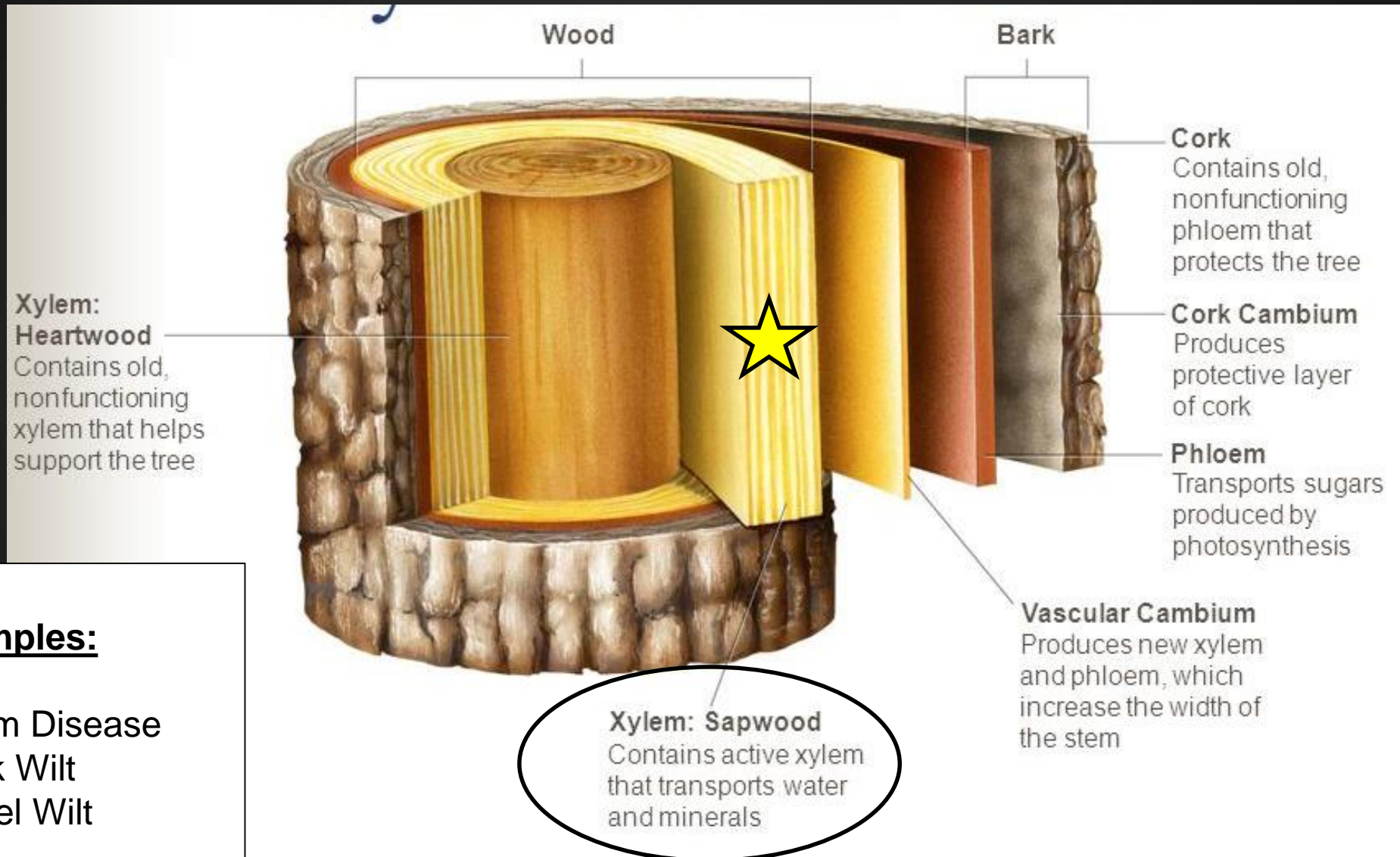
<http://www.discoveringmadeira.com/discover-madeira-laurissilva>

Island relict of a previously widespread laurel forest type, which covered much of Southern Europe 15-40 million ya



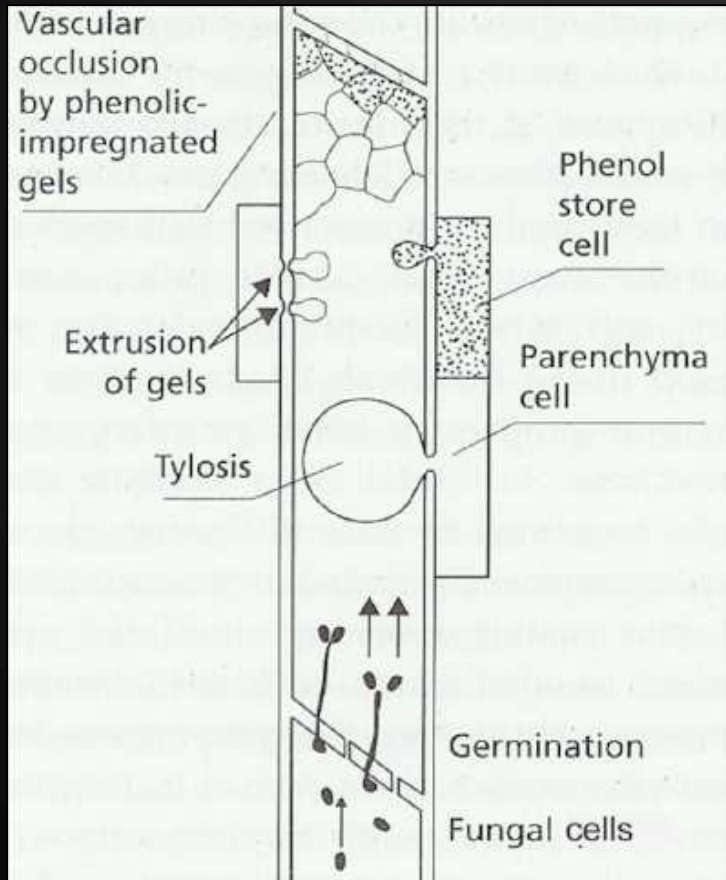
What is Laurel Wilt, and what causes it?

Vascular Wilt Diseases



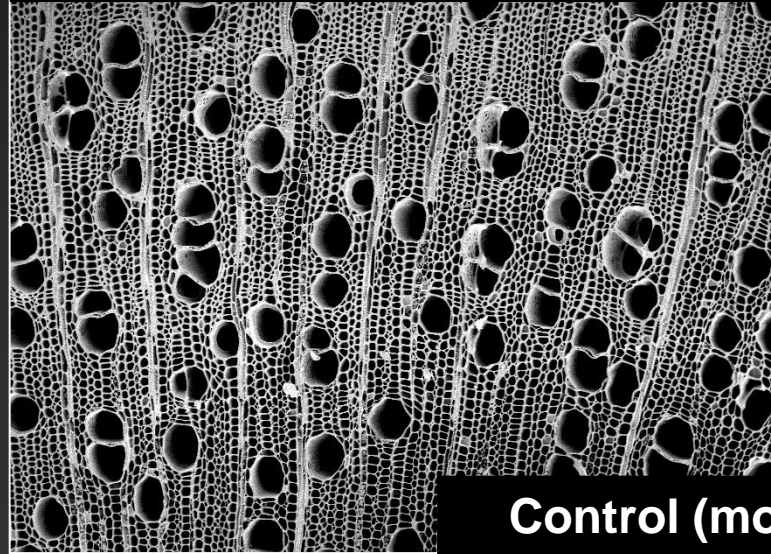
Vascular Wilt Disease

Xylem vessel:

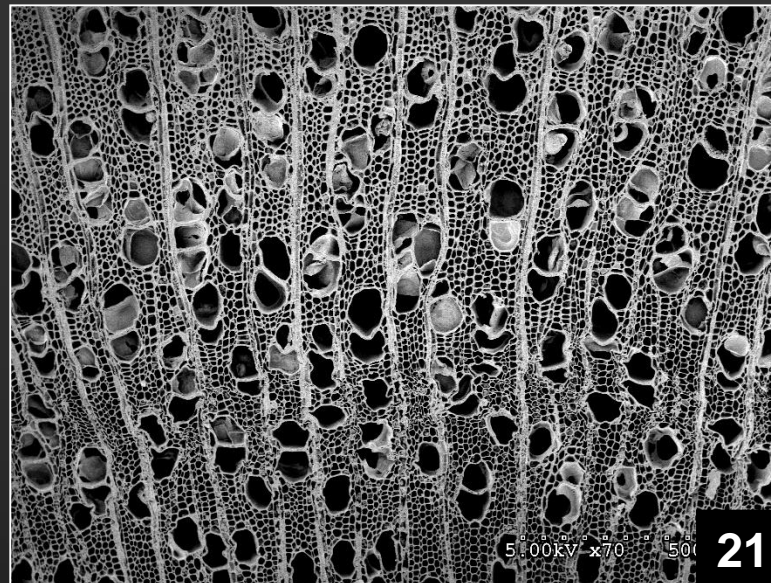
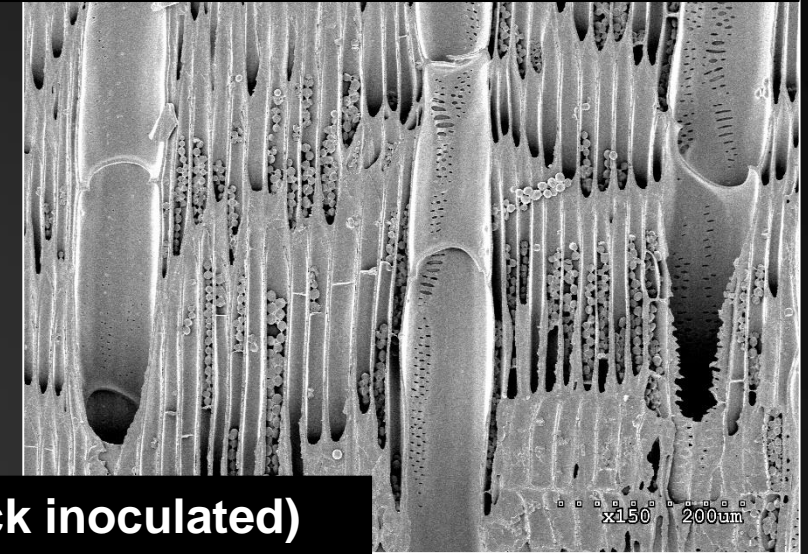


Beckman and Talboys 1981

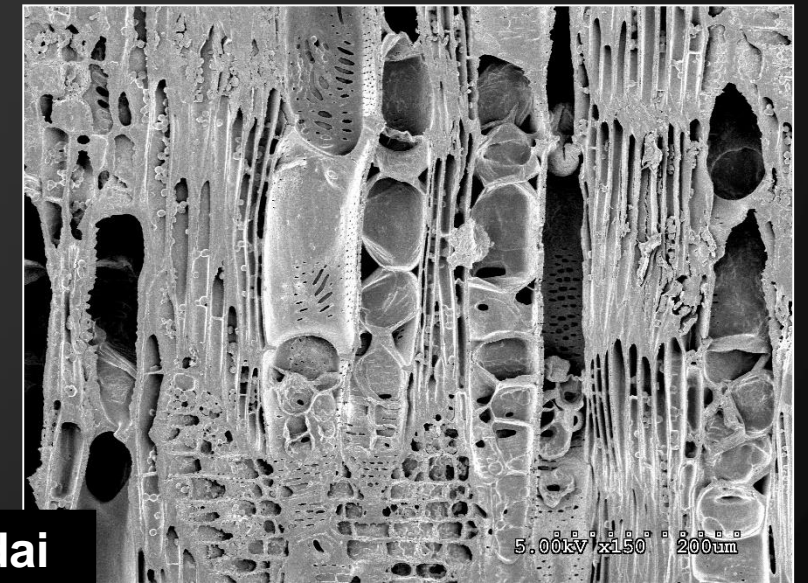
Tylose formation plays a role in xylem dysfunction



Control (mock inoculated)



21 dai



Photos by Randy Ploetz, Univ Fla.
(see Inch and Ploetz (2012) *For. Pathol.* 42: 239)

Laurel Wilt

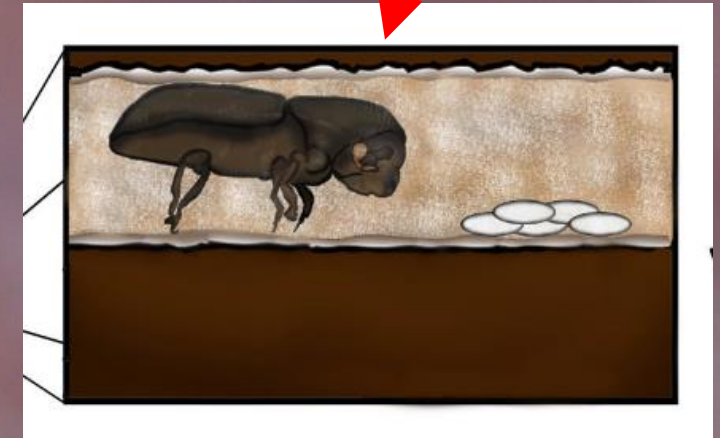
- A vascular wilt disease
- Caused by a fungus (*Raffaelea lauricola*)
- Carried into trees by a non-native ambrosia beetle vector

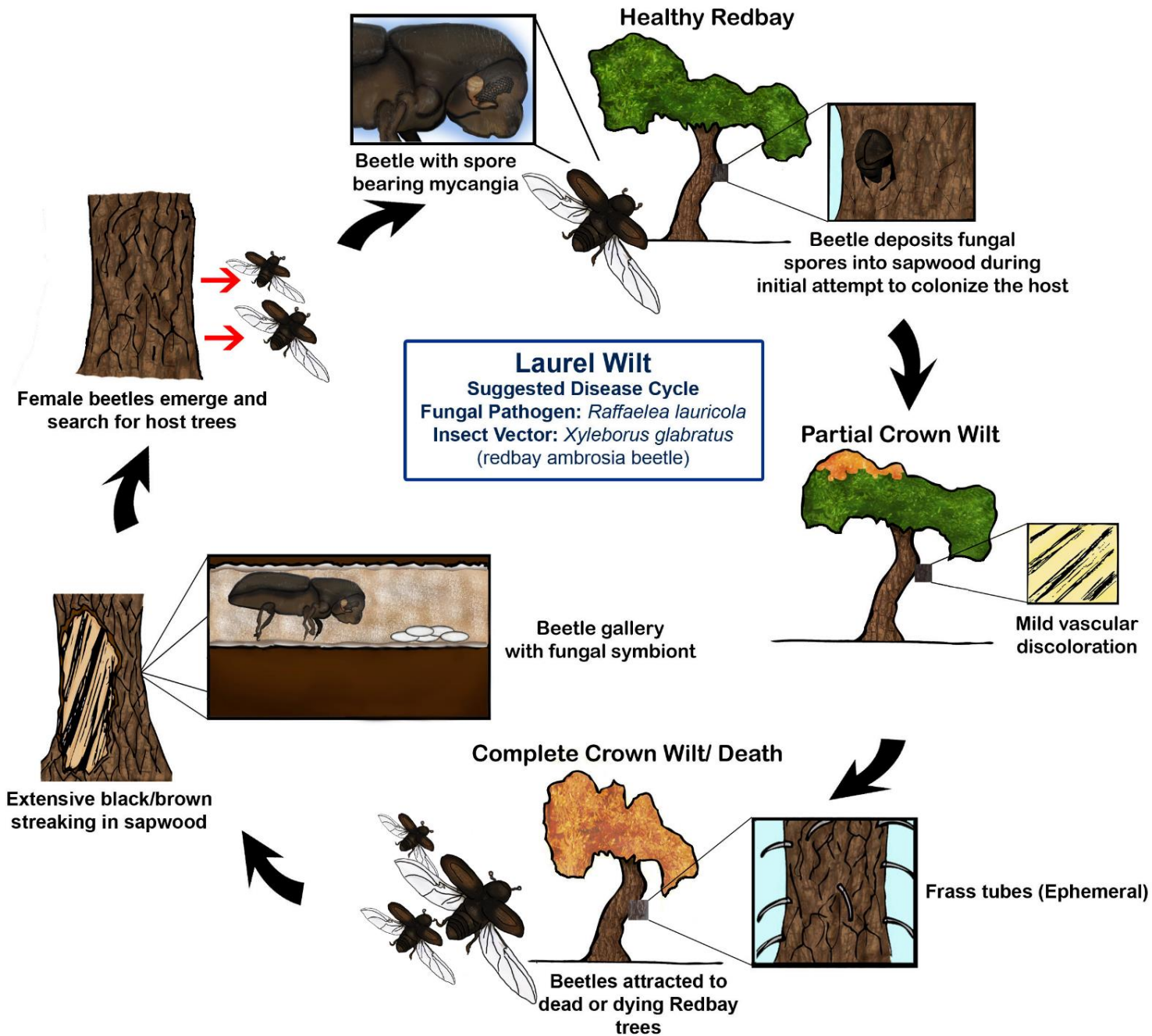


Redbay ambrosia beetle
Xyleborus glabratus
A “fungus farmer”



M.D. Ulyshen





Proposed Laurel Wilt Disease Cycle Model in redbay

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 plantdochughes@gmail.com amayfield02@fs.fed.us jeffreythomasart.com kelseyoy.com

¹University of Florida, School of Forest Resources and Conservation, Gainesville FL

²USDA Forest Service

Underground transmission



Sassafras grows clonally and the pathogen is suspected to travel from stem-to-stem through the roots



Lateral pathogen transfer to additional ambrosia beetles



Xyleborus glabratus



Xyleborus affinis



Xyleborus volvulus



Xyleborus ferrugineus



Xyleborinus gracilis



Xyleborinus saxeseni



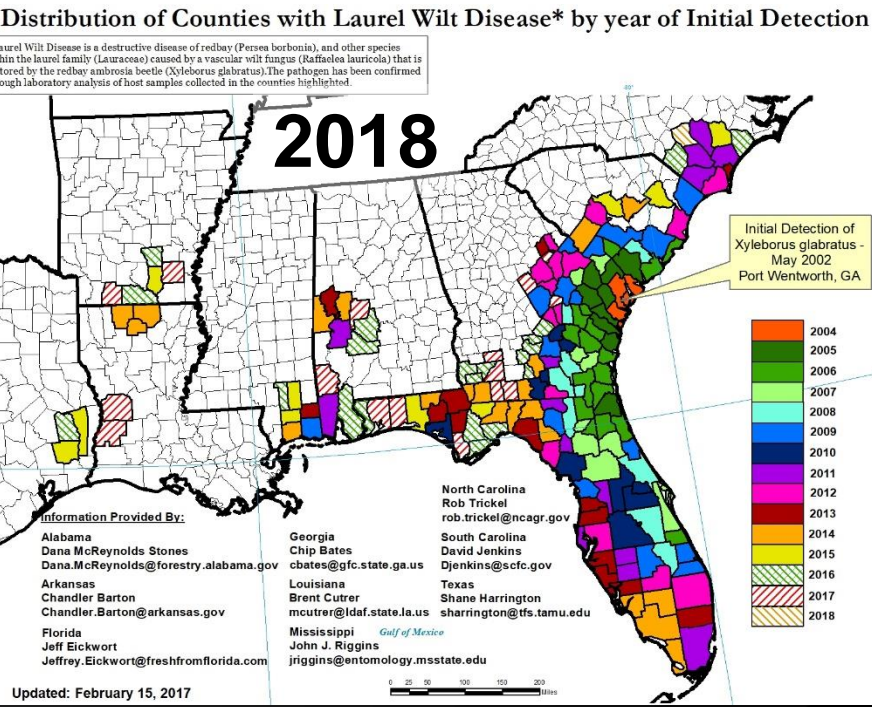
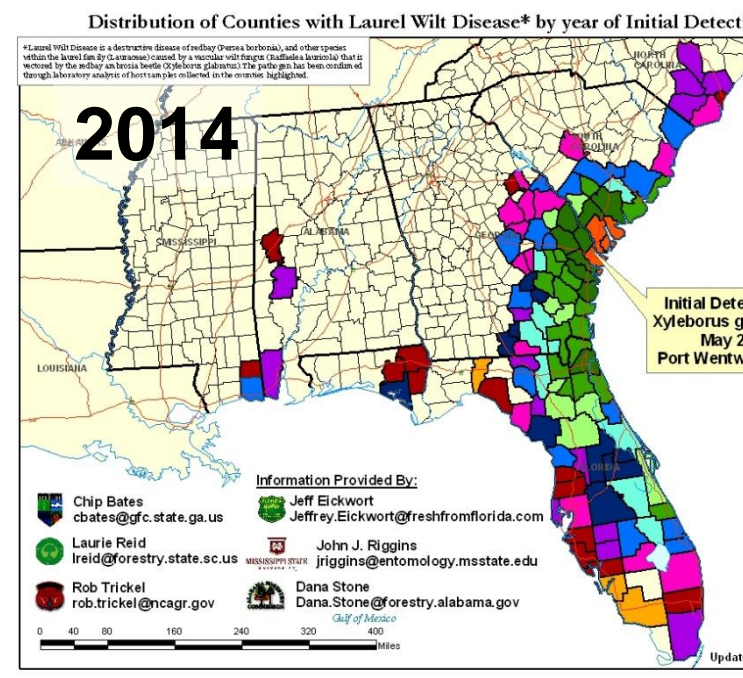
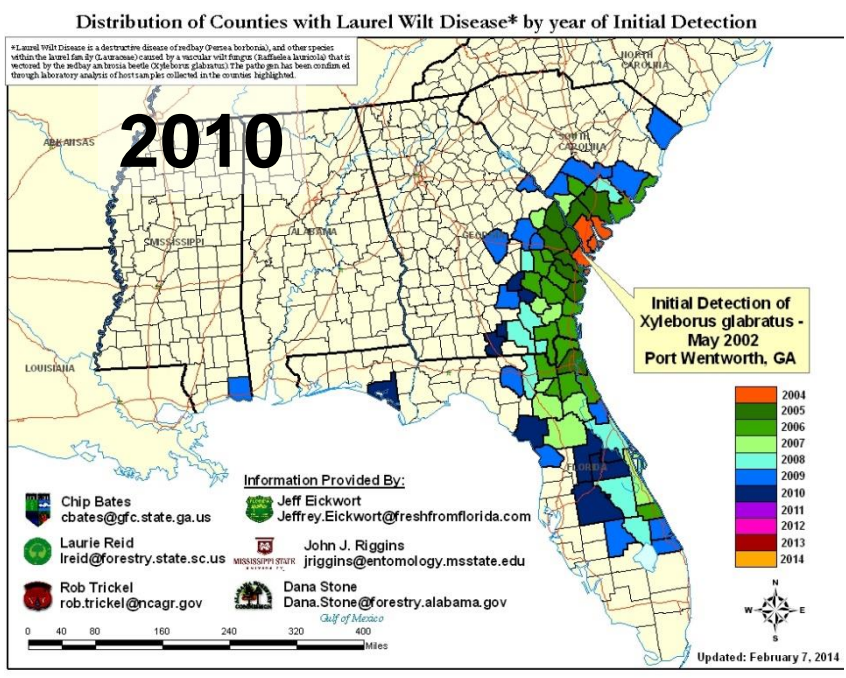
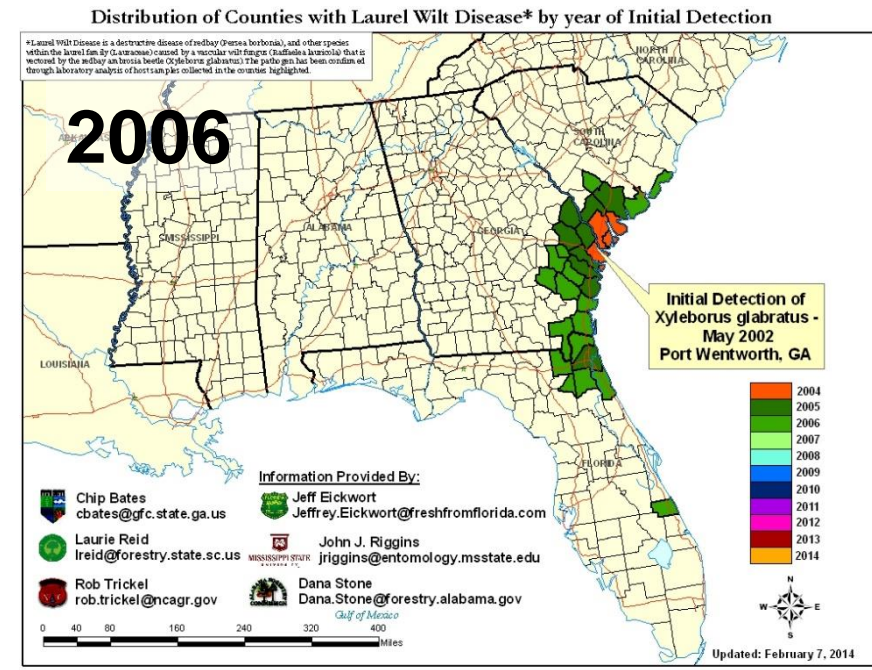
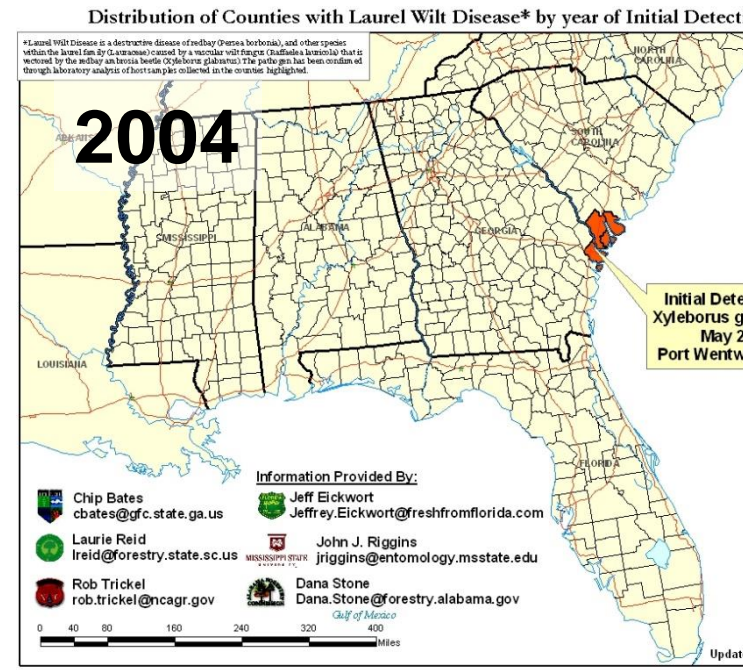
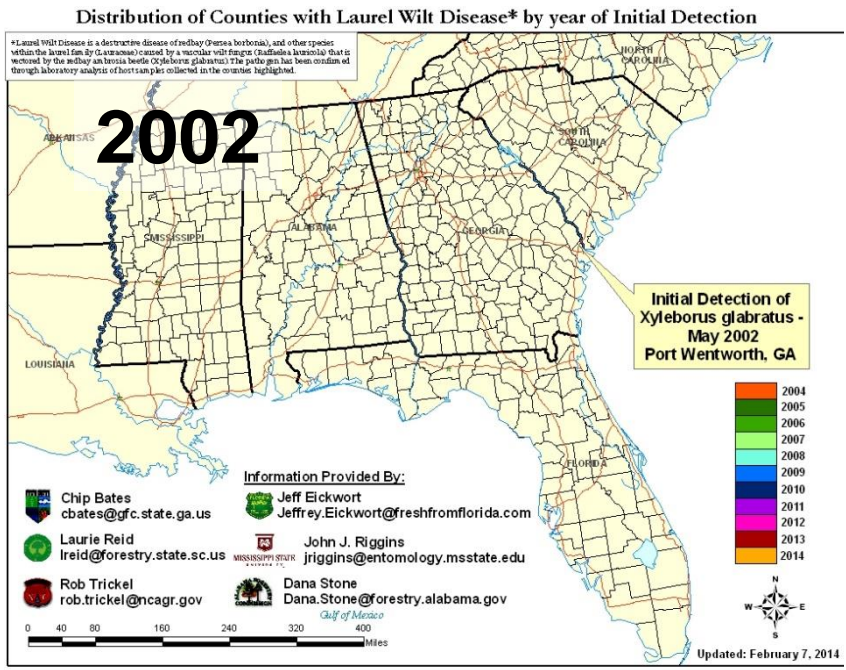
Xylosandrus crassiusculus

Lateral transfer of a phytopathogenic symbiont among native and exotic ambrosia beetle

Carrillo et al. (2014) Plant Pathology 63: 54-62

Six additional ambrosia beetle species that co-occur with *Xyleborus glabratus* in redaby, avocado may carry the LW pathogen. **Role in disease spread uncertain.**

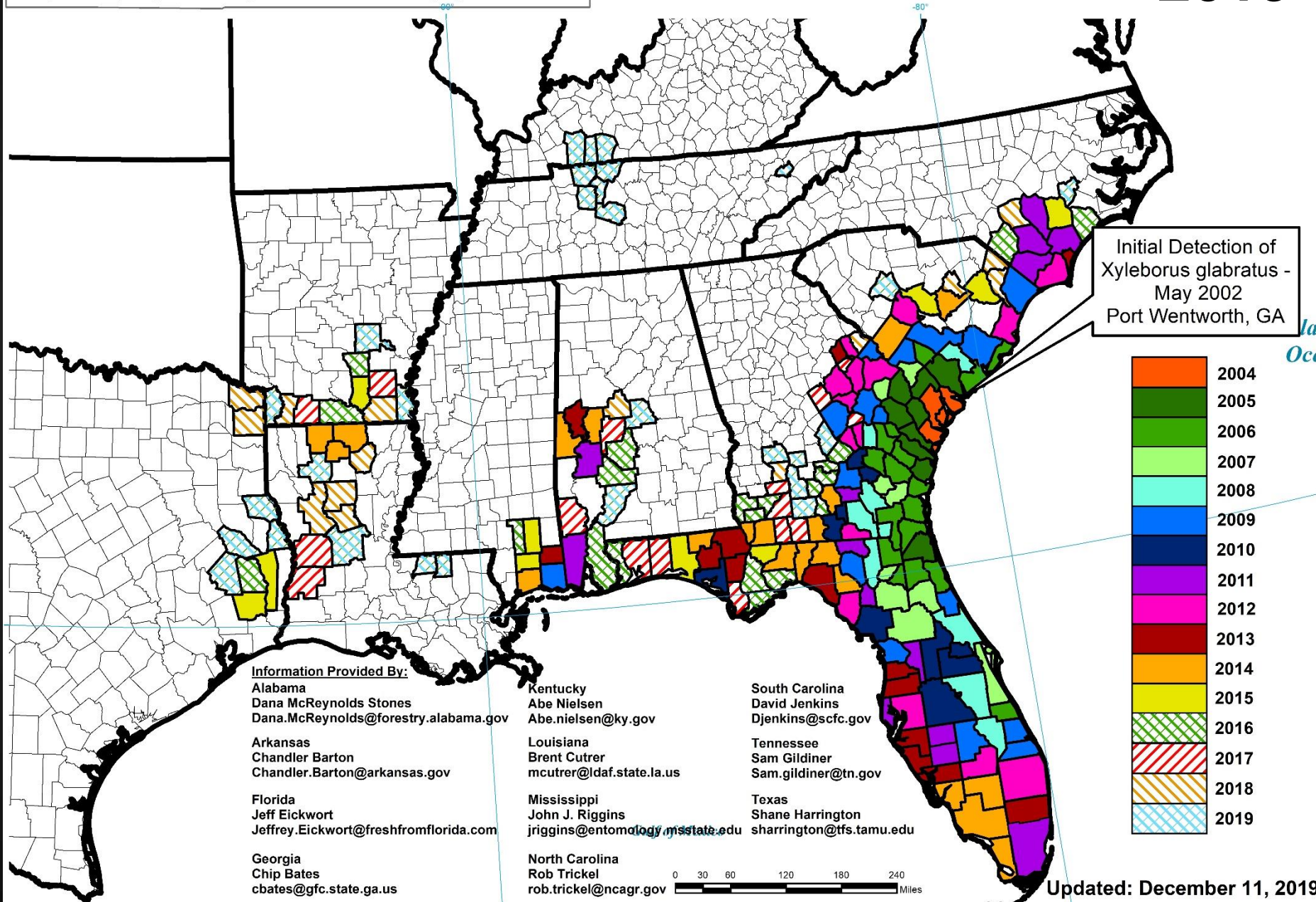
Laurel Wilt Distribution and Spread



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

* Laurel Wilt Disease is a destructive disease of redbay (*Persea borbonia*), 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.

2019



What host plants are affected by
Laurel Wilt?

TABLE 1
Forest tree species with laurel wilt due to natural infections,
with Koch's postulates completed.

Host^a	Reference
<i>Persea borbonia</i> (L.) Spreng. (Redbay)	Fraedrich et al. 2008
<i>Persea palustris</i> (Raf.) Sarg (Swamp bay)	Fraedrich et al. 2008
<i>Sassafras albidum</i> (Nutt.) Nees (Sassafras)	Fraedrich et al. 2008
<i>Persea americana</i> Mill. (Avocado) ^b	Mayfield et al. 2008a
<i>Litsea aestivalis</i> (L.) Fernald (Pondspice) ^c	Hughes et al. 2011
<i>Lindera melissifolia</i> (Walter) Blume (Pondberry) ^c	Fraedrich et al. 2011
<i>Persea humilis</i> Nash (Silk bay)	Hughes et al. 2012
<i>Laurus nobilis</i> (L.) (Bay laurel) ^b	Hughes et al. 2014
<i>Cinnamomum camphora</i> (L.) J. Presl (Camphortree) ^b	Fraedrich et al. 2015

^aPlant names derived from The PLANTS Database (<http://plants.usda.gov>) and The Plant List (2013), Version 1.1. (<http://www.theplantlist.org>).

^bNon-native, landscape or agricultural species.

^cIndicates threatened or endangered status (state or federally).

TABLE 2
Tree species displaying laurel wilt symptoms after artificial inoculation with *R. lauricola*, yet lacking documented cases of laurel wilt in the wild.

Host ^a	Reference
<i>Umbellularia californica</i> (Hook. & Arn.) Nutt. (California laurel)	Fraedrich 2008
<i>Lindera benzoin</i> (L.) Blume (Northern spicebush)	Fraedrich et al. 2008, 2016 [★]
<i>Licaria triandra</i> (Sw.) Kosterm. (Pepperleaf sweetwood) ^c	Ploetz and Konkol 2013
<i>Persea indica</i> (L.) Spreng. (Viñátigo [Spanish]) ^b	Hughes et al. 2013
<i>Nectandra coriacea</i> (Sw.) Griseb. (Lancewood)	Hughes & Ploetz, unpublished

^aPlant names derived from The PLANTS Database (<http://plants.usda.gov>) and The Plant List (2013), Version 1.1. (<http://www.theplantlist.org>).

^bNon-native, landscape or agricultural species.

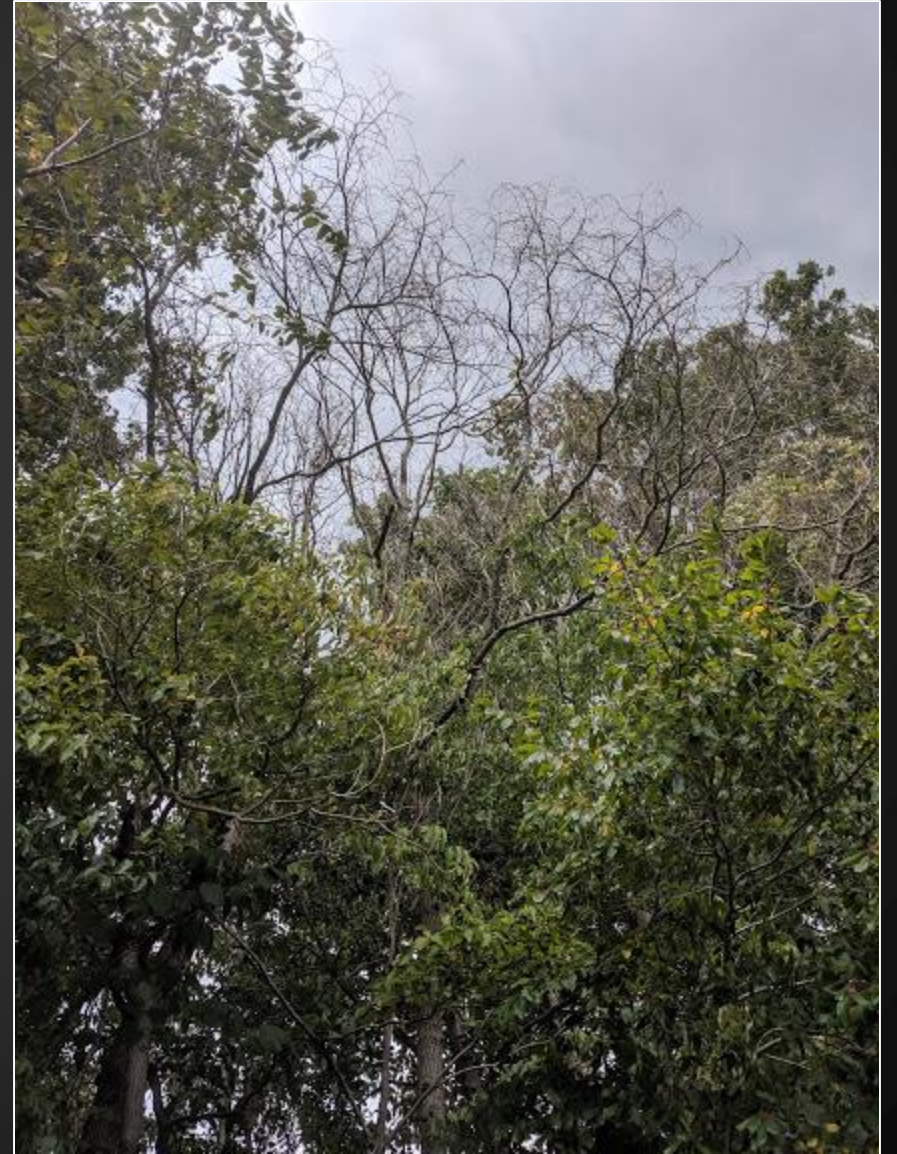
^cIndicates threatened or endangered status (state or federally).

What are the Symptoms of Laurel Wilt?

Wilted Foliage: Sassafras



Leaf drop fairly quick in sassafras



Wilted foliage retained longer in redbay



Stunted foliage in sassafras



Dark discoloration in the outer sapwood



Signs of Ambrosia Beetles

- Not diagnostic for laurel wilt.
- Created by RAB and other species
- Dust is ephemeral

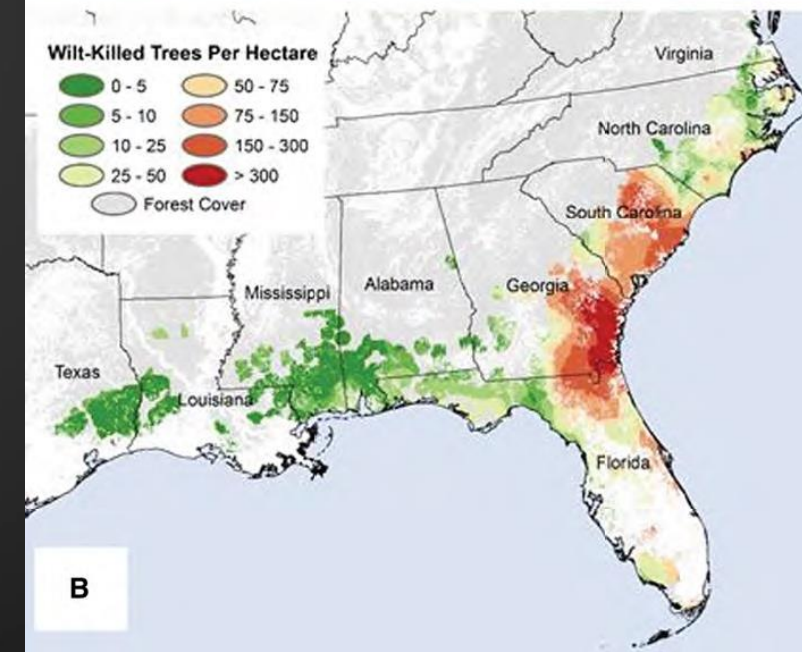
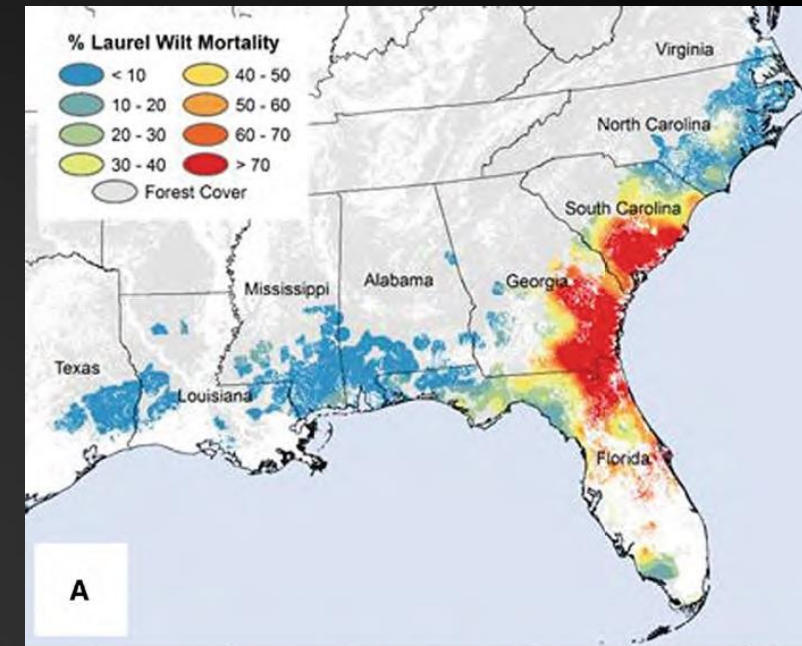


Impacts of Laurel Wilt

Redbay Mortality in the Coastal Plain

Over 300 million trees killed
(Hughes et al. 2017)

- Altered stand structure
- Coarse woody debris
- Hazard trees
- Threatens cultural uses



Laurel wilt in the Everglades

Persea palustris (swampbay)

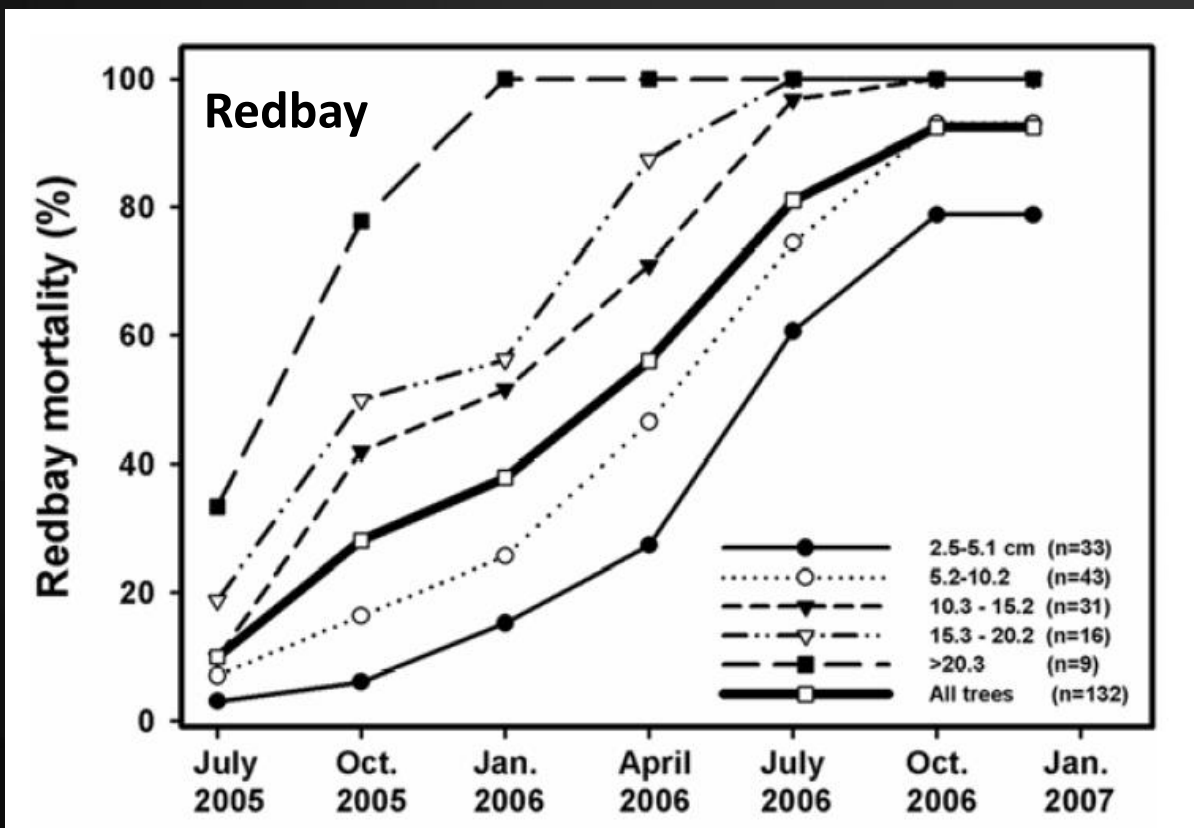
- Everglades are globally unique ecosystem
- Tree islands are critical to ecosystem function
- Laurel wilt killed up to 90% of tree canopies
- Invasion of disturbed areas likely

Photo: LeRoy Rodgers, see Rodgers et al. 2014

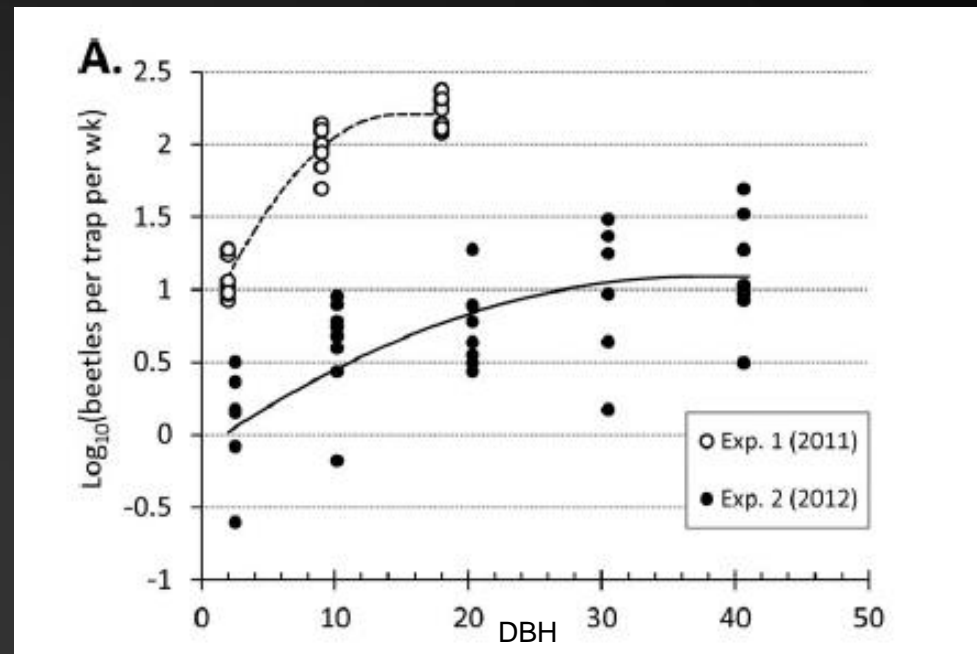
Laurel wilt mortality progression

Larger diameter trees:

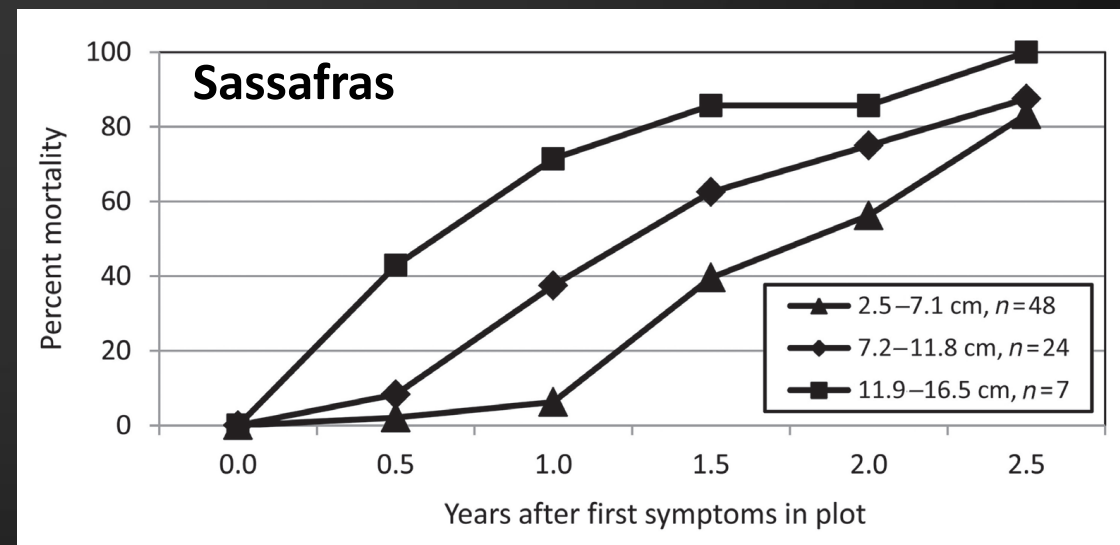
- more visually attractive to the beetle
- Die first and at higher rates



Fraedrich et al. 2008 Plant Disease 92:215



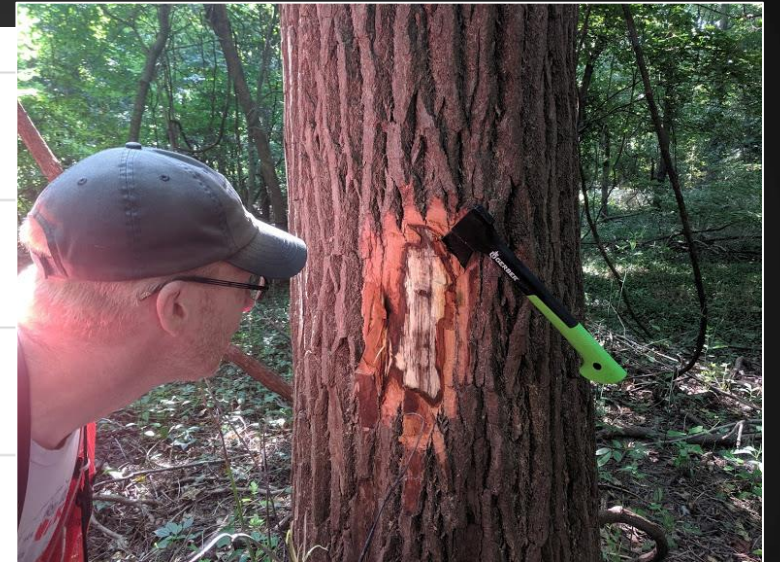
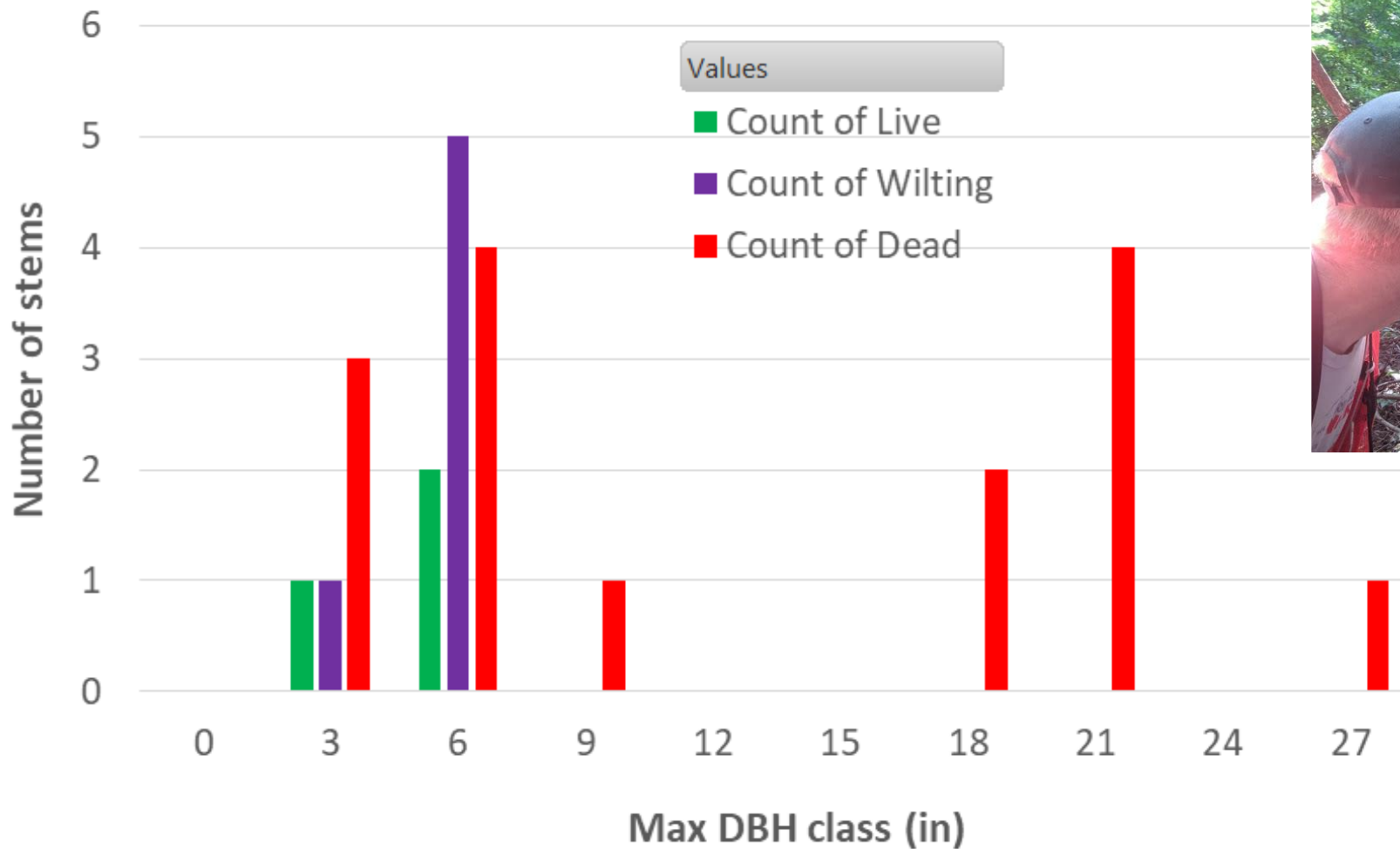
Mayfield and Brownie 2013 Env. Entomol. 42: 743



Cameron et al 2015 Southeastern Naturalist 14:650

Sassafras mortality at Oak Grove, Christian Co., KY

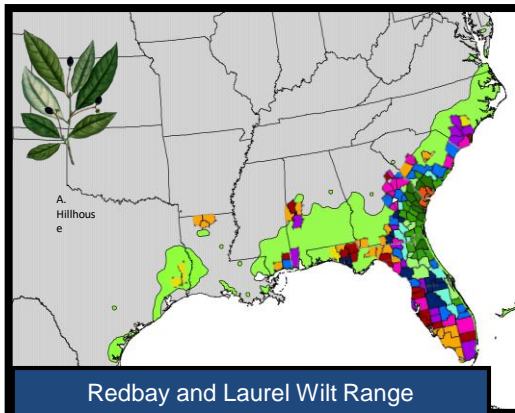
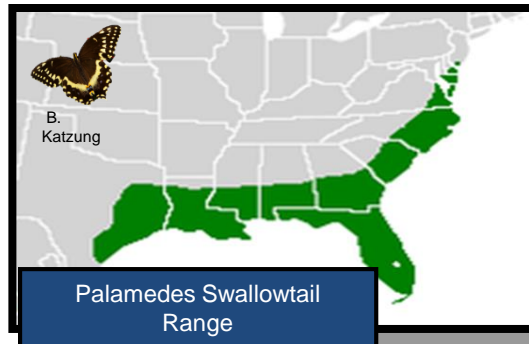
Snapshot of two, 0.2-ac plots on 8/23/2019



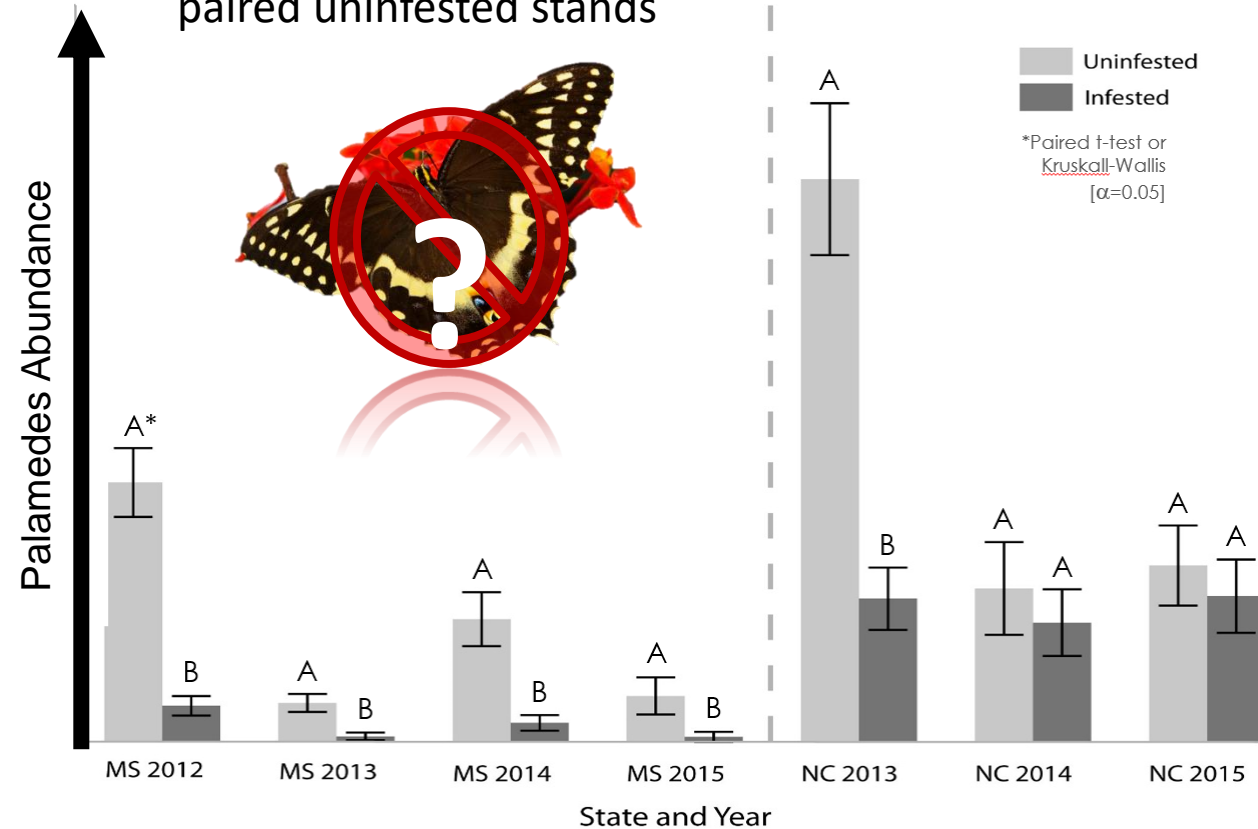
Examples of At-Risk Species: Palamedes swallowtail

Riggins et al. (2019)
Biol Invasions 21:493

■ “Pollard transects”



- 3-7 fold decrease in palamedes abundance versus paired uninfested stands



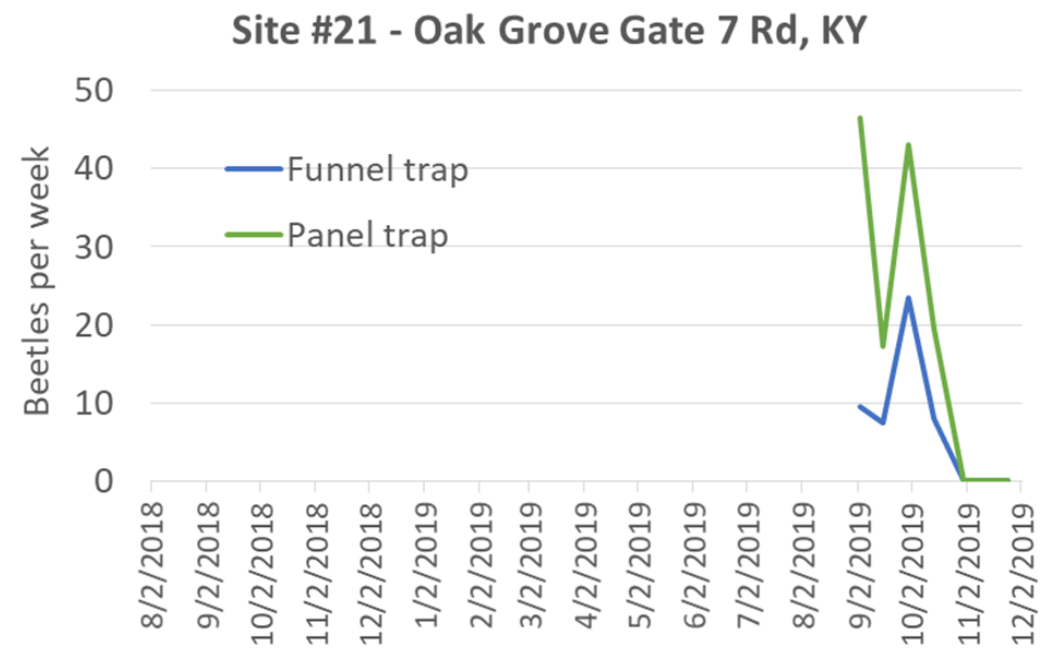
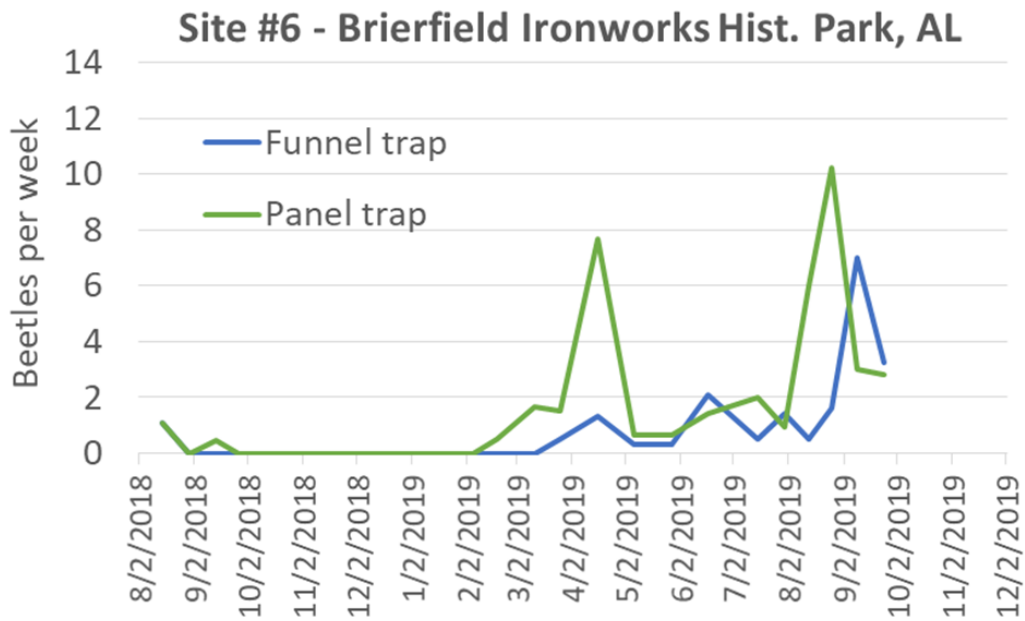
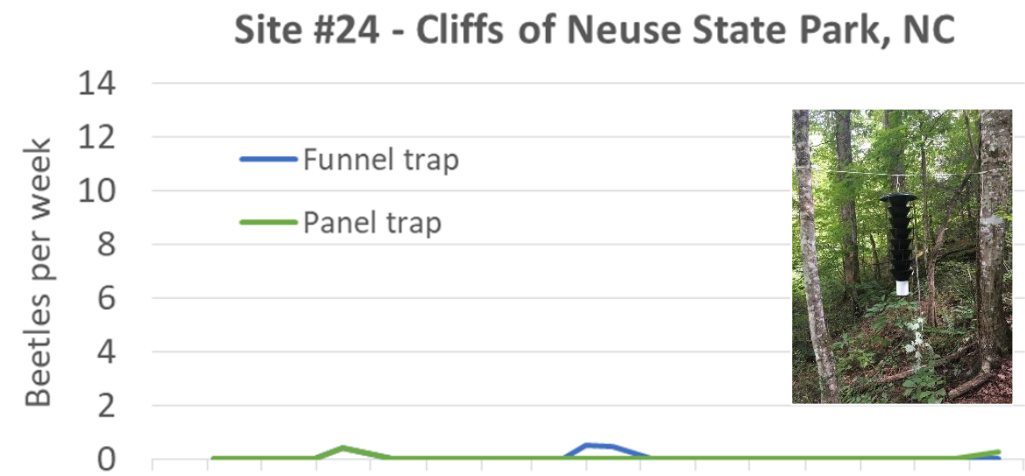
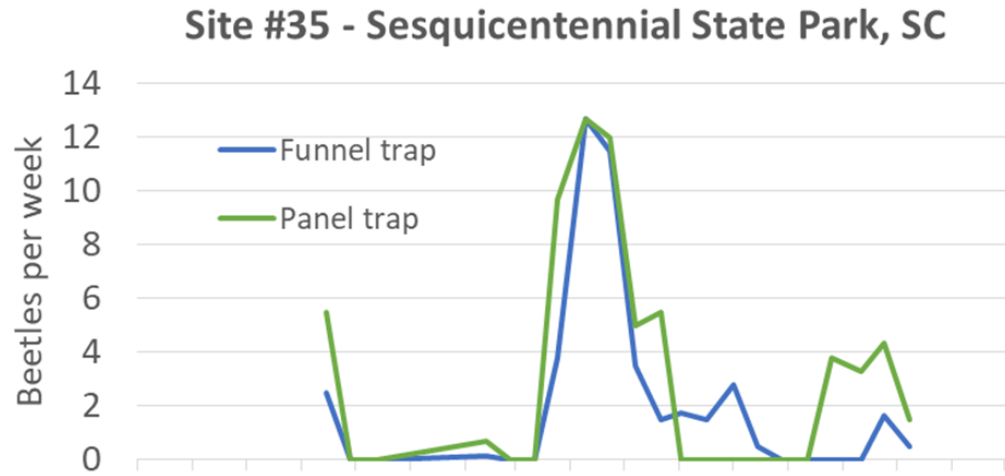
Monitoring for Laurel Wilt

RAB Flight Traps

- Funnel, panel, sticky
 - Mimic host silhouette
 - Bait with host volatiles
 - Commercial essential oil lures
 - Alpha-copaene is a primary attractant
 - Fresh bolts of host trees
 - Short-range attraction
- See Hanula et al (2016)
J. Econ. Entomol. 109: 1196
- No pheromone lures



Fig 4. *Xyleborus glabratus* trap catches at 4 selected sassafras monitoring sites.



Ambrosia beetle monitoring traps at Oak Grove, KY

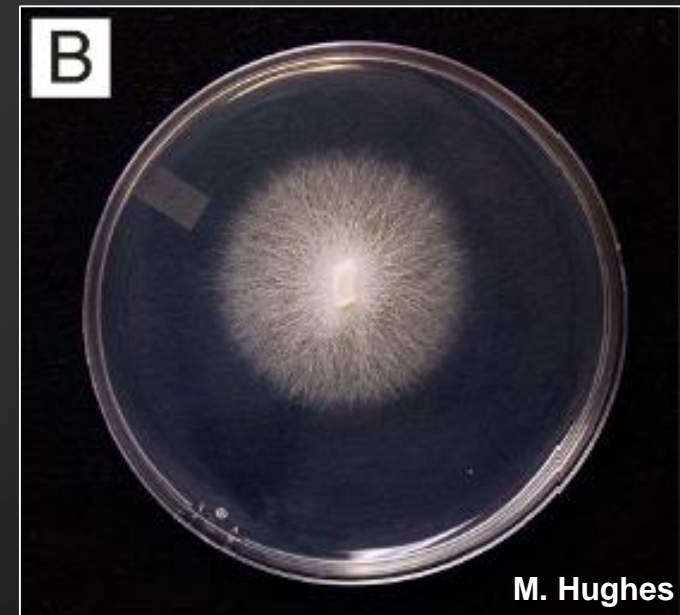
Aug 23-Oct 31, 2019 (2 months, 2 traps)

Ambrosia beetle species	Count	Percent
<i>Xylosandrus crassiusculus</i>	1050	55.6%
<i>Xyleborus glabratus</i>	322	17.0%
<i>Xyleborinus saxeseni</i>	298	15.8%
<i>Xylosandrus germanus</i>	109	5.8%
<i>Dryoxylon onoharaensis</i>	39	2.1%
<i>Euwallacea validus/interjectus</i>	9	0.5%
<i>Monarthrum mali</i>	6	0.3%
<i>Cnestus mutilatus</i>	5	0.3%
<i>Xyleborus affinis</i>	4	0.2%
<i>Monarthrum fasciatum</i>	3	0.2%
<i>Xyleborus ferrugineus</i>	2	0.1%
Unidentified	43	2.3%
Total	1890	100.0%



Laurel wilt pathogen confirmation

- Field collection of moist sapwood with xylem discoloration
- Isolate fungus on selective media
- Morphological ID (Harrington et al 2008 Mycotaxon 104:399)
- DNA extraction and PCR amplification (Dreaden et al 2014 Plant Dis 98:379)
- LAMP assay for DNA-based field confirmation (C. Villari, J. Hamilton, UGA)
- NPDN network has a protocol for diagnostic labs (Harmon et al 2014 NPDN)



Managing for Laurel Wilt

Challenges to regulation and management of redbay ambrosia beetle / laurel wilt

- New detections often = old infestations
- 1 female beetle = dead tree
- 1 female beetle = new population
- Females find geograph. isolated trees
- No evidence for pheromone
- Easily moved in wood
- Most of life cycle within tree
- Low economic value of forest hosts
- Hosts not completely eliminated, beetles remain after epidemics



Management Tactics

- Don't transport untreated firewood, esp. stems of lauraceous species
- Don't sell/transport wilted nursery stock of laurel family plants



Management Tactics

- Don't transport untreated firewood, esp. stems of lauraceous species
- Don't sell/transport wilted nursery stock of laurel family plants
- **Sanitation:** chipping trees may not kill all the beetles but could help reduce local populations, new infections

See Spence et al (2013) J. Econ. Entomol. 106:2093



Photos: Don Spence

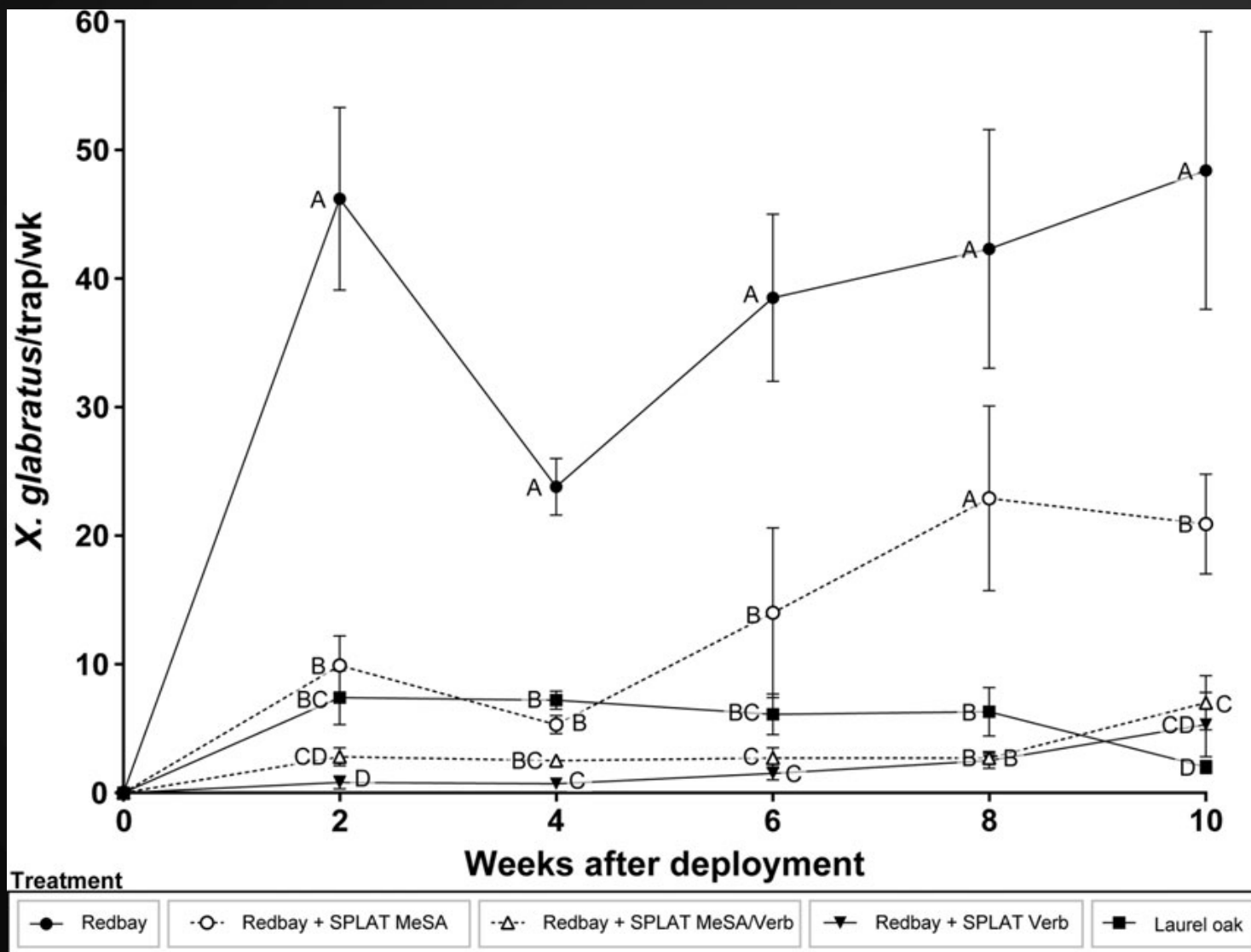
Management Tactics

- Don't transport untreated firewood, esp. stems of lauraceous species
- Don't sell/transport wilted nursery stock of laurel family plants
- **Sanitation:** may not kill all the beetles but could help reduce local populations, new infections
- **Fungicide infusion:** Has been demonstrated to protect redbay, trials in sassafras pending (Andrew Loyd- Bartlett Tree, Rabiun Olatinwo - SRS)



Evaluation of repellents for the redbay ambrosia beetle, *Xyleborus glabratus*, vector of the laurel wilt pathogen

M. A. Hughes^{1,a}, X. Martini^{2,3,a}, E. Kuhns^{2,*}, J. Colee⁴, A. Mafra-Neto⁵, L. L. Stelinski² & J. A. Smith^{1l}



Compound verbenone, applied using SPLAT, repels RAB

Reduces RAB landing rates on trees

Martini et al (2019) Ag. For. Entomol. 22: 83

Marc Hughes
dissertation on
redbay resistance
at UF with
Jason Smith



Tyler Dreaden:
Lingering sassafras
project STDP
proposal for similar
approach



Photos:
Marc Hughes

Closing Points

- Laurel wilt is a vascular wilt disease that has killed hundreds of millions of trees (Laurel family) in the SE Coastal Plain
- It is moving into more upland regions of the eastern US causing sassafras mortality, and is likely to continue spreading, including through wood movement.
- Management options are limited and the potential for negative impacts on Lauraceae in the Americas and beyond is high.

THANKS!

Bud Mayfield

USDA Forest Service SRS

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Raffaelea lauricola
- Littleleaf Disease



Ronald Billings, Texas Forest Service, Bugwood.org

Laurel Wilt

Raffaelea lauricola

Laurel wilt is caused by *Raffaelea lauricola*, a fungal pathogen transmitted by the ambrosia beetle *Xyleborus glabratus*. This beetle and fungus are native to southern Asia, and the beetle was first detected in Georgia in 2002. This disease impacts several trees in the family Lauraceae, including redbay, sassafras, pondspice, bay laurel, and avocado. Extensive mortality to redbay has occurred in coastal areas from North Carolina to Mississippi, with detections also occurring inland in Alabama, Louisiana, and Arkansas.

Infected trees generally die within months, often showing a full crown of dead, brown leaves. There is no cure once a tree has this disease. Preventing the spread of this disease by transporting firewood is of the

USDA Southern Regional Extension Forestry

Southern Forest Health website is sponsored by the USDA Forest Service and Southern Regional Extension Forestry. Copyright © 2015 Southern Regional Extension Forestry

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Pest Alert

United States
Department of Agriculture
Forest Service
Southern Region
State and Private Forestry
RS-PR-01-19
October 2019

Laurel Wilt

Laurel wilt is a disease of woody plants in the laurel family (Lauraceae). Hundreds of millions of redbay (*Persea borbonia*) trees have been killed by laurel wilt in the southeastern Atlantic Coastal Plain region of the United States (US). The disease has also killed large numbers of sassafras (*Sassafras albidum*) trees in forests and landscapes, and avocado (*Persea americana*) trees in commercial production. As of October 2019, laurel wilt was known to occur from Texas to North Carolina, south through Florida and north to Kentucky. Laurel wilt is expected to continue spreading through sassafras in the eastern US, and is a potential threat to California bay laurel (*Umbellularia californica*) in the western US and to Lauraceae species elsewhere in the world.

Laurel wilt is caused by a fungus (*Raffaelea lauricola*) that is carried by an insect, the redbay ambrosia beetle (*Xyleborus glabratus*). These organisms are native to Asia, are invasive pests in North America, and can be easily transported to new areas by movement of infested wood products and firewood.

Symptoms

In early stages of laurel wilt, trees exhibit drooping, discolored leaves (Fig. 1A). In deciduous hosts like sassafras, leaves soon fall from the tree leaving branches bare (Fig. 1B). In contrast, evergreen hosts like redbay will retain reddish or brownish leaves for many months. Diseased trees typically exhibit a dark discoloration in the outer sapwood that runs with the direction of the grain (Fig. 1C). In sassafras, some trees may produce sparse, stunted leaves in the spring following the initial year of infection (Fig. 2).

Redbay ambrosia beetles (Fig. 3) are extremely small (~2 mm long), spend most of their life cycle inside the tree, and are not easily seen in the field. Entrance holes (<1 mm diameter) may be seen on smooth bark or on the wood surface when bark is removed. Many ambrosia beetle species produce fine, light-colored sawdust that may be seen at the bark surface, but neither sawdust nor beetle holes are signs specific to laurel wilt.

Disease Process

Spores of the laurel wilt fungus are carried in the mouthparts of the redbay ambrosia beetle. Host trees typically become infected when a female beetle lands on a stem or branch and bores into the wood. The fungal spores enter the water-conducting cells and spread through trees, causing a reaction that restricts water flow. Trees can die within a few weeks or months after infection. The redbay ambrosia beetle will attack



Fig. 1. Laurel wilt symptoms in sassafras. A) Drooping leaves in the early stages of the disease. B) Diseased trees that have recently dropped their leaves. C) Bark removed to show dark discoloration on the surface of the sapwood.