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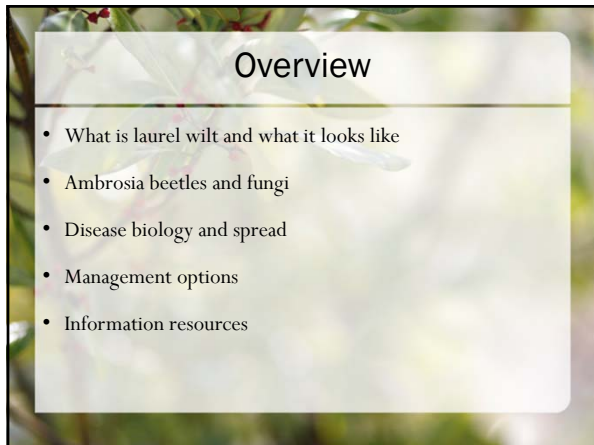
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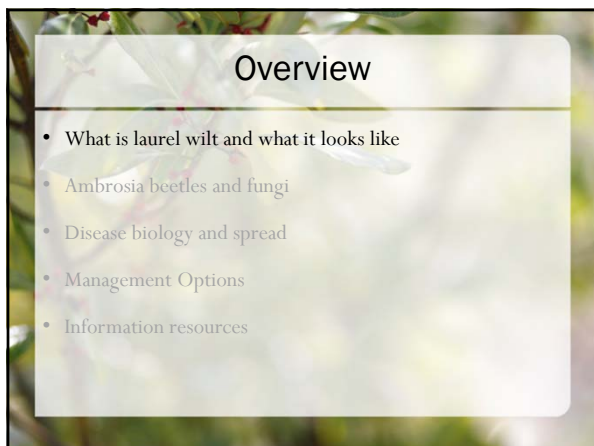
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### Laurel wilt is.....

- ...an introduced **tree disease** that kills redbay and other members of the laurel family (*Lauraceae*)
- ...transmitted by an tiny exotic beetle (**redbay ambrosia beetle or RAB**)
- that beetle carries a **fungal pathogen**
- led to the death of **millions of trees**

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### Impacts

Mortality Rates

- **98%** (2004-2009) on St. Catherines Island (Evans et al. 2013)
- **90%** (over 3 cm DBH) in GA (Spiegel and Lege 2013)
- **90%** on Ft. George Island, FL (Fraedrich et al. 2008)
- **100%** of overstory layer in Etoniah Creek, FL (Shields et al. 2011)
- Mortality in avocado groves

Ecological Impacts

- Changes in forest composition
- Loss of seed producing trees
- Expansion into new ranges via sassafras?
- Palamedes swallowtail (*Papilio palamedes*)?
- California laurel / avocado?
- Tribal cultures and medicine

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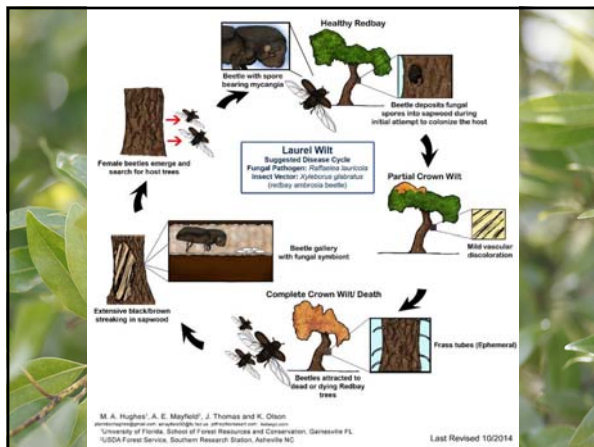
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### General Main Symptoms

Tree canopy

- Transition from green to brown foliage
- Wilt
- Keep wilted leaves or drop them

Wood

- Accumulated boring dust
- Black/brown streaks
- Small circular holes (all ambrosia beetles)
- Redbay ambrosia beetle

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### Foliar Symptoms

Green to olive drab to crispy brown

- Purplish mid-vein



Photos: Chip Bates, Georgia Forestry Commission

• Drooping foliage

Photos: Marc Hughes, University of Florida

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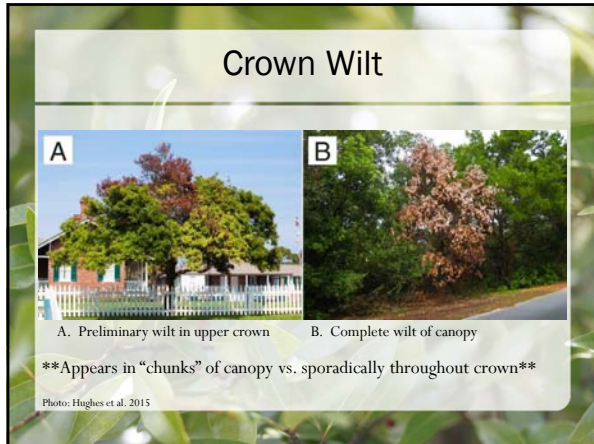
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### Black Twig Borer (BTB) Damage

- BTB damage often misdiagnosed as laurel wilt
- Infects single twigs
- Localized damage
- Hole in stem
- Trees can have both laurel wilt and BTB damage

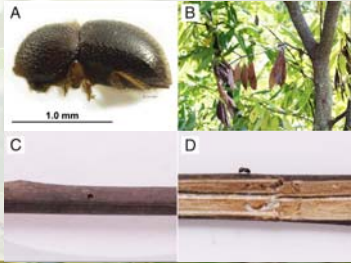


Photo: Hughes et al. 2015

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### Finally, Decay and Stem Snap



- Various decay fungi readily colonize dead trees
- Conks and mushrooms are NOT the laurel wilt fungus

Photo: Hughes et al. 2015

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### Stained Wood

Infected Tree	Healthy Tree
	

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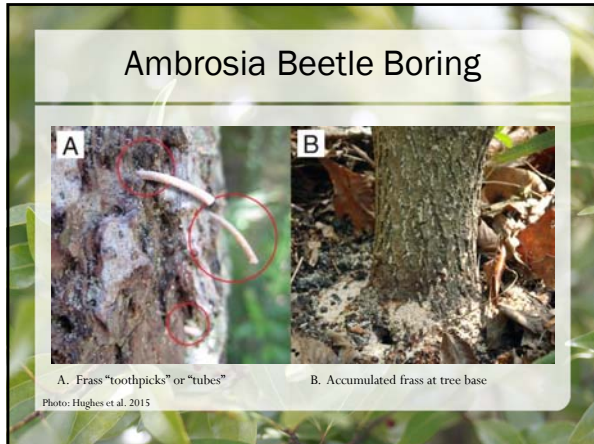
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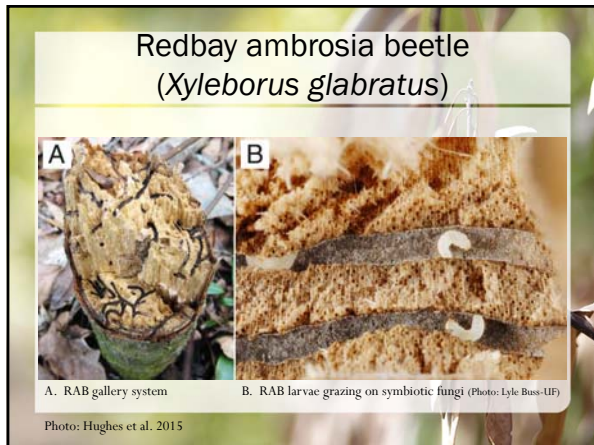
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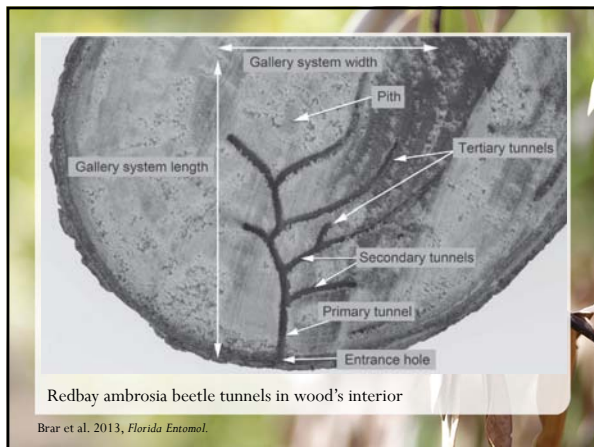
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### Overview

- What is laurel wilt and what it looks like
- Ambrosia beetles and fungi
- Disease biology and spread
- Management Options
- Information resources

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### What is an ambrosia beetle?

- Tiny wood-boring beetles
- Dependent on fungal partner(s)
- Live and excavate tunnels in wood (gallery)
- Thousands of species
- Most look very similar
- Most colonize weak and dying trees




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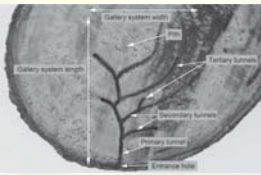
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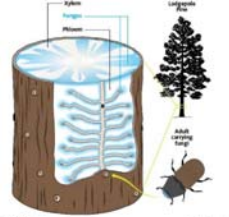
### What type of Beetle?

#### Ambrosia Beetle



- Galleries made within wood (horizontal)
- Feed on fungus living in tunnels
- Ex. Redbay ambrosia beetle

#### Bark Beetle



- Galleries made under bark (vertical)
- Feed on living tissue under bark
- Ex. Southern pine beetle

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### Helpful or Harmful?

<b>Native ambrosia beetles</b> <ul style="list-style-type: none"><li>• Attack weak and dying trees</li><li>• Generalists<ul style="list-style-type: none"><li>- Can attack many species</li></ul></li><li>• Carry native fungi</li><li>• Not killers of healthy trees</li><li>• In balance with ecosystem<ul style="list-style-type: none"><li>- Beneficial to forest nutrient cycle</li></ul></li><li>• Common</li></ul>	<b>Exotic ambrosia beetles</b> <ul style="list-style-type: none"><li>• Can attack healthy trees</li><li>• Specific hosts (or generalist)<ul style="list-style-type: none"><li>- Many target a few host trees</li></ul></li><li>• Carry exotic fungi<ul style="list-style-type: none"><li>- Pathogens</li></ul></li><li>• Tree killers</li><li>• Disruptive and damaging to ecosystems</li><li>• Rare</li></ul>
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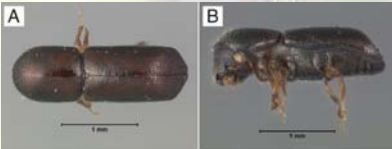
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### Redbay ambrosia beetle (*Xyleborus glabratus*)

A-B = female

- mycangia
- flight
- epidemic driver
- abundant



Photos: Lyle Buss - University of Florida




Photo: Florida Division of Plant Industry

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1.0 mm

Photos: Lyle Buss and Giuseppe Brati - University of Florida

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## What attracts the redbay ambrosia beetle?



Odors

- Wood odors
  - Wounded or exposed wood is especially attractive
- Leaf odors
- Aromatic chemicals common to Lauraceae
- Laurel wilt fungus

Visuals

- Stem silhouette
- Largest trees most attractive (odor + visual)

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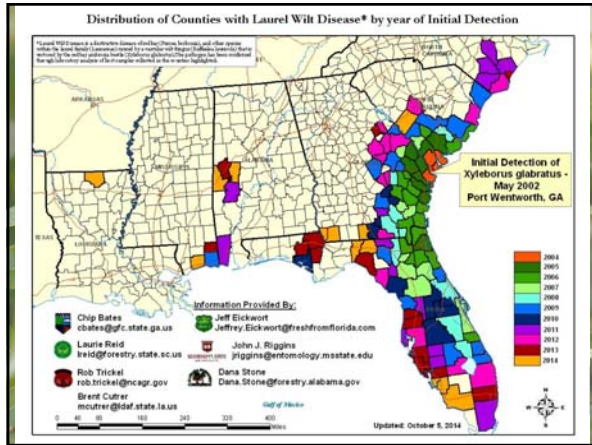
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## Disease Spread

**Methods of movement**

- Natural beetle movement
  - Contiguous
  - 55 km/year
  - Long distance flight possible
- Infested wood and forest products
  - Human-assisted
  - Jumps
  - Difficult to predict

Redbay




Photo: US Forest Service

Sassafras




Photo: US Forest Service

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## Hosts = Laurel Family

- Redbay (*Persea borbonia*)
- Swamp bay (*P. palustris*)      All commonly called "redbay"
- Silk bay (*P. humilis*)
- Avocado (*P. americana*)
- *Persea indica*\*
- Camphortree (*Camphora cinnamomum*)
- Sassafras (*Sassafras albidum*)      Oaks, Pines, Magnolias are NOT HOSTS
- California laurel (*Umbellularia californica*)\*
- Bay laurel (*Laurus nobilis*)
- Pondspice (*Litsea aestivalis*)<sup>T</sup>
- Pondberry (*Lindera melissifolia*)<sup>T</sup>
- Northern spicebush (*Lindera benzoin*)\*
- Gulf Licaria (*Licaria triandra*)\*<sup>T</sup>

\* = artificial inoculation experiments  
T = threatened or endangered

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## Redbays (redbay, swamp bay & silk bay)

### Why 3 different species?

- Slight anatomical differences
- Slightly different habitats
- Symptoms the same across all 3 bays



Photos: Hughes et al. 2012, Steve Hogg

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## Camphortree (*Cinnamomum camphora*)



Xishan Moon Bay: 1200 years old Camphor tree

- Introduced Asian tree
- Common to urban landscape

Wilded Camphortree photo: Chip Batts, Georgia Forestry Commission, B. Campbell

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### Camphortree (*Cinnamomum camphora*)

- More resistant to laurel wilt
  - Co-evolved host?
- Branch dieback
- Extensive attack increases symptoms
- Squirrels chewing on bark can lead to same dieback



Photos: Chip Bates, Georgia Forestry Commission, Bugwood.org

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### Sassafras (*Sassafras albidum*)

- Medium sized shrubby tree
- Deciduous
- Often share a common root system
  - Underground transmission
- Other main host of concern
  - Huge geographic range



Photos: (top) Marc Hughes, (bottom) Larry Kolfschik, University of Florida

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### Sassafras (*Sassafras albidum*)



Photos: R. Scott Cameron, Georgia Forestry Commission

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### Sassafras (*Sassafras albidum*)



Photos: R. Scott Cameron and Chip Bates, Georgia Forestry Commission

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May 2009



Photos: R. Scott Cameron, Georgia Forestry Commission

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August 2009



Photos: R. Scott Cameron, Georgia Forestry Commission

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### Bay Laurel (*Laurus nobilis*)

- Bay leaf spice
- Ornamental tree/shrub

Photo: iFA.org

Photo: Hughes et al. 2014

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### Pondspice (*Litsea aestivalis*)

- Highly rare shrub (often multi-stem)
- Deciduous (drops leaves in winter)

Photo: James Johnson, Georgia Forestry Commission, Bugwood.org

Photo: Hughes et al. 2011.

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### Overview

- What is laurel wilt and what it looks like
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### Physical Tree Protection

**Beetles prefer to bore into lower trunk**

- Screen barriers around trunk
  - Beetle will attack higher locations
  - Beetles bore through screens
- **Not a suggested management option**



Maner et al. 2013

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### Sanitation

- Effective way to lower beetle populations
- However, unlikely to completely eradicate disease from an area

Goals

- Physically destroy beetles and their habitat
- Promote wood drying
- Promote helpful fungi outcompete pathogen
- Stop emerging beetles

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## Wood Chipping Study

<p><b>Un-Chipped Wood</b></p> <ul style="list-style-type: none"> <li>• Over 1,000 RAB emerged (over 10 months)</li> <li>• Pathogen persisted: 3-15 mo.</li> </ul>	<p><b>Chipped wood</b></p> <ul style="list-style-type: none"> <li>• 10 RAB beetles (over 10 months)</li> <li>• Cover chip piles: 0 RAB</li> <li>• Pathogen persisted: 2 days</li> </ul>
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Spence et. al 2013

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## Sanitation Recommendations

- Cut down tree and leave onsite
- Cut and chop (increase drying & fungal competition)
- Cut and chop and cover
- Cut and chip
- Cut and chip and cover (**BEST**)
- Municipal Dumps (if county already has laurel wilt)

Main point

- Destroy wood as much as possible
- Do not move wood around to new areas

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## Dontmovefirewood.org

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### Chemical Methods

**Fungicides**

- Alamo™ (propiconazole)
- Macro-infusion process
- Lasts around 12-18 months
- Requires professional help



**Insecticides:** not effective

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### Chemical Methods

- Standard **fungicides** will not work
- Sprays and soil drenches will not work
- Macro-infusion with propiconazole is only viable method tested for LW
- Refer to extension agents for best advice



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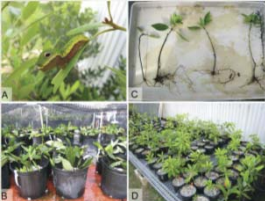
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### Host Resistance

- Propagation of redbay survivors from severely affected sites
- Screen for resistance to LW pathogen
- Tolerance redbays in development



Hughes and Smith 2014, Native Plants Journal

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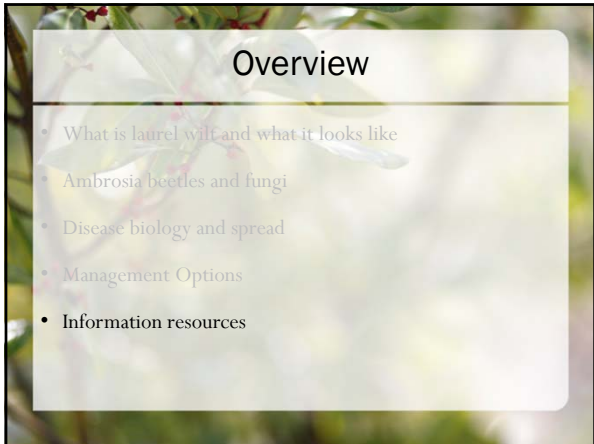
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### Overview

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### Information resources

- Local forestry agency website
  - (Florida forest service, Georgia forestry commission, etc)
- Country Extension Agent (via university system)
- Southern Regional Extension Forestry webpage
  - Laurel wilt fact sheet on the way
- Laurel wilt recovery plan on redbay and other forest species
  - In *Plant Health Progress* online journal (free)
  - "Infrastructure and experts" section has regional contacts
- Laurelwiltresearch.com
- University of Florida EDIS database

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### Thank you for your time

For further questions about this presentation contact:  
Marc Hughes  
[mhughes741@ufl.edu](mailto:mhughes741@ufl.edu)

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