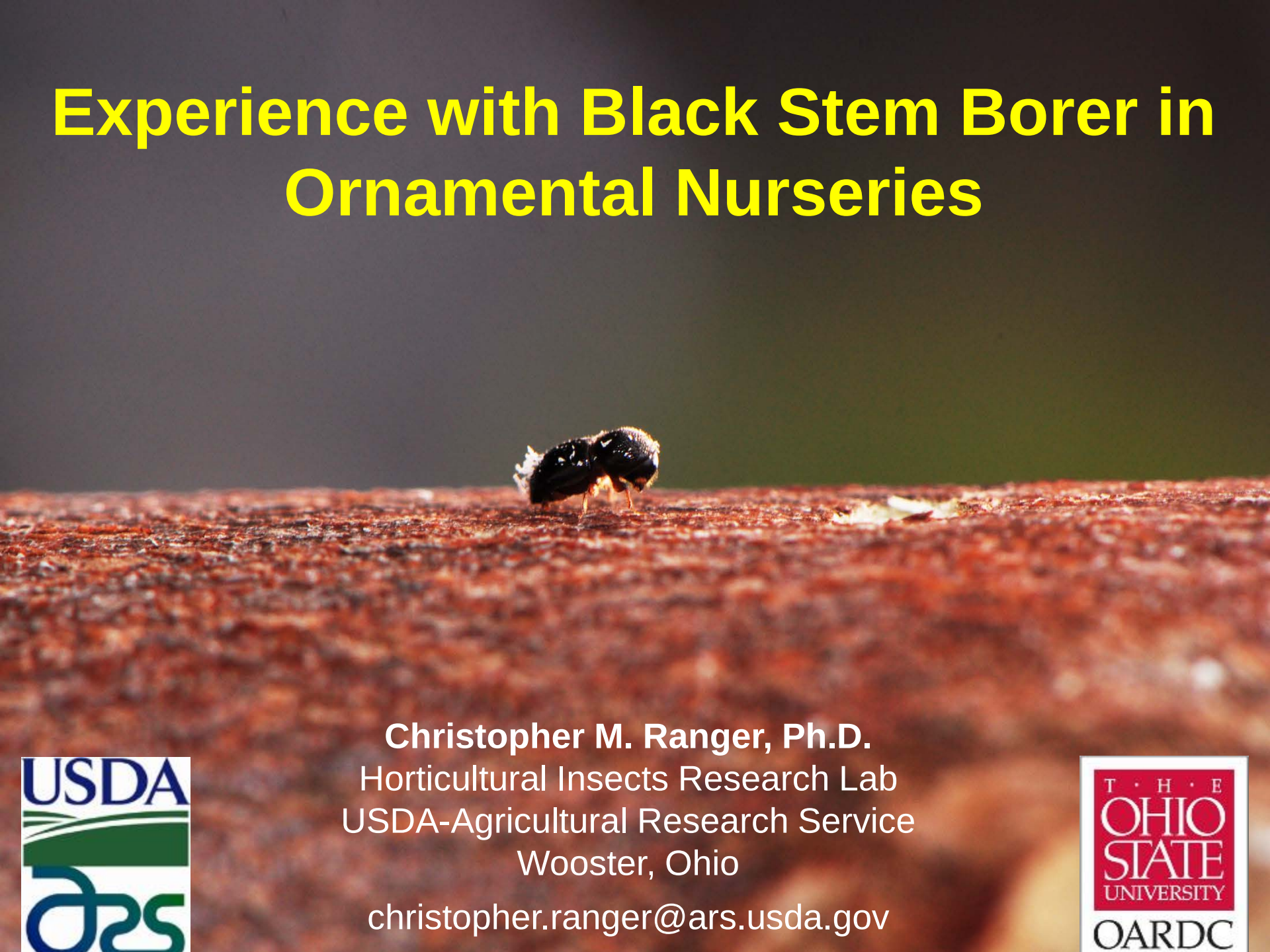
Experience with Black Stem Borer in Ornamental Nurseries



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Ambrosia Beetles

~3,200 species world-wide

>20 non-native ambrosia beetles in the tribe Xyleborini present in N. America

Among the most frequently intercepted groups of insects at U.S. ports-of-entry

Ornamental nurseries, orchards, landscapes, and forests

Frequently asked questions

(1) What species of ambrosia beetles are problematic?

(2) What is their biology and life history?

(3) What trees do they attack?

(4) How do I monitor for them?

(5) What insecticides are effective?

Black Stem Borer
Xylosandrus germanus

- Native to SE Asia
- First reported from NY in 1932

- Northeastern, Midwestern, Southern, and Northwestern US
- Widely established in Europe

- Males are flightless
- Haplodiploid: males from unfertilized eggs
- Inbreeding

Granulate Ambrosia Beetle
Xylosandrus crassiusculus

- Native to SE Asia

- First reported from SC in 1974

- Northeastern, Midwestern, Southern, Northwestern US, and Hawaii

Fruit Tree Pinhole Borer
Xyleborinus saxesenii

- Native to SE Asia

- Among the first non-native scolytids introduced into North America

- Wide spread in N. America

- Most abundant species in S.C. orchards (Kovach, 1986)

Frequently asked questions

(1) What species of ambrosia beetles are problematic?

(2) What is their biology and life history?

(3) What trees do they attack?

(4) How do I monitor for them?

(5) What insecticides are effective?

Wood-Boring Behavior

~1 mm diameter

X. germanus

Tunneling behavior makes detection difficult

Signs of an Infestation: Frass Toothpicks

Cornus florida

Magnolia virginiana

Signs of an Infestation: Sap Production

Cornus florida

Styrax japonica

Styrax japonica

Attacks Are Not Always Obvious

Tunneling and Gallery Formation

Ambrosia Beetle Fungal Symbionts

- *Ambrosiella* species

- *Raffaelea* species
- *Fusarium* species
- Bacteria

Basis for Wilting and Die-Back

- Symbiotic fungus?
- Secondary pathogens?
- Hypersensitive host responses?
- Movement of pathogens?

Xylosandrus germanus Life History

Adults overwintering in galleries

Eggs → Adults

Eggs → Adults

Adults overwintering in galleries

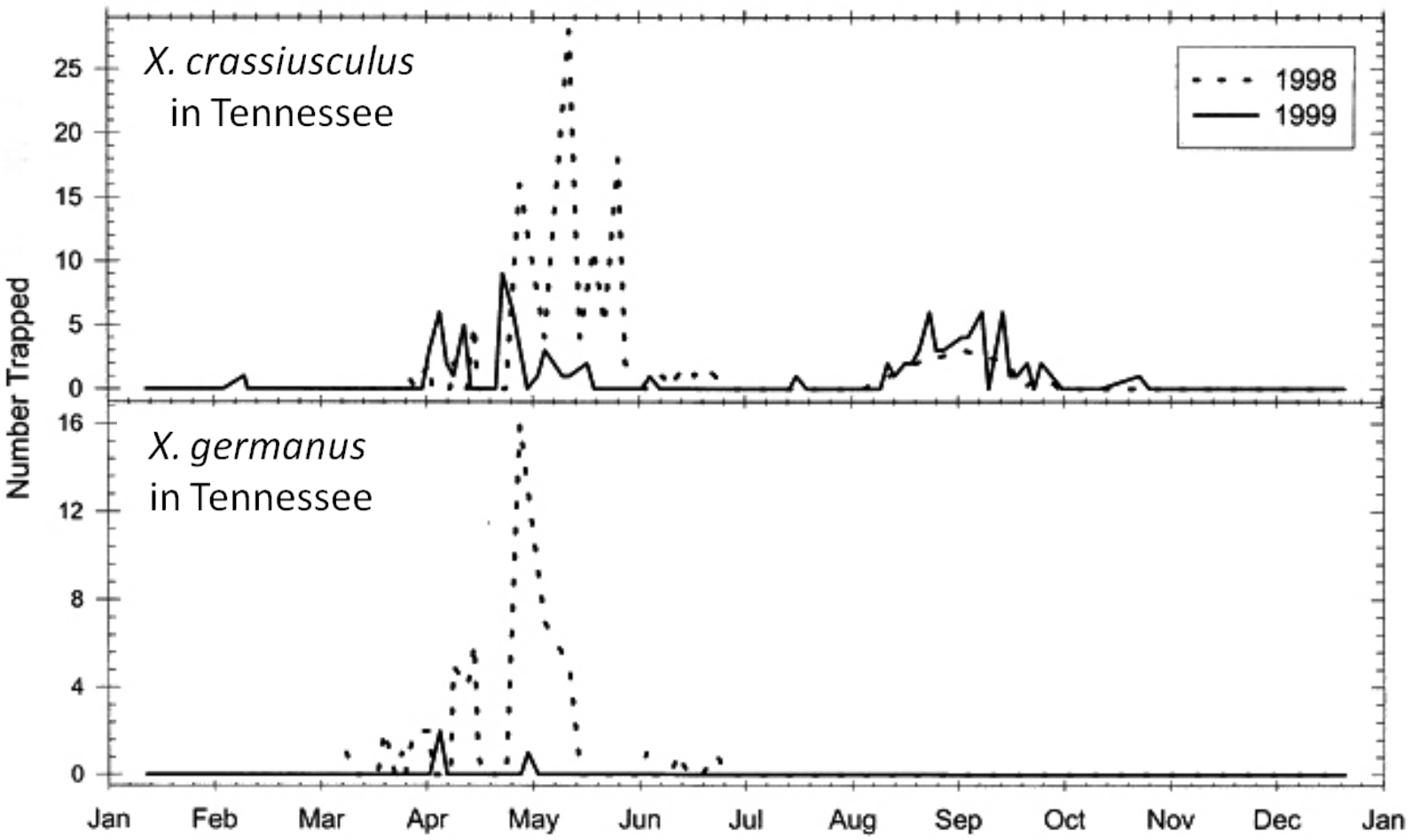
~25 days egg to adult

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

Most abundant attacks (typically)

Weber and McPherson (1983) Annals Entomol. Soc. Am.

Seasonal Activity



Oliver and Mannion (2001). Environmental Entomology


Over-wintering sites

Frequently asked questions

(1) What species of ambrosia beetles are problematic in nurseries?

(2) What is their biology and life history?

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Ambrosia Beetle Host Preference

High degree of variation in host range *and* preference for hosts in a particular physiological condition

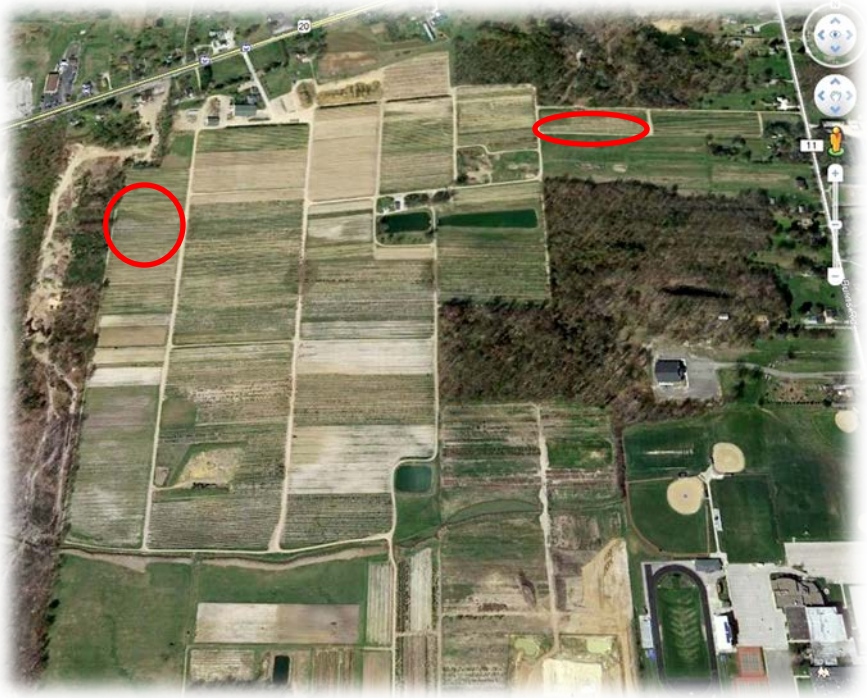
Healthy ⟷ **Weakened** ⟷ **Dead**

Host Range and Preference

- >200 species for *X. germanus*
- >120 species for *X. crassiusculus*

- Opportunistic colonizers of weakened trees
- But, attacks on “apparently healthy” trees too
- Preference for certain species and individuals within a given year and location

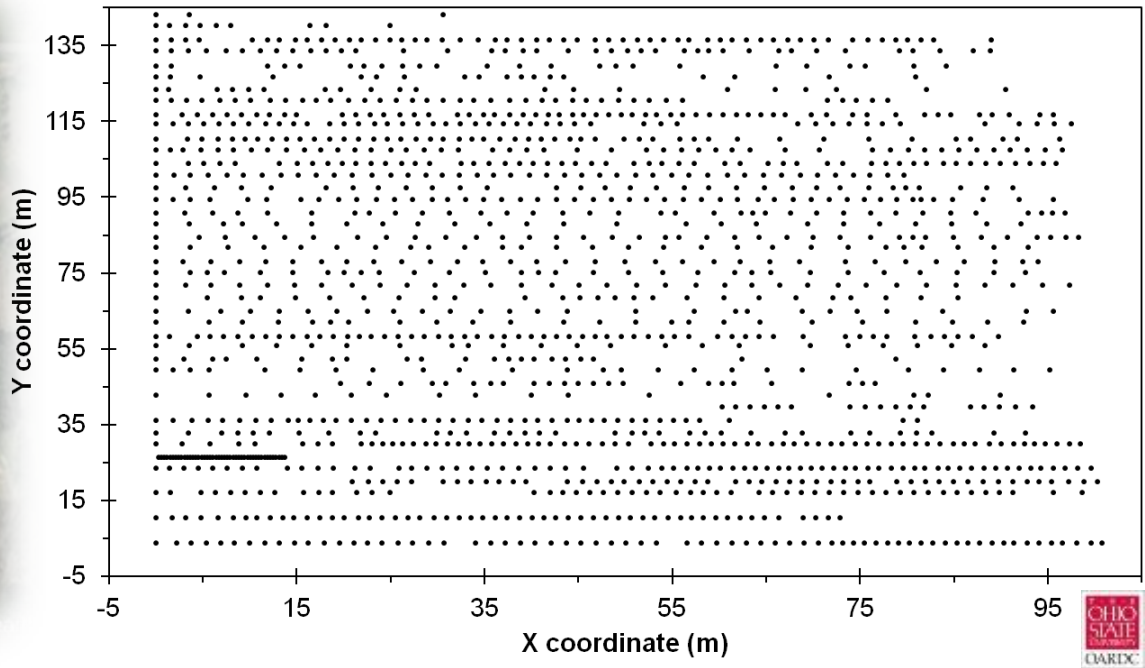
Attacks Reported on Honeylocust *Gleditsia tricanthos* in September 2013



- 99.3% of excavated specimens were *X. germanus*

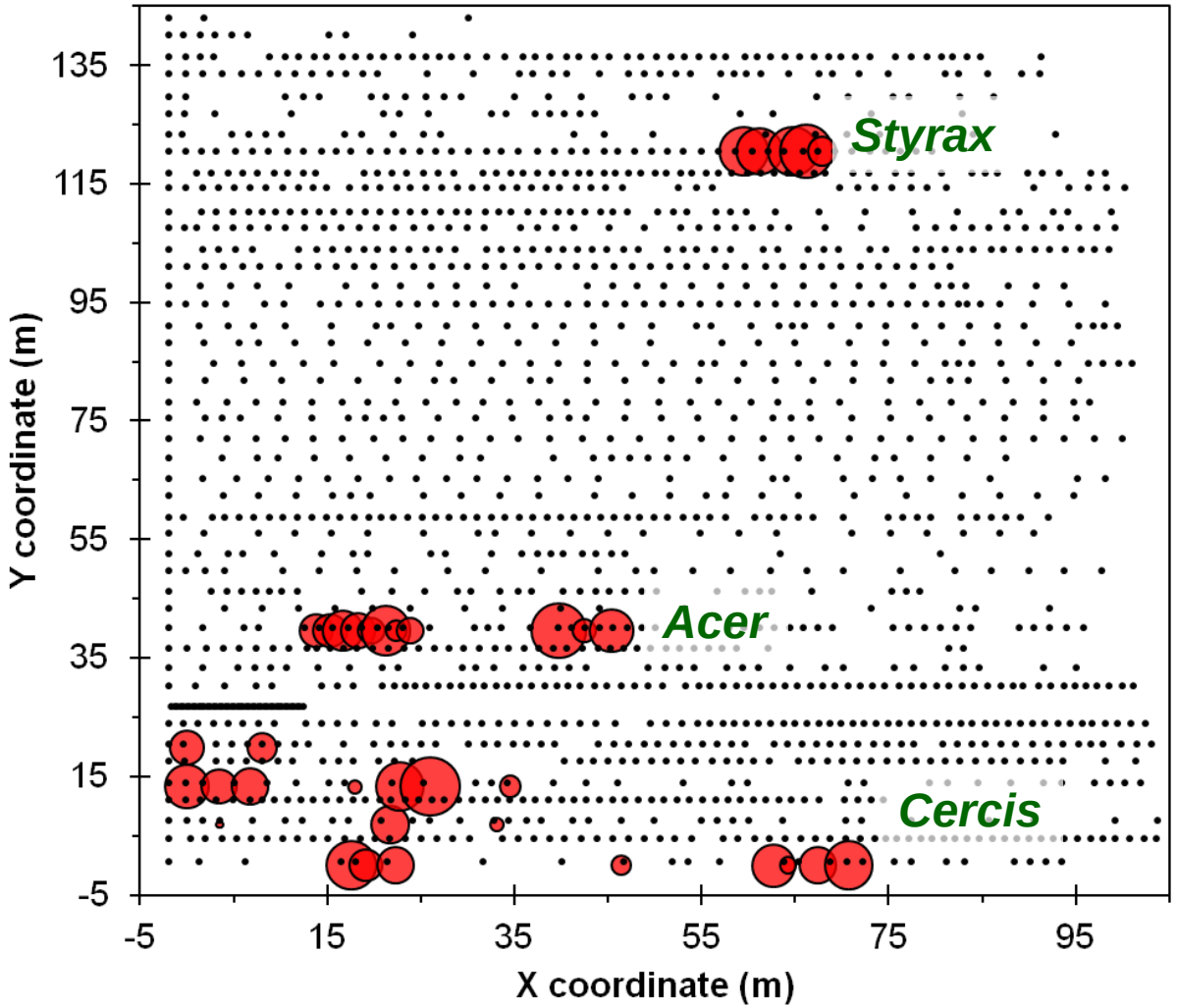
Distribution of Attacks within Nurseries

- Plots at two commercial nurseries in Lake Co., Ohio (2012)
- Tree position recorded
- Species and number of attacks per tree recorded



Non-Random Distribution of Attacks

- Only certain species and individuals within those species were attacked



- 35 of 1671 trees were attacked (2.1%)
- 4-79 attacks per attacked tree
- 32.6 ± 3.3 attacks per attacked tree

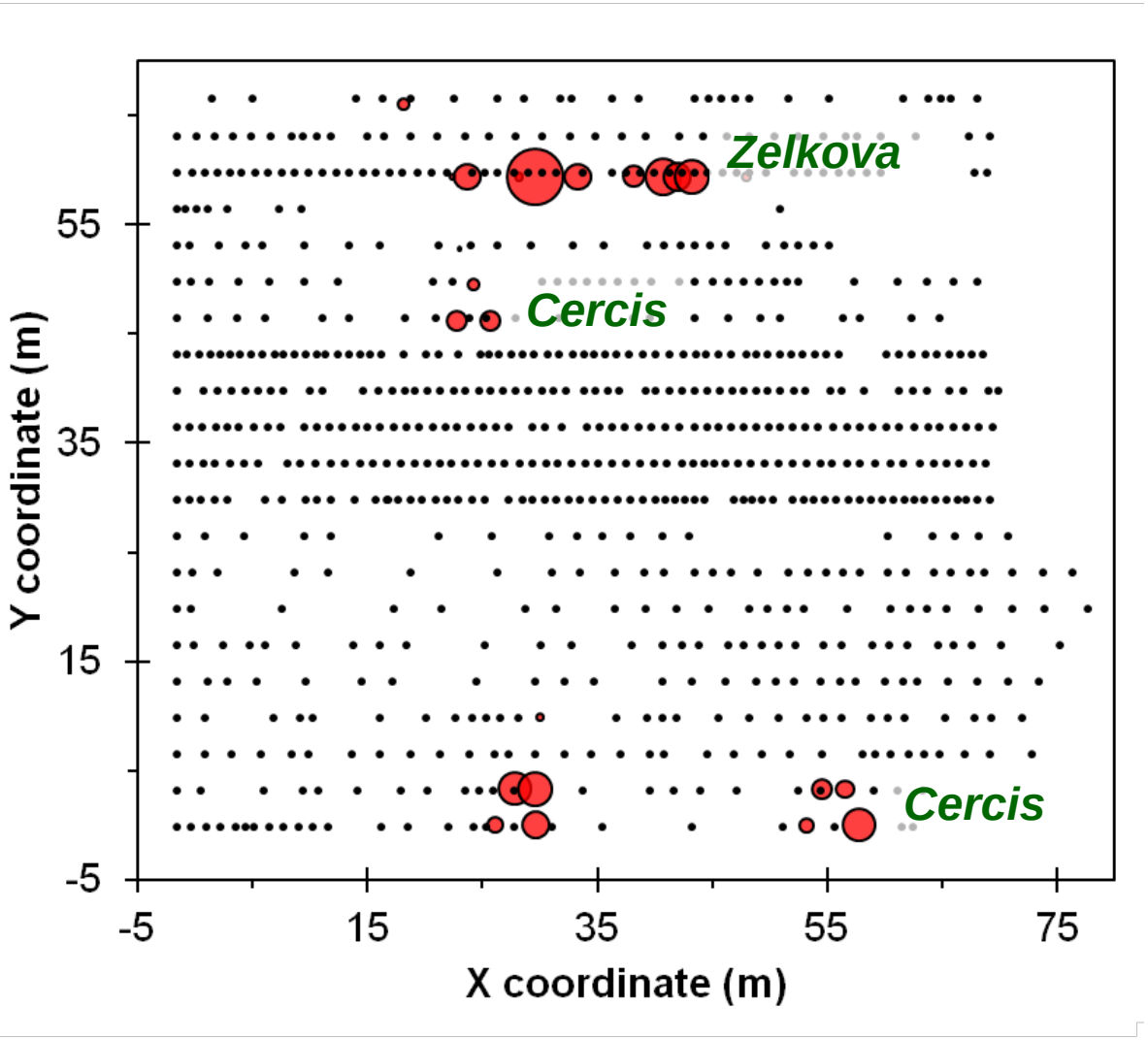
Other potential hosts in plot:

Amelanchier
Carpinus
Chiocanthus
Cornus
Cotinus
Fagus
Gingko
Liriodendron
Luiquidambar
Magnolia
Metaseqoia
Perrotia
Quercus
Salix
Taxodium
Tilia

Ranger et al. (2014) *Biological Invasions*

Non-Random Distribution of Attacks

- Only certain species and individuals within those species were attacked



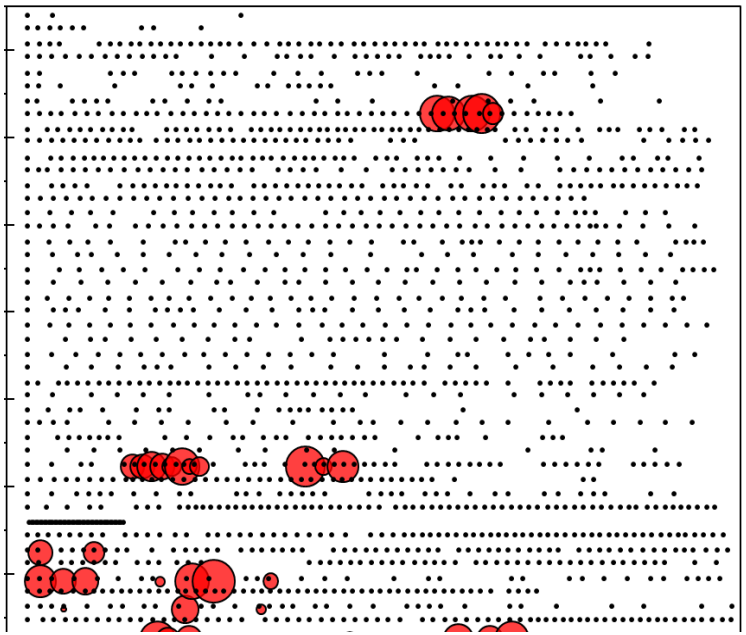
- 23 of 738 trees were attacked (3.1%)
- 1-227 attacks per attacked tree
- 44.6 ± 10.2 attacks per attacked tree

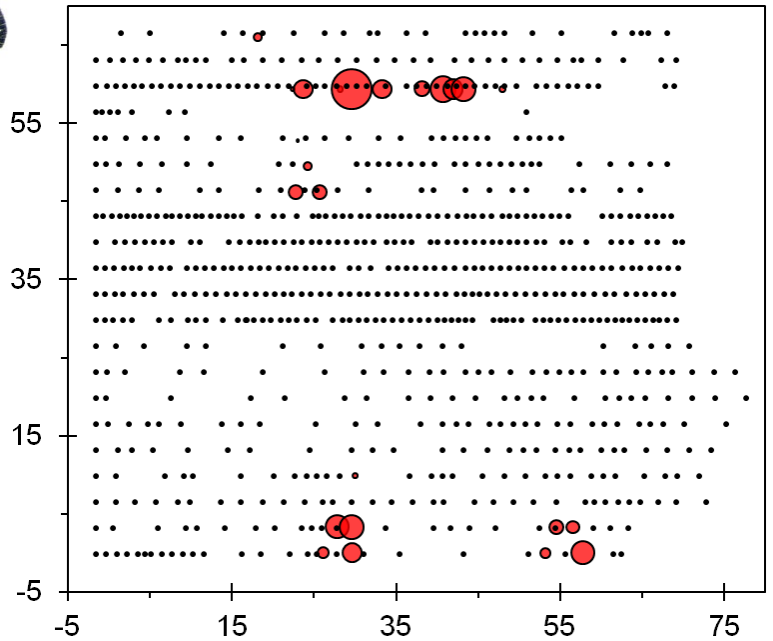
Other potential hosts in plot:

Acer
Cercis
Cornus
Fastigiata
Liriodendron
Zelkova

Ranger et al. (2014) *Biological Invasions*

Despite a large host range (100-200 species), why are only certain species and individuals attacked within a given year and location?



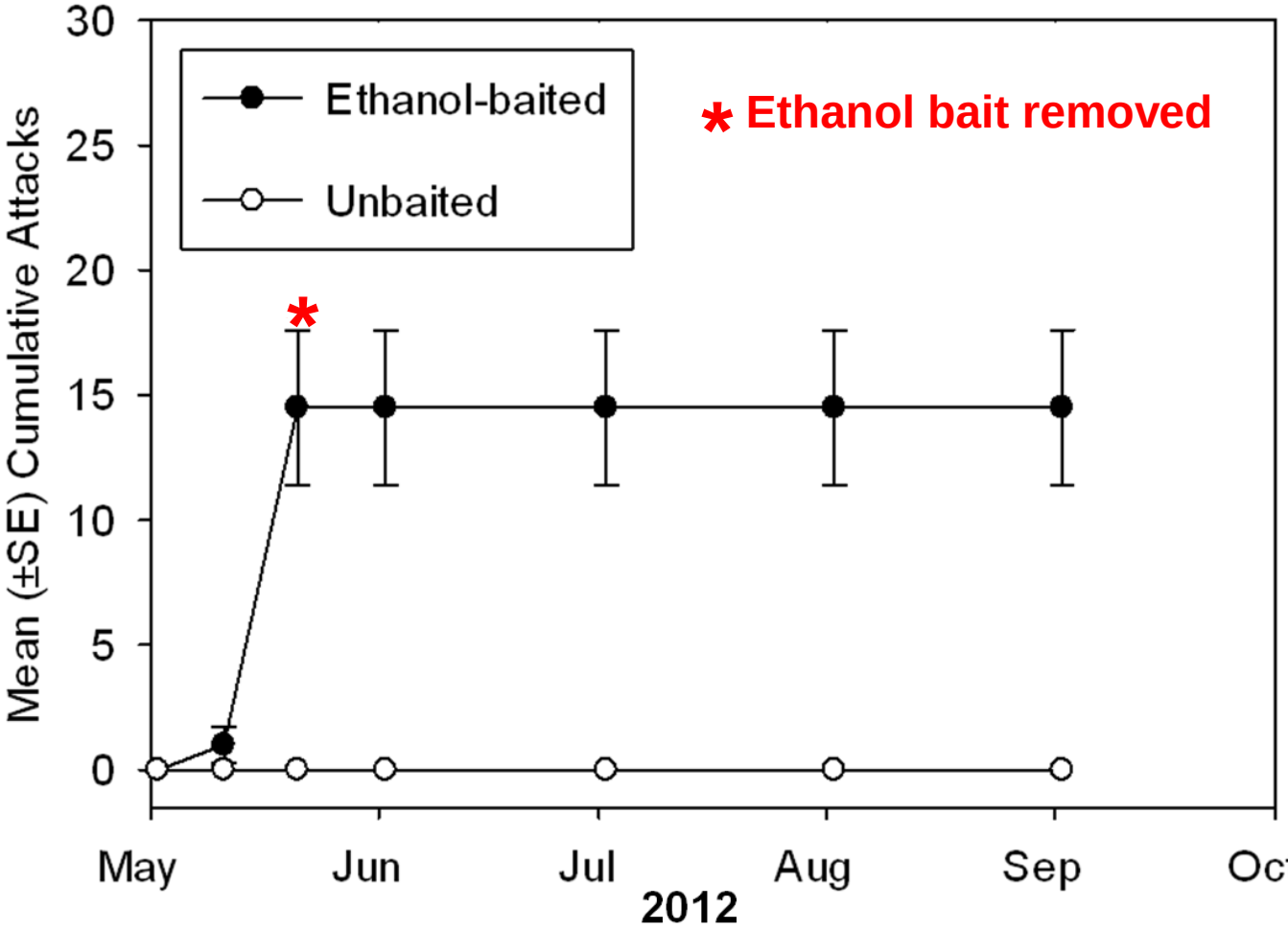


Ambrosia Beetle Host Location Behavior

- Visual Cues

- Olfactory Cues
  - Host-derived volatiles (i.e. ethanol)

Trees Attacked in the Presence of Ethanol

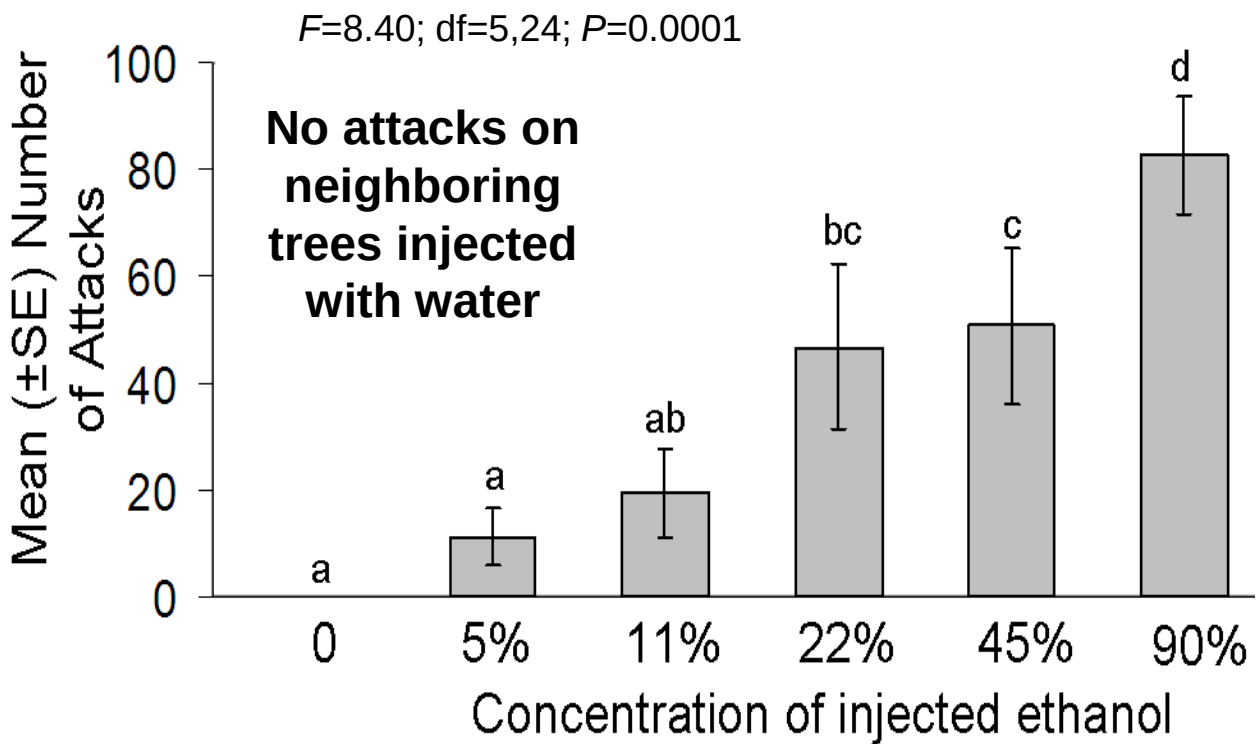


Magnolia virginiana

Attacks ceased in the absence of ethanol

Ranger et al. (2014) *Biological Invasions*

Positive Dose Response



Ranger et al. (2012) *Environmental Entomology*

Host Location Efficiency

- Beetles rarely landed on neighboring trees not emitting ethanol
- 0.0 *X. germanus* entrapped in 2011
- 0.3 ± 0.08 *X. germanus* entrapped in 2012

17.5 ± 2.2 attacks per ethanol-injected tree in 2011

26.3 ± 4.9 attacks per ethanol-injected tree in 2012

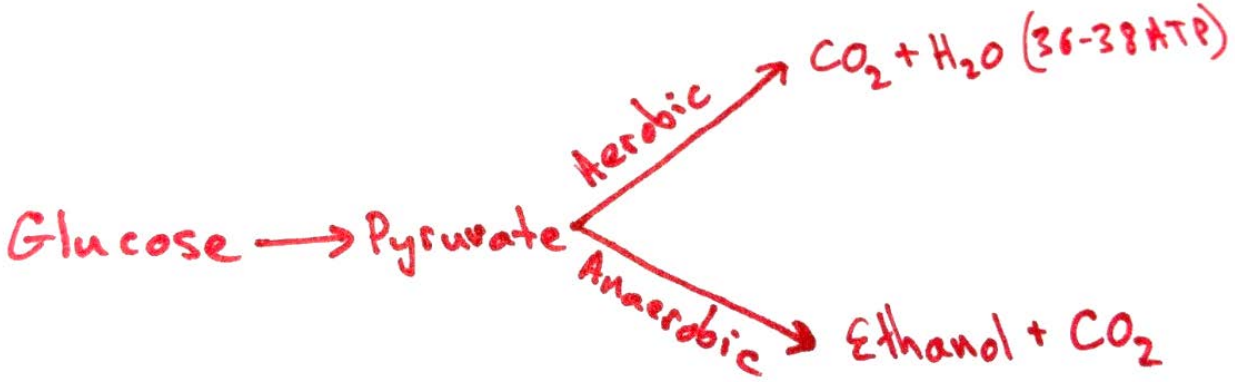
Why ethanol?

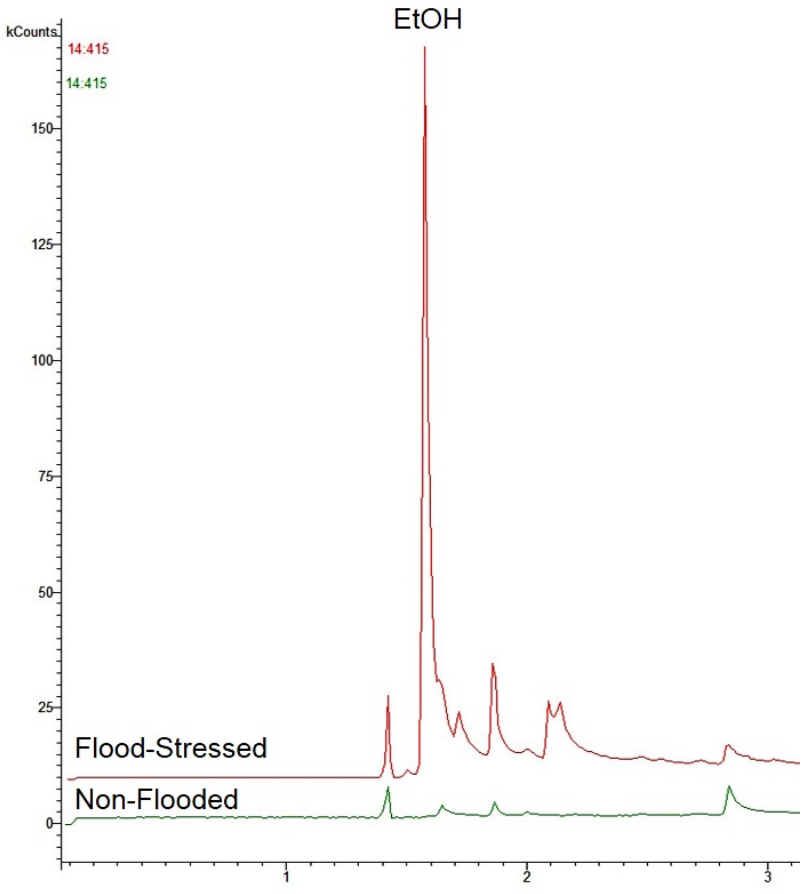
- Abiotic and biotic stressors:
  - Flooding/Over-watering
  - Drought
  - Frost injury
  - Excessive heat
  - Girdling
  - Pollutants
  - Pathogens
  - Impaired root function

- Can be emitted with 1-2 days following stress

- Asymptomatic, but still emit ethanol (i.e. apparently-healthy)

Influence of Flood-Stress





Ranger et al. (2013) *Agricultural and Forest Entomology*

Field Observations of Flood-Stress

- 2011 wettest year on record for Ohio (NOAA, 2012)
- Symptoms and attacks on dogwoods detected on 19-May-2011
- Neighboring species not attacked

Field Observations of Flood-Stress

- 284 dogwoods examined
- 14% exhibited dieback of buds/leaves
- 9% were attacked
- Ambrosia beetles were indicative of weakened trees

Wilting/Dieback

Impaired roots

Field Observations of Flood-Stress

- Symptoms and attacks on dogwoods detected on 7-June-2011
- 166 trees examined
- 99% exhibited dieback
- 70% were attacked

Field Observations of Flood-Stress

- Dieback, but no attacks

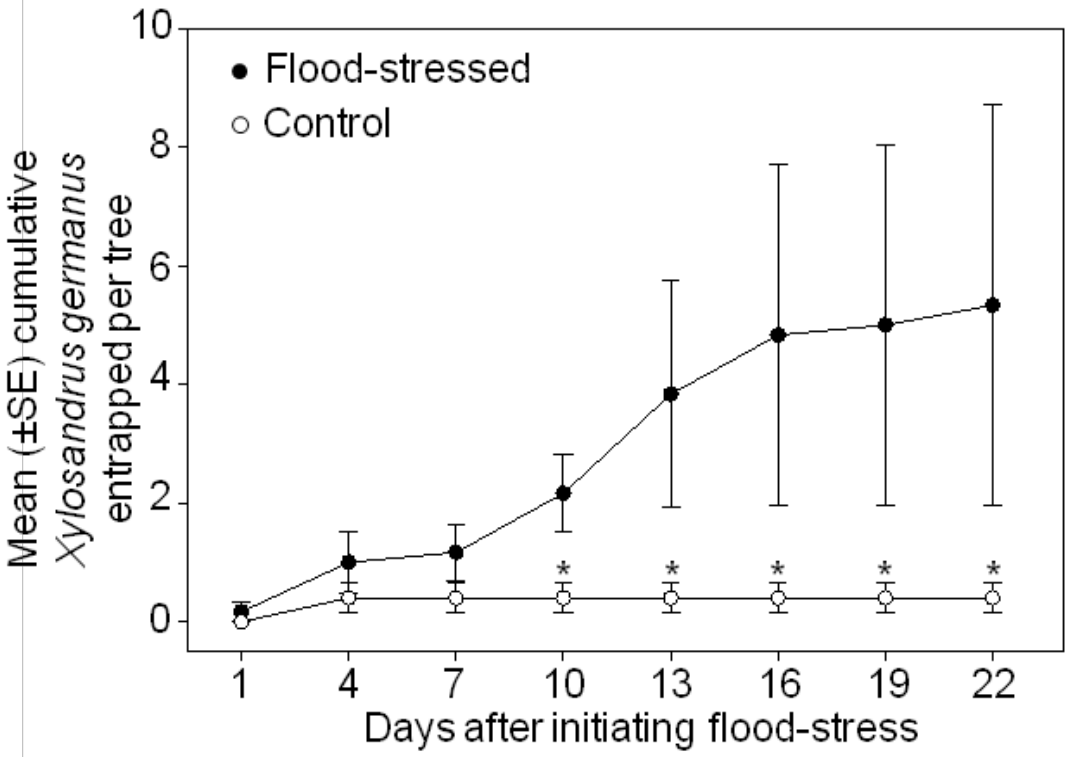
Field Observations of Flood-Stress

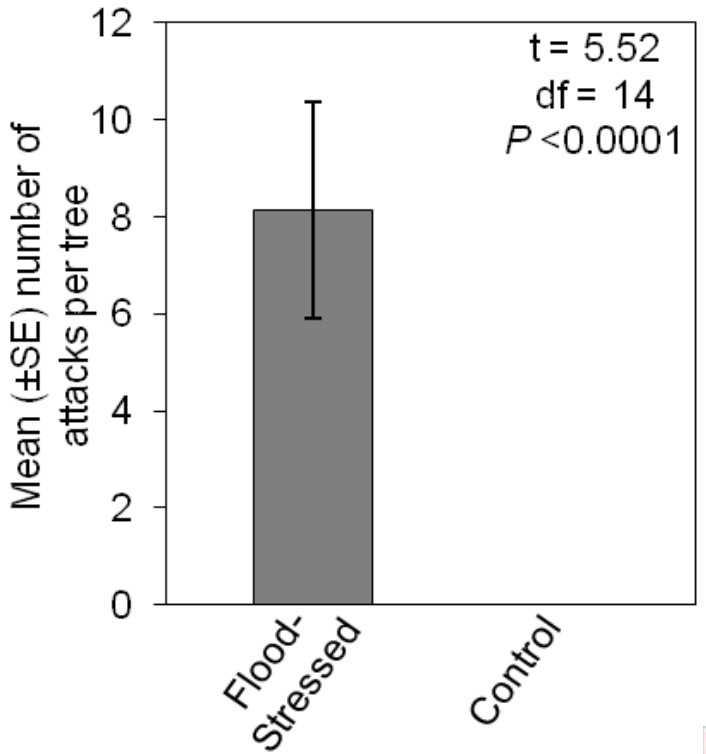
- Planting depth?
- Poor drainage?

Flood-Stress Experiments

- More beetles were attracted to experimentally flood-stressed dogwoods in 2009, 2010, and 2011

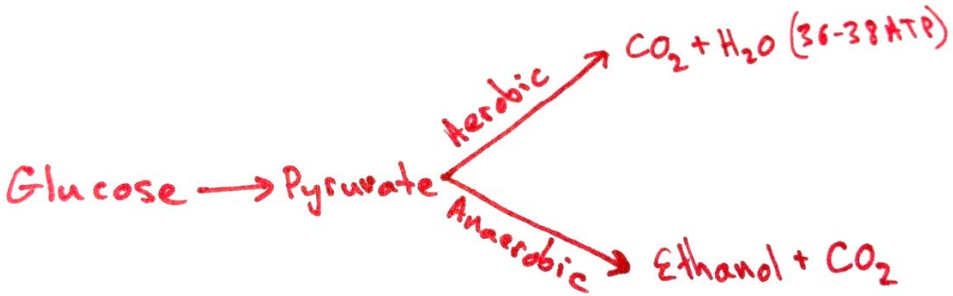
- Beetles only attacked flooded trees in 2009, 2010, and 2011





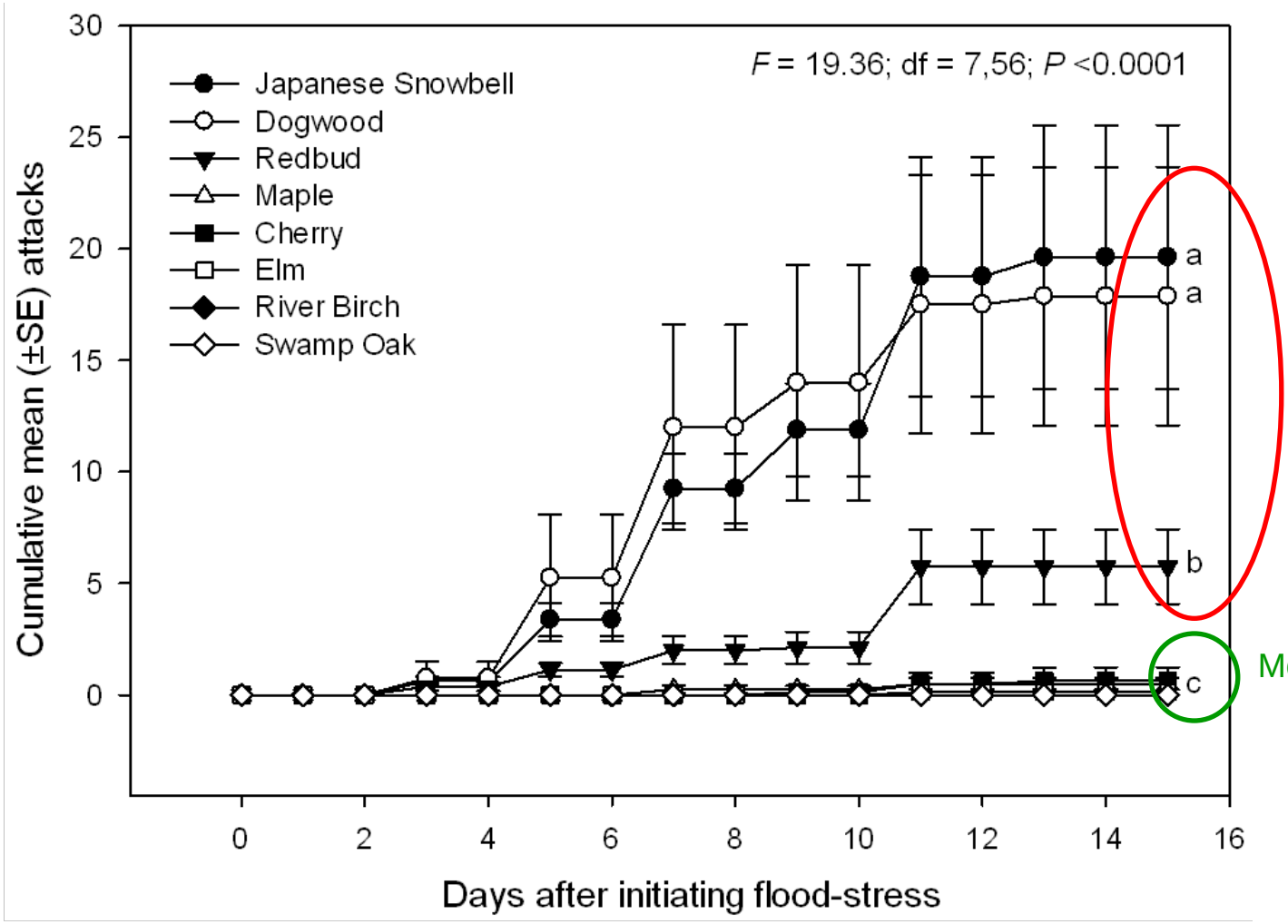
Ranger et al. (2013) *Agricultural and Forest Entomology*

Preference for Trees Varying in their Tolerance of Flooding



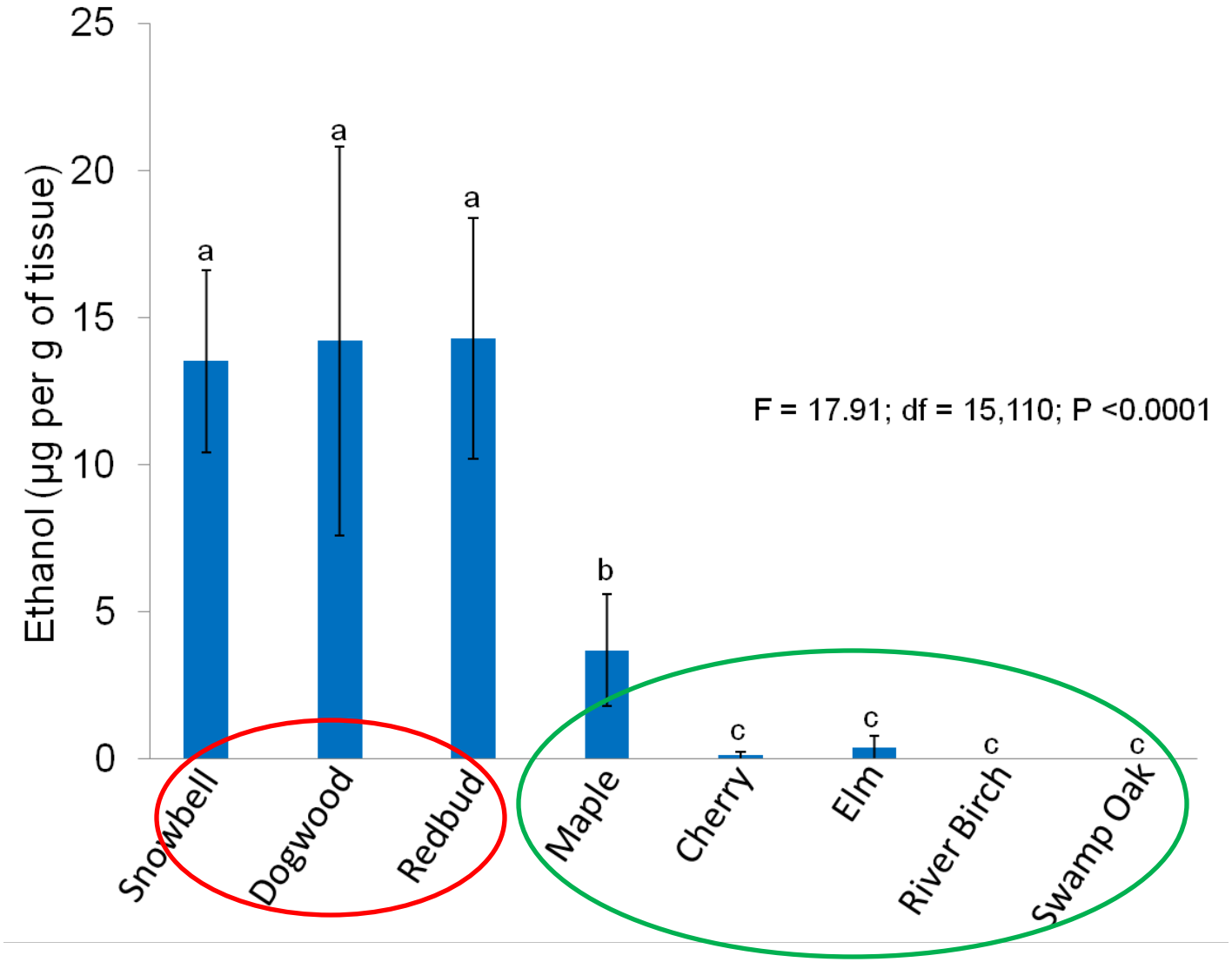
- <u>Intolerant</u>
  - Japanese snowbell, *Styrax japonicus*
  - Dogwood, *Cornus florida*
  - Redbud, *Cercis canadensis*
- <u>Moderately Tolerant</u>
  - American elm, *Ulmus americana*
  - River birch, *Betula nigra*
- <u>Tolerant</u>
  - Swamp white oak, *Quercus bicolor*
  - Silver maple, *Acer saccharinum*

Attractiveness of Tree Species Varying in their Tolerance of Flood-Stress



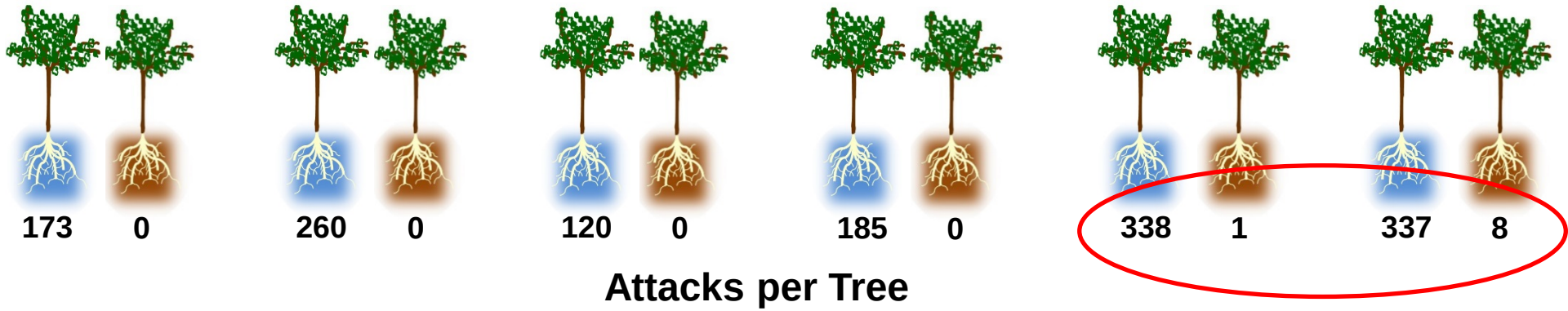
Analysis for Ethanol

3 days after initiating flooding



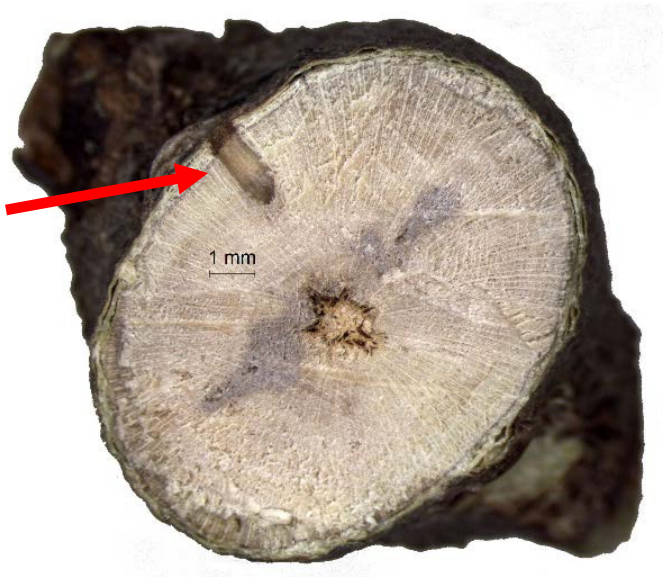
Attacks on Flood-Stressed *and* Apparently-Healthy Trees

- Opportunistic colonizers
- Spill-over onto neighboring healthy trees?



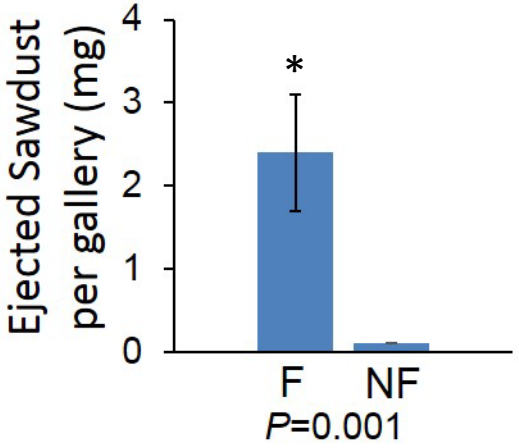
Attacks per Tree

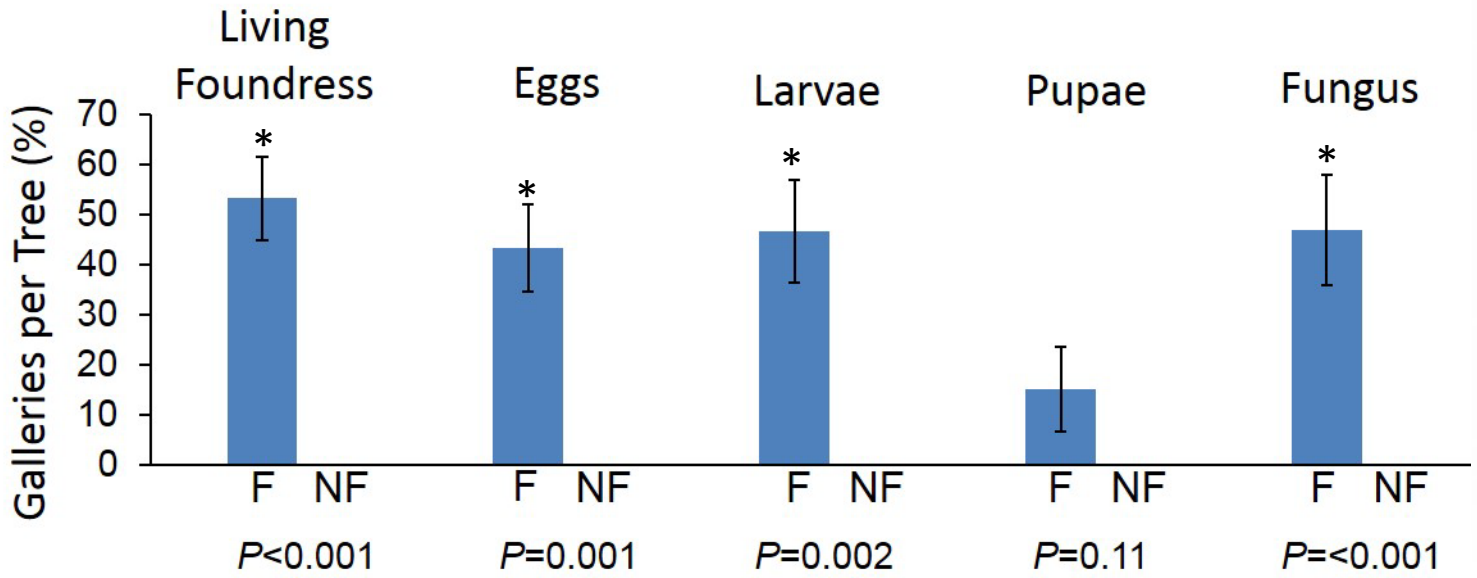
- Superficial tunnels absent of beetles on non-flooded trees.



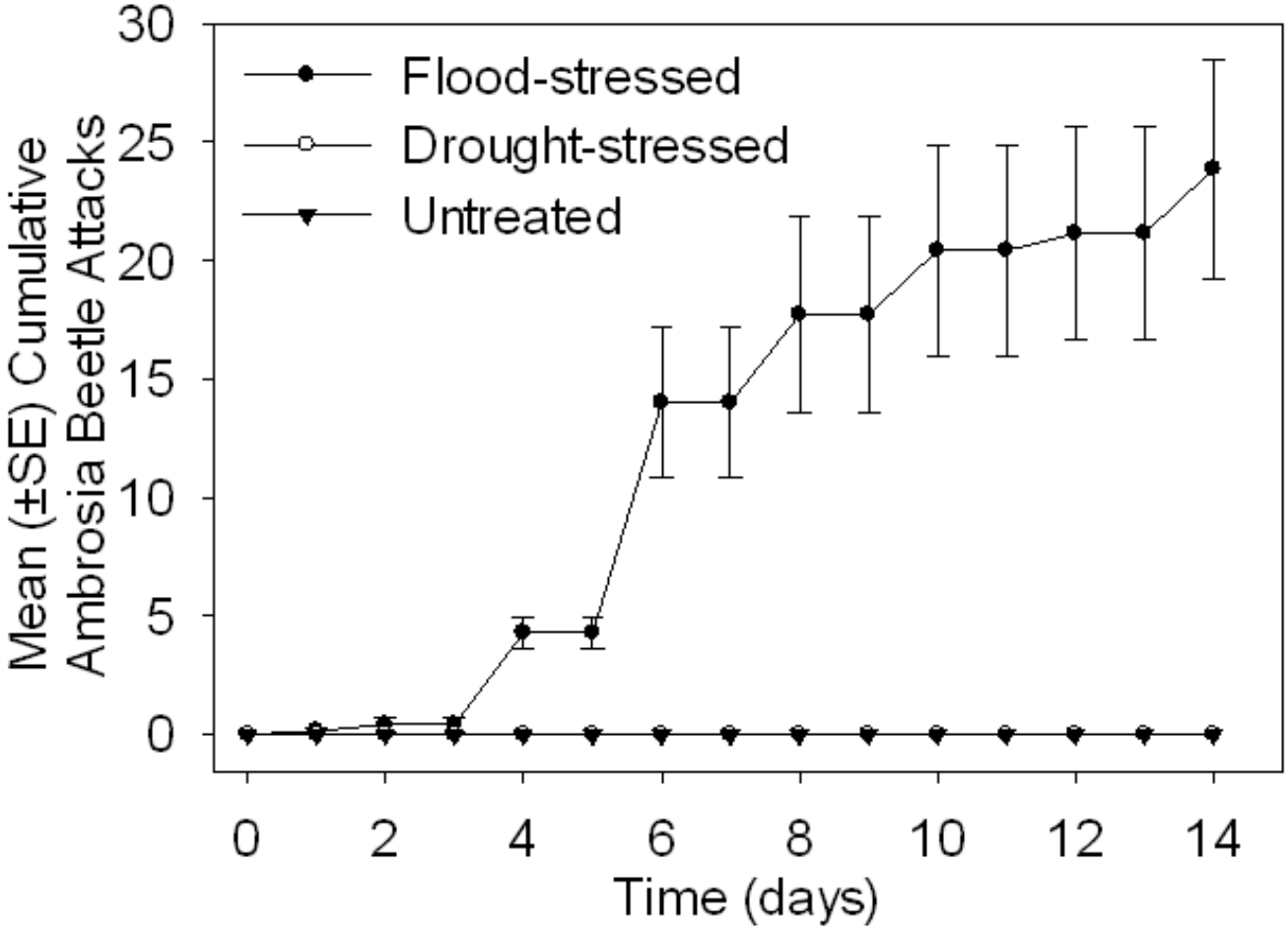
Assessing Host Colonization Success

- No-choice: flooded (F) vs. non-flooded (NF) *Cornus florida*





Flood-Stressed vs. Drought-Stressed



Agricultural and Forest Entomology

Agricultural and Forest Entomology (2012), DOI: 10.1111/j.1461-9563.2012.00596.x

Frost increases beech susceptibility to scolytine ambrosia beetles

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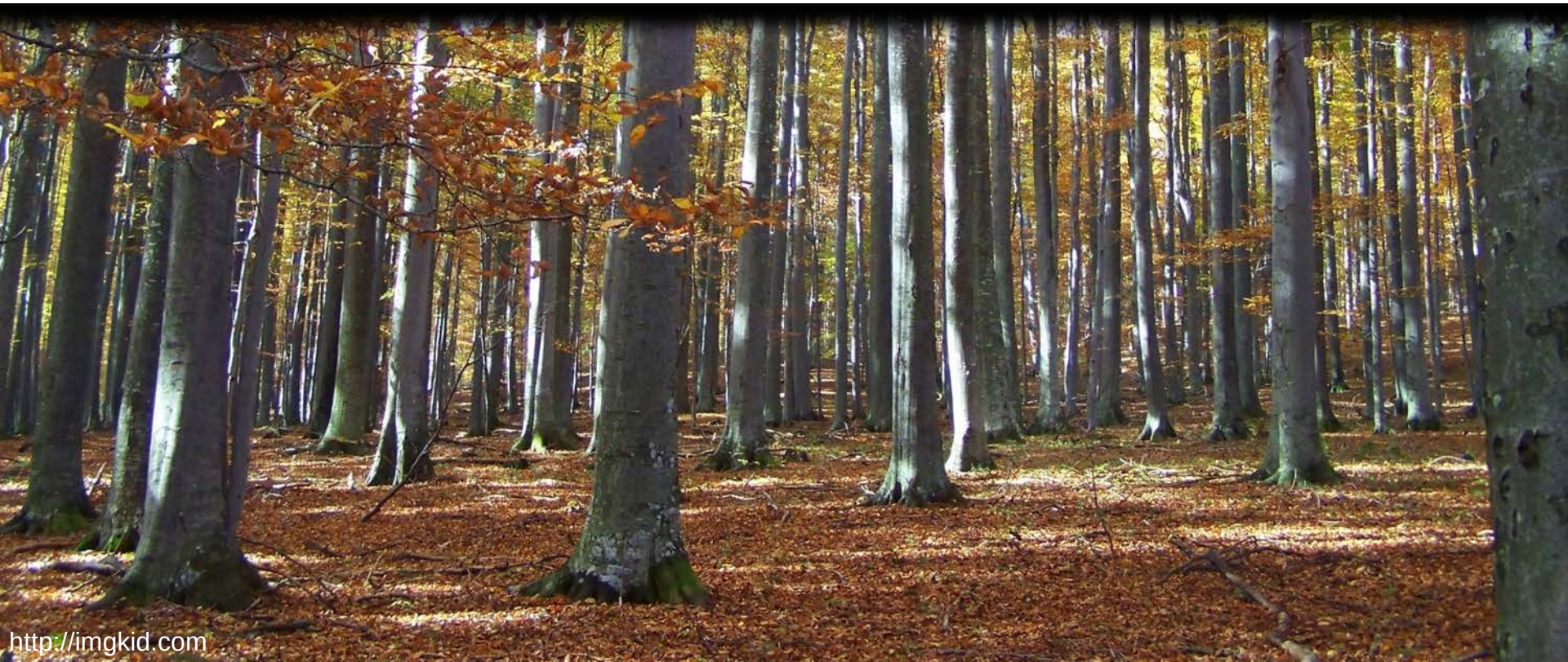
- Attacks were preceded by extreme frost in 1929, 1942, and 1998



http://imgkid.com

Anecdotal Observations of Frost Injury Predisposing Trees to Attack

- Mild winter temps in Ohio and neighboring regions in 2012
- Early budding of trees (1 month ahead of schedule in some cases)
- April 2012 was cooler than March 2012
- At least 3 distinct frost events occurred in April

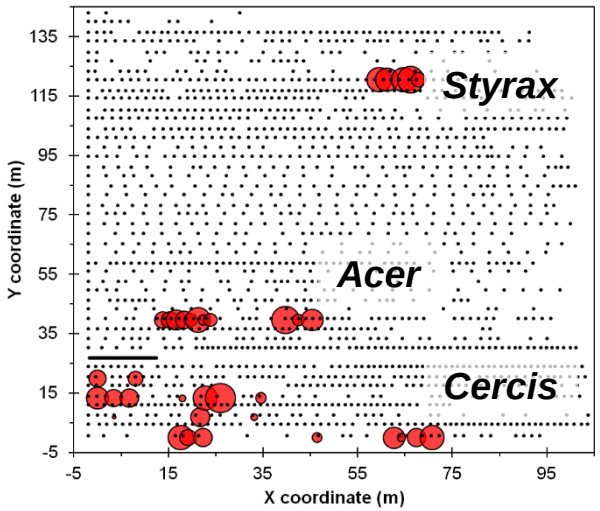
Field Observation of Frost Injury

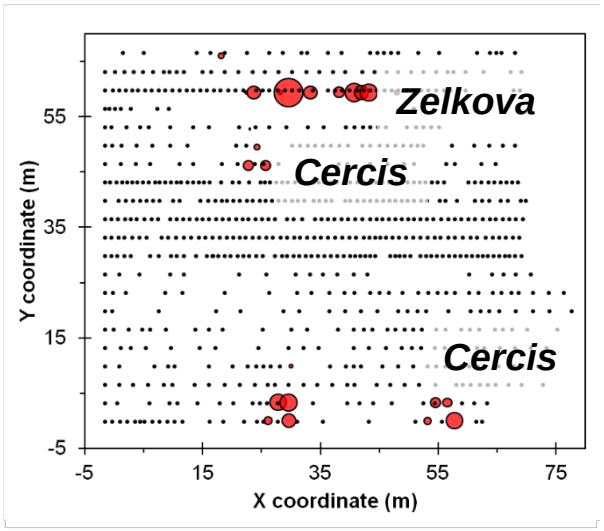
Kentucky Yellowwood, *Cladrastis kentukia*
12” caliper
Tree exhibited dieback from frost damage 2X prior to attacks.

Field Observations of Frost Injury

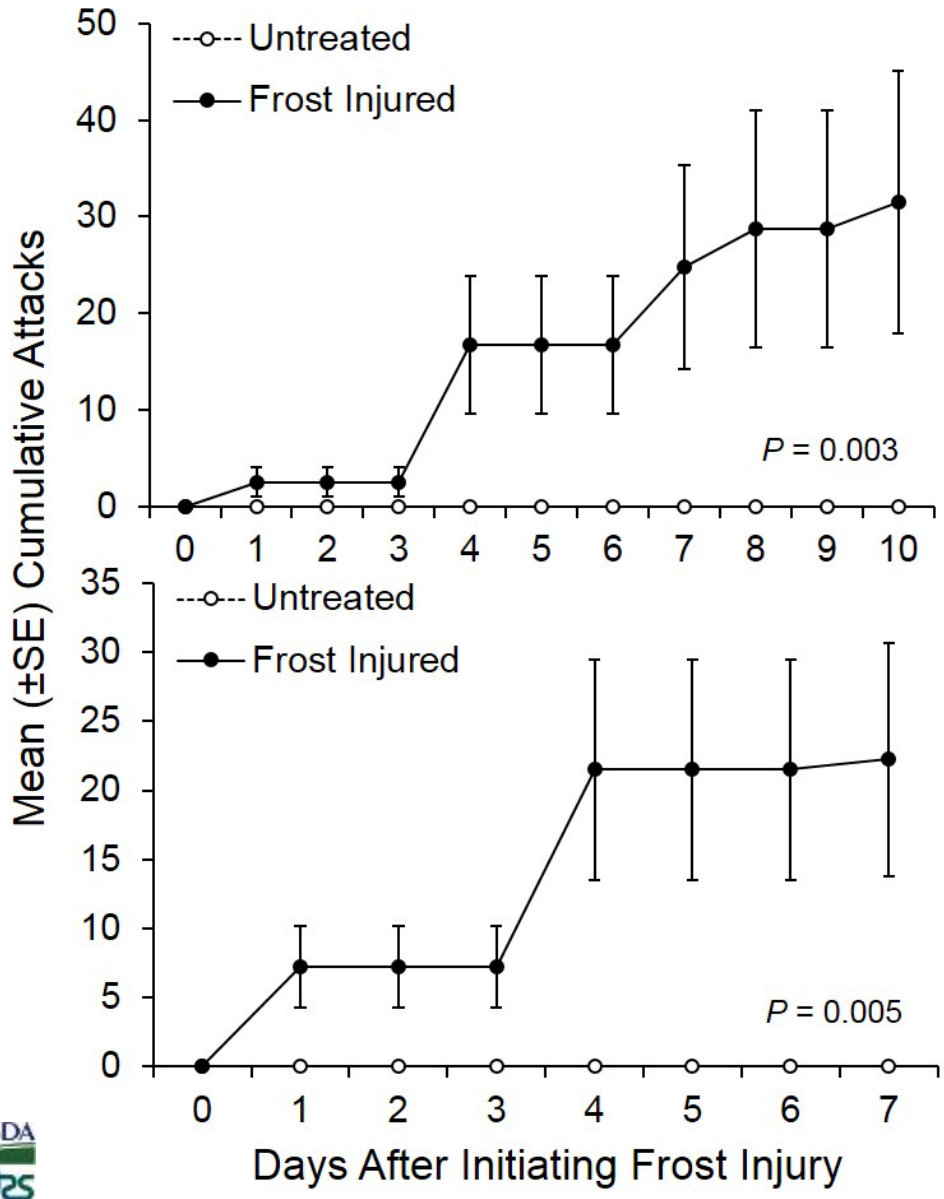
Acer palmatum (Japanese maple)
Styrax japonicus (Japanese Snowbell)
Zelkova serrata (Japanese zelkova)

Cercis canadensis (Eastern Redbud) lacks cold hardiness if improper genetic material is not grown in zones 5 and colder.





Frost Injured *Styrax japonicus* Preferentially Attacked



Xylosandrus germanus

Styrax japonicus

- Held at -10 ^{o}C for 12 hours

Field Observations of Winter Injury in 2014

- Coldest winter in 30 years
  - Record low temps in region

- Attacks on nursery trees

  Acer saccharum
  Cercis canadensis
  Celtis occidentalis
  Crataegus punctata
  Eucommia ulmoides
  Liquidambar styraciflua
  Quercus sp.
  Tilia sp.
  Ulmus parvifolia

Numerous reports of attacks on **fruit trees** throughout eastern US in 2014

Field Observations of Winter Injury in 2014

Frequently asked questions

(1) What species of ambrosia beetles are problematic in nurseries?

(2) What is their biology and life history?

(3) What trees do they attack?

(4) How do I monitor for them?

(5) What insecticides are effective?

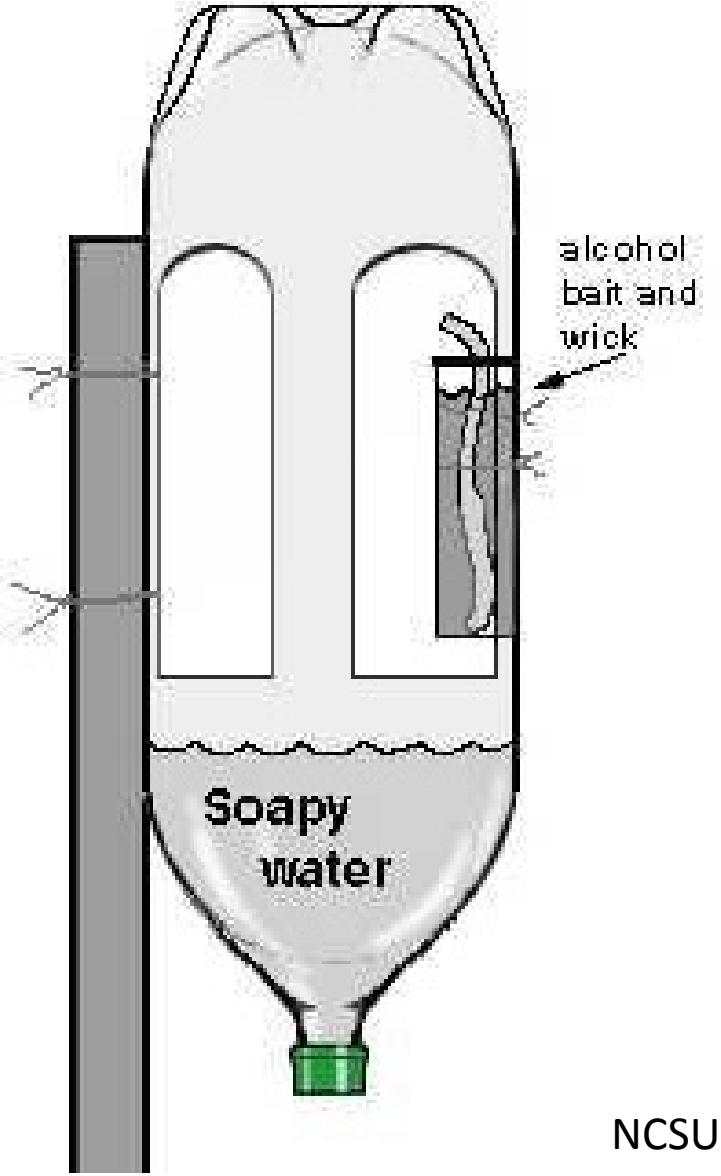
Monitoring Flight Activity

Ethanol lures can be purchased or made using a small container with a wick

Use ethyl alcohol
NOT isopropyl alcohol (rubbing alcohol)

Monitoring Flight Activity

Place traps close to the ground and close to woodlots



NCSU

Monitoring Flight Activity

Soak bolt in ethanol for 24 hours

Or drill a hole into a bolt,
fill with ethanol, and then cap.

Frequently asked questions

(1) What species of ambrosia beetles are problematic in nurseries?

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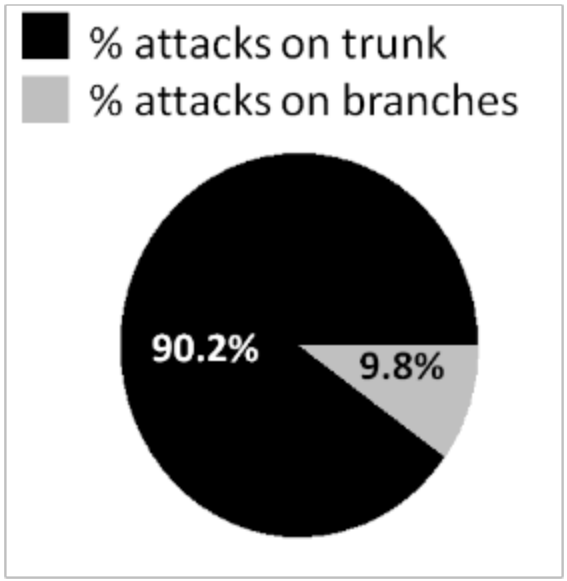
USDA

OHIO STATE UNIVERSITY OARDC

Insecticide Efficacy

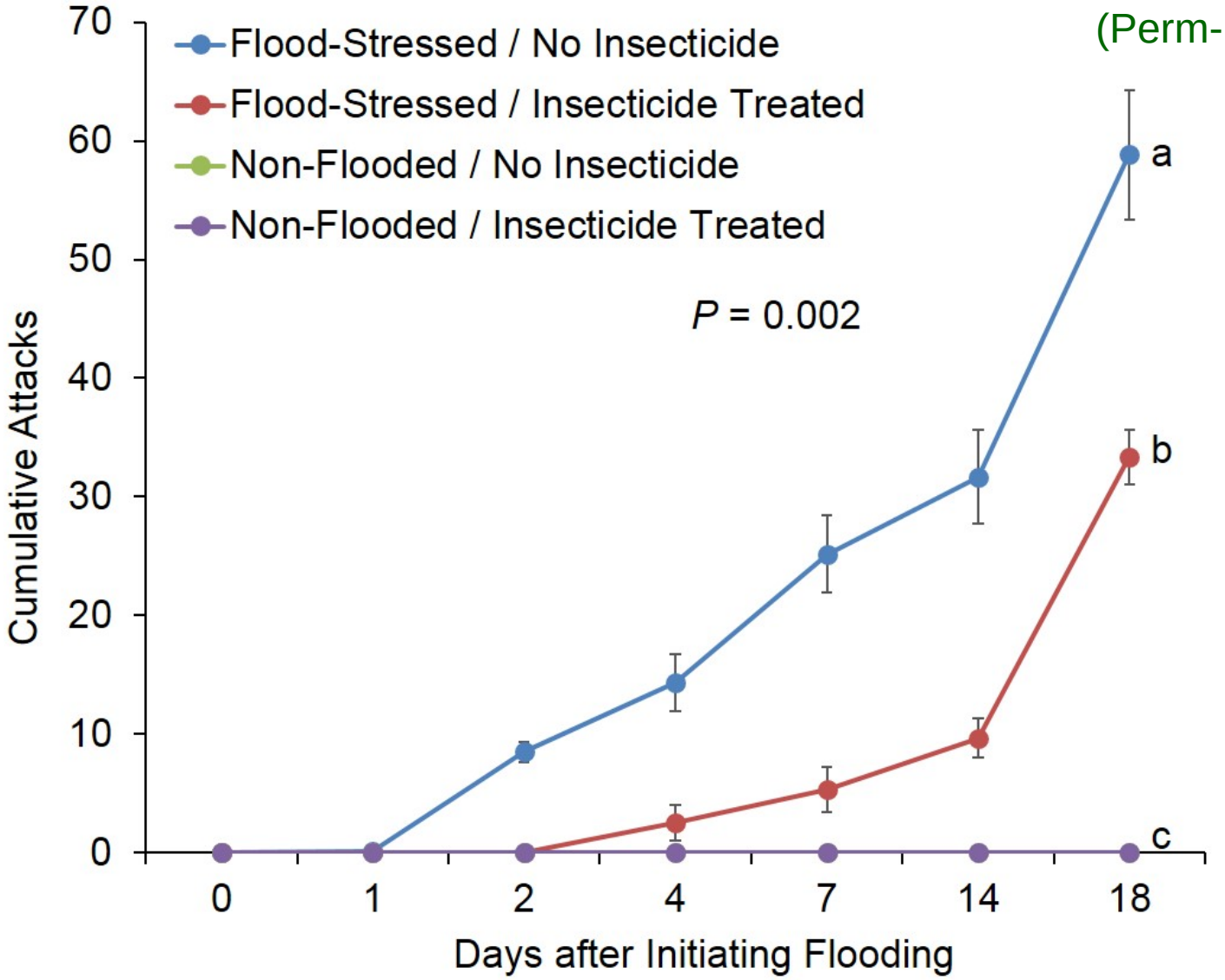
- Permethrin-based insecticides are most effective
  - Tengard SFR
  - Perm-UP 3.2EC

- Systemics are <u>not</u> effective!



Importance of Maintaining Host Vigor?

- Insecticides do not always protect trees from attack



Ambrosia Beetle Management Plan

(1) Maintaining host vigor should be the primary foundation

(2) Monitor spring flight activity with ethanol-baited traps or ethanol-soaked bolts

(3) Thorough coverage of trunk

(4) Use heavily infested trees as trap trees for 2-3 weeks

(5) Trees with a “low” level of attacks can recover

Apparently Healthy to Whom?

- “Apparently healthy” or “Inapparently stressed”?
  - Stressed trees can appear “apparently healthy”, but inconspicuously emit stress-related volatiles
  - Beetles can quickly locate living, but weakened trees
- Extreme climatic events are predicted to increase

Ranger et al. 2010, 2012. Agricultural and Forest Entomology.

Acknowledgements

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Thanks for your attention!

Please feel free to contact me
or to report ambrosia beetle attacks
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