Setting the scene: the view from the epicenter of a disturbance impacted landscape

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Strategies & Tools for Managing Ash and Elm Species

September 13-14; Baltimore MD

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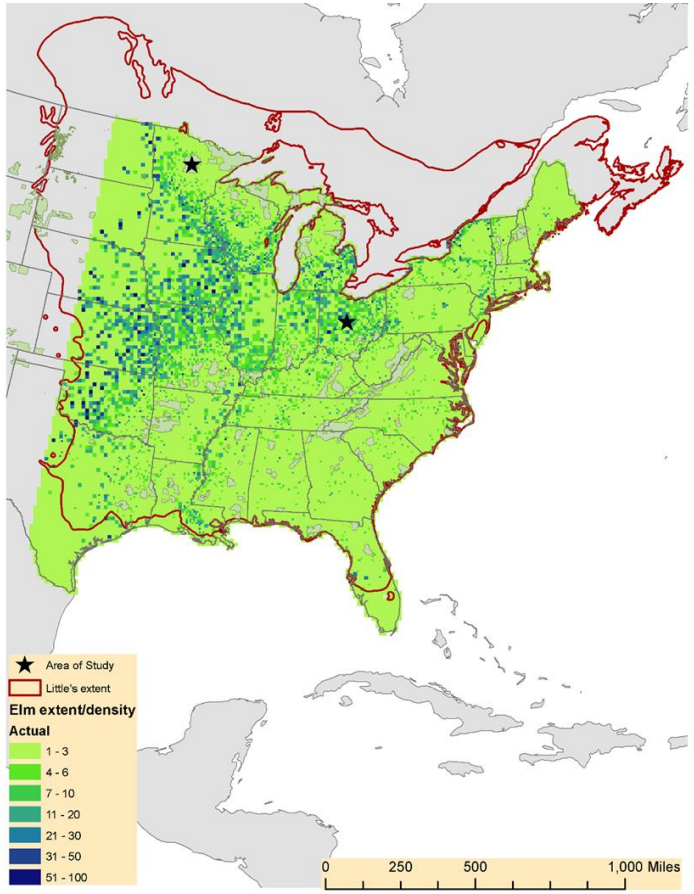
Charlie Flower

Outline:

- Background on elm and ash trees
  - Distributions
  - Ecological importance
  - Role across the landscape
- Primer on DED and EAB disturbance agents
  - From tree to landscape level
  - Emerging patterns
- Opportunities
- Conclusions

Ulmus and *Fraxinus*: A tale of 2 genera



- Elm and ash are widely distributed across North America.
- They are both tolerant of a variety of habitats from bottomlands and floodplain forests to upland systems.
- Their fates are intertwined by co-occurrence and non-native pests and pathogens.

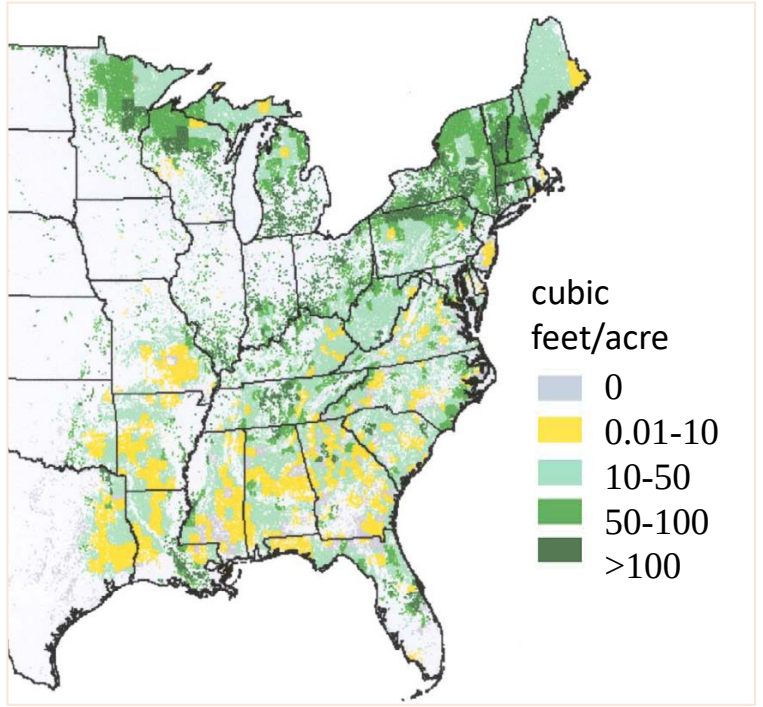


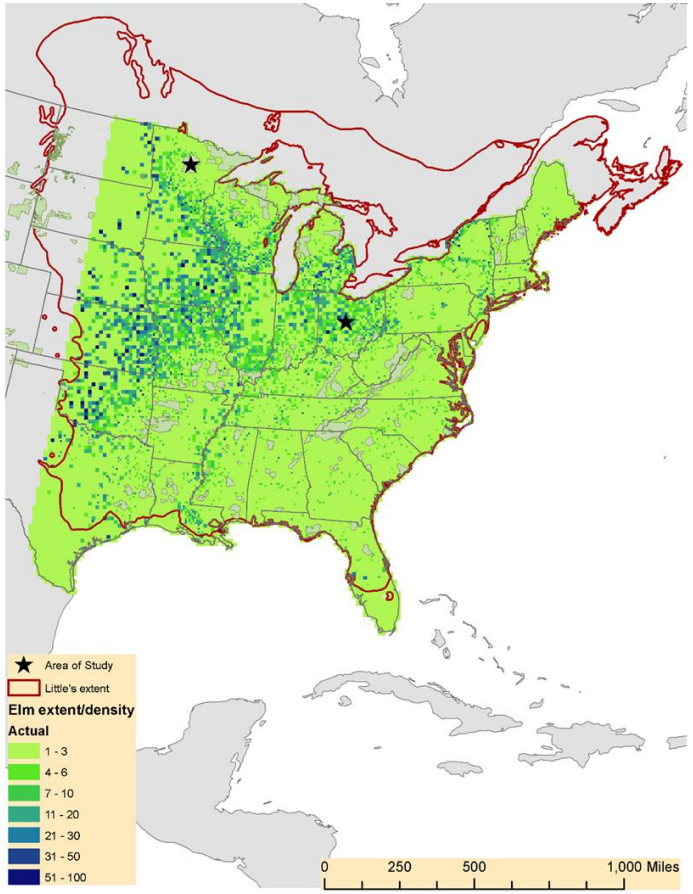
Figure 1: *Fraxinus* distribution and density in the eastern United States (USDA FS, <http://na.fs.fed.us>).

Profile: *Ulmus*

- There are ~30-40 species of elm (8 endemic to North America) (Wallander 2008). Characterized by alternatively branching, ovate leaves w/ serrate edges, and winged samaras.

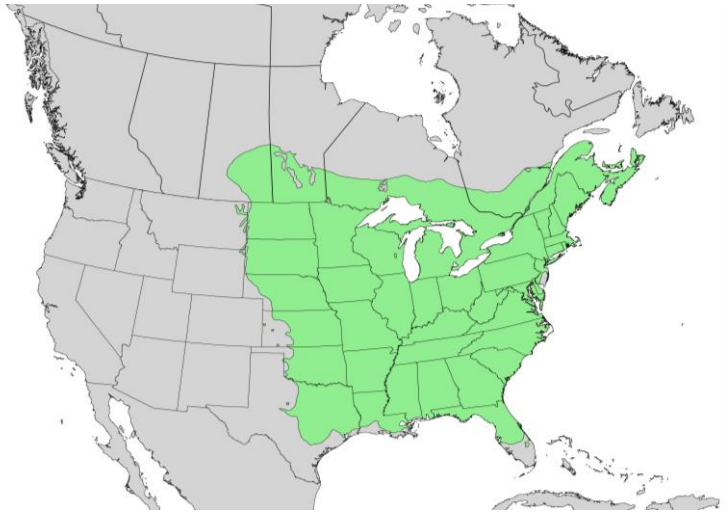
- American elm (primary focus of the USDA FS R&D) is a mid-late successional species, tolerant of a variety of habitats (from seasonally flooded to upland forests).

- *Ulmus* reaches its highest density in forests of the Mississippi watershed and across the Eastern US.



American elm (*Ulmus americana*)

- Early seeds support migratory birds
- Diverse lepidoptera (215 species!) including specialists
- Diverse insects (>500 species!)



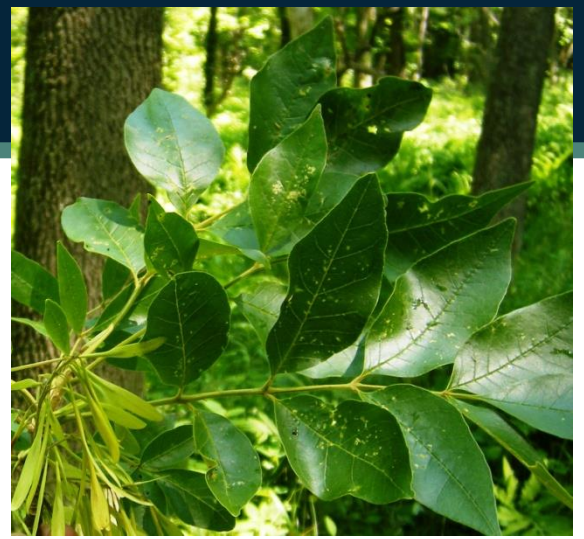
U.S. Geological Survey. 1999. Digital representation of E.L. Little 1971 "Atlas of United States Trees"

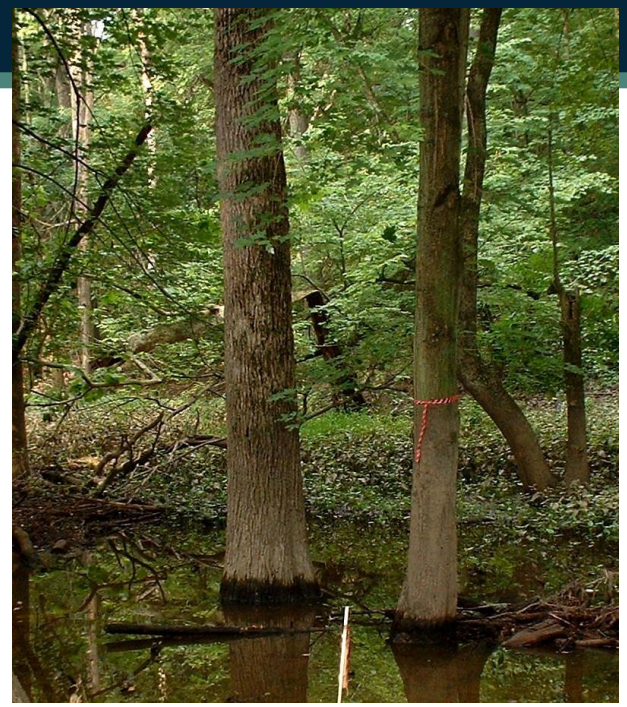
Question mark, *Polygonia interrogationis*

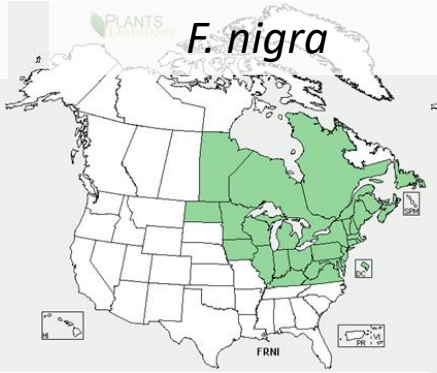
Elm sphinx moth, *Ceratomia amyntor*

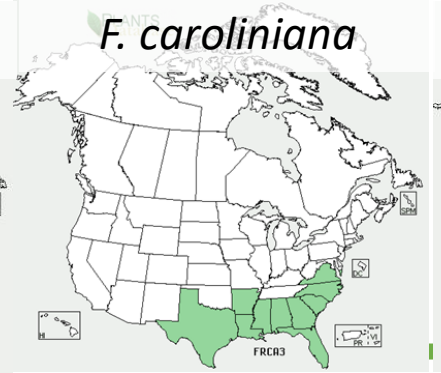
Profile: *Fraxinus*

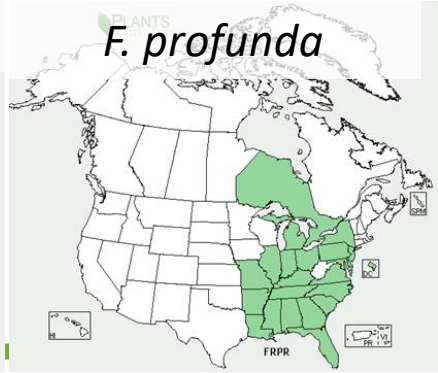
- There are 40 species of ash (20 in North America) (Wallander 2008). Characterized by opposite branching, compound leaves and winged samaras.
- Generically, ash are early-mid successional species, tolerant of a variety of habitats (from seasonally flooded to upland forests).
- Green ash, white ash and black ash are most prominent in Midwest/Eastern US











Elm/Ash and the importance of riparian forests

- Anthropogenic change has resulted in the destruction of more than half riparian forests across the continental United States (Fredrickson & Reid 1986).
- Riparian forests provide critical ecosystem services (Macdonold 2004; Jones et al. 2010)
  - Stabilizing streambanks/ erosion control
  - Reducing runoff
  - Buffering flood risk/dissipate flood energy
  - Improve water quality
  - Host unique biodiversity
- Riparian buffers frequently serve as corridors for species migration and possess disproportionately more plants and animals relative to adjacent areas (Jones et al. 2010)
- These systems enhance human health, provide aesthetic beauty, and improve the environmental quality of urban systems and local economies.
- Despite their ecological, economic and societal benefits riparian forests have been largely neglected across urban environments.

Dutch elm disease (DED)

Caused by *Ophiostoma ulmi* and *Ophiostoma novo-ulmi*

ELM THREAT

A dead elm tree is a silent threat to all living elms. It may serve as a breeding place for elm bark beetles which transmit the lethal Dutch elm disease. Cut down and burn all dead trees. If the tree cannot be removed now, at least strip and burn the bark, which might be a shelter for the beetles.

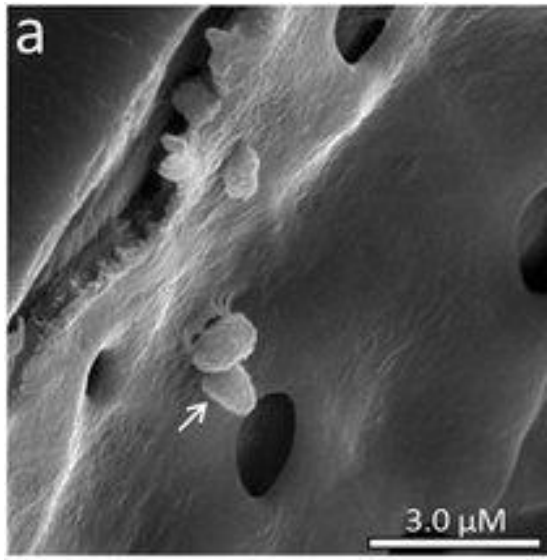
NYT Sept 30, 1956

Scanning electron micrographs of mycelial growth of *O. ulmi* in elm xylem vessels.

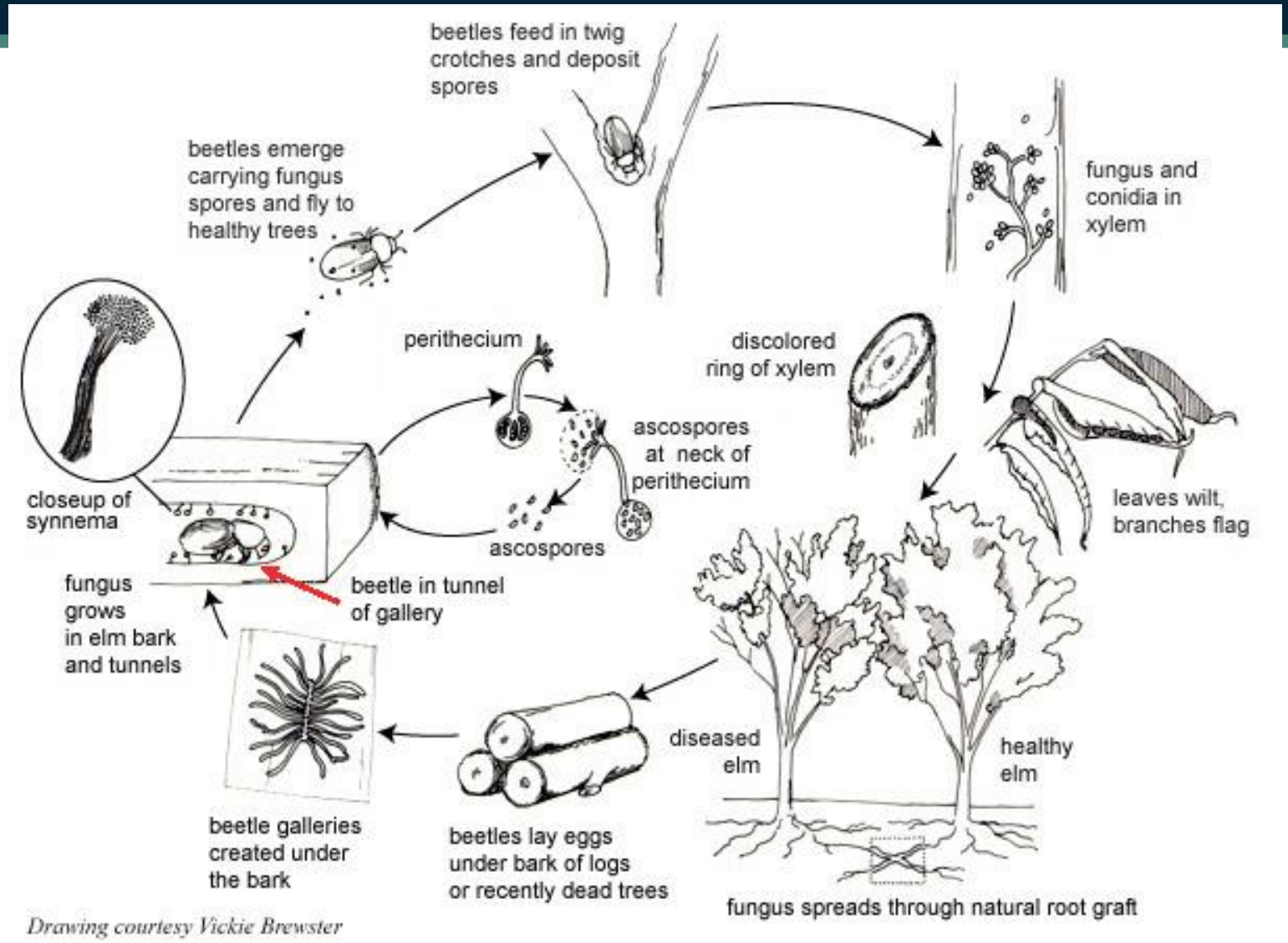
www.dutchelmdisease.org

Smaller European elm bark beetle

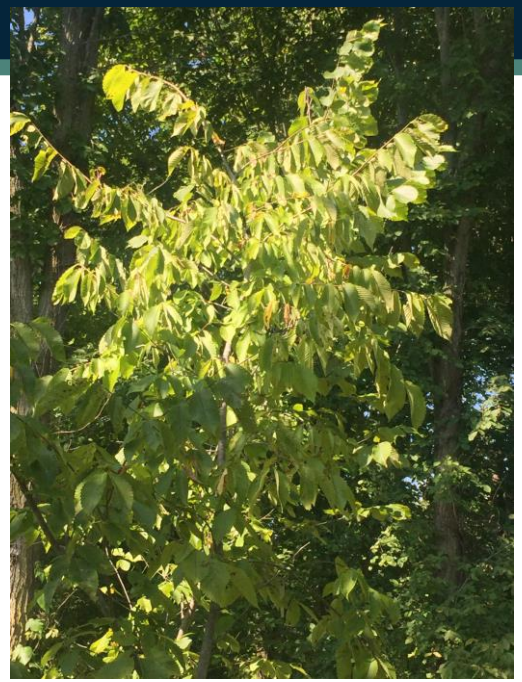
Dutch elm disease



Sherif et al. 2016 Scientific reports. 6:21934.



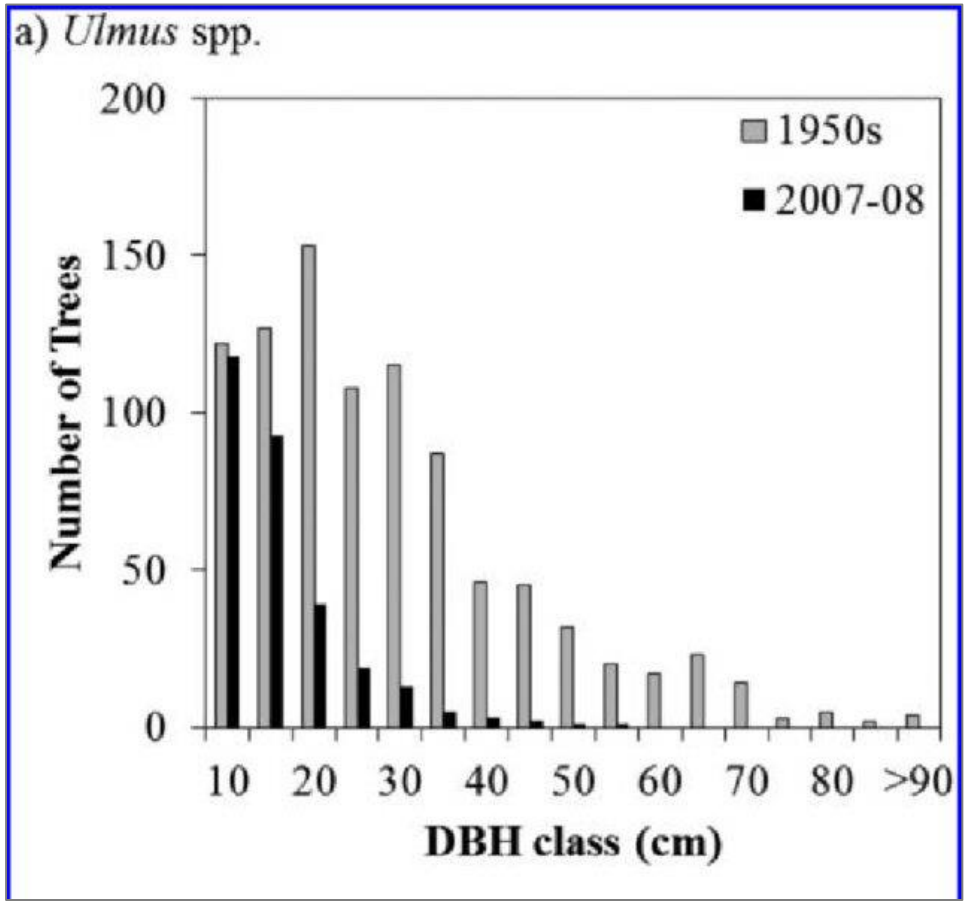
Dutch elm disease symptoms



Dutch elm disease impact on elm populations

The smaller European elm bark beetle side view.

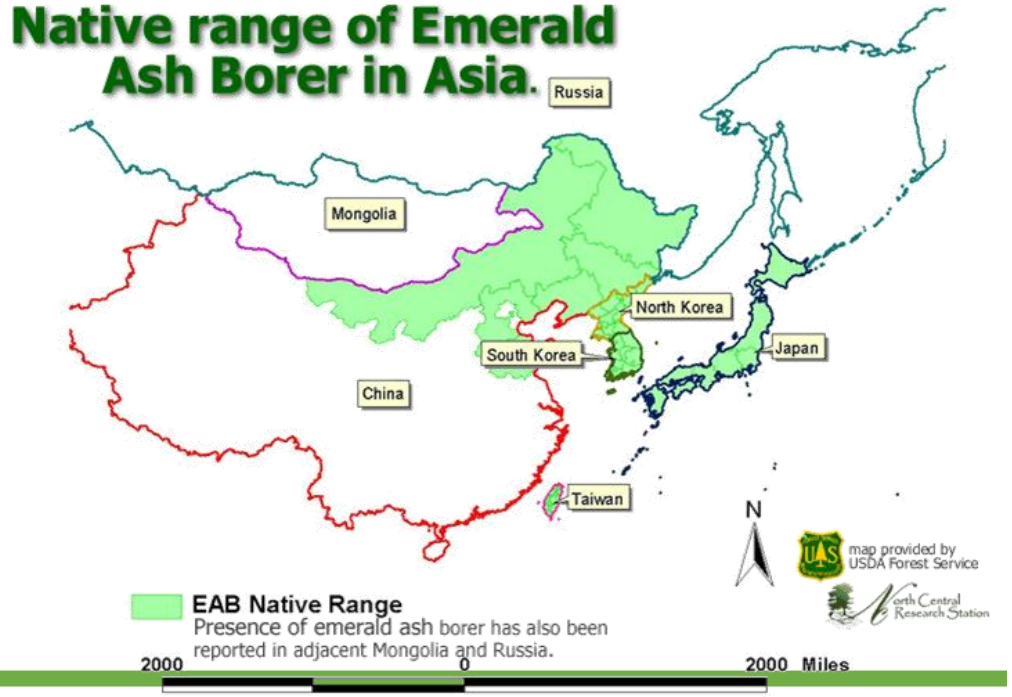
Photo by Mike Ferro



Change in elm diameter distribution in lowland forests of southern Wisconsin (Johnson & Waller 2012)

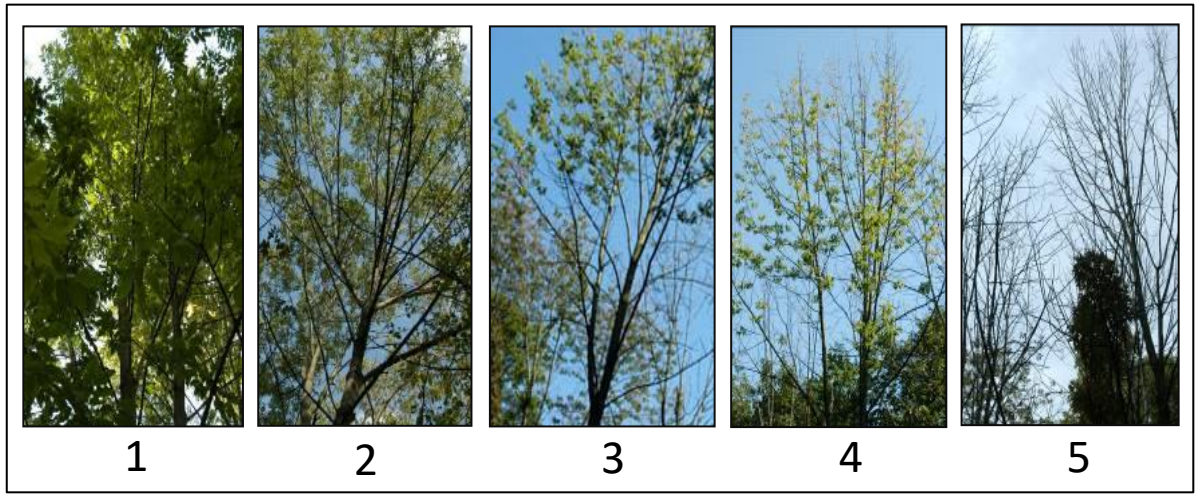
Emerald Ash Borer (EAB; *Agrilus planipennis*)

- EAB is a tree boring beetle
- Accidently introduced into SE Michigan from Asia in the 1990's and first discovered in 2002.
- It predominantly feeds on ash (*Fraxinus* spp.) trees, but also white fringetree.



EAB: Tree Level Impacts

- Tree-level EAB larval densities are correlated with a decline in canopy health.
- This is caused by larval feeding galleries that girdle cambial tissue impacting mass flow resulting in progressive water stress



Flower et al. 2013 - *For. Ecol. & Mgt.*; Flower et al. 2018 - *Forests*

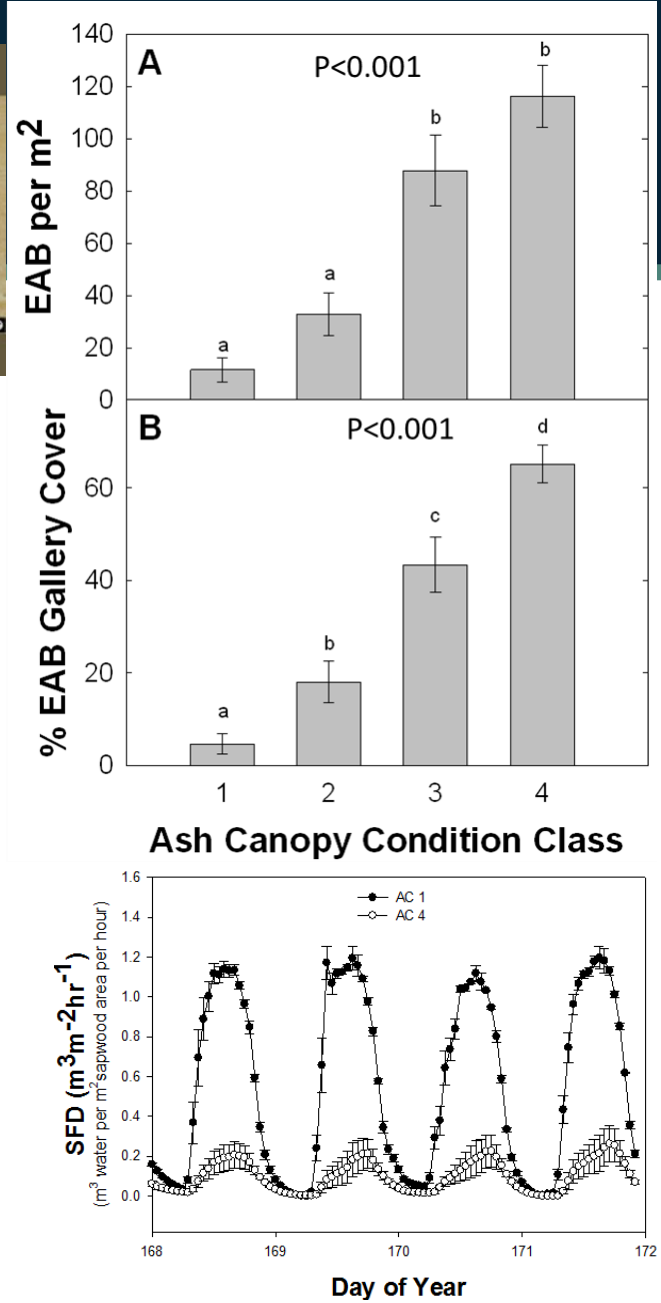
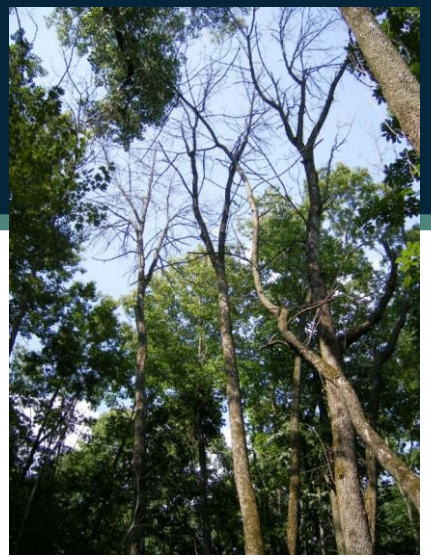


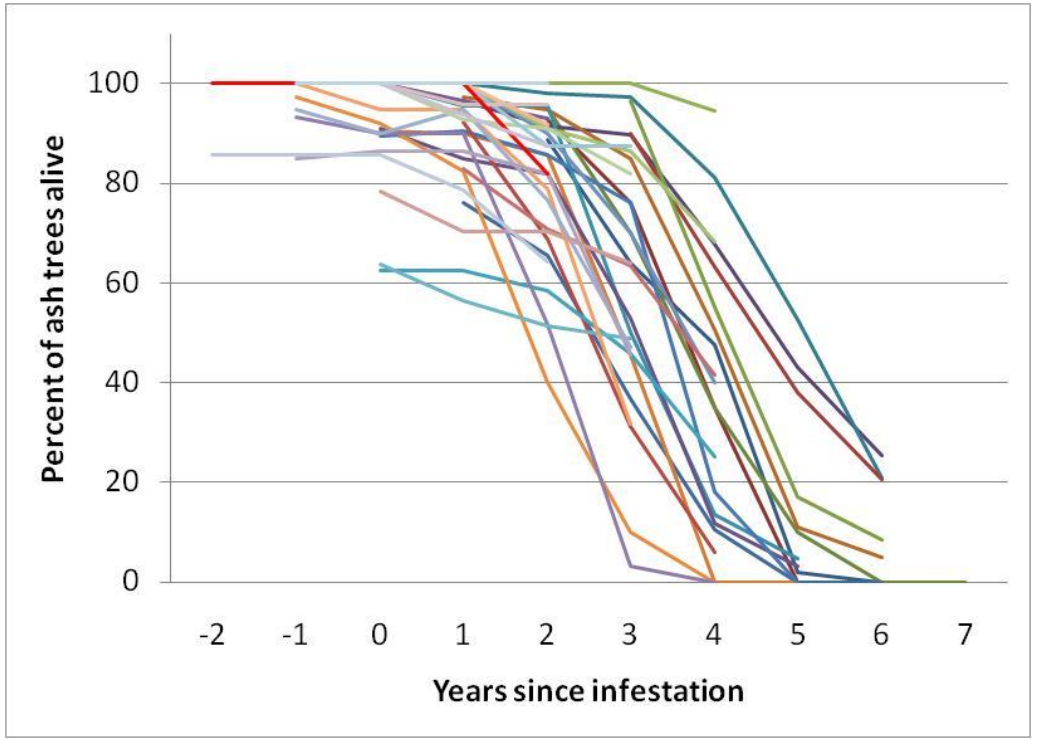
Figure: Sap flux density across 4 days. AC1= low vs. AC4= high infestation levels.

EAB: Tree Level Impacts



- EAB pressure generally result in rapid tree mortality in ~2-5 years and can wipe out a site in ~4-7 years.
  - Based on mortality data from Toledo, OH
    - 2005-2009 (Knight et al. 2013)
    - 2005-2011 (Flower et al. 2013)
    - 2005-2011 (Costilow et al. 2017)

- Mortality was contingent in part on initial ash canopy health, crown class, site conditions (hydrologic class/species), and density.
  - A dilution effect was observed in high density ash sites prolonging survival.



Knight et al. 2013 – *Biol. Inv.*

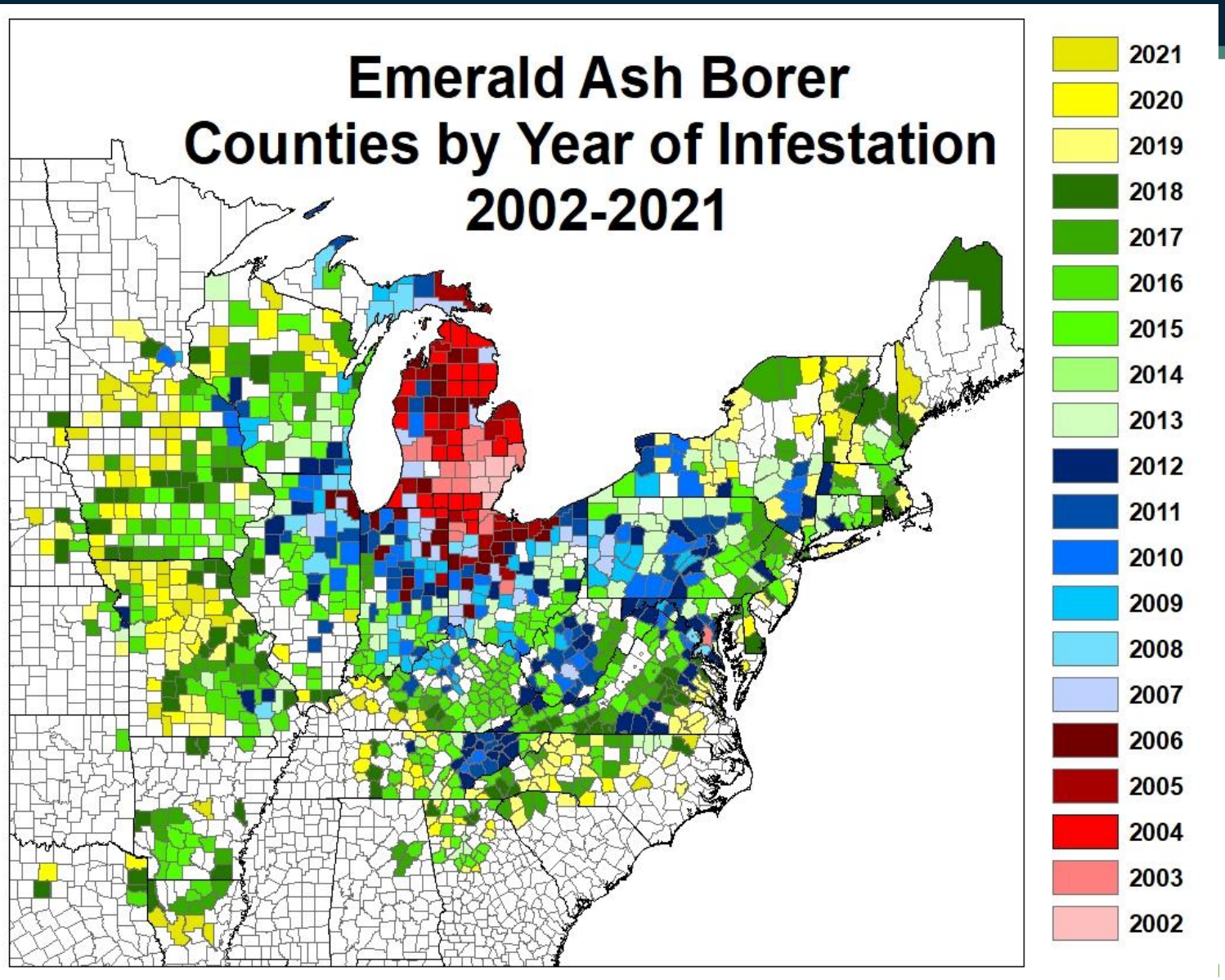
EAB: Tree Level Impacts

- Watch for falling trees!
- They are easier and safer to remove alive.

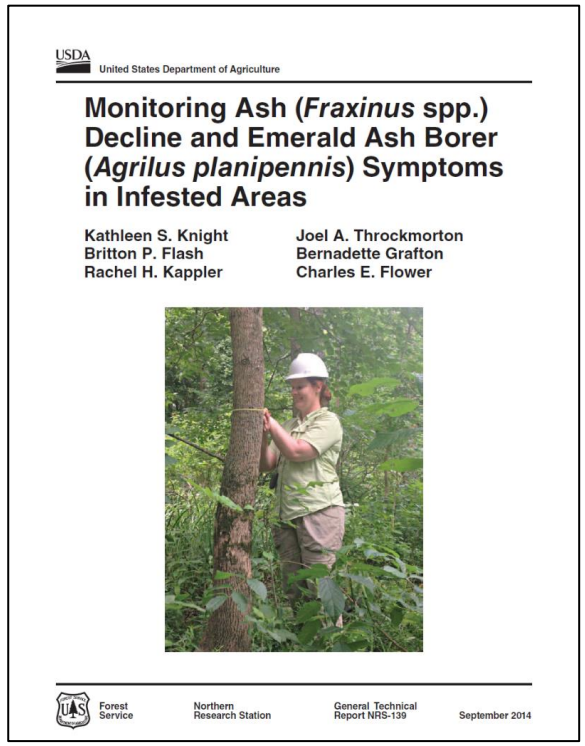
We tracked >1,100 individual trees across our NE OH monitoring network and aligned the year of mortality to understand how quickly the dead ash trees fall.

Knight et al. in prep

US EAB County level detections



EAB Forest Ecosystem Impacts


USDA United States Department of Agriculture

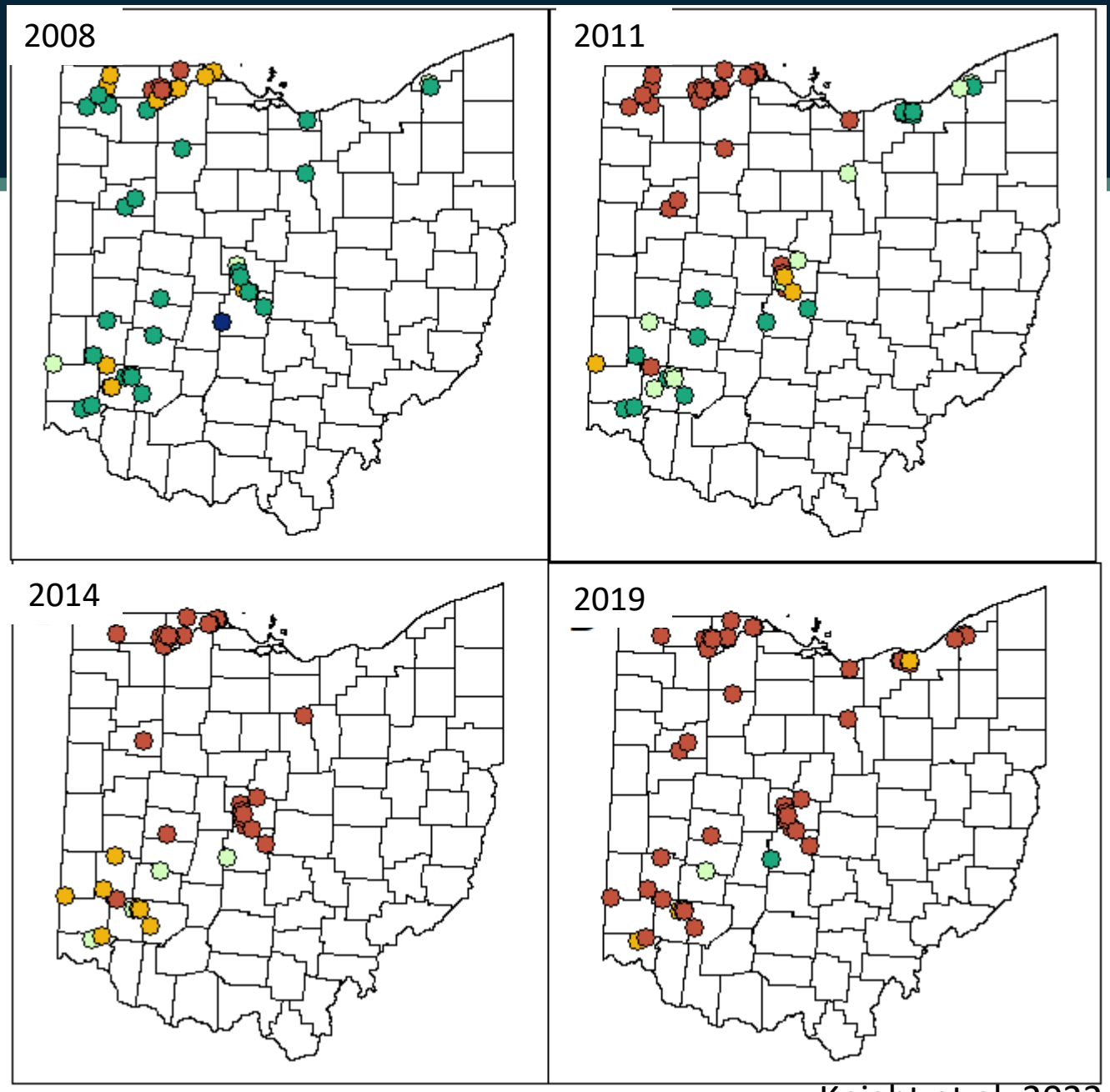
Monitoring Ash (*Fraxinus* spp.) Decline and Emerald Ash Borer (*Agrilus planipennis*) Symptoms in Infested Areas

Kathleen S. Knight, Britton P. Flash, Rachel H. Kappler, Joel A. Throckmorton, Bernadette Grafton, Charles E. Flower

Forest Service | Northern Research Station | General Technical Report NRS-139 | September 2014

Average Canopy Health

- 0.00 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00

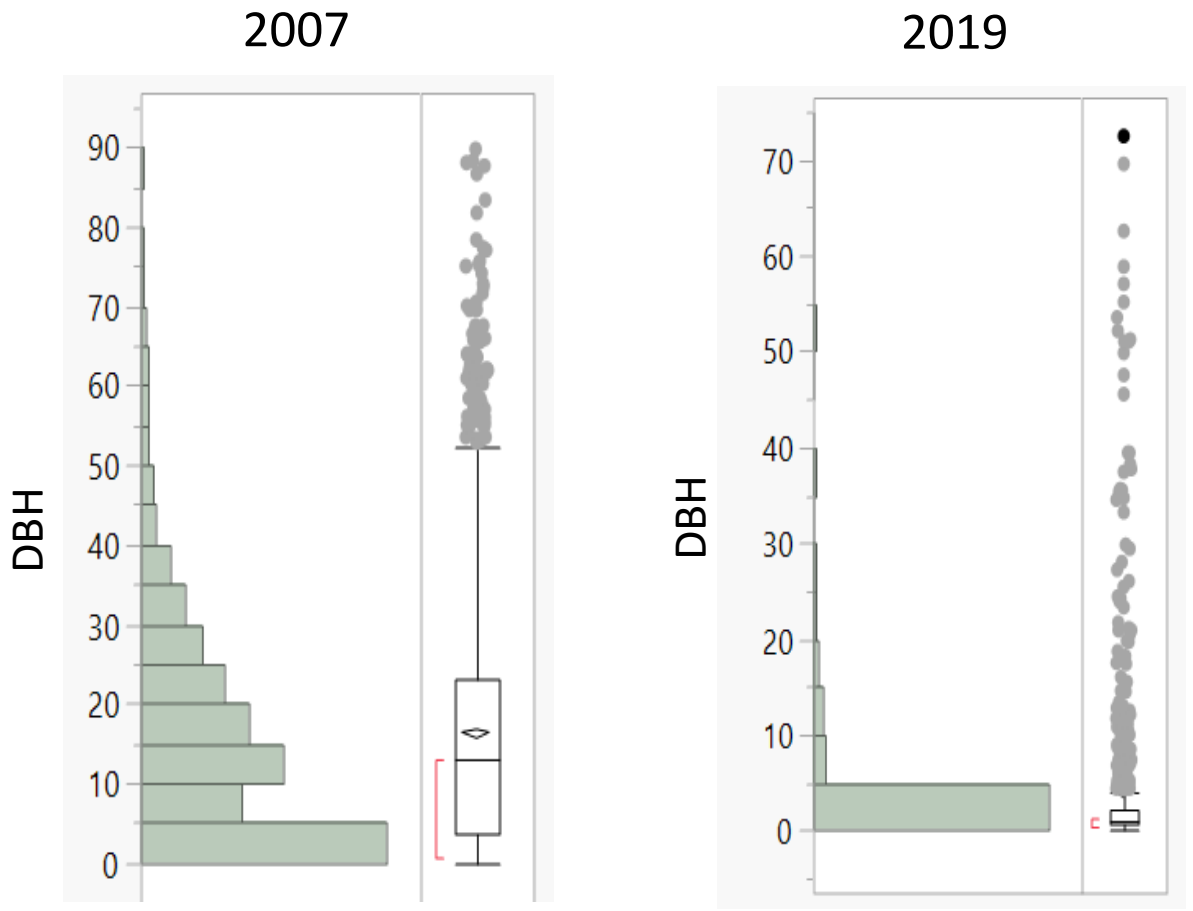


>3000 ash trees tracked individually
>6000 total trees tracked individually
2005-2021
5 ash species, range of ash densities and habitats

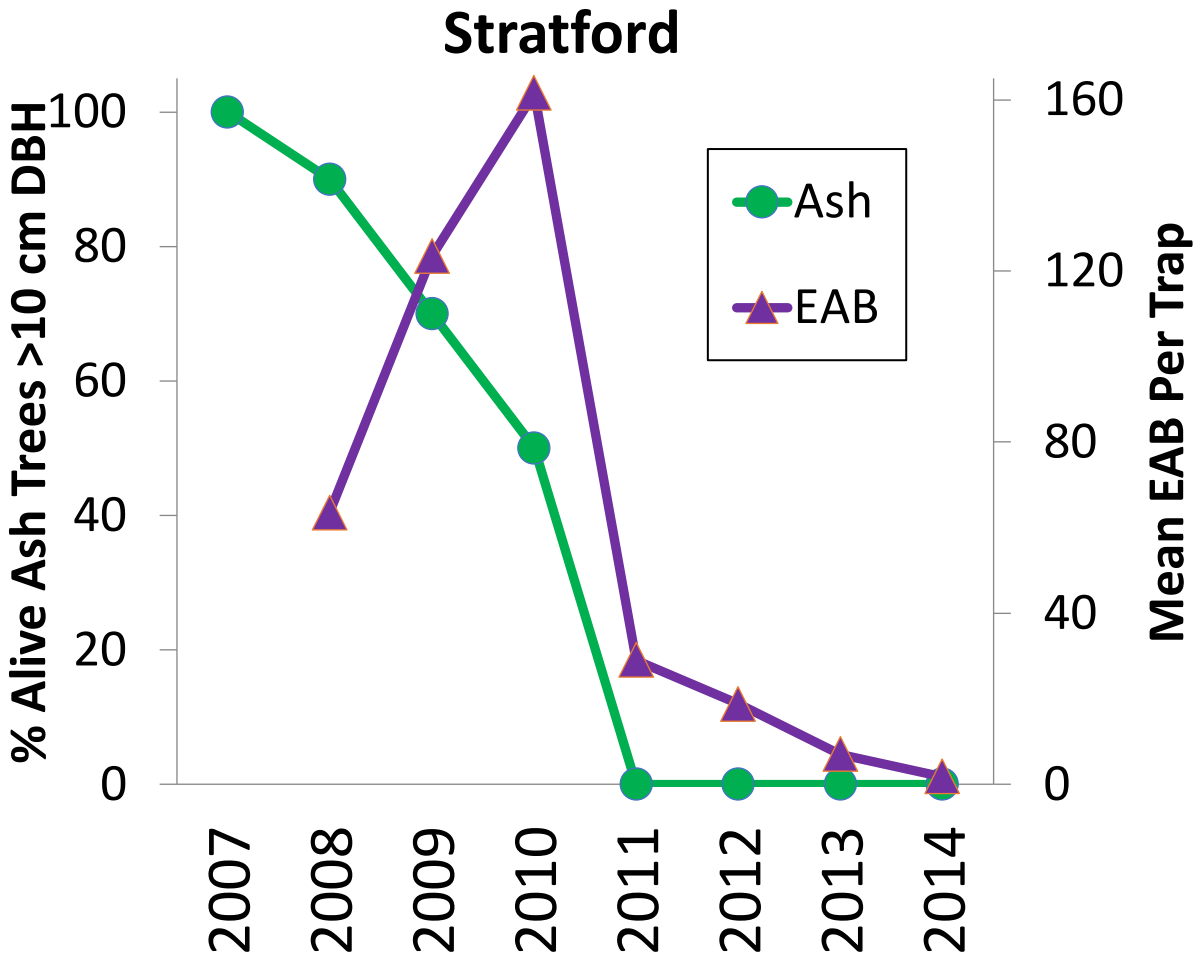
Knight et al. 2022

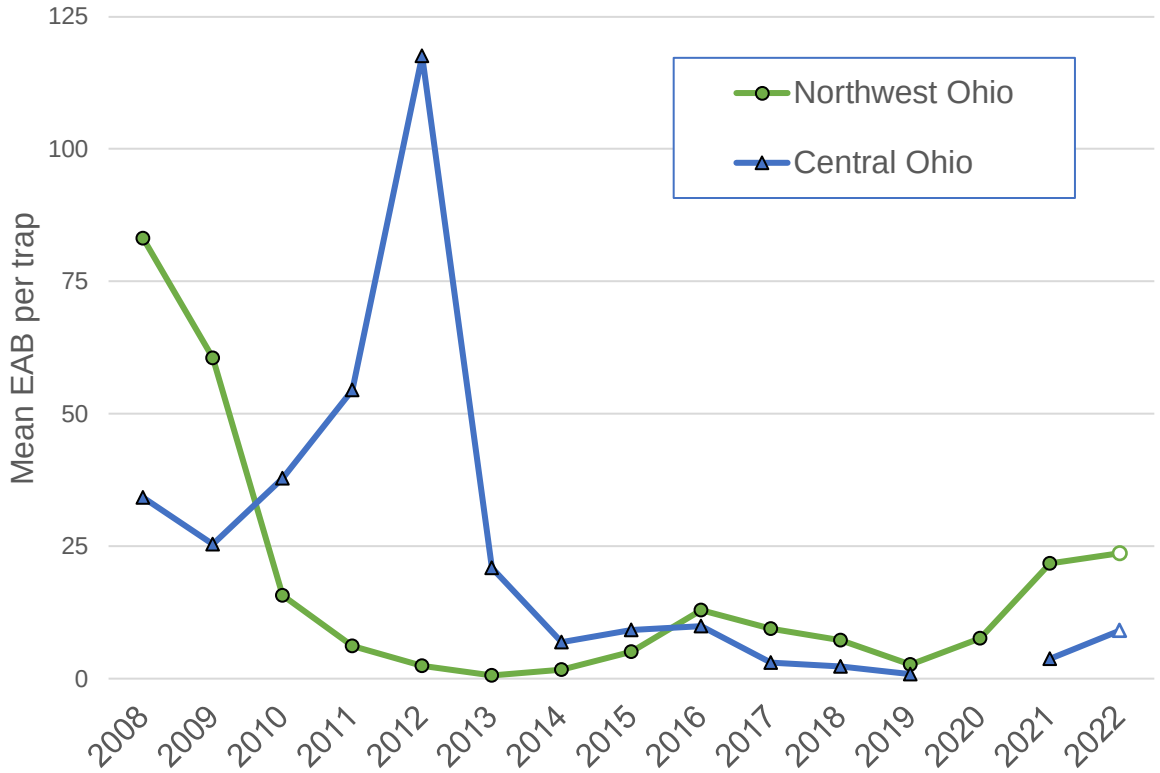
Ash Survival in OH

- By 2019 fewer than 3% of the ash trees in our Ohio monitoring plots were alive.
  - The survivors exhibited considerable variability with some healthy trees as well as many in decline.
- We observed some differences in survival between species with blue, green and pumpkin ash holding up better than white and black ash.

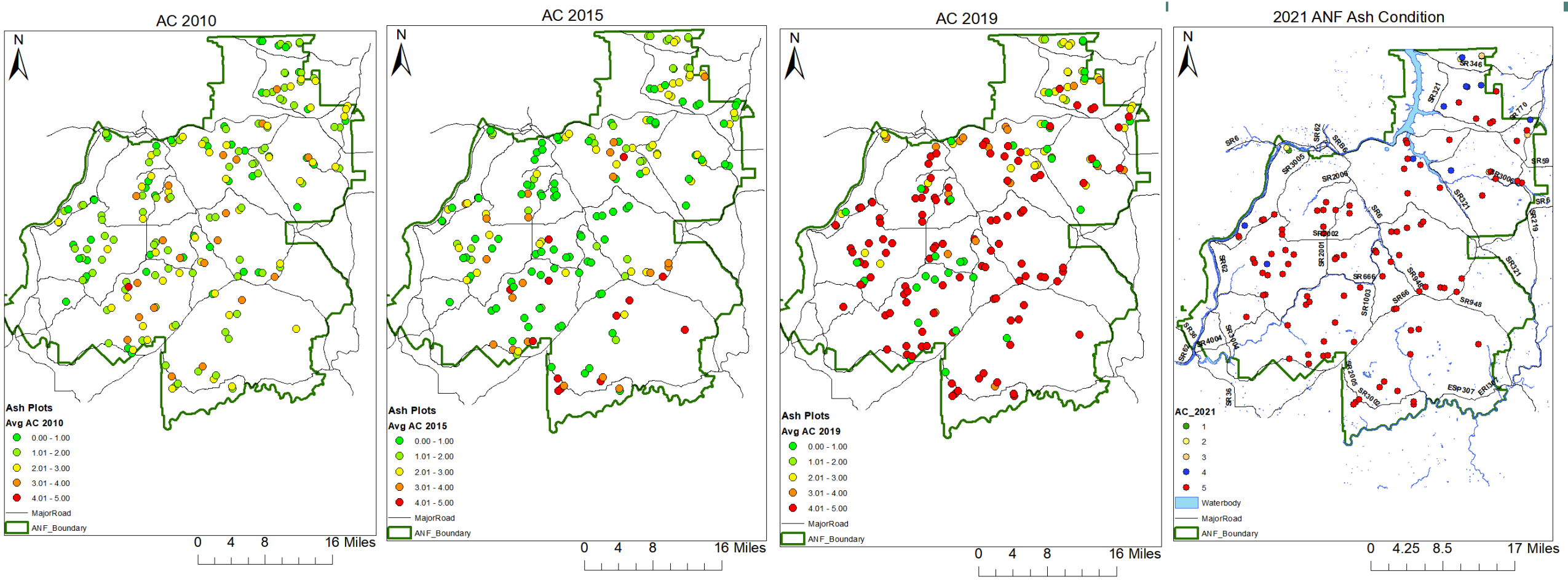


EAB Population Dynamics





Ash Mortality on the ANF

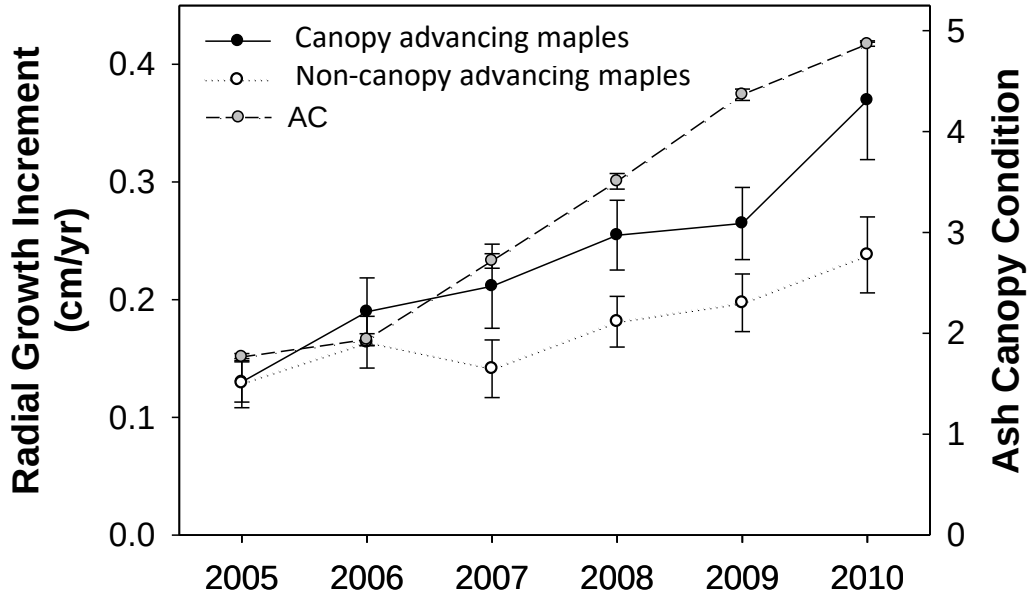


- 180 prism plots monitored periodically across the ANF beginning in 2010 prior to EAB.

Partnership between ANF, NRS, S&PF, and Partners

Mitigation Opportunities: Restoration

- Plant Early!
- Since ash/elm frequently occurs in ecologically sensitive forests, maintaining ecosystem function is of utmost importance.
- To this end, we have initiated several different restoration experiments in riparian/floodplain systems across OH, NY and elsewhere.



➢Results from permanent EAB plots indicate rapid radial growth of residual trees in tandem with ash decline.

Costilow et al. 2017 – Ann. For Sci. 74:10

Conclusions & Implications for Management

- Elm and Ash are widespread, foundational species critical to a myriad of important forest ecosystem types.
- DED and EAB are impacting and continue to impact forests across the eastern US.
- The progression and patterns of mortality are predictable allowing for planning/management.
- Removal/silvicultural efforts have generally proven ineffective at meaningfully slowing the spread.
- An integrated pest management framework combining different science-based strategies may be most effective at preserving the genera as well as maintaining ecosystem functions.
- Mitigation options including insecticides, fungicides, and biocontrol may be effective at preserving healthy trees and reducing pest/pathogen densities.
- Breeding efforts will be critical for producing genetically diverse pest/pathogen resistant material for natural forests.
- Tree planting in sensitive systems can help maintain functioning ecosystems.

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  - Cornelia Pinchot/Kathleen Knight (USDA FS NRS 16)
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