



Genetic Variation is the Key To Resistance



Can a native tree species have resistance to non-native insects & diseases?

Natural stands have LOTS of genetic variation!

- Basis for tree improvement since the early 1950's
- Rare genes can confer resistance without co-evolutionary history
- Rare because no selective advantage prior to invasive threat
- If remaining trees are too few and far apart to cross-pollinate, extinction may occur
- **Breeding programs can provide solution!!**

What does Resistance Really Look Like?

(Schneider & Ayres Nature Reviews, 2008, 889-895)

Resistance: the ability of a tree to limit, or partially limit, insect growth (impact of tree on insect)

Resistant trees may simply live longer than susceptible trees!

(and can be improved further through breeding!!!!)

Genetically Diverse Population: Range of Phenotypes

Types of Resistance

Susceptible

Partial Resistance

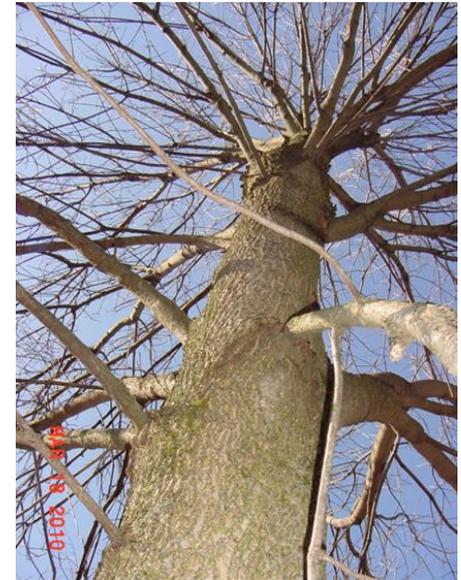
Resistant



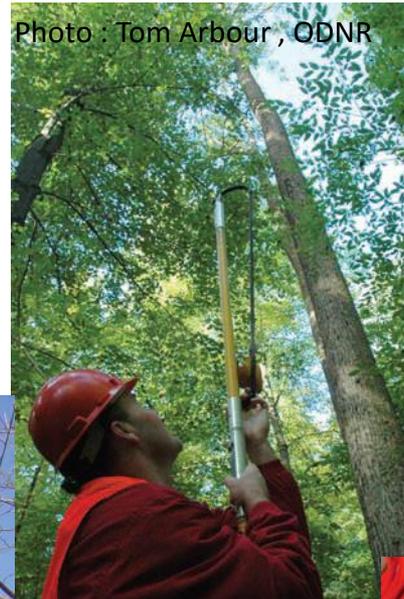
(Common)

(Infrequent)

(Rare)



Scion Collection



Grafting



Hot-Callus Top Grafting



Grafted clones of a lingering ash selections

Field Test to Confirm EAB-Resistance



- Holden Arboretum, Oh
- 10 grafted replicates
- 40 lingering green ash
- 8 lingering white ash
- Known susceptible grafted green and white ash controls
- Second planting installed near FS lab in Delaware



EAB Egg Bioassay

(assess resistance phenotype)

Therese Poland Research Entomologist
USFS



**Coffee filter with eggs
affixed to bark**

**Three grafted replicates of
each genotype**

EAB Egg Bioassay

Metrics:

- Egg hatched Y/N
- Larval outcome:
L1, L2, L3, L4,
Host-killed
- Larval weight

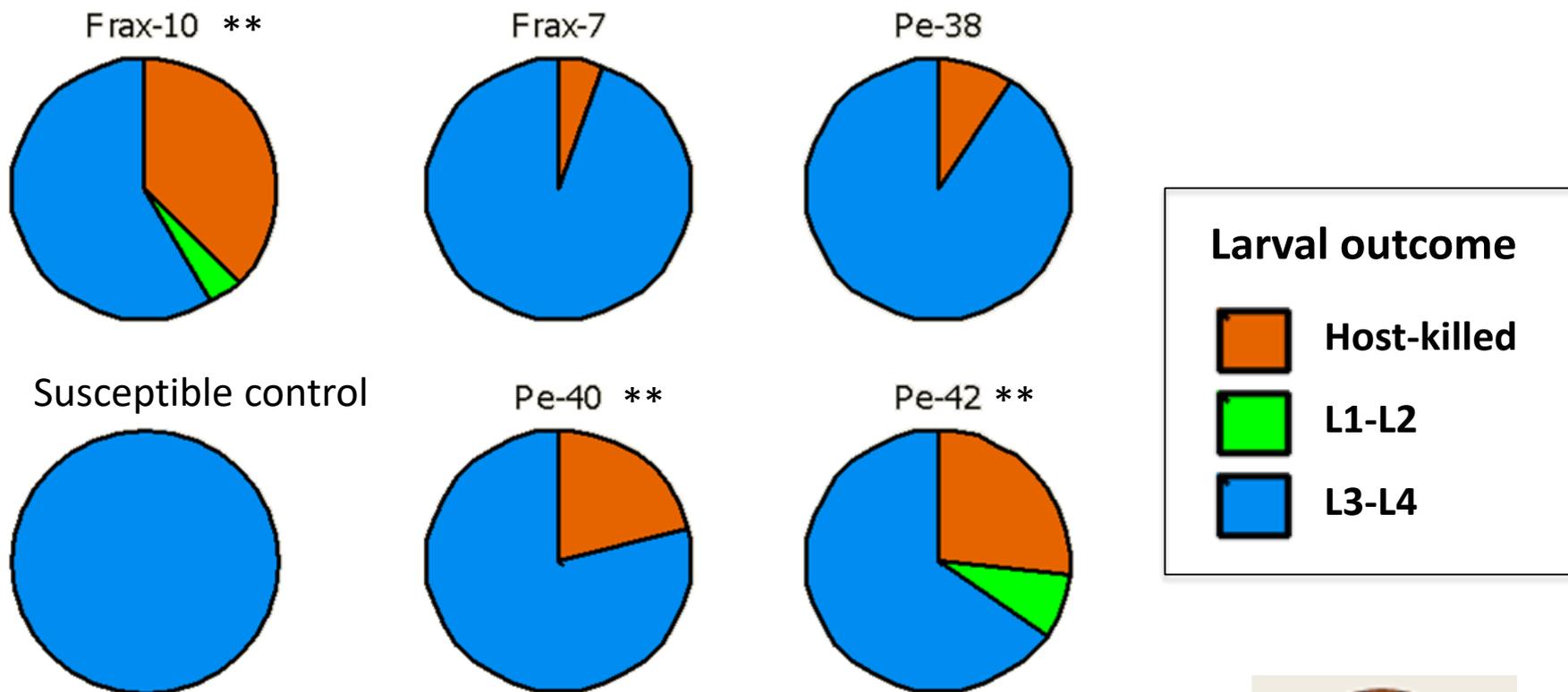


Healthy larva

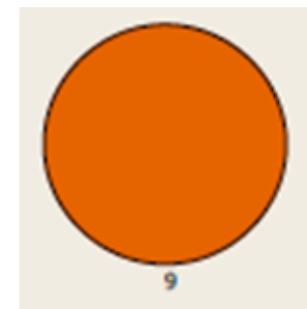


Host-killed larva

A Sample of Initial Results: Green Ash

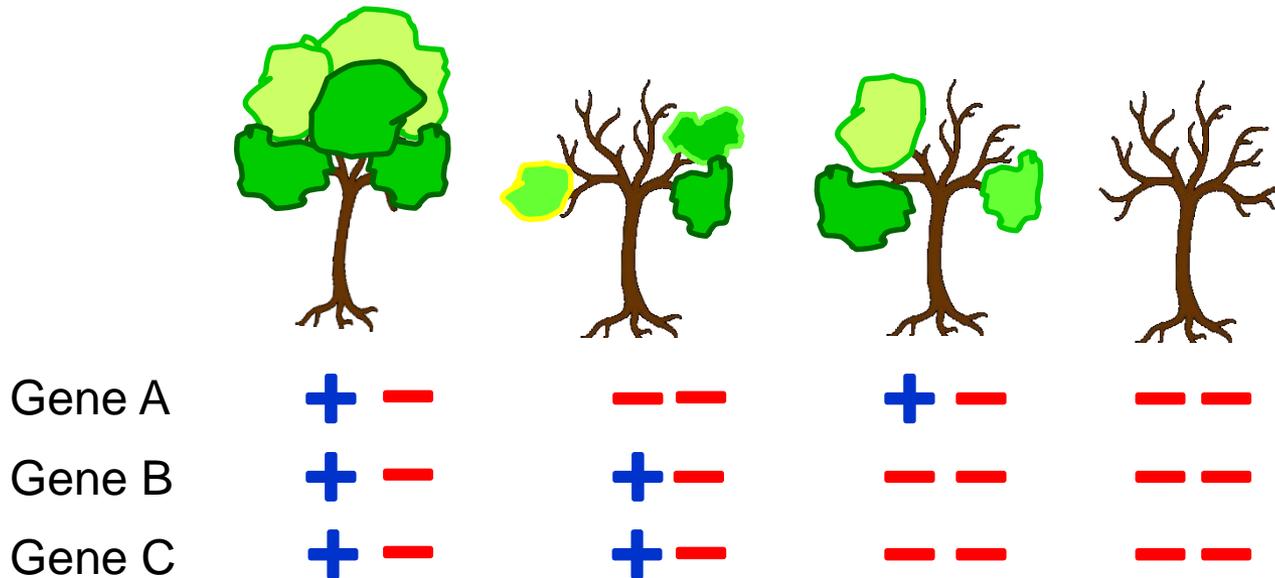
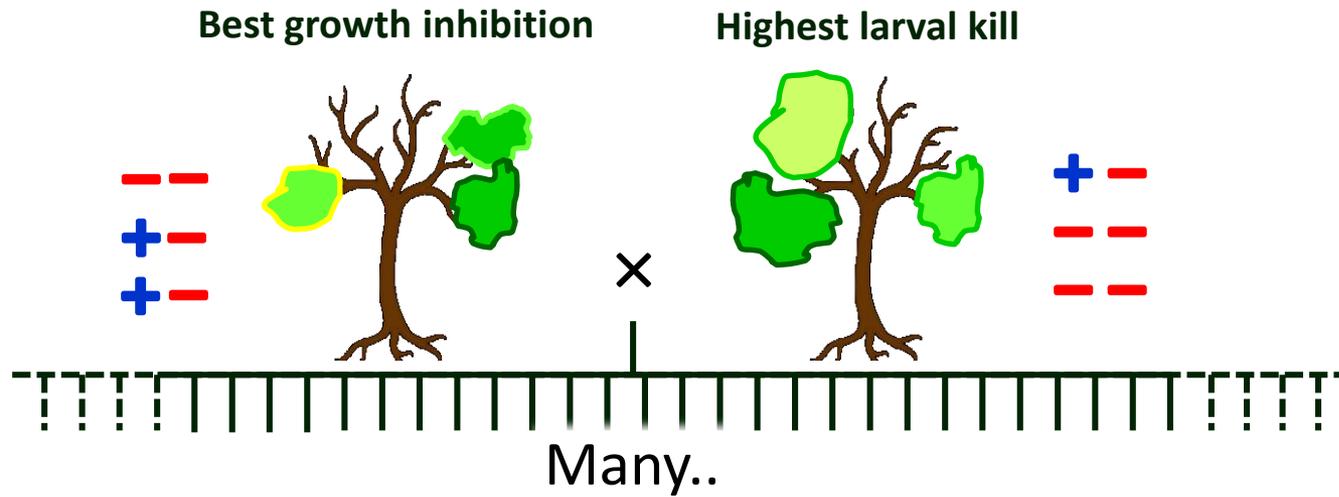


- Similar 'lingering ash' canopy phenotypes
- Different larval outcomes
 - ✓ high # of host-killed
 - ✓ delayed development



EAB- Resistant
Manchurian Ash

Breeding allows combining best genes from each parent!



Further improvement with each generation!

Category

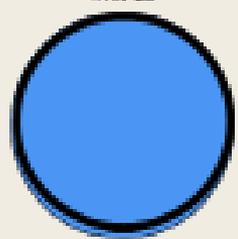
- host-killed EAB
- L1-L2
- L3-L4

Lingering Ash Parents

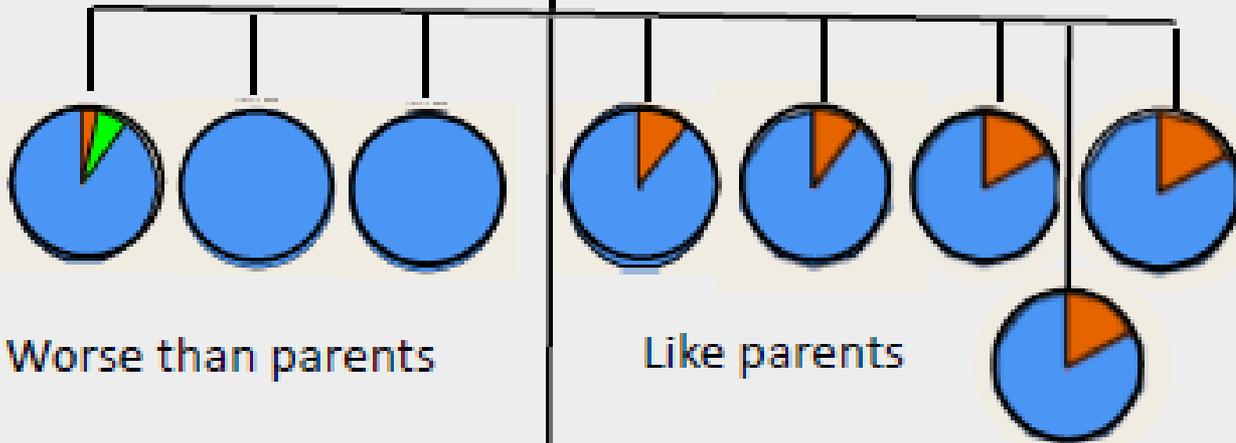
PE-L38



PE-L41



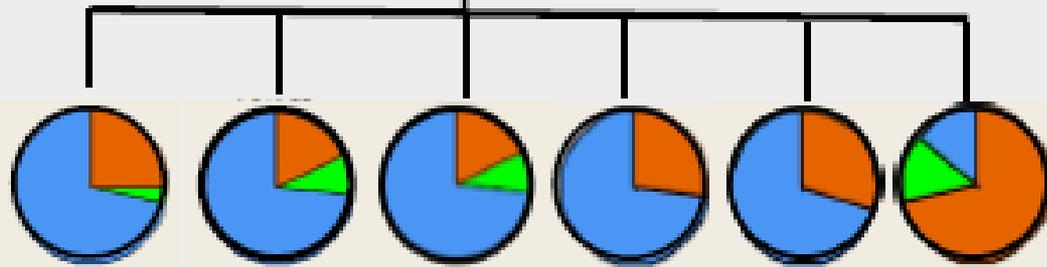
Susceptible Control



Worse than parents

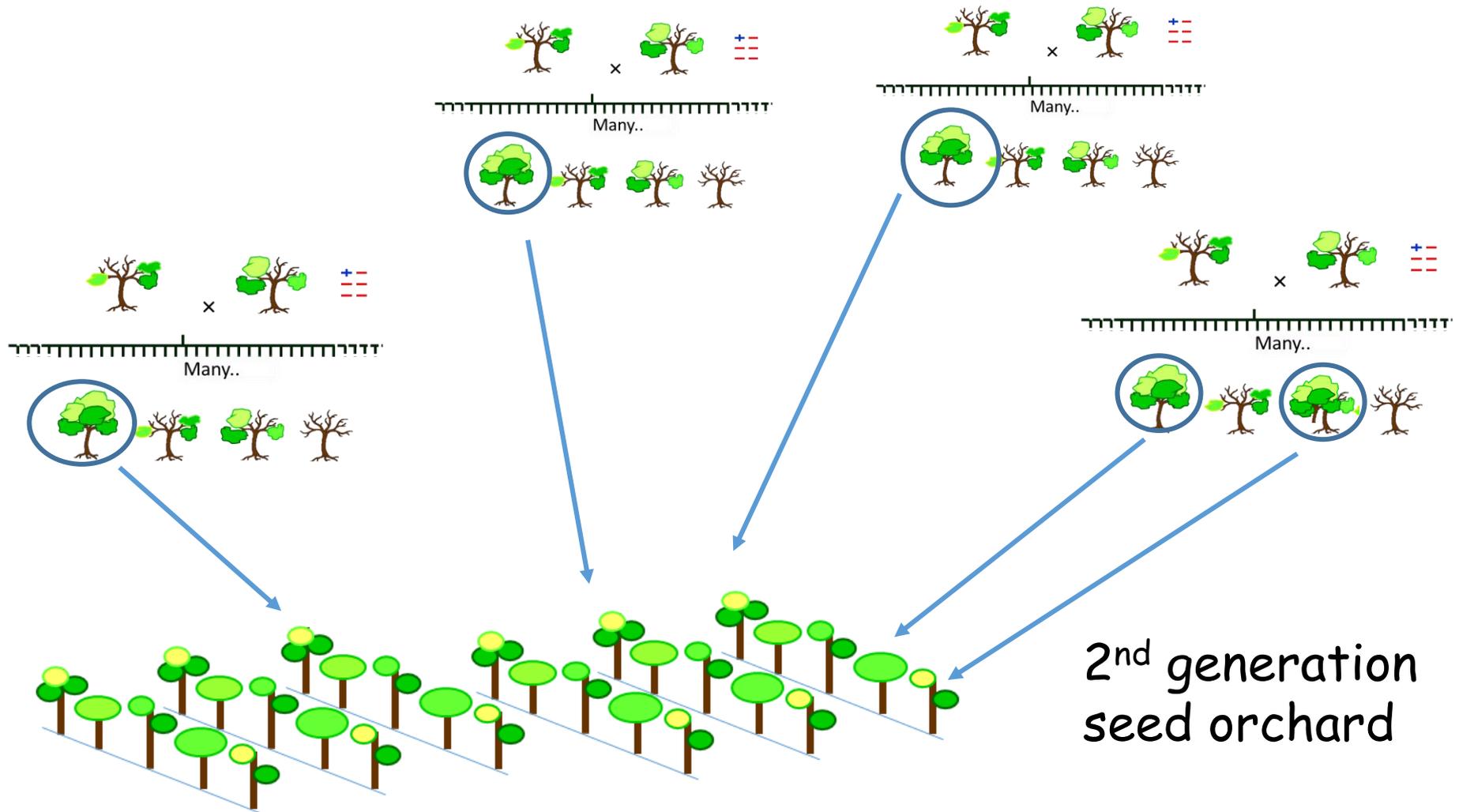
Like parents

F1 Progeny



Better than parents (N=6)

Best from many different L x L crosses



Produce seed with increased defenses against EAB,
retain genetic diversity and adaptive capacity

What can you do to help?

Preserve Lingering Ash:

Lingering ash trees mount a defense response against EAB that can extend life, but they can still die - and the valuable resistance genes they possess will be lost!





Monitor & Report Lingered Ash:

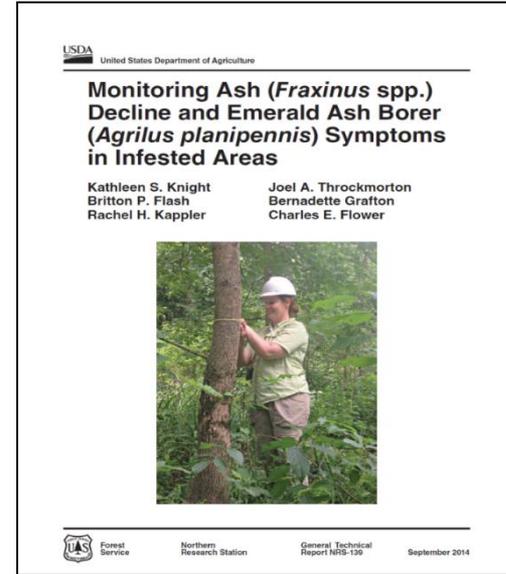
<https://www.fs.usda.gov/treearch/>
(key words monitoring ash GTR-139)

Report a Survivor Ash Tree:
(states & counties to be updated soon)

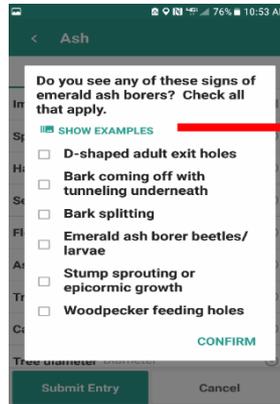
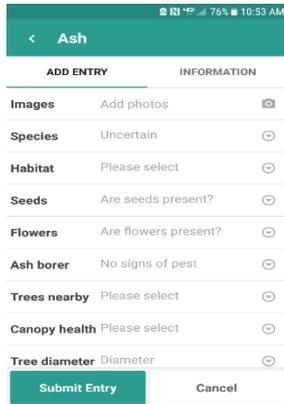
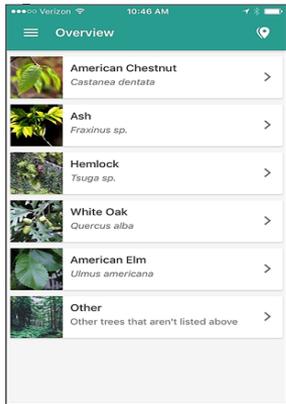
<https://www.fs.fed.us/nrs/tools/ash/>

Treesnap.org

App available at Google Play Store & iTunes Store



Upload photos, enter observations, records GPS files, generates maps



Report healthy & infested trees
Submit annual observations



Resources: Monitoring and Managing Ash Project

Ecological Research Institute
Jonathan Rosenthal and Radka Wildova



Aneccdata
Aneccdata.org

<https://www.aneccdata.org/projects/view/319>

App available at Google Play Store & iTunes Store



Monitoring and Managing Ash
(MaMA) <http://www.monitoringash.org/>

Projects: Ash/EAB Surveys, Ash Mortality Monitoring*,
Lingering Ash Search, Potential Lingering Ash

*participation in this project requires attending a MaMA workshop



Roots of Rock Partnership

- USDA Forest Service, Fender Guitar, American Forests
- Leverage the music industry to play a catalytic role to spark a nationwide movement for forest restoration
- Using ash as a model, expand to other species
- Support research, development and restoration of resistant trees
- Initial planting planned, integrated with Greening of Detroit
- <https://www.americanforests.org/magazine/article/earthkeepers-restoring-the-roots-of-rock/>



Forest Heath Collaborative

- Funded through the Great Lakes Restoration Initiative
- Partnership with USDA Forest Service, American Forests, & the Holden Arboretum
 - Build a network of partners to develop participatory breeding programs
 - Focus on ash, American beech, Eastern hemlock
 - Provide technology transfer of methods to identify & propagate resistant trees, establish test plantings, seed orchards
- More information to come!



Acknowledgements & Funding

The University of Notre Dame

Jeanne Romero-Severson

The Holden Arboretum

David Burke, Charles Tubesing

Roger Gettig

Pennsylvania DCNR

Don Eggen, Mark Faulkenberry

Houping Liu

Michigan DNR

James Wieferich

Indiana DNR

Phil Marshal

Toledo Metroparks

Rachel Hefflinger

Bowling Green State Univ

Rachel Kappler

Huron-Clinton Metroparks

USFS FHP

Amy Hill

Heather Smith

Karen Felton

Ivich Fraser

Rick Turcotte

Funding:

USDA APHIS

USFS FHP (STDP, EM
programs)

MI DNR, Invasive Species
Grant Program

PA DCNR

