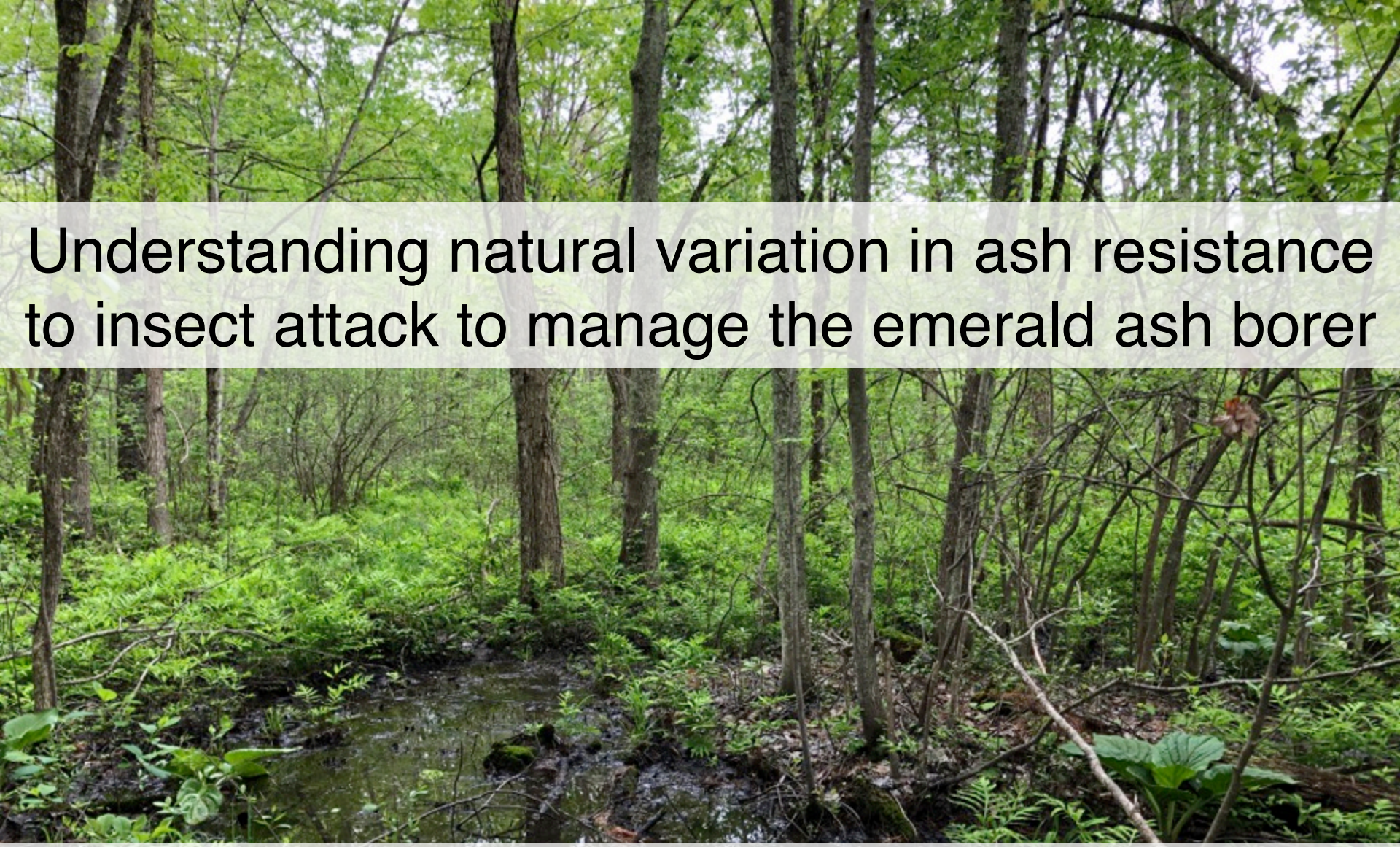


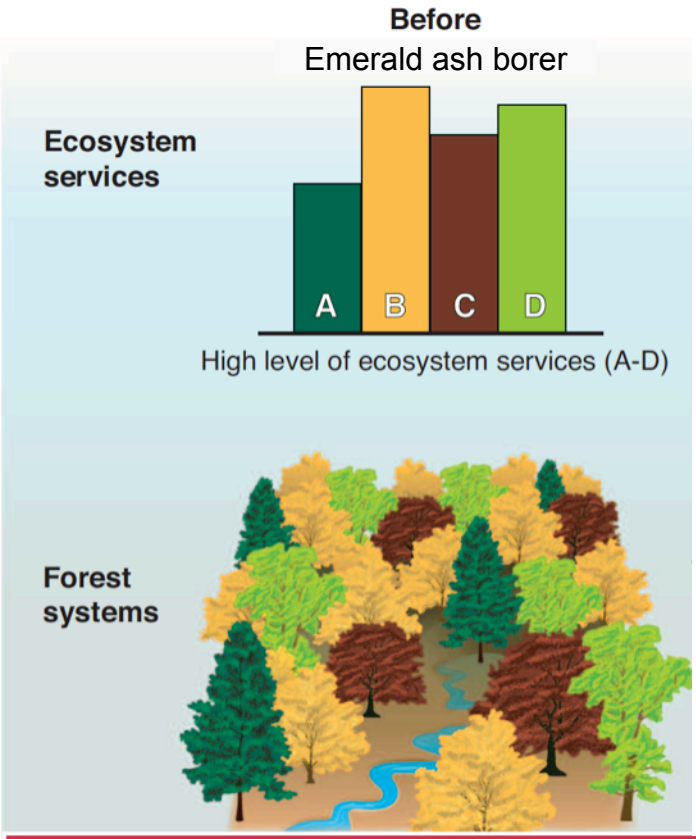
Understanding natural variation in ash resistance to insect attack to manage the emerald ash borer

T.D. Johnson[1], B. Aflague[1], J.R. Gould[2], and J.R. Garnas[1]
[1]University of New Hampshire, [2]USDA-APHIS Buzzards Bay, MA

Ecosystem services are direct or indirect contributions by ecosystems to human well-being

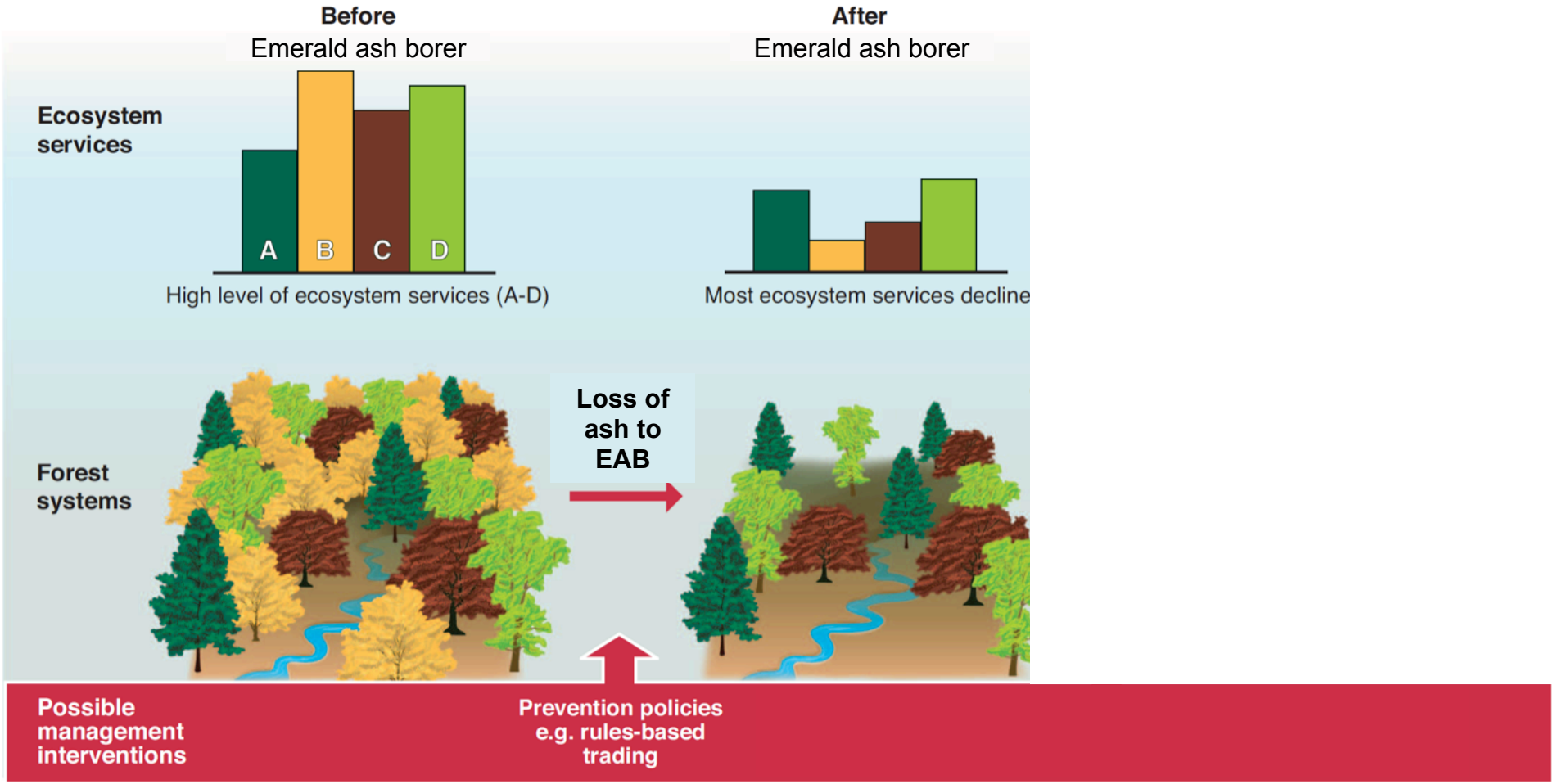
FAO 2014

Forests provide a diverse complement of ecosystem services that benefit humanity broadly



Modified from: Boyd et al. 2013 Science

Pests can negatively affect the amount and type of ecosystem services provided by forests



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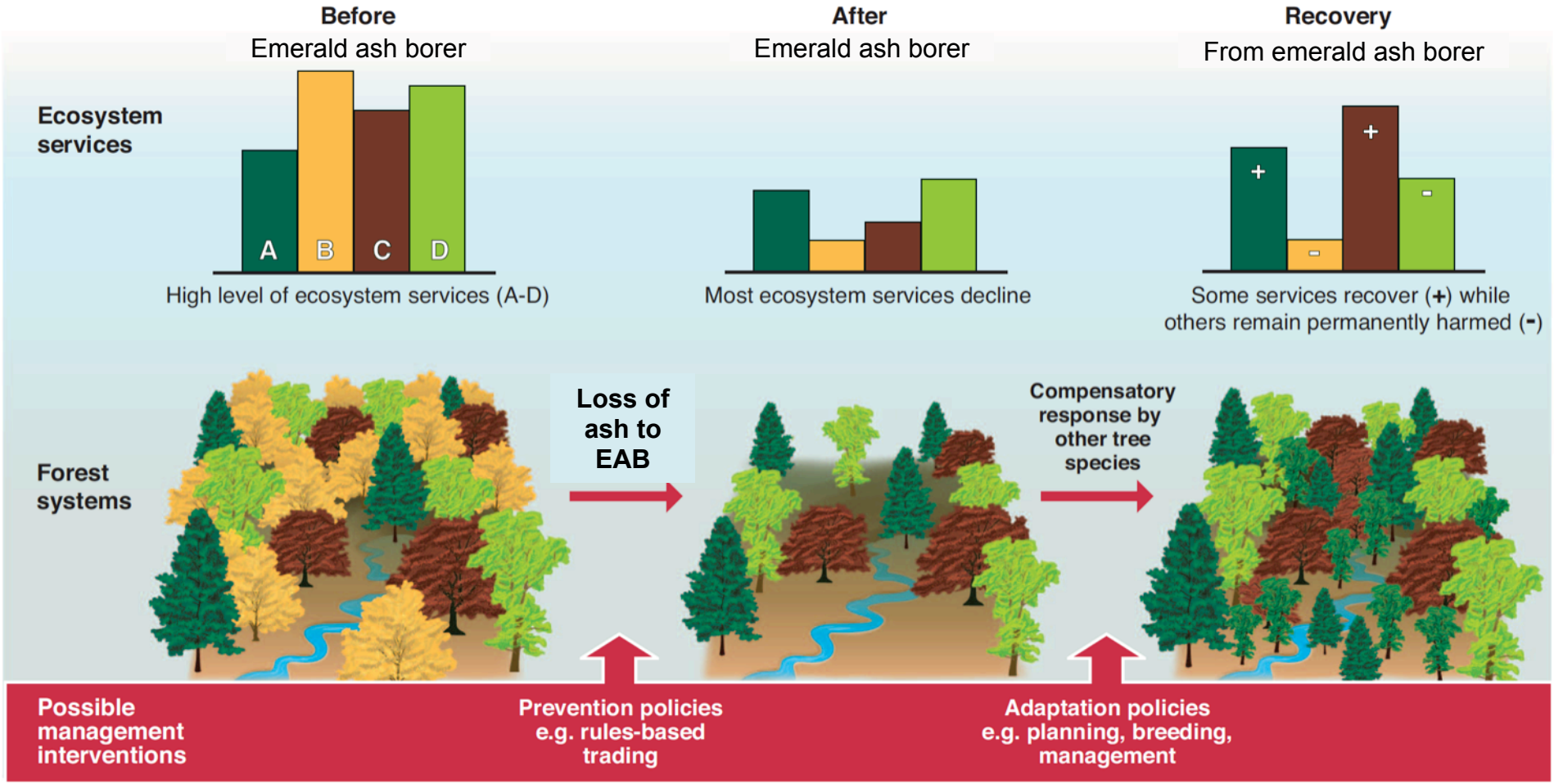
Pests can permanently alter the availability of ecosystem services in forests



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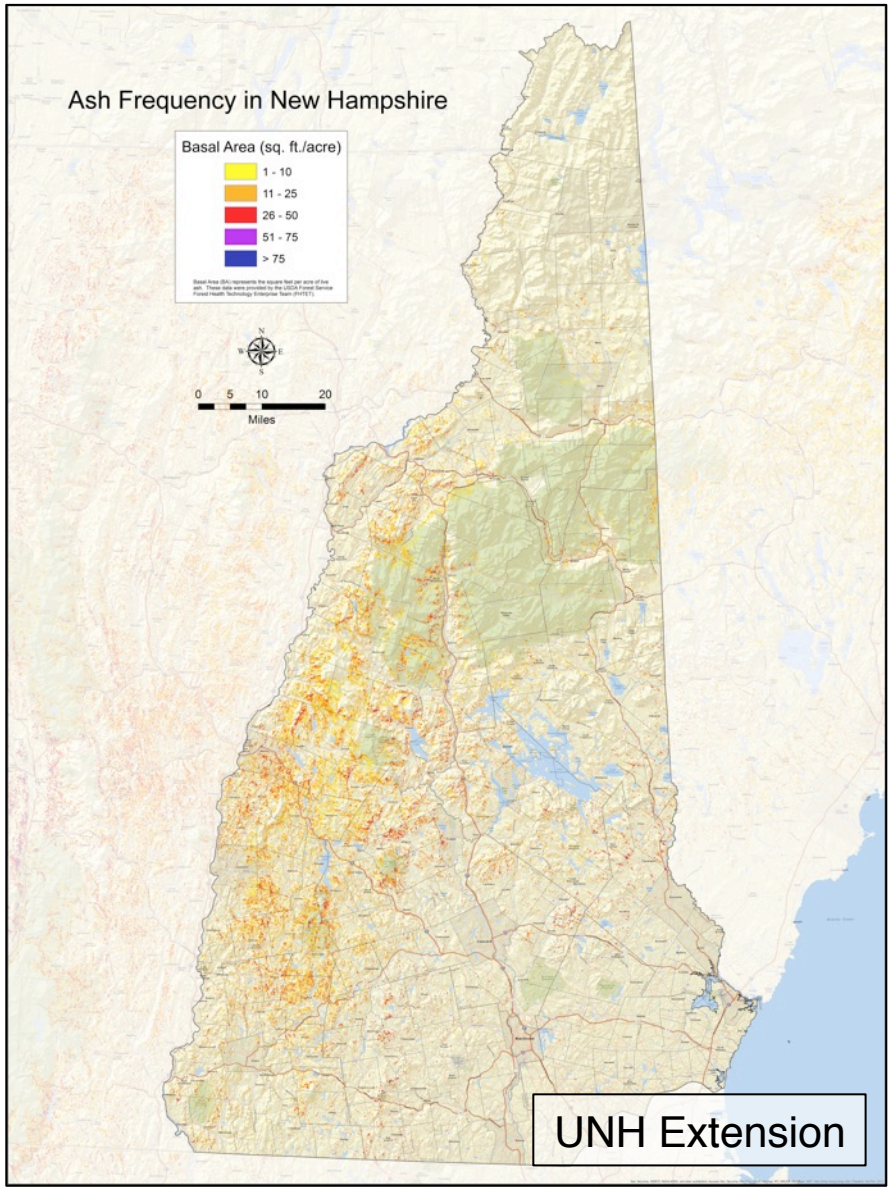
New Hampshire has three native species of ash that are threatened by the emerald ash borer



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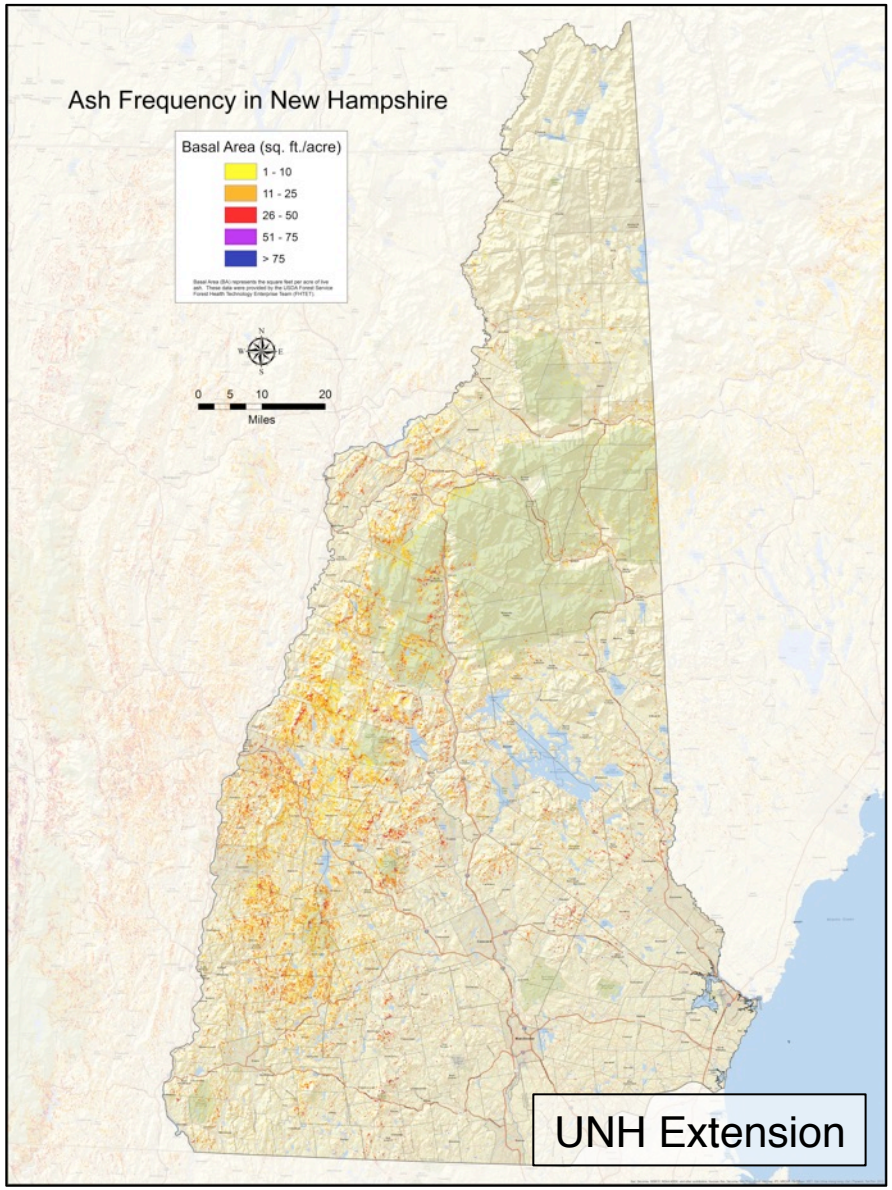
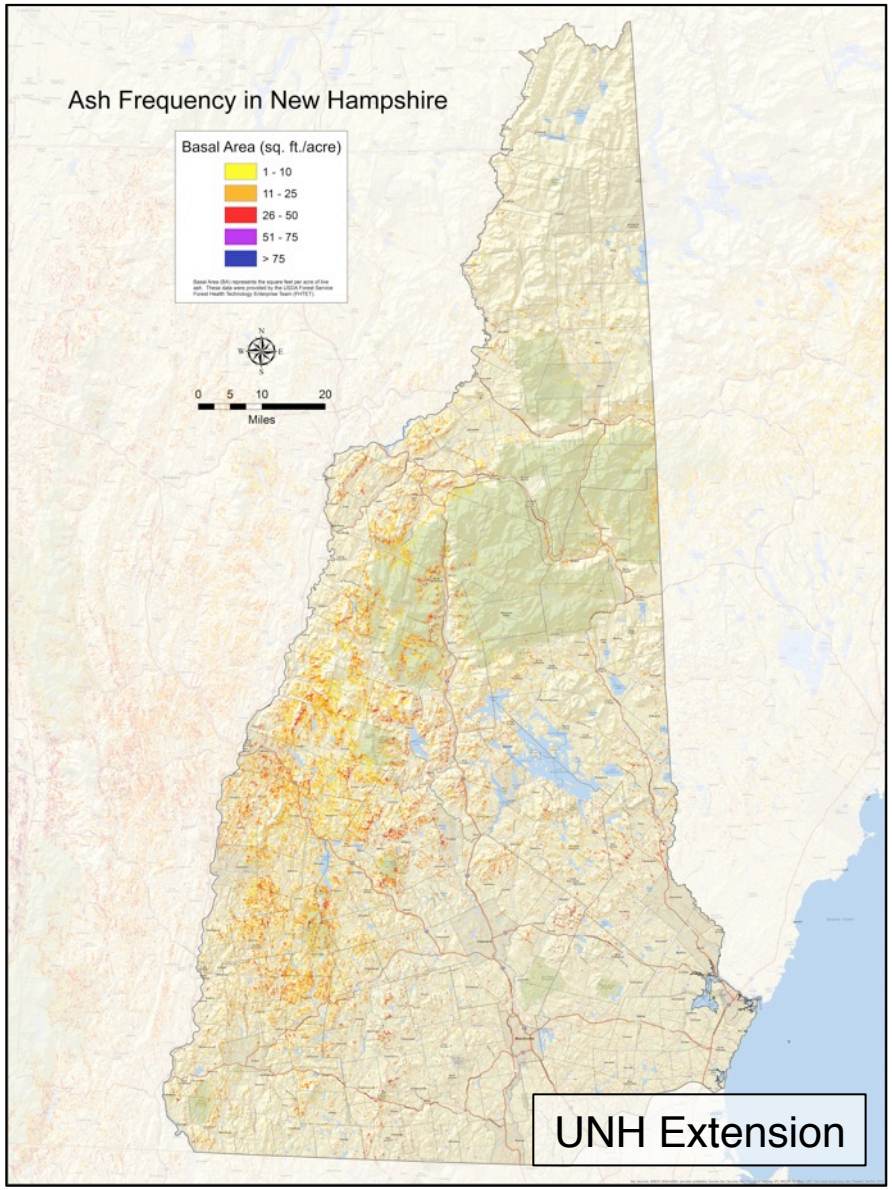


- **Ash (genus *Fraxinus*) comprise 6% of NH forests, but can be locally abundant**

New Hampshire has three native species of ash that are threatened by the emerald ash borer



- **Ash (genus *Fraxinus*) comprise 6% of NH forests, but can be locally abundant**
- **All three species of ash native to NH are susceptible to emerald ash borer**
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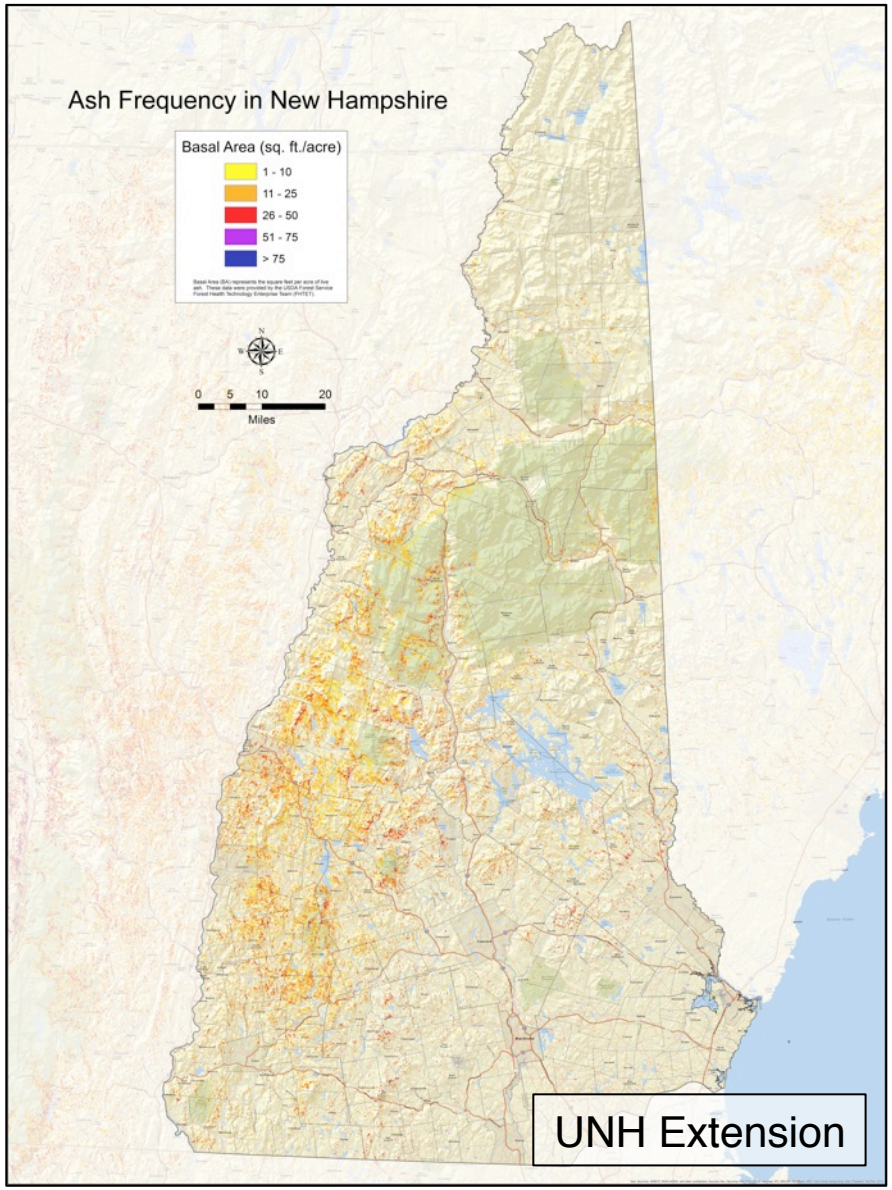

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- **All three species of ash native to NH are susceptible to emerald ash borer**
  - Black (*Fraxinus nigra*)
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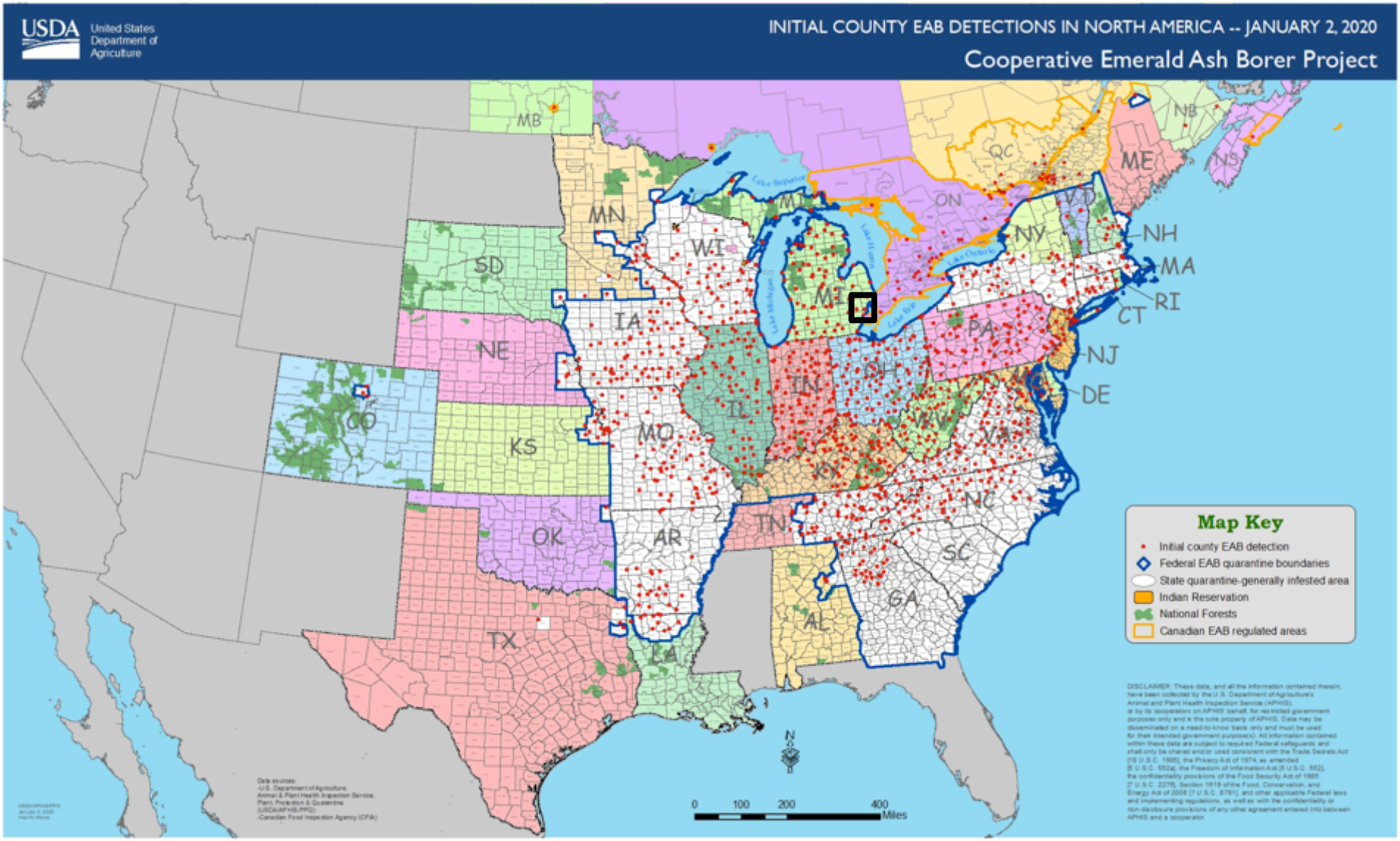
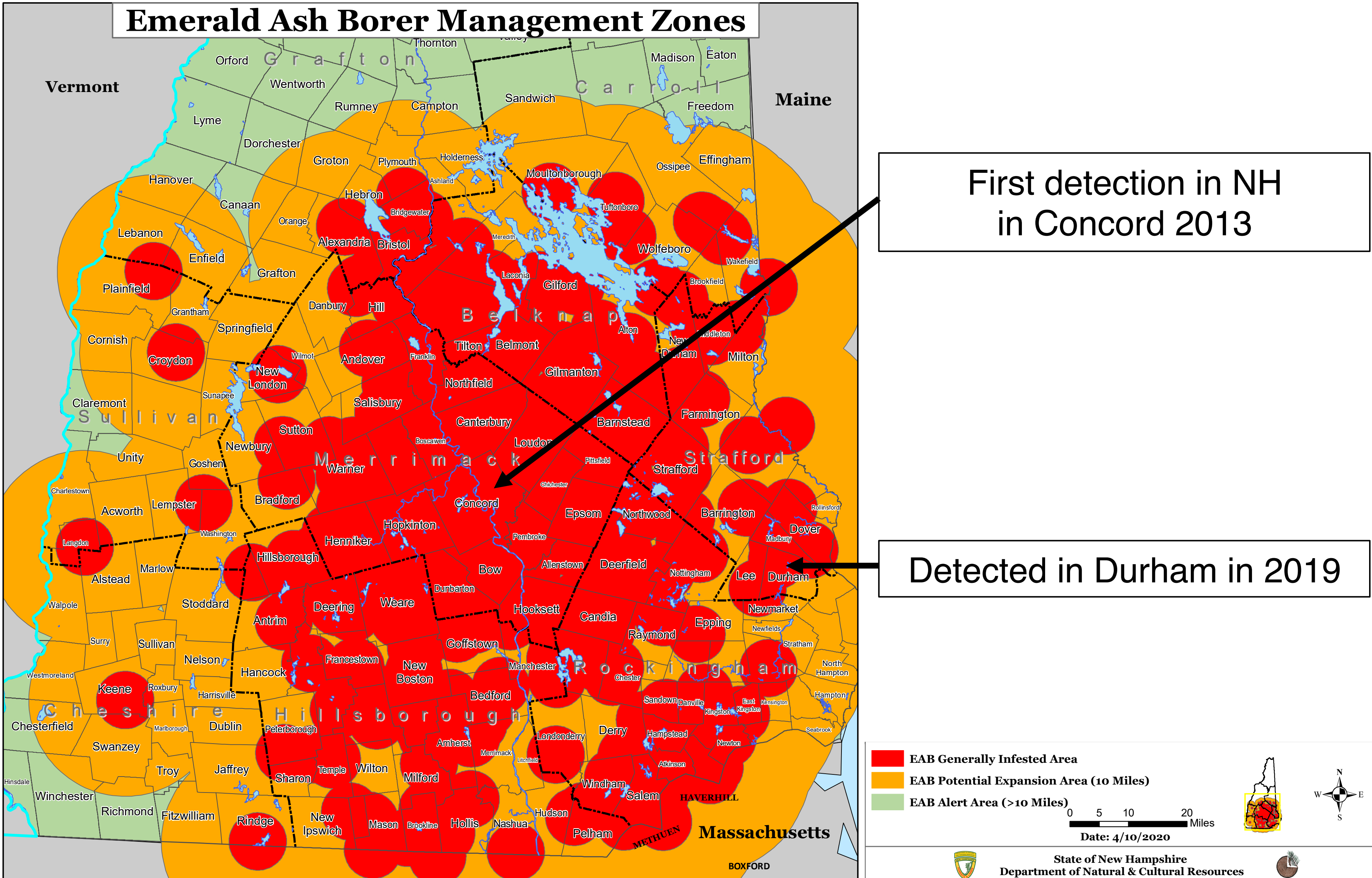
  - White (*Fraxinus americana*)
- **Ash provide many ecosystem services are are culturally important**
  - Important for maintaining water table & erosion control
  - Important habitat for many organisms (Gandhi and Herms 2010)
  - Indigenous baskets from black ash in New England (e.g., Algonquin, Abenaki, Maliseet, Pennacook, Penobscot)
  - Louisville Slugger bats made from ash

Emerald ash borer (EAB) was introduced into the USA in the early to mid 1990s and has spread rapidly



Siegert et al. 2014 Diversity Distrib.

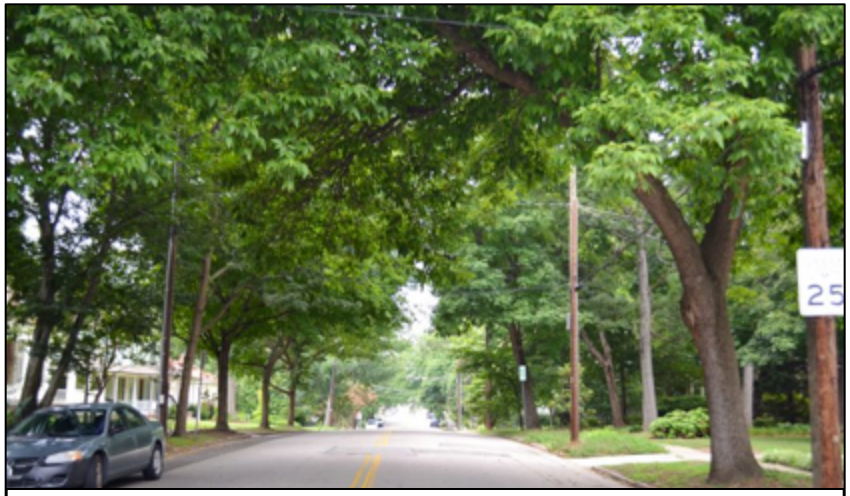
Since its first detection in NH in 2013 EAB has spread rapidly throughout the state



Rapid spread has been attributed to movement of infested materials by humans

Haack et al. 2010 Econ. Entomol.

Management of EAB depends on the type of forest and stage of infestation



Urban forest (e.g., street trees, parks)

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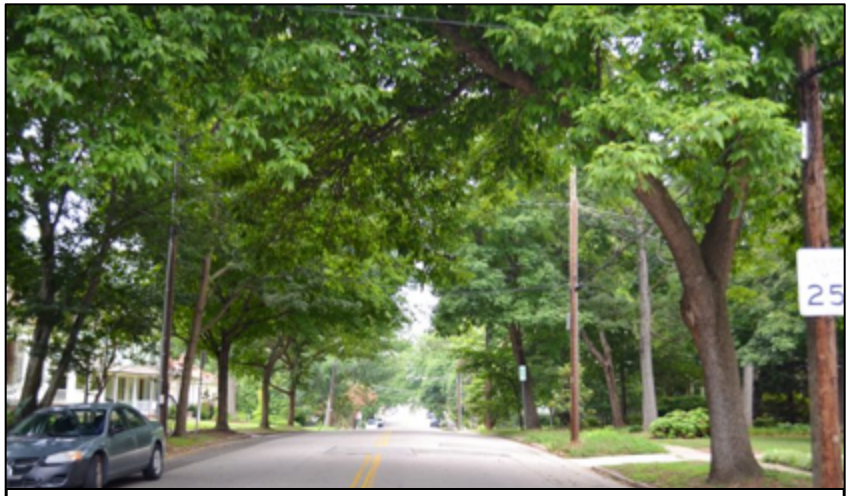

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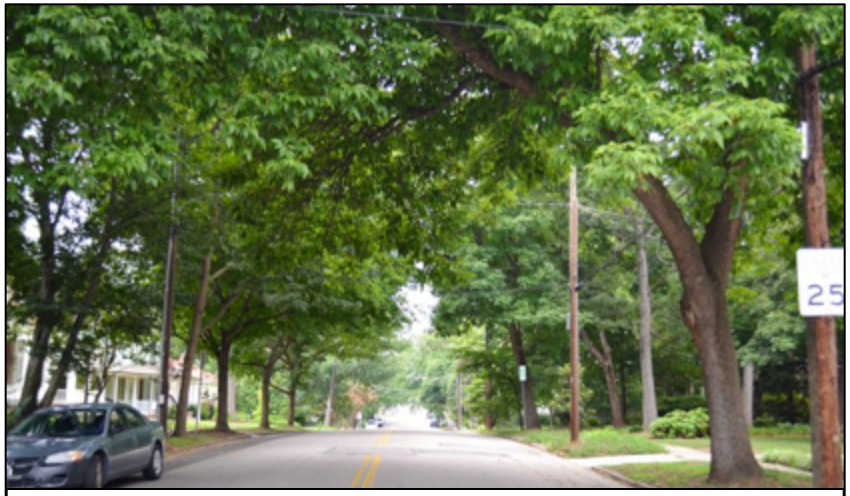

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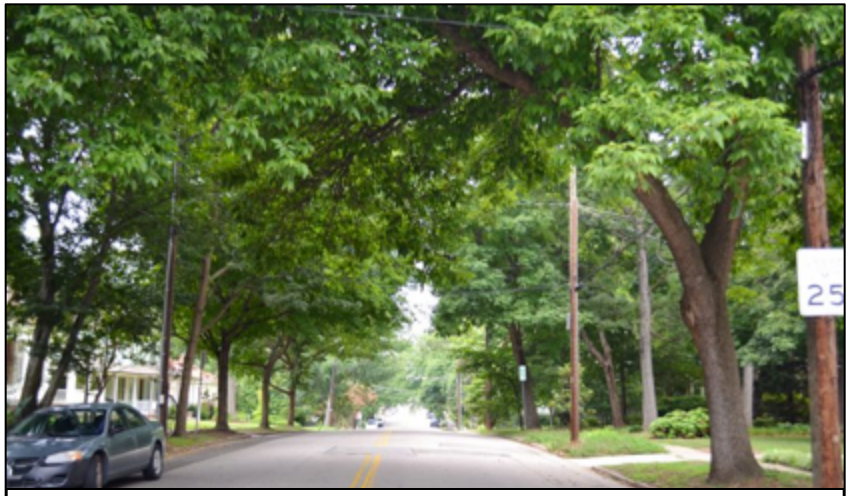

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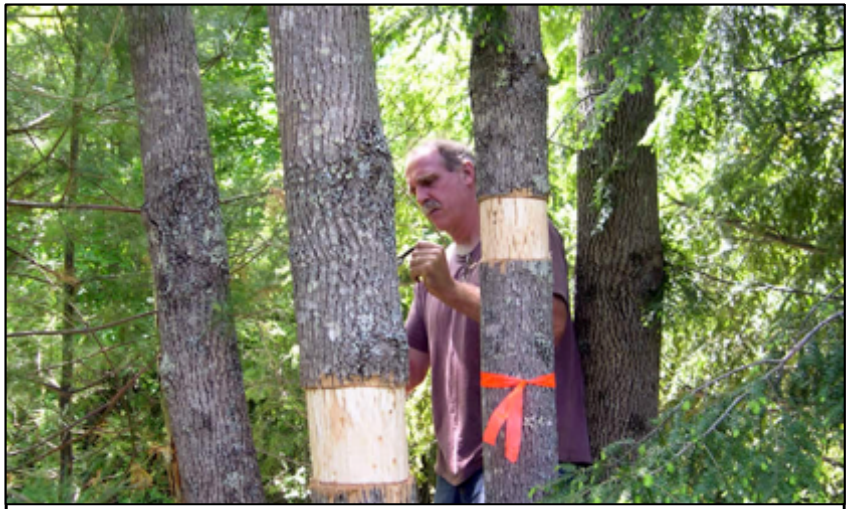

Natural forest

- Pesticides to protect high-value or culturally important trees
- Use of “trap” trees

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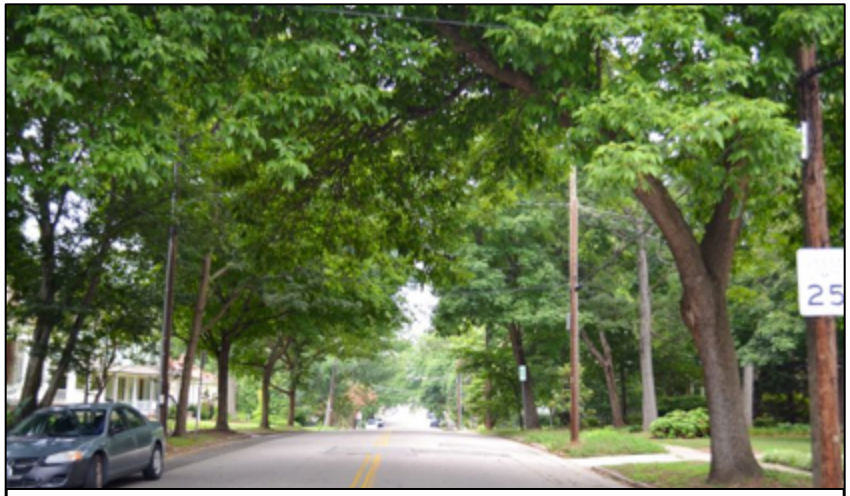

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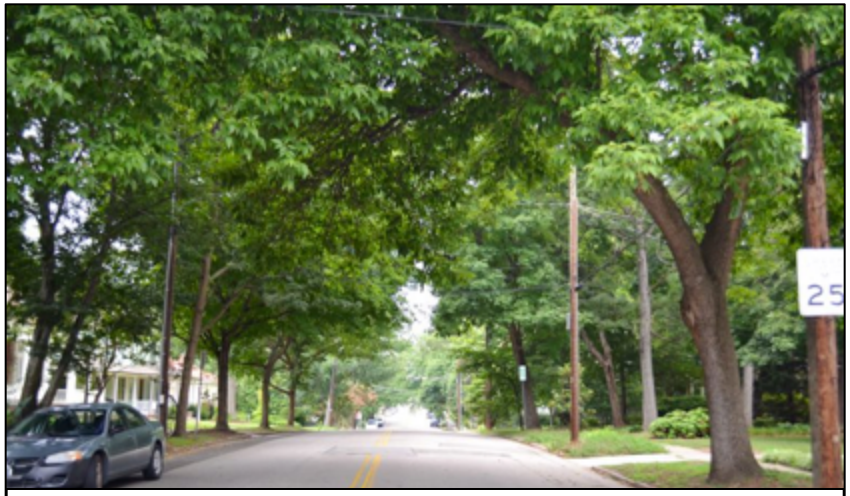

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Natural forest

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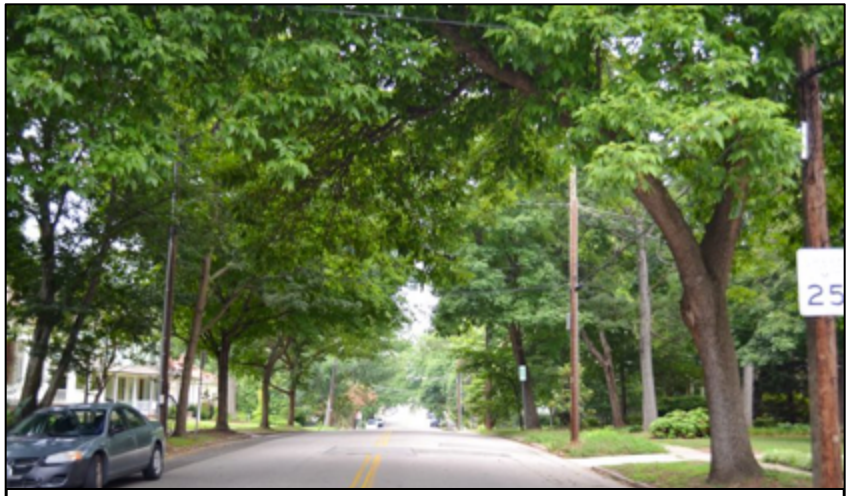
- Use of “trap” trees
- Biological control
- Development of resistant trees

Management of EAB usually entails multiple **short term** or **long term** approaches



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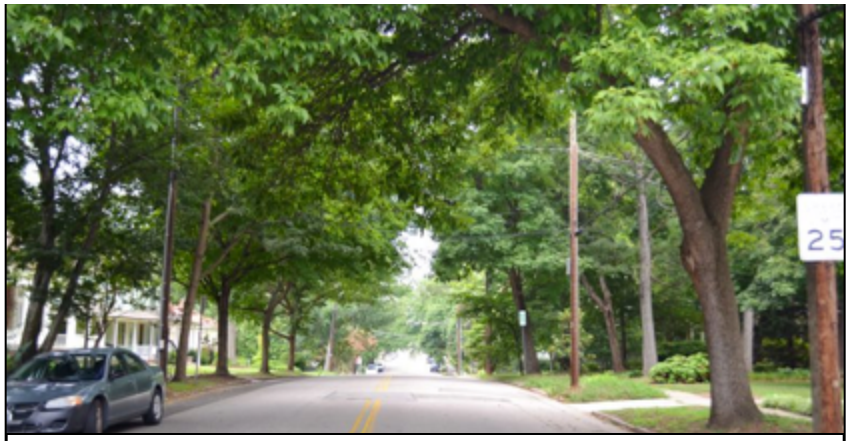
Further development of **long term** approaches for EAB management allows for sustainable protection of ash in natural and urban forests

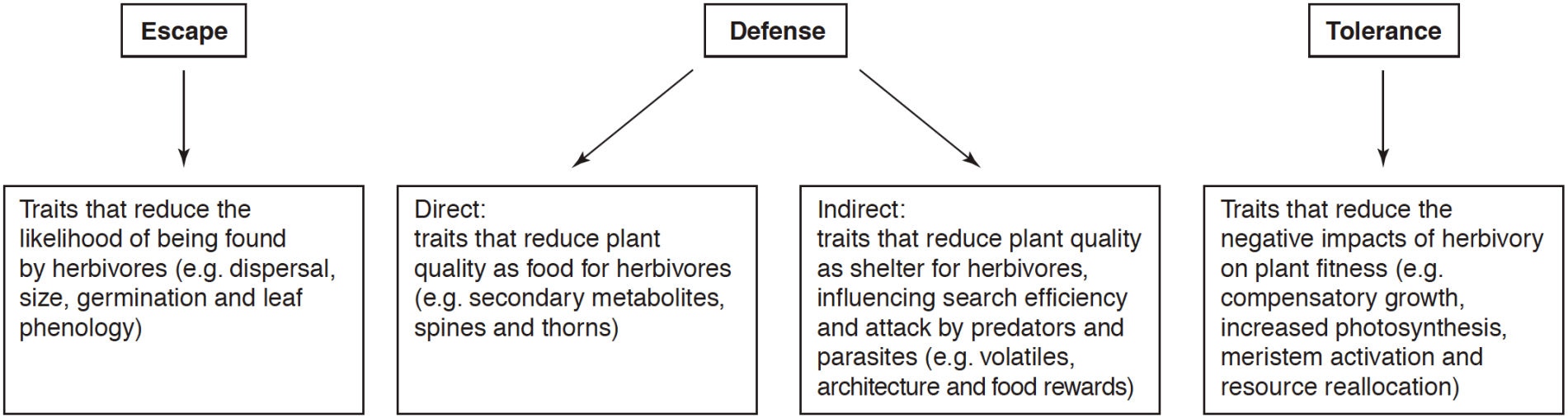


Urban forest (e.g., street trees, parks)

Natural forest

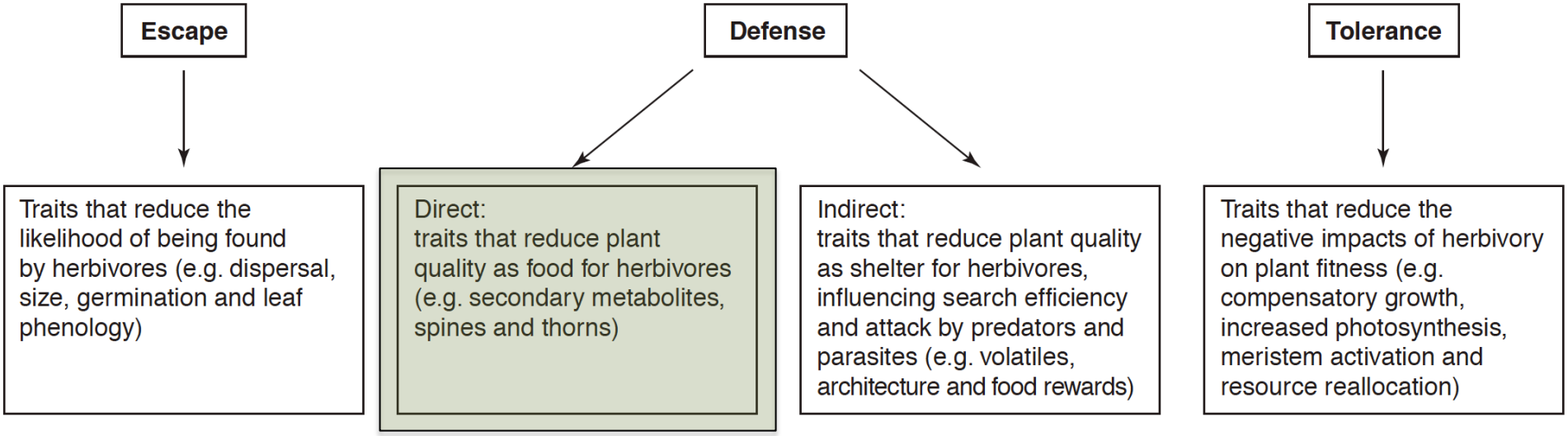
- Biological control
- Development of resistant trees

There are multiple types of traits that contribute to the resistance of trees to herbivores



Boege and Marquis 2014 TREE

Our study is evaluating how chemical defenses vary across tree age/size in green and white ash and their impacts on EAB and its biocontrol



…ultimately to recommend if defensive traits would be suitable for incorporation into tree resistance breeding programs

Boege and Marquis 2014 TREE

We are using four size classes of trees to evaluate variation in chemical defenses

Small (S)
1.2 – 2.4 in

Small-Medium (SM)
2.41 – 3.5 in

Medium-Large (ML)
3.51 – 4.7 in

Large (L)
4.71 – 5.9 in

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...before and after we perform three treatments

Control

Unmodified

...before and after we perform three treatments

Control

Unmodified

EAB eggs

Applied in
four bands
standardized*
by tree diameter

...before and after we perform three treatments

Control

Unmodified

EAB eggs

Applied in four bands standardized* by tree diameter

Small

*16 eggs

Small-Medium

*26 eggs

Medium-Large

*38 eggs

Large

*48 eggs

...before and after we perform three treatments

Control

Unmodified

EAB eggs

Applied in four bands standardized* by tree diameter

Methyl jasmonate

1 M applied in four bands, 4x over 10 d after EAB egg hatch

...before and after we perform three treatments

No attack

Unmodified

Insect attack

Applied in four bands standardized* by tree diameter

Simulated attack

1 M applied in four bands, 4x over 10 d after EAB egg hatch

Phloem tissue is extracted from trees, processed in the laboratory and analyzed for defensive chemistry

Removal location selected randomly for each cardinal direction

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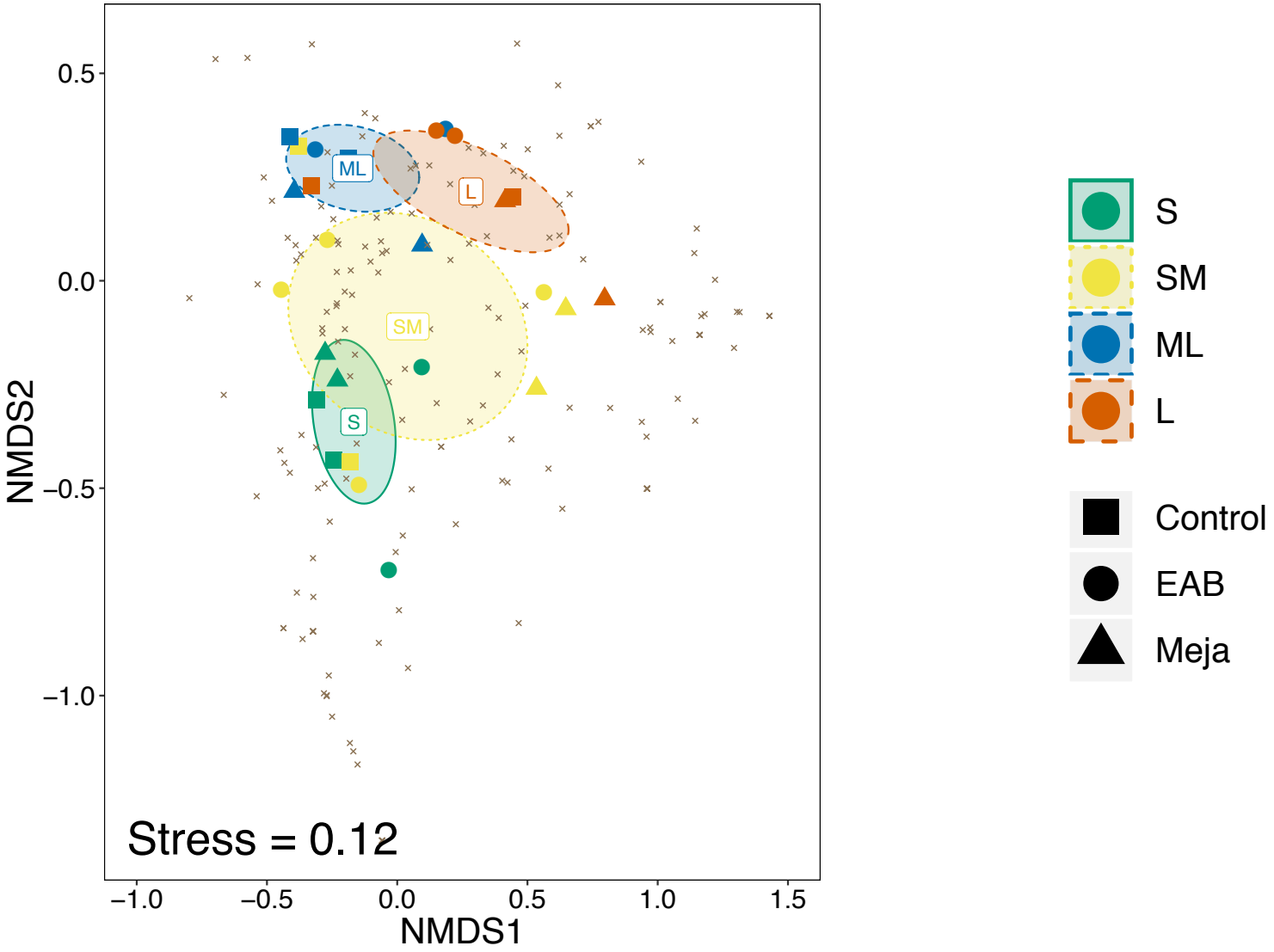
Dissection

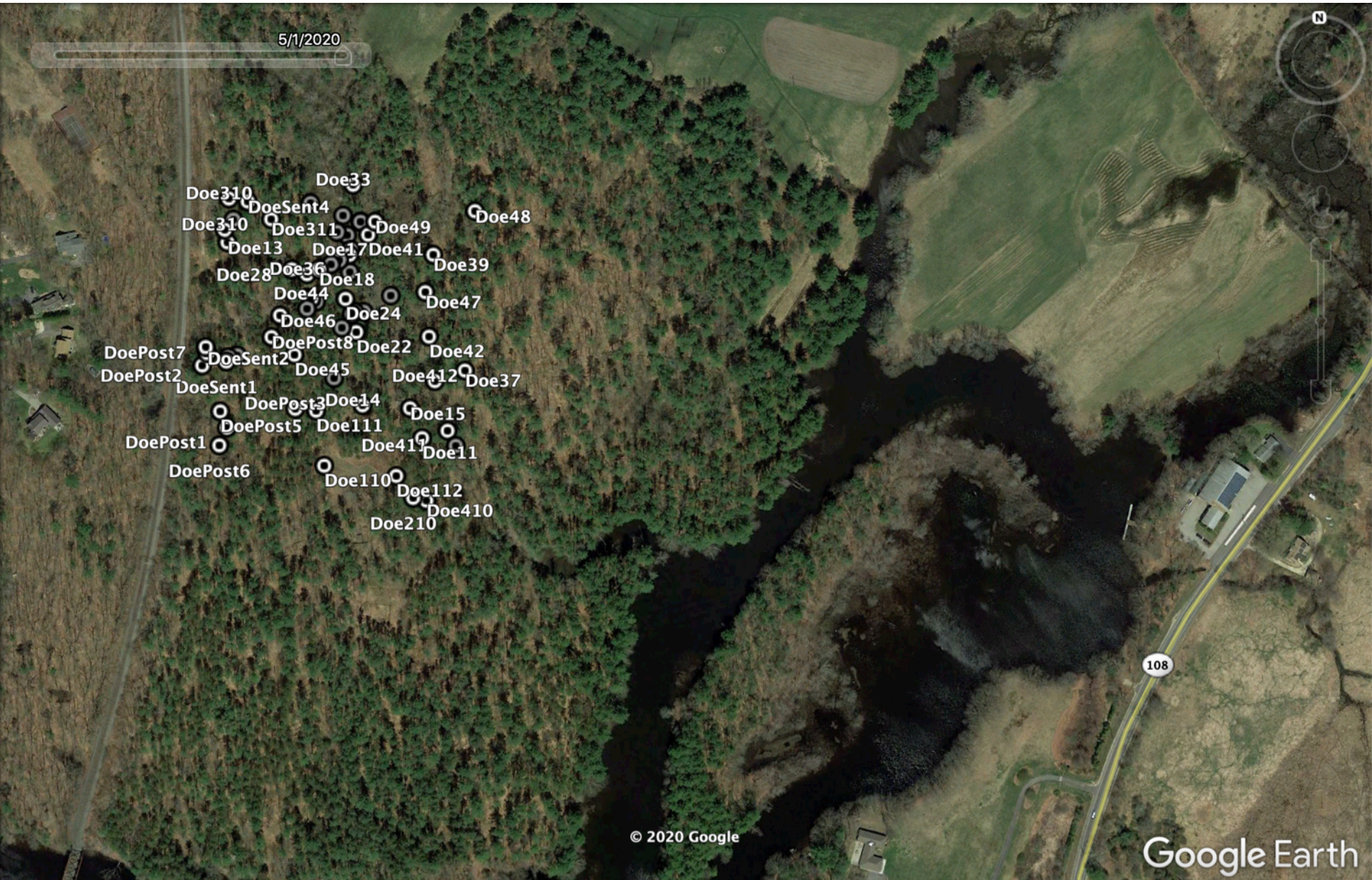
Pulverized in N_2

Chemical identification

Tree age appears to drive changes in defensive chemistry of trees after insect and simulated attack



Proposed work at Doe Farm in Durham Township



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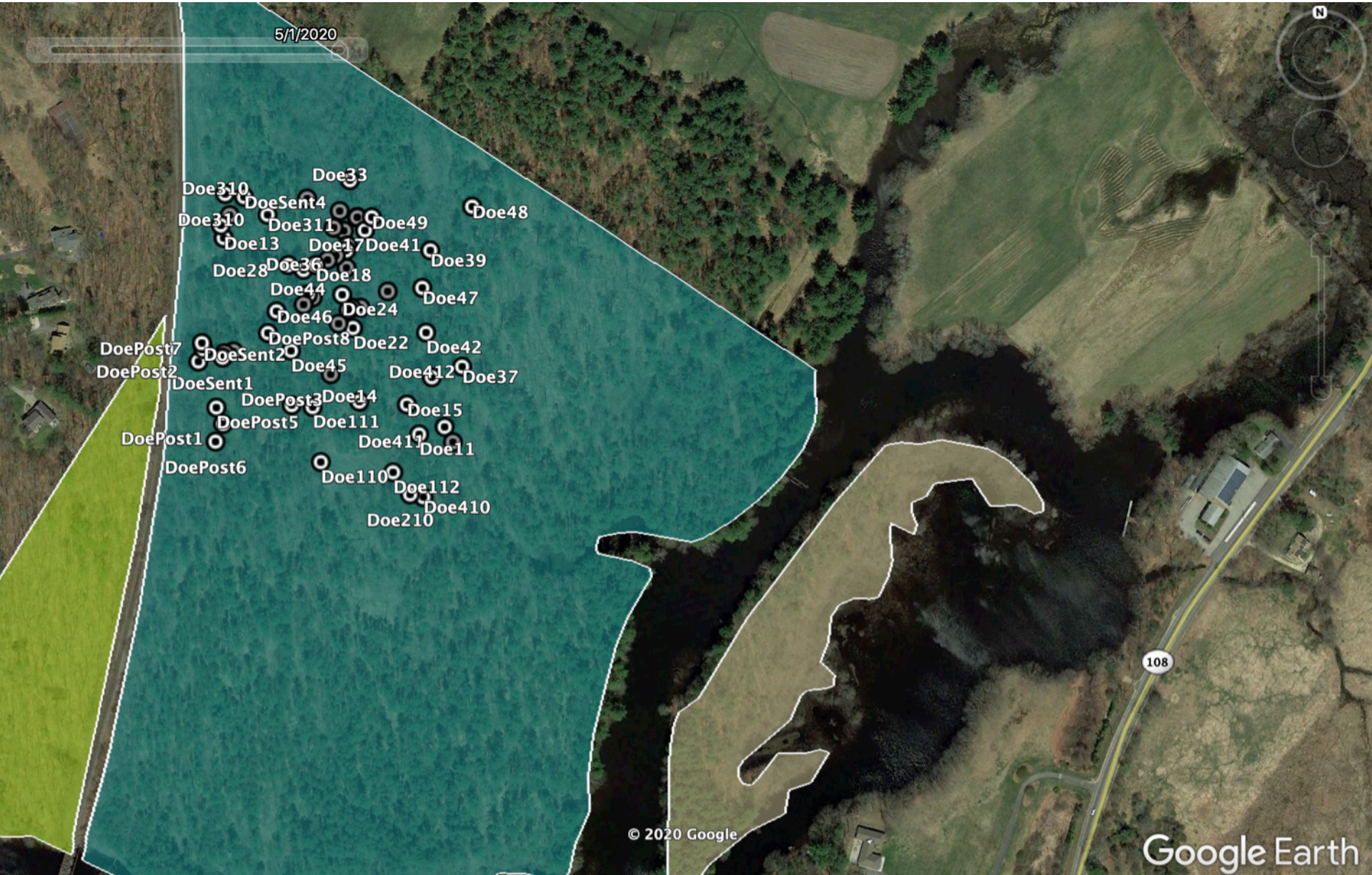
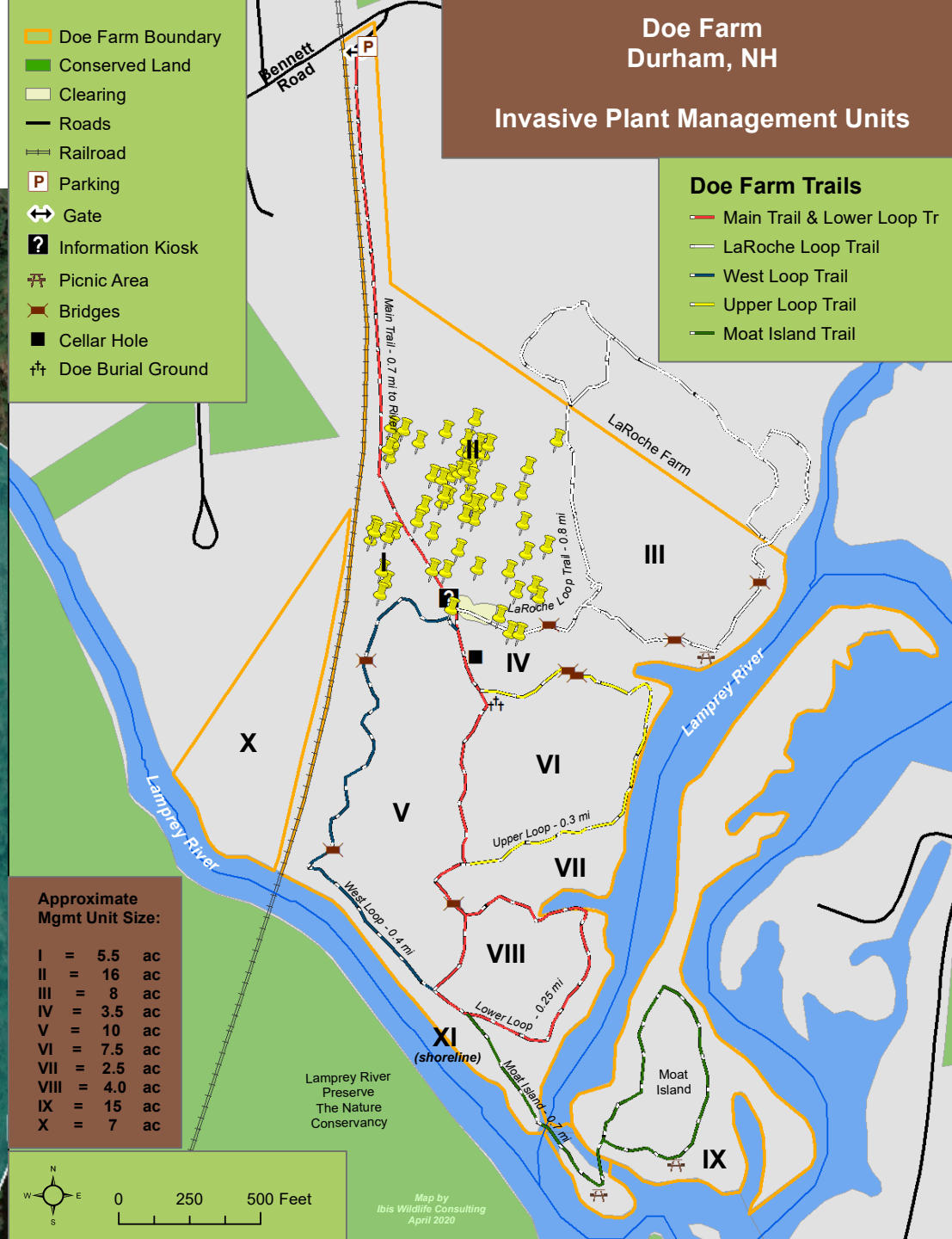


Trees fall into units I, II, and IV



Proposed work at Doe Farm in Durham Township

Proposed Site Alterations

- 52 green ash trees will be studied as part of our experiment
- 20 of these trees will be artificially infested with EAB
- 24 of these trees will be cut and removed in Oct. 2020

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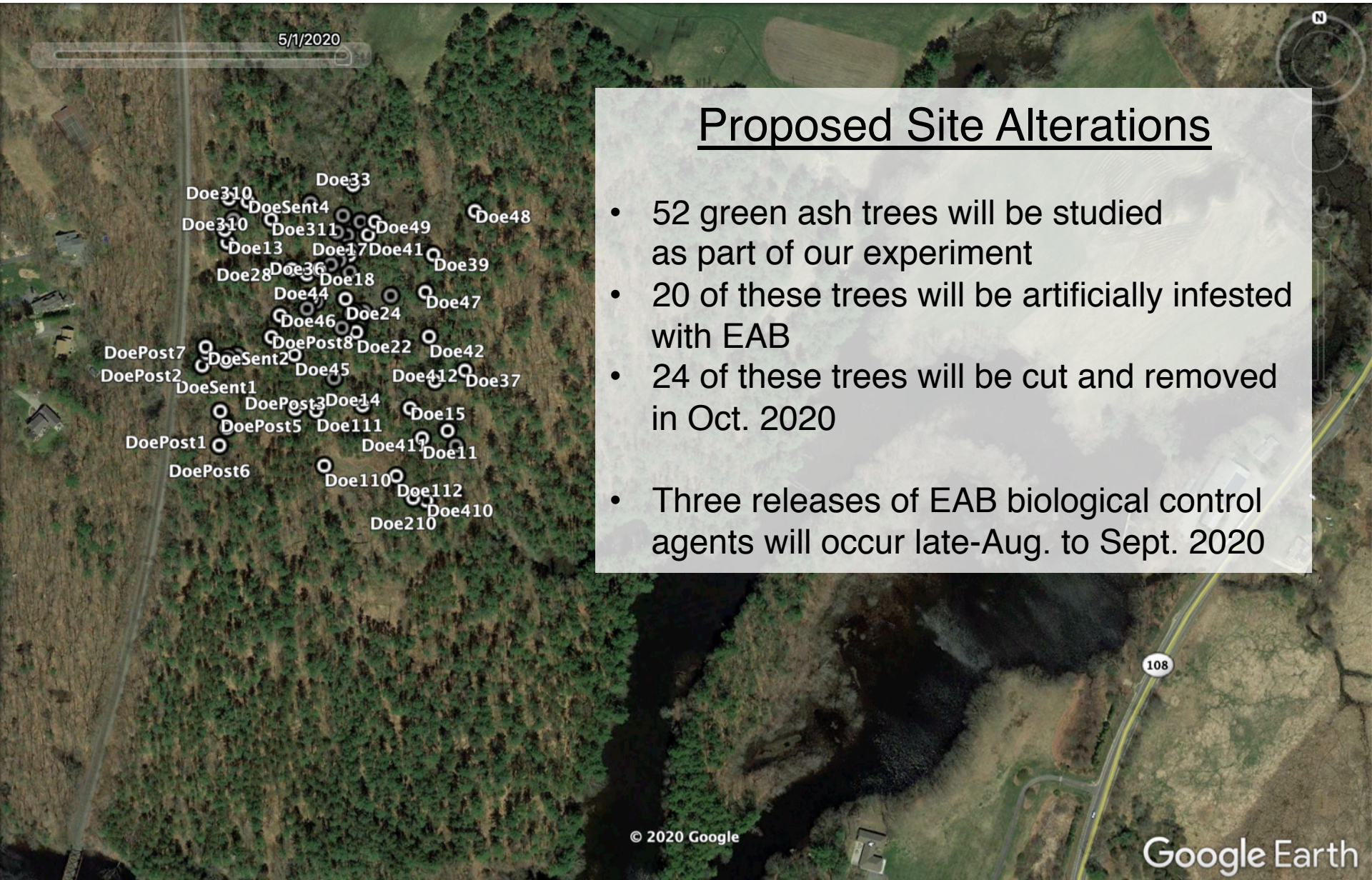

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- 52 green ash trees will be studied as part of our experiment
- 20 of these trees will be artificially infested with EAB
- 24 of these trees will be cut and removed in Oct. 2020

- Three releases of EAB biological control agents will occur late-Aug. to Sept. 2020

Biological control agents are harmless to humans and are unlikely to be noticed by visitors

Tetrastichus planipennisi

Spathius galinae

If you see trees that look like this, **please do not disturb them.**

What is the emerald ash borer?

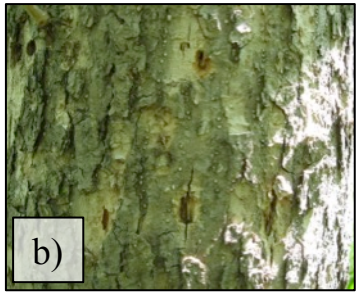
Adult beetle

Immature beetle

The emerald ash borer (EAB) is a non-native insect that was accidentally introduced into the USA in the 1990s. It attacks and kills all species of North American ash trees. Learn more at: www.emeraldashborer.info

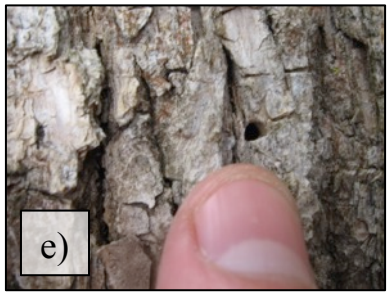
These trees are part of a research study being conducted by the University of New Hampshire and US Department of Agriculture to improve our ability to manage the **invasive emerald ash borer** and protect American forests, such as here at Doe Farm.

Indicators of potential EAB infestation



a) Stems emerging from trunk, b) Splits in the bark, c) Woodpecker damage, d) Missing or dead foliage

Confirmation of EAB infestation



e) D-shaped exit hole, f) presence of S-shaped tunnels

Questions or concerns?
Contact: todd.johnson@unh.edu Twitter: @Plant_Insect

2020 Project Timeline at Doe Farm in Durham Township

March: Site scouting

April - May: Site permissions

Early-June: Bark sampling & Apply EAB eggs/Tyvek to treatment and sentinel trees

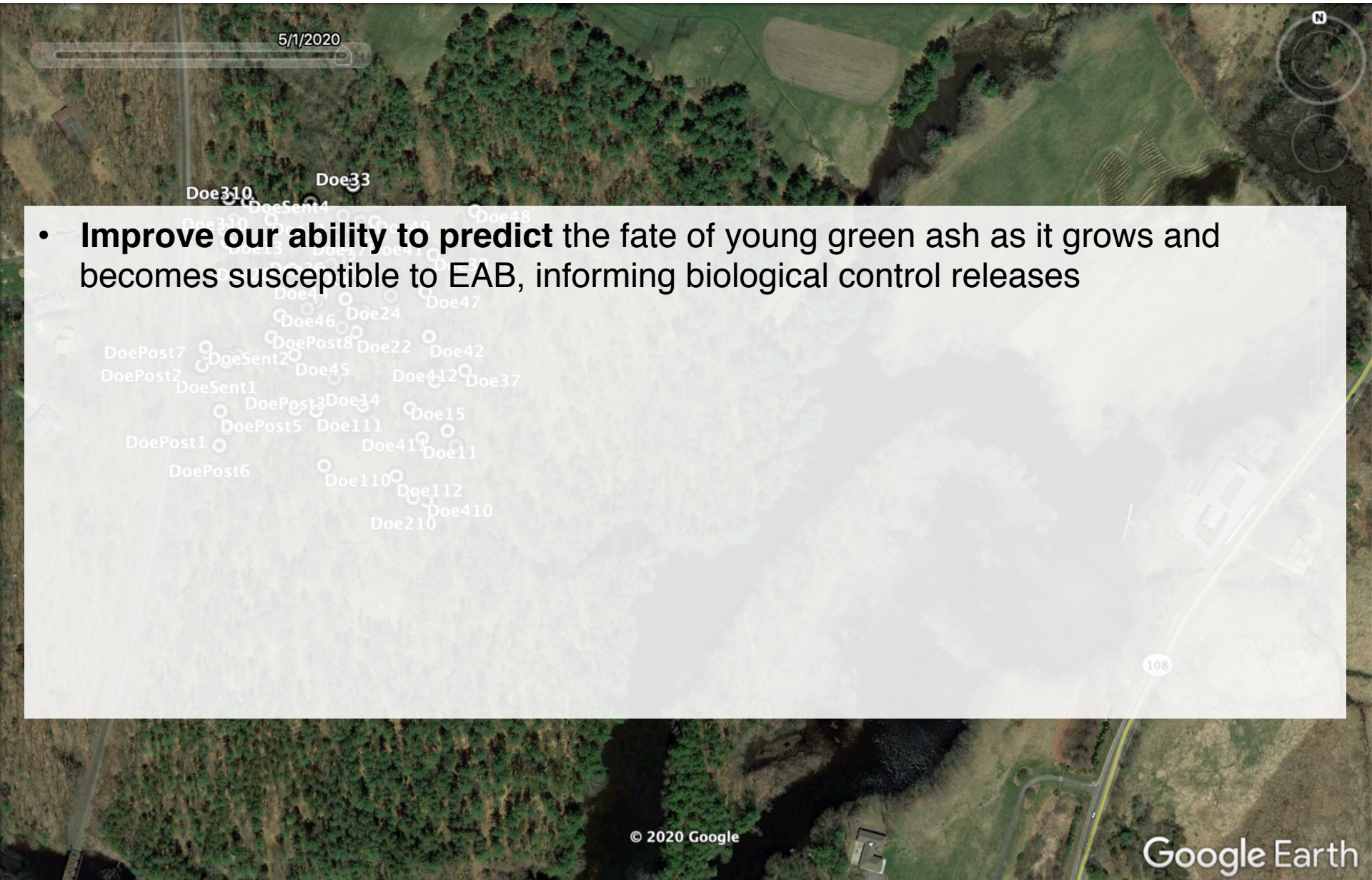
Early-July: Methyl Jasmonate (plant hormone) application and bark sampling

Late-July: Monitoring of sentinel trees to track larval development. Destruction of waste from monitoring and peeling sentinel trees.

August: Release of Tetrastichus planipennisi adults at all experimental sites and trees.

October: Removal of all EAB-infested trees from experimental sites followed by dissection and destruction. All trees will be processed by mid-November.

Proposed research outcomes and benefits



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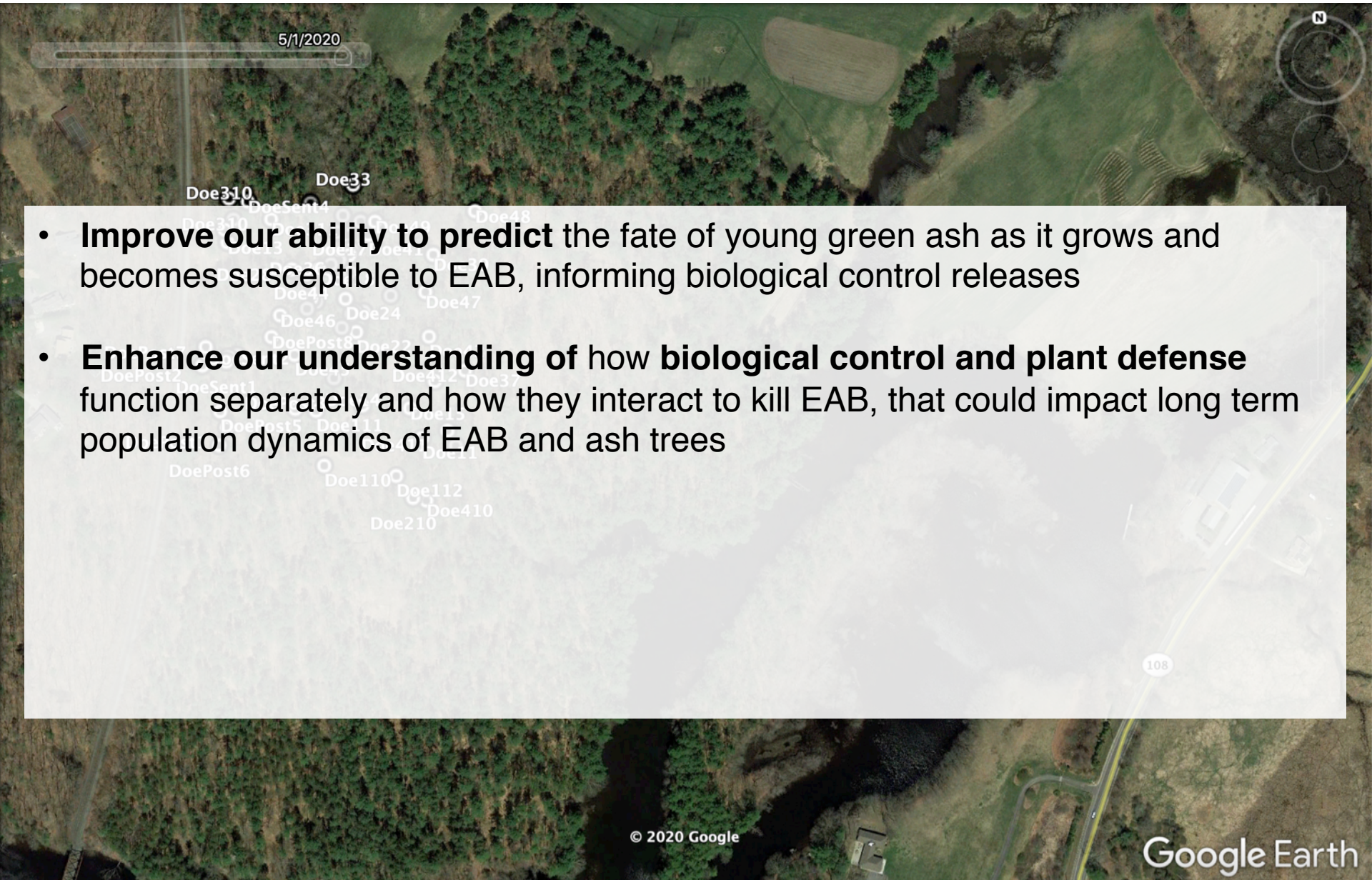

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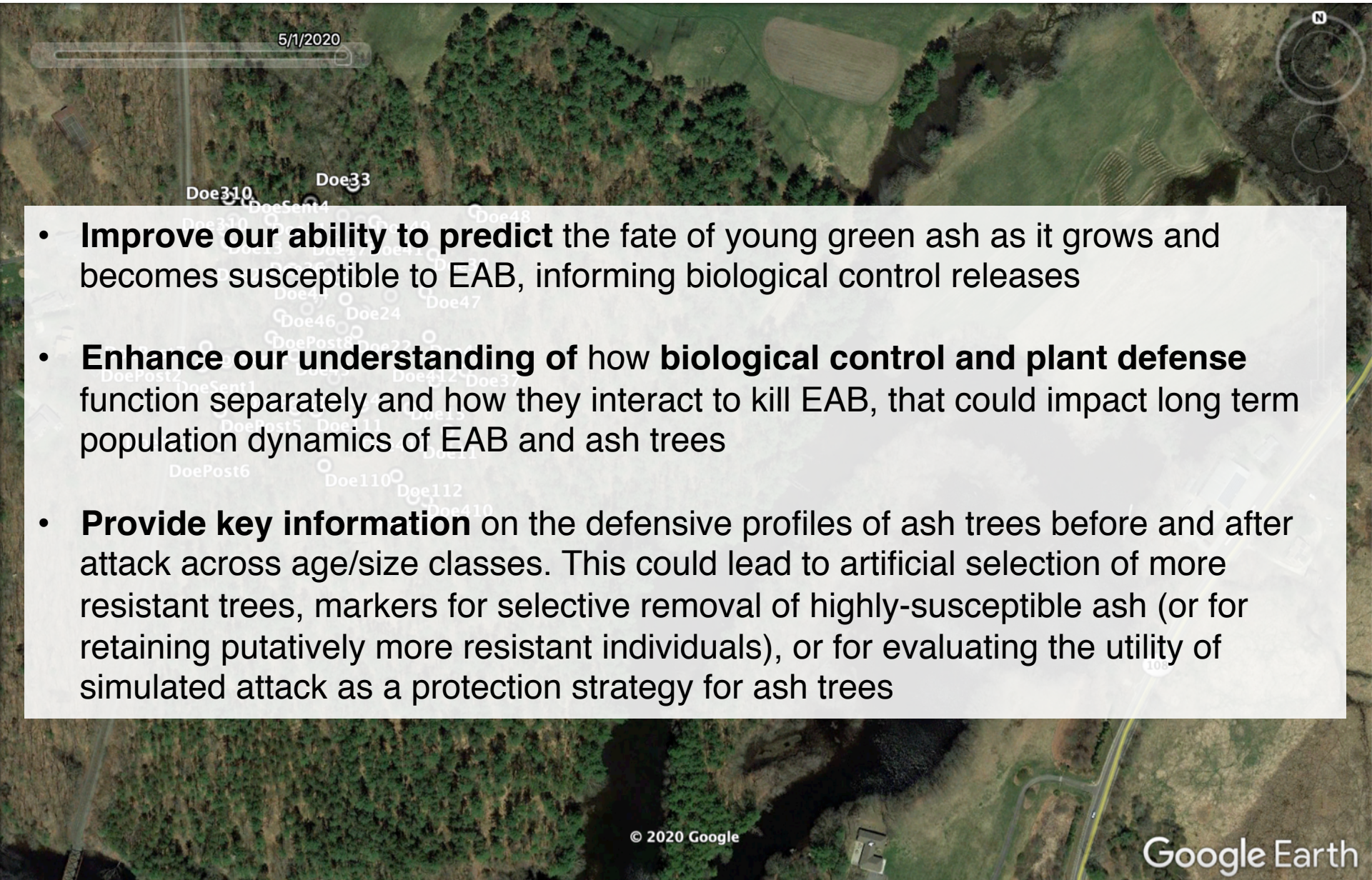

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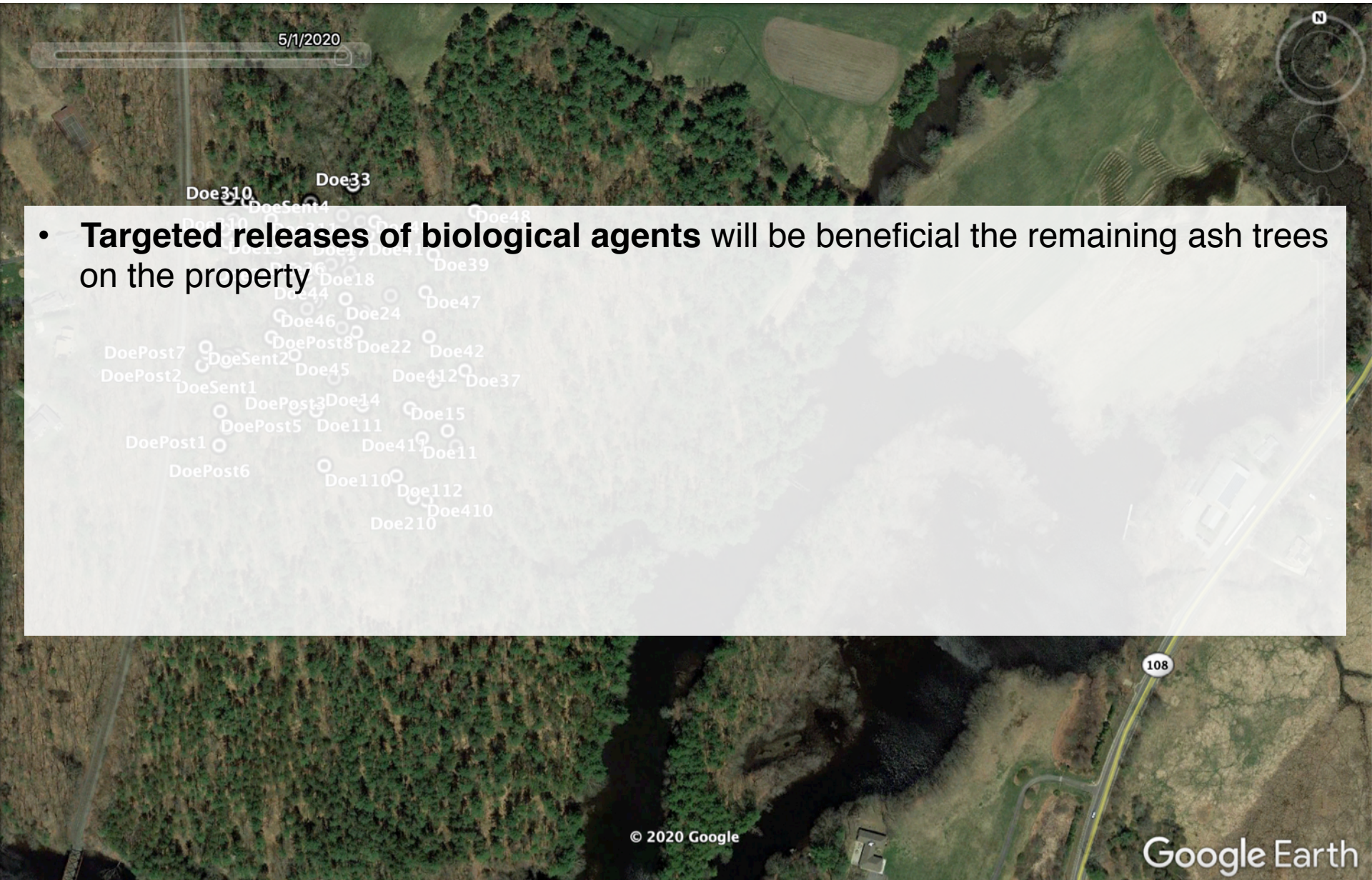
- **Enhance our understanding of** how **biological control and plant defense** function separately and how they interact to kill EAB, that could impact long term population dynamics of EAB and ash trees

- **Provide key information** on the defensive profiles of ash trees before and after attack across age/size classes. This could lead to artificial selection of more resistant trees, markers for selective removal of highly-susceptible ash (or for retaining putatively more resistant individuals), or for evaluating the utility of simulated attack as a protection strategy for ash trees

Broader impacts & benefits to the Town of Durham



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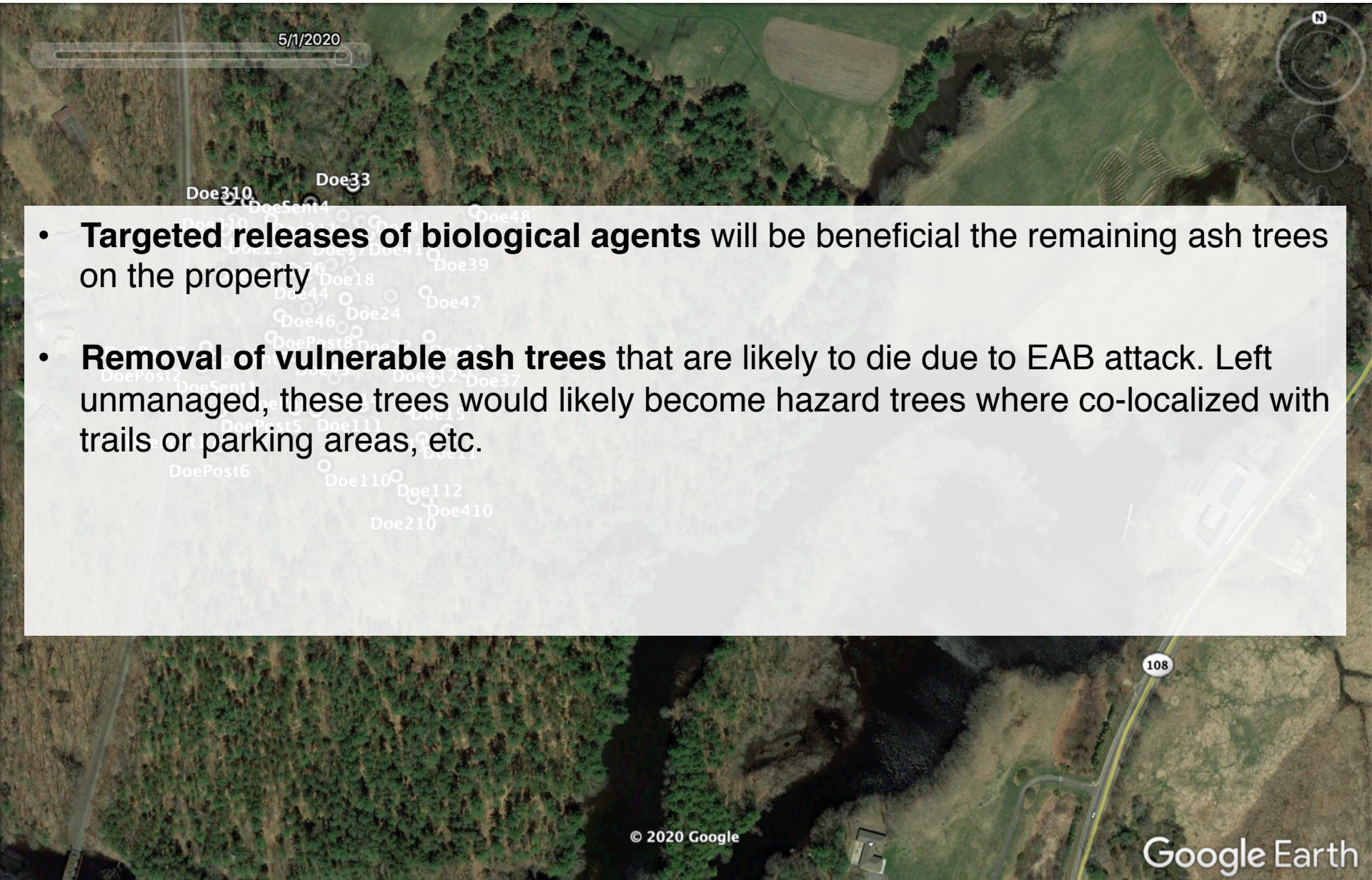

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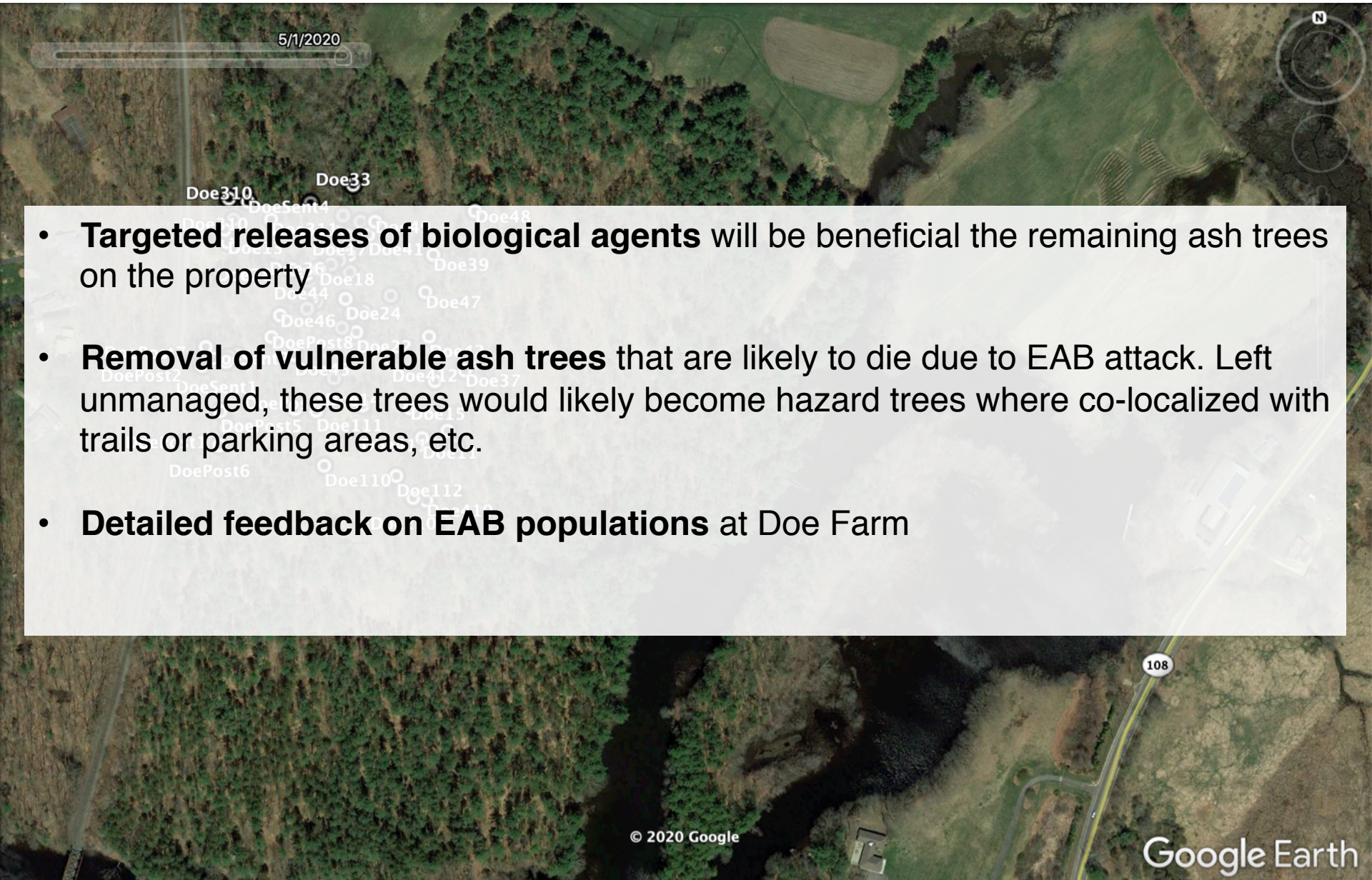

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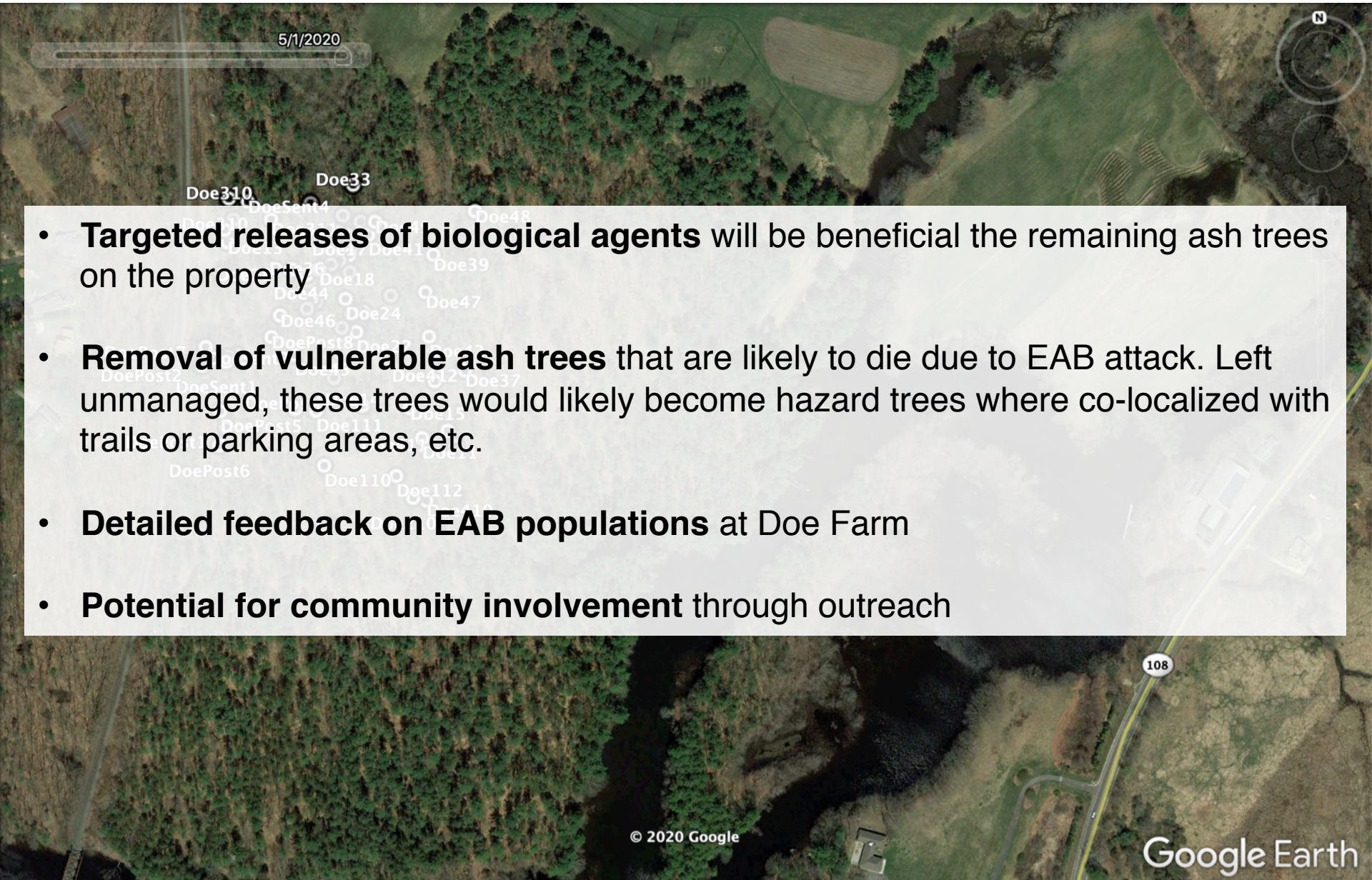

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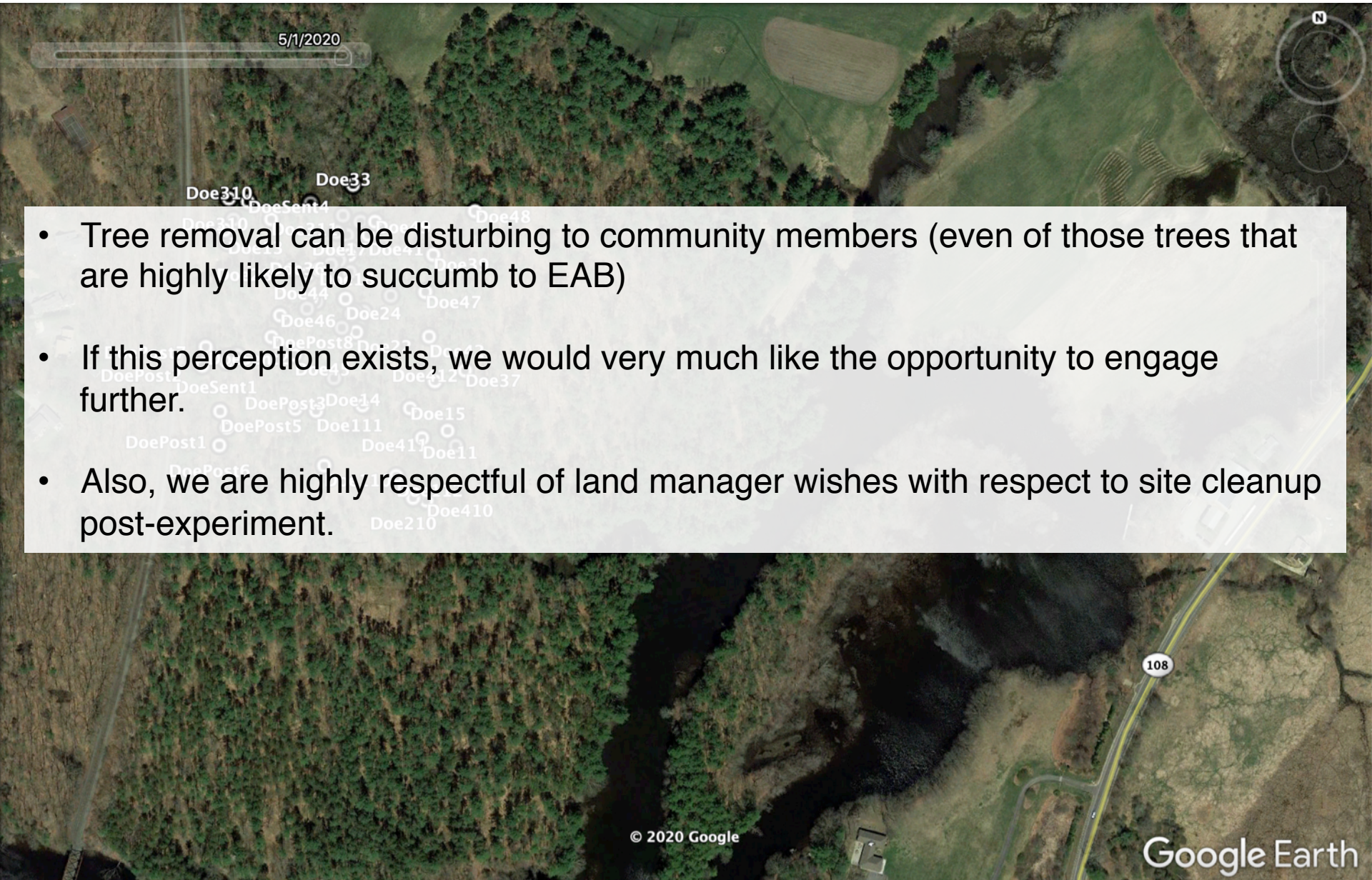
- **Detailed feedback on EAB populations** at Doe Farm
- **Potential for community involvement** through outreach

Potential drawbacks of proposed project



- Tree removal can be disturbing to community members (even of those trees that are highly likely to succumb to EAB)
- If this perception exists, we would very much like the opportunity to engage further.
- Also, we are highly respectful of land manager wishes with respect to site cleanup post-experiment.

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USDA United States Department of Agriculture

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