



An Assessment of Tree Crown Health in Forested Wetlands of the Midwest

Overview

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- Forested wetlands in the Midwestern US are experiencing extensive tree mortality from emerald ash borer (EAB) and other causes.
- Our objective was to assess the amount and cause of tree damage in forested wetlands of the Midwest.
- Analyses were based on a new 0.6-1 m product called Tree Crown Health (TCH), which provides a measure of foliage greenness and contiguity in the canopy.
- Additional data from past Insect and Disease Surveys (IDS) and other sources were used to infer damage causing agents (DCAs).
- Results are intended to highlight potential forest health issues in wetlands, with the goal of informing future forest health monitoring.

Methods

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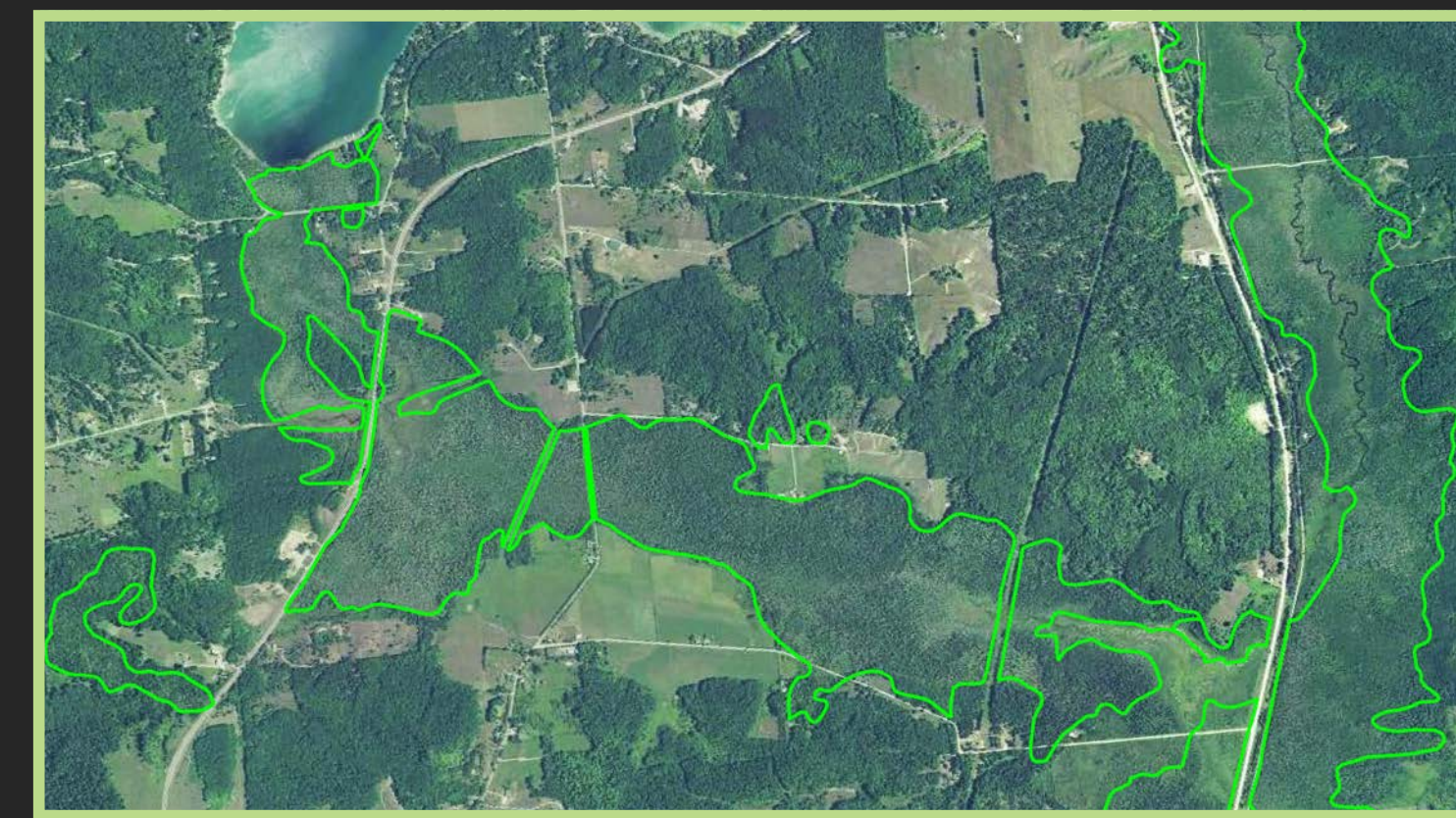
- STUDY AREA**
 - Midwestern States: MN, WI, MI, IN, and IL
 - Forested wetlands from the US Fish and Wildlife Service, National Wetlands Inventory (NWI).
 - Wetlands were excluded from counties where a significant portion of the imagery was collected leaf-off (before June and after late September).
- AMOUNT AND SEVERITY OF DAMAGE**
 - TCH models of damaged gray tree crowns were developed at 0.6 m (MI and IN in 2016) to 1 m (IL, WI, and MN in 2017) using 4 band National Agriculture Imagery Program (NAIP) data (Figure 1).
 - Results were upscaled to 30 m based on the percentage of damaged (gray) trees in each cell (Figure 2). We then calculated the average amount of damaged treed area in each wetland (Figure 3).
- CAUSE OF DAMAGE**
 - Insect and Disease Survey (IDS) data (1997-2018) were used to rank order DCAs based on the total area in each wetland.
 - Ash basal area (240 m) and Animal and Plant Health Inspection Service (APHIS) EAB Quarantine Zones were used to infer wetlands where damage may have been caused by EAB.
- FIELD PHOTOS**
 - Tree damage in forested wetlands of the Upper Peninsula of Michigan. Photos by William Monahan.



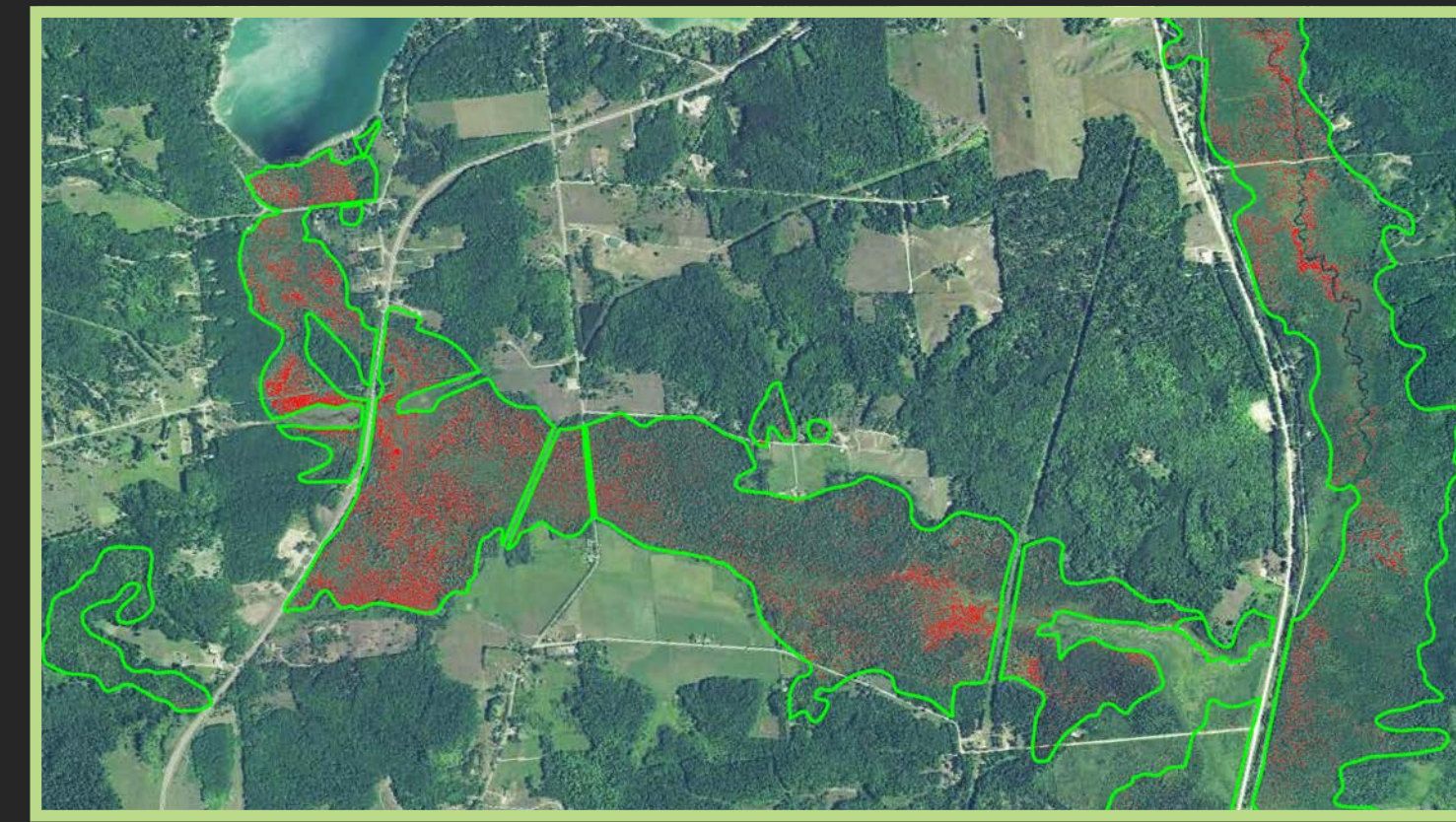
Results

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FIGURE 1: NAIP imagery showing damaged tree crowns

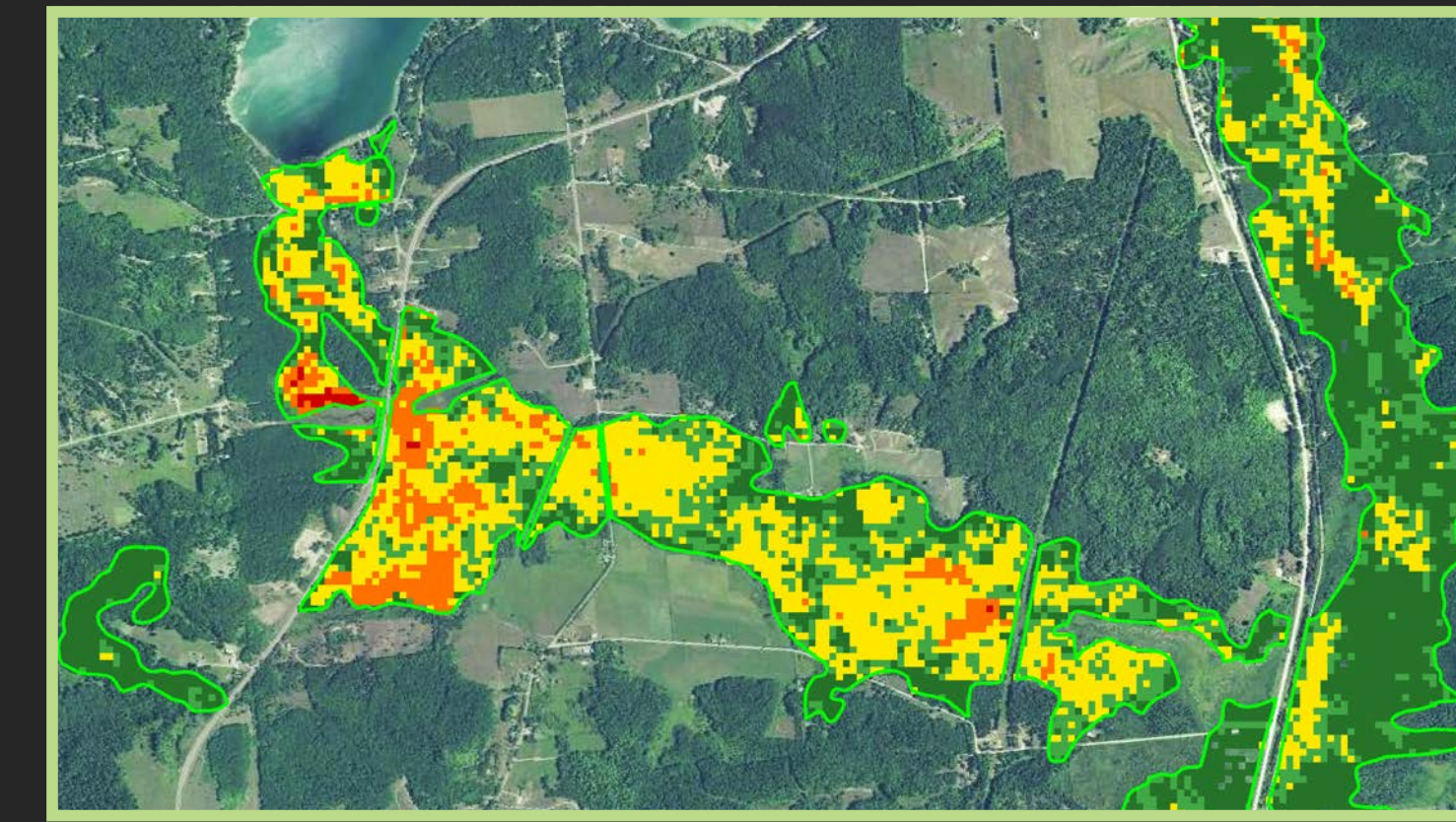


2016 NAIP imagery over Melrose Township, MI showing forested wetland boundaries at 0.6 m resolution.



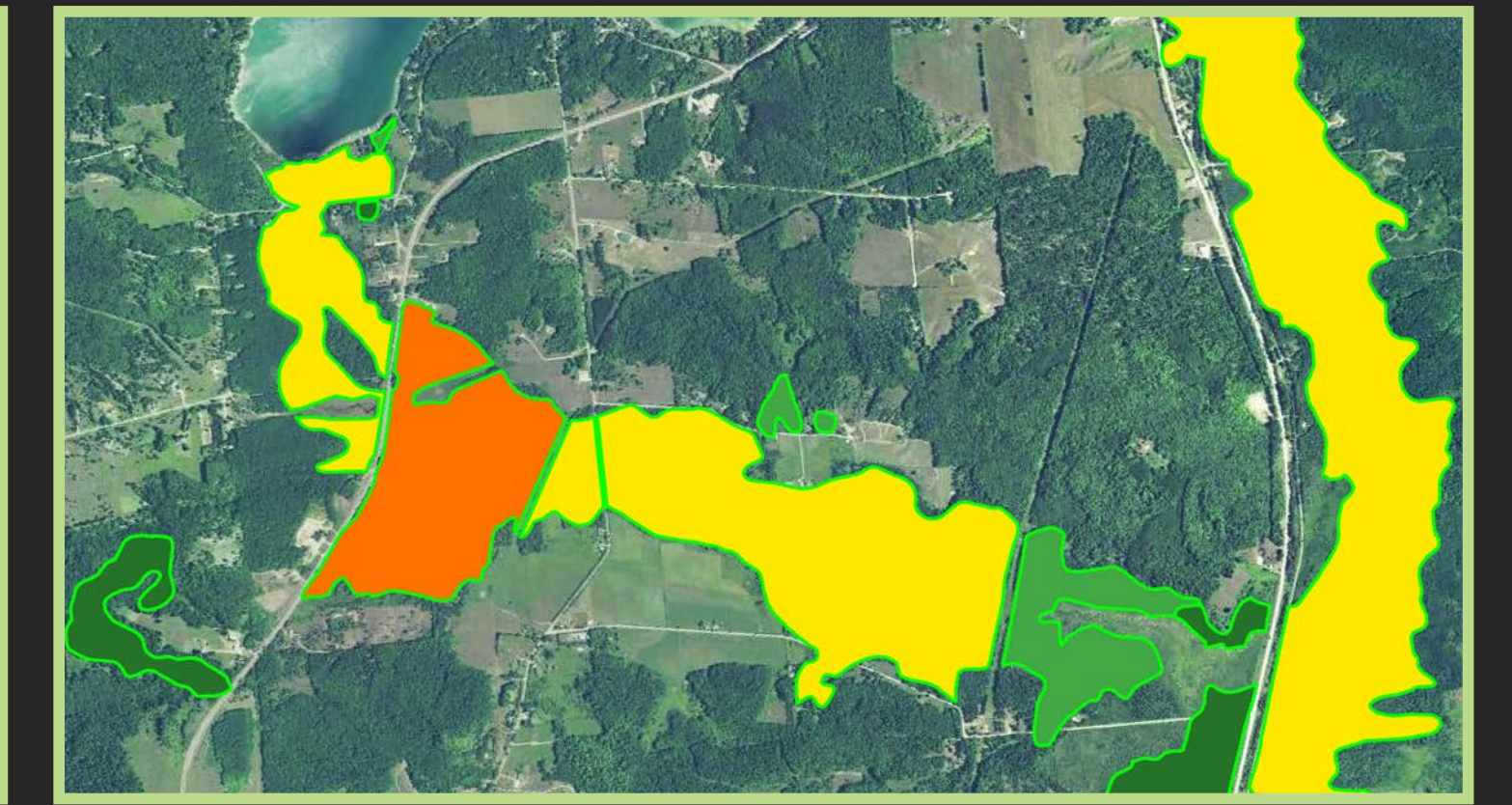
Raw TCH model at 0.6 m resolution. Damaged gray tree crowns from the TCH model are shown in red.

FIGURE 2



The percentage of treed area with damage in each 30 m cell ranging from low (green) to high (red).

FIGURE 3



Average percentage of damaged treed area in each wetland. Wetlands with $\geq 25\%$ are shown in orange and yellow.

RESULTS

- Forested wetland damage is most pronounced in the northern portions of the study area: Minnesota, Wisconsin, and Michigan (Figure 4).
- Areas experiencing significant damage in forested wetlands (Figure 4) generally co-occur with higher densities of ash (Figure 5) and establishment of EAB (Figure 6).
- Of the 165 DCAs evaluated, the most abundant ones occurring in the study area included EAB and flooding, as well as both broad-leaf and conifer defoliators (Table 1).

FIGURE 4: Forested Wetlands with Significant Tree Damage

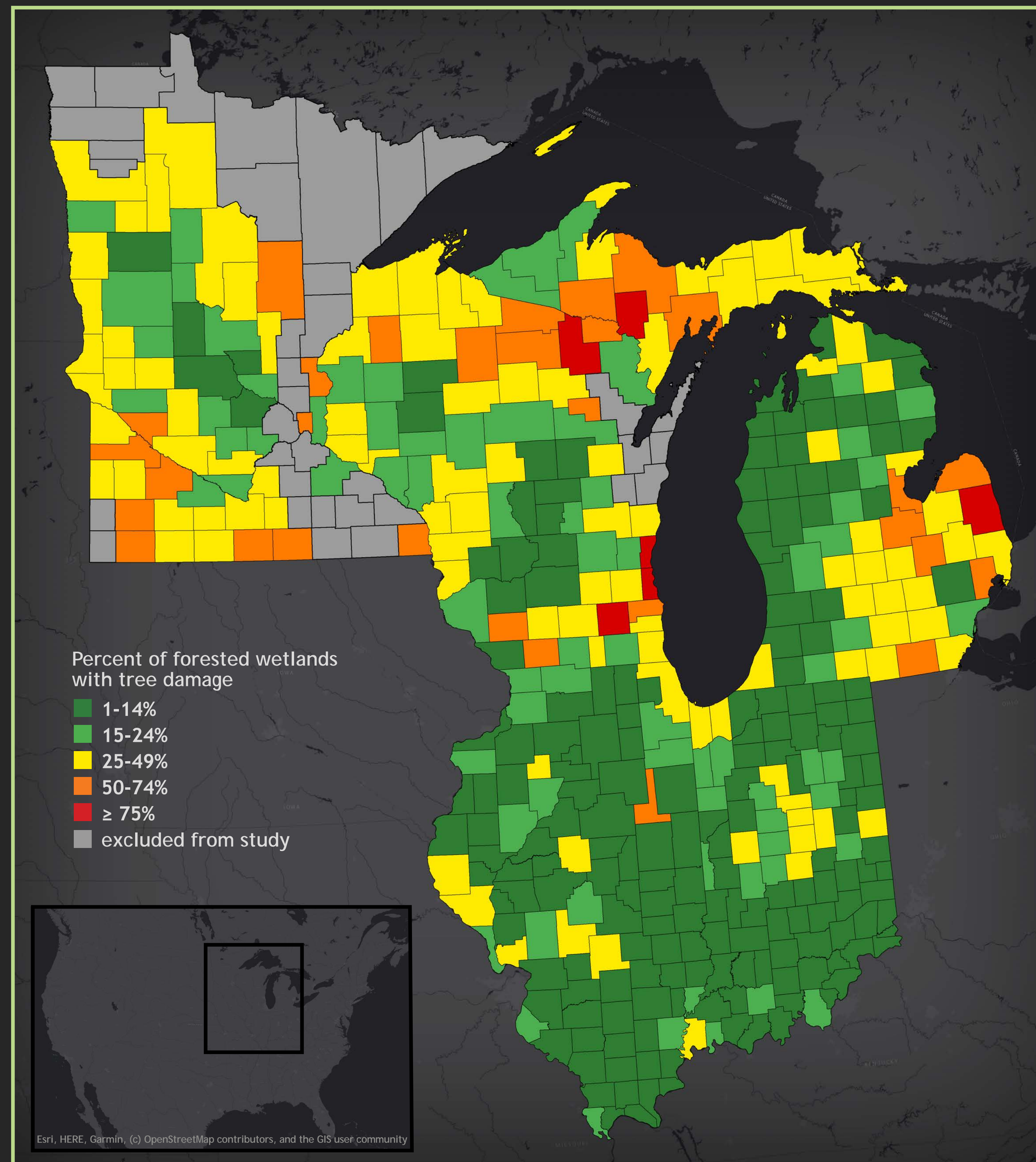


FIGURE 5: Distribution of Ash

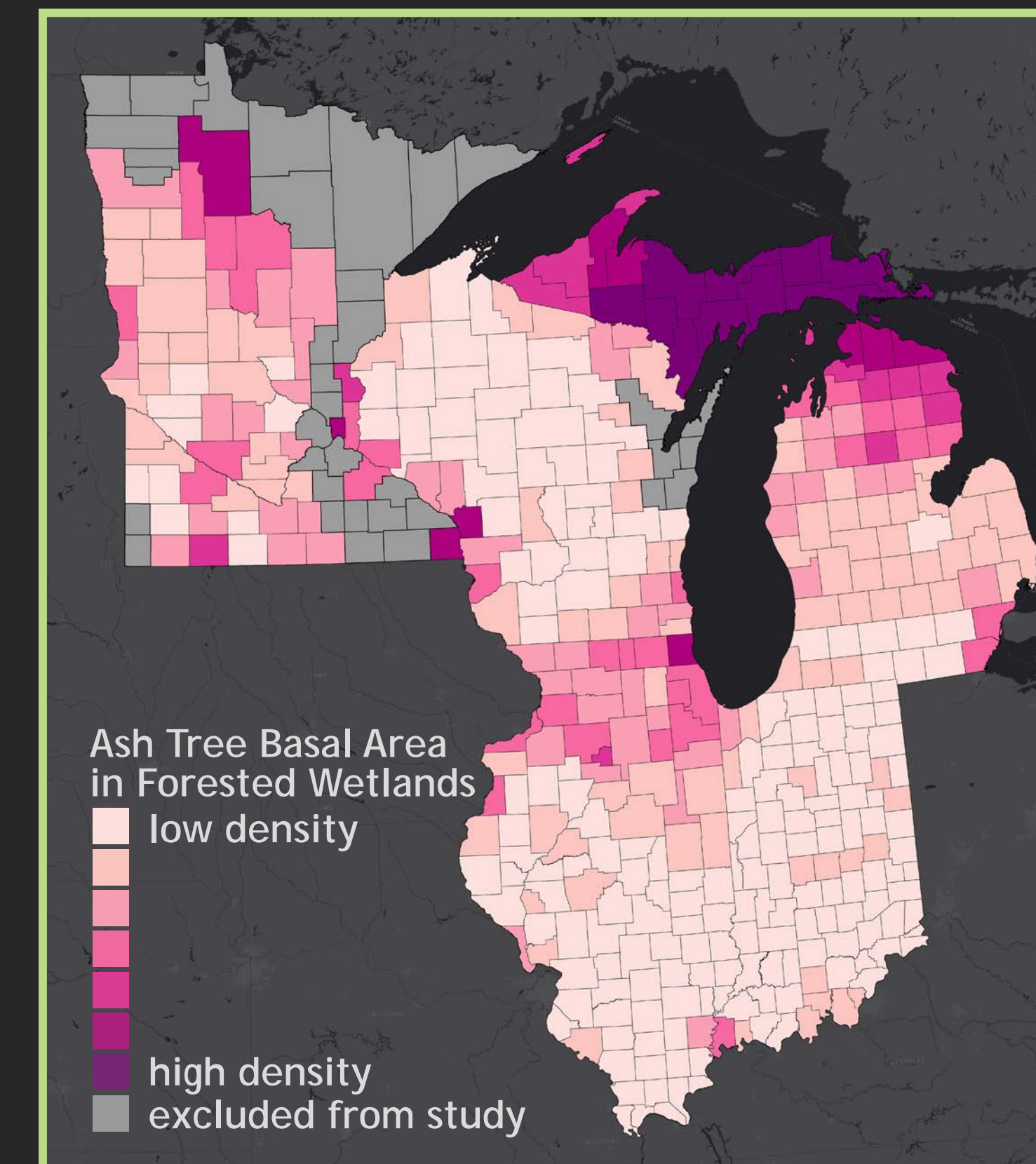


FIGURE 6: Distribution of Emerald Ash Borer

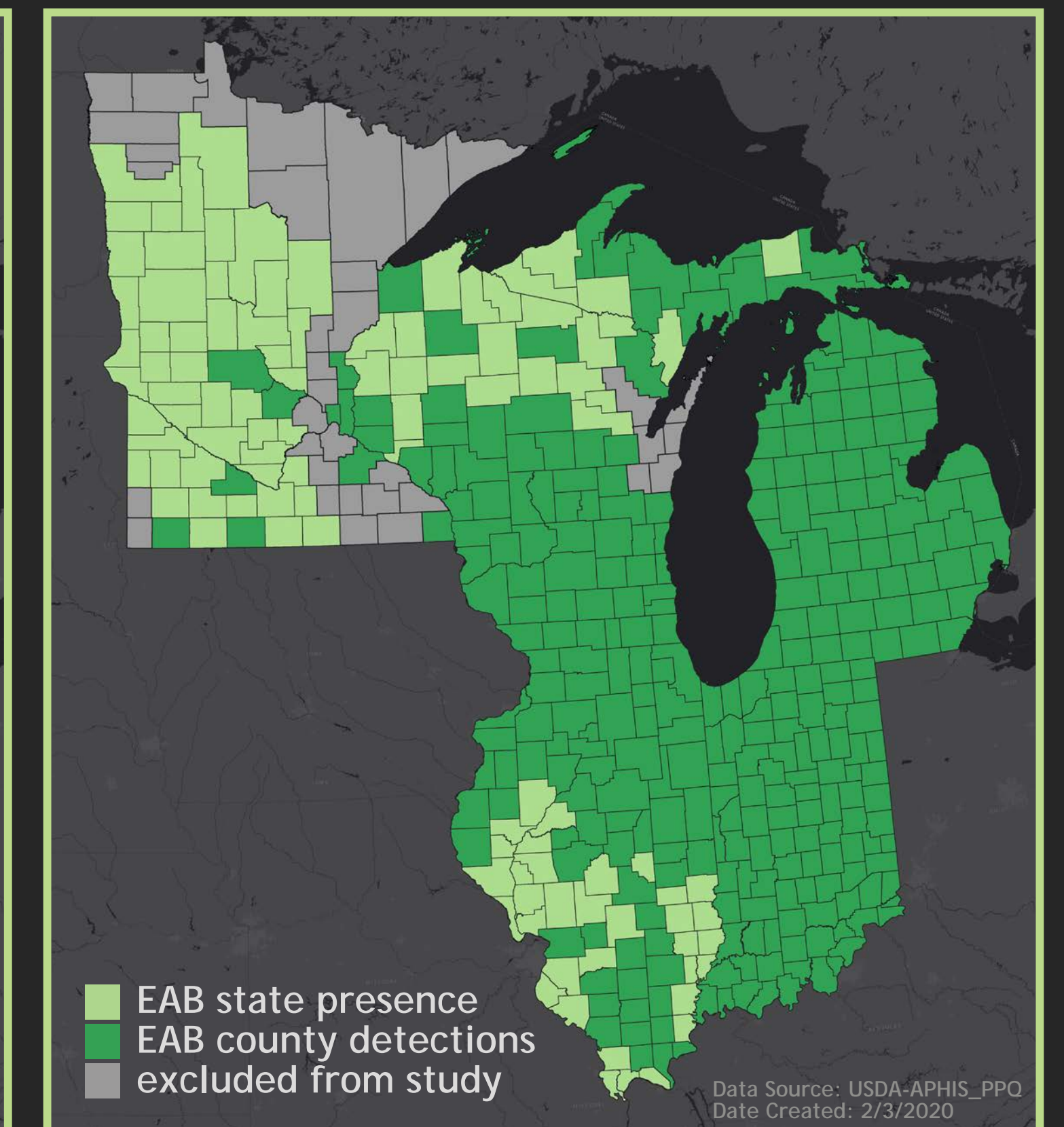


TABLE 1: Top Damage Causing Agents

Damage Causing Agent	Scientific Name	Group
Forest tent caterpillar	<i>Malacosoma disstria</i>	Defoliators
Emerald ash borer	<i>Agrilus planipennis</i>	Wood Borers
Spruce budworm	<i>Choristoneura fumiferana</i>	Defoliators
Bronze birch borer	<i>Agrilus anxius</i>	Wood Borers
Larch casebearer	<i>Coleophora laricella</i>	Defoliators
Flooding-high water		Abiotic Agents
Eastern larch beetle	<i>Dendroctonus simplex</i>	Bark Beetles

Next Steps

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- Extend the analyses to include results for 2018 to 2020, as well years prior to 2016 when EAB was still expanding its range, throughout all eastern states where EAB is established.
- Stratify forested wetlands based on broad-leaf and conifer tree species in order to better infer DCAs.
- Work with Forest Service Region 9 to improve the analyses and apply them to forest health monitoring.