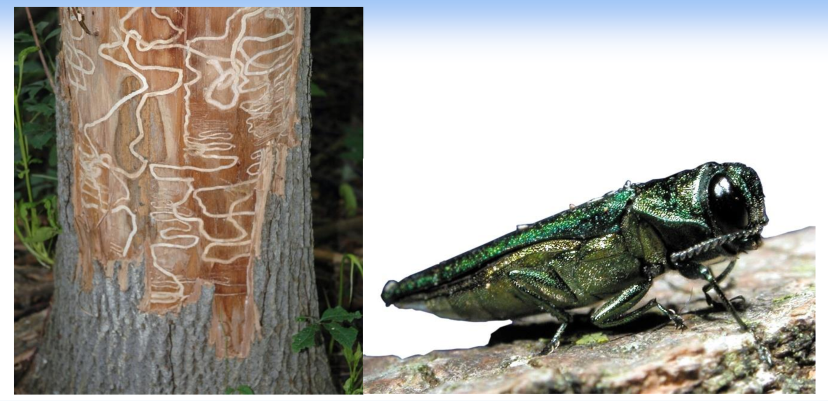

# Emerald Ash Borer in the WVU Arboretum: Differences in Ash Tree Mortality Based on Topographic Factors

Author: Laurence SanBoeuf
Co-Author: Francesca Basil
West Virginia University

West Virginia University
DEPARTMENT OF GEOLOGY AND GEOGRAPHY

## Objectives

The purpose of this analysis was to assess the effects of EAB on ash trees within the study area over a three-year period from 2015-2017, and to address whether topography, specifically slope and elevation, play any role in the speed and severity of these effects.

## Introduction/Abstract

Emerald ash borer, EAB, is an invasive species introduced to North America around 1990, and was first observed on the higher elevations within the WVU arboretum in 2014. Students at WVU collected data from 60-76 ash trees assessed overall tree health. I then evaluated tree mortality over the three-year period and assessed differences based on slope and elevation. The results of these analyses show that in 2017, trees on a slope from 20-26° showed only 33% dead and elevations from 275-300 m showed only 50% of trees dead, while other slope bins were 87-100% dead, and the other elevation bins were 79-100% dead. This suggests that some factors in these areas, possibly levels of moisture and nutrients within the soils, played a significant role in the rate of mortality.

| Study Area Background | |
|---|---|
| Study Area | WVU Arboretum |
| Average Elevation | 304 meters |
| Elevation Data Range | 226-370 meters |
| Geology | Shales, sandstones, coals |

## Methods

**Data Collection:**

In 2015, WVU environmental geoscience students identified and tagged 60 ash trees in the West Virginia University Arboretum. After identifying ash trees, the students recorded geographic coordinates and elevation taken from a GPS unit. They then evaluated EAB presence by recording percentage of tree crown that was alive, on a scale from 1-6, and assessed whether the tree was dead or completely healthy. In 2016 and 2017, students used the geographic data to locate the trees and followed the same procedure of EAB evaluation.

**Data Analysis:**

After analyzing overall ash tree mortality over the three year period, I used ARCGIS to analyze spatial differences in ash mortality by certain defined areas. For the slope analysis, I overlaid a DEM, digital elevation model, provided by the U.S. Geological Survey's National Elevation Dataset and used this to create a slope layer. The values of slope were then extracted for each point associated to each selected tree and these values were binned based by similar mortality rates. The trees were then compared based on healthy vs. dead, as well as percentage of tree crown alive based on their underlying slope. For analysis of elevation, I used only the original 50 trees from 2015 which had data for all three years. The largest variation of elevation measurement for the same tree was about 15 m, so I chose 25 m bins to ensure that the greatest number of trees fell into their true bins. Then each binned group was analyzed based on percentage of crown alive and averages of dead and healthy trees.

## General Analysis

| Crown % Alive Classification | |
|---|---|
| Classification | Crown% Alive |
| 1 | 0-10% |
| 2 | 10-25% |
| 3 | 25-50% |
| 4 | 50-75% |
| 5 | 75-90% |
| 6 | 90-100% |

Table 1 – Outlines Crown Percentage Classifications, note that these bins are not equal

| Elevation Bin Classification | |
|---|---|
| Elevation Bins | Elevation in meters |
| 1 | <250 |
| 2 | 250-275 |
| 3 | 275-300 |
| 4 | >300 |

Table 2 – Outlines elevation bin classifications

| Slope Bin Classification | |
|---|---|
| Slope Bins | Degrees Slope |
| 1 | 0-7° |
| 2 | 7-13° |
| 3 | 13-20° |
| 4 | 20-26° |
| 5 | >26° |

Table 3 – Outlines slope bin classifications

| Year | Total Trees | Sum of Healthy | Sum of Dead | Average Healthy | Average Dead |
|---|---|---|---|---|---|
| 2015 | 60 | 33 | 3 | 55% | 5% |
| 2016 | 75 | 27 | 13 | 42% | 20% |
| 2017 | 76 | 1 | 58 | 1% | 87% |

Table 4 – Outlines the decline of the trees over the entire study period

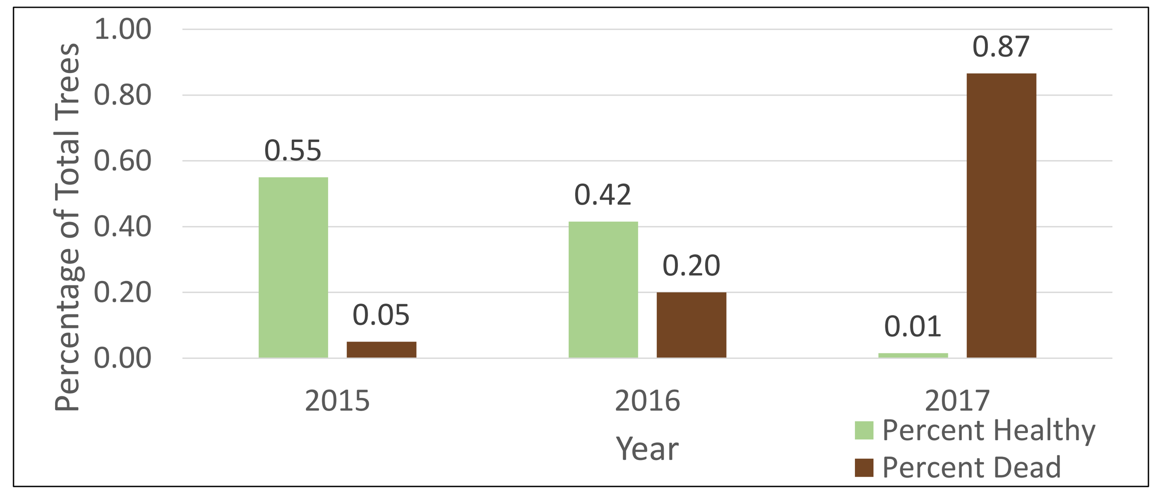


Figure 1 –

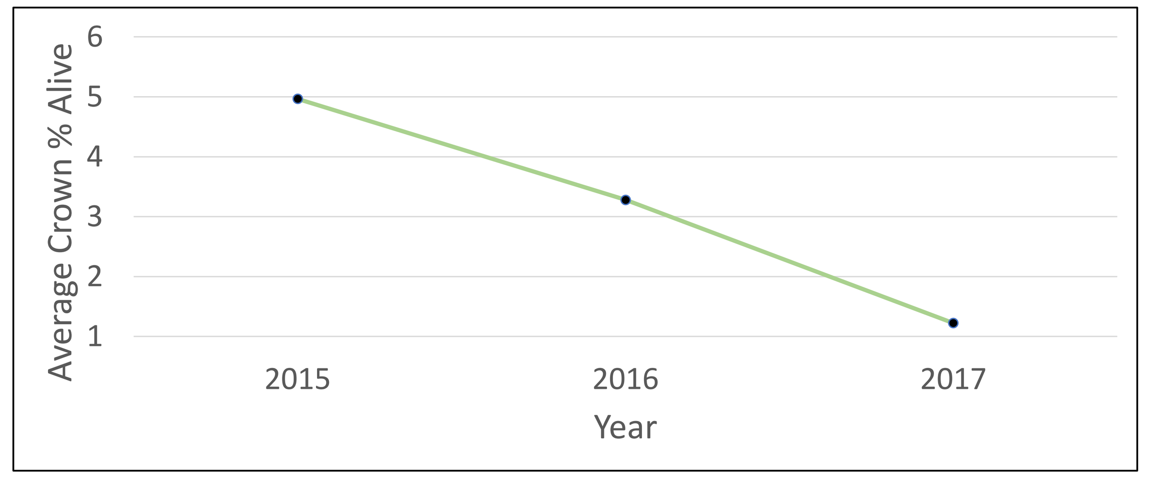


Figure 2 –

## Elevation Analysis

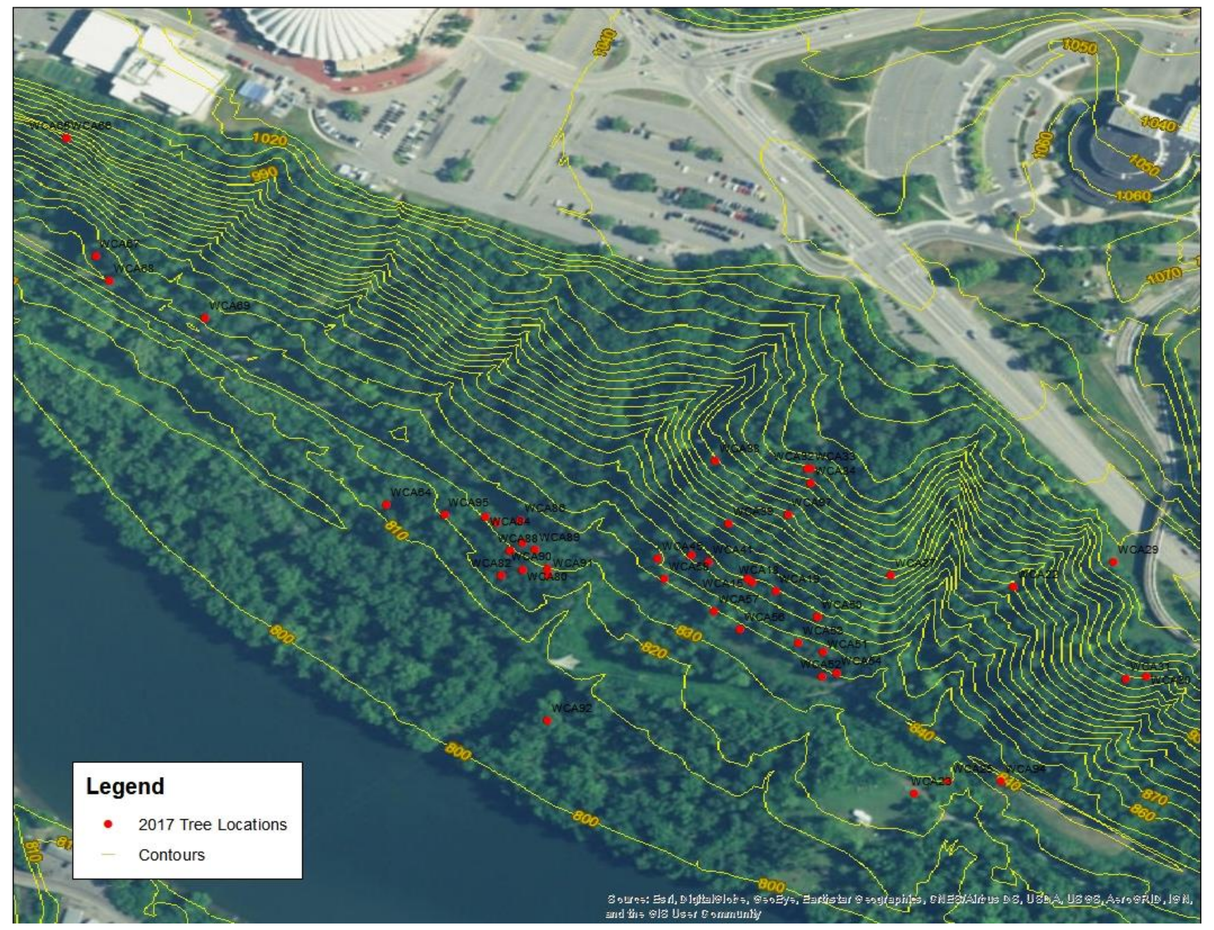


Figure 3 – Outlines the distribution of ash trees and the general elevation change over the area with an underlying contour

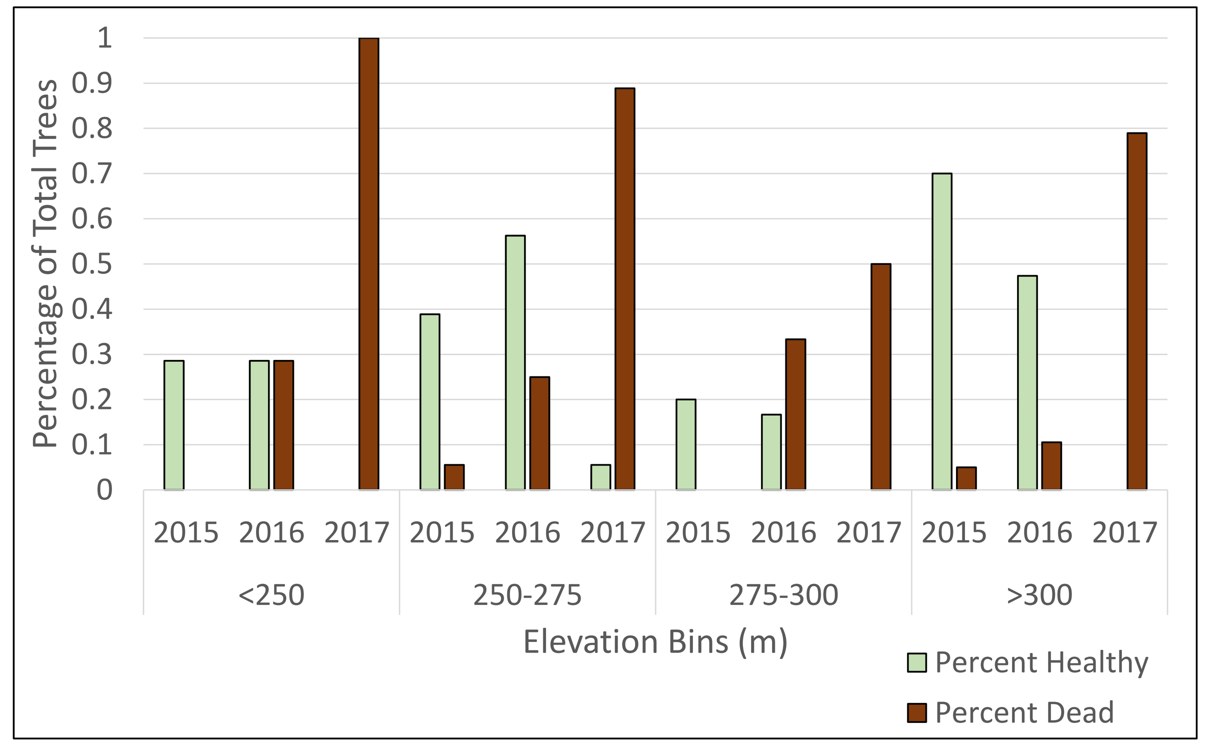


Figure 4 –

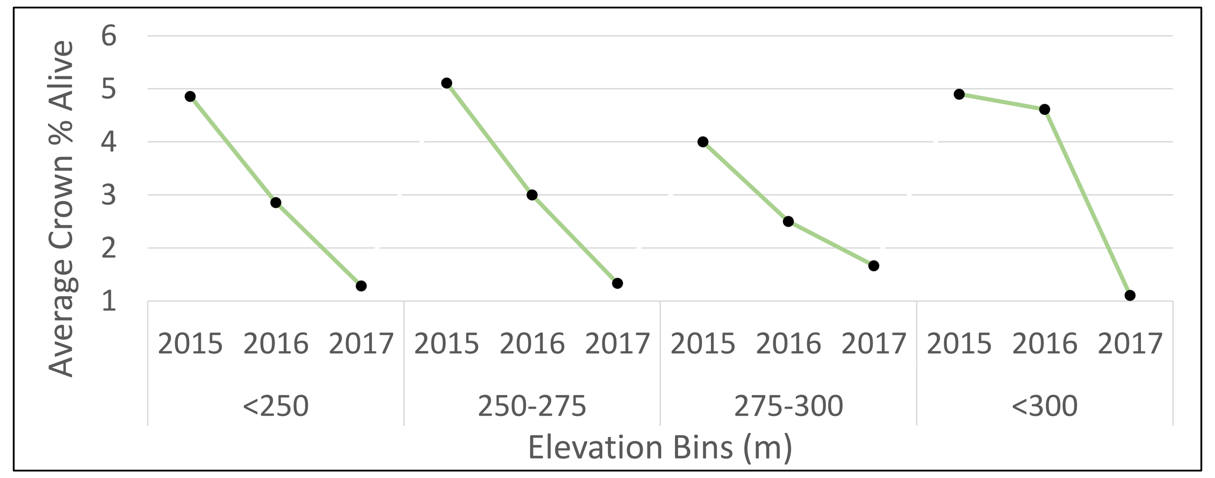


Figure 5 –

## Slope Analysis

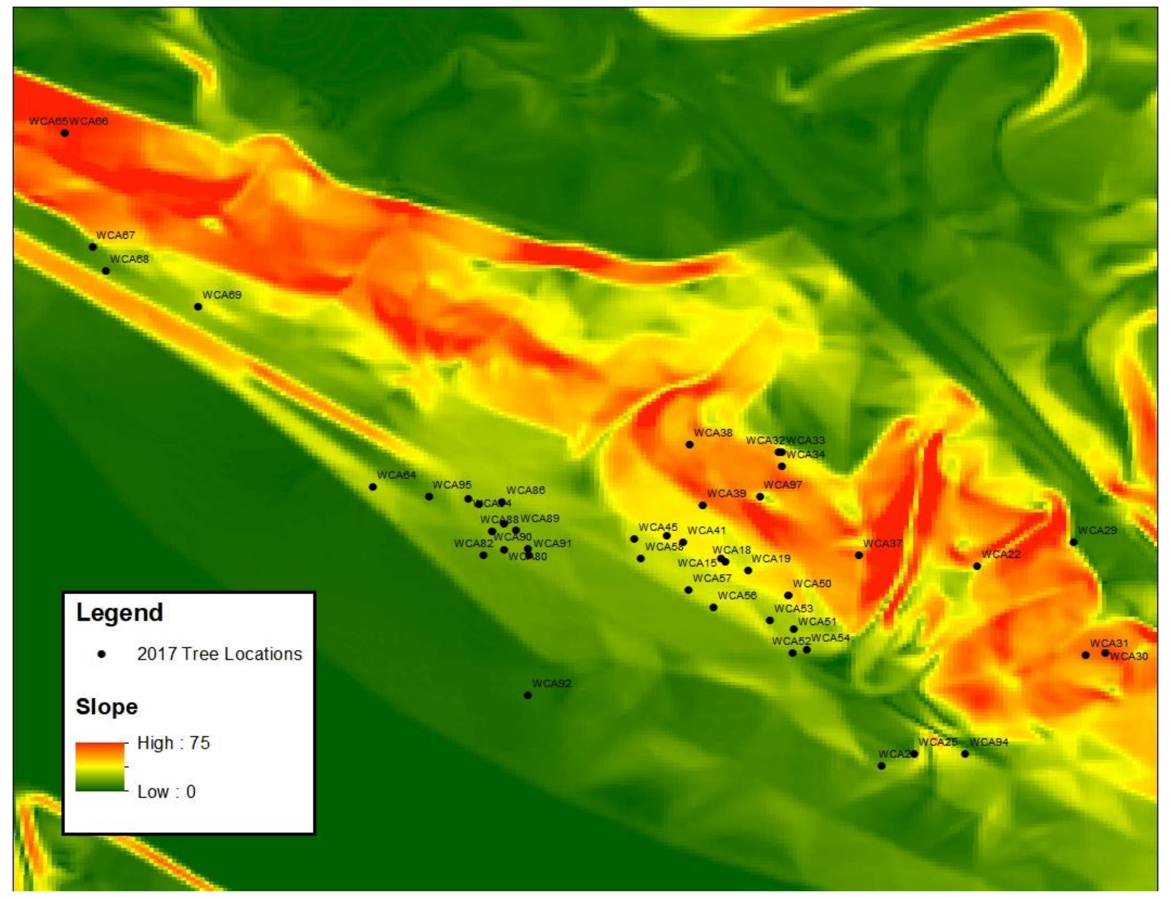


Figure 6 – Outlines the distribution of ash trees in comparison to the slope

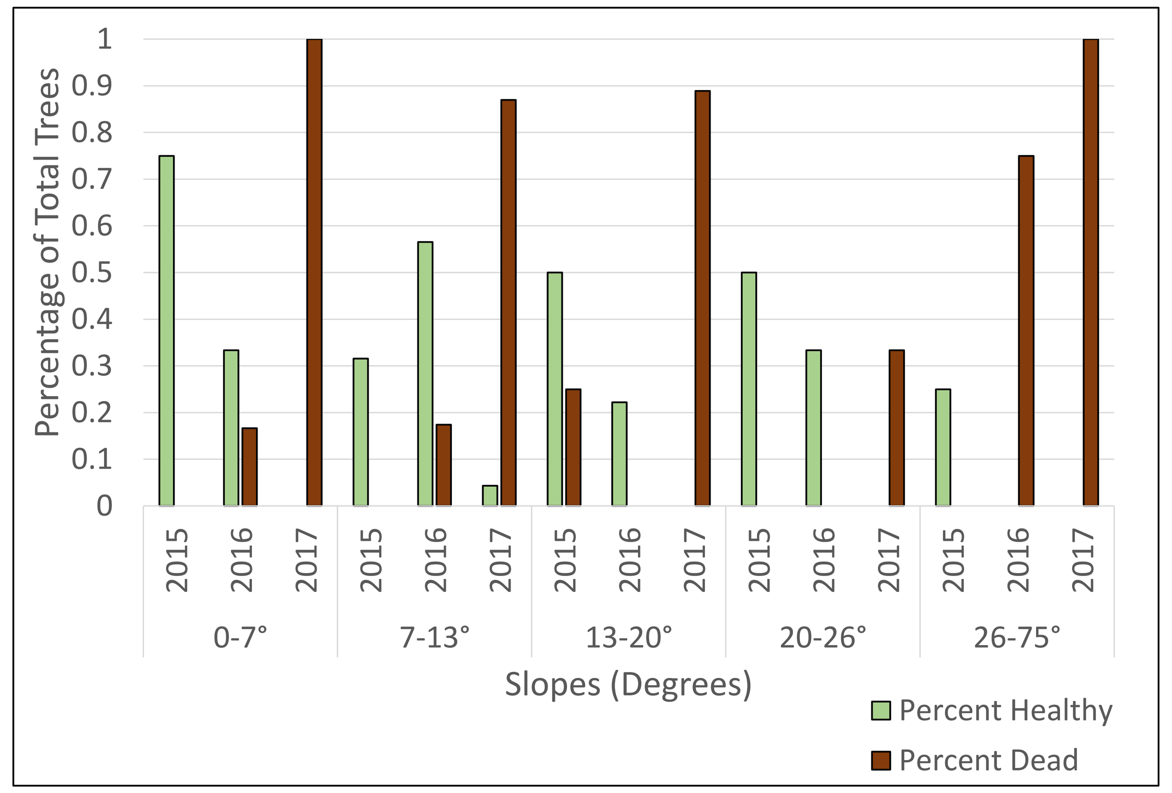


Figure 7 –

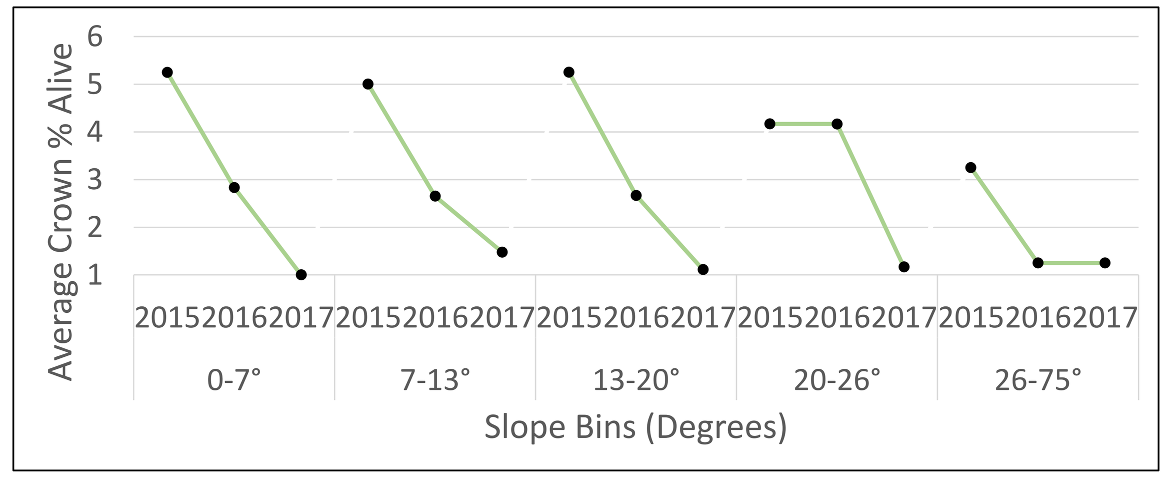


Figure 8 –

## Discussions/Conclusions

**How has ash mortality from EAB changed in the arboretum since 2015?**

By 2017, 87% of all the trees were shown to be completely dead, and only one tree was rated as completely healthy, which does fit several other studies that show 1-3% of ash trees in most areas actually never become infected with EAB (Knight et al., 2012)

**How has topography affected EAB related death to ash trees?**

The highest and lowest slope bin, 0-7° and >26°, both showed 100% dead by 2017. Generally, the more steep the slope is, the less nutrients and water available to the trees. The trees on the lowest slopes were probably the most nutrient and moisture rich before EAB arrived. EAB larvae require a significant moisture content in the phloem to develop successfully (Finley et. al 2016), and since ash tree mortality is directly tied to larvae density (Anulewicz et al., 2008) these trees would exhibit a faster mortality rate. The trees on the highest slopes had the lowest amounts of water and nutrients before EAB arrived, causing them to be affected more easily. The trees on the slopes from 7-26° did better than the other slope bins, specifically the trees on slopes 20-26°, with only 33% being dead in 2017, compared to the other bins with 100%, 87%, 89%, and 100%. These trees may have had a low enough moisture content to negatively affect larvae development, but had enough moisture to keep the tree alive. Generally patterns in the elevation analysis are probably tied to slope since slopes from 20-26° frequently fell into the third elevation bin, 275 - 300 m.

Although these trees are still infected by EAB and will probably die, this knowledge may be useful in modeling EAB distribution and with remediation efforts in other ash tree stands in the future. Further investigation should be done to pinpoint an exact moisture content which restricts EAB larvae development, and to assess soil moisture content and EAB density on differing slopes, so that forest managers could more accurately target susceptible areas in an attempt to control EAB populations in the case of limited funding.

## Contributors

Almass Mohammed, Anderson Brady, Barnes Aaron, Faber Travis, Facemire Olivia, Hally Callum, Harpin Austin, Izon Jason, Kessler-Gaa Ben, King Christopher, Pietkoski Kaleb, Smack Cordrey, White Hunter, and **Dr. Amy Hessl**

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