



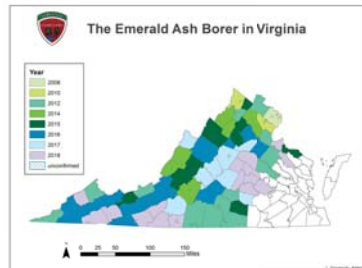
Impacts of the Invasive Emerald Ash Borer (EAB) on Ash Trees in Virginia Forests

Brian Ditch, Adam Allen, Stephen Ruppert, Dr. Christine Small
Department of Biology, Radford University, Virginia



What is the Emerald Ash Borer?

Millions of ash trees (*Fraxinus* spp.) have been killed since the **Emerald Ash Borer** (*Agrilus planipennis*; EAB) was introduced to Michigan in 2002. Since then, this Asian wood-boring beetle has spread rapidly through eastern North America. EAB was confirmed recently in Radford and surrounding counties (2016 to 2018), yet it is one of the most destructive forest pests in Virginia. The entire state is now under federal quarantine to limit its spread.



The Emerald Ash Borer feeds only on ash and closely related trees species. Female EAB deposit eggs on the tree bark. After hatching, larval beetles burrow under the bark to feed. Larvae are the most damaging stage of the lifecycle, often killing adult trees in four years. Adult beetles emerge in spring through characteristic **D-shaped exit holes** (shown to the right).



Research Objectives

Our goals were to investigate impacts of the EAB on ash-dominated forests in the Central Appalachians and support state and national efforts to track ash decline, identify genetically resistant ("lingering") individuals, and forests changes associated with the loss of these important tree species.

Monitoring Ash Tree Health

Wildwood Park is a 50-acre (20.2 ha) forested natural area in Radford, Virginia. In the park, we tagged 80 ash trees and assessed each for health and EAB impacts. Forest structure, composition, topography, and soil also were measured in four 400 m² plots around target trees.

We developed a **bark scale** to measure damage on the lower, middle, and upper sections of each ash tree. Ratings ranged from 1 (no signs of EAB impacts) to 5 (severe damage on at least one side of the tree).



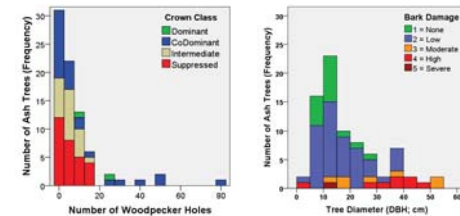
- 1 Bark healthy, intact, healthy, no visible woodpecker or EAB damage
- 2 Bark with minor damage; holes or bark removed on < 10% of trunk
- 3 Bark removed on 10-50% of trunk
- 4 Bark removed on 50-90% of trunk
- 5 Severe woodpecker and EAB damage; > 90% of bark removed; serpentine larval galleries typically visible

Woodpecker damage often is the first sign of EAB infestation. Following monitoring protocols from the U.S. Forest Service (Knight et al. 2014), we counted the number of woodpecker and EAB exit holes from 1.25 to 1.75 m high from the base of each tree.

Other **tree stress measures** included number of epicormic and basal sprouts, bark splits, larval feeding galleries, and extent of canopy dieback. Tree diameter (DBH, measured at 4½ feet high) and crown class (position of the tree within the forest canopy) were also recorded relative to EAB intensity and damage.

EAB Impacts in Radford, Virginia

The graphs below show that co-dominant ash trees had more woodpecker holes. Trees in this **crown class** reach the forest canopy and receive direct sunlight. Suppressed and intermediate ash trees had relatively few woodpecker holes. Trees in this crown class are shorter and receive little direct sunlight. Severity of **bark damage** increased with tree diameter. Larger ash trees often had moderate to high bark damage. Smaller diameter trees had less bark damage (low to none).



The table below shows average ash tree measures and signs of EAB infection. In sites with higher tree density, over 75% of ash trees exhibit EAB and woodpecker holes. Trees with more woodpecker holes also had higher bark damage ratings and more exposed larval galleries.

	Site 1	Site 2	Site 3	Site 4
Tree density (400 m ²)	925	1375	1425	2375
Ash density (400 m ²)	16	37	11	15
Ash diameter (cm)	26.7	12.0	20.1	26.6
# Woodpecker holes	4.4	7.2	9.4	12.9
Presence of woodpecker holes	94%	89%	91%	100%
# EAB holes	10.1	3.7	2.7	4.2
Presence of EAB holes	94%	78%	100%	80%
Bark scale rating	2.1	2.2	2.6	2.6
Presence of larval galleries	6%	14%	18%	40%
Presence of bark splitting	63%	89%	55%	87%

References

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