Impacts of Emerald Ash Borer on Ash Species and Forest Cover In the Upper Peninsula of Michigan

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Introduction

- Emerald ash borer, *Agrilus planipennis* Fairmaire is a wood-boring pest species native to northeast Asia. (1)
- Emerald ash borer (EAB) was introduced to southeast Michigan in the 1990s burrowed in wooden shipping crates. (1)
- Emerald Ash Borer (EAB) was first discovered in the US in southeast Michigan in 2002, spreading to the Upper Peninsula by 2007 . (1)
- EAB solely attacks species of ash, which serve as a host for the pest species. (2)
- Management strategies to slow the spread of EAB have been met with limited success. (3)
- The objectives of this study are to locate areas in which ash species are likely distributed and analyze changes in this distribution and the forest cover between 2001 and 2018.
- It can be expected that forest cover, and ash species suitability will decline as a result of the introduction of EAB into the forest ecosystems.

Methods

- The Upper Peninsula of Michigan was used as the study area due to its high percentage of forested area, proximity to the initial introduction of EAB, and its limited access from lower Michigan.
- NLCD 2001 and 2011 land cover data, along with Landsat 8 OLI imagery, was used to locate areas of suitability for ash species in the Upper Peninsula.
- NLCD 2001 and 2011 data was analyzed for changes in land cover classifications from 2001 to 2011 using the Minus tool in ArcMap 10.5.1.
- NLCD data was also reclassified into ash species suitability using the reclassify tool. **Table 1**.
- Landsat 8 imagery was acquired and clipped to the extent of the Upper Peninsula.
- Each image was classified based on ash species suitability of DN values from band 3 (green).
- The classified 2018 segments were combined together into a new raster image.
- Changes in pixel counts of ash species suitability from 2001 to 2011, and from 2011 to 2018, as well as the locations of these changes, were analyzed.
- Changes between 2001 and 2011 NLCD land cover classifications were also calculated.
- This data was combined together in order to understand the impacts the spread of EAB has had on ash species in the Upper Peninsula, and the overall forest cover.

Table 1.
Reclassifications of NLCD land cover data.

NLCD Land Classification 2001 & 2011	Old Land Value	Ash Species Suitability
Open Water	11	Not Suitable
Developed, Open Space	21	Mildly Unsuitable
Developed, Low Intensity	22	Mildly Unsuitable
Developed, Medium Intensity	23	Not Suitable
Developed, High Intensity	24	Not Suitable
Barren Land (Rock/Sand/Clay)	31	Not Suitable
Deciduous Forest	41	Very Suitable
Evergreen Forest	42	Mildly Unsuitable
Mixed Forest	43	Mildly Suitable
Shrub / Scrub	52	Mildly Suitable
Grassland / Herbaceous	71	Mildly Unsuitable
Pasture / Hay	81	Mildly Unsuitable
Cultivated Crops	82	Not Suitable
Woody Wetlands	90	Very Suitable
Emergent Herbaceous Wetlands	95	Very Suitable

Results

Table 2. Very suitable land cover decreased 9.50% from 2001 to 2018, while mildly suitable land cover increased 12.98%.

Changes in Suitability of Ash Species from 2001 to 2018 in the Upper Peninsula				
Data	% of Very Suitable Land Cover	% of Mildly Suitable Land Cover	% of Mildly Unsuitable Land Cover	% of Not Suitable Land Cover
2001 Ash Suitability	65.07%	11.40%	18.56%	4.96%
2011 Ash Suitability	64.74%	11.89%	18.28%	5.09%
2018 Ash Suitability	55.57%	24.38%	11.02%	9.04%

- **Figure 1**, **Figure 2**, and **Figure 3** show the changes in land cover, specifically the changes in ash species suitability, in the Upper Peninsula of Michigan from 2001, 2011, and 2018. These figures highlight the potential impacts of EAB on the Upper Peninsula.
- **Figure 1** shows the suitability of ash species in the Upper Peninsula prior to the introduction of EAB to the region. **Figure 2** shows the habitat suitability of ash species soon after introduction of EAB into the Upper Peninsula, and **Figure 3** shows the habitat suitability of ash species most recently, when EAB has already become established in the region.
- Results from this study show a 9.5% loss of very suitable ash species land cover from 2001 to 2018. **Table 2**.
- A decrease of very suitable ash species land cover correlates with a 12.98% increase in mildly suitable land cover.

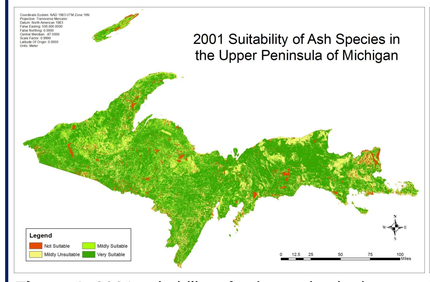

Figure 1. 2001 suitability of ash species in the Upper Peninsula. Acquired from NLCD 2001 data.

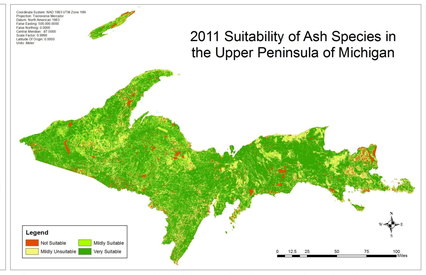

Figure 2. 2011 suitability of ash species in the Upper Peninsula. Acquired from NLCD 2011 data.

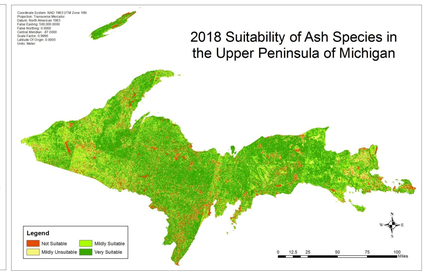

Figure 3. 2018 suitability of ash species in the Upper Peninsula. Acquired from Landsat 8 OLI images.

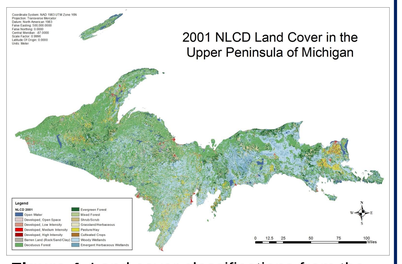

Figure 4. Land cover classifications from the 2001 National Land Cover Database in the Upper Peninsula.

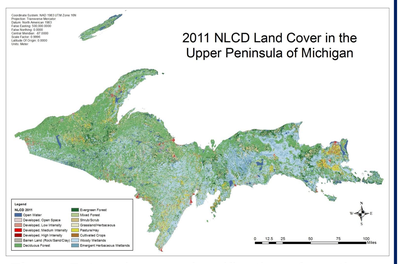

Figure 5. Land cover classifications from the 2011 National Land Cover Database in the Upper Peninsula.

Discussion

- Based on the findings of this analysis, the spread of EAB into the Upper Peninsula correlates with a 9.5% decrease in very suitable ash species land cover.
- A 12.98% increase in mildly suitable ash species land cover further supports the hypothesis that EAB introduction into the forest ecosystems have resulted in a decline of forest cover and ash species suitability.
- The results suggest that EAB has negatively impacted ash species and forest cover, leading to a loss of ash species canopy, and therefore an increased amount of gaps in the forest cover. Increased gaps lead to changes in the forest understory, and potentially leads to the loss of even more forest cover.
- Mortality in ash species due to the introduction of EAB in the environment harm forest ecosystems where ash species are present as a whole.

Conclusion

- Since the introduction of EAB to the Upper Peninsula, a decline in forest cover and suitable ash species habitat has occurred.
- Correlations between the loss ash species habitat and the establishment of EAB in the Upper Peninsula exist.
- Limitations due to the use of Landsat 8 OLI imagery exist.
  - Some of the images used contained limited cloud cover, resulting in those areas being classified as not suitable.
  - Although the images used were acquired during the same season, some images were acquired on different dates and at different times, resulting in inaccuracies in the classification proccess.
  - The Landsat images could not be directly compared to the original NLCD data for 2001 and 2011; the suitability data was necessary to compare the data.
- Similar findings could potentially be found in other areas of the country where EAB has become established.
- Further research should be done in the Upper Peninsula to confirm these findings. On site data would be useful to furthering this research, as well as more data of when EAB impacts can be better understood.

References

- (1) Cappaert, David; D.G. McCullough; T.M. Poland; N.W. Siegert. Emerald Ash Borer in North America: A Research and Regulatory Challenge. Am. Entomol. 2005, 51.3:152-165.
- (2) Herms, Daniel A.; D.G. McCullough; Emerald Ash Borer Invasion of North America: History, Biology, Ecology, Impacts, and Management. Annu. Rev. Entomol. 2014, 59:13-30.
- (3) USDA; APHIS. EAB Story Map. https://www.aphis.usda.gov/aphis/maps/plant-health/eab-storymap (accessed January 31, 2019). Animal and Plant Health Inspection Service.

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