Tree Species Most Likely to Replace White Ash Canopy Trees in the Ramapo Mountains

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Introduction

- Numerous tree species in the northeastern United States have been in decline in recent decades due to a variety of invasive insect species and diseases (Lovett et al, 2010; Potter et al, 2019).
  - A prime example is that invasive emerald ash borers (*Agrilus planipennis)* are causing white ash tree (*Fraxinus americana)* populations to rapidly decline throughout much of their range (Sun et al, 2024).
  - As large white ash trees die, other trees may benefit from the additional sunlight that penetrates through the large canopy openings left behind. However, few studies have addressed which tree species might replace dead canopy ash trees.
- The purpose of this study was to predict which tree species will most likely replace white ash canopy trees within a 30-hectare forest study plot in the Ramapo Mountains, New Jersey Highlands.

Methods

- Study area:
  - Ramapo Valley County Reservation, New Jersey Highlands
    - 80-meter belt transect along both sides of a narrow hiking trail (total area = 30 hectares)
- Field methods:
  - All patches of two or more neighboring canopy ash trees were included in the study (n = 88 trees across 26 patches).
    - GPS coordinates were recorded for each canopy ash tree ≥ 5 m from the trail.
  - Survey of possible replacement trees:
    - Within each patch of ash trees, the species and trunk diameter were recorded for each understory, midstory, and subcanopy tree ≥ 2.5 m height that was within 5 m of a vertical projection of any ash tree canopy within the patch. For fallen canopy ash trees, data were recorded for trees within 7.5 m of the original base of the ash tree.
- Predicting the species composition of replacement trees:
  - For each patch of ash trees, the relative basal area of possible replacement trees was used to predict the relative densities of the tree species that will replace the total number of canopy ash trees in the patch. Relative densities were modified when needed so that the predicted number of replacement trees did not exceed the number of possible replacement trees present for any given specie. Relative densities of possible replacement trees for all patches in the study area combined were weighted by the number of ash trees in each patch.
    - Given that all white ash trees will likely die in the coming years, they were excluded from this replacement model. American beech trees were also excluded because all individuals at the site are visibly infected with deadly beech leaf disease.

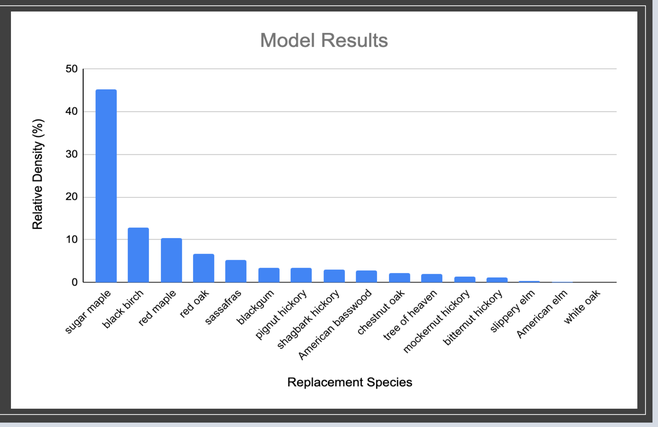
Figure 1. Location of Ramapo Valley County Reservation (red) within NJ.

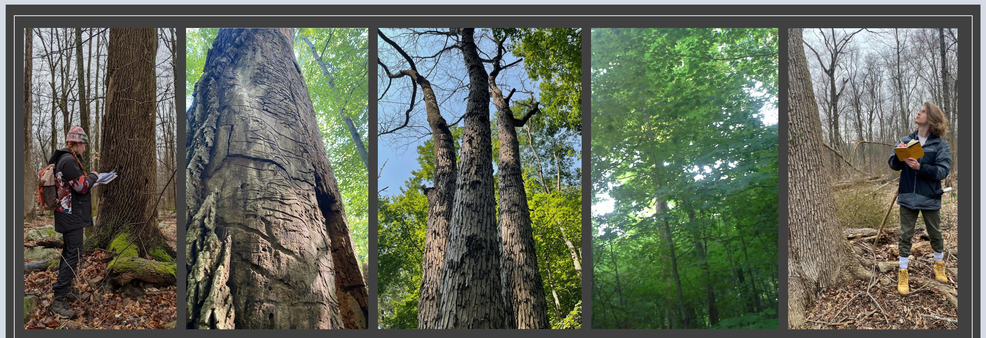
Figure 2. Map of the white ash trees in the study.

Table 1. Summary statistics of possible replacement trees combined across all patches. Note: Relative frequency represents the percentage of patches where each specie was present.

Scientific Name	Common Name	# of Individuals	Relative Density (%)	Relative Basal Area (%)	Relative Frequency (%)
Acer rubrum	red maple	74	8.4	11.5	65.4
Acer saccharum	sugar maple	470	53.5	46.7	100.0
Ailanthus altissima	tree of heaven	18	2.1	2.1	7.7
Betula lenta	black/sweet birch	85	9.6	10.2	65.4
Carya cordiformis	bitternut hickory	2	0.2	0.36	3.8
Carya glabra	pignut hickory	18	2.1	2.5	38.5
Carya ovata	shagbark hickory	25	2.8	3.1	19.2
Carya tomentosa	mockernut hickory	9	1.0	1.2	23.1
Fagus grandifolia	American beech	59	6.7	5.5	46.2
Fraxinus spp.	ash species	12	1.4	0.5	15.4
Nyssa sylvatica	Blackgum	23	2.6	2.2	23.1
Quercus alba	white oak	1	0.1	0.02	3.8
Quercus montana	chestnut oak	8	0.9	2.8	19.2
Quercus rubra	red oak	16	1.8	3.6	30.8
Sassafras albidum	Sassafras	39	4.4	3.5	42.3
Tilia americana	American basswood	17	1.9	3.8	34.6
Ulmus americana	American elm	2	0.2	0.2	7.7
Ulmus rubra	red elm	1	0.1	0.4	3.8

Figure 3. Relative densities predicted by the replacement model. Species are ordered from highest to lowest. American beech and ash species were not included in the model (see Methods section).





Results and Discussion

- 808 possible replacement trees were encountered.
- Both the descriptive statistics from the survey (Table 1) and the results of the replacement model (Figure 3) suggest that sugar maple is likely to be by far the most common specie to replace the canopy ash trees, followed by black birch, red maple, and 13 other tree species.
  - Although American beech is the fourth most abundant tree specie in the survey, the presence of deadly beech leaf disease signifies that this late successional specie will not be among the tree assemblage that will replace dead canopy ash trees.
  - Unfortunately, a relatively small proportion of the likely replacement trees are of nut-producing species on which many animal species rely. Therefore, it appears that the resultant increase in canopy openness from ash die-off is not likely to reverse the decline of nut-producing tree populations at the site (Klenk et al, 2023).
- The species composition of the replacement trees in this study are similar to the results of a separate study about the trees most likely to replace dying canopy beech trees in the same study area. In contrast, however, while 60 % of the canopy beech trees will not likely be replaced by any trees in the near-to-medium future (Stone et al, 2023), we observed potential replacement trees beneath all of the canopy ash trees in our study. Hence, the demise of ash trees at this site will likely have less dramatic impact on the overall physiognomy of the forest.
- Overall, results of this study suggest that the increasing prevalence of maples and birches at the site (Bajracharya et al, 2024) will be accelerated by the rapid loss of ash trees. This raises concern because populations of at least two of these species are expected to decline due to climate change, indicating that tree species composition will likely continue to shift in the coming decades.

Acknowledgments

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