Native tree seedlings and over-abundant white-tailed deer in the metropolitan forest

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Abstract

- Temperate, deciduous, metropolitan forests are essential ecosystems for natural biodiversity and ecosystem services, and they also serve as a way for dense urban-suburban human populations to connect with nature. These forests, however, are threatened by overabundant deer, which can have negative effects on the future forest due to lack of seedling recruitment of a diversity of tree species. We examined native tree seedling abundance and related it to the level of deer pressure in three forests that have high but differing deer pressure. Surprisingly, we found that in the forest with greatest chronic deer pressure (Rosedale) there was significantly higher mean percent cover of native tree seedlings, which we measured in forty 16 m^2 plots per forest. Also, Rosedale had the lowest current deer pressure, which we quantified with browse signs on native woody plants below 1.4 m. The shrub layer is almost nonexistent in Rosedale, offering little food or shelter to deer, so they may tend to avoid it currently, allowing tree seedling cover to increase. Tree seedling cover in all three forests was dominated mostly by the same 4-5 deer-resistant species, but one very resistant species, *Acer saccharum* (sugar maple), was an abundant seedling only in Rosedale, even though it also is an abundant canopy species in one of the other forests. We hypothesize that very severe, chronic deer pressure in metropolitan forests eventually results in low deer visitation, allowing the remaining deer-resistant tree seedlings an escape from current deer herbivory.

Introduction

Temperate, deciduous, metropolitan forests are increasingly facing threats, as shown by an alarming lack of juvenile trees. This lack may be related to overabundant white-tailed deer:

- The abundance of white-tailed deer greatly reduces natural flora because of excessive herbivory.
- Tree seedlings represent the future of the forest.
  - Forest regeneration is critical to maintain the forest; young trees must successfully establish and grow to renew the tree cover.
- Deer are a keystone herbivore; with very high densities in metropolitan forests, they have negative direct and indirect effects on tree seedlings.
  - Deer reduce growth and reproduction directly, by eating photosynthetic tissue of seedlings, which limits recruitment, seedling size, and population density (Rooney, 2001).
- Deer-resistant tree species can persist in forests with overabundant white-tailed deer; examples include *Acer saccharum* (sugar maple), *Acer rubrum* (red maple), and *Fraxinus pennsylvanica* (green ash).

OBJECTIVE: Determine how the tree seedling community is influenced by the extent of deer pressure within metropolitan forests.

Methods

- Three metropolitan forests with high deer pressure, located in Central New Jersey.
- Each forest was divided into 40 16m^2 plots.

Measure of Chronic Deer Pressure

- Quantified the foliage cover of native woody plants at deer-browse height (0.4m - 1.4m.) at 40 points per forest (one point per plot).
- Measured using a 1m^2 quadrat divided into 16 squares, held vertically.
- Viewed from 10m away, cover score based on the number of squares at least partially covered by native woody plants.

Measure of Current Deer Pressure

- Scored deer browse presence or absence on every native woody plant in a 0.5 x 4 m strip on two sides of each plot.
- Browse was evident from shreddy, bitten twig ends.

Canopy Importance Value

- Sampled 10 points per forest X 4 trees per point = 40 trees per forest, total.
- Measured point-to-tree distance, DBH, and identified to species or to Genus (for *Carya* and all *Quercus* species except *Q. alba*).
- For each species in a forest, calculated basal area, relative dominance (RD), relative frequency (RF), relative density (RD). Species Importance Value in a forest: IV = RD + RF + RD.

Herb Layer Census

- A 0.5 x 0.5m (0.25m^2) frame was thrown a total of 16 times into each plot to create subplots.
- Each plant within the subplot was identified and scored on a scale of "+" to 10, for percent cover of the frame (+ is <10%, 1 is 10 to <20%, 2 is 20 to <30% , etc.).

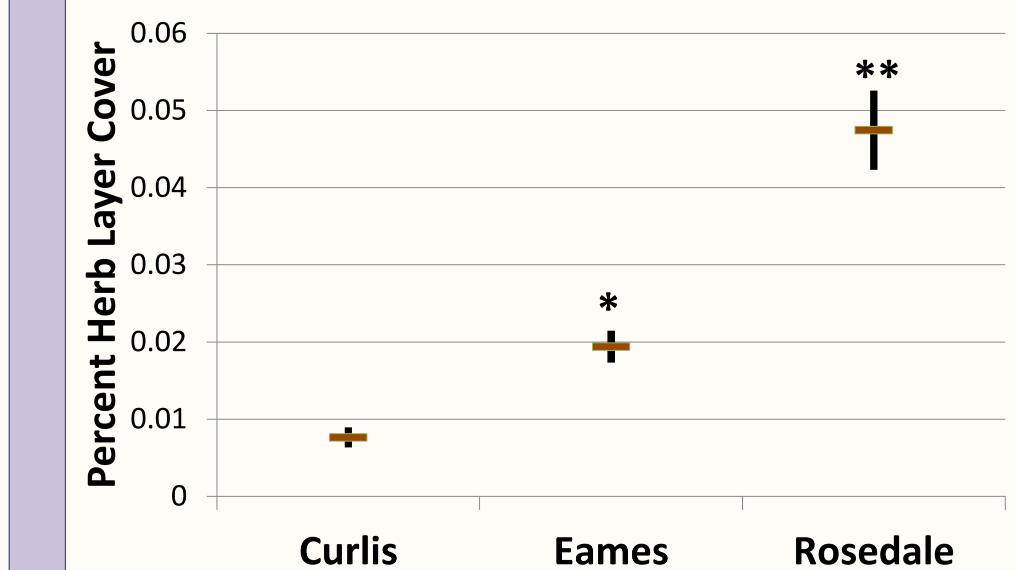

Figure 1. Mean (± SE, n=35,39,32) percent cover of native tree seedlings in the herb layer of each forest. Rosedale had much higher percent cover (ANOVA: $F_{(2,94)} = 54.76$, $P < 0.001$)

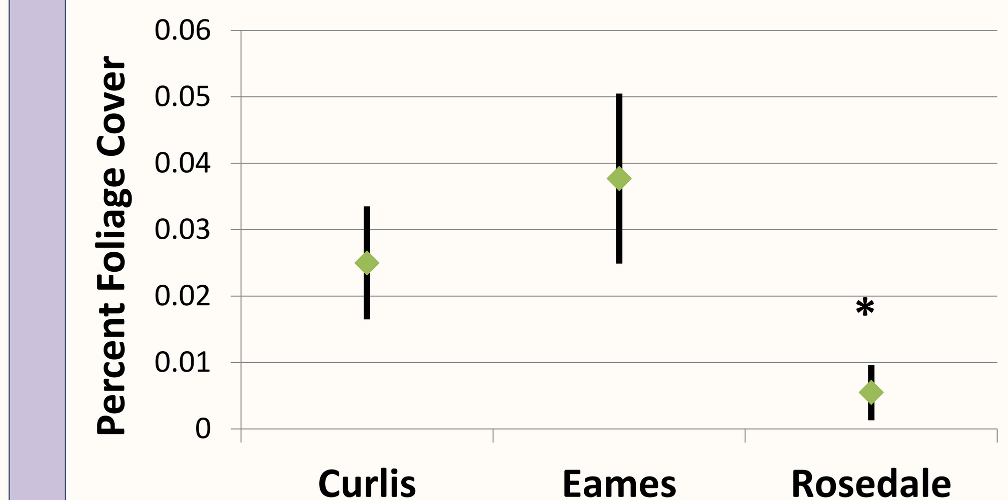

Figure 2. Chronic deer pressure measured as the inverse of native shrub cover. Mean (± SE, n=40) percent foliage cover in each forest. Rosedale had the highest chronic deer pressure (ANOVA: $F_{(2,116)} = 4.19$, $P < 0.02$)

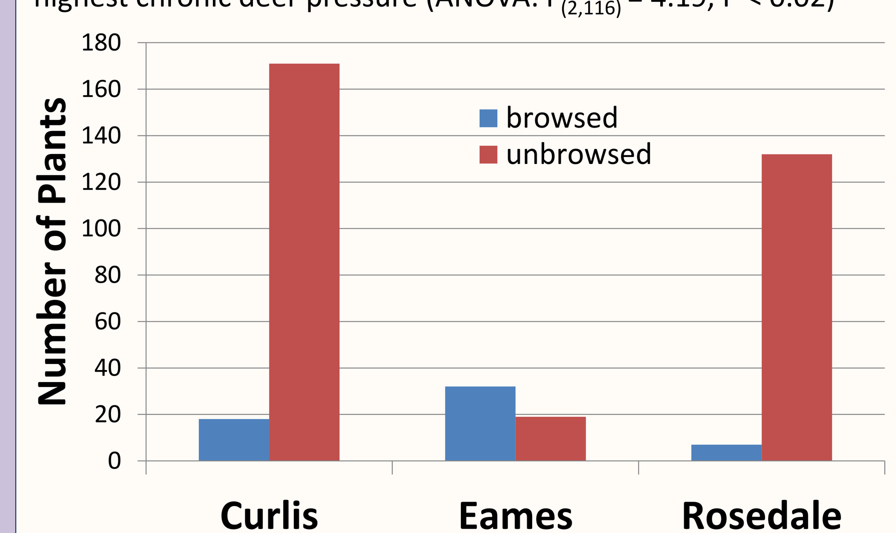

Figure 3. Current deer pressure, measured by number of native woody species browsed and unbrowsed in the herb layer. The relative frequency of browsed woody plants was significantly higher in Eames ($X^2 = 106.22$, df=2, p< .001). Rosedale had the lowest current deer pressure (Rosedale vs. Curlis $X^2 = 2.291$, df=1, P=0.13).

Results

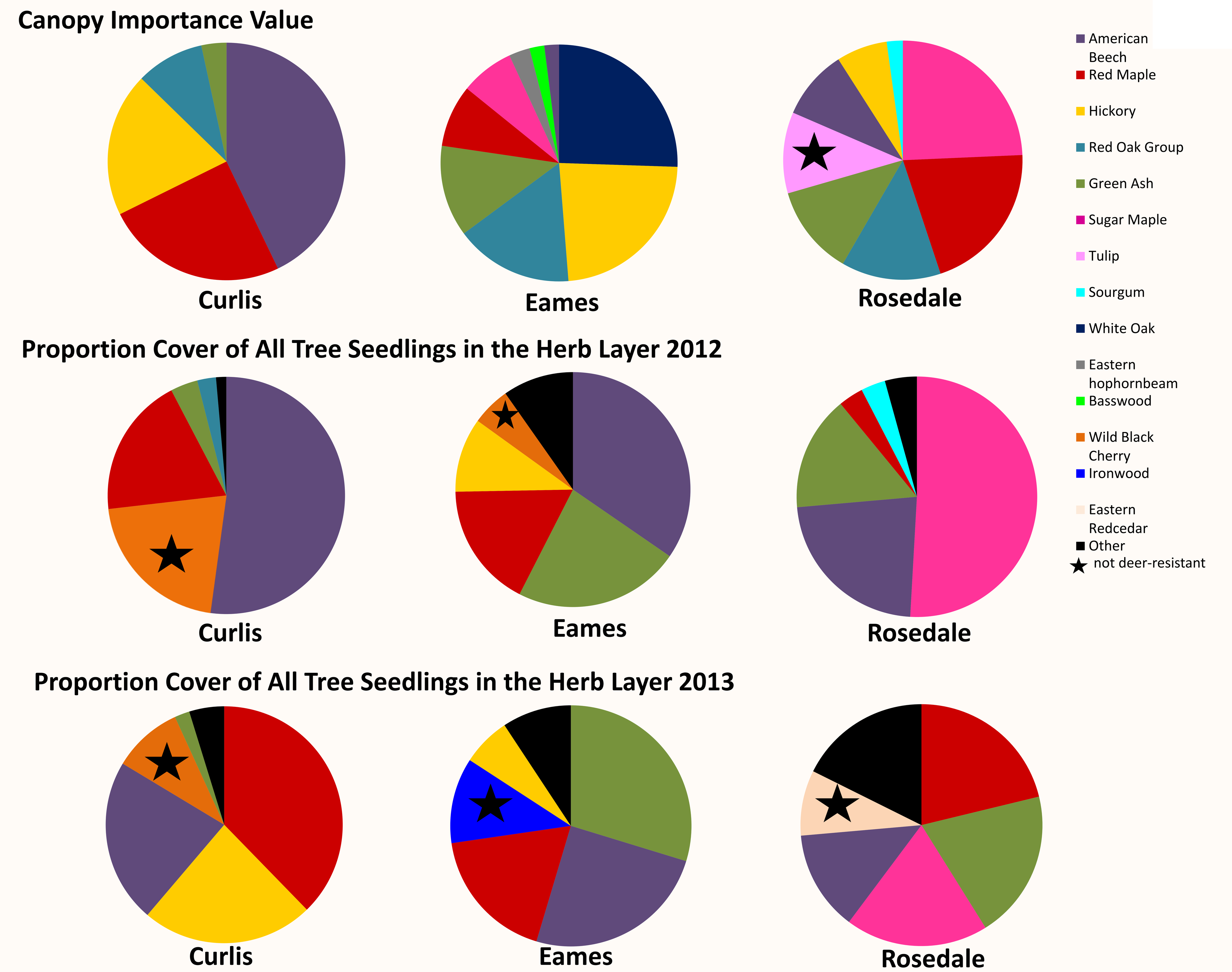

Figure 4. The top row shows the canopy importance value of all trees found in the canopy sampling. The middle row shows the proportion cover of the top 5 trees found in the herb layer in Fall 2012 ,and the bottom row shows the same information in Fall 2013. Non-deer-resistant species are marked with a star. In 2012, both Curlis and Eames had some non-deer-resistant species in the herb layer, while Rosedale had none, even though one was common in the canopy. In 2013, the non-deer-resistant Eastern red cedar appeared at Rosedale , one year after significant canopy disturbance from Hurricane Sandy (a source population is nearby).

Discussion

All three of the metropolitan forests we studied had very low cover in the shrub and herb layers, including tree seedlings – the future forest. These forests are all situated in a region estimated to have with 24 deer/km^2 on average, but the extent of their effects appear variable among forests. We expected that tree seedling cover would decline with increasing deer pressure, but our results revealed complexities about the probable role of deer. The data show that the the forest with the most severe chronic deer browsing was not the forest with the most severe current deer browse. We hypothesize that deer cease general feeding in forest fragments that are nearly empty below the browse line. There is little food or shelter for the deer, so they may avoid the forest. This idea is supported by our finding of greater cover of native tree seedlings in Rosedale, the forest with greater chronic but least current deer browse. Eames had the greatest current deer browse, yet its tree seedling cover was much less than in Rosedale, also supporting the hypothesis that current deer browse and its effects on tree seedlings is greatest where the browse history has been more moderate, with food sources still present.

We explored the possibility that tree seedling cover was greater at Rosedale because its canopy – and therefore its potential seedling community – was more dominated by deer-resistant species. In fact, Rosedale was the only forest with a dominant non-deer-resistant canopy species. Its seedlings were absent from the herb layer, and Rosedale's tree seedling community was dominated by all deer-resistant species in 2012; the other forests each had one dominant non-resistant seedling species in both 2012 and 2013, even though they did not have any in the canopy. In 2013, Rosedale also had one dominant non-resistant seedling species, which immigrated from a nearby stand (following canopy disturbance from Hurricane Sandy). It is likely that the little deer browse that currently happens in Rosedale is targeted to species with low deer-resistance.

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