The relationship between white-tailed deer impact and native and non-native plant species composition in five suburban/exurban forests.

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Abstract

Many ecologists think that invasive plant species in eastern forests suffer little herbivory from overabundant white-tailed deer compared to resident natives, thus promoting invasion; logically, higher browse pressure on the native population should provide stronger advantages to the non-natives. We tested this hypothesis in five suburban/exurban forests in New Jersey. We assessed deer impact on the native plant community by measuring native foliage cover in the shrub layer and deer browse on native woody species, and then assessing species richness of both native and non-native species in 40 4m^2 plots per forest. We also estimated deer density by counting pellet groups in 15 112 m^2 plots per forest. On average, native species outnumbered non-native species in these forests by about a 13:1 ratio. Surprisingly, we found correlations opposite to what we initially hypothesized for non-natives. In more heavily impacted forests, there was a lower species richness per forest for both natives and non-natives, and lower mean percentage per plot of non-native species. These results suggest that, in severely impacted forests, deer may be browsing on both natives and non-natives, depressing numbers of all species types. In forests where deer pressure is reduced by deer management or was historically lower, both natives and non-natives appear to improve recruitment and/or survival. Deer may, in fact, be keeping non-native species richness in check; therefore, a native species restoration program using deer control would also require non-native removals. An extension of this research will be to measure browse directly on non-natives and examine the relationship between deer impact and the abundance of each native and non-native species.

Introduction

White-tailed deer have increased to alarmingly high densities in many eastern North American forests, causing reduction or loss of species, reducing the reproductive output of species, and leading to alternate stable forest states. This is the case in particular within forest fragments situated within the suburban/exurban matrix, where the abundance of forest edge habitat combined with very low predation allows deer populations to thrive. These forests typically also harbor populations of multiple non-native plant species, some of which are invasive, so any effort to understand the effect of deer in these forests should include study of both native and non-native species.

In this study within five forests, we estimated deer impact in three ways and investigated the relationship of these measures to the herb layer species richness of both native and non-native plant species. Deer have specific diet preferences, and it is generally thought that their preference for many native species over non-natives may promote non-native invasion. If this is the case, then we expect that forests with greater deer impact would have decreased native species richness, but that non-native species richness would be unaffected.

Methods

- Five forests (Rosedale Park, Eames Preserve, Curlis Lake Woods, Herronton Woods, Nayfield Preserve)

Variables measured:

Native shrub foliage cover (using forest secchi boards, n = 40/forest, Fall 2008)
Deer browse (% browsed twigs per native individual, n = 30/forest, Fall 2008)
Deer density estimates (counts of pellet groups per forest)

- 15 112 m^2 deer pellet plots in each forest, Spring 2010.
- Two forests with low deer impact (Herronton Woods, Nayfield Park) and three with high deer impact (Rosedale Park, Eames Preserve, Curlis Lake Woods)
- Forty 4m^2 permanent plots on a grid in each forest.
- Species richness of native and non-native species in each plot, Fall 2009.

Microstegium vimineum

Alliaria petiolata

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Results

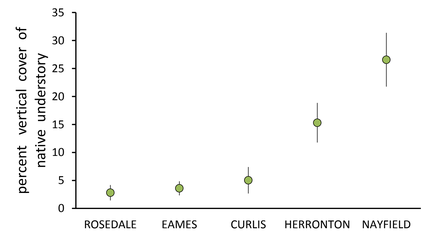

Figure 1.
Foliage cover of native vegetation in the vertical deer browse zone of the understory varied among forests, as a mirror image of current browse intensity.
[Mean (± se) of percentage of 1 m^2 vertical plots obscured by native vegetation from a sighting distance of 10 m; n from left to right: 40, 40, 36, 40, 40].

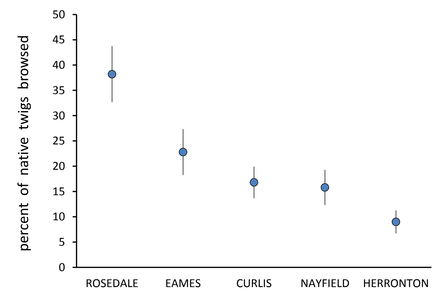

Figure 2.
The intensity of deer browse on native woody plants varied among forests.
[Mean (± se) percentage of native woody twigs per individual with signs of browse by deer; n from left to right: 17, 33, 32, 22, 33].

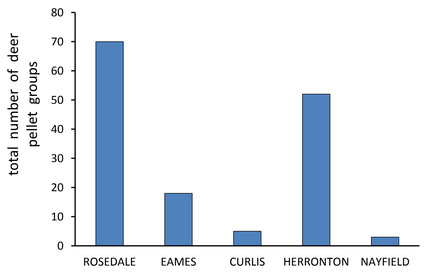

Figure 3.
The total number of deer pellet groups counted in fifteen 112 m^2 plots per forest was variable among forests, but did not correspond to other measures of deer impact (Figs. 1,2).

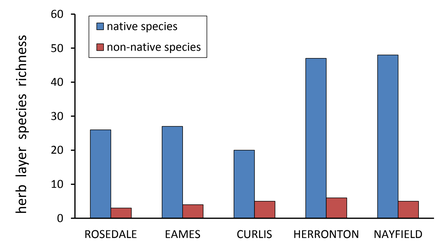

Figure 4.
Native species in the herb layer outnumbered non-native species by 13:1.
The forests with most severe deer impact, as measured by browse intensity and foliage cover (Figs. 1, 2), also had lower species richness of both natives and non-natives.
[Species number pooled across samples from forty 4m^2 plots per forest].

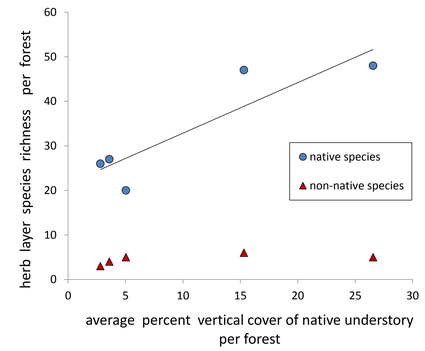

Figure 5.
For native herb layer plants, but not for non-natives, species richness was positively correlated with deer impact as measured by the average per forest vertical understory cover of native plants in the deer browse zone.
[Pearson's correlation, $r_{natives}$ =0.89, P<0.05, n =5; $r_{non\text{-}natives}$ =0.59, NS, n = 5].

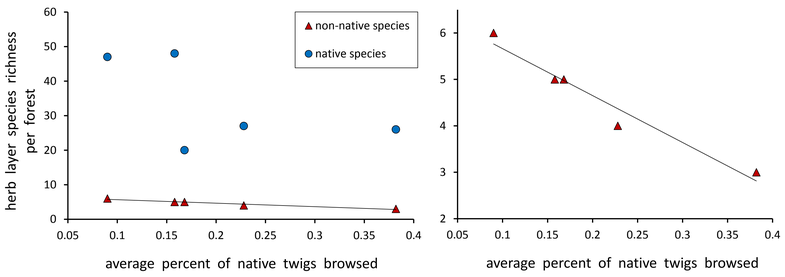

Figure 6.
Non-native herb layer species richness, but not native herb layer species richness, was negatively correlated with deer impact as measured by the average per forest percentage of native woody twigs per individual with signs of browse by deer.
[Pearson's correlation, $r_{natives}$ = -0.56, NS, n =5; $r_{non\text{-}natives}$ = -0.98, P<.01, n = 5].

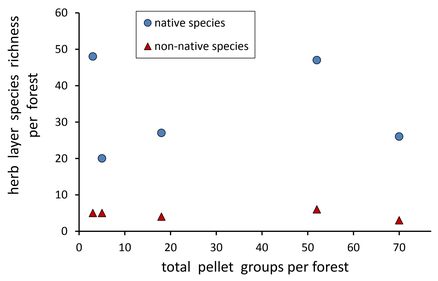

Figure 7.
Neither native nor non-native herb layer species richness was correlated with deer impact as measured by the total number of deer pellet groups per forest.
[Pearson's correlation, $r_{natives}$ = 0.014, NS, n =5; $r_{non\text{-}natives}$ = -0.343, NS, n = 5].

Discussion

The suburban/exurban forests we have studied are representative of an increasingly large proportion of the eastern deciduous forest. The plant communities in these forests typically have strong top-down effects from overabundant deer that influence the native flora, but also may influence the increasingly abundant non-native flora. Indeed, we found negative relationships between herb layer species richness and measures of deer impact, but with several interesting features :

1. Even in the most heavily impacted forests (Rosedale and Eames), we found considerable remaining native species richness, with over 25 native herb layer species found within the 160 m^2 sampled per forest. However, that number was nearly double in the least impacted forests (Herronton and Nayfield).

2. The two measures of deer impact showed similar patterns, suggesting that low cover may be caused by high browse rates, but they had different relationships with native and non-native species richness -- --

2a. The measure of foliage cover in the vertical deer browse zone of the understory captured chronic herbivory; those forests with very low values exhibited a visually obvious "browse line." This measure was positively correlated only with *native* herb layer species richness, which was higher in forests with higher cover (less chronic deer impact), suggesting that native species are more sensitive to chronic deer herbivory than non-natives. Perhaps non-natives are less frequent targets for deer, or are more recent colonists that have yet to experience chronic herbivory.

2b. The measure of browsed native twigs captured current deer herbivory, which was not exactly matched to chronic herbivory. For example, both Rosedale and Eames had very similar, very low cover in the browse zone, but Rosedale had *much* higher current browse. Rosedale also had the lowest non-native species richness, helping to drive the strong negative correlation between current browse intensity and non-native species richness. This suggests that in a forest like Rosedale, with extremely little vegetation in the understory but still a high rate of browse by deer on whatever is left, even non-native species have difficulty establishing and/or persisting.

2c. Non-native species richness was highest in the forest with medium deer impact (Herronton), as measured by both variables. This result conforms to the intermediate disturbance hypothesis and suggests that non-native species management may be needed most in forests with intermediate deer impact.

3. Pellet group counts are not useful as an indirect measure of deer impact because they were unrelated to the direct measures we used.