Variation in abundance of a spring ephemeral wildflower in deer-ridden suburban forests

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Abstract

The abundance of spring ephemeral wildflowers varies widely among suburban forests. We studied wildflower populations, including *Claytonia virginica* (spring beauties), within six deciduous forests in central New Jersey. The forests are in a region with over-abundant white-tailed deer (21 deer/km2), yet abundance of deer resistant *C. virginica* varied dramatically among them. We quantified the forests' levels of chronic deer pressure by measuring native shrub layer cover, near the end of the 2012 growing season, and quantified current deer pressure with browse signs on native woody plants. We measured percent cover of *C. virginica* in 40 plots/forest in Spring 2012 and 2013. The plant was nearly absent from the three forests with lower chronic deer pressure, but was abundant in the forests with higher chronic deer pressure. Among the latter, *C. virginica* cover varied significantly in 2012, with greater cover in the forest with the greatest chronic pressure, but was more similar (greater in the other two forests) in 2013. Forests with severe deer pressure contain almost no shrub layer, leaving spring ephemerals as a primary food source in the early spring, which may allow for competitive release of wildflower species that are deer resistant. In heavily deer-ridden forests with few green plant species in the early spring, deer may even eat resistant plants. We found that forests with greater chronic deer pressure (lower shrub cover) also had lower current browse pressure, so any browsing on *C. virginica* was also likely to be lower in these forests.

Introduction

Many factors may contribute to the varying abundance of spring ephemeral wildflowers among metropolitan forests, including biotic factors like herbivory or competition and abiotic factors like soil nutrients or moisture. In this study, we explored the role that deer herbivory plays in wildflower abundances in suburban forests in central New Jersey, where deer are over-abundant. We examined their relationship by measuring chronic and current levels of deer herbivory and percent cover of *Claytonia virginica* (spring beauties) in 40 plots in each of six forests.

An understanding of the relationship between deer herbivory and spring ephemeral wildflower abundance will allow us to predict the effects that overabundant deer populations can have on native plant populations in fragmented forests. This understanding could be used to improve conservation methods for native plant species that are critical to proper ecosystem function.

Improvements in conservation methods are especially important in today's society due to increasing development and destruction of natural habitats. This results in fragmentation of forests and restrictive hunting laws to ensure human safety, both of which can have negative consequences on the size, abundance, and health of native plant populations, including spring ephemeral wildflowers. Increased fragmentation leads to genetic isolation of populations, which can have negative effects on plant population diversity, while tight hunting laws allow deer populations to increase to the point of being detrimental to the native flora.

Methods

Forest Selection

We examined six suburban, deciduous, second growth forests in Mercer County, New Jersey (Rosedale, Curlis, Eames, Herronton, Nayfield, and Baldpate), which exhibit a range of deer pressure.

Plot Establishment

We established 40 plots in each forest for a long-term experiment about the interactive effects of invasive species and deer. Each plot was randomly assigned an experimental treatment (Figure 1 shows a typical plot arrangement).

Herb Layer Census:

We analyzed a total of 4 m^2 of each 16 m^2 plot for herb layer cover, by estimating cover of each species – including *Claytonia virginica* - in 16 0.25 m^2 subplots per plot, within 10% intervals (0-10%, 10-20%, and so on). We completed the census of each plot by noting the presence of any species not sampled by any of the subplots.

Shrub Cover Assessment:

We assessed the extent of shrub-level woody plant cover by holding a 1 m^2 board divided into 16 squares vertically at a height of approximately 1.5 meters off the ground at the center of two adjacent edges of each plot, while reading it from the centers of the opposite edges. We recorded the number of squares covered even partly by native woody plant material as the cover data.

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Deer Browse Assessment:

We assessed the extent of deer browse on woody plants within a subsample of each plot, assessing each plant for shreddy, bitten ends characteristic of deer browse.

Figure 1. Experimental design. Seeds of *Alliaria petiolata* (ALPE) and *Microstegium vimineum* (MIVI) were added to plots November – December 2012, to stage novel invasions in and out of deer exclosures, which were constructed March-April 2013.

Results

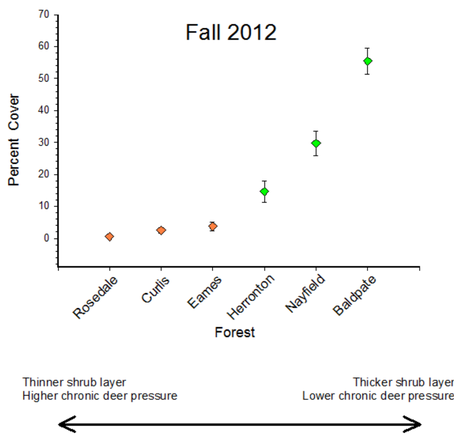

Figure 2. Percent foliage cover of the shrub layers in Rosedale, Curlis, and Eames forests are nearly zero; these forests have almost no shrub layer, and they experience the greatest chronic pressure from deer herbivory. Herronton, Nayfield, and Baldpate forests experience much lower chronic pressure from deer herbivory, as shown by significantly higher shrub layer percent cover measurements. (ANOVA, $F_{(\#,\#)}$ = ##.##, P < #.###).

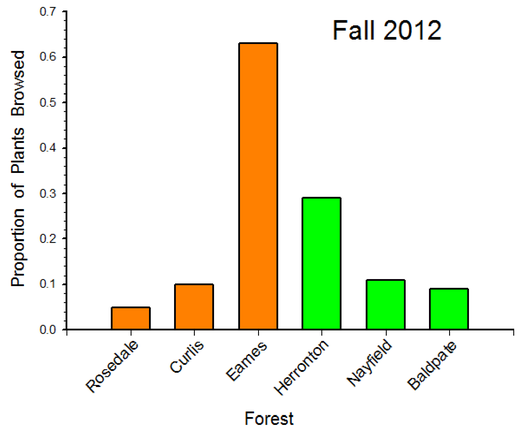

Figure 3. The proportion of all native woody plants browsed was lowest in Rosedale and highest in Eames. This means that Rosedale experienced the lowest current pressure from deer herbivory and Eames experienced the highest level.

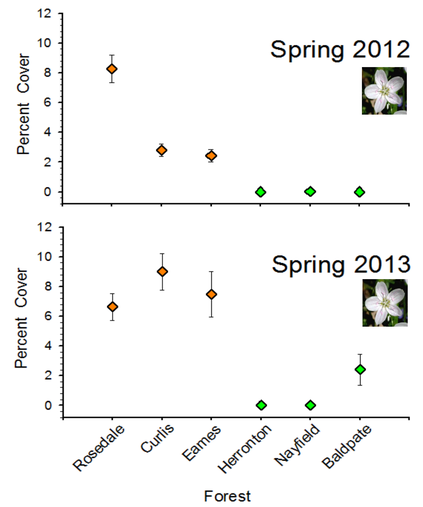

Figure 4. *Claytonia virginica* was nearly absent in 2012 in Herronton, Nayfield, and Baldpate - the three forests with lower chronic deer pressure (higher native shrub cover). It was common in Rosedale, Curlis, and Eames - the forests with higher chronic deer pressure, and highest in Rosedale (ANOVA, $F_{(\#,\#)}$ = ##.##, P < #.###). In 2013, *C. virginica* cover increased in Curlis, Eames, and Baldpate, but Rosedale, Curlis, and Eames still had higher percent cover than in the other three forests.

metropolitan forest with thin shrub layer

metropolitan forest with thicker shrub layer

Claytonia virginica

Discussion

The near absence of *Claytonia virginica* in Herronton, Nayfield, and Baldpate compared to the other forests may be explained by the pattern observed in Figure 2. Forests that experience extremely high pressure from chronic deer herbivory likely have greater decrease in populations of plant species that are prone to deer herbivory. This could release deer resistant species, such as *C. virginica,* from interspecific competition with the vulnerable species, allowing the deer resistant species to flourish. Among the three severely deer-pressured forests, *C. virginica* was most abundant in Rosedale, which exhibited the greatest chronic deer browse, in keeping with this idea. The pattern of increases in percent cover of *C. virginica* between 2012 and 2013 can also be explained by this proposed mechanism. Eames had the highest level of current deer pressure, meaning more deer were feeding there, decreasing competition between vulnerable plant species and deer resistant plant species such as *C. virginica*. This release from competition could explain the observed increase in *C. virginica* abundance from 2012 to 2013.

If this is true, we can expect to see long-term fluctuations in levels of current deer pressure among forests, and fluctuations in abundances of plant species that are deer resistant and plants that are vulnerable. High levels of chronic and current deer pressure allow deer resistant species to thrive due to decreased competition with the vulnerable species. As deer herbivory increases in a forest, the abundance of preferred food plants will eventually reach such a low point that deer will be utilize other locations. This will cause current deer herbivory pressure to decrease, and vulnerable plant species to recover. This will lead to gradual increases in competition between vulnerable plant species and deer resistant species and as a result, decreased abundances of deer resistant species. As deer feed in other forests, the vulnerable plants increase, and deer will eventually return to the forest and the cycle starts again.

The scenario would be even more complex if deer feed on normally deer resistant species in forests with minimal preferred plants. Rosedale showed the greatest chronic deer pressure of the three most impacted forests, and also the lowest level of current deer browse. This forest is so depleted that deer likely go elsewhere to feed. We expect, therefore, that *C. virginica* would be losing its competitive edge as less deer-resistant species make a comeback, resulting in lower cover in Rosedale relative to Curlis and Eames, not greater cover. We hypothesize that this deer-resistant spring ephemeral wildflower is currently existing in a "deer-pressure sweet spot". It benefits by the release from competition with depleted, deer-susceptible species (herbs and shrubs) and by release from deer herbivory itself. In heavily deer-ridden forests where there is still some minimal shrub layer vegetation to attract deer, they may feed during early spring on the few green plants available, such as *C. virginica*, even if it is deer-resistant. If deer mostly avoid a forest altogether due to complete depletion of preferred food sources, *C. virginica* will continue to thrive.

Acknowledgements

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