Effects of Invasive Shrubs on Diversity of Seed Bank Dynamics in Southwestern Wisconsin

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Abstract

Invasive species negatively alter ecosystem health. These impacts have been studied via above ground vegetation, but researchers have seldom investigated how invasive species change soil seed banks. The present study investigated how the invasive shrubs *Lonicera spp*. (honeysuckle) and *Rhamnus cathartica* (common buckthorn) impact temperate forest ecosystems biodiversity by examining seed banks from a forest near La Crosse, Wisconsin. We collected samples from three plots each within invaded, uninvaded, and managed treatment sites. The invaded treatment site was dominated by the invasive shrubs common buckthorn and/or honeysuckle. The uninvaded treatment site had a few invasive shrubs present, but they were not dominating the plots. The managed treatment site was previously invaded, but in the past decade, the shrubs were cut and treated with herbicide. At each plot, we obtained seed bank cores and recorded environmental variables. Soil cores were spread on trays of potting soil and grown in a growth chamber for 14 weeks. We expected there would be a difference in germination counts and species diversity among the treatments. Our results indicated the invasive species did not alter seed bank composition in ways we expected.

Introduction

Background

- The herbaceous layer of temperate forests constitutes 90% of the plant biodiversity and plays an important role in nutrient cycling (Gilliam 2007).
- Invasive shrubs can disrupt temperate forests communities, negatively affect herbaceous species productivity and ecosystem diversity as a result (Gilliam 2007).
- When assessing aboveground vegetation, the herbaceous layers of invaded, non-invaded, and treated forests differed in diversity of the herbaceous layer (Neumeyer Phillips and Gerken Golay unpublished data).
- Seed banks provide memory of past and present vegetation and characterize ecosystem biodiversity (Gioria et al. 2012). Therefore, we used seed banks as a tool to assess the impacts invasive shrubs and management efforts have had on forest understories.
- If management efforts are successful, diversity of the herbaceous layer should rebound after treatment.

Hypothesis

- We expected samples from uninvaded sites to have the highest number of herbaceous germinants and species diversity, samples from invaded sites to have the fewest number of germinants and species diversity, and samples from managed sites to have an intermediate number of herbaceous germinants and species diversity.

Methods

Site Selection

- Temperate forest outside La Crosse, WI, owned by the City and managed by Mississippi Valley Conservancy (MVC).
- Forest had invaded, uninvaded, and managed areas (Figure 1):
  - Invaded: Understory was dominated by honeysuckle and/or common buckthorn.
  - Uninvaded: Understory had few invasive shrubs present that were not dominating the plot.
  - Managed: Understory was once dominated by honeysuckle and/or common buckthorn but was treated with cutting and herbicides within the past decade.

Field Data Collection

- Obtained data from three 5x5 meter plots in each treatment area.
- 10 soil cores (15 x 2.4 cm) from each plot were gathered and homogenized.
- Measured environmental variables to rule out confounding factors (none found).

Lab Procedures (Gross 1990)

- Cold stratified soil cores at 5°C for 3 weeks.
- Spread soil cores over potting soil in germination trays.
- Grown in 25°C growth chamber with 16 hour light periods for 14 weeks.

Lab Data Collection & Analysis

- Recorded germinants and identified species biweekly.
- Germinants were categorized as either native or non-native, as annual, biennial, or perennial, and as either woody or herbaceous.
- Germination data were analyzed by Kruskal-Wallis test because data was not normally distributed.

Figure 1. Images captured in the field of the invaded (1A), uninvaded (1B), and managed (1C) treatments in a temperate forest near La Crosse, WI.

Results

- Of the nine environmental conditions measured, percent cover of invasive shrubs (H(2)=7.45, p=0.024), densiometer (H(2)=7.26, p=0.027), soil texture (H(2)=7.00, p=0.030) were the only conditions that differed among the treatment types.

Table 1. Average germinant counts (± S.D.) for invaded, uninvaded, and managed treatment samples (n=9) from a temperate forest near La Crosse, WI.

Treatment	Woody Germinants	Herbaceous Germinants	Unidentified Germinants	Total Germinants
Invaded	1.0 (±1.0)	5.7 (±6.4)	3.7 (±3.1)	10.3 (±9.3)
Uninvaded	0.3 (±0.6)	2.7 (±3.1)	2.0 (±1.0)	5.0 (±4.0)
Managed	1.3 (±1.5)	0.3 (±0.6)	3.3 (±0.6)	5.0 (±1.0)

- There were no differences in total germination counts among the invaded, uninvaded, and managed treatments (H(2)=0.615, p=0.735; Table 1). Similarly, there were no differences in the number of woody (H(2)=1.23, p= 0.540) or herbaceous (H(2)=3.41, p=0.182) germinants among the three treatments (Table 1).

Table 2. By decreasing prevalence, germinant species identified in invaded, uninvaded, and managed treatment samples (n=9) from a temperate forest near La Crosse, WI.

Invaded	Uninvaded	Managed
Verbascum thapsum (b)*	*Verbascum thapsum* (b)*	*Betula spp. (p)*
Oxalis spp. (p)	*Arisema triphyllum (p)*	*Viburnum spp. (p)*
Viburnum spp. (p)	*Betula spp. (p)*	*Ranunculus abortivus (b)*
Grass seedlings		*Thalictrum spp. (p)*
Plantago spp. (b)*		
Solanum americanum (a)		
Aster spp. (p)		
Eupatorium rugosum (p)		

(b) indicates biennial, (p) indicates perennial, (a) indicates annual. *denotes a non-native species

- There were no differences among treatment types when studying plant origin (non-native H(2)=2.10, p= 0.350) or life history strategies (annual H(2)=4.57, p= 0.102; biennial H(2)=0.673, p= 0.714, and perennial H(2)=3.67, p= 0.159).

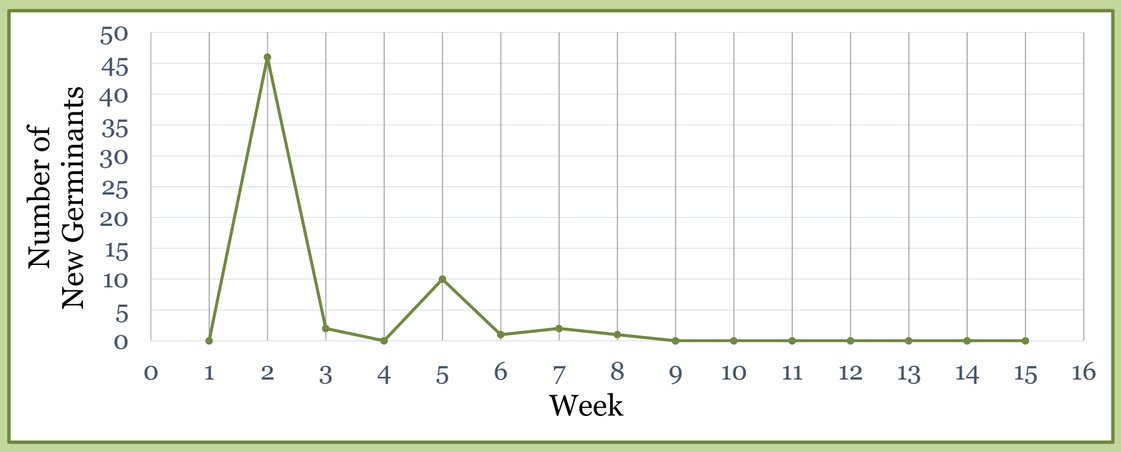

Figure 2. New germinant count totaled per week for the invaded, uninvaded, and managed samples (n=9) from a temperate forest near La Crosse, WI.

- Nearly three quarters of observed germinants emerged during the second week of the germination period (Figure 2)(46 of 62 total germinants).

Conclusions

- The treatment type (invaded by non-native shrubs, uninvaded, and managed), measured by the number of woody and herbaceous germinants in the seed bank, did not differ among treatments. Since woody germinants characterize invasive shrubs of temperate forests, our results indicate invasive shrubs do not influence seed bank dynamics as expected in La Crosse, WI.
- A community shift was not observable from identified germinants among the treatment types. We recorded similar numbers of native, non-native, annual, biennial, and perennial species among the invaded, uninvaded, and managed treatments.
- The low diversity of germinants and lack of invasive shrubs in the seed bank indicate the methods used in this study were not sufficient to meet germination requirements. Future research should focus on identifying specific germination requirements for native and invasive species of temperate forests.
- As expected, the three treatments differed in percent cover of invasive shrubs confirming the MVC's treatment designations.

References

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