European Buckthorn (*Rhamnus cathartica*) Density Impact on Invertebrate Diversity in a Floodplain Forest in Sioux County, IA

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Introduction

European buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*R. frangula*) are invasive plant species brought to the United States in 1849 as ornamental shrubs. Researchers throughout the Eastern U.S. have found various negative ecological effects of buckthorn invasion (e.g., decreased herbaceous ground cover, Boudreau & Wilson 1992; increased nest predation in songbirds, Schmidt & Whelan 1999; host for crown rust and overwintering soybean aphids, Heimpel et al. 2010). Buckthorn leaf litter is high in N, significantly impacting its content in soil during leaf fall (Heneghan et al. 2004). Buckthorn presence may impact nearby stream ecosystems by changing leaf fall timing and its rapid degradation decreases the input of organic material from leaf-fall, decreasing overall energy availability, and possibly affecting the stream food chain (Freund et al. 2013).

Effects in one habitat may not be the same in another so studies that examine the local impacts of buckthorn remain important, particularly in determining the course of future treatment for removing and controlling the shrub. A series of experiments began in 2005 to determine possible impacts of buckthorn in Northwestern College's forest.

Research Objectives:

1. To determine the short- and long-term effects of the invasive European buckthorn on Northwestern College's 5-acre gallery forest along the Floyd River, near Alton, Iowa. Ongoing monitoring includes soil analyses, vegetative surveys, and forest floor invertebrate surveys. **This poster reports findings from an analysis on buckthorn density and its potential relationship to invertebrate diversity in the forest.**
2. Determine whether expensive and time-consuming buckthorn eradication efforts are worthwhile. If long-term negative effects of buckthorn are minor or non-existent, then these efforts would be largely unnecessary.

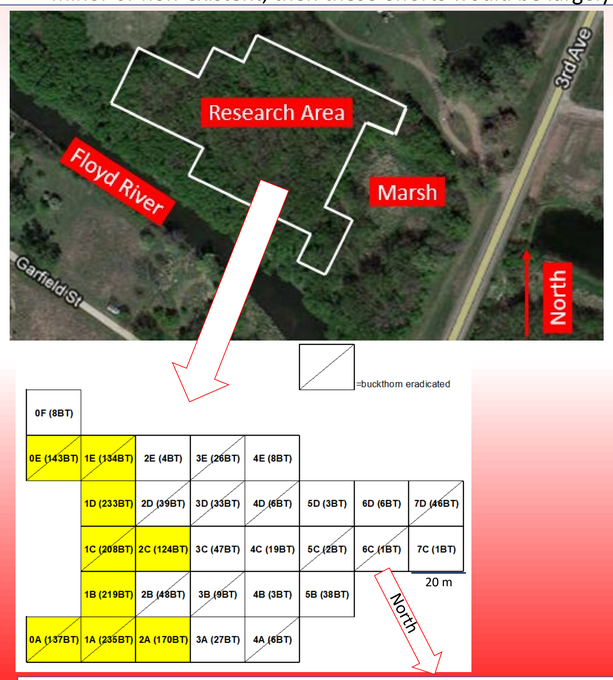

Fig. 1. Aerial view of Northwestern College's forest, with inset showing plot layout and total numbers of buckthorn trees and saplings per plot indicated in parentheses. A diagonal slash indicates buckthorn eradication, representing treatment plots. Treatment plot numbers come from the 2005 survey and control plot data comes from the 2013 survey. Treatment plots had little buckthorn regrowth in 2013. Plots used in analyses are highlighted in yellow.

Abstract

This study explores the relationship between the invasive shrub European buckthorn (*Rhamnus cathartica*) on invertebrate diversity in Northwestern College's forest near Alton, IA. We performed pitfall sampling in June 2020 and found invertebrate richness and abundance to be nonsignificantly lower in high-density buckthorn plots than in treatment plots where buckthorn had been removed. We also found no relationship between buckthorn density and invertebrate diversity. Data from this study will supplement the data collected over the past 15 years to determine whether any seasonal or long-term trends in invertebrate diversity have been occurring since buckthorn were first removed from parts of the forest in 2005.

Materials and Methods

Northwestern's forest is a 5-acre secondary successional floodplain forest along the Floyd River, near Alton, IA. The canopy is dominated by silver maple (*Acer* saccharinum), boxelder (*A.* negundo), and white mulberry (*Morus* alba). Buckthorn and elderberry (Sambucus nigra) dominate the woody understory.

Four acres of Northwestern's forest were divided into 30 contiguous 20m*20m plots in September 2005 (**Figure 1**). Buckthorn shrubs were last surveyed in 2013 by identifying and counting each individual at least 0.5m tall within each study plot.

Invertebrate Sampling

To survey forest floor macroinvertebrates, we performed pitfall samples on June 13, 2020. The layout consisted of 4 pitfall traps 2 m apart near the center of each plot. Traps consisted of plastic cups buried in the ground with their lips at ground level. Each cup contained a 2-3 cm mix of 70% ethanol and liquid soap. Cups were left in place for 24 hours, and contents were collected for later analysis.

Statistical Analyses

We performed independent-sample t-tests to test our hypothesis that buckthorn negatively impacts invertebrate diversity and predicted treatment plots with buckthorn removed (in 2005 and 2013) would have greater species richness and abundance than control plots. We also ran correlation/regression analyses on 14 control plots (buckthorn-filled).

To test possible differences in invertebrate diversity, we calculated both morphospecies richness and invertebrate abundance. Morphospecies richness is the number of morphospecies (categories such as ants, beetles, and isopods), and abundance is the total of all individual organisms present in each plot.

Results

The graph of the ordinal ranking of the natural logarithm of high-density treatment plots vs. high-density control plots (>100 BT) showed a large gap between the 9th and 10th densest plots, suggesting a natural break at 100+ buckthorn. Thus, we limited our analyses of "high-density" plots to the 9 densest plots, where buckthorn would presumably have the greatest effect.

T-tests of High-density control vs. treatment plots

We found a non-significant (p=0.187, **Figure 2**) difference for morphospecies richness between high-density control plots (mean=9.63) and treatment plots (mean=11.23). Likewise, invertebrate abundance was not significantly different (p=0.115, **Figure 3**) between high-density control plots (mean=32.10) and treatment plots (mean=45.32).

Correlation/regression analyses

We found no relationship between the logarithm of buckthorn density and morphospecies richness (**Figure 4**) or morphospecies abundance in control plots.

Discussion

The presence of invasive species in Iowa have become increasingly problematic, and the impact on the native flora and fauna of Iowa is largely unknown. Our effort to explore some of these impacts involved testing the hypothesis that the presence of European buckthorn would have adverse affects on both invertebrate species richness and abundance. We found lower richness and abundance in plots with high-densities of buckthorn, however these differences were not significant. This all occurred within a larger study on the impacts of buckthorn in Northwestern's forest.

The results of this study alone suggest that if maintenance of invertebrate diversity is a reason to continue treatment on buckthorn, then it is not worth the expense or time. However, the conclusions from Heneghan et al. suggest performing this study at the time of leaf fall, when buckthorn leaf litter most impacts soil content. Further studies could also be conducted in the nearby Floyd River to determine impacts that buckthorn may have on the aquatic ecosystem.

Northwestern is conducting similar studies on redcedar invasion in Oak Grove Park and Inspiration Hills, two sites also located in Sioux County, IA. These ongoing studies could provide further insight on the impact of invasive species in the Sioux County region.

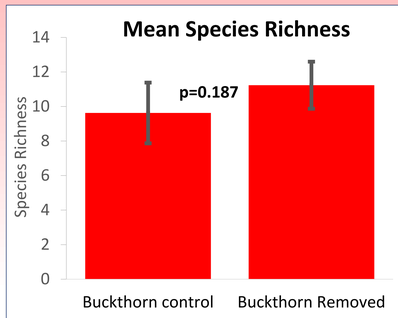

Fig 2. No significant difference was found in mean species richness in buckthorn control versus treatment plots.

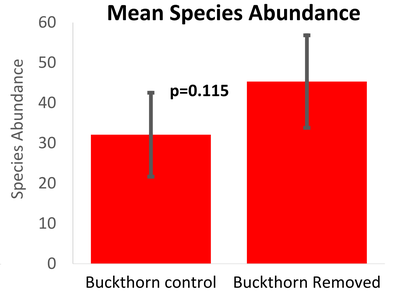

Fig. 3. No significant difference was found in mean species abundance in buckthorn control versus treatment plots.

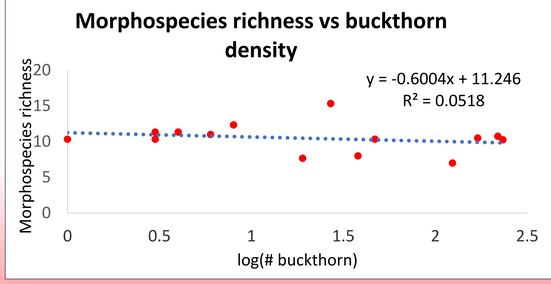

Fig. 4. No relationship was found between morphospecies richness and buckthorn density in control plots of Northwestern's forest.

References

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