The Impact of Invasive Oriental Bittersweet on Plant and Invertebrate Diversity In an Anthropogenic Edge Habitat of a Temperate Deciduous Biome

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Abstract

Invasive species threaten the fragile balance of biodiversity within ecosystems. One species, invasive throughout much of the eastern and midwestern United States, Oriental bittersweet (Celastrus orbiculatus) is spreading at an immense rate across Massachusetts forests and fields. The spread of this invasive allows it to outcompete preestablished native plant populations, potentially affecting invertebrate populations within those food webs. This research aimed to assess the impact of the presence of oriental bittersweet on both native plant and invertebrate communities. The two experimental groups in this project were land with no invasive species and land largely occupied by oriental bittersweet. In order to measure the impact of the oriental bittersweet, I used pitfall traps to measure the species richness and abundance of invertebrates. In addition, I observed the percentage of space that each plant took up per plot. By collecting data on both the flora and fauna, I was able to better see whether the oriental bittersweet mainly alters plant biodiversity by smothering native plants or if it has a larger impact on the ecosystem, altering the entire food web. I hypothesized that the more abundant Oriental bittersweet is in an area, the less biodiversity there will be of native species. For plants, this is because there is more competition for resources like light, nutrients, and space. For invertebrates, the absence of native plants can mean a decrease in food source and habitat availability. I did not find any statistically significant difference in invertebrate species richness, invertebrate abundance, or plant species richness, a result that could suggest that oriental bittersweet is not as detrimental to the environment on the plant and invertebrate levels.

Introduction

Invasive species threaten habitats and ecosystems across the globe. Invasive plants have many impacts on ecosystems and can outcompete native plants for resources like light, water, nutrients, and space (Powell et al., 2011; Patterson, 1974), which can decrease the abundance of native plants (Powell et al., 2011). A decrease in native plant diversity may lead to the disappearance of a species from a specific area (Powell et al., 2011), known as a local extinction. Invasive species lack natural predators in an ecosystem, allowing them to take over. By disrupting the native plant population, an invasive vine known as oriental bittersweet alters the food web, because the former primary producers can no longer thrive. Additionally, invasive species have few or no natural predators, causing them to destroy ecosystems. With decreased producer populations, all the animals that rely on these plants are affected, destabilizing the entire food web.

Oriental bittersweet (*Celastrus orbiculatus*) is an example of an invasive species in Massachusetts. This vine originates from East Asia and was introduced to the United States as a decorative plant around 1860 (Patterson, 1974). The plant was first documented in Massachusetts in 1919 and has since taken over much of the state, growing in various habitats, especially impacted by preexisting native plants. The vine can grow densely and can strangle surrounding trees, as well as block lower growing plants from sunlight. The fast growth and spread of this plant pose a threat to the native plants of the region. By reducing native producer populations and upending the entire ecosystem, oriental bittersweet can reduce the biodiversity in regions it overtakes. Many organisms are not able to easily adapt to these changes, causing them to die out and leading to a loss of biodiversity. The loss of biodiversity ultimately leads to a modified ecosystem structure (Gallien et al., 2017). A lack of biodiversity affects the surrounding ecosystem and humans alike (von Hertzen et al., 2011).

For this study, I established 1 meter by 1 meter plots overrun with oriental bittersweet and plots dominated by other plants to evaluate the impact of oriental bittersweet on biodiversity. By comparing data on the invertebrates and plants within the plots, the findings can reveal whether the presence of the vine impacts the ecosystem. This can help identify trends in biodiversity that may occur due to the dominance of invasive plants.

Methods

In the fall, I collected 10 samples from each type of plot along the same edge habitat. The study was conducted in suburban eastern Massachusetts. Each plot was sampled using a homemade pitfall trap set out for 24-48 hours. In order to assess the invertebrate biodiversity, I identified the insects caught in the pitfall traps after removing them from the plots and kept track of both the number of species and the number of organisms of each species.

To analyze the significance of the differences in invertebrate abundance and diversity, I used a one way analysis of variance (ANOVA). This determined whether the difference in the mean abundance and species richness of each group is significant. The One-Way ANOVA Calculator found the F-statistic and the corresponding p-value. When $p<0.05$, the results are significant within a 95% confidence interval.

Results

Raw data and metadata are shown in supplemental tables at the end of the document. A one-way analysis of variance was conducted to compare the differences among the two treatment groups for the invertebrate abundance, invertebrate species richness, and notable plant species richness. No statistically significant differences were detected in any of the three groups. Despite the lack of statistical significance, there were many observable trends present.

Invertebrate Abundance

The number of invertebrates in the pitfall traps did not differ significantly between the two types of plots (Table 1;Figure 1). The analysis gave an F-ratio of 0.218 and a p-value of 0.646, meaning the abundance was not significantly different between plot types because $p>0.05$. This would suggest that the presence of oriental bittersweet does not significantly impact the invertebrate abundance. Regardless, the range of invertebrate abundance was noticeably greater in plots without oriental bittersweet, suggesting more invertebrate activity in plots without the vine.

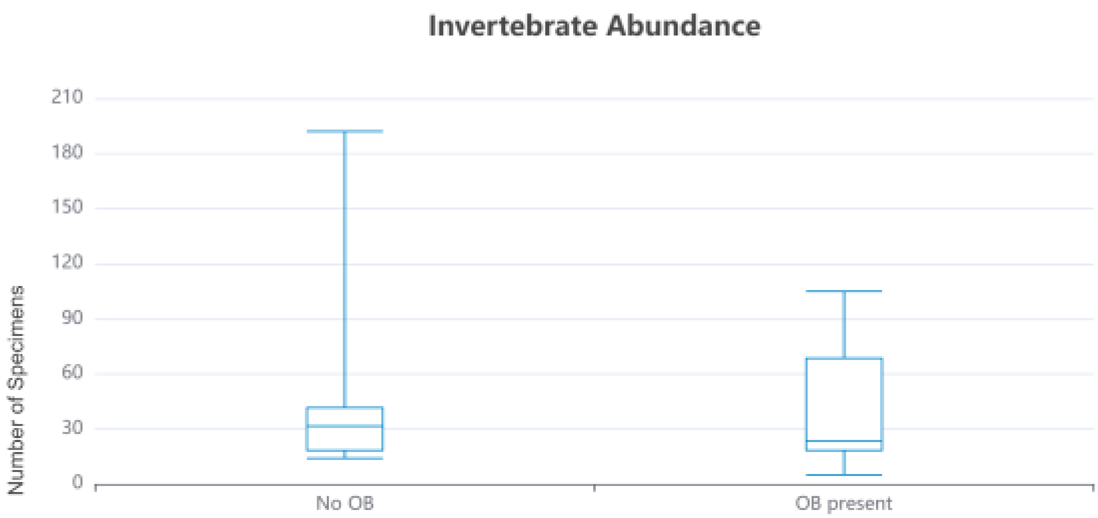

Figure 1. Boxplots showing distributions for the invertebrate abundance of plots with and without OB present. There is no statistically significant difference in the means between the two groups, but the No OB group had a much larger range, with some extremely high outliers.

Invertebrate Species Richness

Like the invertebrate abundance, there was no significant difference in the number of invertebrate species across the two plot types (Table 1; Figure 2). The analysis gave a resulting F-ratio of 0.786 and a p-value of 0.387, so because $p>0.05$, the presence of oriental bittersweet likely does not affect invertebrate species richness. Still, the data shows a greater range of invertebrate species richnesses in the plots without oriental bittersweet, suggesting there is more diversity in the absence of the bittersweet.

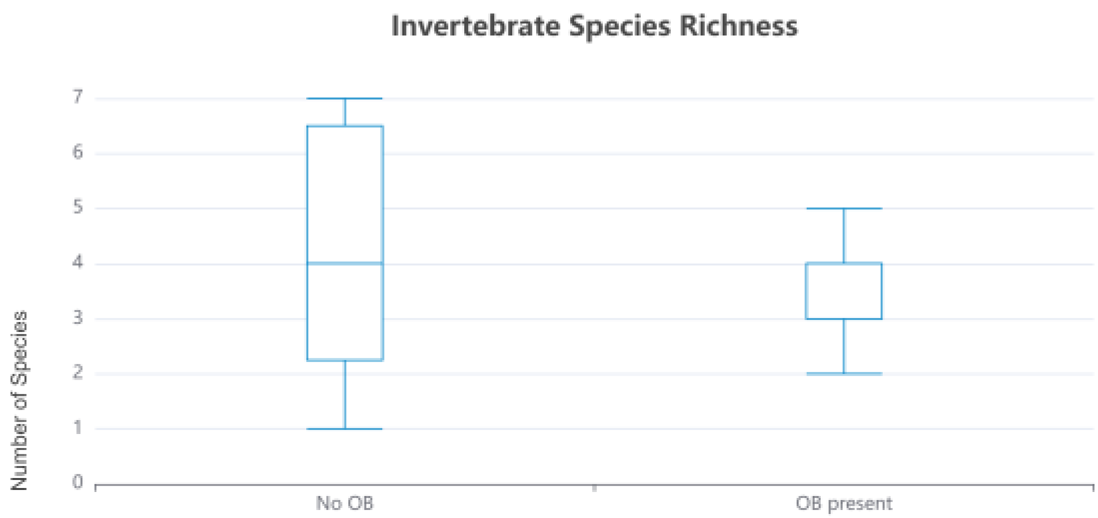

Figure 2. Invertebrate Species Richness. Boxplots show the distribution for the invertebrate species richness of plots with and without Oriental Bittersweet (OB) present. There was no significant difference in means between groups, but the No OB treatment group had a much greater range than the OB present.

Plant Species Richness

The number of plant species within each plot was also not statistically significant (Table 1; Figure 3). The analysis resulted in an F-ratio of 1.25 and a p-value of 0.279, with $p>0.05$, meaning it was statistically insignificant and the presence of oriental bittersweet likely does not affect plant species richness. However, plots without the bittersweet averaged 72.5% invasive plant cover, while plots containing it averaged 86.2% invasive plant cover. Of the 86.2%, 52.5% was solely the bittersweet, demonstrating its incredible ability to compete with not only native plants, but also other invasives.

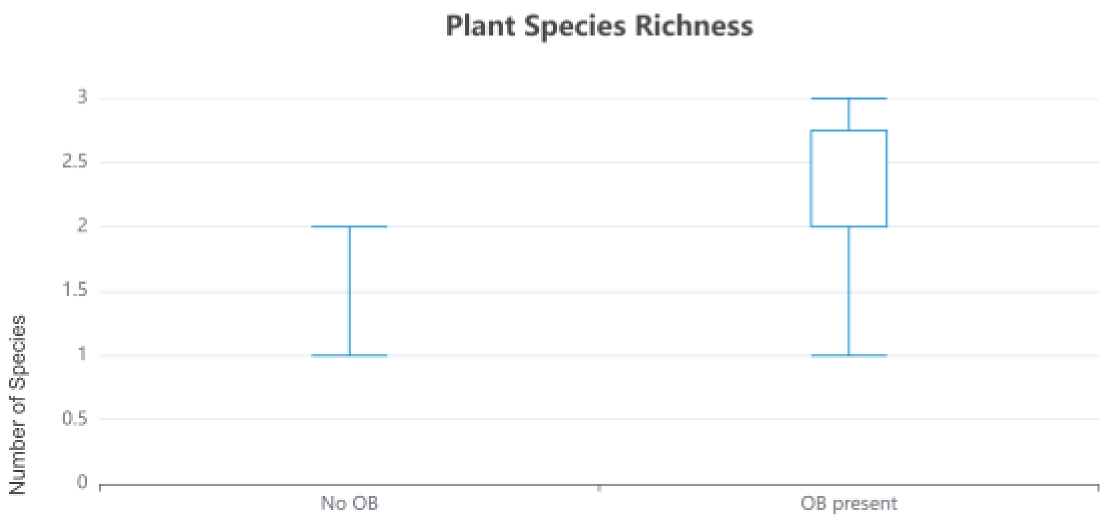

Figure 3. Boxplots showing distributions for plant species richness of plots with and without OB present. There was no significant difference in means between the groups.

Response Variable	F-statistic	p-value
Invertebrate Abundance	0.218	0.646
Invertebrate Species Richness	0.786	0.387
Plant species richness	1.25	0.279

Table 1. Table shows F-statistic and p-value for invertebrate abundance, invertebrate species richness, and plant species richness.

Discussion

Although the statistical analyses did not yield statistically significant differences between the two types of plots, the ecological patterns observed in this study still demonstrate the impact of invasive species. Oriental bittersweet, like other invasive plants, reveals the issues that come with biological outsiders (Patterson, 1974), especially in areas of Massachusetts where it was initially introduced as an ornamental vine. Its ability to spread far and grow fast, common to many invasive species becoming established in a new area, allows it to outcompete the native vegetation and to change the ecosystem (Patterson, 1974; Powell et al., 2011).

Invasive species take a toll on ecosystems by altering them and thus reducing biodiversity (Powell et al., 2011). While the sample size was only ten and the ANOVA results indicated no statistically significant differences in invertebrate abundance, invertebrate species richness, or plant species richness, trends in the data suggest subtle influences. For instance, the ranges for both the invertebrate abundance and species richness were greater in the plots with no oriental bittersweet, meaning higher variability in areas without the vine. They may suggest that the presence of oriental bittersweet homogenizes the surrounding habitat, not allowing for as much diversity, and limiting the ecological niches available. A larger data set may have also resulted in more significant results.

The plant composition of each plot further shows the influence of the oriental bittersweet. Although there was no statistically significant difference in the species richness between plot types, the percentage of invasive species cover across both plot types was high, averaging 72.5% in plots without the oriental bittersweet, and 86.2% in plots containing it, 52.5% of which consistent solely of oriental bittersweet. These findings support the idea of the priority effect, where the earlier establishing and fastest growing plants take over an area, restricting the growth of later and slower plants (Dickson et al., 2012). Observations from the area in which the experiments occurred support this idea, where throughout the unmanaged edge habitat, many patches of vegetation were dominated by a single invasive species, including but not limited to porcelain berries, common mugwort, japanese knotweed, and of course, oriental bittersweet. The only exception to this observation was a patch of native staghorn sumac trees, which may have been able to survive due to their established height and clonal nature (de Witte & Stöcklin, 2010). With the exception of the sumac, the homogeneous patches of vegetation observed likely result from the reduced competition of the slower growing native species (Dickson et al., 2012).

Seasonality very likely played a role in both the plant and invertebrate observations. Around late September to early October, smaller, annual plants, such as wood sorrel were observed in the plots, but as the weather got colder, the smaller plants died out, altering the plant makeup of the plots, and likely the invertebrate populations as well. The experiment took place in a suburban town with many wild birds who may eat the oriental bittersweet fruit, spreading to many new places where it can easily grow (Patterson, 1974), unlike in cities where there is not as much bare land or birds that rely on natural food sources. Additionally, the area in which this experiment was conducted was small, spanning less than a quarter of a mile. The species area effect is an observation of how larger areas tend to include more species, while smaller areas include fewer. This may also have affected the results of the study, and provides reason to conduct a larger scale study for more accurate results.

Altogether, these findings highlight the cumulative impacts that invasive species like the oriental bittersweet can potentially have on local ecosystems. Although results were not statistically significant, the observed trends in variability and vegetation dominance suggest that there may be ecological effects that would require a larger scale study. Future research could also sample across multiple seasons, and compare with fully native dominated plots, something that is becoming increasingly rare across suburban Massachusetts. As invasive species continue to take over Massachusetts, it is important to recognize the consequences they bring in order to protect the remaining native habitats and the animals that depend on them.

References

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Supplemental Materials

Metadata - Information on each round of pitfall traps that were set out.

Date	Location	Treatment	Time.Left.Out	Time.Taken.Back
9/20/25	Location 1	No OB	10:30 AM	9/21/25 4:00 PM
9/20/25	Location 1	OB Present	10:30 AM	9/21/25 4:00 PM
9/20/25	Location 2	No OB	11:00 AM	9/21/25 4:00 PM
9/20/25	Location 2	OB Present	11:00 AM	9/21/25 4:00 PM
10/26/25	Location 3	No OB	10:00 AM	10/28/25 5:00 PM
10/26/25	Location 3	OB Present	10:00:00 AM	10/28/25 5:00 PM
10/26/25	Location 4	No OB	10:00:00 AM	10/28/25 5:00 PM
10/26/25	Location 4	OB Present	10:00:00 AM	10/28/25 5:00 PM
10/26/25	Location 5	No OB	10:00:00 AM	10/28/25 5:00 PM
10/26/25	Location 5	OB present	10:00:00 AM	10/28/25 5:00 PM
11/1/25	Location 6	No OB	12:00 PM	11/2/25 2:30 PM
11/1/25	Location 6	OB Present	12:00:00 PM	11/2/25 2:30 PM
11/1/25	Location 7	No OB	12:00:00 PM	11/2/25 2:30 PM
11/1/25	Location 7	OB Present	12:00:00 PM	11/2/25 2:30 PM
11/1/25	Location 8	No OB	12:00:00 PM	11/2/25 2:30 PM
11/1/25	Location 8	OB Present	12:00:00 PM	11/2/25 2:30 PM
11/2/25	Location 9	No OB	3:00 PM	11/2/25 2:30 PM
11/2/25	Location 9	OB Present	3:00:00 PM	11/2/25 2:30 PM
11/2/25	Location 10	No OB	3:00:00 PM	11/2/25 2:30 PM
11/2/25	Location 10	OB Present	3:00:00 PM	11/2/25 2:30 PM

Plant.Data - Data on plant species in each plot.

Site	Treatment	Species	Percent.Abundance	Herbivory
Location 1	No OB	Common mugwort	84%	yes
Location 1	No OB	Virginia Creeper	14%	yes
Location 1	No OB	Wood Sorrel	1%	yes
Location 1	No OB	Black Locust (sapling)	1%	no
Location 1	OB Present	Oriental Bittersweet	65%	yes
Location 1	OB Present	Virginia Creeper	17%	yes
Location 1	OB Present	Alder Buckthorn (sapling)	17%	yes
Location 1	OB Present	Wood Worrel	1%	yes
Location 2	No OB	Common Mugwort	90%	yes
Location 2	No OB	Virginia Creeper	10%	yes
Location 2	OB Present	Oriental Bittersweet	50%	yes
Location 2	OB Present	Common Mugwort	50%	yes
Location 3	No OB	Bramble 1?	50%	yes
Location 3	No OB	Japanese Knotweed	50%	yes
Location 3	OB Present	Oriental Bittersweet	50%	yes
Location 3	OB Present	Bramble 1?	50%	yes
Location 4	No OB	Staghorn Sumac	70%	yes
Location 4	No OB	Bramble 2?	30%	yes
Location4	OB Present	Staghorn Sumac	50%	yes
Location 4	OB Present	Oriental Bittersweet	30%	yes
Location 4	OB Present	Bramble 2?	20%	yes
Location5	No OB	Multiflora Rose	50%	yes
Location5	No OB	Border Privet	50%	yes
Location5	OB Present	Japanese Knotweed	80%	yes
Location5	OB Present	Oriental Bittersweet	20%	yes
Location 6	No OB	Multiflora Rose	90%	yes
Location 6	No OB	Common Mugwort	10%	yes
Location 6	OB Present	Multiflora Rose	50%	yes
Location 6	OB Present	Oriental Bittersweet	50%	yes
Location 7	No OB	Staghorn Sumac	70%	yes
Location 7	No OB	Bramble 2?	30%	yes

Location 7	OB Present	Oriental Bittersweet	100%	yes
Location 8	No OB	Multiflora Rose	100%	yes
Location 8	OB Present	Multiflora Rose	80%	yes
Location 8	OB Present	Oriental Bittersweet	20%	yes
Location 9	No OB	Japanese Knotweed	100%	yes
Location 9	OB Present	Multiflora Rose	30%	yes
Location 9	OB Present	Border Privet	30%	yes
Location 9	OB Present	Oriental Bittersweet	40%	yes
Location 10	No OB	Multiflora Rose	90%	yes
Location 10	No OB	Common Mugwort	10%	yes
Location 10	OB Present	Oriental Bittersweet	100%	yes

Invertebrate.Data - Raw data for invertebrates caught in pitfall traps.

Site	Treatment	Species	Quantity
Location 1	No OB	Harvestmen 1	1
Location 1	No OB	Harvestmen 2	1
Location 1	No OB	Ant 1	4
Location 1	No OB	Spider 1	1
Location 1	No OB	Beetle 1	1
Location 1	No OB	Springtail	1
Location 1	OB Present	Beetle 1	1
Location 1	OB Present	Ant 1	1
Location 1	OB Present	Hymenoptera 1	1
Location 1	OB Present	Fly 1	1
Location 1	OB Present	Unknown	1
Location 2	No OB	Springtails	20
Location 2	No OB	Hymenoptera 3	1
Location 2	No OB	Hymenoptera 2	1
Location 2	No OB	Ant 1	2
Location 2	No OB	Ant 2	1
Location 2	No OB	Beetle 1	2
Location 2	No OB	Unknown	2

Location 2	OB Present	Ant 1	4
Location 2	OB Present	Unknown	1
Location 3	No OB	Springtails	25
Location 3	No OB	Beetle 1	4
Location 3	No OB	Spider 3	1
Location 3	No OB	Unknown	3
Location 3	No OB	Unknown	1
Location 3	OB Present	Springtails	30
Location 3	OB Present	Spider 4	1
Location 3	OB Present	Fly 2	1
Location 3	OB Present	Unknown	2
Location 4	No OB	Springtails	10
Location 4	No OB	Beetle 1	3
Location 4	No OB	Spider 3	1
Location 4	OB Present	Springtails	20
Location 4	OB Present	Unknown	2
Location 4	OB Present	Beetle 1	2
Location 5	No OB	Springtails	10
Location 5	No OB	Beetle 1	1
Location 5	No OB	Spider 4	1
Location 5	No OB	Fly 3	1
Location 5	No OB	Unknown	4
Location 5	No OB	Unknown	1
Location 5	No OB	Unknown	1
Location 5	OB Present	Springtails	5
Location 5	OB Present	Beetle 1	17
Location 5	OB Present	Spider 5	1
Location 6	No OB	Springtails	100
Location 6	No OB	Beetle 1	9
Location 6	OB Present	Springtails	75
Location 6	OB Present	Beetle 1	3
Location 6	OB Present	Unknown	1
Location 6	OB Present	Unknown	1

Location 7	No OB	Springtails	180
Location 7	No OB	Beetle 1	7
Location 7	No OB	Ant 1	3
Location 7	No OB	Harvestman 1	1
Location 7	No OB	Unknown	1
Location 7	OB Present	Springtails	80
Location 7	OB Present	Beetle 1	9
Location 7	OB Present	Ant 1	2
Location 7	OB Present	Isopod 1	1
Location 8	No OB	Springtails	35
Location 8	No OB	Ant 1	1
Location 8	No OB	Unknown	1
Location 8	OB Present	Springtails	100
Location 8	OB Present	Ant 1	3
Location 8	OB Present	Spider 3	1
Location 8	OB Present	Beetle 1	1
Location 9	No OB	Springtails	15
Location 9	OB Present	Springtails	15
Location 9	OB Present	Ant 1	2
Location 9	OB Present	Beetle 1	4
Location 9	OB Present	Unknown	1
Location 10	No OB	Springtails	15
Location 10	No OB	Beetle 1	3
Location 10	OB Present	Springtails	15
Location 10	OB Present	Unknown	2