

Evaluating Invasive Ecology: The Local Impacts of the Spotted Lanternfly and Japanese Knotweed in an Urban Riparian Habitat

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Introduction

Invasive species are non-native organisms that are typically introduced to an ecosystem through anthropogenic factors, causing detrimental damage to local species, communities, and food webs. Two key non-native species in the New York Metro Area are the Spotted Lanternfly (*Lycorma delicatula*) and Japanese Knotweed (*Fallopia japonica*). *L. delicatula* and *F. japonica*, both originated from East Asia and have been introduced to North America through intentional¹ or unintentional² trade. In a new environment with no natural predators, invasive species have the potential to reproduce rapidly, posing serious ecological and economic challenges.

When *L. delicatula* consumes phloem from trees, it secretes an abundant amount of honeydew³, a liquid rich in sugar. The large infestations of the species causes an excess build up of honeydew which causes an overgrowth of sooty mold in those areas. Sooty mold affects the plants' ability to photosynthesize which has a negative impact on the plants' fitness³.

F. japonica directly alters soil chemistry by generally increasing soil pH, reducing nitrogen levels, and reducing phosphorus levels. This significantly reduces nutrient availability, stunting plant growth and affecting invertebrate fitness⁴. The presence of these invasive species detracts the survival of surrounding native plants and insects while increasing competition for these organisms.

Methodology

This project spanned across two sites within the Bronx Zoo, Mitsubishi Riverwalk (MR) and Twin Dams (TD), located along the Bronx River. These serve as crucial data sites for *L. delicatula* and *F. japonica* due to its accessibility, size, and exposure to anthropogenic factors mirroring wild urban ecosystems.

Knotweed Coverage
A 100-meter long transect (20 bilateral, 4m transects) was established at MR, and a 40-meter transect (16 bilateral, 4m transects) at TD. *F. japonica* percentage coverage was surveyed with a 1m x 1m quadrat at five points (every 0.8 m beginning at transect origin) along each bilateral transect. Each point was assigned a value of either above or below 50% *F. japonica* coverage and all points were aggregated to determine a median value of coverage for each bilateral transect. N = 100 knotweed coverage surveys were conducted at MR, and n = 80 knotweed coverage surveys were conducted at TD.

Invertebrate Surveys
Invertebrate diversity was surveyed using beat sheet, sweep net, and pitfall surveys throughout the entire transect at each site (n = 40 at MR and n = 32). All invertebrates were identified to an Order level according to the *National Audubon Society: Field Guide to Insects & Spiders* and then released at the point of capture. Beat sheeting was conducted on the 3rd point along each bilateral transect to survey for *F. japonica* dwelling invertebrates. A vascular plant that was at least 1m tall was chosen at the 3rd point of each transect. Each vascular plant that was chosen to be surveyed was no further than 1 m from the 3rd point along the transect. Sweep netting was conducted at 10 transects at MR and 8 at TD. Sweep netting began at the origin of the transect and was conducted along the 4 m length of the transect. The tops of the plants along the path were sweep netted and this sweep netting was conducted twice at each transect. Pitfall traps were placed at the 2 m mark of each transect. N = 20 pitfall traps were placed at MR and n = 16 were placed at TD at ground level with proper covers. Traps were collected 1-2 days after placing them.

Lanternfly Traps
Cone traps (n = 18) were affixed to trees (n = 10) at the MR site. Traps were monitored and replaced once every 6-7 days for 4 weeks (n = 4). The traps were attached to three tree species: American Sweetgum (*Liquidambar styraciflua*) (n = 6), Eastern White Pine (*Pinus strobus*) (n = 2), and Eastern Black Walnut (*Juglans nigra*) (n = 2).

Ant Activity
Ant activity was assessed using a 4-point activity scale based on ant abundance, trail formation (i.e., ants moving in organized lines), and the presence of nests. Each tree was observed for a 1-minute interval by two observers on opposite ends of each tree. The observers focused on the trunk from ground level to about diameter breast height (4 ft). Each observer provided their own ant score for each tree based on the 4-point activity scale. Both observers then averaged their ant scores for each tree surveyed.

Soil Testing
To evaluate the relationship between *F. japonica* and soil pH, nitrogen, phosphorus and potassium levels, one soil sample from four bilateral transects were collected. The four soil samples from the four transects were combined into a single composite sample representing that 20-meter area at MR and a 10-meter area at TD. The soil samples were tested using the *LaMotte Garden Soil Test Kit*.

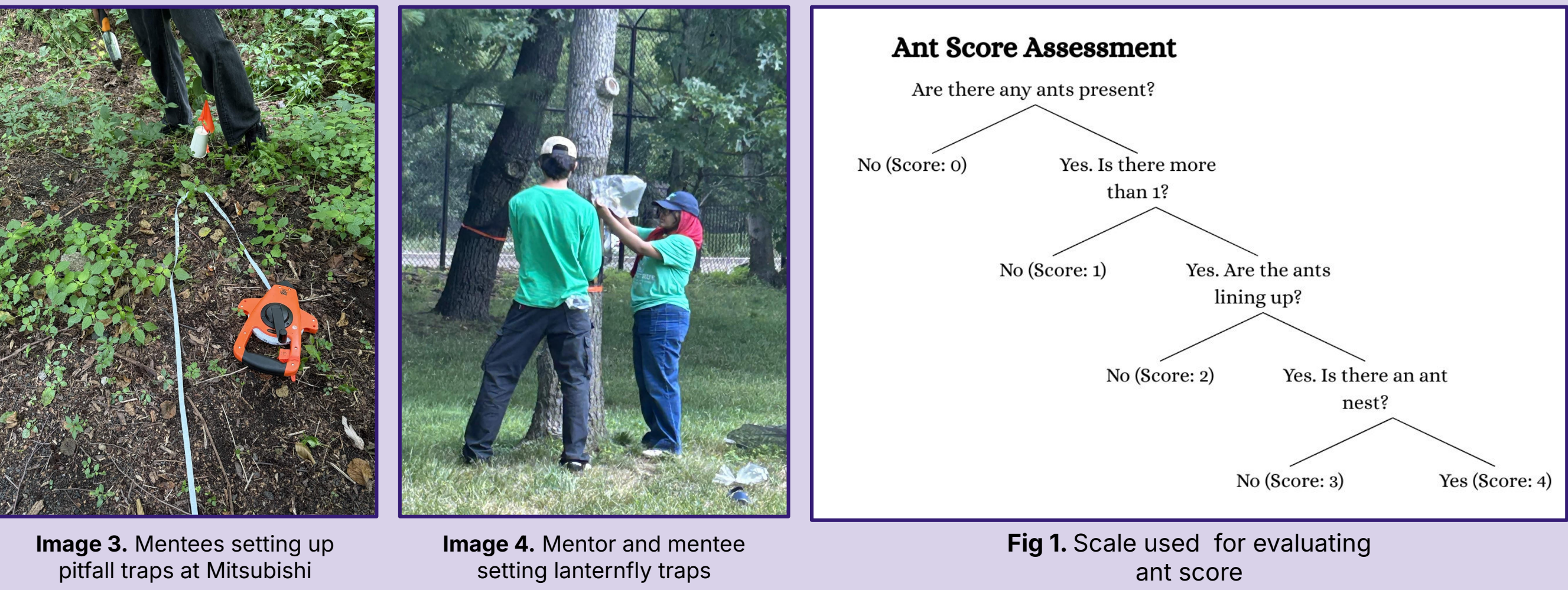


Image 1. Japanese Knotweed (Credit: Scottish Invasive Species Initiative)



Image 2. Spotted Lanternfly (Credit: Getty Images - arlutz73)

Abstract

Invasive species such as *L. Delicatula* and *F. Japonica* are severely detrimental to the environment, spreading rapidly, disrupting ecosystems, and hindering economic profits. Over four weeks, the effects of Japanese Knotweed on ground-dwelling and other invertebrates were surveyed at the Twin Dams and Mitsubishi Riverwalk sites in the Bronx Zoo. In addition, soil chemistry and quality was analyzed to evaluate the relationship between *F. Japonica* presence and ecosystem health. Results indicate that *F. Japonica* alters soil chemistry, negatively influencing the growth of native vegetation and the composition of invertebrate communities⁵. Concurrently, the relationship between *L. Delicatula* abundance and ant populations were assessed, revealing a negative association between increasing lanternfly populations and ant abundance. Understanding these ecological interactions is crucial for developing effective strategies to mitigate the impacts of invasive species and maintain ecosystem resilience and balance.

Research Questions & Hypotheses

- Question 1:** Does invertebrate abundance, order richness, and diversity within *F. japonica* sites differ within two local riparian sites?
- Hypothesis 1:** There will be less aerial invertebrate richness and abundance within knotweed invaded sites. There will be similar invertebrate diversity on both study sites. Knotweed invaded sites will have increased detritivore richness compared to non invaded sites.
- Question 2:** Is there a correlation between the amount of ants on trees with lantern fly traps and the amount of lanternflies caught?
- Hypothesis 2:** There will be a positive correlation between lanternfly abundance and arboreal ant scores.

Results & Figures

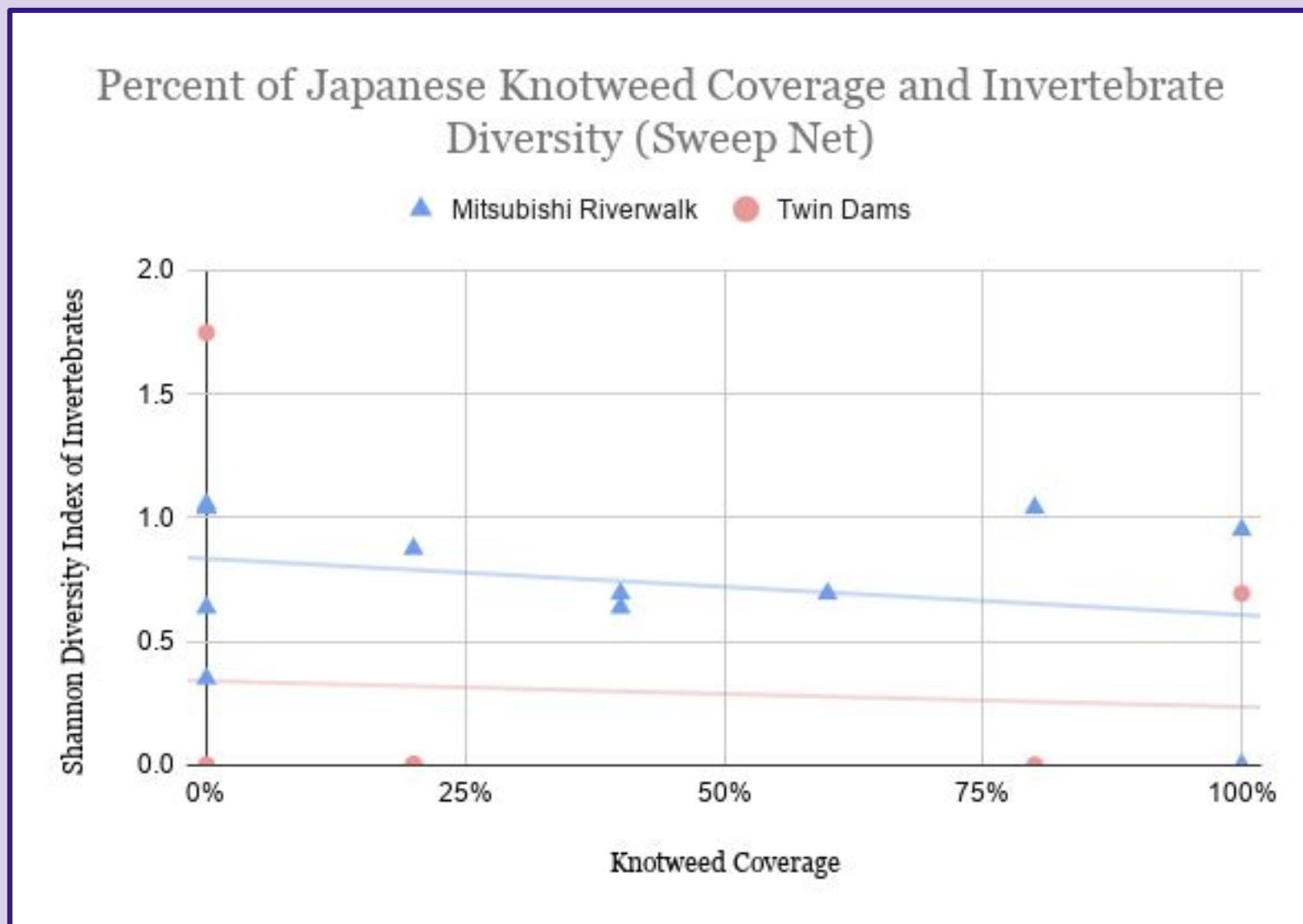


Fig 2. Compares the percentage of knotweed coverage and understory dwelling invertebrates counted using sweep nets at Mitsubishi Riverwalk and Twin Dams

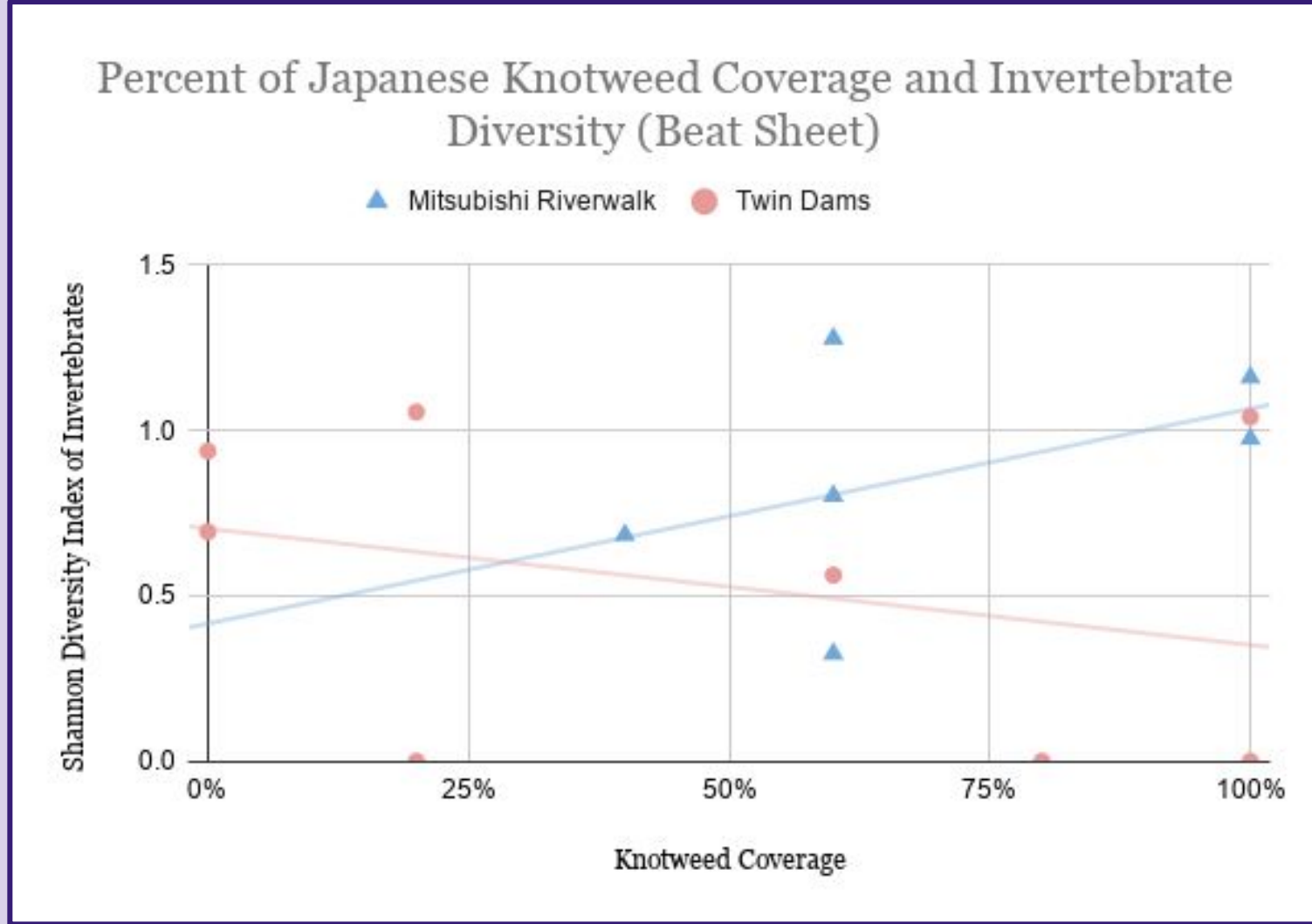


Fig 4. Compares the percentage of knotweed coverage and understory dwelling invertebrates counted using beat sheets at Mitsubishi Riverwalk and Twin Dams.

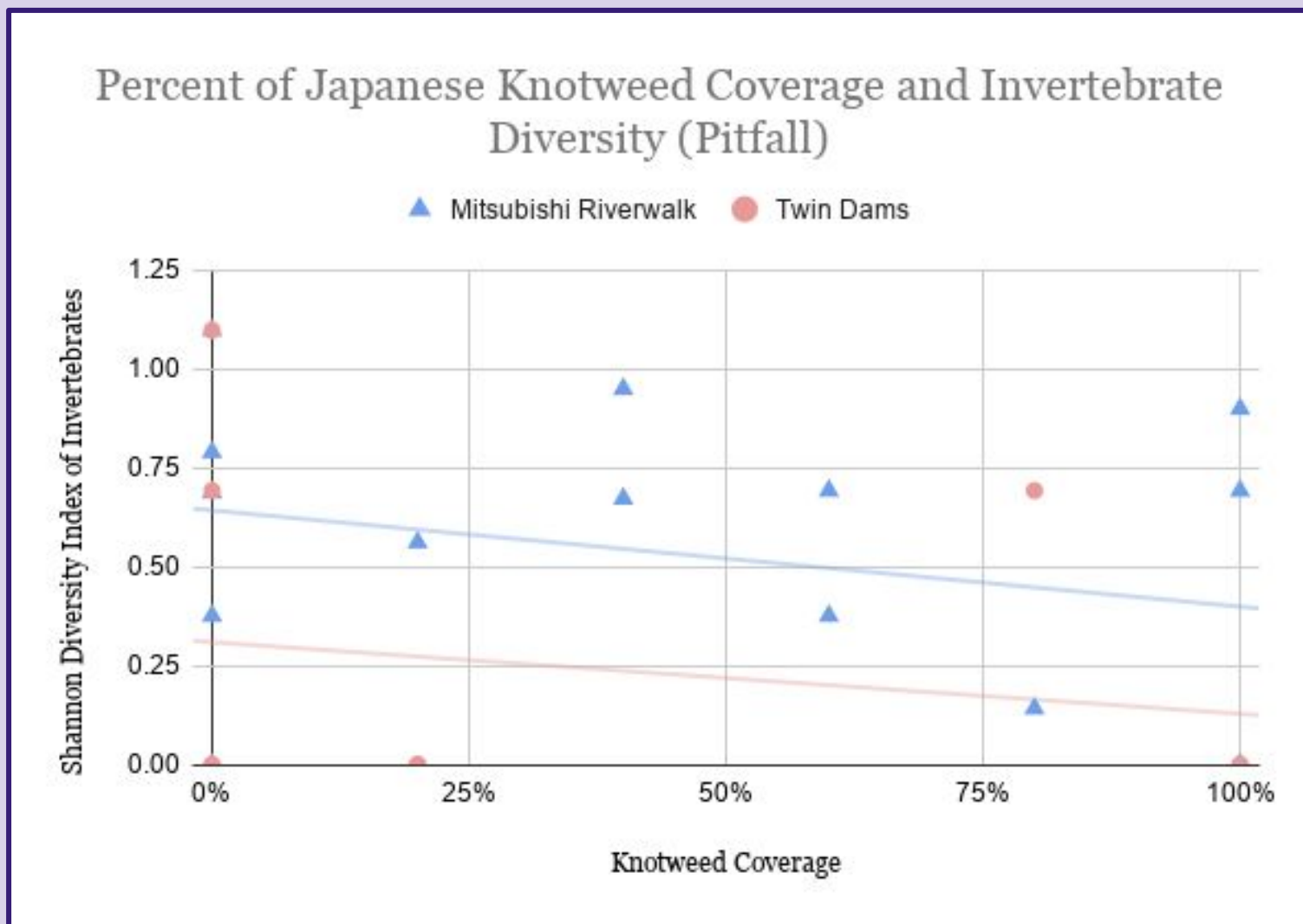


Fig 3. Compares the percentage of knotweed coverage and ground dwelling invertebrates counted using pitfall traps at Mitsubishi Riverwalk and Twin Dams

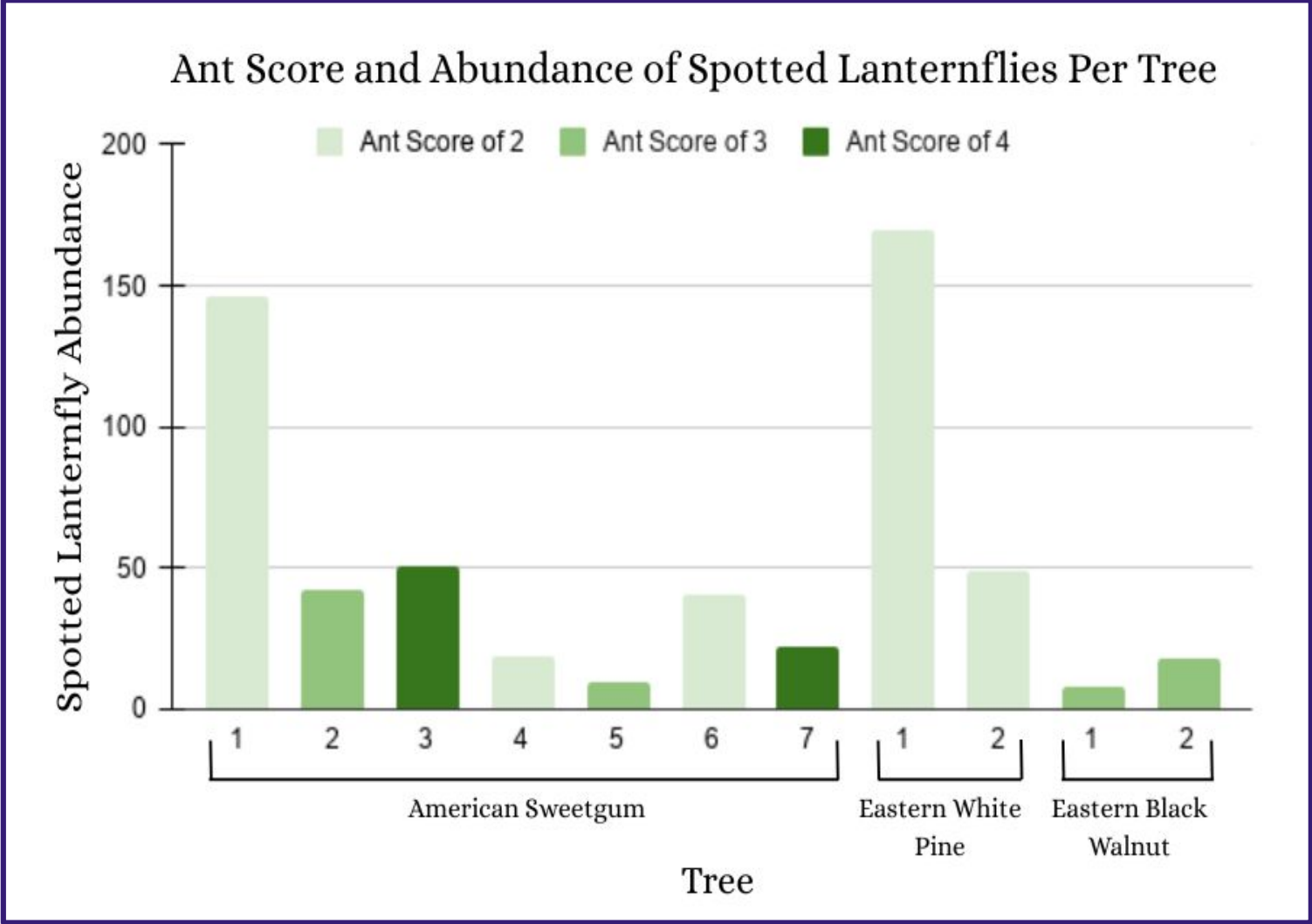


Fig 5. Compares ant scores given to each tree with respective spotted lanternfly abundance separated by tree identification.

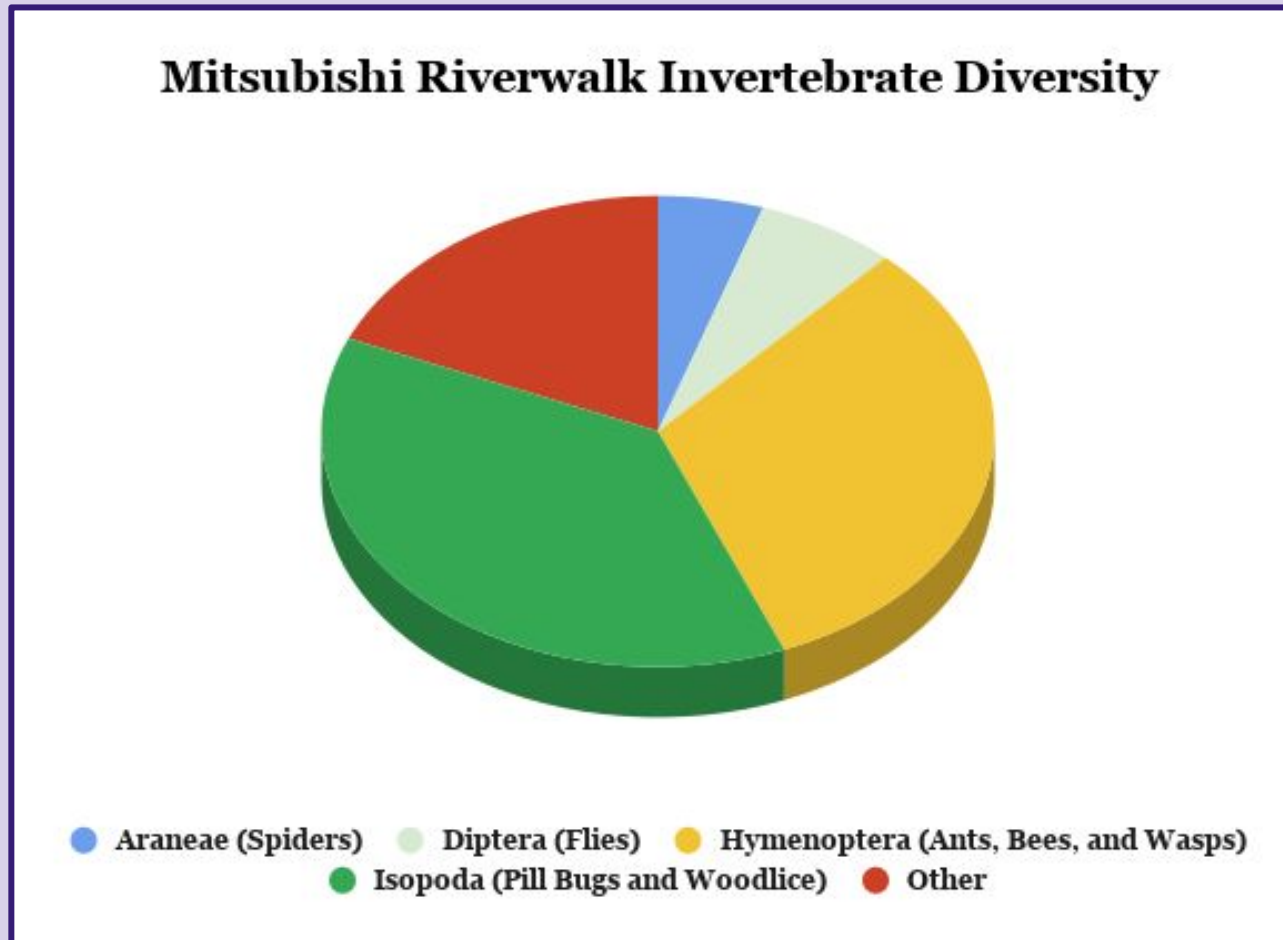


Fig 6. Visualizes invertebrate diversity by order at Mitsubishi Riverwalk. The "other" category includes Colembola (0.4%), Hemiptera (1.8%), Lepidoptera (0.8%), Odonata (0.8%), Psocoda (0.8%), Diplopoda (4%), Archaeognatha (0.4%), Orthoptera (0.8%), Blattodea (3.6%), Ixodida (3.1%), Acari (0.8%), Coleoptera (1.3%), and Neuroptera (0.4%).

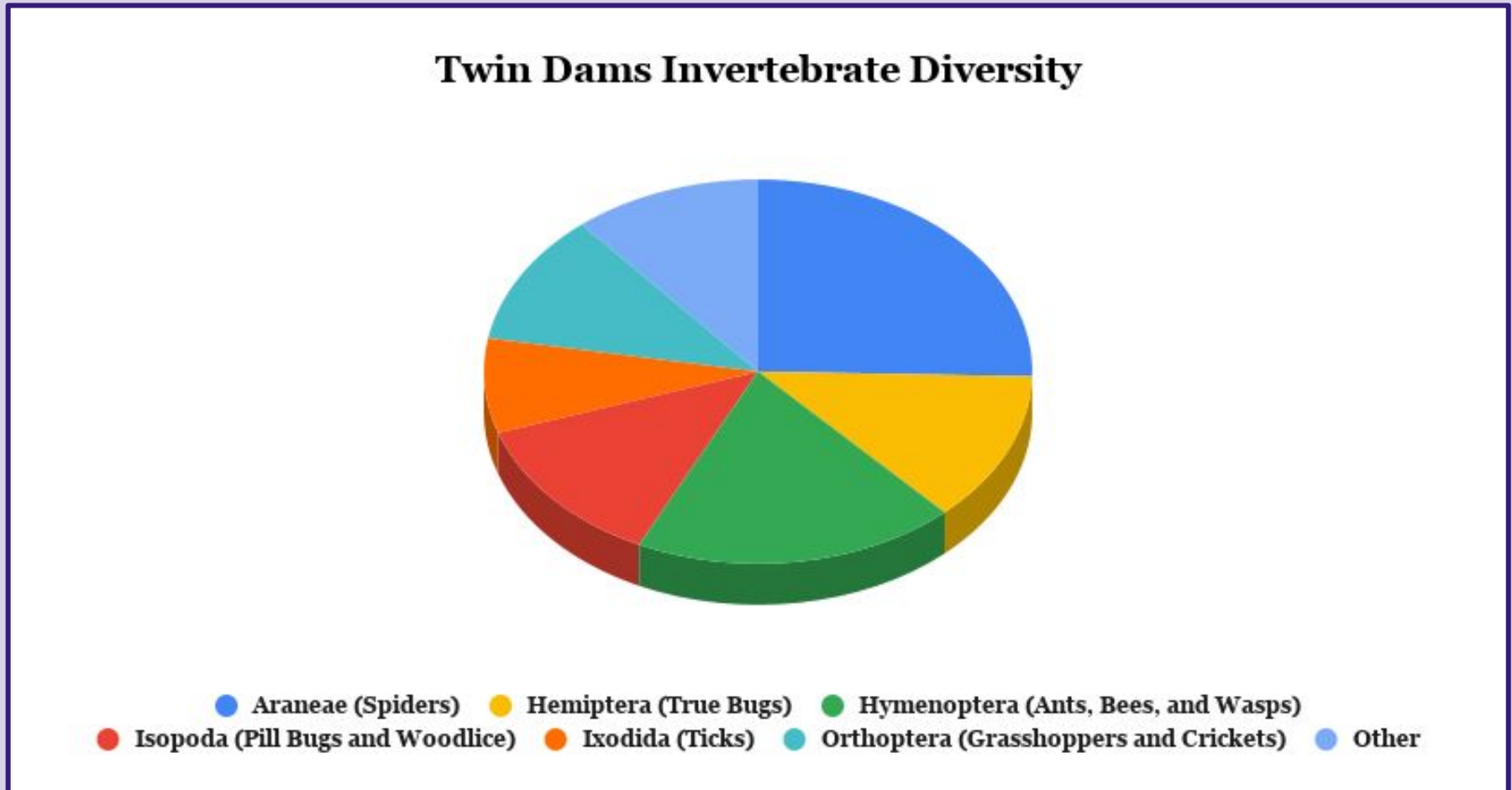


Fig 7. Visualizes invertebrate diversity by order at Twin Dams. The "other" category includes Psocoptera (3.2%), Dermaptera (1.6%), Opisthoptera (1.6%), and Coleoptera (4.8%).

Analysis

A total of 20 transects at MR, 16 transects at TD, and 10 trees at MR were surveyed during the study period. These results demonstrate that the *F. japonica* populated sites at MR and TD display lower Shannon Diversity Index scores of ground dwelling and plant dwelling invertebrates compared to surveyed aerial invertebrates. As displayed in Figs 1-2 as knotweed coverage percentage increases at either MR or TD Shannon Diversity Index scores typically decrease. However, Fig 3 displays that as knotweed coverage percentages increase Shannon Diversity Index scores continue to decrease at TD but increase at MR. Within MR, Fig 5 reveals that the surveyed ground dwelling invertebrate population is predominantly composed of Isopoda (37.6%) and Hymenoptera (32.1%). Moreover, the ground dwelling invertebrate population at TD is predominantly composed of predator and herbivore invertebrates. The soil chemistry within MR typically displayed alkaline pH levels, trace nitrogen amounts, high phosphorus levels, and low potassium levels (Figure 7). The soil chemistry within TD typically displayed alkaline pH levels, trace nitrogen amounts, low phosphorous levels, and low potassium levels (Figure 7).

In Fig 4, trees with a higher population of *L. delicatula* have on average a lower associated ant score. American Sweetgum (*L. styraciflua*) and Eastern White Pine (*P. strobus*) had the highest *L. delicatula* abundance and the lowest ant scores. American Sweetgum (*L. styraciflua*) and Eastern Black Walnut (*J. nigra*) had the lowest *L. delicatula* abundance and the highest ant score.

Discussion

This project hypothesized that there will be similar ecological impacts of *F. japonica* on both riparian study sites. Furthermore it was hypothesized that *L. delicatula* abundance has a positive relationship to arboreal ant abundance. Moreover, it was predicted that there will be increased detritivore richness and a decrease in aerial invertebrate abundance. The data from this study show evidence of low biodiversity in aerial, plant dwelling, and ground dwelling invertebrates. Figures 1-3 show a general negative correlation between knotweed coverage percentage and Shannon Diversity Index scores. However, the Mitsubishi Riverwalk site displayed a general positive correlation between the Shannon Diversity Index score of *F. japonica* dwelling invertebrates and knotweed coverage. This positive correlation could be explained due to the habitat of Mitsubishi Riverwalk. Furthermore, Figure 5 demonstrated predominantly isopoda and hymenoptera (respectively 37.6%, 32.1%) populations. However, Figure 6 displayed the surveyed invertebrate populations at Twin Dams and demonstrated predominantly Araneae, Hymenoptera, Hemiptera, and Isopoda (respectively 25.4%, 19.0%, 12.7%, 12.7%). Mitsubishi Riverwalk invertebrate



Fig 8. Visualizes knotweed coverage percentage at the Mitsubishi Riverwalk and Twin Dams site. It further displays the soil chemistry of both sites.

populations are heavily dominated by detritivores, while Twin Dams is heavily dominated by predatory invertebrates (Araneae). The data from this study further shows evidence that arboreal ant presence decreases with higher *L. delicatula* abundance, Figure 4 shows that surveyed trees with a greater abundance of *L. delicatula* typically have lower ant scores.

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