POLLINATORS PREFER NATIVE PLANTS OVER NON-NATIVE PLANTS

Maryrose Fabrizio, AJ Jacobus-Oseroff, Gabrielle Mendez, Kyle Starkey

ABSTRACT

Non-native plants have detrimental effects on native ecosystems. This can subsequently have a cascading effect on the feeding habits of pollinators. The effects non-native plants have on native plants are clearer; but the relationship between non-native plants and pollinators is more ambiguous. To study this, we went to various parks throughout New York and observed pollinator's habits in reference to preferring native or non-native plants. We also took note of the ambient temperature to see if it affected pollinator activity. The results in our trials concluded that pollinators preferred native plants over non-native plants. We also observed more pollinator sightings during warmer weather trials. Therefore, we can hypothesize that pollinators prefer native plants over invasive plants.

Keywords: ecosystem; invasive alien plant (IAP); native plant; non-native plant; pollinator; preference; plant-pollinator interactions

INTRODUCTION

Human interaction has changed the landscape of Earth by using it to accommodate our own needs. Expansive development and urbanization have caused fragmentation in ecosystems as humans have expanded on undeveloped land and disrupted the natural way of life. By shaping the natural environment to match human needs, we have changed land use in ways that have benefited the human population, at the expense of native plants and animals. Destruction and fragmentation of habitat continues to cause mass displacement of plants and animals (Alarcón and Burkle 2011, Goulson et al. 2015, Harrison and Winfree 2015). This habitat fragmentation puts stress on the ecosystem and those in the surrounding area. As humans populate areas, we bring harmful factors like non-native species, pollutants, and disease that further disrupt native populations (Cane and Tepedino 2001, Goulson et al. 2015, and Lowenstein et al. 2019). These environmental disruptions cause changes in ecosystem structures and dynamics, directly affecting pollinator networks (Valdovinos et al. 2009).

With the introduction of non-native plant species, it's important to understand how these non-native species affect the native environment. Once established, non-native plant species become important to the network structure of plant-pollinator interactions (Valdovinos et al. 2009). Non-native plants are often able to germinate earlier and spread more efficiently than native plant species (Chrobock et al. 2011), increasing their abundance, therefore changing ecosystem networks. Habitat resource availability dictates pollinator action.

Pollinators play a significant role in spreading seeds and pollen of plants. The increasing abundance of non-native plants has decreased the proportion of native to non-native species across global landscapes. To make effective native pollinator conservation measures, it is important to know how they respond to the plants that are available to them across changing landscapes. There is evidence (Harrison and Winfree 2015, Lowenstein et al. 2019, Staab 2020) that supports the optimal foraging theory which predicts changes in foraging behavior of animals (Pyke 1980). This theory helps to suggest that pollinators on man-made landscapes, such as parks, are going to behave differently than pollinators on untouched land. A pollinator's response depends on the resources available to them. If a habitat becomes fragmented, a pollinator spends more time in one place but will travel to less places because of scarce availability of resources (Harrison and Winfree 2015).

As we develop man-made landscapes, we shrink natural habitats and introduce non-native species. Community development, through garden and landscape management choice influence the make-up of the surrounding areas of remaining natural habitat. Though the exact impacts of these decisions are unclear, we do know that bringing non-native species aids in their spread onto natural habitats (Knapp et al. 2012, Lowenstein and Minor 2016, Lowenstein et al. 2019). This causes a domino effect, increasing competition for resources such as nutrients, light, space, and water (Dietzsch et al. 2011, McKinney and Goodell 2011), and ultimately loss of plant species diversity (Bartomeus et al. 2008). Loss of diversity directly affects plant-pollinator relationships. The introduction of a new species gives the pollinator more than one option, and the non-native species will either overtake or coexist with the native species. Non-native plants can hinder native plant reproduction through their pollen introduction, causing pollinators to carry mixed pollen loads and deposit pollen of the non-native species instead of the pollen needed by the native plants (Larson 2008).

Non-native plants tend to be heartier and germinate earlier, enabling them to grow and thrive in new environments (Chrobock et al. 2011). The porcelain berry (*Ampelopsis brevipedunculata*), a deciduous perennial vine native to northeast Asia, is a great example of how non-native species introduction can disrupt native habitats. It was brought to the United States in the 1870s as a landscape plant. The berry has persisted to invade in twelve states, due to its heartiness and pest resistance (PCA 2005). Spread of non-native landscape plants like the porcelain berry affect pollinator behavior by altering their available resources (Gillespie and Elle 2018). Changes in weather patterns can exacerbate the changes further because even in inclement weather or climate change, non-native plants can still survive and adapt, giving them more space to spread.

The goal of our study is to distinguish if pollinators prefer native species over invasive species in city parks. Study of pollinator actions is vital to the conservation of species in plant-pollinator networks. The plant preferences of pollinators have been studied to varying degrees with mixed results. Pollinators will freely visit non-native plants (King and Sargent 2012, Lowenstein et al. 2019), especially in urban environments, where native plants may be scarce (King and Sargent 2012, Harrison and Winfree 2015, Staab 2020). When both native and non-native plants are available, pollinators prefer native and near-native cultivars, but pollinator preference has more to do with plant characteristics than origins, though most have been focused on urban and suburban neighborhoods and rural areas (Lowenstein and Minor 2016, Tiedeken et al. 2016, Lowenstein et al. 2019). Pollinator visitation has been shown to decrease across the urban gradient in numerous studies (Williams et al. 2011, Chrobock et al. 2013, Harrison and Winfree 2015). Several studies have found that pollinator preference has more to do with plant characteristics than origins, though most have been focused on urban and suburban neighborhoods and rural areas. By studying pollinator activity in city parks, we hope to contribute to the understanding of how community development of semi-landscaped plots impacts pollinator preference.

METHODS

Field site. For our sites we chose places that would have a diverse amount of invasive and native plants. We decided that parks are a great representation of the different vectors that spread invasive plants; there are also many examples of native plants at parks as well. We then proceeded to record our data in various parks located in New York State. In total we made 40 observations: 12 at Hutton Park in Kingston (Ulster County), 10 at Blue Mountain Reservation in Peekskill (Westchester County), 6 at Downing Park in Yorktown Heights (Westchester County), and 12 at Kissena Park in Queens, New York City (Fig. 1). All of our data was collected between October 25 and November 7, 2020, a time when pollinator activity usually decreases due to the impending winter. Recording temperature was important to see the relationship between pollinator prevalence and temperature. The instrumental observation of this study was to examine if pollinators were on a native plant or a non-native plant. We would try to find an equal amount of invasive and native plants in each trial, and we would observe the plants for 20 minutes to record pollinator activity. We would take note of the plant species type, the pollinator species type, and the temperature. Upon arriving home, we would insert our data onto a spreadsheet in Google Sheets and Microsoft Excel. The tool that we used to identify the plant species and pollinators was the application iNaturalist on iOS devices. The application was instrumental in our ability to accurately identify the exact plant and pollinator species in our study.

Figure 1. The locations where we made our observations are depicted in the map above. Hutton Park in Kingston was the northernmost point; Kissena Park in Queens was the southernmost point (113 miles apart). The two locations in the middle were Blue Mountain Reservation in Peekskill, and Downing Park in Yorktown Heights (6 miles apart).

RESULTS

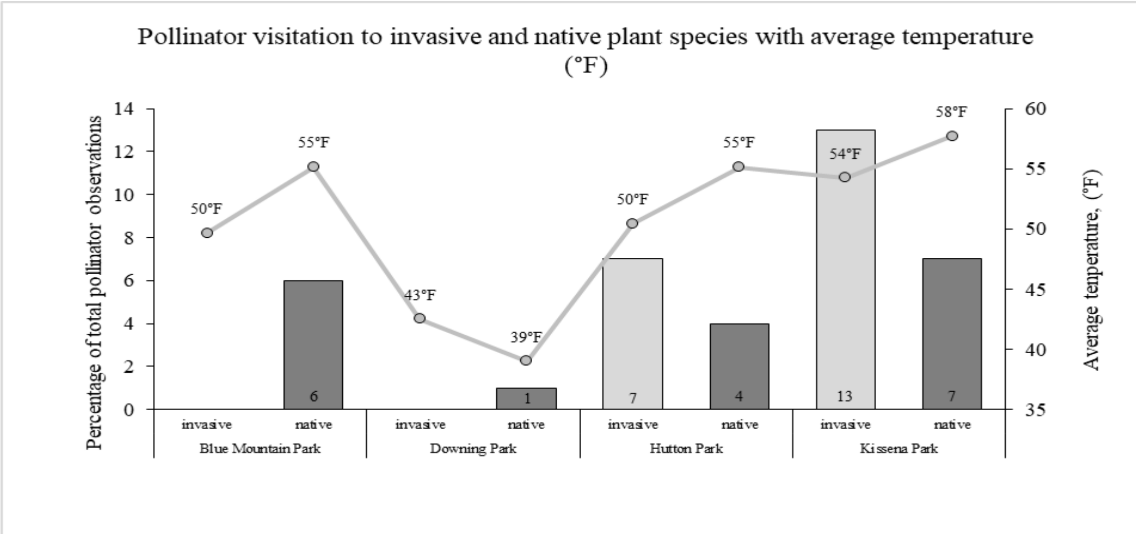

Figure 2. The goal was to see the relationship between pollinator visitation and temperature of the location; it is also to display the variation between pollinators on native vs invasive plants. The temperature during our trials varied by around 19°F and were usually taken between 10AM-12PM. If a pollinator was present it would be noted if it were on an invasive or a native plant. The colder temperatures had an impact on the presence of pollinators; Yorktown Heights (Downing Park) was the coldest and had the least pollinator activity, while Queens (Kissena Park) was the warmest and experienced the most pollinator activity.

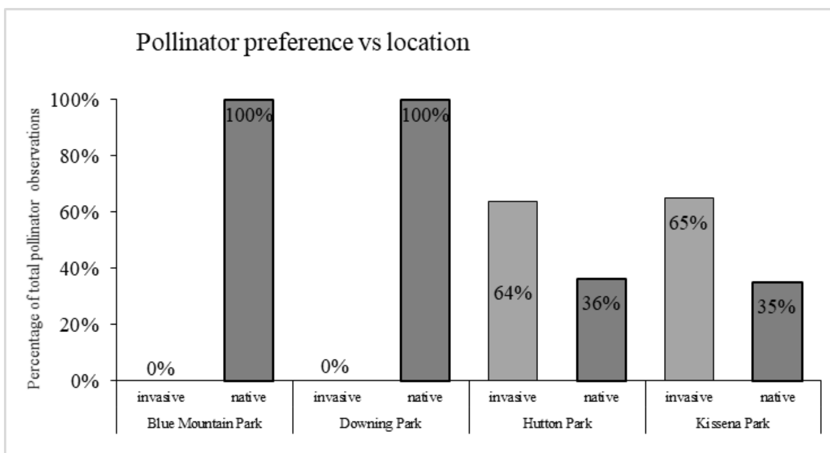

Figure 3. If a pollinator was observed, we would classify the plant based on whether it was invasive or native. 100% of the observed pollinators at Blue Mountain (Peekskill) and Downing Park (Yorktown Heights) were observed on native plants. Hutton Park (Kingston) and Kissena (Queens) both observed slightly more interactions on invasive plants (64% and 65% respectively).

Out of the 40 trials we observed 20 pollinator species on plants. We then took our data and converted them into percentages (%) to display on some of our graphs (Fig. 3). More pollinators were typically observed with a higher average temperature (°F); Downing Park (42°F) had the lowest average temperature and the lowest pollinator involvement as well (Fig. 2). Hutton Park (58°F) and Blue Mountain (57°F) had the highest average temperatures and the most pollinator engagement.

Pollinators at Downing Park and Blue Mountain Park had distinct preferences for native plants, the only place with more pollinators on invasive plants was Hutton Park (Fig. 2). At Downing Park and Blue Mountain pollinators had a 100% preference for native plants, while pollinators at Kissena Park preferred invasive plants (65%) over native plants (35%) (Fig. 3). Pollinators had a slight preference for invasive plants (57%) over native plants (43%) at Hutton Park (Fig. 3).

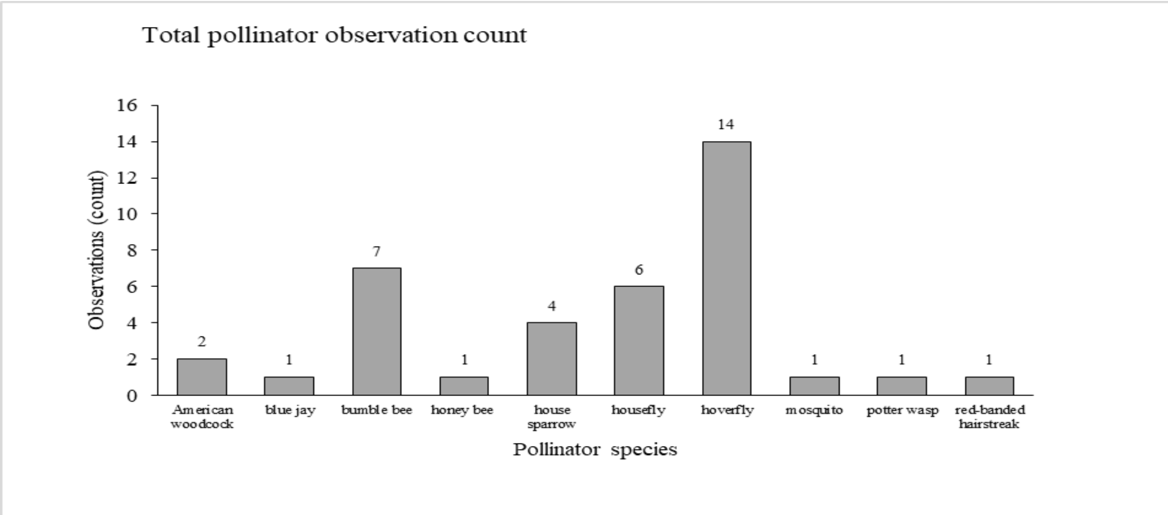

Figure 4. The graph above illustrates which specific pollinator we observed and describes how many times we saw them. This is to help illustrate which pollinators were the biggest contributors to our study. The hoverfly had the highest involvement being seen interacting with different plant species 14 times, followed by the bumble bee, which was observed 7 times.

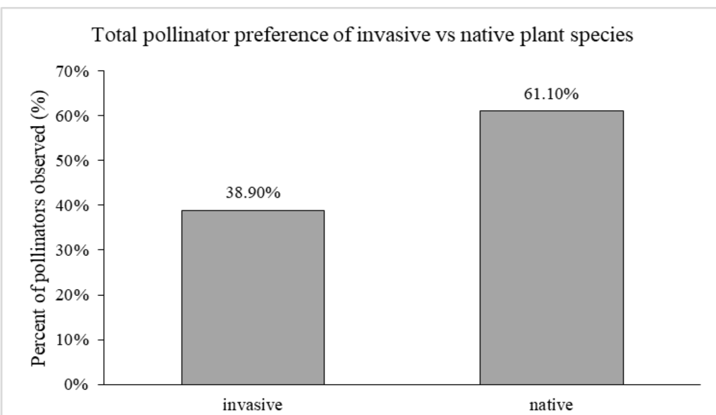

Figure 5. The ultimate goal was to see if pollinators had a preference for native or invasive plants. Out of the 40 trials we did, 20 plants had pollinators, or 50.0% of observations. The data could suggest that pollinators prefer native plants: we observed that 61.10% pollinators were on native plants, and only 38.90% were seen on invasive plants.

We also wanted to acknowledge the different pollinator species involved, so we recorded the sum of different pollinator species we saw. The hoverfly and the bumblebee offered the most pollination during our trials (Fig 4). Birds also appeared in our observations: the blue jay (*Cyanocitta cristata*) was spotted 1 time, the house sparrow (*Passer domesticus*) 2 times, and the American woodcock (*Scolopax minor*) was spotted 2 times.

It is evident from our data collection that pollinators did prefer native plants over non-native plants. In the 20 trials in which we spotted pollinators, 61.10% preferred native plants over invasive plants (Fig. 5). The plant that pollinators preferred the most in our study were asters (*Asteraceae*), accounting for 36% of the plants involved in the sightings. The sum of native plants (58%) preferred by pollinators was greater than the results for invasive plants (42%) (Fig. 6).

DISCUSSION

The goal of this study was to determine whether pollinators prefer native or invasive plants in city parks. Our results show that pollinators in urban areas preferred native plants to invasive ones in the vicinity. This is in line with what we predicted would be seen and is reinforced by previous studies (Grass et al. 2013). Our study was conducted during the fall from mid-October to early November. As a result of the time of year, many of the non-native and native plant species were not flowering. This would virtually

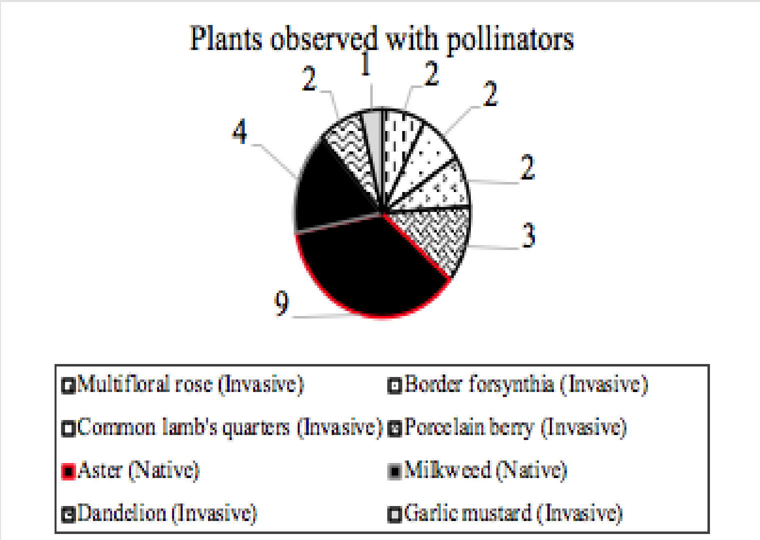

Figure 6. The pie-chart shows each individual plant species we saw a pollinator on and classifies them as native or invasive. Out of the 20 trials with pollinators we observed them on plants 25 times. The black areas of the pie-chart represent pollinators spotted on native plants. Asters (Asteraceae) had the highest number of pollinator involvement out of any other plant in the study with 9 sightings (36%). The white/gray sections of the chart represent invasive plants. We observed a greater sum of pollinators on native plants (52.63%) than on invasive plants (47.37%).

eliminate all pollinator interactions with those plant species, since they rely on the flower parts of the plant. Porcelain berry, multiflora rose, and wild grape are just a few of the non-native species observed that are not flowering at this time. Dandelions flower from May to October and were the only invasive plant that might have been of use to any pollinators. Studies done in the future might consider changing the time of year to spring and summer months. This would ensure that there is a good chance the pollinators will have the opportunity to choose non-native plant species to pollinate. It would be an opportunity to study the effect of differences in floral presentation as well, which has been shown to influence pollinator visitation (Vanparys et al. 2008). Because invasive plants were not flowering, this study did not observe any "magnet species" effects, where plants that are highly attractive to pollinators are favored by them (Laverty 1992). More flowering invasive species during the data collection could have furthered the results of this study. Survival in urban ecosystems can be difficult for many plant and animal species. It has been shown that the diversity of pollinator species decreases as areas become more urbanized, so it is important to protect their interests so that vital ecosystem services are not lost (McKinney 2008). So, since this study shows that pollinators prefer native plants, the survival of those plant species should be a priority. If further studies also conclude that pollinators prefer native plants, then invasive species management plans would need to be created or altered to take this new information into account.

The density and diversity of both non-native and native plant species varied between each of the four parks visited during this study. This can make it difficult to accurately compare the sites and can skew the results. If there were flowering non-native plants at one site and no flowering non-native plants at another, then "use" of non-natives by pollinators would seem very different when it might not be in reality. In other words, the results of this study are prone to type 1 errors. A type 1 error occurs when there is a conclusion that there is a difference in pollinator preference when there is not one. Since there were also areas of the various sites surveyed that had native plants that were still flowering, it is possible that pollinator use of those plants were based on availability rather than preference. Future studies could choose specific species of non-native and native plants that are present at all the sites being surveyed.

Many of the pollinator species that were observed migrate, hibernate, or die as a result of cold winter temperatures. The threshold of too cold for these species and others that can be found in this region of New York was crossed several times over the course of this study. The temperatures during this time of year can vary greatly. There were temperatures as high as 70°F and as low as 29°F, which had an influence on the species observed and the level of activity those pollinators exhibited. During the fall months, several species of butterflies migrate, the most well-known of those being monarch butterflies. This may explain why only one species of butterfly was observed during the data collection period. When temperatures fall below 50°F, bees stop flying and return to their hives where they can keep warm and survive the cold temperatures (Hogeback, n.d.). Our results show that when temperatures were higher more pollinator species were recorded. Because of the fluctuation there may have been a significant impact on pollinator activity. To add to the current understanding of plant-pollinator interactions, future studies should be done during seasons where pollinators will be more active.

In addition to recording only the species of pollinator observed, the number of individuals of each species that visited each site could have been recorded. The size of the observed areas could have also been quantified, as there were no guidelines laid out as to how large or small observed areas should have been in this study. Large areas will likely have more plants and thus more pollinators, and we do not know whether that can be reliably compared to smaller areas or areas of the same size with reduced plant density. Moragues and Traveset (2005) showed that non-native plant presence can have negative, positive, and neutral effects depending on the site, and a detailed and concise future study could show much different results than were found here.

During the data collection portion of this study a miscommunication occurred between group members resulting in inconsistencies in data to analyze. Several members selected four sites at their respective parks to go back to each week and observe for pollinators. Others only went to one site each week to observe for pollinators. One member collected data from four sites one week and then went to one site for the rest. This discrepancy in the data that was collected potentially skewed the data. Future studies might consider making sure all the data collectors collect the same amount of data by implementing stricter, more detailed guidelines for data collection during the beginning stages of the study.

CONCLUSIONS

Based on our findings, we conclude that the pollinators in urban parks have a preference for native plants over non-native plants. Temperature was also shown to have a negative effect on pollinator abundance. Our study, which was done in cold temperatures, yielded relatively few pollinator sightings. Invasive plants have a negative effect on ecosystems and pollinators are especially at risk. Pollinators are vital for ecosystem functioning and are at risk due to increased urbanization (McKinney 2008). It is important to understand pollinator tendencies so that their populations can be preserved. Information from this study and the information gathered from future studies can be used to inform pollinator interactions with invasive plants and whether invasive plant removal and control are necessary.

ACKNOWLEDGEMENTS

We would like to thank Dr. Jackson for her advice and guidance throughout this project. Additionally, we would like to thank Tiffani Rushford for her advice and detailed presentation of how to format a research paper. Finally, we would like to thank each other for being able to work together (remotely) during the Covid-19 pandemic.

AUTHOR CONTRIBUTIONS

Conceptualization (all), data collection (all), data curation (all), formal analysis (all), methodology (all), project administration (all), resources (all), visualization: maps (KS, MF), visualization: figures (AJO, KS), visualization: table (AJO, KS), writing: abstract (AJO, KS, MF), writing: introduction (AJO, MF), writing: methods (KS), writing: discussion (GM), writing: conclusion (GM, KS), writing: review and editing (all).

LITERATURE CITED

Alarcón, R., and L. Burkle. 2011. The future of plant-pollinator diversity: Understanding interaction networks across time, space, and global change. American Journal of Botany 98: 528-538.

Bartomeus, I., M. Vilà, and L. Santamaría. 2008. Contrasting effects of invasive plants in plant-pollinator networks. Oecologia 155:761–770.

Cane, J. H., and V. J. Tepedino. 2001. Causes and extent of declines among native North American invertebrate pollinators: detection, evidence, and consequences. Conservation Ecology 5.

Chrobock, T., A. Kempel, M. Fischer, and M. van Kleunen. 2011. Introduction bias: Cultivated alien plant species germinate faster and more abundantly than native species in Switzerland. Basic and Applied Ecology 12:244–250.

Chrobock, T., P. Winiger, M. Fischer, and M. van Kleunen. 2013. The cobblers stick to their lasts: pollinators prefer native over alien plant species in a multi-species experiment. Biological invasions 15:2577–2588.

Dietzsch, C., O. Spadiut, and C. Herwig. 2011. A dynamic method based on the specific substrate uptake rate to set up a feeding strategy for Pichia pastoris. Microbial Cell Factories 10:14.

Gillespie, S., and E. Elle. 2018. Non-native plants affect generalist pollinator diet overlap and foraging behavior indirectly, via impacts on native plant abundance. Biological Invasions 20:3179–3191.

Goulson, D., E. Nicholls, C. Botías, and E. L. Rotheray. 2015. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. Science 347.

Grass, I., D. G. Berens, F. Peter, N. Farwig. 2013. Additive effects of exotic plant abundance and land-use intensity on plant-pollinator interactions. Oecologia 173:913-923.

Harrison, T., and R. Winfree. 2015. Urban drivers of plant-pollinator interactions. Functional Ecology 29:879–888.

Hogeback, J.. (n.d.). Where Do Honeybees Go in the Winter? Encyclopedia Britannica Demystified Science. https://www.britannica.com/story/where-do-honeybees-go-in-the-winter.

King, V. M., and R. D. Sargent. 2012. Presence of an invasive plant species alters pollinator visitation to a native. Biological invasions 14:1809–1818.

Larson, D. Invasive Plants and Pollinator Interactions, 2008. Endangered Species Bulletin, 33: 46-49.

Laverty, T. M. 1992. Plant interactions for pollinator visits: a test of the magnet species effect. Oecologica 89:502-508.

Lowenstein, D. M., K. C. Matteson, and E. S. Minor. 2019. Evaluating the dependence of urban pollinators on ornamental, non-native, and "weedy" floral resources. Urban Ecosystems 22:293–302.

Lowenstein, D. M., and E. S. Minor. 2016. Diversity in flowering plants and their characteristics: integrating humans as a driver of urban floral resources. Urban Ecosystems 19:1735–1748.

McKinney, A. M., and K. Goodell. 2011. Plant–pollinator interactions between an invasive and native plant vary between sites with different flowering phenology. Plant Ecology 212:1025–1035.

McKinney, M. L. 2008. Effects of urbanization on species richness: A review of plants and animals. Urban Ecosystems 11:161-176.

Moragues, E., and A. Traveset. 2005. Effect of Carpobrotus spp. on the pollination success of native plant species of the Balearic Islands. Biological Conservation 122:611–619.

Porcelain Berry Fact Sheet. (2005). Plant Conservation Alliance. https://www.invasive.org/weedcd/pdfs/wgw/porcelainberry.pdf

Pyke, G. H. 1980. Optimal foraging in bumblebees: calculation of net rate of energy intake and optimal patch choice. Theoretical population biology 17:232–246.

Staab, M., M. H. Pereira-Peixoto, and A.-M. Klein. 2020. Exotic garden plants partly substitute for native plants as resources for pollinators when native plants become seasonally scarce. Oecologia 194:465–480.

Tiedeken, E. J., P. A. Egan, P. C. Stevenson, G. A. Wright, M. J. F. Brown, E. F. Power, I. Farrell, S. M. Matthews, and J. C. Stout. 2016. Nectar chemistry modulates the impact of an invasive plant on native pollinators. Functional Ecology 30:885–893.

Valdovinos, F. S., R. Ramos-Jiliberto, J. D. Flores, C. Espinoza, and G. López. 2009. Structure and Dynamics of Pollination Networks: The Role of Alien Plants. Oikos 118:1190–1200.

Williams, N. M., D. Cariveau, R. Winfree, and C. Kremen. 2011. Bees in disturbed habitats use, but do not prefer, alien plants. Basic and Applied Ecology 12:332–341.

APPENDIX I

Table 1. Pollinator observations on native and invasive plant species at four public park observation sites; all located in the state of New York.

Location	°F	Plant Type	Plant Species Observed	Pollinators Observed
Blue Mountain Park (Peakskill)	29°F	native	common milkweed (*Asclepias syriaca*)	house fly (Musca domestica)
	54°F	native	American aster (*Symphyotrichum*)	hoverfly (Syrphidae)
	54°F	native	swamp milkweed (*Asclepias incarnata*)	hoverfly (Syrphidae)
	65°F	native	common aster (*Symphyotrichum*)	bumble bee (*Bombus*)
	65°F	native	common milkweed (*Asclepias syriaca*)	bumble bee (*Bombus*)
	65°F	native	swamp milkweed (*Asclepias incarnata*)	bumble bee (*Bombus*)
Downing Park (Yorktown Hts)	39°F	native	American aster (Symphyotrichum)	potter wasp (*Vespidae eumeninae*)
Hutton Park (Kingston)	40°F	native	American aster (*Symphyotrichum*)	house fly (*Musca domestica*)
	40°F	invasive	border forsythia (*Forsythia intermedia*)	American woodcock (*Scolopax minor*), house sparrow (*Passer domesticus*), blue jay (*Cyanocitta cristata*)
	40°F	invasive	common lamb's-quarters (*Chenopodium album*)	American woodcock (*Scolopax minor*), house sparrow (*Passer domesticus*)
	52°F	native	American aster (*Symphyotrichum*)	house fly (*Musca domestica*), mosquito (*Culicidae*)
	75°F	native	American aster (*Symphyotrichum*)	house fly (*Musca domestica*)
	75°F	invasive	border forsythia (*Forsythia intermedia*)	house sparrow (*Passer domesticus*)
	75°F	invasive	common lamb's-quarters (Chenopodium album)	house sparrow (*Passer domesticus*)
Kissena Park (Queens)	47°F	native	common aster (*Symphyotrichum*)	hoverfly (*Syrphidae*)
	47°F	invasive	porcelain berry (*Ampelopsis brevipedunculata*), multiflora rose (*Rosa multiflora*), dandelion (*Taraxacum*)	hoverfly (*Syrphidae*)
	49°F	native	common aster (*Symphyotrichum*)	bumble bee (*Bombus*), hoverfly (*Syrphidae*)
	49°F	invasive	porcelain berry (*Ampelopsis brevipedunculata*), garlic mustard (*Alliaria petiolata*)	house fly (*Musca domestica*), hoverfly (*Syrphidae*)
	49°F	invasive	porcelain berry (*Ampelopsis brevipedunculata*), multiflora rose (*Rosa multiflora*), dandelion (*Taraxacum*)	bumble bee (*Bombus*), hoverfly (*Syrphidae*)
	70°F	native	common aster (*Symphyotrichum*)	honey bee (*Apis mellifera*), red-banded hairstreak (*Calycopis cecrops*), hoverfly (*Syrphidae*)

***All observation sites with asters (*Asteraceae*) observed at least one pollinator at site.**