Fresh Water and Hell Gate Meadow Summer Pollinator and Bloom Survey Summary of Research

Randall's Island Park Alliance

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Abstract:

Bees play a key role in the pollination of a majority of plants essential to biodiversity and food webs on the planet. Within the past few decades, bee populations have been steadily declining, raising serious concerns for the future of their species and associated plants. This summer, I had the opportunity to monitor a variety of Hymenopteran species and other prominent pollinators in the Fresh Water and Hell Gate Meadows on Randall's Island to help understand how we can promote a healthier pollinator community. Over the course of a four-week period, I calculated a percent cover of plants in bloom, collected weather data, and recorded the number of pollinators observed in a 30-minute period, twice a day every Monday and Tuesday. Statistical analysis was done through Excel after data collection. The data collected supports the hypotheses that there are more honey bees in the Fresh Water Meadow than Hell Gate, more bumblebees in both meadows than any other hymenopteran, more pollinators on days greater than or equal to 80°F, and more pollinators on days with wind speeds below 5mph. The data does not support the hypothesis that as the study and time progresses there will be more pollinators observed. Shawn and I hope that this study can serve as the foundation for many more meadow-based research projects on Randall's Island.

I. Introduction:

My name is Molly Suba and I am a rising Junior at SUNY Environmental College of Science and Forestry. This summer I had the opportunity to intern with Randall's Island Park Alliance's horticulture department, under Meadow Ecologist, Shawn Ganz. I have an interest in urban botanical science and the connection between public and natural spaces, both of which Randall's Island provided. As the Meadow Ecology Intern, I was tasked with developing a project within the two meadows, Hell Gate and Fresh Water, related to plant pollinator species. The following is a summation of the methods, results and conclusions following my research.

IA. Purpose: There are many intended purposes for this research project, the first being a foundation for internship projects in years to come. Shawn intends to continue expanding the internship program from one to multiple interns in the future. Based off my work, the department will continue to survey and monitor, as well as branch off into more specific research topics. My research aims to collect an overall pollinator population estimate, biodiversity estimate, and plant bloom percent cover. With this data, we hope to understand what pollinators exist, and their distributions, to are to help inform management strategies for the following year. This is the first time research like this has been conducted by a single intern at the park. It is essentially the foundation on which more in-depth and specialized internships may develop, and aims to identify any flaws or areas for improvement in the research methods that may be adjusted for future interns. This study also intends to identify species of interest that may result in grant money from an outside source, including pollinator and plant alike. A current partnership with the New York Bee Sanctuary was formed through this year's internship. I intend on gaining experience with plant/pollinator identification and botanical field research in hopes of helping inform me on which career paths may be suited to my interests.

IB. Meadow Background: Both Hell Gate (14,069 square feet) and the Fresh Water (14,281 square feet) meadows are comprised of mainly native perennial and annual plants. Each meadow is broken up into multiple sections for an individualized approach towards maintenance and care (Odessey, 2017). For both meadows, cutting back is done during the late fall or early spring. The debris from cutbacks is used to stock eight solitary bee hotels (four per site) in early spring (Odessey, 2017). There are also two bat boxes, one within each of the meadows. Notable summer flowers that make up a large percentage of the percent cover of in-bloom include *Echinacea, Monarda,* and *Heliopsis.* Details can be found in the Randall's Island Park Alliance 2017 Wildflower Meadow Report.

IC. Bee Background: Government, private and public institutions have begun allocating more resources toward the preservation and monitoring of native pollinators as awareness begins to spread about their critical status. Without bees, approximately $4.2 trillion dollars would be lost from the global economy every year, and crops like apples, oranges and avocados would cease to exist (Downing, 2017). Shocking statistics like these helps to draw funding. Monitoring the pollinators within our meadow is important to gauge bee health, which is not only beneficial for the gardens and farm of Randall's Island, but benefit the community around us. Bees from Manhattan, Queens and the Bronx find refuge in the gardens of Randall's Island. With over 4,000 native bee species in North America, it can be difficult to distinguish them. Different adaptations like the scopa, or the pollen carrying structures, can help us to identify to the species (Xerces, 2014). Some frequent visitors of the Island include the native Eastern Bumblebee and Green Sweat Bee, as well as the nonnative Western Honey Bee (Odessey, 2017).

II. Hypotheses:

1. **H_0:** The number of honey bees in Hell Gate and Fresh Water Meadows will not differ.

   H_a: The Fresh Water Meadow will have more honey bees than the Hell Gate Meadow, due to a closer proximity to 5 Borough's bee boxes.

2. **H_0**: There will be no difference in the average number of each *Hymenopteran* species.
   H_a: On average in both meadows, there will be more bumblebees than any other Hymenopteran.

3. **H_0:** The number of average pollinators will not differ in temperatures greater than or equal to 80°F, than days below 80°F.

   H_a: There will be more average pollinators on days with temperatures greater than or equal to 80°F, than days below 80°F.

4. **H_0:** The number of pollinators will not change as the study, and time progresses

   H_a: There will be more pollinators as the study, and time progresses.

5. **H_0:** On average in both meadows, there will be no difference in total pollinators on days with wind speeds lower the 5mph than days greater than or equal to 5mph.

   H_a: On average in both meadows, there will be more total pollinators on days with wind speeds lower than 5mph than days greater than or equal to 5mph.

III. Methods:

IIIA. Materials

- Kestrel Weather Monitor
- iNaturalist
- Monitoring Data Sheet
- Xerces Monitoring Protocol-Bee Identification Sheet
- Camera Phone
- Insect Collecting Chamber
- Writing Utensil
- Clipboard

At the start of the internship, download the iNaturalist app. Throughout the summer, upload pictures of known or unknown insect, plant, or bird species to the Randall's Island Park account. To do this, first log-in using the code provided by your supervisor. Next, click 'Observe' in the bottom center of the screen to open the app's camera and take a focused, close up picture of the specimen. Hit next and click 'What Do You See' to bring up a search bar with suggestions for identifying the specimen. Under the 'Notes' section, write any additional information you believe to be helpful for identification. iNaturalist users in the area will help confirm the specimen's identification and notify you.

Two pollinator monitoring sessions occur each Monday and Tuesday. The morning session spans between 7am and 11am, while the afternoon session spans between 11am and 3pm. Monitor the two meadows, Hell Gate and Fresh Water, within the two time sessions for 30 minutes, totaling four sessions per day. The Fresh Water Meadow is surveyed first on Mondays,

while the Hell Gate Meadow is monitored first on Tuesdays to avoid any time biases*. Below is a table approximating when each 30-minute session would take place.

	Monday Morning Session	Monday Afternoon Session	Tuesday Morning Session	Tuesday Afternoon Session
Fresh Water	~7:30-8:30	~11:45-12:30	~8:30-9:30	~12:30-1:30
Hell Gate	~8:30-9:30	~12:30-1:30	~7:30-8:30	~11:45-12:30

* Due to a field trip falling on Tuesday July 10th, Hell Gate Meadow was surveyed first the following Monday July 16th.

Before beginning the pollinator survey on Monday mornings, a percent cover bloom survey must be completed in both meadows. With at least one other person, document all plants in bloom on the Monitoring Data Sheet, as well as yet to bloom and has bloomed. Then estimate the percent cover of the in-bloom plants, only taking in to account the other blooming plants for the total 100%. Once the bloom survey is completed, the 30-minute session may begin. Tally marks are made on the provided Monitoring Data Sheet for the correct pollinator by the individual. The sheet is separated into Hymenopterans (honey bees, bumblebees, large carpenter bees, hairy leg bees, large dark bees, small dark bees, green sweat bees, metallic hairy belly bees, dark hairy belly bees, and cuckoo bees) and Others (wasps, flies, Lepidoptera, beetles, spiders, true bugs, and birds). After 30 minutes are complete, total the tally marks and make note for each category. Data entry and analysis is done through Excel.

IV. Results:

IV.A Hypothesis 1: The hypothesis the Fresh Water Meadow will have more honey bees than the Hell Gate Meadow due to a closer proximity to 5 Borough's bee boxes, is supported by the data. The Fresh Water Meadow had a total of 190 honey bees over the course of the 4-week period, an average of 13.57 per day (Sample Standard Deviation(SSD):4.37,

Standard Error (SE): 4.97), while Hell Gate had a total of 58 honey bees (SSD: 18.60, SE: 1.17), and an average of 4.14 per day. See Figure 1:

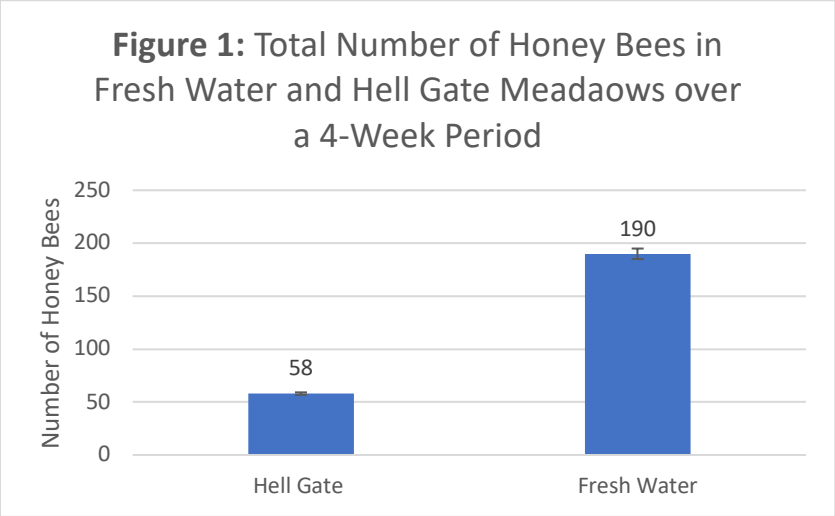

Figure 1: The total number of honey bees in the Hell Gate Meadow is 58, while the total in the Fresh Water is 190, supporting H_a1.

IV.B Hypothesis 2: The hypothesis that on average in both meadows, there will be more bumblebees than any other Hymenopterans is supported by the data. On average per day in both meadows, there were 51.32 bumblebees observed, 1,437 in total (SE: 5.56, SSD: 29.33). The next highest-ranking *Hymenopteran* was the honey bee with an average of 8.86 observations per day, 248 in total (SE: 2.27, SSD: 14.1). See Figure 2:

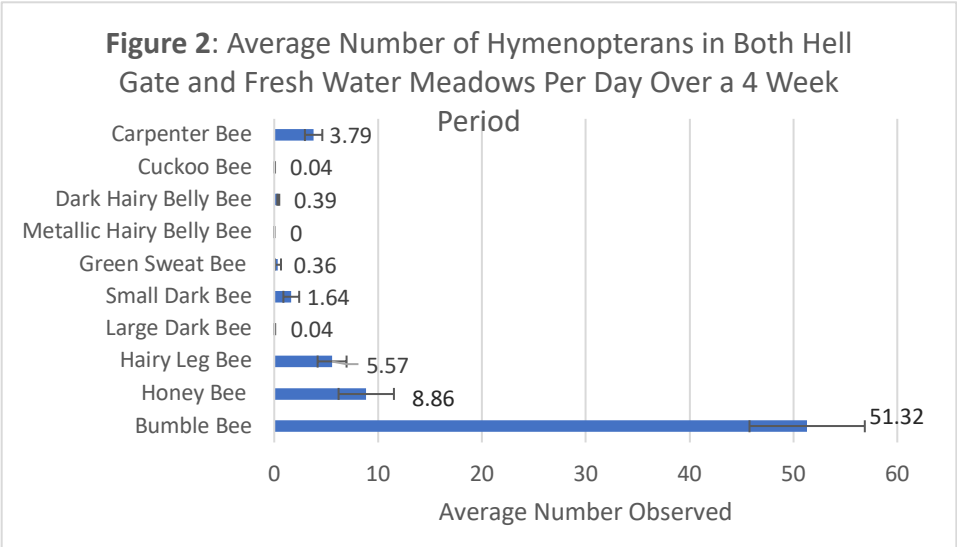

Figure 2: The average number of *Hymenopteran* observations per day shows that bumblebees, with 51.32 observations/day, more than quintuple the next-highest hymenopteran, the honey bee, with 8.86 observations/day. This supports H_a2.

IV.C Hypothesis 3: The hypothesis that there will be more average pollinators on days with temperatures greater than or equal to 80°F than on days below 80°F is supported by the data. On days greater than or equal to there was an average of 166 pollinator observations (SSD: 49.51, SE: 10.50), compared to 135.2 (SSD: 62.02, SE: 14.18) on days below. In total there were 2988 pollinators observed on days over 80°F and 1352 on days below 80°F. See Figure 3:

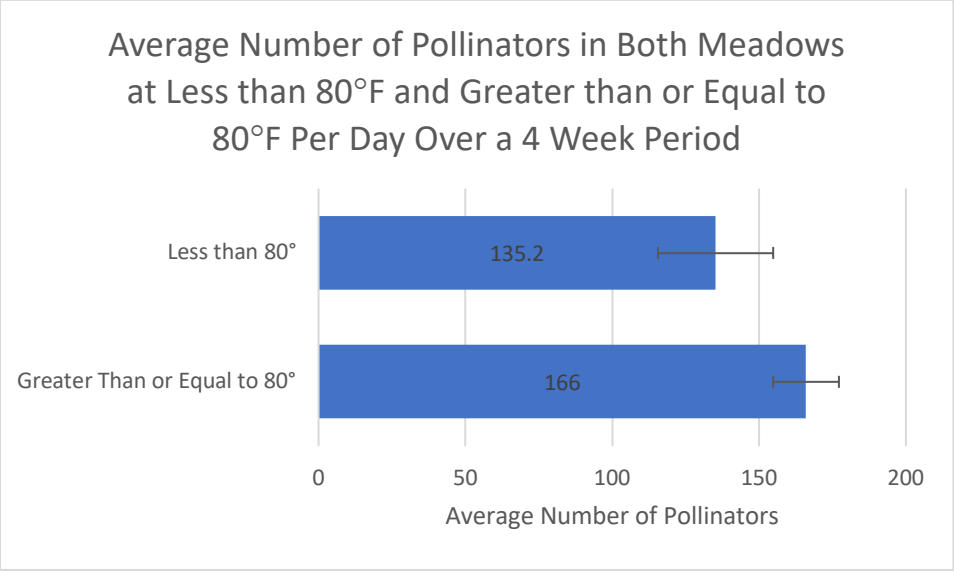

Figure 3: The average number of pollinators in both meadows on days that it is less than 80°F is about 30.8 observations higher than on days in which it is greater than or equal to 80°F. This data supports H_a3.

IV.D Hypothesis 4: The hypothesis that there will be more pollinators as the study, and time progresses is not supported by the data. With a negative slope of -18.623, the trend line displays an inverse relationship between time and number of pollinator observations. Week one there were an average of 175.25 (SSD: 34.15, SE: 12.0753) observations, followed by 171.25 (SSD: 6.45, SE:3.2243) in week 2, a slight increase of 171.38 (SSD: 52.69, SE: 18.6288) in week 3, and 113.13 (SSD:67.03, SE:23.6978) observations in week 4. See Figure 4:

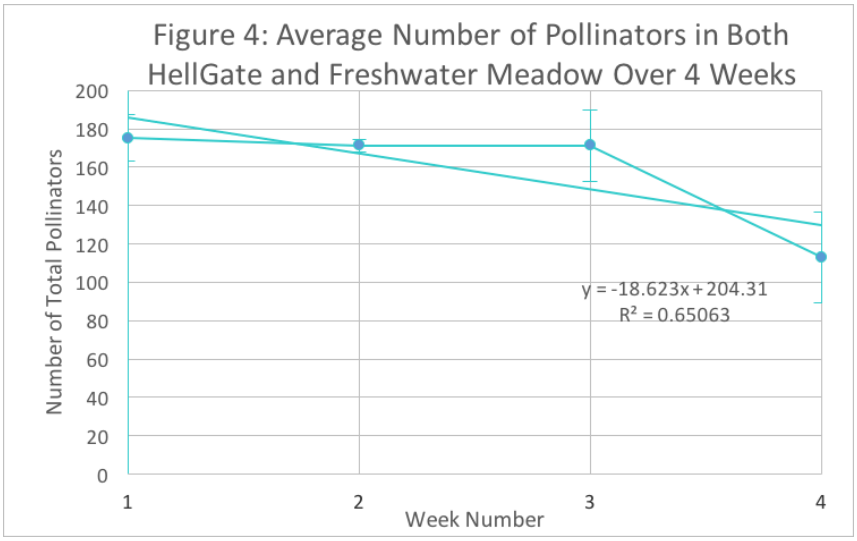

Figure 4: The average number of pollinators in both meadows decreases on average over the four-week period. This is made apparent by the negative slope of -18.623. This does not support H_a4.

IV.E Hypothesis 5: The hypothesis that on average in both meadows, the total number of pollinators observed on days with wind speeds lower than 5mph will be greater than that of days with wind speeds greater than or equal to 5mph is supported by the data. Over the four-week period 2,401 (SSD: 37.81, SE: 10.5024) pollinators were observed on days with wind speeds lower than 5mph, with an average of 184.69 per day. On days with wind speeds of greater than or equal to 5mph, there was a total of 1,963 (SSD: 54.92, SE: 14.1809) pollinator observations, with an average of 130.80 per day.

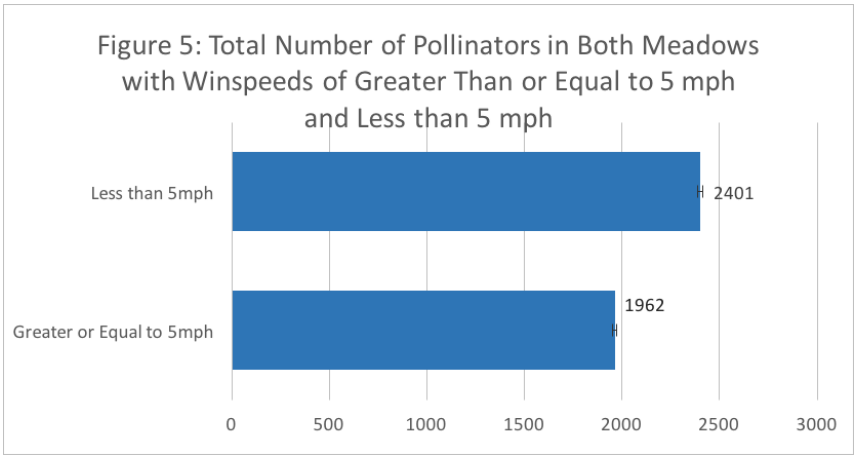

Figure 5: Over the course of the 4-week period, there were 439 more pollinators observed on days with wind speeds lower than 5mph than on days with greater than or equal to 5mph. This supports H_a5.

V. Discussion:

During week four, the *Pycnanthemum* first entered the 'In-Bloom' report, with an estimated 8% cover in the Fresh Water Meadow. At this time in the Fresh Water Meadow, the number of honey bees almost doubled the week before, with a total of 59 observations in week 3 and 108 observations in week 4. *Pycnanthemum* did not appear in the Hell Gate Meadow. In week 3, 11 honey bees were observed, while 5 were observed in week 4. NYC Parks Five Borough Complex, located on Bronx Shore road on Randall's island is home to ten honey bee hives, each with between 10,000 and 30,000 honey worker bees (Rollins, 2013). According to the Chester County Beekeepers Association, honey bees typically fly 2-3 miles per flight from the hive while collecting nectar and pollen (Interesting, 2018). Although both meadows are within 2-3 miles from the Five Borough Complex, the Fresh Water Meadow is potentially a more convenient and energy efficient location for honey bee nectar and pollen collection. It can be concluded that the bloom of the *Pycnanthemum* as well as the location in relation to the hives of Five Borough are potential reasons for the higher rates of honey bees in the Fresh Water Meadow than the Hell Gate Meadow. I recommend that more *Pycnanthemum* be planted in both meadows, focusing specifically on the Hell Gate Meadow.

The hypothesis that more bumblebees would be found than any other *Hymenopteran* was created based on observations made in both meadows at the start of the internship. According to Cornell's Pollinator Network at the College of Agricultural and Life Sciences, *Bombus* is one of the top eleven most populous bee genera found in New York State of the forty-two found (Danforth, 2018). Although their study found that 54% of the population was made up of digger bees, this data still supports the hypothesis tested in our study, with 1,437 as the highest number of bumblebee observations, and the next being 248 honey bees. According to an article by New York City Health, there are approximately 50 species of bumblebees in

North America. Bumblebees are one of the more resilient bee species due to their furry coats that help conserve heat and the bee's ability to generate heat through shivering their flight muscles (Bees, 2017). This fact may be why we have found bumblebees to overwhelmingly dominate in both meadows.

In 2012, a study was conducted in California to better understand how wind resulting from a high-speed rail train would affect bee pollination in nearby meadows. According to the article, honey bees are able to pollinate in temperatures over 55°F, but below 100°F and winds under 12mph, without rain. Cloud cover is not preferred and can deter foraging (C., 2012). Fortunately, we did not experience a temperature of below 55°F or above 100°F on any of our survey days but did experience high wind speeds as well as complete cloud cover and rain. On Tuesday afternoon, July 24th, the Hell Gate Meadow experienced the highest recorded wind speeds, 23mph, which resulted in 63 bee pollinator observations. This is less than half the average of 163.33 pollinators typical for the data set. The morning of Monday the 23rd, 33 pollinator observations were made, making it the lowest of any session this summer. With complete cloudy cover, rain, and wind speeds of up to 13mph during the survey, 33 observations is less than one fifth the average of 176.67 observations for Fresh Water morning sessions. This data could potentially imply that wind speed, cloud cover, and rain could affect total observations in a more direct way than temperature in New York City, as temperatures rarely drop below 55°F and go above 100 °F between mid-June and the end of August.

For bee colonies, spring is reserved for brood rearing, as the days begin to lengthen and warm. At this time, drones are almost completely absent or scarce. By late spring to early summer, the colony population reaches its peak, as it is tasked with foraging for the upcoming winter. Drones are numerous. As days are longest during the summer, this season permits the longest foraging period (Seasonal, 2010). With this knowledge, it was hypothesized that as time

progressed this summer, more pollinators would be observed, but we did not find that to be the case. This most reasonable explanation for this phenomenon would be weather. We experienced clear to partly cloudy skies almost exclusively for the first four research days. For the last three days, eight of the twelve sessions experienced mostly to complete cloud cover. As stated before, wind speed and cloud cover proved to be the influential conditions for pollinator populations. Further research should be done into individualized bee life cycles to better explain any underlying phenomenon.

There are many potential contributions to error in this study, as it is the first of its kind in the meadows and was carried out for a relatively short period of time. The most glaring error source would be lack of identification knowledge. Without the in-depth experience needed to identify bees down to the genus and species, some may have been identified incorrectly, like the cuckoo bee and the small and large dark bees. Population assessments may also be lower than reality due to the size and thickness of the meadows. To minimize damage to the gardens, exploring deep off the path was avoided which may have resulted in a lower bee count than in actuality. Aesthetic changes to the meadows during the monitoring period, like the cutting back of the Larkspur and Fleabane could account for slight changes in data. Slight variation in monitoring time also occurred due to iNaturalizing a specimen or conducting phone research. In the percent cover survey, multiple sources of error were found. A disproportionate percentage of plants bearing a large flower head may have been recorded, when compared to those with smaller, more numerous heads. The same can be said for larger bees, who tend to be easier to see and identify than smaller bees.

If the study was to be conducted again, it is recommended that a more scientific approach to the percent bloom cover is done. Every week, 3-5 plants of a particular species in bloom could be measured and averaged for width of their total flower crown. Then, a rough

count of individual plants would be done and averaged for a total species surface area coverage. All species will be surveyed to equal 100%. So, for example, if 100%=100 feet and there are 20 patches of *solidago*, each 2.5 feet, it is effectively 50% of the total bloom cover. On the Monitoring Data Sheet, bloom data sections on the afternoon and Tuesday sheets should be removed, as they are being surveyed on Monday mornings only. This would allow more room for comments and the addition of a 'Pollinator Found On' section where plants frequented by pollinators can be recorded in order to understand which are most successful at supporting the pollinator community. If the intern is qualified, the dissection of bee genus, like *Bombus,* into numerous species could provide more useful data to interpret. Starting the survey earlier in the summer would result in more data points, and a more accurate representation of the meadows' pollinator health. It would be beneficial, but is not necessary, to have two people completing the survey; one observing while one records, resulting in a more efficient data collection process.

Further research should be done into bee nests within the meadows. Bees were observed flying in and out of nests in the ground and the bee hotels, but interesting data could come from the type of bee and distribution in different homes. The bank in the Hell Gate Meadow near the water provides an ideal location for ground nesting bees and could provide excellent data. Adding the 'Pollinator Found On' section to the Data Monitoring Sheet will help collect further research on the plants most effective in supporting pollinators in our gardens. A more in-depth inspection of bee morphology for a more accurate identification to species could be beneficial as well. To do this, one could utilize the freezing method to stun them and observe the appendage and markings that differentiate them better. In the future, it is also recommended that the study follows the guidelines of the Empire State Native Pollinator Survey more closely to compare with Natural Areas and potentially provide data to the state-wide study.

VI. Conclusion:

Altogether, this study has created a solid foundation for future pollinator monitoring on the island and helped develop my independent research skills immensely. From studying the wind and temperature preferences of bees, the basis for pollinator habitat research has been lain, specifically with our ground nesting bees. The ability to see differences in plant species percent cover related to bee visits is informative for future plantings, like a potential increase in Mountain Mint in both meadows. After disproving H_a4, I think it would be beneficial for the meadow team to research further into bee lifecycles, and to understand at which stage specifically we are interacting with the pollinators. I would like to recommend a potential yellow bumblebee population study to justify future grant applications for endangered species. It is also recommended that the research follow along the lines of the Empire State Native Pollinator Survey, utilizing the data sheet created by Jessica in the Natural Areas department. In the coming months I look forward to keeping in touch with the Randall's Island team to see-through the collaboration with the New York Bee Conservancy, including the media releases and meadow visit from their team.

Acknowledgments:

I would like to first thank Shawn Ganz for mentoring, educating and supporting me during my research and carting me to and from my research sites. Thank you to the Natural Areas team for laying the groundwork for this project and bringing me along on their yearly monitor to learn the process. Jessica Hoch, specifically played a key role developing the template data sheet for the study and providing key insights into research styles. Thank you to Phyllis and EunYoung for providing the opportunity to develop a diverse set of skills through this internship. Finally, thank you to everyone on the Horticultural and Urban Farm team for

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