Comparative analysis of vegetation and pollinator diversity at the Long Island Solar Facility

Chelsea Brown

Department of Natural Sciences, Southern University at New Orleans, New Orleans, LA 71026

Timothy Green

Environmental Protection Division, Brookhaven National Laboratory, Upton, NY, 11973

Chelsea Brown, Department of Natural Sciences, Southern University at New Orleans, LA, 70126

Timothy Green, Environmental Protection Division, Brookhaven National Laboratory, Upton, NY, 11973

Abstract

The Long Island Solar Farm, an aggregation of photovoltaic panels located at Brookhaven National Laboratory (BNL) which generate renewable energy, is a clean and ecologically sound power generating facility for the residents of Long Island. Solar facilities create an improved habitat for wildlife and plants, in which many pollinators coexist in a mutualistic relationship with the vegetation. Specifically, bees have a major role in their contributions to the intricacy of the ecosystem including but not limited to pollination, wild plant growth, wildlife habitat, and biodiversity. The remarkable insects pollinate more than 80% of all flowering vegetation including 70 of the top 100 human food crops. The natural mechanism of pollinators ensuring reproductive success of ecologically important flowering plants and agricultural crops is directly related with the sustainability of human well-being. Recent studies reflect that bee populations are declining which is the basis for their selection as the focal taxa of this research. The goal of the project is to collect and compare the variations in vegetation and pollinators both inside and outside of Solar Fields 1, 2, 4, and 6. This research is unique because it is the first study at BNL to collect the scientific knowledge base, add to the limited existing data, and compare the results. The methodology for surveying the solar facility consists of collecting vegetation data on random rows of the solar farm using 50 m transects. Data is observed and recorded for both vegetation and pollinators at 10 m intervals. To assimilate the influence of large scale solar facilities on wildlife and the ecosystems of habitation is essential. The increasingly diverse makeup of vegetation supports increased pollinator activity in addition to providing and preserving a habitat for bees. This research supports that there is a difference in vegetation and pollinators from inside the solar facility in comparison to outside.

Introduction

Pollinators play a significant role in global biodiversity through supplying essential ecosystem services to crops and wild plants. Pollination is a fundamental task in both human managed and natural terrestrial ecosystems. The necessary service is largely determined by the degree of interdependence between species, the pollinated and the pollinator. The outcome of complex interactions among plants and animals, and the reduction of either will influence the survival of both. Pollination is critical for food production and human livelihoods, and directly links wild ecosystems with agricultural production systems. Pollinators aide in the production of several commodities such as crops, medicines, fibers, and more products used for human consumption. It is estimated that 75% of globally imported crop types are at least partially reliant on insect pollination[1]; the natural mechanism of pollinators is directly related to the sustainability of human well-being. "Without interaction between animals and flowering plants, the seeds and fruits that make up nearly 80 percent of the human diet would not exist"[2]. Interest in the conservation of pollinators has increased on a global scale because countries understand the impact that pollinator declines will have on the economy and environment. The government has developed strategies to conserve pollinator services which involve communities in the conservation of pollinators. A study was conducted entitled "The Conservation of Plant-Pollinator Interactions" which supports amelioration not only by cultivation of a diversity of crop pollinators, but also by changes in habitat use and agricultural practices, species reintroductions and removals, and other means[3]. Specifically, bees have a significant role in pollination, one in three bites of food that we eat is derived from plants pollinated by bees[4]; including almonds, apples, blueberries, cherries, cucumbers, onions, and many more crops. The monetary value of honey bees alone as commercial pollinators in the United States is estimated at over 15 billion dollars annually, with bees accounting for 80% of all crop pollination according to an article released from Office of the White House Press[5]. Recent studies reflect that bees are declining and some species have even been declared endangered by the United States Fish and Wildlife service. The current conservation status of bees threatens the sustainability of human food and crop production, global agricultural market, biodiversity, wild life habitat, wildlife plant growth, and the harmony of the ecosystem which is why they are the focal taxa of this research. Many pollinators coexist in a mutualistic relationship with the vegetation of their habitat. The Long Island Solar Farm is a 32 MW AC aggregation of photovoltaic panels which generate renewable energy, is an innovative, clean, and ecologically sound power generating facility located at Brookhaven National Laboratory (BNL). Managed correctly, the solar farm may create an improved habitat for wildlife and plants. The solar farm supports biodiversity and ecosystem function for improved habitat diversity and increased pollinator services. The goal of the project is to collect and compare the statistically significant variations, if any, in vegetation and pollinators both inside and outside of Solar Fields 1, 2, 4, and 6 to better understand pollinator/plant relationships.

Objectives

The specific objectives of this project are to: (a) collect, collate, and analyze vegetation and pollinator data in and outside of four solar farm arrays, (b) apply statistical tools such as mean, variance, standard error, ANOVA, and correlations to determine whether or not any significant variations exist within data sets, (c) provide/enhance the scientific knowledge base on diversity of vegetation and pollinators, and (d) prepare and present a poster and a manuscript at the end of internship.

Large scale photovoltaic systems otherwise referred to as solar farms are gaining attention for their potential for pollinator habitat, and the demand for documented benefits associated with the solar farm is pertinent. The data associated with solar farms is limited and this research is a key component in expanding knowledge of the long-term impacts. This research is unique because it is the first study at BNL to collect the scientific knowledge, add to the limited existing data, and compare the results with research findings reported elsewhere by the scientific community.

I hypothesize there will be a difference in pollinator plant diversity and pollinators.

Methods

The methodology for surveying the vegetation and pollinator diversity in solar farm consists of collecting data inside and outside of solar farm arrays 1, 2, 4, and 6. Within the solar farm random rows were selected and data were recorded based on visible and careful observations along 50 m line transects. A meter tape is used to establish transect length and data were recorded for both vegetation and pollinators at 10 m intervals using a $1m^2$ quadrat (with four sub-quadrats of 50 cm^2 to collect data as accurately as possible) at each interval(Figure 2). The vegetation types found within each sub-quadrat were recorded in percentages Outside of the solar farm this method was repeated and the global positioning system (GPS) coordinates were recorded at the beginning and end of each 50 m transect. The GPS coordinates were entered using a Geographic Information System (GIS) tool to capture, analyze, manage geographic data, and develop a site map (Figure 1). Once the observations of the solar farm were complete the data will be normalized and evaluated. Data will be analyzed statistically, using Microsoft Excel software, to determine if there is a significant difference in vegetation and pollinators diversity between two habitats – inside and outside of solar farms.

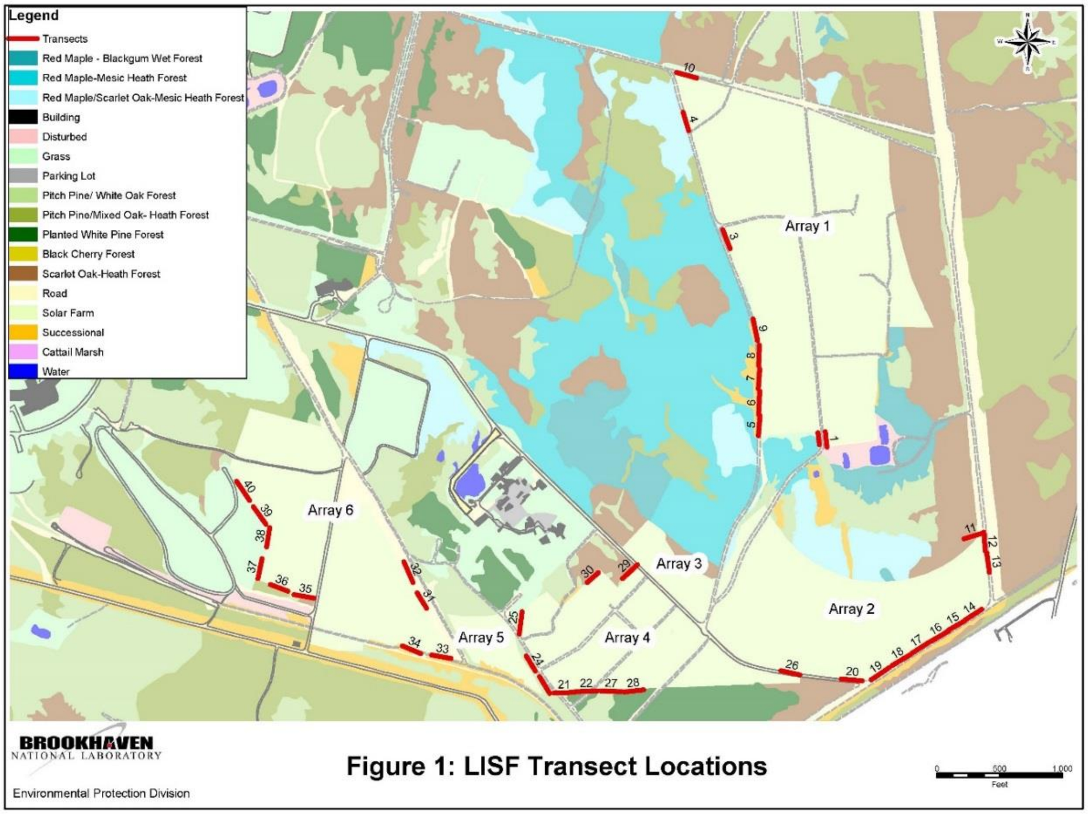
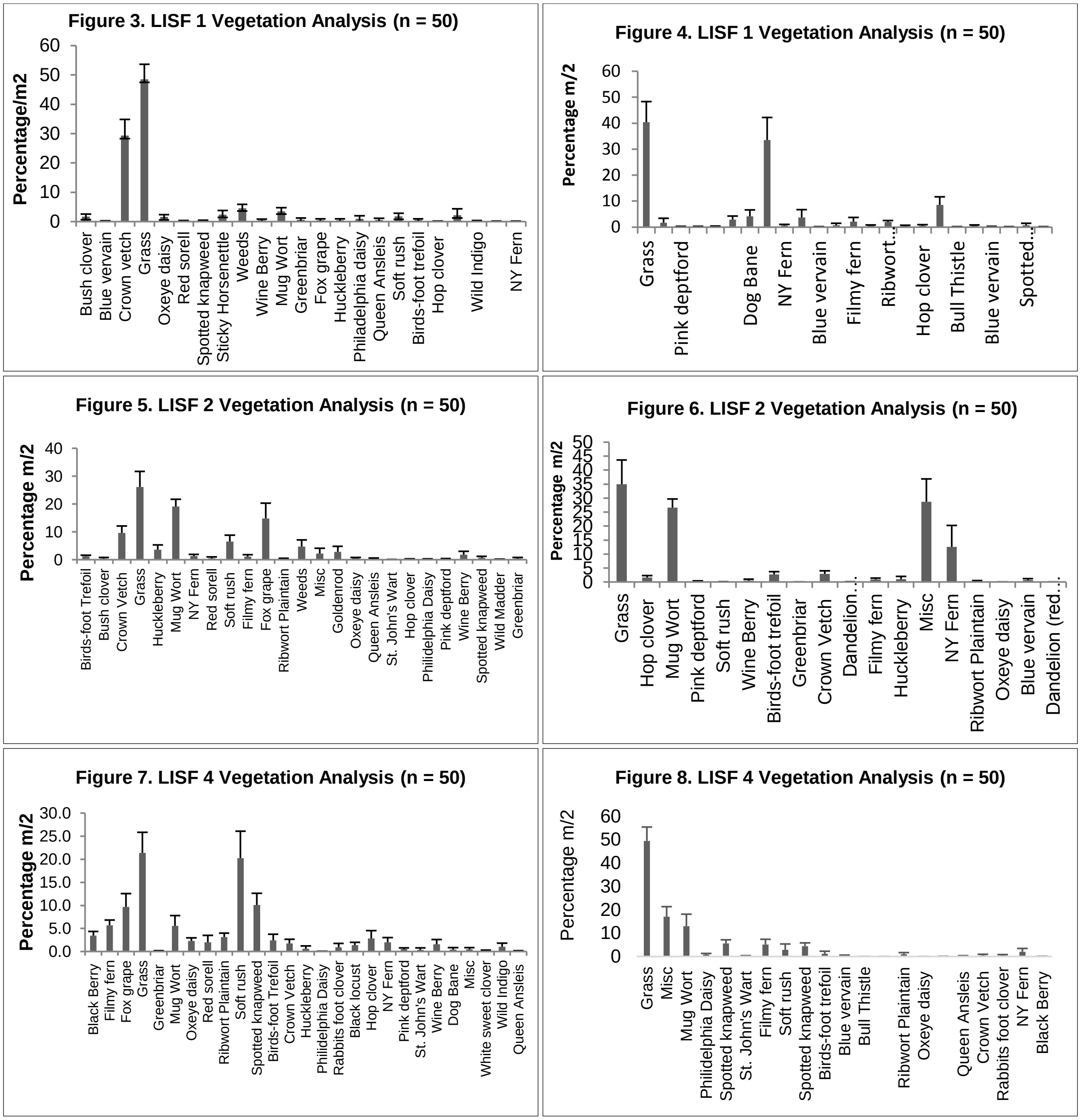


Figure 1: LISF Transect Locations

Figure 2. Method for collecting vegetation data

Results

The details of the plant vegetation diversity among all solar farms both inside and outside are summarized in figures 3-8. Based on statistical analysis grass is the dominant species inside and outside of solar farms 1,2,4, and 6 ranging from 48.5±5.2%/m^2 in SF1 to 15.0±2.2%/m^2 in SF6 (inside) and from 49.5±5.9%/m^2 in SF4 to 34.9± 8.6%/m^2 in SF2 (outside). Collectively, inside of the solar farm followed by grass in dominance are *Securigera varia* (Crownvetch), *Vitis labrusca* (Fox grape), and *Artemesia vulgaris* (Mugwort). The least dominant plant found inside the solar farm are the dandelion species (0-0.1%/m^2). Outside the solar farm followed by grass in dominance is *Artemesia vulgaris* otherwise referred to as Mugwort. The least dominant species are *Cirsium vulgare* (Bull thistle), *Hypericum perforatum* (St. John's-wort), and dandelion species (0-0.1% /m^2). Based on statistical analysis there was a greater diversity of plant species found on the inside of the solar farms. SF 6 was the most diversified with 29 species identified, and SF 1 was the least diversified with 23 species identified. SF 1 has the most diversity of vegetation on the outside with 24 species identified; SF 2 had the least diversity of vegetation with only 18 plant species identified. In the comparison of the solar farm vegetation inside to outside, *Solidago altissima* (Goldenrod) was exclusively found on the inside of the solar farms, just as *Cirsium vulgare* (Bull thistle) and *Asclepias syriaca* (Common Milkweed) were only found outside of the solar farm. *Securigera varia*, commonly known as crownvetch was the most frequent flower visited by the bombus species, the greatest amount accounted for was 29.3%/m^2 in SF1 with 73% of recorded bombus frequency, overall crownvetch accounts for 49.73%/m^2 of vegetation types identified. *Lotus corniculatus* commonly known as birds-foot trefoil was the second most frequented flower by bombus species at 31%, although it only accounts for 9.2%/$m^2$of the vegetation identified both inside and outside of the solar farms



Figures 3-8. Graphs from Solar Farm vegetation analysis

Conclusion

There is a difference in the diversity of vegetation inside and outside of the solar farm. Failure to understand, manage and promote pollinators could lead to decline or collapse in ecological restoration. With ecological restoration estimated to be a trillion-dollar global activity [6.] To assimilate the influence of large scale solar facilities on wildlife and the ecosystems of habitation is essential. The increasingly diverse makeup of vegetation supports increased pollinator activity in addition to providing and preserving a habitat for bees. Solar farms have the potential to increase pollinator activity through providing wildlife habitats, reassuring the presence of species which have great conservation value and reinforce the ecological system with environmental and economic benefits.

Based on this research I have concluded that the solar farm supports vegetation diversity and increases the pollinator habitat. This baseline study carried out at Brookhaven National Laboratory deals with management of natural vegetation and pollinators. This research supports that there is a difference in the diversity of vegetation and the frequency of bees visiting flowers, based on results from inside the solar facility in comparison to outside. In conclusion based on statistical analysis *Securigera varia* (crownvetch) was the most frequently visited flower by bumble bees, followed by *Lotus corniculatus* (birds-foot trefoil). Researchers reported that ecosystem restoration strengthens pollination network resilience and function, through restoring vegetation pollination production has potential to improve; this idea suggests that the degradation of ecosystem functions is at least partially reversible[7]. Biodiversity depletion and the destruction of ecosystems and the services they provide are key concerns modern society must address. The damage of biodiversity has the potential to disturb ecosystems and their functioning, through management of vegetation there is a possibility of an increased pollinator habitat and activity. The economic importance of pollination makes it clear that the conservation of pollination systems is an important priority.

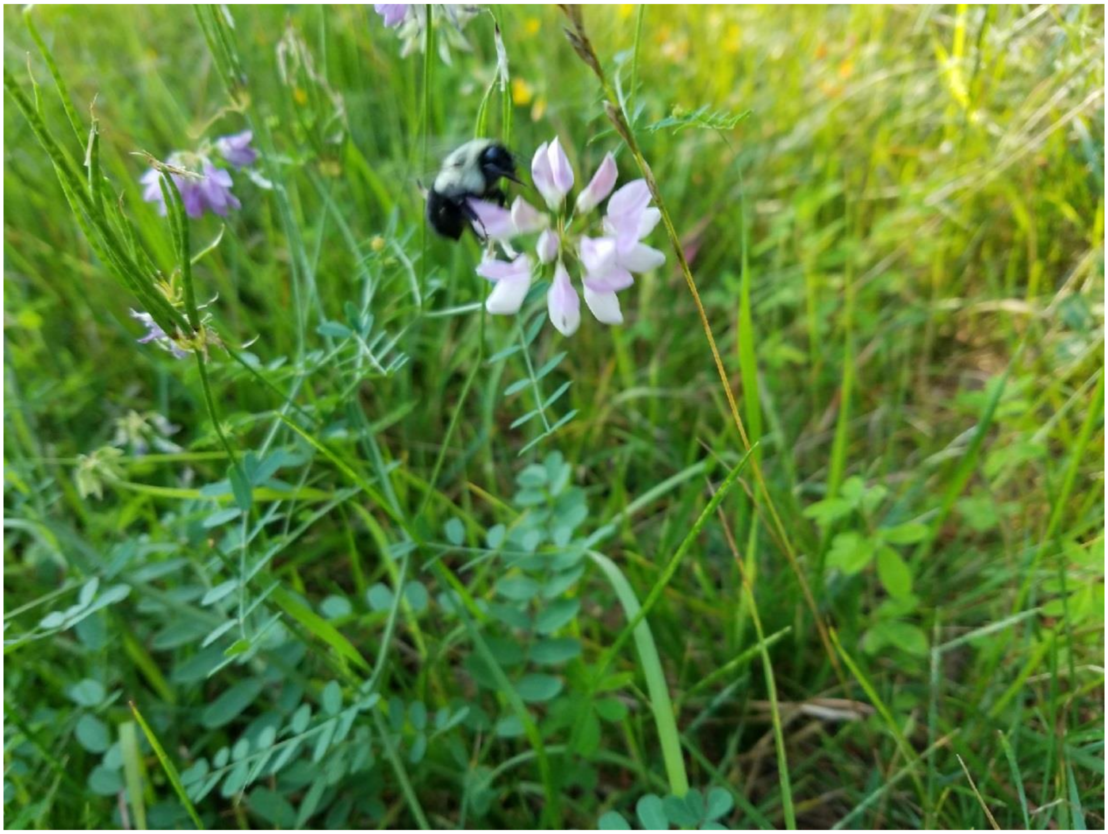
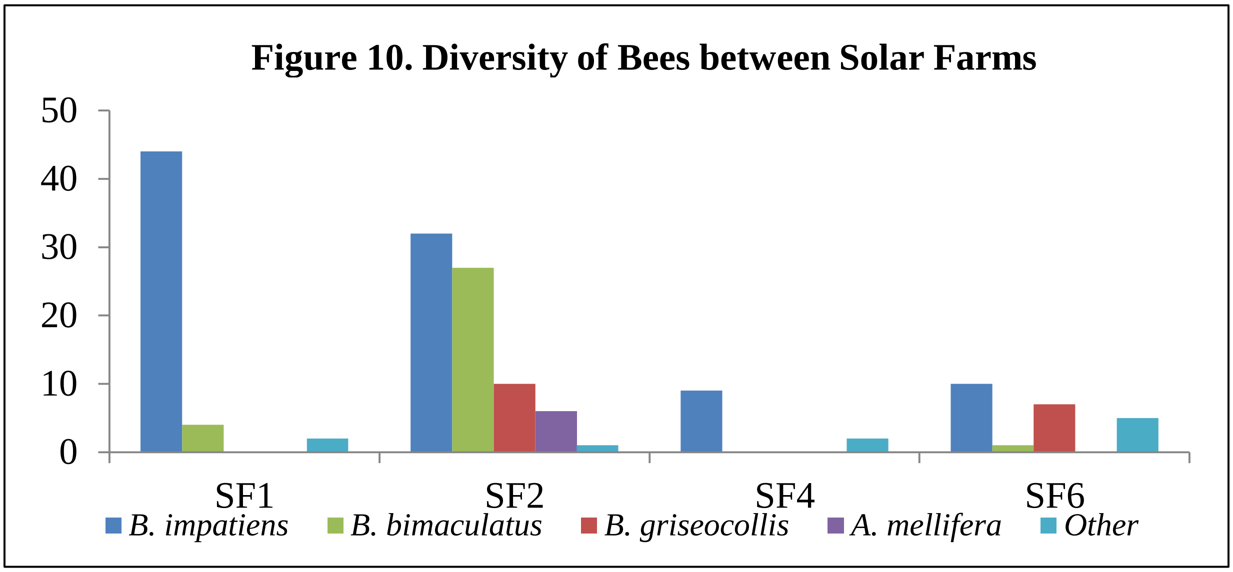
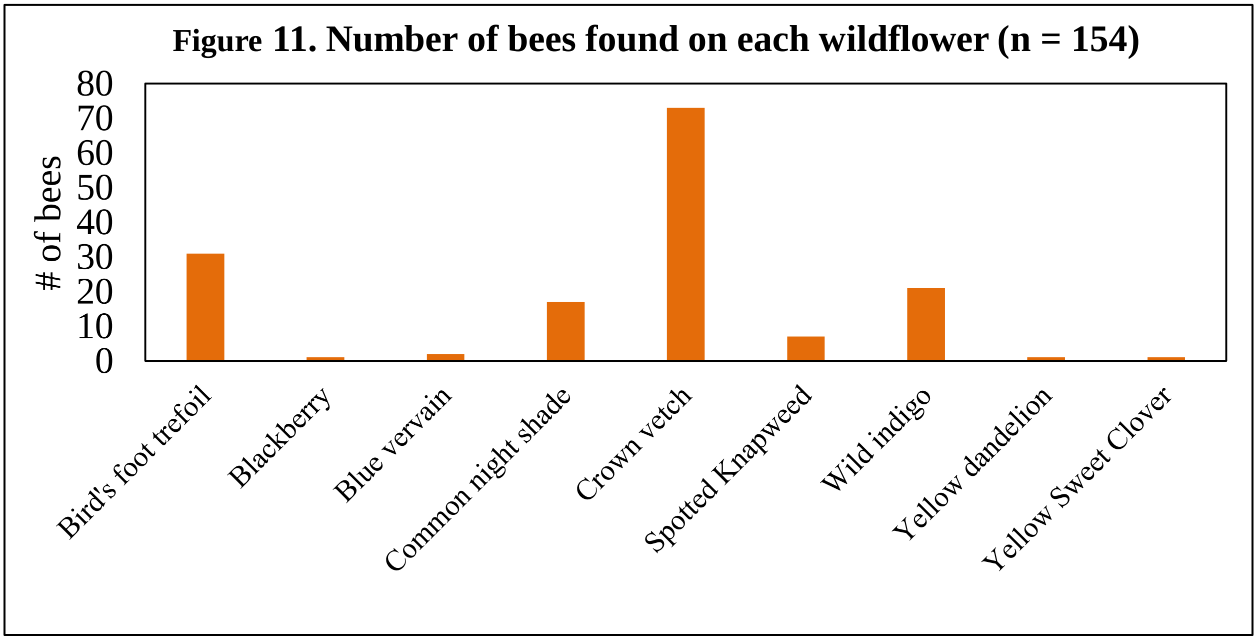


Figure 9. Bee on Crownvetch





Figures 10 and 11. Graphs that represent the diversity of bees, and percentage of bees found based on flower type.

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