The effects of flower color, scent, and native status on butterfly visitation in urban and rural sites

Shenika Christopher, Alasia Miller, Thomas Heslop, Jin Li, Kimesha Reid-Grant, and Acer VanWallemaal

Abstract
Although butterflies are common in many areas, their behavior in urban and rural areas is rarely studied. We observed two sites, Calder Center in Westchester (rural) and Brooklyn Bridge Park (urban) in Brooklyn. Each site had three areas within them that were observed for the following variables: color, scent, and floral status. These variables are thought to attract butterflies to each site. Different colored flowers were observed to attract butterflies. Each site, different colored flowers were observed to attract butterfly color preference. Flowers with applied linalool were observed for butterfly visits to the factorial design. Native and non-native plants were observed for butterfly attraction. Orange flowers attracted more native butterfly species compared to non-native plants. Linalool decreased butterfly visitation. The results demonstrate that the attractiveness of orange flowers, with higher non-native plant proportions, is not suitable to attract butterflies. The concentration of linalool in this study being too offensive to attract butterflies. The purpose of conducting this research is to contribute data about butterflies to aid in future studies and to also find trends that will broaden the public’s understanding of butterflies.

Introduction
Lepidoptera: scientific order that includes butterflies, skippers, and moths.

- Secondary pollutants: organisms that are not the main pollutants in relation to other species such as bees, that may pollinate plants (US Forest Service, 2007). However, their contribution may be crucial for some plant species that have mutually adapted with the lepidoptera.
- They are also a food source for many species including larger invertebrates, birds, and snakes.
- Because butterflies are sensitive to environmental changes, they also serve as ecological indicators (“Butterflies as indicators”, 2006).

Experiment: Butterflies were the main focus. Our research focused on the relationship between flower species richness and relative abundance and their effect on Lepidoptera diversity.

- Species Richness: number of different species in an area
- Relative species abundance: the amount of individuals of one species compared to that of another species
- Brooklyn Bridge Park (urban area): well maintained with plant species naturally introduced to attract butterflies
- Calder Center (rural area) not well maintained by humans, thus having a large biodiversity of species.
- Several variables were further explored: color, scent, and native versus non-native flower species.
- Linalool is emitted from plants that attract butterflies (Down, 2012).

Hypotheses: We hypothesized that because butterflies are sensitive to specific colors such as orange and red (Lunau, K. and Kaufman, Debra. The Making of Flight of the Butterflies in 3D on IMAX. Retrieved August 8, 2016 from https://library.creativecow.net/kaufman_debra/Flight-of-the-Butterflies-3D_IMAX/1), there is a limit in the overall, broad view of the specific factors we need more data and time to better understand the correlation.

Significance: Butterflies are facing population and diversity loss through anthropogenic impacts. Their ecosystems are being destroyed, which makes it crucial for thorough research to be conducted that will aid in the preservation (Atack et al., 1994). Due to the lack of research and the decline in Lepidoptera numbers, our findings would be significant in learning what factors would encourage these organisms to inhabit more of our NY urban and rural areas.

Methods
Sites: Calder Center: Pool, Lake, and Carriage House
- BBP: Pier 3, the Wetlands, and the Butterfly Garden
- Transects ran along the long axis of the plot
- Plant species were identified and given a cover class.

Three individual variables of butterfly observations at a specific flowering plant area:
1. The color of plants that butterflies visited or passed by was documented. For each area, flowering plants were studied for an hour, and the amount of butterflies that visited the flowering plants was noted.
2. Butterfly attraction to linalool was documented using the factorial design set up. Linalool was applied to cotton swabs and taped to the stem of non floral and floral plants in the same general area.
3. In the last variance, non native plant species percentage was calculated for each site using the data collected from the transects. Next, the number of butterflies within the site area was compared with the percentage of non native plant species.

Butterfly guides and butterfly nets were used to examine and identify unfamiliar butterflies.

Correlations were tested using Pearson’s Correlation test and linalool effect tested using ANOVA, both in R.

Results
Butterfly Visits Based On Plant Color In Urban

<table>
<thead>
<tr>
<th>Color</th>
<th>Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>12</td>
</tr>
<tr>
<td>Pink</td>
<td>8</td>
</tr>
<tr>
<td>Red</td>
<td>6</td>
</tr>
<tr>
<td>Green</td>
<td>4</td>
</tr>
<tr>
<td>Blue</td>
<td>2</td>
</tr>
</tbody>
</table>

Butterfly Attraction To Non Native Plant Species

<table>
<thead>
<tr>
<th>Proportion of Non Native Plant Species</th>
<th>Butterfly Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>8</td>
</tr>
<tr>
<td>0.50</td>
<td>4</td>
</tr>
<tr>
<td>0.75</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 1: This chart illustrates the colors butterflies visited most at five different sites located in Calder Center and Brooklyn Bridge Park.

Figure 2: The trend line is linear with an equation of y=21.406^x - 0.438. There is a marginally significant relationship between non-native and butterfly visitation (p = 0.081, p = 0.056).

Discussion
Color
- The original hypothesis was that butterflies would have a color preference. The results illustrated that they visited orange more than other colored flowers. There were 46 butterflies in total, with BBP accounting for 30 of them.
- Park and purple were the most at BBP while orange was the most frequent visited by butterflies at Calder Center, attracting 21 out of the total of 46 butterflies. Yellow was not used by butterflies in the study.
- Some butterflies would use the webcam was observed twice, whether other sites were observed once. While observing at Pier 3, only park, flowers were observed. Scenic, size and shape of butterflies determined the attractiveness to the attractiveness of the flower (Attracting Butterflies, 2016).
- To improve our studies, we could observe all the most attractive flower colors such as red, orange and pink, in one setting and see which one attracts the most butterflies.

Non-native Species
- The hypothesis that butterflies would be more attracted to native than non native species was rejected. The results showed that the butterfly visits occurred more frequently in the areas with non-native plant species.
- The higher non native plant proportion created a larger plant diversity within the area. This most likely contributed to increased butterfly visits, which showed that butterflies were attracted to the areas with overall greater plant diversity.
- By using the Pearson’s correlation test, we found that there was a marginally significant correlation between butterfly visits and proportion of non native plant species, despite there being so few points.

Linalool
- We hypothesized that linalool would increase butterfly visitation. Our results demonstrated that butterflies are more attracted to plants with flowers. Linalool decreased butterfly visitation for flowers and completely repelled butterflies for non-flowering plants.
- According to the anova calculations, it seems that flowers definitely had an effect on butterfly visitation, but linalool did not. Therefore, it seems that linalool repelled the butterflies, but this is not statistically proven.
- Possible explanations for results: strength of the concentration, linalool is a natural pesticide, linalool might possibly be a harmful chemical, there might have been addition in the sample of linalool.
- Further research using different concentrations of linalool.
- Possible trial error: site prejudices.

Conclusion
Floral characteristics are essential to butterfly visitation. However, we need more data and time to better understand the correlations. Since more data and time are needed to observe a correlation, there is a limit in the overall, broad view of the specific factors that attract butterflies.

Acknowledgements
Special thanks to Brooklyn Bridge Park and Calder Center for allowing us to conduct our research on their facilities and to the primary investigators, Dr. Lewis, Dr. Clark, and Dr. Mahro-South, who assisted in this experiment.

Literature Cited