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Bioretention Cells as Reproductive Habitat for Monarch Butterflies in Urban Areas

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Abstract

Over the past 30 years, monarch butterfly (*Danaus plexippus*) populations have declined by over 90% due to loss of their host plant, milkweeds (genus *Asclepias*). This study investigates the potential of bioretention cells to help restore monarch reproductive habitat. Pots of common milkweed (*Asclepias syriaca*) and butterfly milkweed (*A. tuberosa*) were placed in bioretention cells in eight different combinations, and eggs were counted at the sites weekly. Results suggest that the most important factor in determining how many eggs were laid at each site was the diversity of milkweed species at the site. By managing bioretention cells to grow milkweed, we can restore monarch reproductive habitat and help boost their populations' recovery.

Introduction

Monarch population decline

Monarch butterflies (*Danaus plexippus*) are an important pollinator species in North America. They rely on milkweeds (genus *Asclepias*) as their host plant. However, due to agricultural and urban expansion, this habitat has become steadily less available to them, particularly in the Midwest region. Studies estimate there has been about a 58% decline in milkweeds in the Midwest, which has resulted in an 89% decline in monarch populations (Pleasants and Oberhauser 2012). Smaller populations will make this valuable species more vulnerable to environmental threats.

Helping the monarchs recover

In order to help the recovery of monarch butterflies, restoration of their reproductive habitat is crucial. However, a multifaceted approach is needed in order to manage our land for both humans and monarchs. One way of integrating monarch habitat into urban landscapes is the use of bioretention cells. These are a type of rain garden specially engineered for stormwater management, but can also potentially be used to grow milkweed for monarchs to use as their reproductive habitat. This research study investigates the effectiveness of bioretention cells as reproductive habitat for monarch butterflies in urban areas.

Fig. 1. A bioretention cell and a monarch caterpillar on common milkweed.

Methods

Data collection

Fifteen bioretention cells and three reference (natural) sites were chosen. In each of the bioretention cells, I placed different combinations of two species of milkweed, which were either potted, planted, or some of each. Species of milkweed used were common milkweed (*Asclepias. syriaca*) and butterfly milkweed (*A. tuberosa*). Two sites had an additional third species of milkweed, swamp milkweed (*A. incarnata*), already planted. Eggs were counted once a week at these sites from June to September of 2021 and 2022. The number of eggs, the species the eggs were laid on, and the number of plants checked were all recorded.

Data analysis

Data was analyzed using R version 4.1.1. Specific statistical tests used were linear models, ANOVA, and Tukey Honest Significant Differences (HSD). The number of eggs was normalized according to the number of plants checked.

Results

Table 1 shows the difference in average number of eggs found per plant according to site treatment (i.e. what combination of milkweed the site had) at sites that had significant differences. Figure 2 shows a boxplot of the average number of eggs found per plant according to site treatment. Figure 3 shows a boxplot of the average number of eggs found per plant according to milkweed diversity at the site.

Table 1. Difference in average number of eggs found per plant according to site treatment.

Treatment type A	Treatment type B	Difference (A—B)	p-value
Planted *A. syriaca* and planted *A. incarnata*	Potted *A. tuberosa*	0.78	0.005
Planted *A. syriaca* and planted *A. incarnata*	Planted *A. tuberosa*	0.75	0.008
Planted *A. syriaca* and planted *A. incarnata*	Planted *A. tuberosa* and potted *A. syriaca*	0.72	0.013
Planted *A. syriaca* and planted *A. incarnata*	Reference (planted *A. syriaca*)	0.69	0.041
Planted *A. syriaca* and planted *A. tuberosa*	Potted *A. tuberosa*	0.64	0.048

Fig. 2. Chart showing average number of monarchs found per plant according to site treatment.

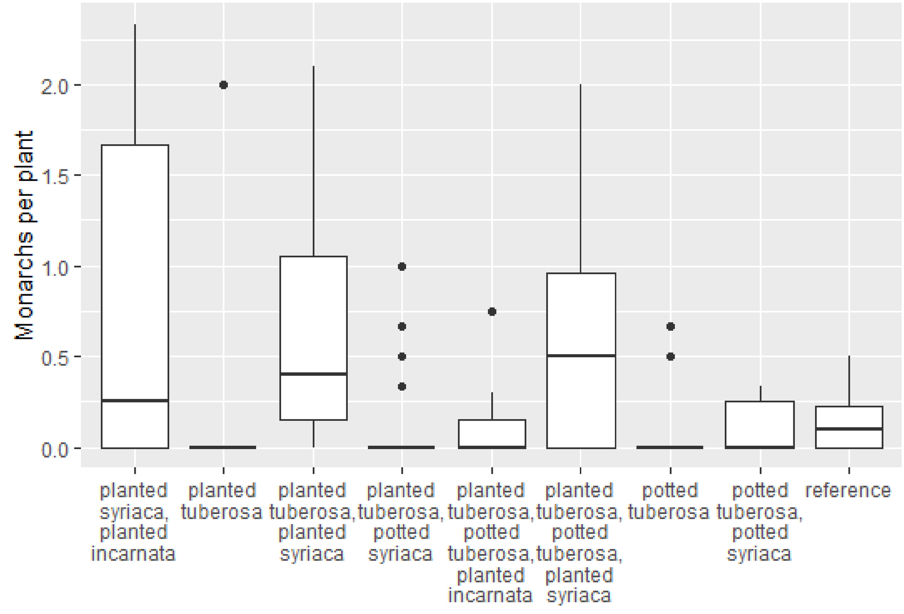
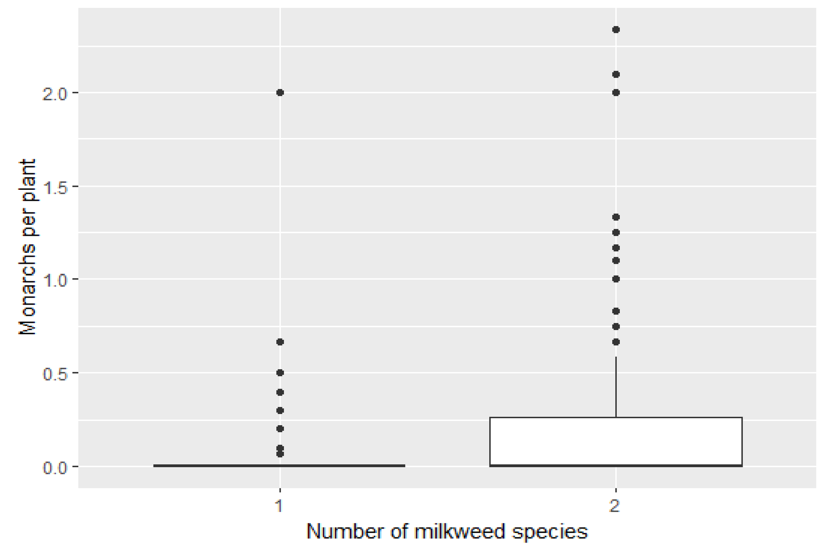


Fig. 3. Chart showing average number of monarchs found per plant according to milkweed diversity.



Key takeaways

The following are the key takeaways about sites where there was a significant difference in number of eggs laid per plant:

- Sites with planted milkweed had more eggs per plant than sites with potted milkweed
- Sites with *A. syriaca* and *A. incarnata* had more eggs per plant than sites with only *A. tuberosa*
- Only one comparison between reference and treatment sites showed a significant difference in eggs laid per plant

Discussion

Interpretation of results

These results suggest that key factors influencing monarch oviposition in these bioretention cells include whether the milkweed is potted or planted and the species of milkweed in the cells. They also suggest that monarchs do not show strong preference towards one site type (reference or treatment) over the other. This means that when bioretention cells have milkweed in them, they can serve as suitable substitute reproductive habitat for monarch butterflies where natural milkweed patches have been lost.

There are a few potential reasons why monarchs may lay more eggs at sites with planted milkweed and at sites with *A. syriaca* and *A. incarnata*. This could be due to preference of milkweed species due to visibility of the plants. Studies have found that monarchs lay more eggs on taller, broader-leaved milkweeds (Baker and Potter 2018), and *A. syriaca* is a tall, broad-leafed species, as opposed to *A. tuberosa*, which is smaller with narrower leaves. Oviposition rates could also be influenced by milkweed diversity, as suggested by the fact that at sites where there was a significant difference, the sites with two species of milkweed had more eggs than sites with only one. The difference may also be attributed to milkweed density; however, that was beyond the scope of this study.

Management implications

These results can be used by cities that are interested in implementing bioretention cells installations for stormwater management. If the cells are managed to grow milkweed, they can serve as substitute reproductive habitat for monarch butterflies. This can help mitigate the effects of urban and agricultural expansion, replacing lost milkweed and boosting the recovery of the monarchs' populations.

Study limitations

The results of this study have a few limitations. There was only one site in the study that had planted *A. syriaca* and planted *A. incarnata*, so any significant differences only represent the difference between that specific site and others, rather than between treatment types. As this was a study done in the field, it was impossible to control for all variables, and thus confounding variables such as proximity to nectar resources or other habitat are possible.

Additionally, each site had a different number of milkweed plants. This was controlled for by normalizing the number of eggs found in the garden according to the number of plants checked, but this approach overinflates the significance of sites where no eggs were found and only a few plants were checked.

Further research

While I have drawn some conclusions from my data so far, I am not finished with the analysis yet. For example, I would like to run tests isolating factors such as milkweed diversity, number of milkweed plants, and species of milkweed on which eggs were found to see if any of these variables have a significant effect.

Additional studies may be done on this topic as well. For example, a study could be done investigating the survival rates of monarch caterpillars in bioretention cells compared to those in natural milkweed patches. This would ensure that we are not creating ecological traps where monarchs lay eggs in bioretention cells only to have lower larval survival rates.

Conclusions

This research indicates that if milkweed is planted in bioretention cells, monarchs may use the cells as reproductive habitat in urban areas at similar rates as they do natural milkweed patches. The results also suggest that higher milkweed species diversity can increase the number of eggs laid in the bioretention cells, but further research on this is needed to draw firm conclusions.

By managing bioretention cells for milkweed growth in addition to stormwater retention, cities can integrate monarch butterfly habitat into human infrastructure, replacing milkweed lost from our landscape to agricultural and urban expansion and supporting monarch butterfly populations' recovery.

Literature cited

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