

PROJECT TITLE:

Green Roofs as a Potential Tool for Monarch Conservation

RESEARCHERS:

Vuong Vu and Michael Iacampo

EXECUTIVE SUMMARY

We examine the effectiveness of green roof butterfly gardens compared to their ground-based alternatives. We aim to study if Houston green roof gardens can increase the survivability of *Danaus plexippus* larvae. We would first assess the abundance and composition of invertebrate species in these environments using pitfall and Malaise traps. We would then introduce two independent patches of milkweed to each environment. Monarch eggs will be introduced to one patch in each environment to assess survivability through the larval stage, the other patch will study environmental preference.

PUBLICATIONS

Our team plans on providing a manuscript for the Ecological Society of Ecology after collecting our data because literature on conservation efforts using green roofs is minimal. Furthermore, the results of this study contributes to methodologies to maintain and foster monarch butterflies, which are endangered in accordance with the International Union for Conservation of Nature (IUCN).

PRINCIPAL PROJECT COUNTRY:

United States of America

Category: Biodiversities, Education, Plants

1. Background

1.1 Origin of Work

Our team has been interested in monarch conservation for many years. Over the past two years, we have been planting milkweed and rearing monarch caterpillars independently. One prominent issue we have noticed during this time is predation by the milkweed assassin bug (*Oncopeltus fasciatus*). These bugs along with others prevent or delay monarch reproduction by months, and significantly hinder our efforts to help as many as possible reach adulthood. Over the past couple of months working on research projects involving the University of Houston (UH) green roof, we have wondered if green roofs can be used to increase the number of monarch butterflies that reach adulthood. The logic being that green roofs are more isolated and inaccessible habitats compared to ground based analogs, which would be fairly easy for the confident flying monarch to reach, but hard for its predominantly ground based, weak flying predators.

Our team did a brief survey of the amount of insects on the Pocket Prairie compared to that of the green roof at the University of Houston. Our methodology utilized the common pitfall trap to measure the density of insects at both locations. Our results suggested that there were more insects in the pocket prairie compared to that of the green roof. More specifically, species under the order hymenoptera, diptera, and coleoptera, all are known to be potential predators for monarch butterfly caterpillars, were seen on the pocket prairie than that of the green roof. As a result, evidence suggests that there was a more abundant number of predators on the pocket prairie than the green roof. Though the pit fall experiment was not done in the fall semester, evidence suggesting that these same animals can be found during the colder months of the year are inconclusive. Likewise, the pitfall trap was not done for other locations, though we expect similar results to be seen to that of the green roof and pocket prairie.

1.2 Contribution of Work

By understanding whether or not green roofs can increase survival rates during monarch butterfly reproduction, the utilization of green roofs can be initiated nationwide for conservation efforts in order to maintain and foster the growth of new monarch butterfly populations. Furthermore, green roofs with milkweeds across the United States could be used to help migrating monarch butterflies by serving as a preferential breeding ground. In addition to that, an outcome of this research is a better understanding of predation on monarch butterflies as a whole, and potentially new unknown predators could be found.

2. Project Activities

2.1 Project Site

This project will be conducted at the University of Houston's Pocket Prairie, University of Houston Green Roof, Hermann Park, and two other ground-locations in addition to three other green roofs in Houston, totalling to 8 different locations in Houston. Furthermore, our team hopes to access green roofs that are inaccessible to the public with fair isolation of the green roof. The climate of Houston provides adequate moisture and light for milkweeds to grow. The Green Roof and Pocket Prairie at the University of Houston are close in proximity with similar species make-up, making these two locations ideal for a comparison between a ground-based and roof-based environment. Hermann Park contains a diverse group of species in addition to mimicking conservative areas related to environments in a city. Furthermore, the green roof is inaccessible to University of Houston students with the exception of those with keys to access the green roof. Additionally, the pocket prairie is utilized for ecological projects, so having both of these conditions provide adequate conservational importance and prevents the tampering of our project. Other locations, yet to be determined, will follow similar conditions to those of the Pocket Prairie and Green Roof at the University of Houston.

2.2 Fieldwork

During the 2-week larval period, after introducing the eggs to the milkweed, extensive fieldwork will be required. This would mean about three hours a day, 5 days a week. Apart from this period, monitoring will still be required but much less frequent, about 1 hour per day, 1-2 times a week. This will be necessary to understand the interaction of monarch butterfly larvae to surrounding abiotic and biotic factors. After the juvenile period, fifth instar caterpillars will be collected. In addition to the requirement of frequent monitoring, field work in terms of transporting milkweeds will also be required and work to maintain the field by watering and landscaping would be required to account for other factors throughout the experiment.

2.3 Activities and Timescale

The timeline for the project will occur from July 1, 2023 to July 1, 2024. The primary activities that will be executed includes the planting of milkweed on the roofs and ground locations; introducing monarch butterfly eggs onto the milkweeds; and monitoring of activities and predation on the caterpillars

Two separate timelines in this study will be examined: one in the spring and one in the fall. This way, our team can assess the different types of predation on monarch butterflies in addition to interactions the larvae have with other abiotic and biotic factors. More specifically, the planting and transporting of milkweeds will be done during July and persist until the end of the study.

3. Methods

3.1 Methods to be used

Patches of milkweed will be planted on the roof and ground locations in a randomly distributed manner. More specifically, two patches of milkweeds will be planted: one patch will be used for introduced eggs, and one patch will act as a control for the natural egg-laying process of monarch butterflies, which will be used to identify environmental discrimination. The eggs (or first instars) will be introduced in a consistent manner. 3-5 eggs(or first instars) would be introduced per plant patch with a total of five plants per patch to ensure an adequate food source for the caterpillars. We will survey the larvae 5 days a week, recording the total number of larvae and number of each instar. This study will consist of two egg introductions: one in the spring and one in the fall. Cameras will be placed in accordance with the milkweed patches as a way to further monitor monarch butterfly larvae. The fifth instar caterpillars, as determined by defining characteristics, will be collected to prevent double counting of organisms and to serve as the metric for survivability. At the end of the experiment, a ratio calculation will be performed to determine the ratio of larvae that survived and made it to the fifth instar.

3.2 Reasoning

To adequately measure survivability, we must have an accurate count of the number of eggs initially laid to determine what percentage survive to 5th instar. For this reason, our measure of survivability will be done using introduced eggs. This allows us to have a precise and accurate count of the number of eggs initially present. However, this measure of survivability is not enough to infer the conservation potential of green roofs. We must also confirm that the egg laying monarchs do not discriminate against green roof environments. For this reason, a second patch of milkweed is planted in each environment with no eggs introduced. These patches will be surveyed periodically throughout the experimental time frame to look for naturally introduced monarch larvae. These

larvae will give us insight into discrimination/preference in egg laying location by adult monarchs. For this experiment we plan to introduce 3-5 eggs per plant with 10 plants per roof. This will hopefully ensure that each monarch Caterpillar has plenty of food, and that we have enough caterpillars to get a good survivability metric. These larvae will be surveyed and monitored almost daily. This will give us great insight into predation at each instar and growth rate between environments.

4. Conservation Benefits

4.1 Conservation Outputs

The potential of our experiment can have long term effects on the Monarch butterfly species by conserving and increasing their population. We expect for the density of insects, specifically ground-insects, on the green roof to be less than that of the pocket prairie. As a result, we expect that monarch butterflies have a higher survivability rate, as determined by the ratio of larvae making it to the 5th instar, on the green roof compared to that of the pocket prairie due to the limited numbers of ground-predators on the green roof. As a result, we can increase the population of the monarch butterfly, *Danaus plexippus*.

4.2 Conservation Evidence

An experimental evaluation will be done to compare the differences in species abundance between all of the locations once data is collected. One experimental evaluation using the pit fall trap was done in March of 2023. The Pocket Prairie at the University of Houston showed significant differences between the species abundance of the green roof and pocket prairie. More specifically, there were far more species and abundance of animals on the pocket prairie compared to that of the green roof.

4.3 Conservation Importance

The monarch butterfly species, *Danaus plexippus*, can be benefited nationally from this work as they are currently an endangered species as classified by the International Union for Conservation of Nature (IUCN). The results of this study can tell us whether or not green roofs provide adequate breeding grounds for monarch butterfly adults and a habitable environment for the monarch butterfly larvae. If successful, we can utilize green roofs planted with

milkweeds as a methodology for conservation and fostering the growth of new monarch butterfly populations.

5. Monitoring

The success of our work will come from the amount of 5th instar caterpillars being collected from all of the locations. The 5th instar caterpillars will act as the determinant factor on the extent in which the green roof provides an adequate environment to host monarch butterfly larvae. Furthermore, the frequency of the predation on monarch butterflies on the green roofs to ground-based environment will serve as a basis for success for this experiment. At the end of the study, a ratio calculation will be completed in order to determine the rate of survivability.

6. Your Team and Other Contacts

6.1 Team Description

Vuong Vu and Michael lacampo will be the main researchers for this project Both primary researchers have extensive knowledge in the field of ecology through the University of Houston with experience in experimentation on both the Green roof and Pocket Prairie.

6.2 Your Skills

Our team members have experience in ecological research based on green roofs and the pocket prairie. Furthermore, Vuong is experienced in social behaviors of animalia. Michael has experience with monarchs including instar identification, handling and milkweed growing.

6.3 Links

<https://www.nwf.org/Our-Work/Wildlife-Conservation/Monarch-Butterfly>

<https://uh.edu/nsm/biology-biochemistry/research/divisions/ecology-and-evolution/>

The University of Houston E&E research division provides extensive knowledge on the environment surrounding the Houston area in addition to having access to two areas of study for our experiment.

The National Wildlife Federation is involved in conservation works across the United States with collaboration with organizations to maintain species like Monarch butterflies.

Financial Information

We are applying to the Rufford Small Grant (which provides a grant up to 6,000 dollars).

Below is our financial needs and supplies needed for this study.

\$3,600 – Labor during egg introduction: 4 people, \$15.00/hr. 3hrs 5 day/week. Once in fall, once in spring.

\$600 – Eggs: \$3.00 per egg, \$5.00/plant, \$5.00 plants per patch, 8 locations.

\$800 – Plants: 10 plants per location, \$10.00 per plant.

\$260 – Malaise trap. bugdorm.com

\$50 – pitfall traps, estimated for cups, dish soap, and sifter.

\$200 - Miscellaneous Gear: Outdoors equipment, shovels, gardening gloves, boots

\$192 - Gas Mileage: Estimate 20 mi per day per person. 10 working days per season. Estimate 25 mi per gallon, estimate \$3.00 per gallon.

\$343 - Cameras: \$42.80 each, 8 locations

Total budget needed: **\$6,000.00**