# Ideal Breeding Conditions For Mosquitoes

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**Abstract**

Obtaining samples from infected mosquitoes (Culicidae), data was collected and stored in the GLOBE computer database and compared with samples obtained from previously-known targets of infestation throughout the world. Houston, Texas ranks fifth nationally for harboring mosquito-borne diseases and illnesses in mammalian populations. My study sought out and targeted area spawning sites, as well as infestation and breeding-colonies. I electronically measured temperature anomalies and fluctuations in precipitation as well as rising water levels due to flooding, natural disasters, and ecological variances. I measured monthly air temperatures and precipitation pertaining to meteorological factors affecting the area. Attracting and trapping samples included the usage of oviposition mosquito traps made of black wool and heavy, non-reusable plastic containers, which particularly enabled analysis of gravid female mosquito populations. Traps were checked weekly during morning hours between 7am-8am CDT and recorded into the main database. Two factors affecting mosquito abundance are temperature and precipitation. These were monitored for analyses of both increasing and decreasing risks of contracting illness. I also monitored peak colonization and infestation periods so adequate preventative measures could be taken. This study also monitored relevant mosquito larvae and proliferation in relation to area humidity- and precipitation-levels at several area swamp-sites.

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<u>Research Question</u>: *What is the effect of monthly air temperature and precipitation on the mosquito abundance (measurement of the number of mosquito larvae) in Houston, Texas?*

<u>Background Information</u>:

Mosquitoes are winged insects that originate from the family Culicidae. They have a life cycle that consists of four stages: egg, larva, pupa, and adult. First, gravid female mosquitoes lay their eggs in a source of stagnant water. The eggs are either laid one at a time, or they form rafts by attaching to each other. After approximately 48 hours, these eggs hatch into larvae, which, in turn, live in the water and consume organic matter and microbes. The larvae shed their skin four times, growing into a larger one; by the fourth shedding, the larvae turn into pupae. While the pupae are in a resting and non-feeding stage, they are still mobile and responsive to environmental changes, such as those in light. Eventually, an adult mosquito emerges after breaking through the pupal skin (A.M.C.A, "Life Cycle").

While mosquitoes feed on sugars from plants, for female mosquitoes to lay eggs, they must consume proteins, which can be obtained by sucking on the blood of animals, such as small mammals or birds. Specifically, to get their blood meal, female mosquitoes use their proboscis, an elongated sucking mouthpiece, to consume the blood of their hosts and store it in the rear section of their fore-gut (Capinera, *Encyclopedia of entomology*, 2008).

As a result, this breeding process is influenced by many factors, most notably air temperature and precipitation. According to a study conducted by Román A. Corfas from the Rockefeller University, air temperature impacts mosquito abundance and the likelihood of female mosquitoes laying their eggs in a particular region. This is because most female mosquitoes are attracted towards the body heat of endothermic blood hosts, such as humans, other mammals, and birds; in fact, they use the temperature and heat of these organisms to find ideal hosts. As a result, female mosquitoes are heat-seeking and have an ideal range of temperature that they prefer (Corfas, “Genetics of Mosquito Heat-Seeking Behavior”, 2016). Furthermore, precipitation has an effect on mosquito abundance. After heavy rainfall has occurred, there is an increase in potential mosquito breeding sites, as there is more stagnant water. However, at the same time, heavy rainfall can wash out larval habitats. Hence, mosquito abundance is dependent upon the frequency and amount of precipitation (Chowell, "Assessing the potential impact of vector-borne disease transmission following heavy rainfall events: a mathematical framework", 2019).

As a result, the purpose of this investigation is to explore the correlation between air temperature and precipitation and mosquito abundance. In this exploration, I will measure the number of mosquito larvae found in mosquito traps positioned throughout a local park. I will build oviposition mosquito traps, which are particularly effective in attracting gravid female mosquitoes, and will check these traps once every week. With this, I could establish what temperature values and precipitation amounts attract mosquitoes.

*Hypothesis:*

There will be a higher mosquito abundance as a result of higher temperatures and larger amounts of precipitation. Higher values of air temperature would result in a greater number of mosquito larvae, as these temperatures would reflect that of the blood hosts that female mosquitoes feed on. This would thus attract the mosquitoes to these regions and encourage them to lay eggs. Also, high precipitation would be related to an increase in mosquito abundance, as more rain would result in the formation of more stagnant water sources, thus providing more potential breeding sites for mosquitoes.

*Variables:*

| | **Variable Measured** | **Method to Record** |
|---|---|---|
| **Independent** | Air Temperature (℉) | Utilize National Weather Service Monthly Dataset |
| | Precipitation (inches) | |
| **Dependent** | Mosquito Abundance | This factor is measured by recording the number of mosquito larvae found in oviposition traps, and the data is collected by taking images using a clip-on microscope. |

| **Controlled Variables** | **Variable Measured** | **Method to Control** |
|---|---|---|
| | Amount of Sunlight | The amount of sunlight that a mosquito trap receives influences mosquito abundance. Therefore, because mosquitoes prefer a shady environment, I will be placing all of my traps in locations with little to no sunlight. |
| | Mosquito Trap | The type of mosquito trap that was built was an oviposition trap. All of the traps will be built in the same exact way, including using the same brand and color for long black socks. |
| | Trap Bait | Alfalfa pellets were used as trap bait. The same bait is used for all traps, as well as the same amount (4 pellets per trap). |

| | | |
|---|---|---|
| | Water Source | The source of water placed in all traps is constant. The source is a local swamp, as this source will contain very rank water and stagnant water that attracts all mosquitoes. |
| | Time | The time at which the data from all of the traps was recorded was constant. All traps were checked weekly. Furthermore, the time of day at which the data is collected was constant. Traps were checked at 5:30 PM. These periods of time must be constant in order to have consistent results. |

*Materials:*

- 12 22 oz. Black Stadium Cups
- 6 Pairs of Black Socks (Size Large)
- 18 Gauge Wire
- Alfalfa Pellets
- Metal Screen
- Drill
- Silicone Glue
- Universal Clip Type LED Cell Phone Microscope (80X-120X)
- Petri Dish

*Safety Considerations:*

While conducting this experiment, it is important to consider certain safety protocols. First, when building the oviposition traps, tools, particularly drills and wire cutters, were used. Hence, I must be mindful while utilizing these tools, and this can be done by putting gloves on. Also, as I am recording mosquitoes near vegetation, I need to dress appropriately. I must wear long pants and shirt, as well as closed-toed shoes. This will protect me from insect bites as I collect my data.

*Procedure:*

For this experiment, there are two steps: the construction of oviposition traps and the positioning of the traps and recording data.

First, the following is the procedure for building oviposition traps:

1. Drill two holes in the 22 oz. black stadium cup. One hole should be placed close to the top of the cup, and it must be wide enough to fit an 18 gauge wire. The second hole should be .25 inches wide, and it should be positioned at about 80% of the way up the cup. There should be two sets of these holes on opposing sides of the stadium cup.
2. Using silicone glue, paste the toe of the black crew sock to the bottom of the stadium cup. The color black is specifically vital for the socks used in these traps, since mosquitoes are attracted towards the heat that these darker colors absorb.
3. Use the top of the stadium cup as a template to trace it onto the metal screen sheet. Then, cut the circles of metal screening.
4. Next, cut the 18 gauge wire into a 1.5 feet long piece.
5. Stretch the sock to cover the mouth of the stadium cup. Stretch it around the bottom, too. The sock needs to be taut around the cup, so be sure to cut any excess sock at the bottom.
6. Place the circular metal screen into the top of the cup. This screen must be pressed into the cup, to the point where the screen is right above the .25 inch hole drilled. This can be done by pressing the screen at the center until half of the screen is at the appropriate height, and then, rotating the cup and pressing down the other half. This will allow the uneven edges of the screen to hold onto the stadium cup. The purpose of this screen is to allow the mosquito larvae to live in the water in the trap, but prevent them from escaping once they have become adults.
7. Then, insert a piece of 18 gauge wire through the two small holes near the top of the cup, and twist them to keep it in place. With this, the trap can be carried or hung anywhere.
8. Dip the trap into stagnant and rank water from a local swamp. The .25” hole should drain any excess water. By dipping the trap, the sock will become moist, which will attract mosquitoes.
9. Add 4 alfalfa pellets into the water to use as bait, as well as to keep the water rank.
10. Repeat the following steps until 12 oviposition traps are constructed.

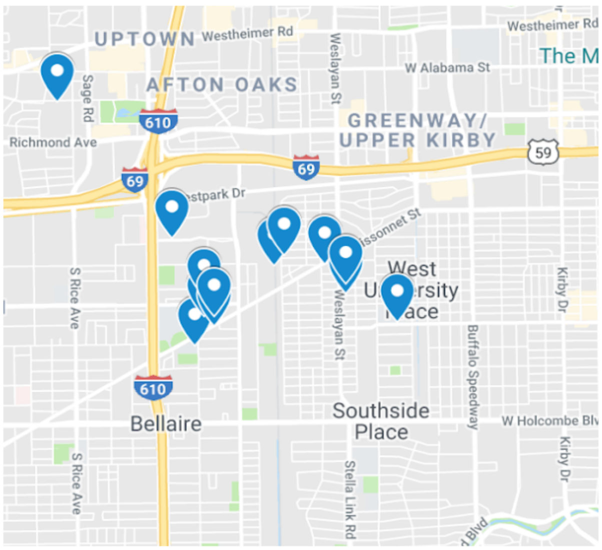
Next, the following is the procedure for the positioning of the traps and the recording of data.

1. Position mosquito traps throughout a local park. Ensure that it is positioned in an area with little to no sunlight.
2. Check mosquito traps once every week at 5:30 PM in the evening.
3. When checking the mosquito trap for larvae, first, pour a sample of water from the trap onto the petri dish.
4. Attach the microscope to a phone and open a camera app
5. Cover the petri dish with a clear cover and lay the microscope flat on the cover’s surface.

6. After adjusting and focusing the microscope, move it around and search for mosquito larvae.
7. Record data and repeat the following steps.
8. Incorporate data with that from GLOBE database.

*Results:*

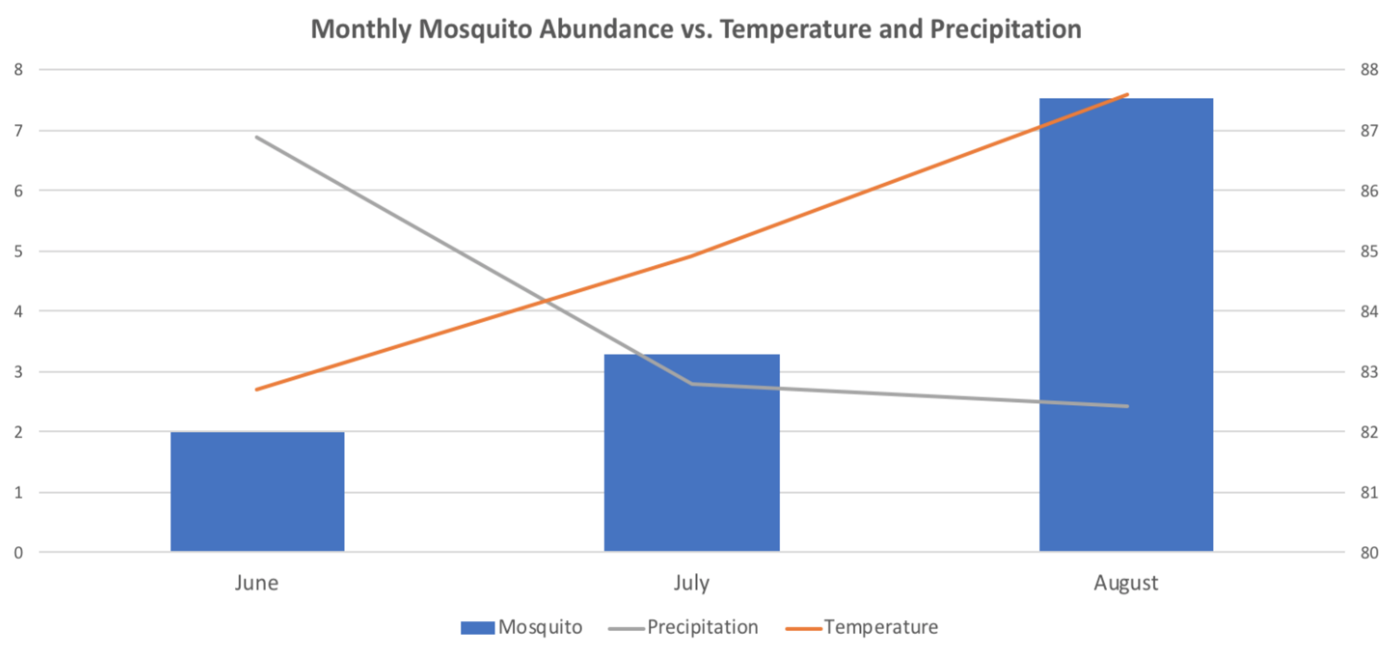
Regions with the Most Concentrated Mosquito Populations




Southwest Houston Area


Northwest Houston Area

The largest number of mosquito larvae found was in Southwest and Northwest Houston. This Southwest Houston region was an urban area that had a moderate amount of vegetation, such as trees and shrubs. The Northwest region was a residential area, where most of the mosquito larvae were found in proximity to a small lake. The vegetation found in this region was mostly grass and a few trees.




As seen in the graph above, over the course of three months in the season of summer, there was a steady increase in average temperature, while there was a decrease in the amount of precipitation. However, mosquito abundance only increased over this period of time.

*Conclusion:*

Overall, the hypothesis is true only to a certain extent. While the increase in mosquito abundance was a result of high temperatures, low precipitation also led to a larger mosquito population. This investigation supports the idea that mosquitoes favor high temperatures, as they are attracted to the temperatures that mimic that of their warm-blooded hosts. However, this investigation rejects the idea that high precipitation is favored by mosquitoes; low precipitation could be favorable, as heavy and frequent rainfall could wash out larval habitats.

Also, the results indicate that August is the peak of mosquito season, out of three months of summer. This is because August has the highest mosquito abundance at an average of 8 mosquitoes, and it has the highest average temperature at 87.6 °F and the lowest amount of precipitation at only an average 2.42 inches that month. However, June had the lowest mosquito abundance, with the lowest temperature and highest amount of precipitation. As a result, it is important to recognize the month of August as a period of time where the risk of infection increases; extra precaution must be taken during this month.

*Errors of Uncertainty & Challenges:*

In this investigation, there were some errors of uncertainty; these errors were random and caused by humans. One error of uncertainty was the way the traps were built, specifically the size and position of the holes created in the stadium cup. Because the holes were created by humans, there would be slight uncertainty in the measurement of the radius of the hole, as well as the position of the hole on the stadium cup, among the multiple mosquito traps. This would lead to miniscule differences in each mosquito trap built, specifically influencing the water level in each trap. Another error of uncertainty was the way the mosquito traps were positioned in the local park. While the traps were supposed to remain in a region where there was no sunlight, depending on the time of day, a little bit of sunlight would still come through at times. Because mosquitoes prefer shady conditions, this uncertainty could slightly influence the mosquitoes' attraction to the trap.

Furthermore, one challenge in this exploration was the lack of weekly mosquito data. Since the data that I collected was only from a local park, I needed more data that covered the Greater Houston Area. Hence, I utilized the GLOBE database. However, there was no consistent recording of the number of mosquito larvae found each week in this database. As a result, if I chose to analyze my weekly data, the results would have been very skewed and inaccurate. To overcome this challenge, I broadened the time period of my investigation to exploring the monthly mosquito data. This way, the GLOBE data could more easily and more efficiently be incorporated into this research.

*Further Steps:*

To further expand my research, I would record mosquito data throughout the entire year in order to mark the effect of seasonal changes in temperature and precipitation on mosquito abundance. Furthermore, I would also investigate the influence of the type of water source (artificial or natural) on mosquito abundance; to add to this topic, I would attempt to define the time it takes for a mosquito breeding site to form, as well as how long it would last. This would increase further understanding of the relationship between precipitation and mosquito abundance. I will continue learning about mosquitoes and the factors that influence their population in an internship, doing research at the University of Houston.

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