



## **Investigating Eastern Equine Encephalitis in Michigan**

**Bayle Buvia  
Muhammed Muheisen  
Sophia Payne  
Alyvia Roll**

**[Shumate Middle School \(Gibraltar School District\)](#)**

**30778 W. Jefferson - Gibraltar, Michigan 48173  
United States of America**

**Mr. Jeffrey Bouwman, Science Teacher  
Mr. Eric Cassie, Principal  
Mr. David Anderson, Assistant Principal**

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### **Abstract:**

This environmental research study was conducted by Shumate Middle School students: Bayle Buvia (Seventh Grade), Muhammed Muheisen (Seventh Grade), Sophia Payne (Seventh Grade), and Alyvia Roll (Seventh Grade). This study is the second phase of our research (see *What are the Humidity, Precipitation, and Temperature Conditions Associated with Active Mosquito Season?*) that we started during the 2018 - 2019 school year. In our study, we are trying to measure larvae count found on the Shumate Middle School campus in Gibraltar, Michigan (United States of America). Additionally, we were aiming to monitor the genera found to ensure that we do not have mosquitoes that carry the Eastern Equine Encephalitis virus (EEEV). This virus can be carried by the *Aedes* and *Culex* species. The time frame for our study was Thursday, October 17, 2019 through Wednesday, March 4, 2020. Overall, we found no mosquito larvae in our retention pond and in our mosquito traps (bottle), this was expected because of the cold conditions here in Wayne County, Michigan during the late fall and winter months. All data utilized in this study was submitted to the GLOBE Program via the GLOBE Observer app. While this data yielded fantastic results for the Shumate Middle School campus and the City of Gibraltar, Michigan, it is still very important to monitor mosquitoes as the EEEV has been spreading across the state of Michigan. Moving forward, our group plans to continue monitoring ponds and mosquito traps. Please see our environmental data collected in this study.

*Keywords:* mosquito, virus, Eastern Equine Encephalitis, *Aedes*, *Culex*

## Table of Contents

<u>Content</u>	<u>Page Number(s)</u>
<a href="#"><u>Introduction</u></a>	3 - 4
<a href="#"><u>Materials and Methods</u></a>	5 - 7
<a href="#"><u>Data Summary</u></a>	7 - 12
<a href="#"><u>Analysis and Results</u></a>	12 - 13
<a href="#"><u>Conclusions</u></a>	13
<a href="#"><u>Discussions</u></a>	13 - 15
<a href="#"><u>Collaboration</u></a>	15 - 16
<a href="#"><u>Acknowledgments</u></a>	16
<a href="#"><u>References</u></a>	17

## International Virtual Science Symposium Badges

- **I am a STEM Professional** - For this project, our research team worked directly with NASA's Dorian Janney. Mrs. Janney is a lead on the GLOBE Mission Mosquito research team, and she gave our team many ideas on how to investigate mosquitoes, and how to research EEE.
- **I Make an Impact** - Our group is also interested in applying for this badge as we believe our measurements are significant. It is important to monitor mosquitoes as Shumate is located next to a large wetland area. EEEV is spreading across Michigan, and we must monitor.
- **I am a Data Scientist** - In this report you will view a significant amount of data collected from the retention pond and via mosquito trap bottles on the Shumate Middle School campus in Gibraltar, Michigan.

## **Introduction**

### **Research Question:**

Our research team decided to continue building upon our GLOBE International Virtual Science Symposium (IVSS) research started last year (2018 - 2019). Again, we will be conducting environmental research at Shumate Middle School (Gibraltar School District) in Gibraltar, Michigan (United States of America). For last year's IVSS, we created a report entitled, "What are the Humidity, Precipitation, and Temperature Conditions Associated with Active Mosquito Season?" In this report, our team focused on finding the ideal humidity, precipitation, and temperature parameters that are associated with active mosquito season. To say the least, this project has been an eye opener for our team as we had no idea of how dangerous and deadly mosquitoes actually are.

In this project, we examine the Eastern Equine Encephalitis virus (EEEV) in Wayne County, Michigan (United States of America). We considered this to be phase two of our research. According to the Center for Disease Control and Prevention (CDC), in order for transmission of EEEV to humans, a mosquito species (*Aedes* and *Culex* - see Image 1 below) must be capable of creating a "bridge" between infected birds and uninfected mammals (2019). Also according to the CDC, the incubation period for EEEV ranges from 4 to 10 days, and an infection can result in a systemic febrile illness or neurologic disease, including meningitis or encephalitis (2019). Recently, there have been reports of people getting sick due to EEEV in states including Alabama, Connecticut, Michigan, New Jersey, North Carolina, Rhode Island, Tennessee, Georgia, Indiana, and Massachusetts. If people are beginning to get this mosquito-transmitted disease, then the *Aedes* and *Culex* species of mosquitoes that transmit this disease in Michigan. Although our group was not familiar with EEEV at the beginning of this project, the environmental factors that the *Aedes* and *Culex* species of mosquitoes thrive on must be present here in Michigan. We want to protect ourselves

## Investigating Eastern Equine Encephalitis in Michigan

and our community, and learn the best prevention measures to take against mosquito-transmitted diseases. For this environmental study, our research question is, ***“Will we find any Aedes or Culex mosquito larvae on the Shumate Middle School campus?”***

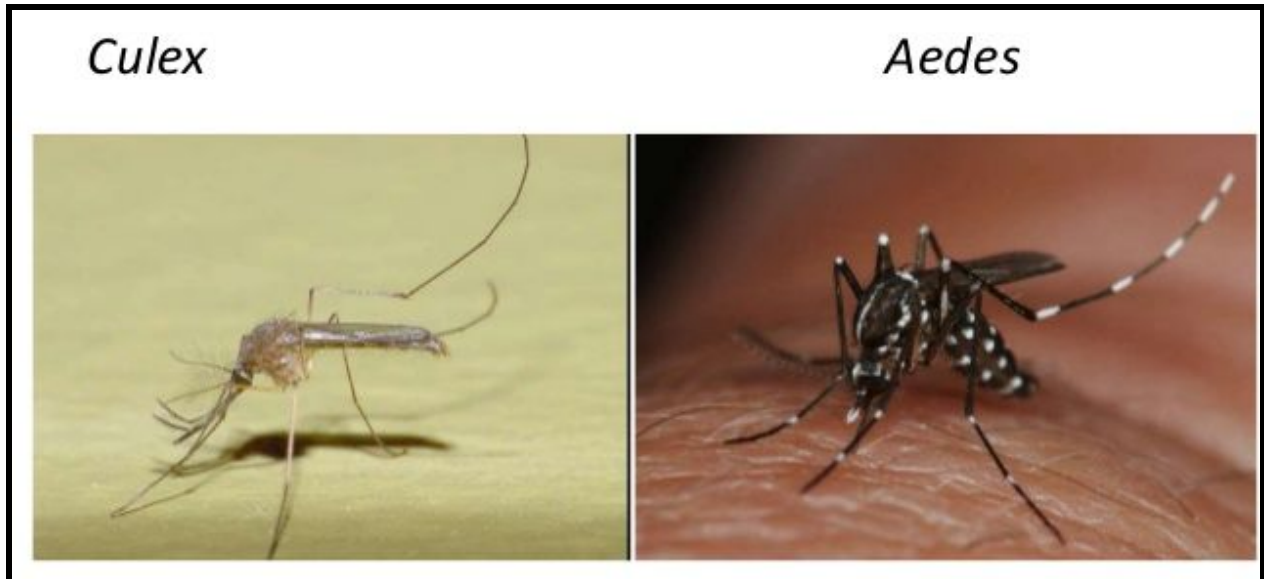
### **Hypothesis:**

For this project, our group believes:

**Mosquito Larvae Count** - Our research team believes that we will find 35 mosquito larvae in the retention pond and mosquito traps (bottle traps) on the Shumate Middle School campus.

**Mosquito Larvae with EEEV** - We do not expect to find mosquitos (Aedes and Culex) that carry EEEV on the Shumate Middle School campus.

### **Image 1 - Aedes and Culex**



## **Materials and Methods**

### **GLOBE Protocols Utilized in this Study:**

- Biosphere:
  - Mosquito Habitat Mapper
- Focus - Shumate Middle School - Gibraltar, MI (United States of America)
  - Study Sites: (See Below)
    - Retention Pond (Water Sample)
    - Small Courtyard (Bottle 1)
    - Teacher's Lounge Courtyard (Bottle 3)
    - Cafeteria Courtyard (Bottles 2 and 4)
- Time Frame - Thursday, October 17, 2019 - Wednesday, March 4, 2020

### **Materials:**

- **Mosquito Trap** - A contraption made out of a 2 liter bottle with pond water to capture mosquito larvae.
- **Chromebook** - Used to locate data, create charts and graphs, and to communicate (Zoom webinars).
- **Google Spreadsheet** - Utilized to store data and create data tables and graphs.
- **iPad** - GLOBE observer, mosquito and larva counts.
- **Small Bucket** - Observing and collecting water samples.
- **Chromebook** - Research, webinars, and Google Spreadsheet.
- **GLOBE Observer App** - Mosquito Habitat Mapper and Land Cover tools.

### **Methods:**

#### ***Step-by-Step Mosquito and Larva Counts: (Phase Two)***

- Collect a water sample from a pond, ditch, puddle, etc.
  - Make sure the sample is in a clear container so you can observe.

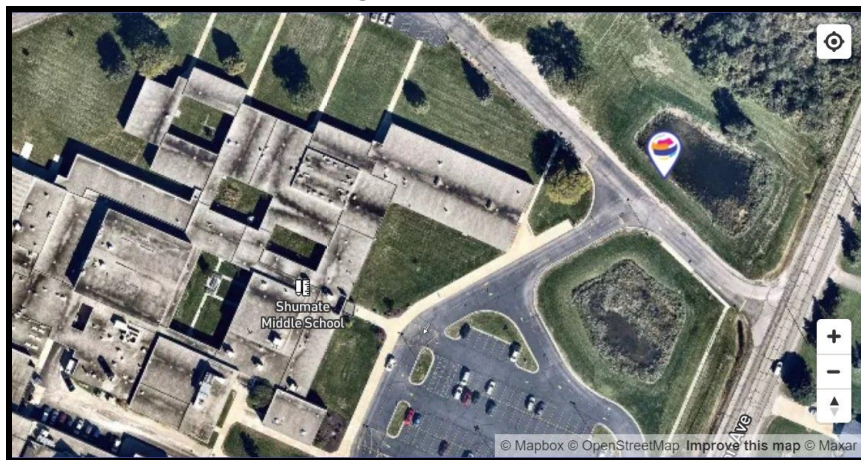
## Investigating Eastern Equine Encephalitis in Michigan

- Count and identify the mosquito larvae in the clear container.
- Use the GLOBE Observer Mosquito Habitat Mapper to take the mosquito count.
  - Follow the instructions (prompts) on the app.
  - Submit once all required data has been entered.
- After the observation is finished, dump the water down the drain.

### Study Sites:

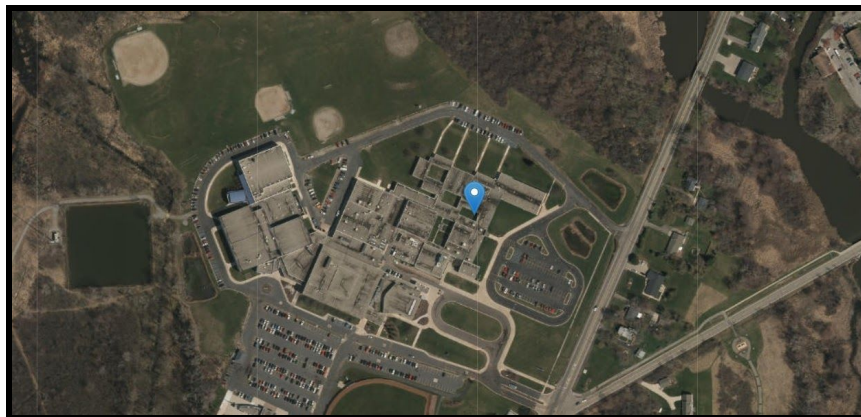
#### Aerial Image 1 - Study Site - Retention Pond

*Latitude 42.08,5997, Longitude -83.209067, Elevation 176.7m*



#### Aerial Image 2 - Study Site - Small Courtyard

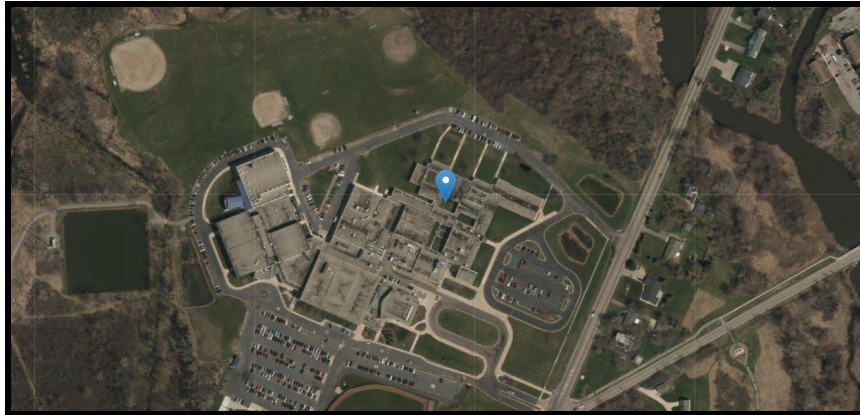
*Latitude 42.085763, Longitude -83.210494, Elevation 176.7m*



# Investigating Eastern Equine Encephalitis in Michigan

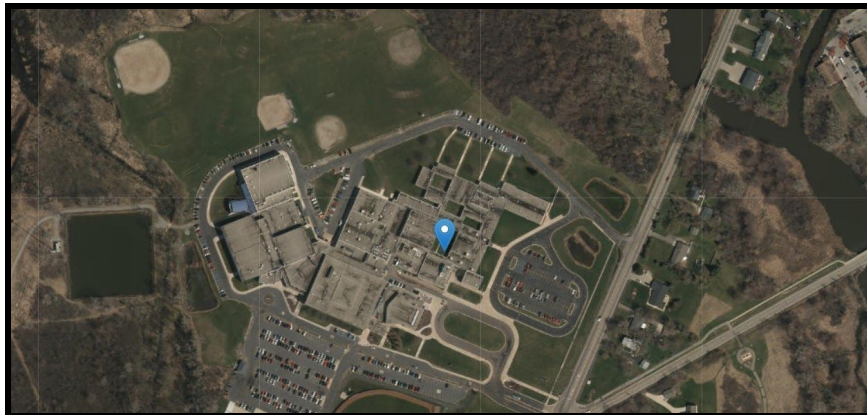
## Aerial Image 3 - Study Site - Teacher's Lounge Courtyard

Latitude 42.085955, Longitude -83.210832, Elevation 176.7m



## Aerial Image 4 - Study Site - Cafeteria Courtyard

Latitude 42.085547, Longitude -83.211044, Elevation 176.7m



## Data Summary

### Data Table 1 - Larvae Count and Temperature

<u>Date</u>	<u>Front Pond - Larvae</u>	<u>Bottle 1 - Larvae</u>	<u>Bottle 2 - Larvae</u>	<u>Bottle 3 - Larvae</u>	<u>Bottle 4 - Larvae</u>
10/17/2019	0.00	0.00	0.00	0.00	0.00
10/18/2019	0.00	0.00	0.00	0.00	0.00
10/19/2019	0.00	0.00	0.00	0.00	0.00
10/20/2019	0.00	0.00	0.00	0.00	0.00
10/21/2019	0.00	0.00	0.00	0.00	0.00
10/22/2019	0.00	0.00	0.00	0.00	0.00
10/23/2019	0.00	0.00	0.00	0.00	0.00



# Investigating Eastern Equine Encephalitis in Michigan

10/24/2019	0.00	0.00	0.00	0.00	0.00
10/25/2019	0.00	0.00	0.00	0.00	0.00
10/26/2019	0.00	0.00	0.00	0.00	0.00
10/27/2019	0.00	0.00	0.00	0.00	0.00
10/28/2019	0.00	0.00	0.00	0.00	0.00
10/29/2019	0.00	0.00	0.00	0.00	0.00
10/30/2019	0.00	0.00	0.00	0.00	0.00
11/1/2020	0.00	0.00	0.00	0.00	0.00
11/2/2019	0.00	0.00	0.00	0.00	0.00
11/3/2019	0.00	0.00	0.00	0.00	0.00
11/4/2019	0.00	0.00	0.00	0.00	0.00
11/5/2019	0.00	0.00	0.00	0.00	0.00
11/6/2019	0.00	0.00	0.00	0.00	0.00
11/7/2019	0.00	0.00	0.00	0.00	0.00
11/8/2019	0.00	0.00	0.00	0.00	0.00
11/9/2019	0.00	0.00	0.00	0.00	0.00
11/10/2019	0.00	0.00	0.00	0.00	0.00
11/11/2019	0.00	0.00	0.00	0.00	0.00
11/12/2019	0.00	0.00	0.00	0.00	0.00
11/13/2019	0.00	0.00	0.00	0.00	0.00
11/14/2019	0.00	0.00	0.00	0.00	0.00
11/15/2019	0.00	0.00	0.00	0.00	0.00
11/16/2019	0.00	0.00	0.00	0.00	0.00
11/17/2019	0.00	0.00	0.00	0.00	0.00
11/18/2019	0.00	0.00	0.00	0.00	0.00
11/19/2019	0.00	0.00	0.00	0.00	0.00
11/20/2019	0.00	0.00	0.00	0.00	0.00
11/21/2019	0.00	0.00	0.00	0.00	0.00
11/22/2019	0.00	0.00	0.00	0.00	0.00
11/23/2019	0.00	0.00	0.00	0.00	0.00
11/24/2019	0.00	0.00	0.00	0.00	0.00
11/25/2019	0.00	0.00	0.00	0.00	0.00
11/26/2019	0.00	0.00	0.00	0.00	0.00
11/27/2019	0.00	0.00	0.00	0.00	0.00

# Investigating Eastern Equine Encephalitis in Michigan

11/28/2019	0.00	0.00	0.00	0.00	0.00
11/29/2019	0.00	0.00	0.00	0.00	0.00
11/30/2019	0.00	0.00	0.00	0.00	0.00
12/1/2019	0.00	0.00	0.00	0.00	0.00
12/2/2019	0.00	0.00	0.00	0.00	0.00
12/3/2019	0.00	0.00	0.00	0.00	0.00
12/4/2019	0.00	0.00	0.00	0.00	0.00
12/5/2019	0.00	0.00	0.00	0.00	0.00
12/6/2019	0.00	0.00	0.00	0.00	0.00
12/7/2019	0.00	0.00	0.00	0.00	0.00
12/8/2019	0.00	0.00	0.00	0.00	0.00
12/9/2019	0.00	0.00	0.00	0.00	0.00
12/10/2019	0.00	0.00	0.00	0.00	0.00
12/11/2019	0.00	0.00	0.00	0.00	0.00
12/12/2019	0.00	0.00	0.00	0.00	0.00
12/13/2019	0.00	0.00	0.00	0.00	0.00
12/14/2019	0.00	0.00	0.00	0.00	0.00
12/15/2019	0.00	0.00	0.00	0.00	0.00
12/16/2019	0.00	0.00	0.00	0.00	0.00
12/17/2019	0.00	0.00	0.00	0.00	0.00
12/18/2019	0.00	0.00	0.00	0.00	0.00
12/19/2019	0.00	0.00	0.00	0.00	0.00
12/20/2019	0.00	0.00	0.00	0.00	0.00
12/21/2019	0.00	0.00	0.00	0.00	0.00
12/22/2019	0.00	0.00	0.00	0.00	0.00
12/23/2019	0.00	0.00	0.00	0.00	0.00
12/24/2019	0.00	0.00	0.00	0.00	0.00
12/25/2019	0.00	0.00	0.00	0.00	0.00
12/26/2019	0.00	0.00	0.00	0.00	0.00
12/27/2019	0.00	0.00	0.00	0.00	0.00
12/28/2019	0.00	0.00	0.00	0.00	0.00
12/29/2019	0.00	0.00	0.00	0.00	0.00
12/30/2019	0.00	0.00	0.00	0.00	0.00
12/31/2019	0.00	0.00	0.00	0.00	0.00

# Investigating Eastern Equine Encephalitis in Michigan

1/1/2020	0.00	0.00	0.00	0.00	0.00
1/2/2020	0.00	0.00	0.00	0.00	0.00
1/3/2020	0.00	0.00	0.00	0.00	0.00
1/4/2020	0.00	0.00	0.00	0.00	0.00
1/5/2020	0.00	0.00	0.00	0.00	0.00
1/6/2020	0.00	0.00	0.00	0.00	0.00
1/9/2020	0.00	0.00	0.00	0.00	0.00
1/10/2020	0.00	0.00	0.00	0.00	0.00
1/11/2020	0.00	0.00	0.00	0.00	0.00
1/12/2020	0.00	0.00	0.00	0.00	0.00
1/13/2020	0.00	0.00	0.00	0.00	0.00
1/14/2020	0.00	0.00	0.00	0.00	0.00
1/15/2020	0.00	0.00	0.00	0.00	0.00
1/16/2020	0.00	0.00	0.00	0.00	0.00
1/17/2020	0.00	0.00	0.00	0.00	0.00
1/18/2020	0.00	0.00	0.00	0.00	0.00
1/19/2020	0.00	0.00	0.00	0.00	0.00
1/20/2020	0.00	0.00	0.00	0.00	0.00
1/21/2020	0.00	0.00	0.00	0.00	0.00
1/22/2020	0.00	0.00	0.00	0.00	0.00
1/23/2020	0.00	0.00	0.00	0.00	0.00
1/24/2020	0.00	0.00	0.00	0.00	0.00
1/25/2020	0.00	0.00	0.00	0.00	0.00
1/26/2020	0.00	0.00	0.00	0.00	0.00
1/27/2020	0.00	0.00	0.00	0.00	0.00
1/28/2020	0.00	0.00	0.00	0.00	0.00
1/29/2020	0.00	0.00	0.00	0.00	0.00
1/30/2020	0.00	0.00	0.00	0.00	0.00
1/31/2020	0.00	0.00	0.00	0.00	0.00
2/1/2020	0.00	0.00	0.00	0.00	0.00
2/2/2020	0.00	0.00	0.00	0.00	0.00
2/3/2020	0.00	0.00	0.00	0.00	0.00
2/4/2020	0.00	0.00	0.00	0.00	0.00
2/5/2020	0.00	0.00	0.00	0.00	0.00

# Investigating Eastern Equine Encephalitis in Michigan

2/6/2020	0.00	0.00	0.00	0.00	0.00
2/7/2020	0.00	0.00	0.00	0.00	0.00
2/8/2020	0.00	0.00	0.00	0.00	0.00
2/9/2020	0.00	0.00	0.00	0.00	0.00
2/10/2020	0.00	0.00	0.00	0.00	0.00
2/11/2020	0.00	0.00	0.00	0.00	0.00
2/12/2020	0.00	0.00	0.00	0.00	0.00
2/13/2020	0.00	0.00	0.00	0.00	0.00
2/14/2020	0.00	0.00	0.00	0.00	0.00
2/15/2020	0.00	0.00	0.00	0.00	0.00
2/16/2020	0.00	0.00	0.00	0.00	0.00
2/17/2020	0.00	0.00	0.00	0.00	0.00
2/18/2020	0.00	0.00	0.00	0.00	0.00
2/19/2020	0.00	0.00	0.00	0.00	0.00
2/20/2020	0.00	0.00	0.00	0.00	0.00
2/21/2020	0.00	0.00	0.00	0.00	0.00
2/22/2020	0.00	0.00	0.00	0.00	0.00
2/23/2020	0.00	0.00	0.00	0.00	0.00
2/24/2020	0.00	0.00	0.00	0.00	0.00
2/25/2020	0.00	0.00	0.00	0.00	0.00
2/26/2020	0.00	0.00	0.00	0.00	0.00
2/27/2020	0.00	0.00	0.00	0.00	0.00
2/28/2020	0.00	0.00	0.00	0.00	0.00
2/29/2020	0.00	0.00	0.00	0.00	0.00
3/1/2020	0.00	0.00	0.00	0.00	0.00
3/2/2020	0.00	0.00	0.00	0.00	0.00
3/3/2020	0.00	0.00	0.00	0.00	0.00
3/4/2020	0.00	0.00	0.00	0.00	0.00

**Data Table 2 - Larvae Data Count by Study Site**

Site Id	School Name	Site Name	Protocol	Data Count	Latitude	Longitude	Elevation
40359	Shumate Middle School	17TLG171 616	Mosquito Habitat Mapper	2	42.08518	-83.2114	177.5
39664	Shumate Middle School	17TLG171 617	Mosquito Habitat Mapper	1	42.08608	-83.2114	177.6
50688	Shumate Middle School	17TLG172 616	Mosquito Habitat Mapper	45	42.0852	-83.2102	177.4
41015	Shumate Middle School	17TLG172 617	Mosquito Habitat Mapper	4	42.0861	-83.2102	177.7

*\*Summary data collected from GLOBE ADAT on Saturday, March 7, 2020.*

### **Visualizations Note:**

At the time of this IVSS project, our team could not obtain a print screen of all of the mosquito data submitted to the GLOBE Program. When we tried to obtain a screen shot from the Visualize Data option on the GLOBE website, none of the study sites would show up on the map. To combat this problem, we provided a summary data table (see above) collected from the Advanced Data Access Tool (ADAT). Per the rubric for the IVSS, a print screen of GLOBE Visualization page is required. We request not to be penalized because of this technical issue. We are sorry for the inconvenience.

## **Analysis and Results**

**Mosquito Larvae Count Analysis and Results** - According to Data Table 1, we did not find any mosquito larvae in the retention pond and bottles 1 - 4, thus our mosquito larvae average, maximum, and minimum count was 0 mosquito larvae. We will provide our thoughts on these results below (see Discussions).

## Investigating Eastern Equine Encephalitis in Michigan

**Mosquito Larvae with EEE Analysis and Results** - Once again, according to Data Table 1, we did not find any mosquito larvae (including Aedes and Culex) in the retention pond and bottles 1 - 4, thus our mosquito larvae average, maximum, and minimum count was 0 mosquito larvae. We will provide our thoughts on these results below (see Discussions). Thus, no mosquito larvae with EEE have been found on the Shumate Middle School Campus.

**Mathematic Equations Utilized** - We utilized average, maximum, and minimum equations on our data tables to better analyze the data.

**Possible Uncertainties Present in the Data** - Human and/or technology error(s).

## **Conclusions**

**Mosquito Larvae Conclusion** - In conclusion, our hypothesis was incorrect. We did not find a single mosquito larvae in the retention pond samples and in our four mosquito traps (bottles). As stated in our hypothesis, we were expecting to find 35 larvae at a minimum. However, not finding mosquito larvae in the retention pond and traps is a good thing for the Shumate Middle School learning community (see Discussion below).

**Mosquito Larvae with EEE Conclusion** - In conclusion, this part of our hypothesis was correct. As believed, we did not find any Aedes and Culex larvae that could potentially carry EEEV in the retention pond samples and in our four mosquito traps (bottles). As stated above, our team did not find any mosquito larvae in the retention pond and in our traps. Once again, not finding Aedes and Culex larvae on the Shumate Middle School campus is a great thing.

## **Discussion**

As stated above, last year our research team started investigating mosquitos and we created the GLOBE IVSS report entitled "What are the Humidity, Precipitation, and

## Investigating Eastern Equine Encephalitis in Michigan

Temperature Conditions Associated with Active Mosquito Season?” This was the first phase of our research, and we were driven by the known fact that mosquitoes are very deadly insects; they're considered to be the world's most dangerous animal as they kill more humans than any other animal by spreading various dangerous diseases (D. Janney, personal communication, March 14, 2019). Moving into our second phase, our team was expecting to collect a significant amount of mosquito larvae between the retention pond and mosquito larvae traps (bottles). We also did not expect to find mosquito larvae that carry EEEV disease as we have not heard of any cases in Wayne County, Michigan. While we did not find any larvae (*Aedes* and *Culex*) capable of carrying the EEEV disease (which is a good thing), we were surprised that we did not collect any mosquito larvae at all! We expected to collect approximately 35 mosquito larvae, and we collected none. However, the late fall and winter months were rather cold on our campus. Cold temperatures are not ideal for active mosquito season, thus cold temperature could have influenced an extremely low mosquito count.

Simply put, EEEV is a scary disease, and it's one that must be taken seriously in the state of Michigan. According to Shamus, EEEV causes severe swelling and inflammation in the brain. It can lead to loss of speech and paralysis. In Michigan alone in 2019, six people died, and four others were hospitalized (2020). This virus affects both humans and animals. In Michigan, the EEEV sickened humans in Barry, Berrien, Calhoun, Cass, Kalamazoo and Van Buren counties. The virus also was confirmed in 39 animals in Allegan, Barry, Berrien, Calhoun, Cass, Genesee, Jackson, Kalamazoo, Kent, Lapeer, Livingston, Montcalm, Newaygo, St. Joseph, Tuscola and Van Buren (2019). While Wayne county is not on this list, the threat of the EEEV must be taken seriously, and people need to take the proper precautions during the active mosquito season. According to the CDC, the most effective way to prevent infection from Eastern Equine Encephalitis virus is to prevent mosquito bites. Mosquitoes bite during the day and night. Use insect repellent, wear long-sleeved shirts and pants, treat clothing and gear, and take steps to control mosquitoes indoors and outdoors (2019).

## Investigating Eastern Equine Encephalitis in Michigan

Moving forward, our group plans to continue taking more mosquito measurements using the GLOBE Observer app. We will measure throughout the spring and into early summer (the school year ends on Wednesday, June 10, 2020). We will continue sending mosquito counts to the GLOBE Program daily. Additionally, we hope to share our results with the GLOBE Mission Mosquito team and possibly the City of Gibraltar, Michigan. Shumate Middle School is located next to an adjacent wetland area, and it is within close proximity to the Detroit River and Lake Erie. There are many different locations with water year round. Thus there are an increased number of hotspots for mosquitoes. It is our goal to continue monitoring the Shumate Middle School campus to keep our learning community healthy and safe.

## Collaboration

### Group Roles:

- **Bayle Buvia** - Collect measurements, submit data to the GLOBE website, manage Google Spreadsheet, analyze data, and project author.
- **Muhammed Muheisen** - Collect measurements, submit data to the GLOBE website, manage Google Spreadsheet, analyze data, and project author.
- **Sophia Payne** - Collect measurements, submit data to the GLOBE website, manage Google Spreadsheet, analyze data, and project author.
- **Alyvia Roll**- Collect measurements, submit data to the GLOBE website, manage Google Spreadsheet, analyze data, and project author.

### Advantages of Collaboration:

For this project, all members participated equally and collected, analyzed, and submitted mosquito measurements data to the GLOBE Program via the GLOBE Observer app. Our research team also worked directly with Ms. Dorian Janney (NASA and GLOBE Mission Mosquito Campaign Coordinator). Ms. Janney gave our team insight on EEE, and she model best practices for collecting mosquito data. Our team



## Investigating Eastern Equine Encephalitis in Michigan

had the privilege of speaking with Ms. Janney via Zoom webinar four times throughout our IVSS research campaign. We also worked directly with the Shumate pH Hydrology team (Burgei, Sikora, and Stec). The pH Hydrology team would bring in water samples from the retention pond for our team to test.

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