Drones are an accurate and efficient way to identify mosquito breeding grounds in Medford, NJ

Abstract

Mosquitoes are a risk to humans and animals. Though there are some regions where a higher risk occurs, Burlington County, NJ is made up of wetland and swampy areas. Many schools and businesses (like the Post Office) drain the water from the roof to retention ponds that stay wet all year. Trying to locate mosquito breeding areas by walking and looking from the ground takes a lot of time. This research uses high tech drones to identify potential mosquito breeding habitats. Drones were flown above three areas in the Medford Public School District. After taking the images, they were analyzed. Areas where water collects and is stored, are good areas for mosquitoes to breed. Flat roofs are also good areas to check. To help answer the question, "How can drones be used to identify mosquito breeding habitats in Medford, NJ?" the following objectives were assigned to the research. The ideas for these objectives came from the GLOBE program Mission Mosquito project.

- Identify the breeding habitats using drones.
- Sample and count mosquitoes.
- Identify species of larvae.
- Eliminate the breeding site, if possible.

The research in this report centers on "Identify the breeding habitats using drones." The rest of the objectives will be met when mosquito season begins and breeding becomes active. Larvae from locations identified using drone pictures will be counted. Recommendations to eliminate breeding sites found will be given to the Medford Township Board of Education to try and decrease the number of larvae and hopefully decreasing the risk of diseases. Drones were found to be a efficient way to locate mosquito breeding sites because of their ability to take pictures of large areas of land fast and with great detail. It is the suggestion of this research team that future CSEPers continue the research next school year.

Keywords: mosquitos; drones; mosquito habitat mapper; mosquito traps

Research question

"How can drones be used to identify mosquito breeding habitats in Medford, NJ?"

Although mosquitoes are one of the smallest animals, they make a larger impact on mankind than imaginable. Globally, they are an ongoing issue for many people. Because mosquitoes are so small, it is hard to feel their bites. It is important to eliminate breeding sites so their population will decrease. This research will see if using drones to locate these breeding sites will simplify the task for community members and government officials. After drone pictures are taken and analyzed, as soon as active mosquito season picks up, the pictures will be used to identify potential mosquito breeding habitat grounds. Mosquito traps will be set around each school. Then, the larvae will be sampled and counted, and the species breeding (either *Culex* or *Aedes*) in that particular area will be identified. By studying the different types of larvae, it will be easier to identify the type when a breeding ground is located. Finally, the Board of Education and the superintendent of Medford schools will be notified. Hopefully, they will then proceed to eliminate the habitats in an effort of lowering the risk of disease spread in Medford, NJ.

Figure 1.
Drones are used for taking aerial photos. This is considered a helpful
option when planning to investigate a large area.

Introduction

Mosquitoes are a worldwide threat to mankind. Each year, the bugs are the cause of more than 700,000 deaths due to the diseases transmitted through their bites. (Barcelona Institute for Global Health, 2017) Mosquitoes are, in fact, considered the biggest killer out of all species of animals (Bill Gates, 2014). During active mosquito months, mosquito-borne diseases drastically increase. Although diseases like Zika are not common in Medford, New Jersey, mosquitoes are still a problem. Both the *Aedes Aegypti* and *Aedes Albopictus* are present in New Jersey. Plus, the genus *Culex* mosquitoes spread diseases such as West Nile Virus and Eastern Equine Encephalitis (NJDEP, 2018).
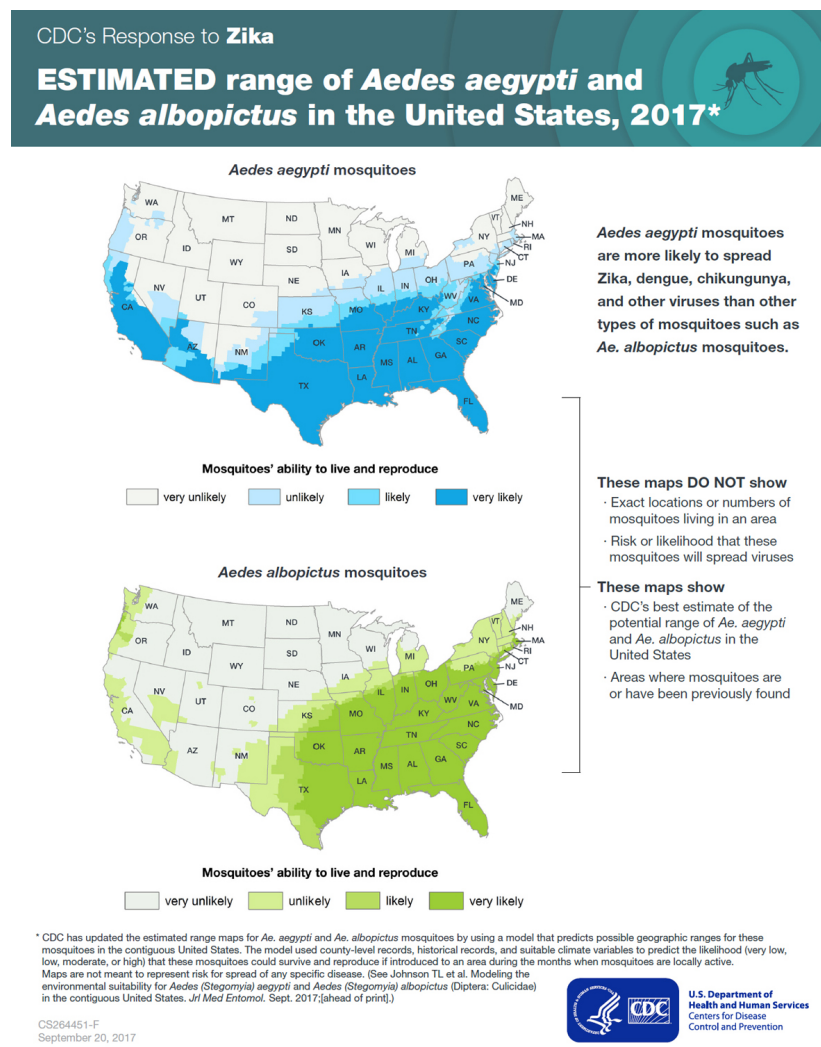

Figure 2.
The research team was really surprised to learn that both the *Aedes aegypti* and *Aedes albopictus* are very likely and likey (respectively) to be found in South-Central New Jersey.

3

These mosquitoes can be identified based on the shape of their siphon. While a *Culex* has a flat tipped siphon, the *Aedes* genus has a straight siphon.
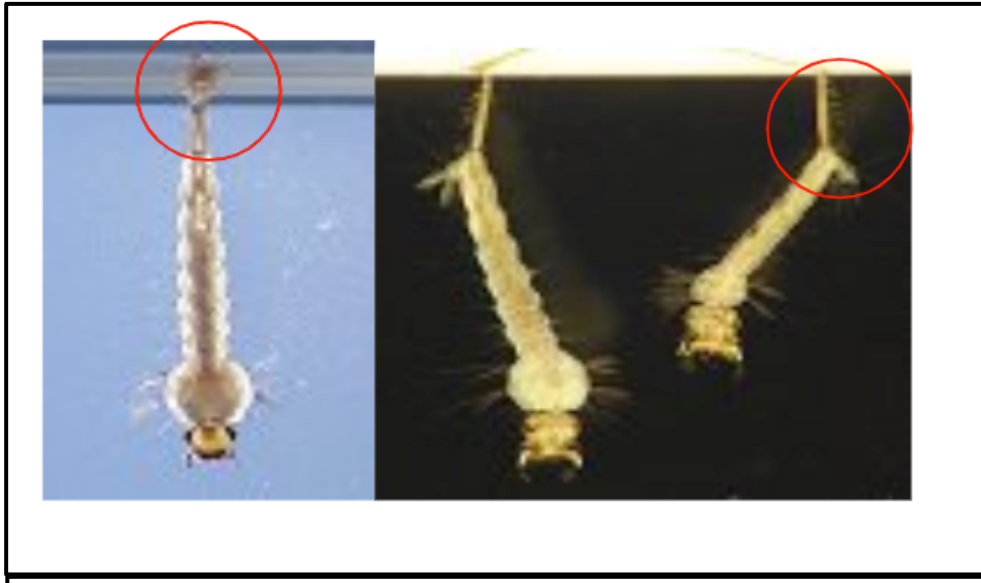

Figure 3.
Shows a side by side comparison of the *Aedes* genus larvae (left) and the *Culex* genus larvae (right). As visible from the red circled areas, the Aedes genus has a straight siphon, while the Culex genus has a flat tipped siphon.

Currently, it is inactive mosquito season in Medford, NJ. However, temperatures are beginning to rise. When the temperature reaches around 50 degrees or higher, mosquitoes will begin to come out of diapause, or mosquito hibernation (Molly Murray and Natalie DiBlasio, 2014). At this point, the risk of disease in NJ generally increases. For this reason, it is important to eliminate breeding sites once they have been identified and the number of potentially dangerous mosquito bites will decrease. Breeding sites are not always easy to find. You have to cover a lot of lands to look and search thoroughly. Therefore, a new innovative way should be created to locate these breeding areas. Drones have the ability to look at large areas of land and take detailed pictures. The research conducted will justify whether drones will make it efficient to discover breeding areas in a faster way.

1. https://www.isglobal.org/en/new/-/asset_publisher/JZ9fGljXnWpI/contentmosquito-el-animal-mas-letal-del-mundo[1]
2. https://www.gatesnotes.com/Health/Most-Lethal-Animal-Mosquito-Week
3. https://www.nj.gov/dep/mosquito/depfs.htm
4. https://www.usatoday.com/story/weather/2014/04/08/mosquito-season-coming/7461715/

Research methods

The first thing the research team did was learn as much about mosquitos as possible. Watching GLOBE's webinars helped to understand mosquitos more thoroughly.

During non-mosquito season, a close look was taken at the GLOBE Mosquito Habitat Mapper (MHM) app. To become familiar with collecting data, the team used the app to look at potential breeding grounds and taking pictures of the areas. This was done during the winter months. The pictures included areas where water collected, such as swamps, drains, and small bodies of water outside of Medford Memorial Middle School, Medford, NJ. Then the data was put into the GLOBE MHM.

While waiting for active breeding season, and while the leaves were off the trees, drone images were taken of three different locations in the Medford Township Public Schools District. Each school was visited by the team and a drone expert pilot, Mr. Tyler who taught the team all about drones. A small drone was programmed by Mr. Tyler and flew a pattern automatically and on autopilot over one of the schools. A larger drone was also used. Mr. Tyler operated it to go exactly to areas were the team felt pictures were needed. For safety reasons, the drone was put into a square area marked by cones before takeoff. Then, the drones took off and an aerial view could be seen on an ipad and with the press of a button pictures could be taken. Next, the pictures were analyzed using a checklist. The checklist was developed by the research team.

In March and April, mosquito traps were made in anticipation of active breeding season. As Phase 2 of the research project begins, the traps will be placed outside in spots which were identified as potential breeding habitats, based on the drone pictures. The traps will be checked upon twice weekly to study mosquito larvae activity.

Figure 4.
CSEP students and Mr. Tyler standing with
the large drone.

Figure 5.
Mr. Tyler explains the functions of the small drone
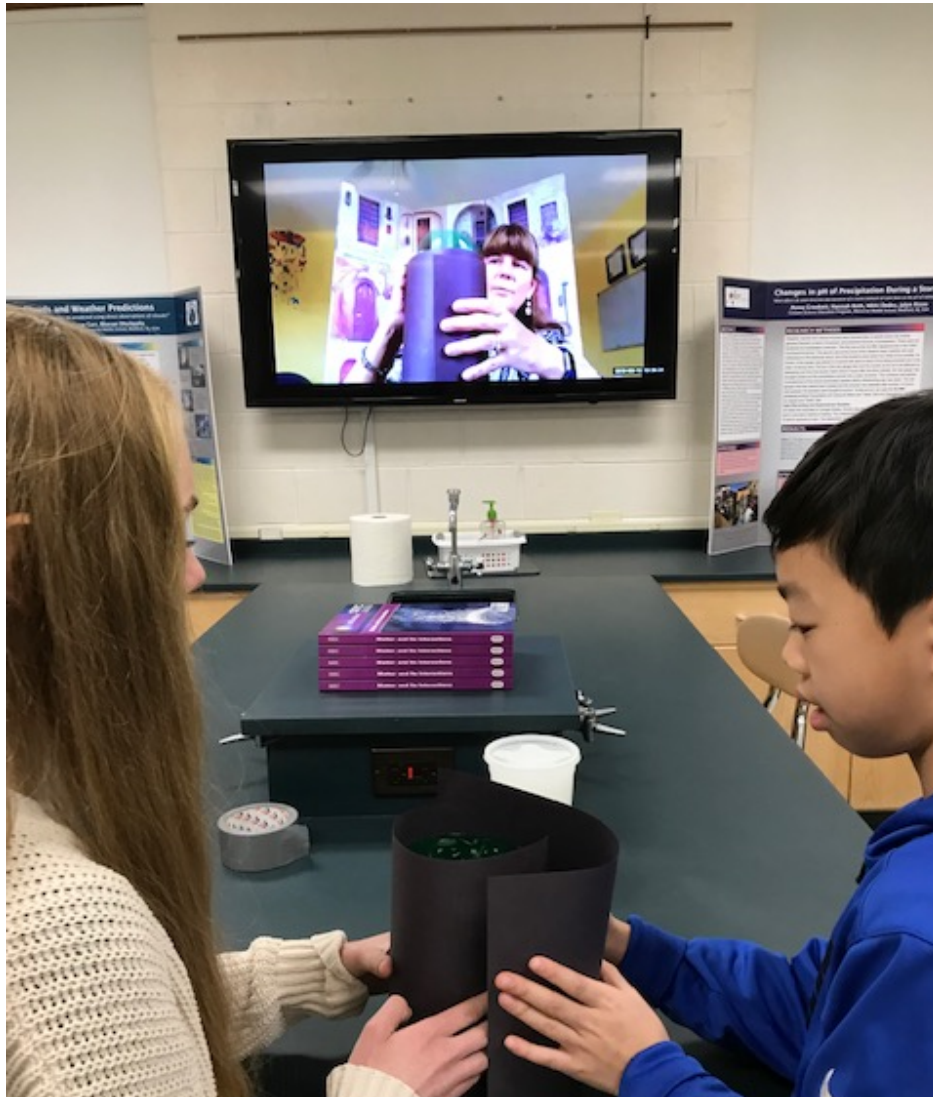and how he programs it.

Figure 6.
Research Team members, Morgan and Gavin watch GLOBE Webinar. Directions
are being given by Ms. Dorian Janney, NASA on how to build a mosquito trap.

Results

The drone pictures were analyzed by going through a checklist. The checklist was created by the research team.

- ❑ Identify location of photo
    - ❑ Latitude and longitude
    - ❑ Street address
    - ❑ Direction (N, S, E, W)
    - ❑ Area type (rural, urban, suburban)
- ❑ Identify large natural landmarks and features
- ❑ Identify large man made landmarks and features
- ❑ Identify smaller natural landmarks and features
- ❑ Identify smaller landmarks and features
- ❑ Use MUC to identify land cover of the image
- ❑ Identify potential mosquito breeding habitats
    - ❑ Stagnant water
    - ❑ Identify whether water is manmade or natural
    - ❑ Identify what type of body of water it is
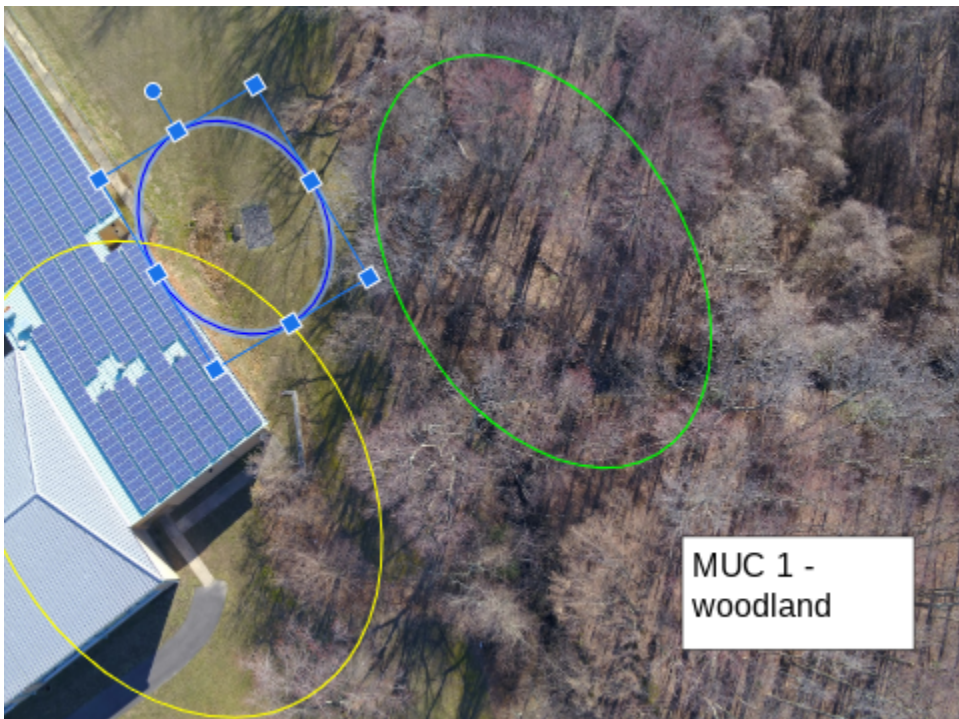   - ❑ Areas in which water could get trapped

MUC 8 - Cultivated land

Drone image 1- Board of Education

MUC 8 -
Cultivated land
farms
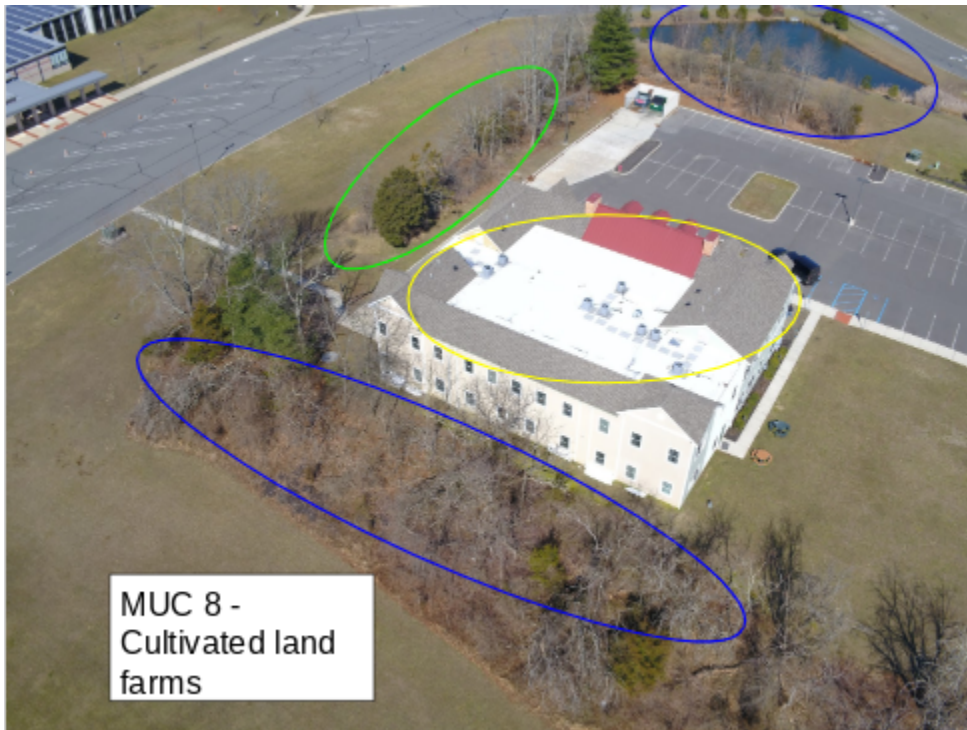
Drone image 2- Board of Education

MUC 1 -
woodland

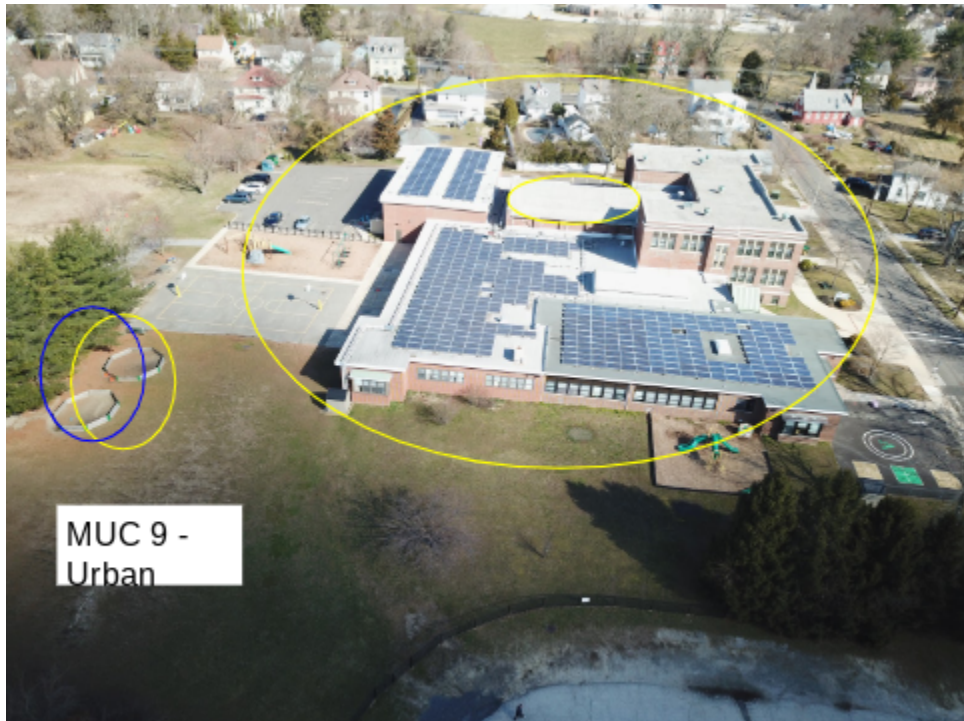Drone image 3- Medford Memorial Middle School

Drone image 4- Medford Memorial Middle School

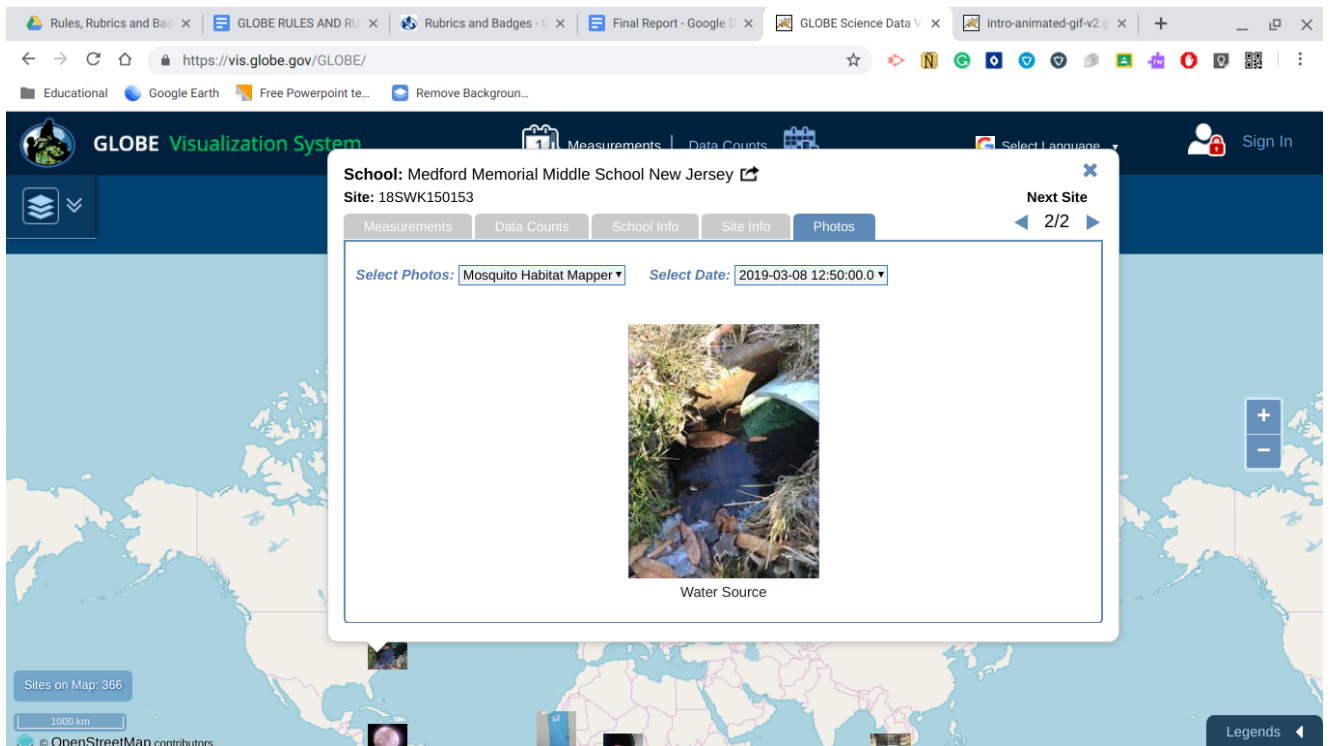Drone image 5- Milton H. Allen

Drone Image 6- Milton H. Allen

Figure 7

GLOBE Visualization Screenshot of data input on 3/8/19. The team went out for data collection practice,

taking pictures of areas that could be potential mosquito breeding habitats.

<u>Discussion</u>

Color coded circles were used to help analyze the pictures. A blue circle represents water, green circles stand for natural features/ landmarks, and yellow circles stand for manmade features/ landmarks. Through color coding the pictures, it was easier to fully understand areas of possible mosquito breeding. MUC classification was also used to identify the different types of land around the schools.

The results received based on the drone images in comparison to the outcome originally predicted varied in accuracy. While water was expected to collect on the roof of each school, it did not. It was discovered that the each roof is pitched at a specific angle, allowing the water to pull into the gutters, travel down the downspout, run through pipes along the side of the school, and eventually make its way into a retention pond. Of course, the team would not have been able to see the tops of the roofs if a drone wasn't used.

As for Medford Memorial Middle School there are four significant breeding grounds: Retention Pond 1, located in the back right corner of the school, Retention Pond 2, located just behind the bus loading area, Retention Pond 3, in the woods behind the school and the fully enclosed courtyard located across from the Large Group Instruction Room. After talking to the Head Custodian of Medford Memorial Middle School, it was discovered the water that drains from the schools is pushed out into larger areas (retention ponds). These ponds remain with some level of water all year round. This system is placed in every school, thus explaining why water collection was not seen on any roofs.The courtyard opposite the Large Group Instruction room holds water because of a poor drainage system that was never correctly connected to a retention pond. For Memorial Middle School, there are three retention ponds on the property. Two are used for school drainage, though one pond is manmade and the other drains into the wooded area on the southeast side of the school. The third pond, located on the corner of the teacher parking lot is used for the Post Office and a nearby church. This information was collected April 2, 2019 from Mr. Dan Foley, the head custodian of Medford Memorial. At the other schools, the retention ponds took on different forms. In drone image 2, a body of water was identified. This body of water was thought to be a man made retention pond because of its perfect triangle shape.

Although the team was incorrect about finding water on the roofs, the prediction of water in courtyards was correct. There was only one courtyard that did not hold water long enough to be a good breeding ground for mosquitoes.

An advantage of using drones is that it is a faster way to look at a bigger area of land. The drone we used took aerial pictures of a large school and the surrounding area in less than fifteen minutes. In contrast, a challenge, depending on drone availability and cost, may be that it is difficult to find a drone and correctly operate it. Drones are expensive and they can't always see the small details the human eye can see. However, using drones is still very effective in the search for potential mosquito breeding grounds.

Conclusion

After examining the images, drones were found to be an efficient and effective way to locate potential mosquito breeding sites. This work is best done during a season when there are not too many leaves on the trees. Medford, NJ is a good place to use drones. If the area is very dense with trees or bushes, then using a drone might not be so helpful. Still, large lakes, ponds and rivers can usually be seen. Once Phase 2 of this research project is finished, the results will show if the potential breeding habitats actually had mosquitoes. For future research, this research team suggests that next year's Citizen Science Education Program (CSEP) students continue to find breeding sites and eliminate them.

13

<u>Badges</u>

Be a data scientist:
Drone pictures were taken to use to try and identify mosquito breeding habitats. The pictures were taken with the help of a professional and then analyzed. Examining them, we searched for potential mosquito breeding grounds.

Make an impact:
Mosquitos are a global threat and an issue in many communities. Using the drone images, mosquito breeding habitats will be pinpointed and larvae will be sampled. A recommendation to eliminate the breeding habitats will be given to the Superintendent and BOE of the district. Hopefully, actions will be taken towards eliminating breeding sites. The risk of mosquito-borne diseases would then decrease in the community.

Be a STEM Professional:
Work was done with a professional when drone pictures were taken. The professional was an expert in drones who aided in answering the research question concerning whether or not drones can be used to identify potential mosquito breeding habitat grounds. Working with Mr. Tyler provided insight on the importance of using drones to see things you wouldn't notice without them.

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