



PART THREE. LIFE TASK LIST

This is the list of tasks for Part Three. Life Check them off as you complete them.

- 3-1 Col 3-2 Cor 3-3 Inv 3-4 Unv 3-4 Unv 3-5 Anz 3-6 Anz 3-7 Del
- Collecting Mosquito Eggs
 - Comparing Mosquitoes
 - Investigating Mosquito Distribution
 - Understanding Mosquito Life Cycle
 - Analyzing Collected Eggs and Larva
 - Analyzing Community Surveys (Life)
 - Debriefing Life

In this part, the team will focus on learning about the life of the mosquito. Research will include collecting and comparing mosquitoes within research sites while studying the life cycle and global distribution of different mosquitoes.







Collecting Mosquito Eggs

Welcome to Part Three: Life and Task 3-1. In Part Two you learned more about what people in your community think about mosquitoes. Now the team will begin learning more about the life of the mosquito. For the tasks later in Part Three, it will be beneficial to collect and observe live mosquito eggs, larvae, and pupae in your research site. You may have already started doing this in Task 1-4. However, if you have not, the collection process can take some time. So it's a good idea to build and set out the traps and then monitor them daily while you are working on the other tasks in Part Three.



In this task, the team will be focusing on the following questions from the question map. How can we monitor the distribution of mosquitoes?

Monitoring the local mosquitoes can help the team determine where mosquitoes are distributed across the community. Teams will also have the opportunity to participate in a larger Citizen Science project called The Invasive Mosquito Project. This project involves collecting samples from teams over a much larger area. This data will be used to make larger distribution maps of mosquitoes. Participation in the Citizen Science project is voluntary, but participate if you can.



Participate in the Invasive Mosquito Citizen Science Project if you can. Also, do research to see if there are other citizen science projects in your location you can participate in.

 Go to the Task 3-1 folder and get the Collecting Mosquito Eggs step-by-step guide for setting up collection cups, Egg Collection procedure, Live Collection instructions, Citizen Science- Invasive Mosquito Project background information, and Invasive Mosquito Project collection form.



2. As a team, use the step-by-step guide and egg collection procedure to set up egg collection cups in your research site. If you're experimenting with the collection design, outline your experimental design. Read the safety notes in the procedure and collection notes before placing cups outside.



- 3. Mark your research site map from Task 2-1 with the location of your team's cups.
- 4. Monitor the cups daily. Refill with water as needed. Be careful of any eggs or larvae in the container.
- 5. Leave the cups out for seven to fourteen days. Then follow the collection procedure to observe any eggs, larvae, or pupae.
- Use the Invasive Mosquito Project Collection record form to collect data. Use this even if the team is not participating in the Citizen Science project.
- 7. If you're participating in the Citizen Science project, mail some of the eggs according to the procedure and collection notes. Save some eggs for others tasks later in this part.
- 8. If you have found a different Citizen Science project involving mosquito eggs to participate in, do that!



Research Tip

More information about identifying and storing collected eggs and larvae is included in Tasks 3-4 and 3-5, if you need it now.



The more people that participate in Citizen Science projects, the more we all will learn from them. Think about how you could gather information about your community to be part of these global projects.

Hooray! You completed Task 3-1. Check it off the task list. Go to Task 3-2!



Comparing Mosquitoes

Objective

In this task, the team will be focusing on the following questions from the question map:

How do different mosquitoes compare and contrast?

How do mosquitoes spread diseases?

In this task, the team will examine different types of mosquitoes. The team will learn about different physical characteristics and behaviors of these different mosquitoes.

- 1. Go to the Task 3-2 folder and get the Mosquito Images. There is only one version of this task.
- Look at the images of the five different types of mosquitoes. Remember, there are more than 3,000 different types of mosquitoes around the world. So, this is a small sample of the different types.
- For each mosquito, make a list of observations to compare and contrast each type by describing the physical characteristics of each. Include observations about different parts of their body, including the head, proboscis, back of the mosquito, legs, wings
- 4. As a team, share some interesting observations that are unique to each type of mosquito.
- 5. Are all mosquitoes physically the same? Why or why not? Use your observation evidence to support your claims. Remember to use the claim/ evidence sentence starters during the discussion.
 - I think this piece of evidence supports this claim because ...
 - I do not think this piece of evidence supports this claim because ...
 - I agree because ...
 - I disagree because ...

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- 6. As a team, compare and contrast the feeding habits of each mosquito. What are some common sources of food for different male and female mosquitoes?
- 7. Using the feeding habits evidence, make a claim stating which of these types of mosquitoes you think could transmit diseases to humans. I think the ______mosquito could possibly transmit diseases to humans. I think these pieces of evidence support this claim...
- Using the feeding habits evidence, make a claim stating which mosquitoes you think probably do not transmit diseases to humans.
 I think the ______mosquito possibly does not transmit diseases to humans. I think these pieces of evidence support this claim.
- 9. Using the evidence, make a claim about which gender (male or female) you think is more likely the cause of disease transmission to humans. I think the ______mosquito is more likely the cause of disease transmission to humans. I think these pieces of evidence support this claim...
- As a team, share your claim statements and supporting evidence. Remember to use the claim/evidence sentence starters during the discussion.
- 11. Go to the Task 3-2 folder and get the Meet the Team-Medically Important Mosquitoes reader.
- 12. Read the Meet the Team reader. Use the evidence in the reader to analyze your claims in steps seven, eight, and nine about mosquitoes. Does the evidence from the researcher support your claims? Why or why not?
- 13. Why is it important to always support your claims with evidence?
- 14. Update your claims as needed.

Hooray! You completed Task 3-2. Check it off the task list. Go to Task 3-3!



Part Three. Life



In Task 3-2, the team learned that not all mosquitoes spread diseases to humans. We also learned more about the medically significant mosquitoes that can spread disease to humans. These are the mosquitoes we will focus our research on. A big question we must investigate is where these mosquitoes live. We also need to learn about the environmental conditions that affect where mosquitoes like to live.

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Task 3

Part Three. Life



In this task, the team will look at various maps to help us with these questions. Then the team will determine how to monitor the local environment over time. This data can be used to support decisions about when mosquitoes may be a problem in the community.

In this task, the team will be focusing on the following questions from the question map in Task 1-10. Where do mosquitoes live? What factors influence where they live?

Go to the Task 3-3 folder and get the Mosquito Distribution Maps. This task has only one version.



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Research Tip

Maps can be printed or viewed digitally. Do what works best for your team. And if you have other maps you want to include in this analysis, do it!

- Follow the directions in the task folder to complete the Mosquito Distribution Map analysis on the following:
 - Political distribution
 - Aedes and political distribution
 - Temperature, *Aedes*, and political distribution
 - Precipitation, temperature, *Aedes* and political distribution
 - *Anopheles*, precipitation, temperature and political distribution
 - Culex, precipitation, temperature and political distribution



- 2. As a team, discuss:
 - How can maps be helpful when studying mosquitoes and mosquitoborne diseases?
 - How do the environmental conditions (temperature and precipitation) change throughout the year in your location?
 - Does it rain more or less in your community at different times of year?
 - Does it snow in your community?
 - Does the temperature change at different times of the year in your community?
 - How does understanding the environmental conditions (temperature and precipitation) of your location help when thinking about the problem question: How can we ensure health for all from mosquitoborne diseases?
 - How could you monitor the changes in temperature and precipitation in your community throughout the year?
- 3. To understand the mosquito problem better in your local community, it is useful to collect some data evidence in your research site about the environmental conditions of temperature and precipitation. This data can then be used to determine if there are different times of the year when the conditions are better for mosquitoes.
- 4. Go to the Task 3-3 folder and get the Monitoring Local Weather instructions. Use the information and data sheet to determine how you will monitor the local weather over time in your community. Determine how this information could be useful to your local community when thinking about mosquitoes.

Hooray! You completed Task 3-3. Check it off the task list. Go to Task 3-4!

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) Understanding Mosquito Life Cycle

In Part Three the team has learned about different types of mosquitoes. Your team may have already collected mosquito eggs during Task 3-1. These eggs are one stage of the mosquito life cycle. Soon they will become adult mosquitoes. It is important to understand all stages of the mosquito life cycle.

Objective

In this task, the team will work to understand the life cycle of the mosquito. If live egg, larvae, or pupae samples are available to the team from Task 3-1, experimentation methods are suggested here. If live samples are not available do not worry. Continue to monitor your collection cups in your research site. You can always come back to this experiment after you collect samples.

In this task, the team will be focusing on the following questions from the question map in Task 1-10. How do mosquitoes develop and reproduce? What factors influence how mosquitoes develop and reproduce?

The team will use this analysis to think about factors that may effect the life cycle and problem question. The team will also think about how understanding the life cycle could be useful when making solutions for the community.

- Go to the Task 3-4 folder and get the Understanding Mosquito Life Cycle instructions. Choose the Mosquito A or Mosquito B task from the task folder. The Mosquito B task includes the instructions for working with live samples. You can also do both tasks if you want.
- 2. As a team, discuss how understanding the life cycle of the mosquito could be helpful when thinking about our problem question: How can we ensure health for all from mosquito-borne diseases?



Research Tip

When collecting or working with live samples, follow basic safety precautions. Review the safety documents in the task folder as needed.

Hooray! You completed Task 3-4. Check it off the task list. Go to Task 3-5!



Analyzing Collected Eggs + Larvae

In Task 3-1 the team started collecting mosquito eggs and larvae in your research site. If your team has been successful in collecting mosquito eggs and larvae then the next step is to analyze them. If you have not collected any eggs and larvae at this point in your research, do not worry. Continue to monitor your collection cups in your research site. Then return to this task if and when you collect eggs or larvae.





In this task, the team will learn how to analyze live mosquito eggs and larvae. If live egg or larva samples are available to the team, analysis methods are suggested. The team will use this analysis to think about factors that may effect the life cycle and problem question.

In this task, the team will be focusing on the following questions from the question map: How do different mosquitoes compare? How can we monitor the distribution of mosquitoes?

- 1. Go to the Task 3-5 folder and get the Analyzing Collected Eggs and Larvae instructions. There is only one version of this task. If you have not collected eggs or larvae move on to the next task. If you collect eggs or larvae in the future, come back to this task.
- Use this resource to learn about the different parts of eggs and larvae. Use this resource to analyze your live samples.
- 3. If possible, try to identify whether you collected an Aedes, Anopheles, or Culex mosquito. Remember, it isnot easy. There are also thousands of other types ofmosquitoes. So it one of these.
 Task 3-1. Also, do research to see if there are other to see if there are other citizen science projects might loating you can participate in using the participate in u
- e Citizen Science Tip

Consider participating in the Invasive Mosquito Citizen Science Project from Task 3-1. Also, do research to see if there are other citizen science projects Migoue IDCationGyou can participate in using the samples you collected.

- 4. As a team, discuss the following questions.
 - How can identifying the mosquitoes living in our community be helpful to understand the distribution of mosquitoes?
 - Problem question: How can we ensure health for all from mosquito borne diseases?

Hooray! You completed Task 3-5. Check it off the task list. Go to Task 3-6!

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3-6) Analyzing Community Surveys (Life)

In Task 2-3, the team surveyed people in your local community about mosquitoes.



In this task, you will do the same analysis you did during Task 2-4. Now you will focus on the community survey results only for Part Three: Life. The team will analyze the other parts of the survey in future tasks. So, keep the survey results in a safe place.

In this task, the team will be focusing on the following questions from the question map in task 1-10. What do people in our local community think and know about mosquitoes and mosquito-borne diseases? How can we effectively share and communicate mosquito borne disease evidence with the community?

- Go to the Task 3-6 folder and get the survey analysis instructions and questions. Choose the Mosquito A or Mosquito B task from the task folder.
- 2. As a team, determine how to compile the community survey results for part three for all team members. You will want to analyze the compiled data from the entire team and community. Develop your own method for compiling the data for part three, or use one of the methods in the instructions.
- Create some graphs about this compiled community survey data. Use the instructions and examples in the task folder.
- 4. Use the graphs and data to answer these questions.
 - What interesting patterns do you see in the data from part three questions?
 - Which questions did most people in the community agree on?





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As you may have noticed, the survey is broken into the same parts as this research guide. Analyze only the results from that part of the survey while working on that Part of the guide to make the analysis more manageable.

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- Which questions did people in the community have different responses for?
- Discuss how this survey evidence could be useful when thinking about the question: What do people in our local community think about mosquitoes and mosquito borne diseases?
- Discuss how this survey evidence could be useful when thinking about the question: How can we effectively share and communicate mosquito borne disease evidence with the community?
- Discuss how this survey evidence could be useful when thinking about the problem question: How can we ensure health for all from mosquito-borne diseases?
- 5. Select one or two survey questions, write a claim, and provide the supporting evidence for the claim based on the question and evidence collected.
- 6. Examples:
 - The local community does not have a good understanding of what time of day mosquitoes bite.
 - The local community does not have a good understanding that only female mosquitoes can transmit diseases to humans.
- 7. Explain how the data evidence from the community survey supports your claims.
- 8. As a team, share some claims you created and the evidence that supports those claims.

Hooray! You completed Task 3-6. Check it off the task list. Go to Task 3-7!

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Debriefing Life

This is the last task of Part Three: Life.



In this task, we will debrief Part Three: Life. This is good to do before we move on to the next part. The objective is to think about and discuss helpful information that was gathered during that part.

- 1. Remember the team norms.
 - Recognize the benefits of listening to a range of different perspectives and viewpoints.
 - Be open to new ideas and perspectives that challenge your own.
 - Be willing to cooperate with others to change things for the better.
- 2. Remember to use your meaningful conversation starters as needed throughout this discussion.
 - I agree with _____ because...
 - I disagree with _____ because...
 - I'd like to go back to what _____ said about ...
 - I'd like to add_____
 - I noticed that ...
 - Another example is ...
- 3. Remember when you are making claims from evidence to use the following sentences.
 - I think this claim is best supported because ...
 - I do not think this claim is best supported because ...
 - I think this piece of evidence supports this claim because ...
 - I do not think this piece of evidence supports this claim because ...

Mosquito!







- 5. Follow the instructions in the task folder to complete the five sections of the debrief.
 - Question map analysis
 - Community partners
 - Perspectives
 - Identity
 - Problem guestion

Hooray! You completed Task 3-7 and Part Three. Check it off the task list.

Congratulations, you have completed Part Three of your research. Give yourself a pat on the back. You now know more about the life of the mosquito. Keep this research easily available. Think about how it could help with your final project. The next part of your research will focus on understanding more how diseases are transmitted or spread to humans. This includes learning about:

- Mosquito-borne disease distribution
- Disease hosts
- Factors that affect transmission

Continue to Part 4: Transmission

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Task 3-1 Collecting Mosquito Eggs



Materials and Procedure







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General Materials



- Scissors
- Pliers or other sharp object
- Permanent marker
- Scotch tape
- Water







Oviposition Cups



You will need TWO cups. Any material will work.

The interior of the cups must be a dark color.

If you do not have dark cups, you can use tape, fabric, or another material to make the inside of the cups dark.





Oviposition Surface/Substrate



You will need a surface for the mosquito eggs to cling to.

Here are some examples of materials that can be used:

- Paper towel
- Wooden tongue depressor
- Popsicle stick
- Cotton fabric







Step 1: Prepare Oviposition Cups

Label each cup with:

- Its name (A or B)
- Its location (sun or shade)
- Today's date



Use the pliers (or other sharp object) to poke 2-3 small holes in each cup.

The holes should be about 2/3 of the way up from the bottom of the cup.

The holes will drain excess water.











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Mosquito! Part 3. Life: Task 3-1

Step 2: Prepare Oviposition Surface/Substrate

Option 1: Paper towel or fabric



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Measure and cut 2 strips of material.

They should be about 2/3 of the height of the cup.

Label the corner of each strip the same way you labeled the cups.

Option 2: Popsicle stick or tongue depressor



You will need two sticks.

Label the tips of each stick the same way you labeled the cups.







Mosquito! Part 3. Life: Task 3-1

Step 3: Assemble Collection Device

Option 1: Paper towel or fabric



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Cross section

Roll each strip so that the label is on the inside and place it inside the corresponding cup.

The material should sit about 1/3 of the way from the bottom of the cup. Secure with tape if necessary.

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Option 2: Popsicle stick or tongue depressor



Place each stick inside the corresponding cup.

Step 4: Placing the Trapping Cups (Sun vs. Shade)



Fill the cups about 2/3 of the way up with water. Excess water will drain out of the holes.

Place Cup A in a sunny location and Cup B in a shady location.

Mark the location of your cups on your research map you created in Task 2-1.

Using the Egg Collection form, document:

The presence of plants within a 5 foot radius of cup.







Mosquito! Part 3. Life: Task 3-1

Step 4: Collecting Eggs



Tip: If you live in a windy area, you can place a washer, rock, or other heavy object in the bottom of the cup to weigh it down.







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Step 5: Experiment Notes

- In this experiment, you will collect data on whether eggs are found in a particular container or not (sun vs. shade).
- The Response variable is the presence of eggs in a particular container or not.
- The Explanatory variable is the location (sun vs. shade)
- Create a hypothesis about which container you think will capture more eggs.





Step 6: Collecting Eggs

- Leave the cups out for 7 days, refilling to 2/3 level as necessary. Check daily.
- After 7 days, take the germination surface out of the cup to collect your eggs. Check the water in the cup for any larva moving around.
- If you find larva in the water, move them to a container, such as the setup option for an Emergence Chamber described in Task 3-4.
- Use one of those setups so you can safely observe them over the next few weeks.
- Complete the rest of the collection form.
- If you are participating in the Invasive Mosquito Project, mail your eggs according to the directions in the egg collection procedure.
- Even if you are participating in the Invasive Mosquito Project, save some of the eggs and place them into either the Adult mosquito trap in the Emergence Chamber setup described in task 3-4. This will allow you to safely observe first instar larvae hatching from eggs and further develop into fully mature larvae and pupae inside of the container.





Including Experimental Design in Egg Collection (optional)

- The egg collection experiment is a great opportunity to explore and test the many different variables in the design.
- These experiments can help your team evaluate and determine which collection setups work the best in your location.
- As you work through this guide, think about how you could setup an experiment to explore different variables in this setup.
- Think about how you could control these variables to determine their effect on mosquito egg capture.
- Use the following guidance to design an experiment of your own.
- This is not required, but an option if you are interested in exploring!





Including Experimental Design (optional)

There are a variety of variables you can test in this setup. As you learn more about the basic collection procedure think about how you could design an experiment to test these variables and their effect on mosquito egg collection.

- Cup Size
- Cup color
- Cup interior color
- Cup material
- Cup Opacity
- Water color or composition (add food coloring, organic matter such as soil or plant matter, fish food, sugar, yeast)
- Hole placement
- Amount of cup that is covered or open
- Germination surface (wood, paper towel, cotton, wood wrapped in paper towel or cotton)
- Water vs. no water
- Cup placement (shade, sun, partial sun, inside vs. outside)





Including Experimental Design in Egg Collection (optional)

Use the following questions to help you design your experiment.

- State your question.
- State the purpose of your experiment.
- State your Hypothesis.
- List your variables.
 - What is your independent variable?
 - What is your dependent variable(s)?
 - What is your controlled variable(s)?
 - Make sure you are conducting a fair test by only changing one variable per experiment.

• Design your Experiment.

- What materials will you use?
- Write out the procedure for your experiment.
- Provide any pictures or drawings to illustrate your setup.
- What will your control setup include?
- Will you conduct multiple trials?

• Conduct Experiment and Share results with the team.





Variables- Conducting additional Experiments

You can test different variables of the egg collector to see which features make for the most effective design.







Suggestion 1: Change the coverage of the germination paper in the cup. But, keep the amount of water, size of cup, and color inside all constant.

Suggestion 2:

Change the color of the inside of the cup. But, keep the amount of water, size of cup, and color inside all constant.

Suggestion 3:

Change the size of the cup. But, keep the amount of water, the color inside, and the coverage of the germination paper all constant. These are a few suggestions, but feel free to get creative and think about what other variables can be changed. Remember to only change one variable at a time when conducting more tests. Keep all other variables constant. This way you can determine what variables are making certain traps more effective in collecting eggs.

- Cup material
- Cup Opacity
- Water color (add food coloring or organic matter)
- Hole placement
- Interior material composition (paper/cotton/polyester/plastic)
- Amount of cup that is covered or open







Mosquito! Part 3. Life: Task 3-1

Others ways to collect mosquito larvae

You can use any vessel that holds standing water to collect mosquito larvae. Here is a list of some ideas:

- Empty food containers
- Buckets
- Bird baths
- Tires
- Tarps
- Wheelbarrows
- Toys
- ***Just make sure if you place a collection vessel outside to check it regularly so eggs are not given enough time to grow into adults.













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Collected Eggs Example Just remember they are very small!











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Active Surveillance - Others ways to collect mosquito larvae

Collect live samples

- 1. Go outside where your team meets or around your house and look for live mosquito larva + pupae in puddles, water filled containers, and anywhere that water naturally pools.
- 2. Look for things that wiggle around when the water or container is disturbed.

3. Use a net, spoon, eye dropper, turkey baster, or other device to move the larva into a container for observation. Observation containers can be plastic bags, clear plastic bottles or glass jars.

4. If taking the containers with live larva or pupae inside a building, make sure they cannot escape if they turn into adult mosquitoes.

5. If you are able to view the collected larva or pupae under a microscope, do it! Describe what you see.

 ***Just make sure if you place a collection vessel outside to check it regularly so eggs are not given enough time to grow into adults.





Citizen Science in United States

- If you are collecting mosquito eggs in the United, participate in the Invasive Mosquito project if you can. Find more information here to participate :
- http://www.citizenscience.us/

Citizen Science in Australia

- If you are collecting mosquito eggs in Australia, participate in the Zika Mozzie Seeker project if you can. Find more information here to participate :
- https://metrosouth.health.qld.gov.au/zika-mozzie-seeker





Active Surveillance - Others ways to collect mosquito larvae

Collect live samples

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5. If you are able to view the collected larva or pupae under a microscope, do it! Describe what you see.

 ***Just make sure if you place a collection vessel outside to check it regularly so eggs are not given enough time to grow into adults.





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Task 3-1 Collecting Mosquito Eggs

Use the included resources for background, procedures, collection forms, and a step-by-step guide for setting up and monitoring mosquito egg collection cups. These resources include:

- Invasive Mosquito Project
 - Egg Collection Notes
 - Egg Collection Procedure and Protocol
 - Collection Record Form
- Step-by-step guide to making collection cups and monitor eggs
 - Includes optional experimental design activities for the team, if you're interested

Information on Invasive Mosquito Project—Optional Citizen Science Project

The **Invasive Mosquito Project** is a citizen science project that anyone can participate in. It is aimed at teaching research teams all over the world how to collect and monitor invasive mosquito species that live in containers. By doing this monitoring, we can determine where invasive mosquito species, as well as native species, are distributed across the world and define at-risk human and animal populations based on this distribution. This citizen science project provides anyone interested the protocols and opportunity to collect real data and contribute to a national mosquito species distribution study.

Participation in the Invasive Mosquito Project is **completely voluntary**. So no pressure at all. This is something we are recommending you participate in, but it is up to your team to decide. However, even if you decide not to participate in the Invasive Mosquito Project, we recommend the team still use the same collection protocols from this project to collect and study mosquitoes in your local space on your own.

So, let's learn more about some protocols for collecting mosquito eggs and adults in your research site. Find more information here to participate: http://www.citizenscience.us/



Invasive Mosquito Project

Collection notes

Egg Collection: In order to get a census of invasive mosquito populations, students are asked to collect eggs and send the eggs to the USDA. Doing so will give the USDA a good figure of invasive mosquito population distributions across the United States which can help with public health.

Procedure: See "Egg Collection Procedure" handout

Placement: Each student will set out 2 cups, one labeled "A" and the other labeled "B". Cup A is to be placed in a sunny location and Cup B is to be placed in a protected shady location. On the egg collection paper, students are encouraged to write about the surroundings of the cup (such as flowering vegetation nearby, shade sources, and cover plants, trees, etc).

Safety: Aedes mosquitoes feed throughout the day, therefore students should wear long sleeves, long pants, and insect repellent when near the oviposition cups. These precautions will limit exposure to potential mosquito bites and encourage good behavior and personal protection. Also, students should only place cups around their homes—traveling is not required for this process and will reduce the risk of travel-related injury.

Collection: After a week of letting the oviposition cups sit outside, the collected eggs will be dried with the egg paper and sent to the USDA in Manhattan, Kansas. If desired, ¼ of the eggs may be raised to adulthood as part of a second lesson plan where students will learn more about scientific protocols and the life stages of mosquitoes.

Counting and Shipping: When all the eggs have been collected, students should count the number of eggs on each paper and record on their personal record sheet as well as contribute to class data for shade vs. sun egg collection. Students may input their information from their personal recording sheets into the website so it may be viewed by everyone. Students should observe the difference between eggs (a magnifying glass or microscope will be useful for this) and record information with class data. Class data can be basis for discussion (why one location might have more eggs than another). When observations and discussion have ended, send 3/4th of slightly damp paper (paper should not crinkle) and eggs to a local collaborator (within the same city) who can do the identifications or the USDA in Manhattan, Kansas (USDA-ABADRU – Invasive Mosquito Project, 1515 College Ave., Manhattan, KS 66502). Please be careful when shipping eggs; do not send them to other locations because these are invasive species and can colonize locations quickly and easily. If desired, ¼ of the eggs can be reared to adulthood as part of a 2nd lesson that will also discuss in more detail the mosquito life-cycle, mosquito adaptations, transovarially transmitted mosquito diseases, and scientific protocol.
Materials

Materials participant must provide:

- Oviposition cups (ideally, interior of cup should be black, red, or dark colored)
- Germination paper (brown or dark paper towel)
- Water
- Tape
- Permanent Marker

Procedure

- 1. With a permanent marker, label germination paper (paper towels) with location information, date, cup name (A or B) and water level
- 2. Take germination paper and place ends together as to make a large tube with the paper
- 3. Place the rolled paper in the oviposition cup
- 4. Label the cup "A" on the exterior and be sure the properly labeled paper is in the cup
- 5. Punch drainage holes in the cup at 2/3 of the way to prevent over filling with water during rain or when refilling. Then fill the cup 2/3 of the way with water.
- 6. Repeat steps 1-3 one more time for the second cup, but label the cup "B"
- 7. Place cup A in a very sunny location with full sun most of the day; (the location can be any place on dirt, cement, decks, etc.) and tape or weight it down to prevent it from being knocked over.
- 8. Place cup B in a permanently shady and protected location such as under a roof or in a bush.
- 9. Check on the cups' water levels once a day

a. If the water has evaporated, refill to the 2/3 level

- b. The cup should not fill with water because of the drainage holes, but if it has, carefully dump the water so it returns to the 2/3 level (be careful of any eggs in the container)
- 10. Leave cups out for seven days
- 11. After seven days, take germination paper out of the cup and let it air dry with the eggs (this will prevent them from hatching). The paper should be slightly damp where the paper does not crinkle. Fold paper in thirds and place into a ziplock bag.
- 12. Take paper to class on scheduled day and count eggs and record datasheet to email to USDA

Safety

To avoid contact with the egg-laying mosquitoes, avoid going near oviposition cups when possible, except to add water. Participants should wear long sleeves, pants, and mosquito repellent when near the cups. For the safety of the participants and their collections, cups should be placed near the home. Teachers might also find a location near their classroom for additional cups. When observations and discussion have ended, send 3/4th of dried paper and eggs to a local collaborator (within the same city) who can do the identifications or the USDA in Manhattan, Kansas (USDA-ABADRU – Invasive Mosquito Project, 1515 College Ave., Manhattan, KS 66502). Please be careful when shipping eggs; do not send them to other locations because these are invasive species and can colonize locations quickly and easily.



Invasive Mosquito Project

Collection Record Form



School Name:	Teacher's Nan	ne:		
School's Street Address:	Teacher's Email:			
School District Number:	Date Cup was Placed (YYYY/MM/DD):			
City/State/Zip Code:	Date Cup was Retrieved (YYYY/MM/DD):			
	Collector Name(s):			
County:				
How mosquito eggs, larvae, or pupae were	Eggs		Larvae	e/Pupae
collected (circle one or many)			Open Water	Contained Water
			Ø	
	Oviposition cu	qu	Dipper cup	Turkey baster
Location of cup (circle one)	Shade	Sun		
What mosquito stage was collected? (circle one or many)	Eggs	Larvae	Pupae	Adults
How many?	Eggs=	Larvae=	Pupae=	Adults=
What species of mosquito?				
Are you sending the mosquito(s) to be identified (circle one)? If yes, who is doing the identification?	Yes	No		
Number of individuals of each mosquito species collected				
Biotic Factors	Presence of P	lants Within 5-I	Foot Radius of Cup	(circle one or many):
Abiotic Factors	TreesBushesGrassFlowersTemperature (°F) of Day Cup was Retrieved:Weather Conditions of Day Cup was Retrieved:			
	Temperature (°F) Day Before Cup was Retrieved: Weather Conditions Day Before Cup was Retrieved:			

Principal Characters for Identifying Mosquitoes of General Importance



New Jersey Agriculture Experiment Station Publication SA220-5M-86 Mosquitoes in Your Life Donald J. Sutherland, Research Professor in Entomology and Wayne J. Crans, Associate Research Professor in Entomology







Task Link for Task 3-1

Invasive Mosquito Project Link http://www.citizenscience.us/imp/









Team News Articles for Task 3-1

Lee Cohnstaedt USDA News Article 1 http://www.fox5dc.com/news/local-news/md-students-taking-part-in-researchproject-to-help-track-mosquitos-that-may-carry-zika

Lee Cohnstaedt News Article 2 https://www.denverpost.com/2016/05/16/usda-wants-citizen-scientists-tohelp-fight-zika/

Part 1. Problem. Task 3-1



Task 3-2

Comparing Mosquitoes

Question from Map:

What are the similarities and differences between mosquitoes? What behaviors make mosquitoes dangerous to humans and animals?

All images by J. Stoffer, WRBU







3-2 Data Table – Option 1

Mosquito Part	Similarities	Difference
Head		
Proboscis		
Back of the Mosquito		
Legs		
Wings		
Feeding Habits		





3-2 Data Table – Option 2

Mosquito	Head	Proboscis	Back	Legs	Wings	Feeding Habits
#1: Toxorhynchites rutilis						
#2: Aedes aegypti						
#3: Malaya jacobsoni						
#4: Anopheles gambiae						
#5 Culex pipiens						

₩





3-2 Observation Table – Option 3

• Make your own data table!







#1: Toxorhynchites rutilis



(top view of back of mosquito)









Mosquito! Part 3. Life: Task 3-2

#1: Toxorhynchites rutilis

Head (side view)



CuA

Wing







#1: Toxorhynchites rutilis

- Feeding Habits:
- Females and males feed on fluids, such as nectar and sugars from plants, such as flowers.





#2: Aedes aegypti



(top view of back of mosquito)









#2: Aedes aegypti

Head (side view)



Wing









#2: Aedes aegypti

Feeding Habits:

- Males and females feed on the nectar and sugar from plants and flowers.
- Females also feed on human blood. Only the females bite humans during the day, but feeding may occur any time between sunrise and sunset. Females are also known to attack humans at night in artificial light and even total darkness. Females bite humans in forested areas.





#3: Malaya jacobsoni



(top view of back of mosquito)







Mosquito! Part 3. Life: Task 3-2

#3: Malaya jacobsoni

Head (side view)









Mosquito! © 2018 Smithsonian Institution

Wing

#3: Malaya jacobsoni

• Feeding Habits

• Females and males both feed on the regurgitation (throw-up, vomit) of ants. To accomplish this, the mosquito accosts an ant and brings the tip of its proboscis into contact with the mouth of the ant until a drop of liquid is produced. The regurgitated liquid is rapidly sucked up and the ant goes away unharmed.





#4: Anopheles gambiae



(top view of back of mosquito)







Mosquito! Part 3. Life: Task 3-2



#4: Anopheles gambiae

Head (side view)









Wing

#4: Anopheles gambiae

• Feeding Habits:

- Males and Females feed on sugar from plants, such as flowers.
- Females of *Anopheles* also feed on humans for their blood. They mainly feed on humans late at night both inside and outside of the home.





Mosquito! Part 3. Life: Task 3-2

#5 Culex pipiens



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(top view of back of mosquito)



Mosquito! Part 3. Life: Task 3-2

#5 Culex pipiens



Head (side view)









Wing

#5: Culex pipiens

• Feeding Habits:

- Males and Females feed on sugar from plants, such as flowers.
- Females of *Culex* also feed on humans for their blood. They mainly feed on humans late at night both inside and outside of the home.





Extension - Readings

• Use the resources in the Learning Lab 3-2 Task Folder to read more about interesting anatomy and behaviors of mosquitoes.











Mosquito! Task 3-2 Comparing Mosquitoes

Medically Important Mosquitoes



David Pecor - Walter Reed Biosystematics Unit (WRBU)

There are thousands of species of mosquitoes in the world. However, only a small number of them are medically important. Medically important means they are mosquitoes that can spread diseases to humans or other animals. Not all mosquitoes can spread diseases to humans. Only about 10 percent of all mosquitoes are medically important. This is a very small number of all the mosquitoes on the planet. So it is helpful for your reserach to focus on the ones that cause the problems. When studying these medically important

mosquitoes, it is important to understand their different behaviors. Behaviors include the time of day they feed on humans, where they like to rest, and what animals they like to bite. We must think about these behaviors when developing solutions to the problem in a community. We also mainly focus on studying female mosquitoes. Female mosquitoes are the only ones that bite or get blood from a human. Males do not feed on humans. So males are not currently of medical importance. Here is data on three medically important mosquitoes the research community has identified.



Mosquito name: Aedes aegypti

Hosts: Female Aedes aegypti commonly feed on dogs, deer, rabbits, and humans.

Feeding time: Females primarily bite during the day. They commonly enter buildings to feed. They do their searching at two different periods of the day: in the morning and later on in the day. Depending on the environment, *Aedes* mosquitoes will adjust their hours of

feeding. So when humans change their behavior, the mosquito will as well. This helps them find a host.

Resting behavior: *Aedes* rest in open clearings or areas where there is amplespace and containers for egg laying. In some areas they have been foundresting at the edge of forests where a canopy is present.



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Meet the Team



Mosquito name: Culex pipiens

Hosts: Culex pipiens females seek mammal hosts, including rabbits, horses, cattle, and humans.

Feeding time: They primarily bite humans a few hours after sunset. Females typically attack humans both indoors and outdoors.

Resting behavior: Adults commonly rest during the daytime in shaded areas such as tree cavities and animal burrows.



Mosquito name: *Anopheles* gambiae Hosts: Female *Anopheles* gambiae prefer to feed on human hosts.

Feeding time: Females usually feed on humans at night. Some have been found to feed in early evening and early morning.

Resting behavior: After taking blood

from a human, females often rest on nearby walls within the human host's home.







Team News Articles for Task 3-2

David Pecor WRBU News Article

https://insider.si.edu/2016/06/smithsonians-mosquito-collection-weapon-battlezika/









Additional Articles for Task 3-2

Inside a Mosquito's Heart http://www.smithsonianmag.com/science-nature/inside-a-mosquitos-heart-37230148/

How Mosquitoes Are Out-Smarting Humans http://www.smithsonianmag.com/smart-news/how-mosquitoes-are-outsmarting-humans-60585253/

How Do Mosquitoes Fly in the Rain? http://www.smithsonianmag.com/science-nature/how-do-mosquitoes-fly-in-therain-116626497/









3-3 Investigating Mosquito Distribution:

Monitoring Local Weather Instructions and Log Table

When studying mosquitoes, it is useful to understand changes in local weather throughout the year. The team will need to compare this local weather data to your observations of mosquitoes in the research site. This information will help support your claims about when mosquitoes may be more of a problem for the community. It will also help support claims about the possible future effects on mosquitoes of changes in the climate in your community. Depending on what resources you have available, you can monitor your local weather in many different ways. Pick the method that works best for you.

- 1. Use current and historical weather data collected by regional weather stations. This data can be collected online or from television or radio broadcasts.
- 2. Use tools to manually collect temperature and precipitation data in your research site.
 - **a.** Build your own weather station. Use the NOAA instructions to build your own weather collection tools to track data over time in your research site.
 - **b.** Purchase and set up a weather station in your research site.
- 3. The team will focus mainly on temperature and precipitation data at this time. However, please collect any other weather data you think could be useful for your research or would like to explore. These could include:
 - a. Wind speed
 - **b.** Wind direction
 - **c.** Atmospheric pressure
- 4. Use or make a data table to collect daily or weekly measurements in your research site throughout the year.
- 5. Mark on your research site map from Task 2-1 where you are taking your daily or weekly measurements.
- 6. When collecting weather data, make a daily general mosquito observation in your research site. Do you see adult mosquitoes in or around your site? If so, can you do a general count?
- 7. If you are collecting mosquito eggs as outlined in Task 3-1, note on your data sheet what days you did or did not collect eggs.
- 8. Compare your temperature, precipitation, and egg and adult collection data.
- 9. How could this data be useful to address the problem question: How can we ensure health for all from mosquitoes?





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Weather Observation Data Table

Date	Time	Outside	Precipitation	Notes (observations of
		temperature (°C)	(mm)	mosquitoes in research site,
				atmospheric pressure, wind)

Go back to Research Guide now





Task 3-3 Investigating Mosquito Distribution

Mosquito Distribution Maps

Questions from Map: Where do mosquitoes live? What factors influence where they live?







Step 1 – Political Distribution

- Look at the Political map of the World on the next slide.
- As a team, find the country where you live. Where inside this country do you live?
- What are the names of some other countries near or around you?





Mosquito! Part 3. Life: Task 3-3







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Step 2 – Aedes and Political Distribution

- Look at the Global Distribution Map of the Aedes Mosquito on the next slide
 - Work with your team to read the instructions and understand the color scale
- Find where you live on this Aedes distribution map
- Using the color key, what is the probability or chance that Aedes live where you live?
- Describe the distribution of *Aedes* in countries near or around where you live.
- Describe the distribution or patterns of *Aedes* in other parts of the world.
- Using the World Political Map and Global *Aedes* Map together, make a list of the names of some different countries where *Aedes* has a very high probability or chance of living.
- Identify some clear lines of divide between areas of high and low mosquito distribution.
- What do you think could be causing these patterns?
- What could this relationship possibly tell you about the environment *Aedes* prefer to live in?





Global Distribution Map of Aedes Mosquito

The color tells us how likely it is to be present at that location. Blue indicates low probability or chance of there being *Aedes* mosquitoes Yellow indicates higher probability or chance of there being *Aedes* mosquitoes Red indicates very high probability or chance of there being *Aedes* mosquitoes






Step 3 – Temperature, *Aedes* and Political Distribution

- Look at the Average annual Temperature map
 - This map tells you how hot or cold on average a place is throughout the year.
 - Red indicates it is hotter
 - Blue indicates it is colder
- Find where you live on the Temperature map
- What is the approximate average annual temperature where you live?
- Describe any patterns you notice on the temperature map.
- List some countries where the average temperature is very low. List some countries where the average temperature is very high.
- Compare and contrast the patterns on the *Aedes* map to the Average Annual Temperature map.
- Do you see any similarities between where *Aedes* live and the temperature?
- List some countries and places where you see very similar patterns between the temperature and *Aedes* mosquitoes.
- What does this relationship possibly tell you about the environment Aedes prefer to live in?





Average Annual Temperature



Data taken from: CRU 0.5 Degree Dataset (New, et al.)

Atlas of the Biosphere

Center for Sustainability and the Global Environment University of Wisconsin - Madison





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Step 4 – Precipitation, Temperature, *Aedes* and Political Distribution

- Look at the Annual Total Precipitation map
 - This map tells you how much it rains in a place throughout the year.
 - The darker areas mean it rains more there
 - The lighter areas mean it rains very little there
- Find where you live on the Precipitation map
- What is the approximate annual precipitation where you live?
- Describe any patterns you notice on the precipitation map.
- List some countries where the precipitation is very low. List some countries where the average precipitation is very high.
- Compare and contrast the patterns on the *Aedes* map to the Precipitation map.
- Do you see any similarities between where *Aedes* live and the amount it rains there?
- List some countries and places where you see very similar patterns between these two maps.
- List some countries and places where you see very similar patterns between the *Aedes* map, the Annual Total Precipitation map, and the Average Annual Temperature map.
- What does these relationships possibly tell you about the environment *Aedes* prefer to live in?





Annual Total Precipitation



Data taken from: CRU 0.5 Degree Dataset (New et al)

Atlas of the Biosphere

Center for Sustainability and the Global Environment University of Wisconsin - Madison







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Step 5 - Anopheles, Precipitation, Temperature and Political Distribution

- Look at the map showing the distribution of the mosquito Anopheles globally.
 - Work with your team to read the instructions and understand the color scale
- Find where you live on the *Anopheles* map. Do *Anopheles* mosquitoes live where you live?
- Describe any patterns you notice on the Anopheles map.
- What are some countries that might have high probability of *Anopheles*, use the political map to see the names?
- Compare and contrast the patterns on the *Anopheles* map to the *Aedes* mosquito map.
- List some countries where both *Aedes* and *Anopheles* mosquitoes are probably living.
- List some countries where Aedes mosquitoes are probably living, but Anopheles are not.
- List some countries where Anopheles mosquitoes are probably living, but Aedes are not.
- Compare the *Anopheles* map with the Annual Total Precipitation map and the Average Annual Temperature map.
- What do these relationships possibly tell you about the environment *Anopheles* prefer to live in?





Distribution of Anopheles mosquitos

The orange area indicates where they are likely to be found. The grey indicates areas where they are not likely found.









Mosquito! © 2018 Smithsonian Institution

Step 6 - *Culex,* Precipitation, Temperature and Political Distribution

- Look at the map showing the distribution of the mosquito *Culex* globally.
 - Work with your team to read the instructions and understand the color scale
- Find where you live on the *Culex* map. Do *Culex* mosquitoes potentially live where you live?
- Describe any patterns you notice on the *Culex* map.
- What are some countries that might have high probability of *Culex*, use the political map to see the names?
- Compare and contrast the patterns on the *Culex* map to the *Anopheles* and *Aedes* mosquito maps.
- List some countries where *Culex, Aedes* and *Anopheles* mosquitoes are all potentially living.
- List some countries where *Culex* are living, but *Aedes* or *Anopheles* are not.
- Compare the *Culex* map with the Annual Total Precipitation map and the Average Annual Temperature map.
- What do these relationships possibly tell you about the environment *Culex* prefer to live in?





Distribution of *Culex* mosquitos

The orange area indicates where they are likely to be found. The grey indicates areas where they are not likely found.







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Build Your Own Weather Station



"I believe there is a train under here somewhere!"

Standing tall on North Dakota snow. A March blizzard nearly buried utility poles. Caption jokingly read "I believe there is a train under here somewhere!" Courtesy Dr. Herbert Kroehl, NGDC Every year, thousands of lives and millions of dollars are saved by severe weather warnings from the National Weather Service. From its earliest beginnings (on February 9th, 1870), the primary mission of the National Weather Service has been to protect life and property by providing information about dangerous weather conditions. Originally, the National Weather Service was called "The Division of Telegrams and Reports for the Benefit of Commerce" and was part of the U.S. Army. Later, its name was shortened to the Weather Bureau and it became part of the Department of Agriculture, then the Department of Commerce.

The first "weathermen" were "observing-sergeants" of the Army's Signal Service Corps. Weather forecasting in those early years was based almost entirely on the assumption that the weather observed in one location on a particular day would move to downwind locations on following days. Today, satellites, computers, and a variety of scientific instruments are added to this basic assumption to make accurate weather predictions and provide warnings about dangerous weather.

Here's how you can make your own weather observation station!

What You Will Do Build six instruments that you can use to make scientific measurements of your local weather

Build an Anemometer to Measure Wind Speed

What You Will Need

- □ Five paper cups Three ounce size
- **T**wo straight plastic soda straws
- □ Straight pin
- **D** Paper punch
- □ Stapler
- □ Sharp pencil with eraser
- **D** Felt tip marker
- □ Watch or timer

Warning

Be careful with the straight pin!

How to Do It:

- 1. Using a paper punch, punch a hole in four paper cups about 1/2-inch below the rim of the cups.
- 2. Punch four equally spaced holes in a fifth paper cup about 1/4-inch below the rim, and a fifth hole in the center of the bottom of the cup (you will probably need to use the pencil to make the hole in the bottom).
- 3. Push a soda straw through the hole in one of the first four cups. Flatten the end of the straw and staple it to the side of the cup



opposite the hole. Repeat this step with the other straw and another of the first four cups.

 \mathcal{Y} . Slide one of the cup and straw assemblies through two opposite holes in the side of the fifth cup. Push another one-hole cup

onto the straw, and turn this cup so that the open ends of the two cups on the straw face in opposite directions. Flatten the end of the straw, and staple it to the side of the second cup. Measure the distance between the centers of the two cups. This is the diameter of your anemometer.

- 5. Repeat Step 4 with the remaining cup and straw assembly and the remaining one-hole cup. Before stapling the end of the straw to the last cup, turn the cups so that the open end of each cup faces the closed end of the next cup.
- 6. Adjust the cup and straw assemblies so that they are centered inside the fifth cup. Push the straight pin through the two straws where they intersect.
- 7. Push the eraser end of the pencil through the hole in the bottom of the fifth cup, and push the straight pin into the eraser as far as it will go. Now your anemometer is ready to use.
- 8. To use the anemometer, hold the pencil vertically in a wind, and count the number of revolutions per minute (use the felt tip marker to make a mark on one cup so that you can easily see when the cup has travelled through one complete revolution). To convert revolutions per minute (rpm) into approximate wind speed:



a. Multiply rpm by the diameter (in inches) of your anemometer (measured in Step 4)

b. Multiply the result by 0.003. This is the approximate wind speed in miles per hour.

This calculation does not give exact wind speed, because drag, friction, and other forces also affect the speed at which your anemometer rotates.

Build a Weather Vane to Find Wind Direction

What You Will Need

- Broomstick or long wooden dowel, about one inch diameter
- Aluminum baking dish, about six inches x nine inches
- Wood stick, about 3/4 inch square and 12 inches long
- □ Nail, about one inch long
- Metal washer with a hole slightly larger than the nail
- Duct tape
- □ Small saw or serrated knife
- Scissors strong enough to cut the aluminum baking dish
- □ Ruler or tape measure
- □ Silicone or other glue that will stick to aluminum
- □ Leather gloves
- Optional) Hand drill, and small drill bit slightly larger than the nail

Warning

Be careful of the sharp edges on the pieces of cut aluminum! Use gloves to protect your hands until the edges are taped.

How to Do It

- Use the saw or serrated knife to cut a notch about 1/2-inch deep into each end of the wood stick. The notches shuld be parallel (see drawing on page 65).
- 2. Rotate the stick so that the two slots are vertical. Use the ruler or tape measure to find the exact center of the wood stick.

tail

Mark this spot on the upper surface of the stick, and drive a nail through the marked spot. Be careful: if the nail is too big, the stick will probably split. To avoid this, drill a hole slightly larger than the nail through the marked spot. You may need an adult to help with the drilling.

3. Cut the head and tail pieces of the Weather Vane from the aluminum baking dish using the pattern as a guide. Be Careful—The Edges Are Sharp! Use duct tape to cover the sharp edges.





or dowel, by placing the washer on one end of the dowel and hammering the nail through the wooden stick into the dowel. you can while still keeping it steady and secure.

Build a Barometer for Measuring Atmospheric Pressure

What You Will Need

- □ 12-inch ruler
- Drinking glass or other container with sides tall enough to support the ruler
- Clear plastic drinking straw or piece of clear plastic tubing, about 12-inches long
- □ Modeling clay or chewing gum
- Clear tape
- □ (Optional) Food coloring

How to Do It

- Tape the plastic straw or plastic tubing to the ruler so that one end is lined up with the "1/2-inch" mark on the ruler.
- 2. Stand the ruler-tubing assembly upright in the glass (or other container), and tape the assembly to the top of the container.
- 3. Fill the container about 3/4-full of water. If you want colored water, first mix food coloring with the water in another container.
- ⁴. Use the modeling clay or chewing gum (you'll have to chew it until it is soft enough) to plug the end of the straw or plastic tubing near the top of the ruler.

5. Carefully pour out some of the water so the container is about half full. Be sure the lower end of the straw or tubing stays beneath the water surface while you do this! When you are finished, the water in the gum or clay straw or tube should be higher than the water in the container. Your barometer is now fintape ished. Since barometers are sensitive to minor changes in weather conditions, keep your clear straw or

plastic tubing

ruler

glass container

tape

Keep a daily record of the height of the water in the tube, using the scale on the ruler. The water level in the tube will rise and fall as atmospheric pressure changes. When atmospheric pressure increases, air presses on the surface of the water in the container causing the height of

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barometer indoors for

greatest accuracy.

the water in the tube to rise. When atmospheric pressure decreases, there is less pressure on the surface of the water in the container so the height of the water in the tube falls. Decreasing atmospheric pressure usually indicates that a low pressure area is approaching, and this often brings clouds and rain. Increasing atmospheric pressure often indicates fair weather.



Finished Barometer

Build a Screened Thermometer to Measure Air Temperature

What You Will Need

- A wooden or plastic box, large enough to hold the thermometer and your hygrometer; see Step 1 under "How to Do It"
- □ Thermometer, about 0°F to 120°F
- **D** White paint and paint brush
- Nails, screws, glue, or tape to attach the thermometer to the box

How to Do It

- 1. The wood or plastic box is supposed to protect your weather instruments from wind, rain, and direct sun, but still allow air to circulate so the instruments can get accurate readings. A box with a hinged lid that can be turned on its side is perfect. Turn the box on its side, and cut several slots near what is now the bottom of the box. Paint the outside of the box with white paint, and find a safe, shady outdoor location. The north side of buildings has the most shade. Try to find a location that is three to four feet above the ground.
- 2. Attach the thermometer to the back of the box with tape, glue, screws, or nails. The bulb of the thermometer should be about two inches above the bottom of the box.

Build a Hygrometer to Measure Humidity

What You Will Need

- Piece of wood or styrofoam about nine inches long and four inches wide
- Flat piece of plastic, thin enough to cut with scissors; about three inches long and one inch wide (an old credit card or laminated luggage tag works well)
- Two small nails
- Three strands of human hair, about eight inches long
- 🗖 Dime
- 🗖 Glue
- Tape
- Hammer
- **D** Scissors

How to Do It

1. Cut the plastic into a pointer as shown on the pattern below.



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- 2. Poke one of the nails through the pointer near the base of the triangle. Wiggle the nail around until the pointer moves freely and loosely around the nail.
- 3. Tape the dime onto the pointer near the tip of the triangle.
- $\ensuremath{\mathcal{H}}$. Glue the hair strands onto plastic between the nail hole and the dime.
- 5. Use a nail to fasten the pointer to the wood or styrofoam base about 3/4 of the way down the side. Be sure the pointer can still turn freely on the nail.
- 6. Attach the other nail to the base about one inch from the top of the base, in line with the spot where the hair is glued to the pointer.
- 7. Pull the free ends of the hair tight so that the pointer is horizontal. Wrap the hair

around the upper nail and glue to hold the hair in place.

- & Make a photocopy of the scale and cut it out. Glue the scale to the base so that the pointer is pointed to the "0" mark. Your hygrometer is finished!
- 7. Human hair will expand and lengthen when the air is moist, causing the pointer to move down. When the air is dry, the hair will contract and shorten, causing the pointer to move up. Use the scale to record the pointer's position. Keep your hygrometer in a sheltered location. The box used for the screened thermometer is ideal.

15

10 5

-10 -15



http://noaa.gov

Build a Rain Gauge to Measure Rainfall

What You Need

- Straight-sided glass or plastic container, with a diameter of about two inches or less (such as an olive jar)
- Coat hanger or wire bent to make a holding rack (see picture)
- Measuring spoons: One teaspoon and 1/4 teaspoon
- □ Hammer and nails to secure the rack
- $\ensuremath{\square}$ Felt tip marker

How to Do It

1. Rain gauges measure the amount of rainfall in cubic inches. So your first task is to make a scale for your container that shows how many cubic inches of water are in the container. One cubic inch of water is about 3 1/4 teaspoons, so you can draw the scale on your container by measuring 3 1/4 teaspoons of water to your container, then drawing a short line at the level of the water. If you look closely, the top of the water will seem to be slightly curved and thickened. Draw your line so that it matches the bottom of the curved surface (which is called a meniscus). This line corresponds to a rainfall of one inch.

- 2. Add another 3 1/4 teaspoons of water to the container and draw another line. The second line corresponds to a rainfall of two inches.
- 3. Repeat Step 2 until you have at least five marks on the container. This will be enough for most rain events; but you may want to add another line or two, just in case!
- 4. Find a location for your rain gauge where there is nothing overhead (such as trees or a building roof) that could direct water into or away from your gauge. The edge of a fence away from buildings is often a good spot. Another possibility is to attach your

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rain gauge to a broomstick driven into the ground in an open area. Be sure to record rainfall soon after a rain event to avoid false readings caused by evaporation. Empty your gauge after each reading, and you are ready for the next event!

This activity is adapted from "Build Your Own Weather Station" by the Educational Technology Programs Team at the Franklin Institute, Philadelphia, PA (<u>http://www.fi.edu/</u> weather/todo/todo.html).

Finished Rain Guage

glass container

coat hanger or wire



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Mosquito!

Task 3-4 Understanding Mosquito Life Cycle—Mosquito A

Cut out the pictures.

Put the pictures in the life cycle chart in the order you think they belong.

Label each stage.

Images: J. Stoffer, WRBU











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Mosquito!

Use one or both of the following pieces of evidence to assess your life cycle chart.



Image: LCOSMO/iStock/Thinkstock



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Mosquito!



Image: LCOSMO/iStock/Thinkstock

Additional resources for this task (images and videos) can be folder. View these resources in the Task 3-4 folder on Learnir

Based on this picture and any of the videos you watched, revis needed.

Mosquito life cycle PowerPoint: Use the PowerPoint in the task folder to go over life cycle vocabulary and parts of the cycle, as needed.

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Task 3-4 Understanding Mosquito Life Cycle—Mosquito B

1. Additional resources for this task (images and videos) can be found in the Learning Lab task 3-4 folder. View these resources in the Task 3-4 folder on Learning Lab.

2. Mosquito life cycle PowerPoint: Use the PowerPoint in the task folder to go over life cycle vocabulary and parts of the cycle.

3. Mosquito life cycle emergence chambers activity: Follow the instructions in the HHMI mosquito life cycle emergence chambers activity to observe the life cycle with live mosquitoes.

Build the emergence chamber described in these instructions, and use any eggs or larvae you collected during Task 3-1. Do not use any collected adult mosquitoes for this activity.

Place the eggs or larvae you collected in Task 3-1 from your research site into the emergence chambers described in this task.

Record your results and observations according to the instructions in the activity.

Analyze your results according to the instructions.

Safety: Make sure to follow the disposal instructions after all adults have emerged! If you're concerned about safety or mosquitos getting released indoors, complete the entire experiment outside.

4. Extension: Using the materials, setup, and live egg samples from the life cycle activity, experiment with factors (temperature, light exposure, water composition) that might affect the mosquito life cycle. Use the instructions in the task folder to help set up your experiment and collect the results. Share the results of the team experiments and determine how these results could help with the problem question.





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mosquito habitat mapper





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What do you know about the life cycle of mosquitoes?



Mosquito Life Cycle Four stages: Egg, Larva, Pupa, Adult



Important Vocabulary

Egg: laid in or near water; hatches to become larva.

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Larva: (larvae) immature form that lives in water; breathes at surface; eats microorganisms; molts four times to grow.
Instar: phase between two periods of molting. (We observe the 4th instar- which is also called a "wiggler.")
Pupa: (pupae) last immature stage before emerging as an adult. Non-feeding stage.
Also known as tumblers.
Adult: flying insect

*Length of each stage depends on species and ambient temperatures.







The adult female mosquito lays eggs in or near water. The eggs are deposited singly, or attached together to form rafts.

Some mosquitoes, like those that transmit yellow fever mosquito and dengue, prefer to lay their eggs in small containers near humans- like flower pots and water containers.

Most eggs hatch into larvae within 24-48 hours after becoming moist but some can also persist for weeks or months through dry periods. Others can withstand subzero winters!





Egg

Many mosquitoes lay eggs on the surface of fresh or stagnant water. If they prefer open air, breeding sites they usually choose where the water is sheltered from wind by vegetation. Other mosquitoes prefer a protected habitat, such as a natural container (tree or rock holes) or an artificial container, such as a dish or cup. Eggs can be found in pastures, tree holes, and stream bottoms and hatch when flooded with water.

- *Culex* lay eggs in a "raft" that floats on the surface of the water.
- Anopheles lay single eggs on the water surface
- *Aedes* lay eggs in damp soil or on the sides of containers; the eggs begin to develop when the water level rises and floods the eggs.





Larva

The larva hatches from the egg and lives in the water. Some mosquito eggs, however, need to be dried completely before they will hatch.

Most species, such as found in *Culex* and *Aedes* genera, have a siphon or air tube and spend most of their time on the surface breathing. *Anopheles* does not have a siphon. Instead, it lays parallel to the surface and breathes through openings on its 8th abdominal segment (spiracles).

Some species have specialized siphons and attach to emergent plants found in water, using the plant tissue to access air to breathe.





Larva

Larvae eat constantly- feeding on algae, plankton, fungi, bacteria and other aquatic organisms. One genera of mosquito is specifically adapted to eat other mosquito larvae!

The larvae hang on the surface of the water with their mouths open. They have brushes (hairs around their mouth) that filter water- so only particles small enough to be eaten enter the mouth.





Larva

- During growth, the larva molts (sheds its skin) four times. (The fourth molt results in the change from larva to pupa)
- The stages between molts are called instars.
- At the 4th instar, the larva can a length of almost 10 mm. Toward the end of this instar feeding ceases.







Larva

• When the 4th instar larva molts, it becomes a pupa.

• When identifying mosquito larvae, look for the largest larvae in your sample, the 4th instar. The diagnostic features you are looking for are most pronounced in this stage.





Pupa

- Mosquito pupae, commonly called "tumblers," live in water from 1 to 4 days, • depending upon species and temperature.
- The pupa is lighter than water and therefore floats at the surface. It takes ٠ oxygen through two breathing tubes called "trumpets."
- The pupa does not eat, but it is not an inactive stage. When disturbed, it ۲ dives for safety in a jerking, tumbling motion and then floats back to the surface.





Pupa

The metamorphosis of the mosquito into an adult is completed within the pupal case.

 The pupal case is like a "factory" where the mosquito larva becomes an adult. The adult mosquito splits the pupal case and emerges to the surface of the water where it rests until its body dries and hardens.





Adult

- Adults emerge, and fly away looking for their first meal and to mate.
- Adults eat nectar, like many other insects.





Adult Female

- Only female mosquitoes bite, seeking blood from humans and other animals. Blood provides pre-natal supplements needed for egg development.
- After her blood meal, the female lays eggs on or near the water. The eggs can survive dry conditions for a few months.
- Not all species of mosquitoes require females to eat a blood meal to make eggs, but those are the mosquitoes you are most familiar with!
Acknowledgements

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The **GLOBE Observer Mosquito Habitat Mapper** is a NASA-sponsored project that is the result of the combined efforts of an extended team that includes the Institute for Global Environmental Strategies (IGES); NASA Goddard Space Flight Center, Langley Research Center, and Jet Propulsion Laboratory; Space Science Applications, Inc. (SSAI); the GLOBE Implementation Office (GIO), GLOBE DIS and Brooklyn College.

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Activity Link for Task 3-4

Mosquito! Task 3-4 Understanding Mosquito Life Cycle - HHMI Activities https://www.hhmi.org/biointeractive/mosquito-life-cycle-activity









Videos for Task 3-4

Life Cycle of a Mosquito - Video

Description:

Watch this video to see the entire life cycle of a mosquito. Think about how this could be useful when thinking about the problem question. https://www.youtube.com/watch?v=AYpFTrVnteg

Animated Life Cycle of a Mosquito Explained

Description: Use this video to learn more about each stage of the mosquito life cycle. https://youtu.be/93wPfE78SYY



Task 3-5 Analyzing Collected Eggs + Larvae



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Knowing your mosquito larvae involves...

- recognizing the gross morphological characteristics of mosquito larvae.
- learning the morphological features used in identifying a larva specimen.

You will investigate and identify the larvae of three genera of mosquitoes:

- Anopheles
- Aedes
- Culex

These three genera are of interest because they contain species that can transmit pathogens to humans and cause disease.

To know the larvae of these three genera, you will examine morphological features on the terminal abdominal segments (8-10).

Anopheles

 Anopheles mosquito larvae are found in a wide variety of habitats. Many species of Anopheles prefer open-water pools with submerged and floating vegetation, but others have adapted to morespecific habitats like fallen leaves andtree holes.

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 Anopheles species lay individual eggs supported by floats on the water surface or on moist soil immediately adjacent to fluctuating water bodies.



Anopheles gambiae Credit: James Gathany Source: CDC



Aedes

Aedes aegypti and Aedes albopictus are container breeding mosquitoes.

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Aedes aegypti lay their eggs in water found in artificial containers- such as flowerpots and water jugs. The females lay the eggs along the edge, just above the water level. When the water level rises, it moistens the eggs and they then begin to develop.

Aedes albopictus also lay their eggs in artificial containers but, in addition, will use natural containers such as a tree hole or a coconut shell.

Other species of *Aedes* mosquitoes breed in floodplains after rain events, in irrigation ditches, in woodland pools, brackish swamps and salt marshes.





Culex

Culex mosquitoes breed in stagnant water found in:

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- Sewage systems
- Drainage systems
- Septic tanks
- Containers: tires, buckets and rain barrels
- Open surface water habitats: swamps, marshes, bogs, rice fields, pastures

They prefer to lay eggs in rainwater barrels, storm drains, and septic tanks. Eggs are laid in rafts that float on the water surface.



Culex quinquefasciatus Credit: Jim Gathany Source: CDC





MOSQUITO LARVA ANATOMY



GENERAL ANATOMY



Head is round or slightly oblong and flattened



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Thorax: appears distinct from the head and abdomen, being normally wider than the latter two sections.

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Abdomen: segmented section behind thorax



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The abdomen has 10 segments, but not all are distinct. In *Aedes* and *Culex*, the ninth segment is not distinct; in *Anopheles*, the tenth.

The four white protrusions on the anal segment are anal papillae which perform osmotic regulation of the organism.



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side of the siphon.

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Comb scales: a line or patch of scales found on the 8th abdominal segment in most genera.

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Saddle: a thickened and dark plate that encircles or partially encircles the 10th abdominal segment. It looks like a saddle, hence its name.

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First step in mosquito larvae identification

Place the larvae in cups, vials or plastic bags. Observe them to see how they suspend from the surface of the water. If the larvae are lying flat on the surface, they are from the genus *Anopheles.* This is the only genus of mosquito that lies flat on the surface; all others are suspended from the surface at an angle.





Details of abdominal morphology

*Key features are often found on the anal segment and the siphon.



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Siphon: the air tube used by some species of mosquito to breathe. (more on next slide)

Saddle: a dark, thickened band on the anal segment. It can ring the segment, be in two pieces, or appear like it does here, as a saddle

Comb scales: scaly or spiny spicules found in rows or a patch on the abdomen.

Pecten: an even row of tiny spines found on the siphon.

Siphon

- The siphon is an air tube located on the abdomen of the larva.
- Because the larva hatches from the egg and lives in the water, the siphon allows the larva to breathe.
- Most species, including those in the genera *Culex* and *Aedes*, have a siphon and spend most of their time on the surface breathing.
- Anopheles does not have a siphon. Instead, it lays parallel to the surface and breathes through openings on its 8th abdominal segment (spiracles).
- Some species have specialized siphons and attach to emergent plants found in water, using the plant tissue to access air to breathe.

Abdominal Hairs

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The placement and number of hairs on the abdomen can be diagnostic.

Setae, Brushes, Tufts and Hairs:

Tuft: more than one hair growing together.

Brush: a clump of tufts

Setae: another word for insect "hair"

Anal Brush: the anal brush is is used like a rudder when the larva is swimming

Note: Distinguishing between *Aedes albopictus* and *Aedes aegypti* requires at least 35x magnifier.

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You will need to look at the **comb scales**. Note the differences shown in the diagrams above.

Identifying mosquito genera and species in your area

Familiarize yourself with the general anatomy of the mosquito larvae and the key features that distinguish those genera or species that are found in your locality.

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Consult with mosquito experts or mosquito identification keys for your locality to identify important species in your region.

HEAD THORAX ABDOMEN Sipho Antenna **GENERAL ANATOMY** Comb scales Ventra Pectin Saddle Ventral (or anal) **IDENTIFICATION FEATURES**

MOSQUITO LARVA ANATOMY



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Task 3-6 Analyzing Community Surveys—Mosquito A

Compiling Survey Data Options

First we must compile the answers from the community surveys to all of the questions from Part Three: Life. The team will look at the other parts in later tasks.

Here are some options for compiling the answers to the survey questions. But, as always, if you have different method you prefer, do that!

Option 1

Hand out a survey to each person.

Go through each question and team members can raise their hands to vote for the answer they prefer. Some team members can count up the votes and others can write down the totals for the team.

Option 2

Have questions on a board, paper, or computer where tallies can be compiled. Tally the responses and share the results.

Option 3

Digital survey: If you did the survey digitally, you should be able to see the results for each question.

Option 4

Create your own way of compiling survey data.

Graphing Survey Data

How could you graph parts of these survey results?

Which questions could you graph?

If you have the resources, pick some questions to graph that you think would be useful.

How would these graphs be useful when supporting claims with evidence?



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Community Survey—Mosquito A

Use this survey to compile data.

Part 3: Life

Are both male and female mosquitoes able to transmit diseases to humans?			
Only male mosquitoes are able to transmit diseases to humans	Only female mosquitoes are able to transmit diseases to humans	Both male and female mosquitoes can transmit diseases to humans	Not sure

What time of the day do mosquitoes bite? (check all that apply)			
Day time	Night time	Morning	Not sure









Task 3-6 Analyzing Community Surveys (Life)—Mosquito B

Compiling Survey Data Options

First we must compile the answers from the community surveys to all of the questions from Part Three: Life. The team will look at the other parts in later tasks.

Here are some options for compiling the answers to the survey questions. But, as always, if you have different method you prefer, do that!

Option 1

Hand out a survey to each person.

Go through each question and team members can raise their hands to vote for the answer they prefer. Some team members can count up the votes and others can write down the totals for the team.

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Option 4

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Graphing Survey Data

How could you graph parts of these survey results?

Which questions could you graph?

If you have the resources, pick some questions to graph that you think would be useful.

How would these graphs be useful when supporting claims with evidence?







Community Survey—Mosquito B

Use this survey to compile data.

Part 3: Life

Are there different types of mosquitoes, or are they all the same?			
There are different types of mosquitoes	They are all the same	Not sure	

Are both male and female mosquitoes able to transmit diseases to humans?			
Only male mosquitoes are able to transmit diseases to humans	Only female mosquitoes are able to transmit diseases to humans	Both male and female mosquitoes can transmit diseases to humans	Not sure

What time of the day do mosquitoes bite? (check all that apply)			
Day time	Night time	Morning	Not sure

Where do mosquitoes get their food from? (check all that apply)			
Flowers	Sap from plants	Garbage	
Blood from animals	Other	Not sure	

Do mosquitoes lay eggs or give birth to developed mosquitoes?		
Lay eggs	Developed mosquitoes	Not sure









Task 3-7 Debriefing Life

Question Map Analysis

- 1. Look at your team question map from Task 1-10. Are there any questions on your map that were addressed in Part Three: Life?
- 2. What evidence did you collect during Part Three that could be useful to answer any questions on your question map?
- 3. How could this evidence or information be useful to develop a solution to the problem question: How can we seek to ensure health for all from mosquitoes?

Take time to rearrange, update, or modify any questions on your question map at this time.

Community Partners

- **1.** As a team, look over the list of community partners created in Task 2-5.
- **2.** As a team, determine if there are any community partners you could contact to get more information about these research questions you identified on your question map from Task 1-10.
 - Make a plan as a team to communicate with these partners.
 - Create a list of questions you would like to ask the partners.
 - Email, phone, or write to each partner with your questions.
 - If your team decides it's appropriate, invite the community partner to meet with the team. Use your list of questions to have a conversation with them.

Perspectives—Four Corners Strategy

- Label four corners of the room with the following signs: Social, Economic, Environmental, Ethical. If you do not have corners, just mark four different areas in the room.
- 2. Four different statements will be read to the team, one at a time.

Statements

- People in our community need to learn more about different types of mosquitoes.
- Not all mosquitoes are harmful to humans and not all should be killed.
- Male and female mosquitoes have some different feeding habits and behaviors.
- Local organizations and governments should only think about the mosquitos that cause human problems when spending money on a solution.
- 3. After each statement is read, take a minute and let each team member think about which category they think this statement best belongs in: Social, Economic, Environmental, or Ethical.
- 4. You can write down your answers and reasons for your choice, if you would like.



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- 5. All team members should move to the corner that corresponds to their choice.
- 6. Move to a whole team discussion.
 - Remember, team members must back up opinions with information and other team members must listen carefully to one another.
 - Can individual team members explain to the team the reasons for their position at that corner?
 - How many team members changed their positions after hearing people talk during the whole team discussion?
 - What led you to change your mind?

<u>Identity</u>

- Look at your personal and team identity maps from Tasks 1-1 and 1-4. What aspects of your or your team's identity might influence your opinions on the perspectives?
- How might your decisions be influenced by these parts of your identity?
- Have any parts of your identity map changed?

Problem Question

• Is there anything you learned in this discussion that would be useful when thinking about the problem question: How can we ensure health for all from mosquitoes?





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