



This lesson was developed by the Khaled bin Sultan Living Oceans Foundation and Louisiana Universities Marine Consortium (LUMCON) using grant funding from the National Geographic Society. The lesson has been designed for secondary school students but can be adapted for other uses.

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Khaled bin Sultan Living Oceans Foundation & Louisiana Universities Marine Consortium *Lesson 9A: Secret Agents – Investigating Insect Vectors.* [www.mangrovedetectives.org](http://www.mangrovedetectives.org).

#### **About Khaled bin Sultan Living Oceans Foundation**

The Khaled bin Sultan Living Oceans Foundation was incorporated in California as a 501(c)(3), public benefit, Private Operating Foundation in September 2000. The Living Oceans Foundation is dedicated to providing science-based solutions to protect and restore ocean health through research, outreach, and education. The educational goals of the Khaled bin Sultan Living Oceans Foundation and development of this are generously supported by Prince Khaled bin Sultan of Saudi Arabia.

#### **About Louisiana Universities Marine Consortium (LUMCON)**

LUMCON's vision and mission is to maintain a national and international reputation as a leading marine research and education Consortium, and stimulate, promote, facilitate, and conduct research and education collaborations among Louisiana's universities in marine and coastal sciences relevant to the sustainability of coastal and marine environments of the Gulf of Mexico.





Dear Educator,

The Khaled bin Sultan Living Oceans Foundation and Dr. Ryann Rossi have partnered once again to develop a lesson plan about the vectors of mangrove disease. The lesson provides students with the ability to participate in hands-on research through a citizen science program called Mangrove Detectives.

Around the world mangroves are in peril. Much of the decline of mangrove forests has been due to human destruction, including overexploitation, coastal development, changes in water flow, oil spills, and marine debris. In the Bahamas and greater Caribbean, there is great concern because large areas of mangroves have completely died off. As a result, scientists have been researching these areas in hope of finding out what is causing the die-off, so that damage to critical mangrove habitats can be mitigated.

Dr. Ryann Rossi first became interested in mangrove die-offs throughout the Bahamas when she was getting her doctorate at North Carolina State University. In 2013, Dr. Rossi started researching various mangrove die-off areas in the Bahamas. She found that mangroves are dying due to the combined effects of plant pathogens, herbivory, and altered abiotic factors, possibly due to humans. In 2017, Dr. Rossi and the Khaled bin Sultan Living Oceans Foundation partnered to develop a lesson plan that allowed high school students to participate in citizen science. During the lesson, students collect, process, and analyze potentially diseased leaves of mangroves. Then they determine what pathogens are present and explore what could be causing the disease. The Khaled bin Sultan Living Oceans Foundation, in collaboration with their partners at FRIENDS of the Environment, implemented these lesson plans into their Bahamas Awareness of Mangroves (B.A.M.) program. For more information about B.A.M. visit [www.lof.org/BAM](http://www.lof.org/BAM).

Dr. Ryann Rossi, the Khaled bin Sultan Living Oceans Foundation, and Friends of the Environment had a larger goal to build a program called Mangrove Detectives, which would allow them to expand the already existing curriculum and make it available to a larger audience. In 2018, they received a grant from the National Geographic Society to create Mangrove Detectives. With this funding they developed two additional lesson plans, instructional videos, and built a website to host this information and collect student data.

In this lesson, students will investigate insects that live in the mangroves. Activities include building an insect trap, deploying and collecting the trap, and analyzing the insects caught in the trap. Students will participate in citizen science by uploading their data to the Mangrove Detectives website. This information will help scientists document all of the insects living in the mangroves.

For more information, please visit the Mangrove Detectives program website at: [www.mangrovedetectives.org](http://www.mangrovedetectives.org).

Our Best,

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## AUTHOR

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## LEARNING OBJECTIVES

- Construct an insect trap.
- Record location, date, time, tide, temperature, and wind speed and direction.
- Determine the latitude and longitude of mangroves using a GPS unit or other electronic device.
- Make observations about the mangrove forest.
- Identify red mangrove trees.
- Deploy and collect insect traps.
- Label and photograph insect samples.
- Record results in data tables.
- Measure insect length.
- Identify insect structures.
- Classify insects by order.
- Explain why scientists classify organisms.
- Determine the greatest and least number of insects (classified by order).
- Conclude how the size of insects affects the spread of disease.
- Deduce what insect(s) spread disease.
- Compare and contrast the insects caught to other students' or groups' insects and conclude why there were similarities or differences.

## KEYWORDS

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| <ul style="list-style-type: none"> <li>Citizen Science</li> <li>Classification (biological)</li> <li>Disease</li> <li>Geographic Location</li> <li>Geographic Positioning System (GPS)</li> <li>High Tide</li> <li>Host</li> <li>Insect</li> <li>Low Tide</li> </ul> | <ul style="list-style-type: none"> <li>Mangrove</li> <li>Observation</li> <li>Order (taxonomy)</li> <li>Pathogen</li> <li>Taxonomy</li> <li>Temperature</li> <li>Trap</li> <li>Vector</li> <li>Wind Speed</li> </ul> |
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## MATERIALS

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| <ul style="list-style-type: none"> <li>16 ounce (473 mL) plastic bottle</li> <li>Scissor or scalpel</li> <li>Hole punch</li> <li>24 inches (61 cm) cotton rope (5/32-inch diameter rope works well)</li> <li>8 ounces (237 mL) sugary liquid (soda or sugar water)</li> <li>Measuring cup, beaker, or graduated cylinder</li> <li>Petri dish</li> <li>Permanent marker</li> <li>White paper</li> <li>Ruler (metric)</li> </ul> | <ul style="list-style-type: none"> <li>Camera</li> <li>GPS or electronic device</li> <li><b>Lesson 9A: Secret Agents – Investigating Insect Vectors</b> student worksheet</li> <li><b>Hanging Insect Trap</b> video</li> <li><b>Appendix A: Creating an Insect Trap</b></li> <li><b>Appendix B: Instructions for Using Offline Maps</b></li> <li><i>Pictorial Key to the Order of Adult Insects</i> (<a href="https://extension.entm.purdue.edu/401Book/pdf/order_pictorial_key.pdf">https://extension.entm.purdue.edu/401Book/pdf/order_pictorial_key.pdf</a>)</li> </ul> |
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## EXTENSIONS

- In the Bahamas, scientists have found the presence of disease in mangrove leaves. They are researching the insects that live in the mangroves because they are believed to be the vectors of disease. Students can research the presence of disease in the mangroves by completing **Lesson 8: Outbreak Investigation** or for a shorter activity, complete **Read It! Disease in the Trees**.
- Download data from [www.mangrovedetectives.org](http://www.mangrovedetectives.org) website and compare and contrast the insects found in mangroves all over the world.
- Calculate the biodiversity of insects in the mangroves using the Simpson's Diversity Index.
- When recycling the insect traps, extend the lesson by discussing the importance of recycling.

## STANDARDS

### Ocean Literacy Principles and Fundamental Concepts (Grades 9-12)

- Principle 5.B.11: Ocean ecosystems are connected to each other in a macro food web. Over time, organisms move from one ecosystem to another as they grow, migrate, and die. Changes in an ecosystem or an organism may have unpredictable effects on other ecosystems.
- Principle 6.E: Achieving sustainability of the diverse ecosystems and resources in the ocean depends upon collective and individual action based on scientific research and exploration.
- Principle 7.B.5: Exploring the ocean involves global participation because there is only one ocean that connects and sustains all life.

## PROCEDURE

### PART 1: FIELD DATA COLLECTION

#### A. PREPARATION:

1. In case of inclement weather, have a backup plan.
2. Make sure to follow all school or education facility policies.
3. When first discussing the field trip, be sure to cover the following safety procedures:
  - a. Everyone will have a buddy. You are to stay with that buddy at all times.
  - b. Do not wander from the path or away from your instructor(s).
  - c. Wear comfortable, close-toed walking shoes that could possibly get dirty and/or wet.
  - d. Bring water on the hike. It will be hot, and everyone needs to stay hydrated.
  - e. There will probably be bugs, so bring bug spray.
  - f. Wear sunscreen. Hats are allowed, as well.
  - g. Do not touch anything unless your instructor asks you to.
4. Inform parents/guardians of the field trip and get all permission slips and/or liability waivers signed. Send parents a description of the field trip and a checklist of items that the students will need to bring the day of the field trip.
5. Bring a fully stocked first aid kit on the mangrove field trip.
6. In case of emergency, make sure that at least two adults have a way to communicate (such as a cell phone). Make sure to share this contact information with the school or education facility.
7. Check for wind speed and direction at <http://www.wunderground.com>.
  - a. In the search field (upper right-hand corner), if conducting the activity outside of the United States, type in the name of the city and country where the mangrove field trip will take place. If conducting the activity in the United States, type in the name of the city and state.
  - b. Click on the date under the 10-day weather forecast.
  - c. Print out the hourly weather, which contains the wind speed and direction. **NOTE:** To be as accurate as possible, look up the information as close to the day and hour of the field trip as possible.
8. Before going to the mangrove site, make sure to check the tide tables. If the mangrove forest typically has standing water, survey when the tide is low. Tide tables can be found at [http://tidesandcurrents.noaa.gov/tide\\_predictions.html](http://tidesandcurrents.noaa.gov/tide_predictions.html).
  - a. In the search field, type the name of the city and country where the mangrove walk will take place.



- b. Enter the date that you will be going on the field trip.
- c. Print out the tide table.

**NOTE:** If you cannot find the mangrove location on the NOAA website, check tide tables at: <https://www.tide-forecast.com>.

9. Print and laminate **Appendix A: Creating an Insect Trap** and **Appendix B: Instructions for Using Offline Maps** (optional).
10. If using **Appendix B: Instructions for Using Offline Maps**, make sure to charge electronic devices prior to the field trip and complete step A in *Appendix B*.
11. Download, print, and laminate *Pictorial Key to the Order of Adult Insects* at: [https://extension.entm.purdue.edu/401Book/pdf/order\\_pictorial\\_key.pdf](https://extension.entm.purdue.edu/401Book/pdf/order_pictorial_key.pdf).
12. Collect 16 ounce plastic bottles.
13. Purchase soda or make sugar water mixture. To make sugar mixture, add 2 cups (256 g) of granulated sugar to 33.8 ounces (29.6 mL) of hot water. Stir the mixture until all of the sugar is dissolved. Bring the mixture to room temperature.
14. Decide if the students are going to make traps individually or in groups.
15. Find a mangrove forest that has numerous red mangrove trees.

## B. IN CLASS:

1. Handout **Appendix A: Creating an Insect Trap**.
2. In the classroom, instruct students to create insect traps using **Appendix A: Creating an Insect Trap**. **NOTE:** The supplies listed on Appendix A will make one trap.

## C. FIRST FIELD TRIP: SETTING INSECT TRAPS

1. Inform students to bring two pencils and their **Lesson 9A: Secret Agents – Investigating Insect Vectors** student worksheet on the field trip.
2. Students need to be able to identify red mangrove trees. Review the characteristics of a red mangrove tree (prop and drop roots; leaf shape, color, and texture; red tannin beneath bark).
3. Instruct students to set insect traps by hanging them on a red mangrove tree branch. Make sure that students hang their traps on different trees. Watch **Hanging Insect Trap** video for instructions on how to hang the insect traps in the red mangrove trees.
4. Using a measuring instrument, ask students to fill the trap with 8 ounces (237 mL) of sugary liquid.
5. Prompt students to fill out *Table A* on **Lesson 9A: Secret Agents – Investigating Insect Vectors Part 1: Field Data Collection** student worksheet.

**NOTE:** If your school does not have a GPS device(s), you can use a smart phone or tablet to mark the GPS location using offline maps. You do not need the internet to use these maps. One example of an app that utilizes offline maps is Google Maps. For instructions on how to use Google Maps, see **Appendix B: Instructions for Using Offline Maps**. No matter which device you choose to use, make sure to protect your device(s) from the varying environmental conditions (water and heat) that are present in the mangroves by equipping your device(s) with the appropriate hardware.

6. Return 1-3 days later to collect the students' traps and their contents.

## D. SECOND FIELD TRIP: COLLECTING INSECT TRAPS

1. Instruct students to find their insect trap and carefully remove it from the tree, so that they do not spill any of the contents.
2. To contain the liquid in the bottle, place wax paper or beeswax wraps (both biodegradable) over the bottle opening and use a rubber band to hold it in place. The rubber bands can be reused.
3. Return to the classroom with insect samples.

## PART 2: SAMPLE PROCESSING

1. Instruct the students to follow the instructions on the **Lesson 9A: Secret Agents – Investigating Insect Vectors Part 2: Sample Processing** student worksheet.



2. When students have finished using their traps, rinse the plastic bottles out and recycle them. The cloth rope can be thrown in the garbage, as it is biodegradable.



# LESSON 9A

# SECRET AGENTS

## ADDITIONAL BACKGROUND INFORMATION

Scientist Dr. Ryann Rossi has discovered the presence of diseased mangroves in the Bahamas, which may be causing large numbers of mangrove trees to die. The pathogen that causes the disease was determined to be *Pestalotiopsis*, a genus of fungus. This pathogen infects the leaves of the mangrove trees causing the leaves, and potentially the tree, to die. To make matters worse, Dr. Rossi also believes that grasshoppers may be vectors or carriers of the fungus, which cause the disease to spread. *Pestalotiopsis* spores may attach to the legs of grasshoppers and as they jump from leaf to leaf of the mangrove tree, the spores are transported, infecting more leaves. Scientists are now researching these insects and others that live in the mangroves to determine if they are carriers of the disease and how the disease might be spreading. Today, you will be a citizen scientist participating in their research by collecting additional data about the insects that are present in the mangroves.

## PART 1: FIELD DATA COLLECTION

**INSTRUCTIONS:** Fill in the following information.

**TABLE A:**

<b>Mangrove Location Name:</b>			
<b>Date (month/day/year):</b>		<b>Time:</b>	
<b>Wind Speed:</b>		<b>Direction:</b>	
<b>Tide</b>			
<b>Time Low:</b>	<b>Height Low (m):</b>	<b>Time High:</b>	<b>Height High (m):</b>
<b>Geographic Location</b>			
<b>Latitude (N or S):</b>		<b>Longitude (E or W):</b>	

**Observations:** Make observations about the area surrounding your trap. Remember an observation is when you draw a conclusion based off of one of the five senses: sight, sound, touch, taste, and smell.

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## PART 2: SAMPLE PROCESSING

**INSTRUCTIONS:** Follow the instructions below.

1. Pour the contents of your bottle into a petri dish. **NOTE:** You may have to pour some of the excess liquid off first, but be sure not to discard any insects that may be in your container.
2. Use forceps and/or tweezers to gently remove the insects from the petri dish.
3. Lay the insects on a paper towel to remove any excess sugary liquid.
4. Place an individual insect on a piece of white paper.
  - a. Assign the insect with a unique identification (ID) label. **NOTE:** The labels should be consecutive (e.g. ME1, ME2, ME3).
  - b. In pencil, write the ID next to the insect.
  - c. For scale, position the metric side of a ruler next to the insect, but do not cover the ID label. See the image below for an example.



5. Use a camera to take a photo of the insect. Hold the camera approximately 3 inches above the insect and center the camera horizontally over the insect. Make sure that the image is not blurry and take the photo.
6. Use the *Pictorial Key to the Order of Adult Insects* to fill in *Table B* and identify the order that each insect belongs to.
7. Repeat steps 4-6 for each insect. **NOTE:** Make sure to erase the insect ID before processing the next insect.
8. Upload photos and data to the project website at <https://mangrovedetectives.org/lessons/>.



TABLE B:

Insect ID	Length of Insect (mm)	Primary Color of Insect	Secondary Color of Insect	# of Legs	Mouthpart	Wings	Body Region	Order



**INSTRUCTIONS:** Answer the following questions.

1. Why do scientists classify organisms? Give two answers.
2. What was the most difficult part of classifying the insects to order?
3. What order had the greatest number of insects? How many insects were in this order?
4. What order had the least number of insects? How many insects were in this order?
5. How do you think that the size of the insects affects the spread of disease in the mangroves? Explain.
6. What insect(s) might spread disease? Explain your reasoning.
7. If you did not catch many insects, what do you think might have contributed to this?
8. How did the insects in your trap compare to other students' or groups' findings? Why do you think there were differences or similarities?



## CREATING AN INSECT TRAP

### SUPPLIES:

- 16 ounce (473 mL) plastic bottle
- Scissor or scalpel
- Hole punch
- 24 inches (61 cm) cotton rope
- Permanent marker
- **Appendix A: Creating an Insect Trap**

### INSTRUCTIONS:

1. Measure 1/3 distance from the mouth of the bottle and place a dot using a permanent marker. Repeat this step on the opposite side of the bottle. Draw a line around the bottle, connecting the two dots. Use scissors or a scalpel to cut the plastic bottle into two pieces using the line as a cutting guide.



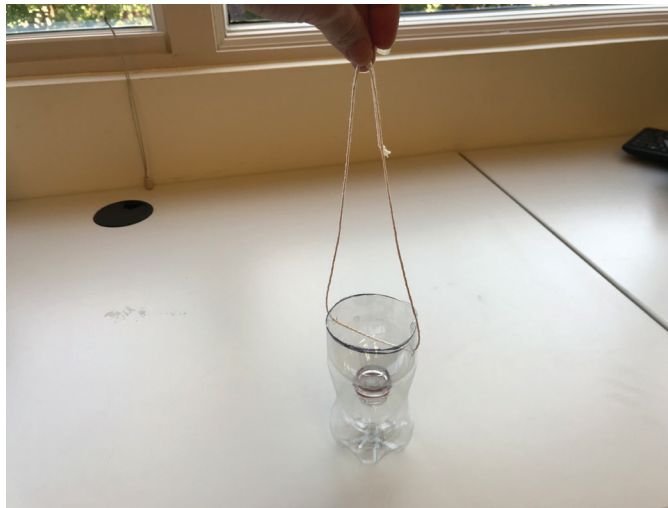
2. Remove the top portion of the bottle (funnel), invert it, and place it into the bottom portion of the bottle.



3. Cut 24 inches (61 cm) cotton rope.
4. Use scissors or a hole punch to create two holes on opposite sides of the bottle that are large enough for the string to fit through. Make sure that the holes pierce the overlapping upper and lower sections of the bottle.



5. String the rope through the holes on both sides of the bottle. Then, tie each end of the rope together forming a knot. Make sure to create the knot near the end of the rope so that you have enough length to hang the insect trap from a tree branch.

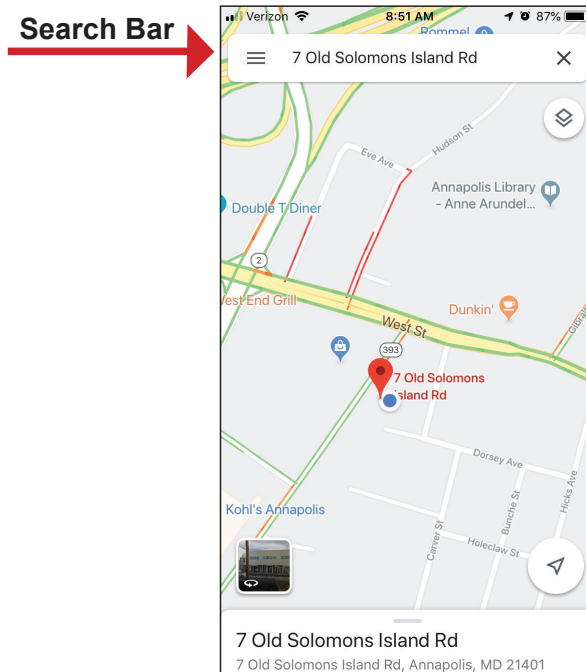


6. Using a permanent marker, label your insect trap with your name or group information.

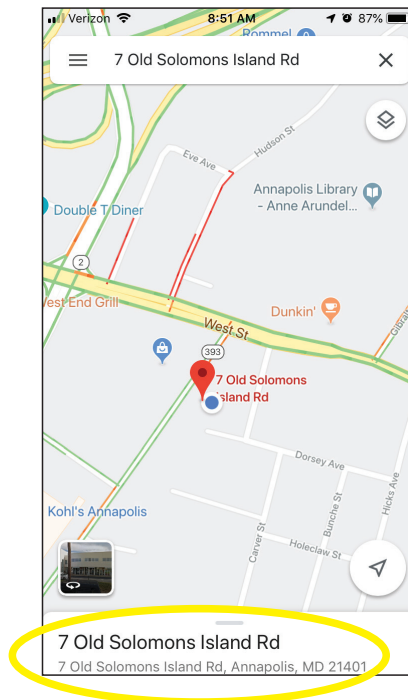
## INSTRUCTIONS FOR USING OFFLINE MAPS

### A. DOWNLOAD AN OFFLINE MAP:

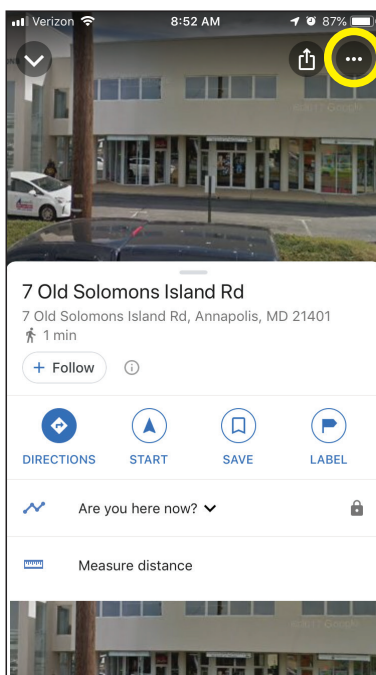
1. Establish an internet connection on your electronic device.
2. If Google Maps is not already downloaded on your device, then download the app.
3. Sign-in to Google Maps or setup login information.
4. In the search bar, enter the city or island name nearest to the location of the mangrove forest you will be visiting.



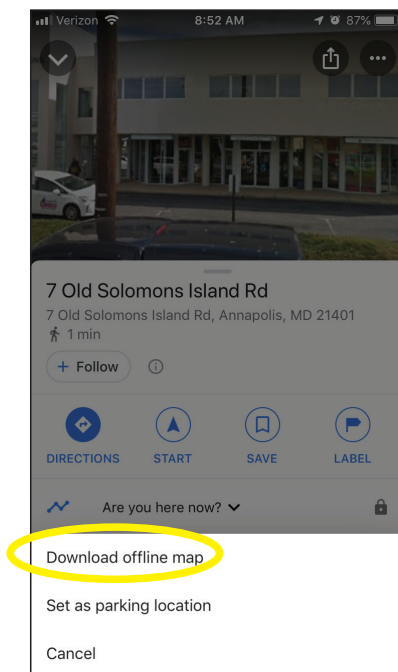
5. At the bottom of the screen, tap the name of the location that you just entered.



6. Then, tap the symbol that is circled (in yellow) in the upper right-hand corner of the screen.

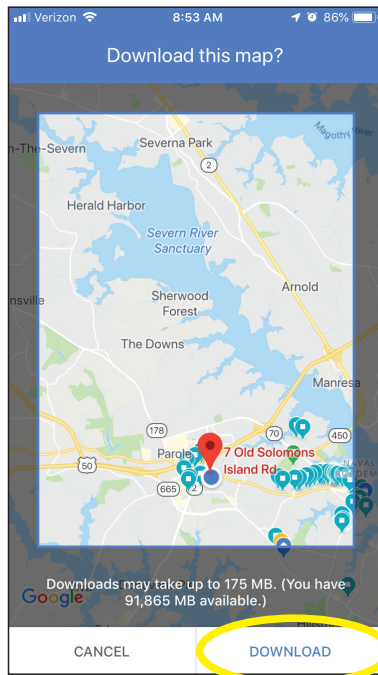


7. Select "Download offline map."

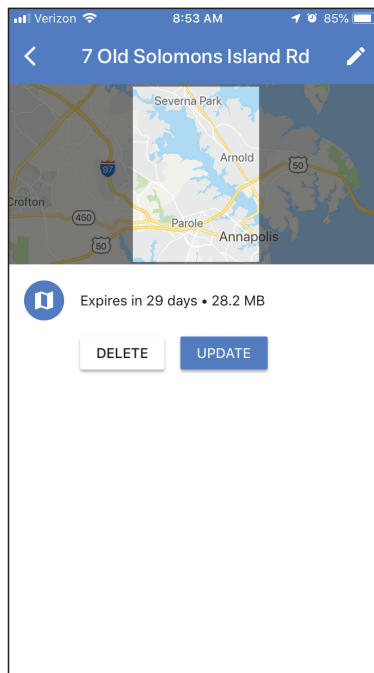


8. Using two fingers, zoom in and out to select the mangrove area. It's better to capture a larger area that includes the area surrounding the mangroves.

9. Select "Download."

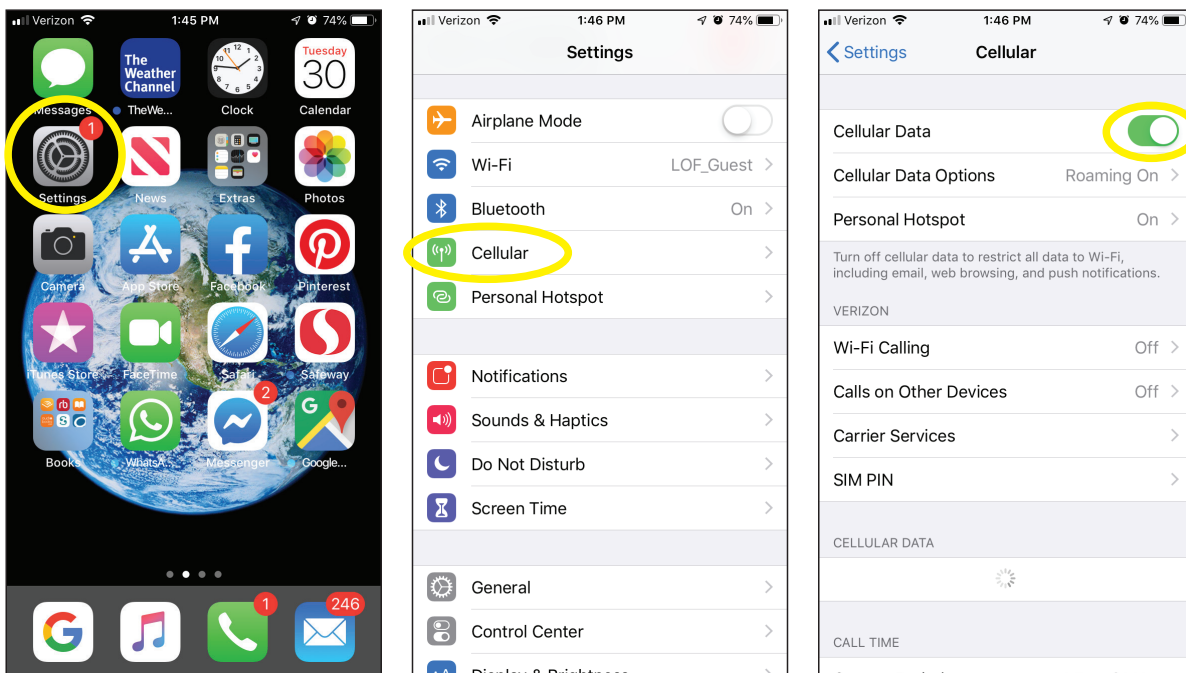


10. The map will be downloaded and saved offline for 30 days.

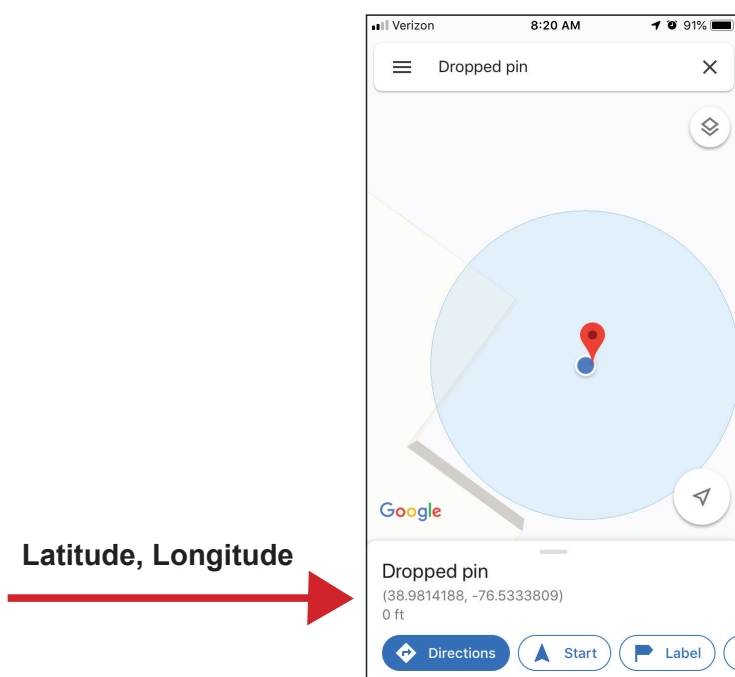


**B. USE AN OFFLINE MAP:**

1. If applicable, turn off data on the electronic device.
  - a. Go to “Settings.”
  - b. Select “Cellular.”
  - c. Turn off the “Cellular Data” by pushing the toggle (will turn grey when off).



2. Open Google Maps app.
3. Use Google Maps as you normally would.
4. When you need to find your GPS coordinates, use two fingers to zoom in to your location, which is represented by a blue dot. Make sure to scroll in close to the blue dot.
5. Drop a pin over the blue dot. To do so, hold your finger over the blue dot to drop a pin.



6. Record the GPS location (latitude and longitude) in *Table A* on your **Lesson 9A: Secret Agents – Investigating Insect Vectors** student worksheet.

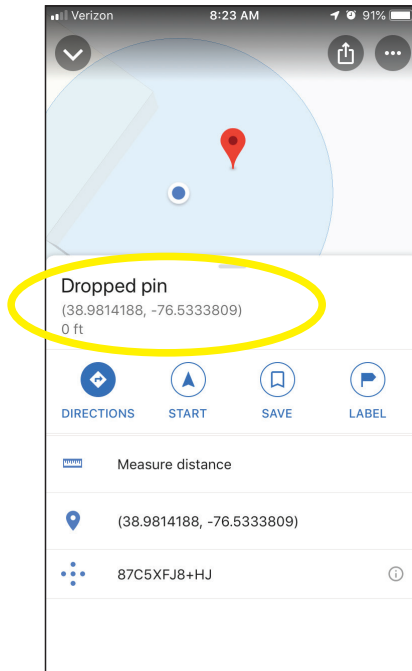




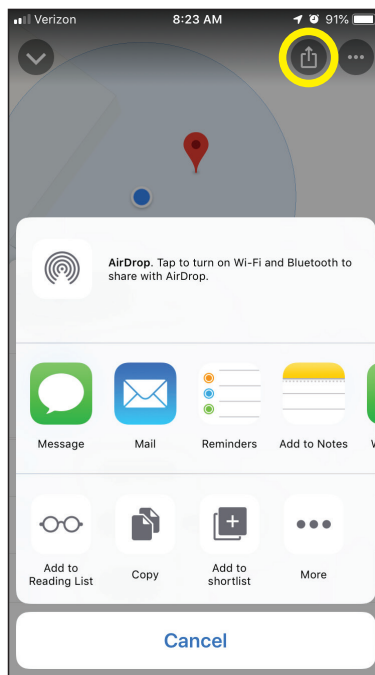
7. To save a pin:

a. For Apple devices:

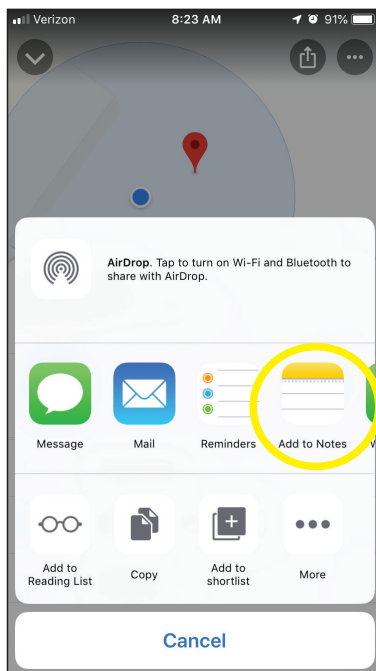
- i. At the bottom of your screen, use your fingers to tap the GPS location.



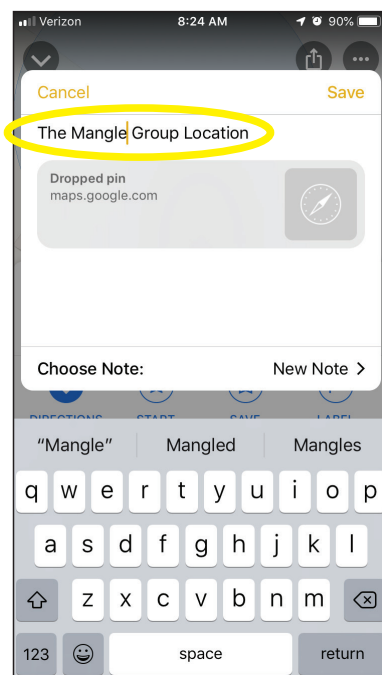
- ii. Select the Share button circled in yellow.



iii. Select “Add to Notes.”



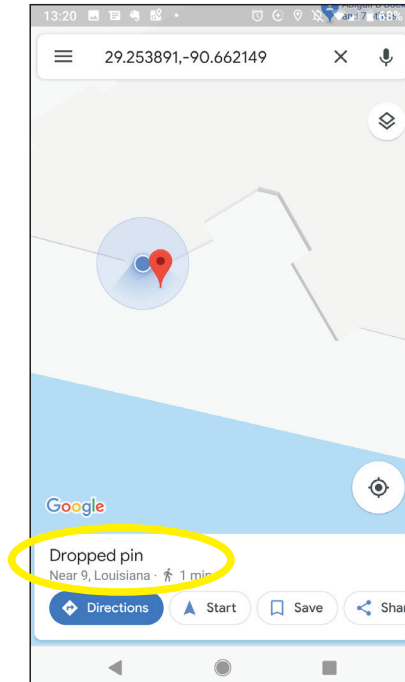
iv. Label the pin with your group information or your name.



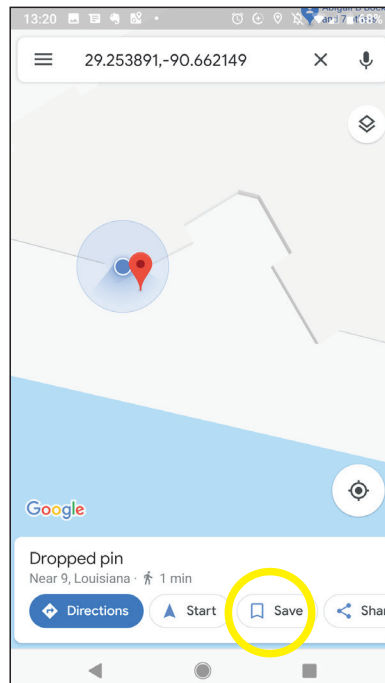
v. Select “Save.”

b. For Android devices:

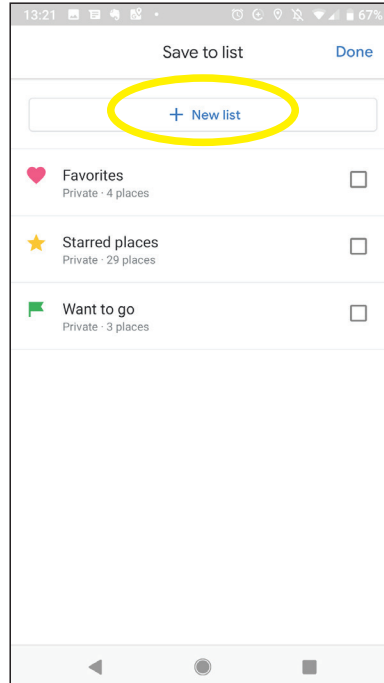
i. Tap the location of the place.



ii. Tap "Save."



iii. Click on “New List.”



iv. Type your group information or your name into the text field.

v. Hit “Create.”