Where the Waste Goes 1

Lesson Plan

Description

In this lesson students will conduct investigate their own trash consumption and become aware of how improperly handled trash impacts the environment.

Emphasis

Building conceptual knowledge regarding where our waste goes once it is disposed of. In addition, students will comprehend the difference between types of trash (biodegradable vs. non-biodegradable) and their affect the environment.

Objectives

- Students will be able to define biodegradable and non-biodegradable waste.
- Students will be able to identify types of biodegradable and non-biodegradable trash.
- Students will understand the basic chemistry/ biology of how materials biodegrade (or don't!).
- Students will understand how recycling may offset the overall trash production in their household, community, island, and the world.
- Students will comprehend the process of trash disposal, from your house to the landfill.
- Students will discuss how they will change their current practices to ameliorate their own 'trash' situation.
- Students will develop a mini-PR campaign promoting the advantages of recycling in our communities.

Subjects
Earth Science, Ecology, Biology, Environmental Science, Marine Biology

Grade-level
Elementary, 3-5
Middle School, 6-8
High School, 9-12

Time required
3 or more days of 50-minute class periods.
(additional time req'd for homework assignments and assessment tools)

Materials required
- Paper
- Pencil
- Internet
- Household trash

Related background reading
None

Related documents
None

Related Links
None

Assessments Techniques

1. The "Good Litter Survey" - functions like a pre and post test. (Example provided below.)
2. Take Home Assignments - in response to videos shown in class

Day 1: Assessing Prior 'Trash' Knowledge

Teacher Notes

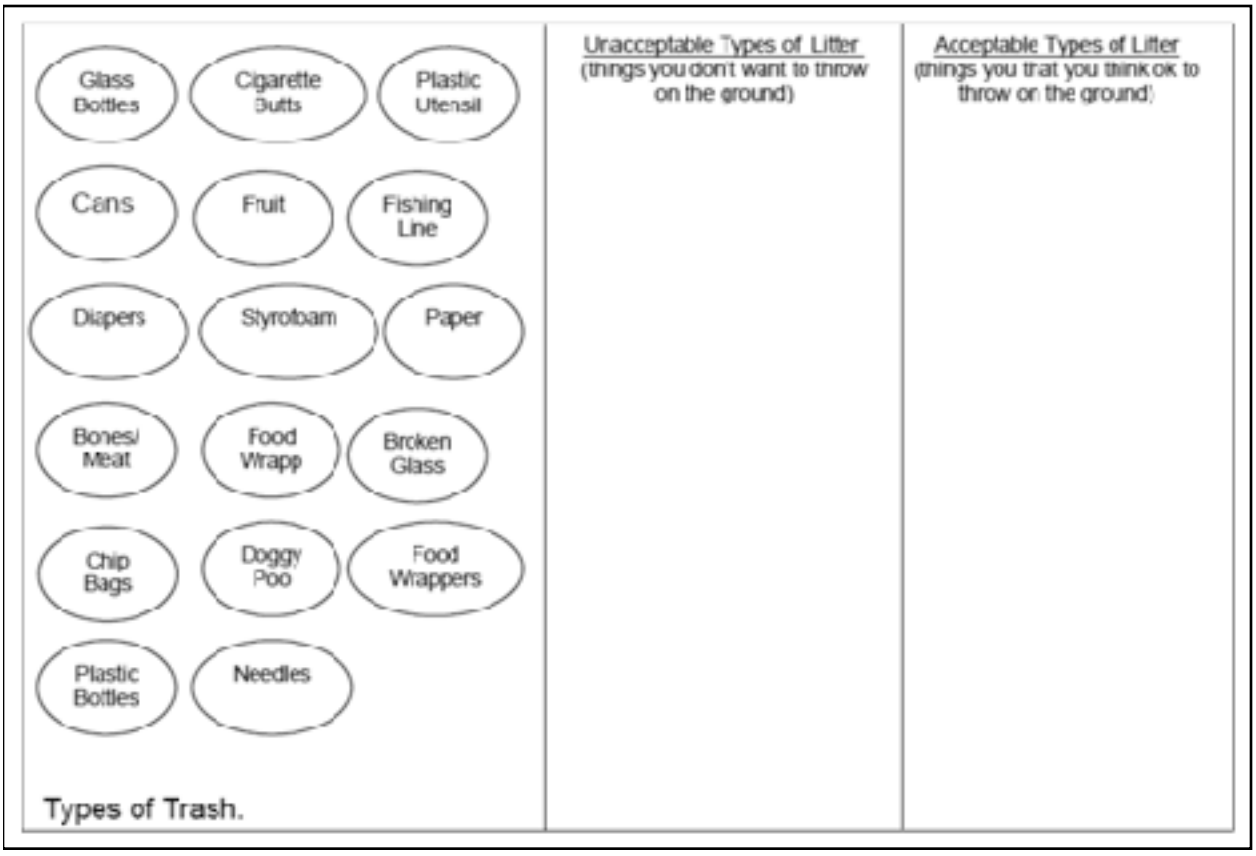
Resist any urges you have to tell them where the items belong!! This is a pre-activity that will be revisited after the students have gained instructional knowledge regarding proper waste disposal.

Where the Waste Goes 1

Pre-activity
Hand out the "Good Litter Survey" (GLS). Ask students to cut out all the potential sources of debris we generate in our daily lives. Students can fill in any they think of that aren't listed. Once the 'debris items' are cut out, ask the students to organize them in the table according to where they think they belong. Tape or staple the items in the 'appropriate' category.

Make sure students put their names on their table (somewhere, anywhere, does not have to be on the front) and save them for later discussion. You can even display them around the room.

Example



Background Information
As we all know, there is a significant 'trash problem' here on Guam, whether one is referring to the fact that our dump is overflowing and costing the government millions of dollars to remedy, or that our roadways, beaches, oceans, public and private property trash are littered with trash.

Lesson Plan Goals
This lesson plan aims to:
1. Educate our youth that we can address this problem and clean up our island for good.
2. Develop a scientific understanding of the processes surrounding the disposal of our trash.

3. Develop comprehension that improperly disposed of trash negatively affects our livelihood (the watersheds, our reefs and fishing industries, and the tourism industry).

Biodegradable vs. non-biodegradable
Refer to websites listed below for more information about biodegradable vs. non-biodegradable re- sources.

In the simplest terms "**biodegradable**" means a material that is able to degrade or break down. Examples of biodegradable materials are apple cores, bones, paper, flowers, serving utensils, plates made of corn products.

"**Non-biodegradable**" refers to materials that are not broken down by organisms. Examples of non- biodegradable materials are plastic, glass, polyester clothing items, and aluminum cans.

> *Something is biodegradable when little tiny microorganisms in the earth can break the object apart and turn it into soil. It looks like the thing disappears, but it just becomes part of the soil.*

Things that are biodegradable are often made of organic materials, or things naturally occurring in our environment, not those synthetically produced in a lab. For instance, a banana peel is biodegradable and will take approximately 3 days to degrade, but a plastic bottle will take hundreds of years!

Take a diaper for example… how many years do you think it takes for a disposable diaper to biodegrade?

Answer: 500-600 YEARS!

Day 2 (or homework): Investigating Decomposition Rates

Activity
Have students guess how long it takes for the following items to degrade in the environment (days, weeks, months, years). The class can investigate how long it ACTUALLY takes for things to degrade or it can be assigned as a homework assignment. *(Some helpful links provided below).* It may be difficult to find the exact time for certain items, like a folding chair. In this instance, estimate the actual time based on the parts of the item, the cloth and the metal frame.

Examples of How Fast/Slow Materials Biodegrade:

- Green Eco Services: How Long Does It Take For Trash to Biodegrade (http://www.greenecoservices.com/how-long-does-it-take-for-trash-to-biodegrade/)
- Keetsa: How Long Does It Take For Trash To Biodegrade (http://keetsa.com/blog/recycle/how-long-does-it-take-for-items-to-bio-degrade/)
- Coral Reef Alliance: How Biodegradable Is Your Trash (http://www.coral.org/node/3916)
- World Wildlife Fund (WWF): Biodegradable And Non-biodegradable Materials (http://www.panda.org/about_our_earth/teacher_resources/webfieldtrips/bio_nonbio_materials)

Where the Waste Goes 1

Below is a discussion of scientific experiment that attempts detailing how decomposing plastics have a negative affect the ocean environments. Previously thought to just be an unsightly source of pollution, a Japanese group has demonstrated that the plastics in plastic shopping bags release harmful chemicals into the water. Its direct effect on marine organisms is currently unknown:

- Ustream Video File: Plastics in the oceans decomposes (http://video.google.com/videosearch?client=safari&rls=en&q=chemistry%20of%20biodegradable%20materials&oe=UTF-8&um=1&hl=en&ie=UTF-8&sa=N&tab=iv&tbo=0#q=plastic+decomposition&hl =en&view=2&emb=0&client=safari&qvid=plastic+decomposition&vid=28804690 48201392259)

Scientists are trying to come up with biodegradability formulas that can tell us how long it will take a material to biodegrade using the known chemical composition, and the impact on the environment of those chemicals.

Challenge Questions:

1. Were your estimates close to the actual time taken for some items to degrade?
2. What most surprised you about the results?

Item	Time Thought to Degrade	Time Actually Taken To Degrade
Bones		
Styrofoam plate		
Apple		
Plastic Cup		
Newspaper		
CDs		
Sky Cracker Tin		
Doritos Bag		
Dead Animal		
Aluminum Can		
Diaper		
Plastic Shopping Bag		
Tomato		
Folding Chair		
Plastic Bottle Cap		
Cigarette Butt		
Battery		

Day 3: Learning About the Great Pacific Garbage Patch

How did we get here? At some point in our history, we used only things that we could find in our natural environment. As we have evolved, our needs have demanded the production of materials that are durable and weather-resistant. This leaves us with many products that take hundreds or thousands (!) of years to biodegrade. The following assignment aims to help students realize how much trash they are producing and the ratio of biodegradable to non-biodegradable materials that are consumed in their daily lives. This is a good opportunity for the teacher to model this assignment to see if their consumption differs from their student body.

Background Information

Just to the north of Guam, there is a region of the world known as The Great Pacific Garbage Patch, or the North Pacific Gyre, an area of the ocean where marine debris has conjugated due to the ocean's currents. This area located at 135° to 155° W and 35 ° to 42°N contains a high density of plastics and other debris, estimated to be TWICE THE SIZE OF TEXAS!

Article on The Great Pacific Garbage Patch:

- Telegraph: Drowning in plastic: The Great Pacific Garbage Patch is Twice the size of France (http://www.telegraph.co.uk/earth/environment/5208645/Drowning-in-plastic-The-Great-Pacific-Garbage-Patch-is-twice-the-size-of-France.html)

Videos on The Great Pacific Garbage Patch:

- Good Morning America on YouTube: The Great Pacific Garbage Patch (http://www.youtube.com/watch?v=uLrVCI4N67M&NR=1)
- YouTube: The Garbage Patch (http://www.youtube.com/watch?v=tnUjTHB1lvM)
- Metacafe video for kids: The Great Pacific Garbage Patch (http://www.metacafe.com/watch/1262507/the_great_pacific_garbage_patch/)

How plentiful is plankton in our world's oceans? VERY. It is the primary source of food for the organ- isms living in the ocean. In these videos, the scientists report that in some samples of water from The Patch, there were 6X more plastics than plankton!

Challenge questions

1. If there are 6384 pieces of plastic debris in one liter of sea water collected from The Garbage Patch, how many plankton were in the sample?
2. Do scientists believe that the volume of plastics in The Garbage Patch can be reduced?
3. Do you believe that Guam's waters contribute plastic to The Garbage Patch? What about the trash on our roadsides and rivers? Why?
4. Given the following statement: The debris that ends up in the oceans surrounding Guam contributes to volume of debris found in The Garbage Patch.

As a scientist, how would solve this problem locally, here on Guam?

Day 4-6: Assessing My Trash Production

Assignment In class

Fold a piece of 8.5 x 11 paper in half, label one column Biodegradable, the other Non-Biodegradable.

Take Home

Have students record the items that they use in their daily lives over a give period of time (day, week, etc) and return to class with the following questions answered. As an added bonus, and for use in future experiments (The Dump, part 2 of 4) have students collect all their consumables and bring them to class.

Answer the following questions based on your assessment of the items you use in your daily lives. For questions that ask for your opinion (do you feel?), detailed complete sentences are required:

1. What do you consume more of biodegradable or non-biodegradable items?
2. Estimate how many pounds of trash do you produce in one day (weigh the bag of trash or each item, finger scales used for fishing can be helpful in this exercise). What about one week? A month? A year?
3. Look at the non-biodegradable items you consumed in a day. How many of those items can you reuse? How many of those items do you actually reuse? How many items do you 'throw away'?
4. If you went back in time on Guam to 1925, and did the same project with a young student your age, what do you think the answers to questions would be? How would their 'trash' differ from yours?
5. What percentage of the materials are you able to recycle? What percentage of the materials consumed did or will you recycle?
6. What does it mean to be sustainable? You can use the internet to formulate your own answer, consult this website:
    a. J500 Media And The Environment: What Does Sustainable Mean? Does It Mean Anything Or Everything?
7. You may also use the definition your teacher gave you. Do you think that they way you live is sustain- able? Could your lifestyle be more sustainable? How?
8. Do you feel recycling is important? State why or why not.
9. Do you think recycling could be improved on Guam? State why or why not.
10. Create a media project displaying how people in your community can become more sustainable. This could include making a pamphlet for distribution to patrons at the grocery store, a poster for dis- play in the mall or Agana Shopping Center, a letter to the editor of the PDN, or a letter to Tammy Jo Anderson (tammyjo.anderson@gmail.com) for inclusion in her weekly insert in the PDN.

Challenge Questions

1. What are the advantages and disadvantages of biodegradable materials?
2. What are the advantages and disadvantages of non-biodegradable materials?
3. What non-biodegradable items could you live without in your life?

4. What non-biodegradable items that you use could be replaced with biodegradable ones?

Activity
Considering what has been taught so far have students organize the following items in ascending order according to the time it will take them biodegrade.

Apple Core, soy sauce bottle, picture frame, chicken bone, water bottle, soda can, tree branch, lamp shade, cracker tin, Doritos bag, diaper, sewing machine, rotten fruit.

Post-activity
Hand out a new copy of Good Litter Survey (GLS). Ask students to cut out all the potential sources of debris we generate in our daily lives. Students can fill in any they think of that aren't listed. Once the 'debris items' are cut out, ask the students to organize them in the table according to where they think they belong. Make sure the students put their name on their table (somewhere, anywhere, does not have to be on the front). Have the students compare their post-GLS to their pre-GLS.

Editor's Note: Funding for this lesson plan was provided by the Sea Grant Program, University of Guam. Please email Laura Biggs, PhD at biggs.laura@gmail.com with any questions or comments.

Where the Waste Goes 2

The Dump-Investigating Trash Decomposition (Part 2 of 2)

Lesson Plan

Description

In this lesson students will conduct hands on experiments investigating how 'trash' degrades over time.

Emphasis

This lesson emphasizes on building conceptual knowledge regarding where our waste goes once it is disposed of. In addition students will comprehend the difference between types of trash and their impact on the environment.

Objectives

- Students will understand that materials decompose at varying rates.
- Students will comprehend that the rate of decomposition depends on the composition of the decomposing material.
- Students will understand how recycling may off set the overall trash production in their household, community, island, and the world.
- Students will comprehend the process of trash disposal, from your house to the landfill.

Assessment Techniques

1. Go Away Trash Survey - functions as a pre- and post- test
2. Take Home Assignments

Subjects
Earth Science, Ecology, Biology, Environmental Science, Marine Biology

Grade-level
Elementary, 3-5
Middle School, 6-8
High School, 9-12

Time required
4 or more days of 50-minute class periods

(at least one month required for experiment to 'incubate' to produce optimum results for discussion. Additional time req'd for homework assignments and assessment tools)

Materials required
- Paper
- Pencil
- Trash from numerous households
- Two sturdy containers
- Wax pencil or permanent marker

Related background reading
None

Related documents
See references: Golabi, et al. 2006
Denton, et. Al 2008

Related Links
History and Use of Landfills and Dumps (http://www.bookrags.com/research/landfillwoc/)

Day 1: My Trash Cycle

Activity

Administer the Go Away Trash survey prior to instruction. For younger ages, students can be provided with a scaffold:

Draw a flow chart showing the production of trash in your household from where it is acquired to where the trash goes when it is out of your hands. Illustrations encouraged.

Where the Waste Goes 2

Background Information

We all throw our trash 'away'. But where does it go after that? In our case, the trash we produce goes to a dump, currently Ordot dump. This dump is at capacity and has been since October 2007, that's over two years ago! The Ordot dump is an area roughly 54 acres in size located in Ordot, Guam. Trash is received from trash trucks and community members on a daily basis. What happens when our trash arrives at the dump? This process can be broken down into several basic steps: (Consult with students' responses to the previous activity what they think happens to their trash, then discuss what happens)

1. Our trash arrives at the dump, whether its picked up at the house or you drop it there yourself.
2. The trash is moved beyond the dump gates and piled along with all of the waste that was collected that day.
3. After the trash reaches a certain height it is covered with limestone rocks. Standards dictate how much limestone rock should be deposited. The limestone rock aids in decomposition and filtration of the leachate that is a byproduct of the dump (more on leachate below).
4. **There are major differences between a dump and a landfill.**
    a. Both landfills and dump produce leachate, a toxic liquid byproduct of the decomposing matter in the dump. Leachate is formed primarily by precipitation that filters through the landfill contents. Leachate can vary in its composition, depending on what the dump or landfill contains. ** This provides a good opportunity to review or introduce the water cycle!**
    b. Think of a dump as a hole in the ground where trash is deposited, the pile keeps getting higher. A landfill is more sophisticated in that it is a hole in the ground, lined with durable plastic to prevent leachate from contaminating the surrounding soil. In a landfill there are mechanisms in place to remove some of the toxic leachate and the toxic gas methane that builds up as a result of decomposition. In dumps, these mechanisms are not present, so both the leachate and methane gas escape into the environment.
        i. Consult this video for information about a landfill in Massachusetts. Vimeo File: So how does a modern lanfull work? (http://vimeo.com/5413636). Dumps get old and there are protective mechanisms for environmental safety that can fail. Even the best landfill gets old, and leachate is deposited in the environment and can present risks to the population, as is the case in this video.
        ii. In Guam's case, rain is the primary form of precipitation forming leachate. When it rains, the H20 seeps into the soil and the dump contents eventually making it to the bottom of the dump where the leachate directly enters the environment. The leachate that exists in the Ordot Dump has been researched by professors, Dr. Golabi and Dr. Denton, at the University of Guam. Their work has been very important in identifying how the dump effects our local environment. These scientists sampled areas within the landfill and at sites

along the Lonfit River. Their findings are summarized below, the articles are published in Micronesica (references below):

1. A significant amount of leachate leaks from the surface of the dump.
2. The leachate contaminates the ground water and springs minimally due to the type of soil that surrounds the dump.
    a. The soil that surrounds the dump is able to retain toxic nitrate and phosphate compounds. This soil is known as kaolinitic soil, commonly known as china clay. The clay reduces the concentration of toxicants in runoff and thereby reduces the contaminants infiltrating the Lonfit River, a major waterway in the Pago Bay Watershed.
3. Heavy metals, such as lead, manganese, iron, chromium, and barium, are found in the leachate. In some cases these heavy metals exceed the Guam Water Quality Standards for surface and/or drinking water (i.e., Lead, Chromium, Manganese and Nickel). Small amounts of some heavy metals (iron, cobalt, copper, manganese, molybdenum, and zinc) are required for normal physiological processes, however, excessive amounts can be hazardous to organisms, including humans.
4. Levels of Enterococci and E. Coli (bacteria that can be toxic to humans) exceeded U.S. EPA recreational water quality standards from the dump to the extent of Pago Bay.
5. Nitrates, likely from fertilizers and pesticides, were often found to exceed U.S. EPA surface water quality standards for nitrates. Nitrates can be hazardous to our health and that of ecosystems. Nitrate can can cause nitrification of our water systems supporting the growth of algae and plants which negatively affects the propagation of coral reef ecosystems.
6. Phosphate levels were insignificant. This is good because phosphates can also be damaging to our bodies and healthy coral reef ecosystems.

5. Read more about the history and use of landfills and dumps here:History of Landfills (http://www.bookrags.com/research/landfill-woc/)

Activity

Have the students draw a picture/poster of the trash disposal process.

Challenge Questions

1. Considering what you learned in the last week with Where the Waste Goes lesson plan, how long do you think it will take the Ordot dump to decompose all the waste that has been collected since 1941 when it was created?
2. What is the difference between a landfill and a dump? Find your answer here: Ordot Fact Sheet (http://iconguam.com/guamsolidwaste/? pg=fact_sheet.diff_bet_dumpandlandfill)
3. Why it is important to know what contaminants are entering our waters from a dump or landfill?
4. How do scientists test for contaminants?
5. What do we know about the soil composition at the new landfill site (Dan Dan Landfill)?

6. What happens if the soil is not capable of filtering the leachate as it does at the Ordot Dump?

Revisit what it means to be biodegradable
The information in this lesson plan aims to build on the information in Lesson Plan 1 by the following:
1. Give students an opportunity to compare and contrast decomposing matter of varying makeup,
2. Visualize that organic materials (biodegradable) decompose at a faster rate than non organic (non biodegradable) materials.

In the simplest terms biodegradable means a material that is able to be degraded, or broken down. Refer to the websites listed below for more information about biodegradable vs. non-biodegradable resources. Examples of biodegradable materials are: apple core, bones, paper, and flowers. Non- biodegradable refers to materials that are not broken down by organisms. Examples of non- biodegradable materials include: plastic, glass, polyester clothing items, and aluminum cans. Things that are biodegradable are often made of organic materials, or things naturally occurring in our environment, not those synthetically produced in a lab. For instance, a banana peel is biodegradable and will take approximately 3 days to degrade, but a plastic bottle will take hundreds of years!

Assignment

Each student should be tasked with bringing in trash. A suitable amount of trash would be that produced by their family unit within one day. Family unit defined as those people with which the student resides. Encourage students to include all trash, smelly or not, plastics, fish bones, food parts, etc. If you conduct the experiment the following day, you won't have to worry about a smelly classroom! Have students create a log of the trash they have brought in (this way they don't have to log it in your classroom.)

Using the trash log that you have created, answer the following questions:
1. What percentage of your trash is biodegradable?
2. What percentage of your trash is non-biodegradable?

	Biodegradable	**Non Biodegradable**	**Totals**
Number of Items			
Percentage of Total			

Day 2-3 (and beyond): Making a DUMP/Landfill!

This part of the lesson plan involves long-term monitoring, the longer the period of 'incubation' the more conclusions can be made from the results of the experiment. Follow the following steps to create your own mini-DUMP. It may be best if you can arrange with your school principal for a outdoor location for you mini-DUMPs to incubate, the heat and exposure to the elements (rain, wind, etc) will best replicate that which occurs in our very own Ordot Dump. *What we are replicating is most like a landfill because we have an impermeable lining at the bottom of our depository.*

Prep work

Drill several small holes in the top the plastic container that will act as your landfill for the next 30 days or so. *Clear plastic bins are nice so you can visualize the decomposition process over time.* The class can be divided into small groups to minimize supply cost, so each group of students will place their trash into one plastic container.

1. Place some soil on the bottom of the container.
2. One at a time, have students dump the contents of their trash collection into the bin. Make sure that the contents of each dump are spread out evenly over the surface of the dump. After each deposit into the dump, cover the contents with 6 inches of soil.
3. When all the students have deposited their trash into their dump place another 6 inches of soil on top of the contents.
4. Place the lid on container and wait.

Follow-up

1. Check back on the contents of the dump on a weekly basis. Ideally, the dump should incubate for 30 days or more.

Challenge Questions

(to be completed at the completion of the dump incubation)

1. After dissecting the contents of your dump, what contents had degraded? (Use your trash log to reference what you put in it in the first place).
2. What contents had not degraded?
3. List the contents that did not degrade:
4. Why did some contents not degrade in the given period of time?
5. What percentage of the items rang true to their names, biodegradable or non-biodegradable?
6. How could you change your trash production to increase the percentage of biodegradable trash that you produce?

Day 30+: My Trash Cycle (post-activity)

Activity

Administer the Go Away Trash survey prior to instruction. For younger ages, students can be provided with a scaffold:

Draw a flow chart showing the production of trash in your household from where it is acquired to where the trash goes when it is out of your hands.

For further reading

Golabi, MH; Denton, GRW; Wood, HR; Wen, Y; Iyekar, C. "Impact of Ordot Dump on water quality of Lonfit River Basin in central Guam. 1. Soil characterization of nutrient retention." *Micronesica* 39, Vol. 1 (2006): 41-54.

Denton, GRW; Golabi, MH; Wood, HR; Iyekar, C; Concepcion, LP. "Impact of Ordot Dump on water quality of Lonfit River Basin in central Guam. 2. Aqueous chemical and biological contaminants." *Micronesica* 20, Vols. 1/2 (2008): 149-167.

Editor's Note: Funding for this lesson plan was provided by the Sea Grant Program, University of Guam. Please email Laura Biggs, PhD at biggs.laura@gmail.com with any questions or comments.