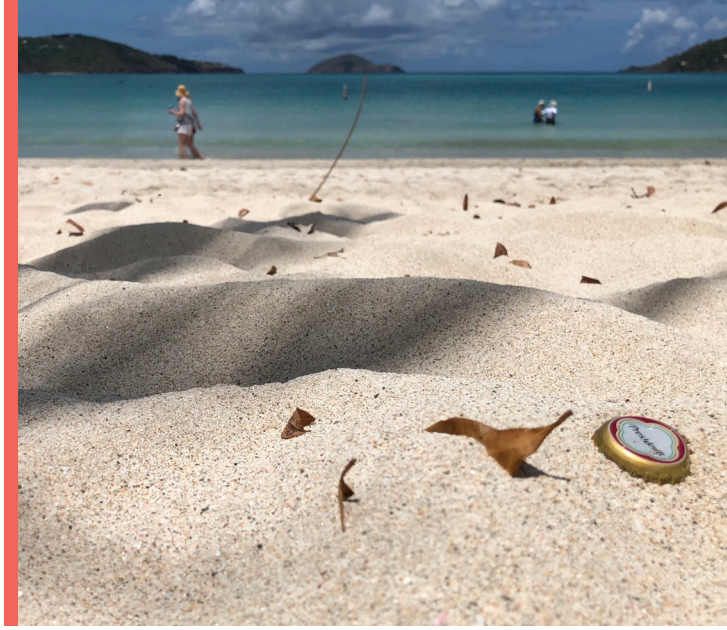
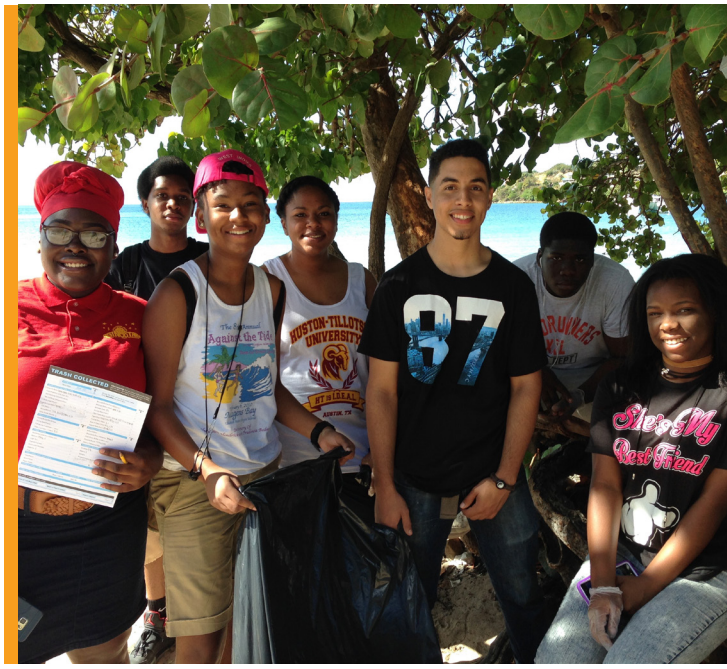
KEEPING OUR COASTLINES CLEAN

A U.S. Virgin Islands Marine Debris Curriculum





COMPOSITION & ABUNDANCE

Links to the Next Generation Science Standards, Quick Reference Guide

Curricula by Sub-Section		Middle School						High School					Sci & Engineering Practices
		ESS 3-1	ESS 3-2	ESS 3-3	ESS 3-4	ETS 1-1	ETS 1-2	ESS 3-1	ESS 3-3	ESS 3-4	ETS 1-1	ETS 1-2	
Composition & Abundance	Beach Box Exploration			✓									✓
	Investigating Oceanic Garbage Patches			✓					✓				✓
	A Degrading Experience			✓					✓				✓
Sources & Transportation	Watershed Walk	✓		✓				✓					✓
	Sources of Microplastics: Microbeads			✓									✓
Impacts	Entanglement Problems			✓	✓				✓	✓			✓
	Natural Disasters and Marine Debris		✓	✓	✓			✓					✓
Solutions	Linked Beach-Ghut Clean Ups	✓		✓					✓				✓
	Mitigating Microplastics			✓					✓				✓
	Upcycling Plastic Bags					✓	✓				✓	✓	
	Making Connections Through Art			✓					✓				✓

LESSON: A Degrading Experience

This lesson is sourced from NOAA Marine Debris Program's Turning the Tide on Trash Curricula, lesson three "A Degrading Experience," (https://marinedebris.noaa.gov/turning-tide-trash). Most of the guiding questions in this lesson are taken directly from the NOAA lesson. The lesson has been modified to include locally-relevant examples.

Grade Levels: 5-12

Subject Areas: Marine Biology: Debris Sources, Ecology

NGSS Connections:

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Appendix F: Science & Engineering Practices

Time: The duration of this lesson is approximately two months. This includes two, 40-minute class periods to introduce and set up the experiment, followed by a small amount of time (~10 min) each class to record data at several points over the subsequent two months.

Description & Objectives: In this activity, students will investigate how long it takes different types of debris to degrade and how weather and sunlight affect the breakdown rate. Students will learn how degradation rates impact how long debris persists in the environment. Students will learn the difference between human-made and natural materials.

Guiding Questions:

- What is marine debris?
- What physical traits do marine debris materials have in common?
- How do different physical processes affect the breakdown of human-made and natural materials?

Key Ideas & Concepts:

- Marine debris is any persistent solid material manufactured or processed and then disposed of or abandoned in the marine environment.
- Marine debris is mostly plastic.
- Most marine debris comes from land-based sources (us!).
- Natural items and marine debris items degrade and break down over time, but at different rates, especially under different environmental conditions.

Pre-Requisite Skills: Students will need to understand the basics of what makes up human-made and natural products. Students will also need to understand the earth science cycles: water, nitrogen, carbon, etc., and how science is a process.

Teacher Preparation:

- Take care to clean/check trash for safety issues (i.e., sharp objects/materials and harmful chemicals).
- Part of this experiment takes place outside. Scout a location that will not encourage wildlife interference, such as a second floor balcony, nor one that will be interfered with by other people.

Materials Needed:

- Assorted pieces of trash in pairs. The following kinds of trash are recommended: two apple cores, two paper bags, two plastic bags, two candy wrappers, two plastic cups, two waxed-paper cups, two drink boxes and straws, two paper eggs cartons, two foam plastic egg cartons, two pages of newspaper, two foamed plastic packing peanuts, two starch packing peanuts, two six-pack rings, two steel cans, and two glass bottles.
- Two transparent containers covered with a net or screen (reduces windblown trash and discourages wildlife).
- Two pieces of rope or string, outdoor thermometer, and newspaper.
- Gloves, tongs, and additional cardboard and newspaper for removing and examining the trash pieces.
- Balance or scale to measure mass of each item, at beginning and end of experiment (optional).
- Optional - Create a model of one complete experimental set-up depending on how much guidance you want to give students.
- Data sheets (included at end of lesson) for inside and outside experiments.

Teacher Instructions: This is a long-term class science experiment.

In class discussion/lesson: Tell students they are starting a long-term class experiment to learn about trash degradation. Talk with them about what degradation is, using the following guiding questions:

- What are the signs of degradation of different objects (changes in shape, color, and size)? How would you measure degradation (length, weight, color charts, etc.)? What abiotic (non-living) factors cause something to degrade? Guide students to think about the amount of sun, wind, rain, and heat to which the items are exposed and how those might impact degradation. What biotic factors cause something to degrade? Guide students to think about animals, insects and microorganisms that may eat or use organic materials.
- ***Teacher Note:*** *"The loss of an item's ability to withstand being pulled apart also is an important sign of degradation, but this only should be evaluated at the end of the experiment so that the natural degradation process is not accelerated" (NOAA).*

Experimental set-up & data collection:

1. Have students fill both containers halfway with water. Make sure one of each type of trash is put in each container. As the students are building the containers, discuss why the experiment is being set up the way it is.
    - Depending on how you are having students measure degradation, you will want them to measure, weigh or otherwise assess the objects before putting them in the containers.
    - **Guiding questions:** Why are we putting the same type of item in each container? Would we be able to compare the things that affect degradation and persistence if we were comparing apples outside to oranges inside? Guide students into thinking about the importance of control variables in experimental design.
2. Cover one of the containers with a net or screen and secure with the rope or string. Label the container and put it outside in a sunny area where it won't be disturbed by people or animals, but is also secure (e.g., think about the storms that occur in the territory and make sure the container is in a sheltered enough place that it will not blow away). Put the second container in the classroom in an undisturbed area with a sign cautioning other students and school employees that it is a school project.
3. On the data sheets (included at the end of this lesson) have a student record weather conditions (outdoor temperature, type, percent of cloud cover, and precipitation) each day. You may consider using the data sheets as class data stored on a clipboard near the indoor container.
    - If your school has a weather station from the Water Ambassadors Program or the Virgin Islands Water Resources Research Institute, use that station to record outside air temperature and precipitation.
    - If not, use a thermometer to measure outside air temperature and a rain gauge to measure precipitation. No rain gauge, no problem! Create a qualitative precipitation scale with your students: this could be as simple as, did it rain today or not? Or it could include multiple categories (e.g., no rain, light rain, heavy rain). It is up to you to decide how to measure this and how to measure can be a good discussion topic for students.
        - ***Teacher Note:*** *Add a second thermometer to measure inside air temperature. Add this variable to your data collection and analyses and compare to outside air temperatures when examining the final experimental results for added, interesting discussion.*
    - To measure cloud cover, you can use multiple options depending on the amount of time and resources available:
        - Use a weather website to determine how much sunlight was recorded on the island that day.
        - Build a cloud cover estimator (see: Measuring Cloud Cover) and have students estimate the percentage based on the number/amount of the quadrants covered.
            - Measuring Cloud Cover: https://www.sserc.org.uk/wp-content/uploads/2012/04/Resource-2_2-Measuring-Cloud-Cover.pdf
    - ***Teacher Note:*** *You may need to continually refresh students about why we record data in metric not imperial measurements, why actual measurements are usually better than estimates, how both quantitative and qualitative data can be useful, etc.*
4. Every week (for a minimum of two months), have the class observe the changes in the trash items, both in the indoor and the outdoor containers. Have different students fill in the "Degradation Data" handouts every week.
    - ***Teacher Note:*** *You can use a camera to take weekly pictures of the containers as a record. If you do this, make sure you have a card with the date on it to remember when the photo was taken or re-name the digital image, appropriately. This is a good time to discuss with students about why you might want to take pictures when possible (e.g., reducing bias, possibility for quantifying change over time using image processing techniques).*

In class activity & discussion: what did they find?

1. At the end of the experiment, remove the contents from the two containers and spread over a tablecloth or newspaper. Make sure to have different sections for the inside and outside container. If you had students measure, weigh, or assess the trash at the beginning, make sure they measure, weigh, or assess the trash in the same way now.

2. As students are removing the items, have them compare the visible differences between the "indoor" and "outdoor" pieces of trash. Students should try to pull apart the trash to determine if there is a difference in strength between the "indoor" and "outdoor" pieces.
    - **Guiding questions**: Which pieces of trash have degraded? Does the location (outside or inside) affect if and how the trash was degraded? If so, how much? What types of trash (paper, plastic, food) were degradable? Which types were persistent? Do you think how an object degrades determines if it is found in the marine environment?

Assessment and evaluation:

- Have the students develop a hypothesis on whether the degradability of an object affects how marine debris develops.
    - UPSCALE: Have students make a prediction and design an experiment to test their hypothesis.
- Have students compare the Weather Watch data sheets and the Degradation Data sheets and answer the following questions (worksheets included):
    - Did the weather seem to affect the rate of degradation? How so? What weather conditions seemed to increase the degradation rates the most? Can you tell? How so?

Additional activities for grades 9-12:

- Begin the lesson with a field trip to the local landfill and/or locations that were damaged heavily by the 2017 Hurricanes Irma and Maria. Discuss the types of debris observed and the degradation process.
    - ***Teacher Note:*** *Coordinate with the Virgin Islands Waste Management Authority to ensure safety on the field trip and to provide additional information about the landfill and waste management in the U.S. Virgin Islands.*
- The experiment can also be conducted outside of class by individuals or groups of students, with the testing of additional variables that may influence degradation rates and the collection of additional data, such as mass (before and after). For example, students could bury debris items (in a controlled way) near their homes (to investigate what happens as debris is buried or composted in landfills), or agitate the items in water to simulate wave action.
- Have your students participate in a thought experiment:
    - Ask them to consider the landfill on their island. The landfills on St. Thomas and St. Croix are either slated to be closed in a few years or are already over capacity. Consider what you have learned about the degradation of materials and the landfill on your island to answer questions on the degrading experience thought experiment 9-12 worksheet (included at the end of this lesson).

Larger pieces of plastic, like these found along a remote shoreline of the East End Marine Park on St. Croix, can photodegrade and break down into smaller pieces over time (Photo credit: Kristin Wilson Grimes).

Degradation & Weather Worksheet

Adapted from NOAA Marine Debris Program's Turning the Tide on Trash Curricula, lesson three "A Degrading Experience," (https://marinedebris.noaa.gov/turning-tide-trash)

Compare the weather data and degradation data on your data sheets.

1. Make a line graph displaying the average weekly temperature and average weekly rainfall.

2. Make a note of the average weekly cloud cover.

3. Compare your graph to your degradation data from the box outside and inside.
   a. Did the weather seem to affect the rate of degradation? How so? _____

   b. What weather conditions seemed to increase degradation the most? How can you tell?

4. What types of debris persisted the longest? _____

5. What types of debris degraded the quickest? _____

6. What might these results mean for the marine life of the U.S. Virgin Islands? _____

7. What are some things you can do to help prevent the types of debris that don't degrade from becoming marine debris in the U.S. Virgin Islands? _____

Degrading Experience Thought Experiment 9-12

Adapted from NOAA Marine Debris Program's Turning the Tide on Trash Curricula, lesson three "A Degrading Experience," (https://marinedebris.noaa.gov/turning-tide-trash)

You have just finished the degradation class experiment. Let's take what you learned a step further. The landfills on St. Thomas and St. Croix are either slated to be closed in a few years or are already over capacity. Consider what you have learned about degradation of materials and the landfill on your island to answer the following questions about marine debris in the U.S. Virgin Islands.

1. Based on what you know about how quickly (or slowly) different materials degrade, what do you think the landfill on your island is full of? Be as detailed as possible. _____

2. What do you think the most persistent items are in the landfill? _____

3. What were those materials originally used for? _____

4. Did those items originate on or off-island? _____

5. Think about the location of the landfill, the watershed it is in, and the trash being thrown away. When people throw out a piece of debris that is resistant to degradation, what do you think happens to it? _____

6. Does it make it to the landfill? _____

7. If it does, do you think it stays there until it is completely degraded? _____

8. How long do you think it stays in the landfill? _____

9. Do you think it's possible for trash to fall/blow out of the landfill and eventually end up in the marine environment? _____

10. What objects do you think persist the longest in the landfill? _____

11. If the landfill is really close to the ocean, like on St. Thomas, what do you think happens to marine life and their habitat near that landfill? _____

12. If the landfill is really close to several ghuts and small ponds, like on St. Croix, what do you think happens to those habitats near that landfill? _____

13. There are several abiotic factors (like wind, rain, and heat, among others) that influence how long debris persists in the environment. For each of the following factors, describe how those factors may impact degradation of a debris item. Does it matter what the item is made of? What properties of the item make it more or less resistant to degradation?
    a. Physical degradation (getting crushed, torn, etc.): _____

    b. Weather degradation (wind, rain, and heat): _____

    c. Photo degradation (sunlight): _____

14. Which of the three degradation processes listed above has more of an impact in the U.S. Virgin Islands compared to another place, like Canada? _____

    a. How so? _____

15. Considering your answers to all the above questions, make a prediction about how the environment impacts the degradation of marine debris breakdown. _____

HANDOUT

Degradation Data – Outside

Month: _____

Teachers: customize this handout based on the trash items you have in your experiment.

Item	Week 1	Week 2
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

Weather Watch - Week 1

Date	Temperature	Cloud Cover	Precipitation

Weather Watch - Week 2

Date	Temperature	Cloud Cover	Precipitation

HANDOUT

Degradation Data – Outside

Month: _____

Item	Week 3	Week 4
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

Weather Watch - Week 3

Date	Temperature	Cloud Cover	Precipitation

Weather Watch - Week 4

Date	Temperature	Cloud Cover	Precipitation

HANDOUT

Degradation Data – Inside

Month: _____

Teachers: customize this handout based on the trash items you have in your experiment.

Item	Week 1	Week 2
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		