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: Investigating Oceanic Garbage Patches

This lesson was modified with permission from Oregon Sea Grant's "Investigating the Great Pacific Garbage Patch" activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum (https://oregoncoaststem.oregonstate.edu/marine-debris-steamss/md-grades-9-12/composition-and-abundance).

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: 1-2 class periods

Description & Objectives: Students will learn about what happens to floating marine debris (surface, near surface, and in the water column) that doesn't get collected during beach cleanups. They will apply knowledge of oceanic water movement to understand why trash gets trapped in specific areas in the Atlantic and Pacific Oceans. Students will interpret maps published in news articles. This also tests students reading comprehension skills.

Guiding Questions:

- What is marine debris?
- Where is marine debris found?
- What physical traits do marine debris materials have in common?

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 exists both where we can easily see it (beaches and wrack lines on the beach) and cannot easily see it (ghuts leading to the beaches, in the sand and on or under the surface of the water).
- Marine debris is mostly plastic.
- Most marine debris comes from land-based sources (us!).

Pre-Requisite Skills: Students will need to understand the basics regarding the chemical makeup of plastic and a basic understanding of ocean circulation.

Teacher Preparation:

- To prepare for this topic, it may be good to review a few articles about oceanic garbage patches and the NOAA Garbage Patches Fact Sheet (included).
- There has been some misinformation about oceanic garbage patches. Some individuals tend to over-hype the size of the patches. While sizable and not a natural part of the environment, you cannot see the patches from a satellite, nor are they the size of Texas, nor can you walk across them (particles are dispersed through the upper part of the water column).
- Additionally, it may be helpful to review basic ocean circulation. The Boundary Currents page of the NOAA National Ocean Service provides a great refresher on the forces that create Oceanic Gyres (included). However, the entire tutorial may be a useful resource for you if you wanted to cover currents in more detail in your classroom.
- Students will read a news article about plastics then answer a worksheet about it.

Materials Needed:

- NOAA Garbage Patches Fact Sheet (included at the end of this lesson)
- Oceanic Garbage Patch Worksheet (included at the end of this lesson)
- Computers for students to access this map, or color-printouts for them to reference: https://bigblueorb.files.wordpress.com/2011/03/atlantic-trash-chart2.jpg
- Transport of Coral Tree after Hurricanes - VI EPSCoR: https://viepscor.com/news/2017/12/22/coral-tree-found
- Video Links
  - "Ocean Heroes: What is a Gyre?", One World One Ocean: https://www.youtube.com/watch?v=h6i16CrI8ss
  - "What's An Ocean Garbage Patch?", Discovery: https://www.youtube.com/watch?v=J-gqJAsXiKQ
  - "TRASH TALK: What is the Great Pacific Garbage Patch?", NOAA Marine Debris Program: https://

marinedebris.noaa.gov/videos/trash-talk-what-great-pacific- garbage-patch-0
- "The Ocean Cleanup launches to the Great Pacific Garbage Patch", CNET: https://www.youtube.com/watch?v=nYC4Q-0wcAc
- "How the oceans can clean themselves: Boyan Slat at TEDxDelft", TEDx Talks: https://youtu.be/ROW9F-c0kIQ. The Ocean Cleanup Project Founder Discussing Developing the Idea. This project was developed by an undergraduate student pictured in the TED talk above and can serve as an inspiration for students to pursue their ideas.

Teacher Instructions: This lesson will help engage students with understanding what happens to plastic marine debris that isn't collected and reused, recycled, or disposed of properly.

In class discussion/lesson: Have a conversation with your students. Share the following information with them:
- There is a great deal of information and misinformation about how much marine debris exists in the open ocean and how it is distributed.
- There are oceanic garbage patches in both the North Pacific and North Atlantic Oceans that are being studied by scientists. Often, it is said that "The Pacific Garbage Patch is twice the size of Texas," but scientists don't actually know for certain how large it is, because it is constantly moving and the amount of marine debris is changing day by day.

Use videos:
- To introduce the idea of oceanic garbage patches: https://www.youtube.com/watch?v=J-gqJAsXiKQ
- To explore how water flows around the globe: https://www.youtube.com/watch?v=h6i16CrI8ss
- To understand how some microplastics move through the oceans: https://marinedebris.noaa.gov/videos/trash-talk-what-great-pacific-garbage-patch-0

After watching any of the videos, review (or teach) how water moves around the globe (earth movement and wind patterns contribute to the way water flows).

Reading & worksheet (in class or as homework): Provide students with the NOAA Garbage Patches Fact Sheet (https://marinedebris.noaa.gov/fact-sheets/garbage-patches-fact-sheet; also included at the end of this lesson) and have students read the article "Massive North Atlantic Garbage Patch Mapped" (https://www.wired.com/2010/08/atlantic-plastic/) and/or the "Garbage Patches" (https://marinedebris.noaa.gov/info/patch.html) informational page from the NOAA Marine Debris Program.

The links to these websites are available here:
- NOAA Garbage Patches Fact Sheet: https://marinedebris.noaa.gov/fact-sheets/garbage-patches-fact-sheet
- Massive North Atlantic Garbage Patch Mapped: https://www.wired.com/2010/08/atlantic-plastic/
- Garbage Patches: https://marinedebris.noaa.gov/info/patch.html

Then have the students complete a worksheet (note: there is a different worksheet for grades 9-12).

Assignment follow-up: After your students have completed the worksheet (either in-class or as homework) use these **guided questions** to have a discussion. You can summarize their answers on the blackboard/whiteboard.
- Why do you think some people may exaggerate the size or extent of the garbage patches? Lead them to think about how this can cause misconceptions about the problem of marine debris and what it looks like (for instance there are more microplastics, but people tend to focus more on macroplastics).
- Ask students to think about ways in which plastic or debris from the U.S. Virgin Islands could end up in the North Atlantic Garbage Patch. Do they think this is possible? How?

Invite students to read the short VI EPSCoR program blogpost on the transport of a coral nursery tree (made mostly from plastic) from the U.S. Virgin Islands to the Bahamas after Hurricanes Irma or Maria (https://viepscor.com/news/2017/12/22/coral-tree-found). Then, lead a discussion with them:
- **Guided questions:** Ask students to reflect on how this method of transport compares to those they just learned about. This is a good opportunity to lead a discussion on what the important forces are that concentrate marine debris in oceanic gyres (use information from the NOAA National Ocean Service Boundary Currents page to help inform your discussion (https://oceanservice.noaa.gov/education/tutorial_currents/04currents3.html).

Ask students to brainstorm ways to convey the problem of marine debris to others in ways that are both compelling, yet based on accurate information:
- Students could write up their own news story about marine debris for the school paper.
- Students could write a script for a radio station PSA about marine debris locally to be played on their school radio station or during the daily announcements.
- Students could create an infographic to hang somewhere in the school to educate other classes.

Another discussion option is to ask students to brainstorm ways to keep the ocean's gyres clean. You can either use the videos below to stimulate conversation in your class or use the videos to reinforce or contrast the suggestions made by students in your class.

- About The Ocean Cleanup Project: https://www.youtube.com/watch?v=nYC4Q-0wcAc
- The Ocean Cleanup Project Founder Discussing Developing the Idea: https://youtu.be/ROW9F-c0kIQ This project was developed by an undergraduate student pictured in the TED talk above and can serve as an inspiration for students to pursue their ideas.

Additional activities for grades 9-12: Ask your students to research the issue further. Have students investigate the location and composition of the five ocean gyres. Then, lead them in a discussion using the following guided questions:

- Does water stay in its own gyre or does it move around the globe? How can they tell?
- What does this mean in terms of plastics found in the different gyres?
- Have them look up the differences in the size (surface area and depth) of the five different garbage patch gyres. How are the patches similar and different? Is there enough information to answer the question? What research needs to be done? (worksheet included)

Teacher Note:
For more information about plastics in local U.S. Virgin Islands waters, please see Spotlight: Plastics in the Water.

View of the coastal waters of St. Thomas from Hassel Island (Photo credit: Kristin Wilson Grimes).

Oceanic Garbage Patch Worksheet

1. Where is the North Atlantic Garbage Patch in relation to the USVI (North, South, East or West)?

Go to the following web address to view a map of plastic collected in the Atlantic Ocean: https://bigblueorb.files.wordpress.com/2011/03/atlantic-trash-chart2.jpg

Warmer colors on this map (red, orange and yellow) indicate where scientists have found high concentrations of plastic. The black-line contour indicates the boundary of the North Atlantic subtropical gyre: a part of the ocean bordered by strong currents that collectively flow clockwise. Most of the trash collected (83%) was found within the North Atlantic subtropical gyre. Within the gyre, water moves slowly (~2 cm/second).

Use the map image to answer the following questions.

2. If the distance between 20°N and 30°N is approximately 680 miles, how far is the densest part of the NA Garbage Patch from the USVI, approximately? _____

   a. How can you tell? _____

3. If the distance between 70°W and 60°W is approximately 650 miles, how far is the densest part of the NA Garbage Patch from the USVI, approximately? _____

   a. How can you tell? _____

4. Why is it important for the researchers mapping the North Atlantic Garbage Patch to collect data for multiple years? _____

5. What impacts do you think having a moving 'garbage patch' so close to the USVI means for marine life and people who need the marine environment to survive? _____

Oceanic Garbage Patch Worksheet 9-12

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3. If the distance between 70°W and 60°W is approximately 650 miles, how far is the densest part of the NA Garbage Patch from the USVI, approximately? _____

   a. How can you tell? _____

4. Think about what you've learned about water currents; can marine debris from the U.S. Virgin IslandsI end up in the North Atlantic Garbage Patch? Why or why not? _____

   a. What about the Pacific Garbage Patch? Why or Why not? _____

5. What impacts do you think having a moving 'garbage patch' so close to the USVI means for marine life and people who need the marine environment to survive? _____

6. How can the way marine debris is described sometimes lead to people developing misunderstandings about topics that are really important to marine communities?

_____

_____

_____

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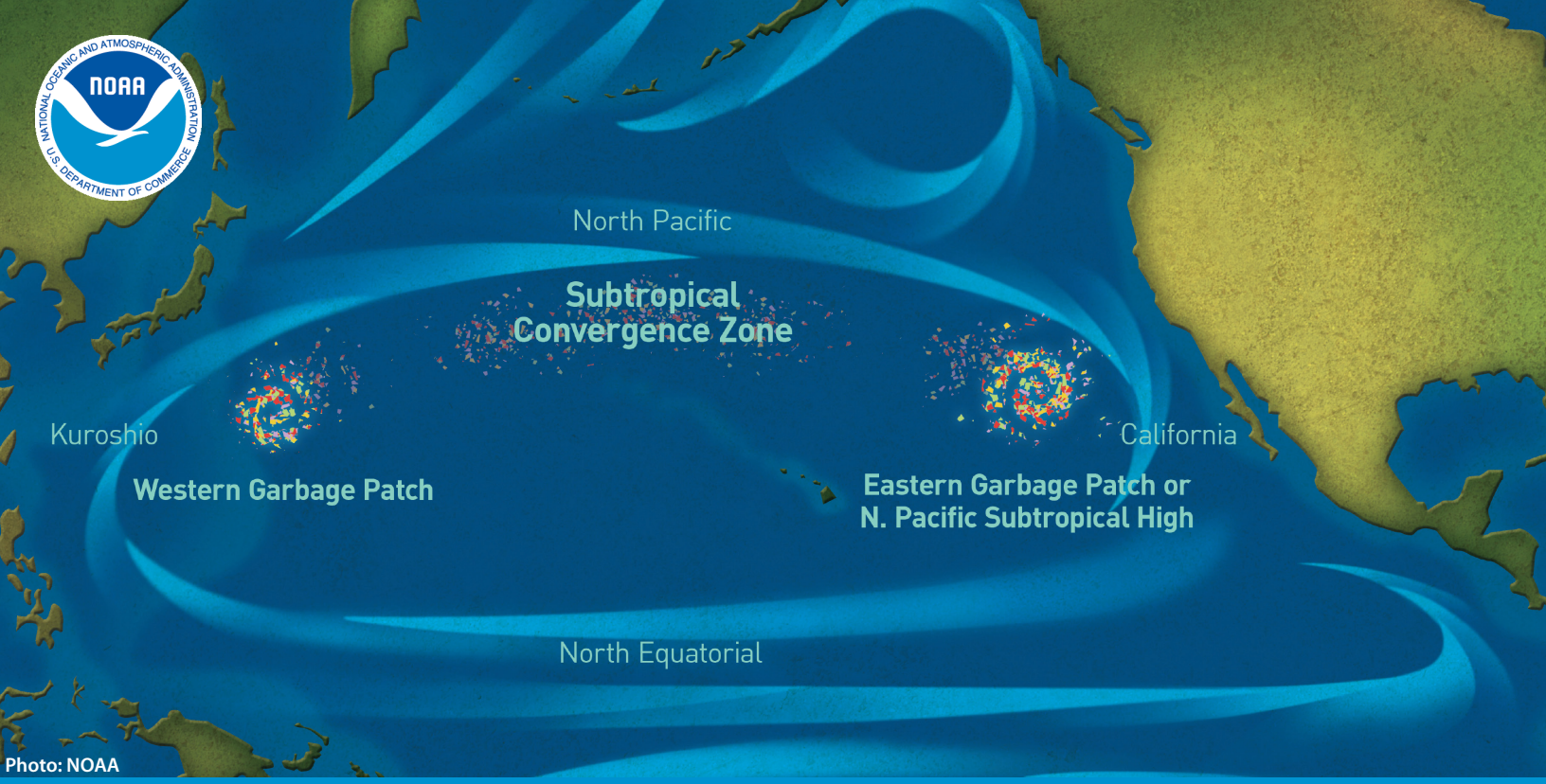

Photo: NOAA

What are Garbage Patches?

The term 'garbage patch' is a misleading nickname for areas of the open ocean where man-made litter and debris accumulate. Although many believe that garbage patches are "islands of trash" that are visible from afar, these areas are actually made up of small plastic pieces, called microplastics, that are easily missed at first glance, or bundles of derelict fishing gear. This debris is always moving due to winds and currents, causing the garbage patches to constantly change size and shape. The items making up the garbage patches can be found from the surface all the way to the ocean floor.

Garbage patches are created from rotating ocean currents called gyres. These currents pull debris into a centralized location, forming 'patches' where marine debris accumulates. Although these patches exist around the world, the most well-known is the 'Great Pacific Garbage Patch,' located between California and Hawaii in the North Pacific Subtropical High.

What are the impacts of garbage patches?

Large accumulations of marine debris can threaten wildlife through entanglement, ingestion, and ghost fishing, and can be a hazard to ocean vessels by clogging engines and propellers. More research is needed to fully understand the specific impacts of garbage patches on both humans and the environment.

Why don't we just clean up the garbage patches?

Cleaning up marine debris found in the open ocean is not as simple as it may sound. The NOAA Marine Debris Program instead focuses on the prevention of marine debris, as well as removal from coastlines where debris is more accessible. Cleaning the open ocean would be challenging for several reasons:

Things keep moving. The areas where debris accumulates move and change throughout the year as wind and water currents shift.

They're really big. These accumulations of debris are usually very large and debris is unevenly distributed from the surface of the water all the way to the ocean floor.

Most of the debris is tiny. The garbage patches are composed mainly of microplastics, bits of plastic that are five millimeters or less in size. Because of their small size, microplastics can't be easily removed from the water column.

It would cost a lot. Collecting and transporting marine debris from the open ocean to shore for disposal could be very costly. Resources can go much farther when removal is focused along the coast.

How YOU can help!

The best way to prevent large accumulations of debris from getting larger is to stop debris from entering the ocean in the first place.

GET INVOLVED
and participate in local cleanups in your area.

REMEMBER
that our land and sea are connected.

DISPOSE OF WASTE PROPERLY
no matter where you are.

REDUCE
the amount of waste you produce.

REUSE
items when you can. Choose reusable items over disposable ones.

RECYCLE
as much as possible! Bottles, cans, cell phones, ink cartridges, and many other items can be recycled.