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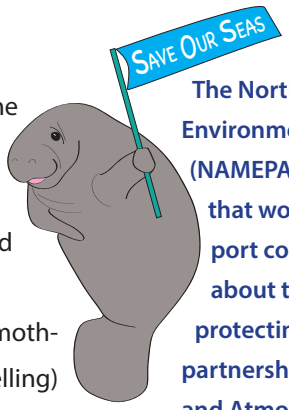
An Educator's Guide to Marine Debris

AN EDUCATOR'S GUIDE TO MARINE DEBRIS

Introduction



Marine debris is a problem that plagues coastlines around the world. In the past, it was considered primarily an eyesore. Today, through research, we know how seriously marine debris impacts marine habitats, marine wildlife, human health and safety, navigation and the economy.

Plastic bags, abandoned fishing nets and other debris can smother sensitive coral reef habitats as well as benthic (bottom-dwelling) ecosystems. Each year, many marine mammals, birds, and other organisms become entangled in or ingest various forms of debris. Fishing and shipping industries are also impacted by marine debris, as they pay vessel repair costs and must replace any damaged gear to continue working. In addition, coastal communities spend millions cleaning up their shorelines every year.

Despite its prevalence, marine debris is a problem that each individual citizen can help prevent. Education is the first crucial step in mitigation. Through the use of this guide, we can help foster environmental stewardship and create advocates for the marine environment. With every person that participates in a cleanup, uses a reusable bag or water bottle, or spreads the word about marine debris, we move one step closer to creating a more beautiful and healthy marine environment. *Source: NOAA, 2007*

The North American Marine Environment Protection Association (NAMEPA) is an industry-led organization that works to educate seafarers, port communities and students about the need and strategies for protecting the marine environment. In partnership with the National Oceanic and Atmospheric Administration (NOAA), NAMEPA has created *An Educator's Guide to Marine Debris* to provide educators with a tool to help students become more informed on marine debris and encourage environmental stewardship.

This easy-to-use guide is designed to provide maximum flexibility for educators in both formal and informal settings. It may be used as a standalone teaching tool, or to supplement lessons in other areas. This guide includes information about marine debris and useful lessons for students grades K-12, with a focus on STEM (Science, Technology, Engineering, Mathematics) objectives.

This guide is based on NOAA's "Turning the Tide on Trash: A Learning Guide on Marine Debris" and was published in 2014. To access presentations referenced in this guide and for additional information, visit www.namepa.net/education or our junior website, www.namepajr.net. We hope to continue to update this guide with new lessons and resources.

Acknowledgements

This learning guide is a collaborative effort between the North American Marine Environment Protection Association (NAMEPA) and the National Oceanic and Atmospheric Administration (NOAA). It was created using content from the "Turning the Tide on Trash" marine debris curriculum developed by NOAA.

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View this publication online at: www.namepa.net/education and http://marinedebris.noaa.gov.

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Micro-Plastic Investigation

Grade Level: 9-12

Time: 1 hour
Note: to do this in 1 day, prepare all the materials in advance.

SUMMARY

This activity introduces students to the processes that break marine debris plastic down into small sizes: photodegradation and mechanical degradation. Students assess where particulates are suspended in the water column (premade plastic slurry). Next, the slurry is mixed into a tub of water that is designed to mimic seawater and students take samples to assess the amount, size, and type of the particulates. Students relate this activity to what they might actually find in the ocean. They will assess the difficulties of sampling and the limitations of the activity. Students are evaluated by their explanations of the abundance of plastic in the oceans and assessment of potential impact of plastic micro-debris to the health of marine ecosystems.

STEM APPLICATIONS

- Collect and analyze micro-debris samples through a classroom simulation (Science, Technology)
- Identify and measure the shape and size of plastic micro-debris (Science, Mathematics)
- Understand the challenges associated with categorizing marine debris (Science, Engineering)
- Depict the analysis of their results in graph form (Science, Mathematics)

VOCABULARY

- **Marine Debris:** 'Any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the Great Lakes' (NOAA, 2007)
- **Mechanical degradation:** A physical interaction between ocean waves and plastic, in which rubbing, smashing, or grinding against the water and/or solid objects causes the plastic to break into smaller pieces
- **Photodegradation:** The process by which a substance or object is broken down via sunlight
- **Transect Grid:** A path or grid along which a researcher makes a series of observations
- **Water column:** The conceptual layers of water from surface to bottom

Background

Plastic is one of the most common types of marine debris. As familiar as we are with plastics (and the role they play in our everyday lives), how much do we really know about them? As society has developed new plastics and new uses for those plastics, the variety and quantity of plastic items found in the marine environment has increased dramatically. These products range from common domestic material (bags, foam cups, bottles, balloons) to industrial products (strapping bands/zip ties, plastic sheeting, hard hats, resin pellets) to lost or discarded fishing gear (nets, buoys, traps, lines).
Plastics can enter the marine environment a number of ways; ineffective or improper waste management, intentional or accidental dumping and littering on shorelines or at sea, or through storm water runoff (to name a few). Eventually, these plastics will degrade into smaller and smaller pieces.

MATERIALS

- Clear tubs for water (1 per group of 3-5)
- 26.5 L, 23 x16.75 x 6 inches works best
- String
- Duct tape
- Markers – permanent/waterproof
- 20L of 3.5% saline "ocean water" per water tub
- Blender
- Two dissecting scopes OR magnifying glasses
- One 600-ml beaker per group
- 50 ml collection beakers (~20, 1 needed per quadrant in each water tub)
- 16/18 oz plastic water cups
- Small paper cups (~4 oz), 1 or 2 for each group

o Optional: soft 3" aquarium nets

- 3 6 oz. Styrofoam cups
- Popsicle sticks or coffee stir sticks
- Plastic wrap
- Ruler
- PowerPoint Presentation (available on NAMEPA website)

If doing lesson in 1 day, prepare these materials in advance:

1. 3.5% saline seawater: Add 35g of salt per liter of water. Prepare 20 L per tub.

2. Transect grid: Construct the sampling grid using a clear storage box with the dimensions listed above. Align string to make a grid pattern consisting of roughly 20 equal quadrants. Use tape to label each quadrant with letters along the short edge and numbers along the long edge.

3. Labeling beakers: Each group needs one 50ml beaker per quadrant. Use tape and a permanent marker to label each beaker with a quadrant (i.e., A-1, A-2, etc.).

4. Sampling device: A 3oz. paper cup with a stick attached to it with duct tape.

5. Plastic/Styrofoam Micro-Debris Mixture: Cut out pieces from a Styrofoam cup and a plastic cup. Add these to a blender with 500ml of the "sea water." Cover and pulse the blender for about 45 seconds. Pour mixture into a 600 ml beaker, or similar and label with class info. Cover with wrap. Repeat until you have enough mixtures for each group.

ACTIVITY

1. Engage (10 min):
Have students answer the following questions in their notebooks (in PowerPoint presentation). This will get them thinking about plastic, marine debris, and sampling, and let you know what prior information they have. Give the students about 5 minutes to write, and then have students share while compiling their responses.

1. Do you think scientists know what type of plastic exists in the ocean and how long it has been there?
2. How do you think plastic might break down in the ocean over a period of time?
3. What types of plastic do you think you might find in the ocean? Write 3 down.
4. Do you think these will change over 1 year? 5 years? 10 years? Feel free to make a drawing but make sure to include a scale.
5. How do you think scientists take samples when researching marine debris?

Present the rest of the PowerPoint, which goes over biodegradation, mechanical degradation and photodegradation, as well as solutions.

2. Explore (25 min):
Have students get into groups. If the plastic/foam/sea water mixture is pre-made, bring that out now. Remember that there should be 1 mixture per group. Otherwise, instruct the students to make their own mixtures now. If they are making their own, feel free to let them experiment with different types of plastic. If the mixture is pre-made, mix up the particulates, then let it rest for a minute. Ask the students to make a sketch of the water column. Where are the particulates in the water: on the surface? In the middle? Settled on the floor? Remind the students to mark their water lines and volume in their sketches.

(5 min) In their groups, students should discuss how plastic in the marine water column may or may not be similar to the mixture in the beaker. Remind them that oceans have their own geography, currents, and wind that move the water around as well as the material in it. Each group should make a Venn diagram or similar representation based on their discussion. Make sure to walk around, listen to the discussions and look at the diagrams.

Each tub should be filled with 19.5 L of the salt water. Each group should have their plastic/Styrofoam mixture. Gently stir for a few seconds and pour it into the "ocean" (the saltwater tub). Stir to make sure the mixture covers the whole tub. Then, set up each group with the transect sampling grid (or they can do this themselves, but be sure to show them a model. The most efficient method is to have grids set up for them to place over the top of the tub. Some students can work on this and some can work on creating their sampling device (small paper cup with a stir stick duct taped to the inside).

If teaching this as a 2-day lesson, another option is to allow the students to design their own sampling device. Additionally, some groups can use the nets if available and compare/contrast methods. Within groups, the sampling should be consistent and careful – slowly lower the device into each quadrant to ensure that the procedure is the same for each sample. The device should be filled completely each time, then carefully poured into the beaker with the same label as the quadrant the sample was taken from. If supplies and/or time are limited, it is also okay to assign certain quadrants to groups and use less tubs.

Students should rinse the sampling device in-between each sample taken. For an expedited process, multiple devices can be used within groups if supplies are available.

3. Explain (15 min):
Students should remove the debris from the beakers, and using a magnifying glass, a dissecting microscope (if available), and a ruler, collect information about:
a. The number of plastic pieces
b. The number of Styrofoam pieces
c. The approximate size of each (measured with a ruler)
Once the students have finished collecting their data, they should create 2 bar graphs: one to analyze the amount of the 2 types of debris in each quadrant, and another for the sizes of debris of each type in each quadrant.

4. Evaluate/Wrap-Up (5 min):
Have students write a paragraph summarizing their investigation. What is plastic micro-debris? How did they collect, measure, and categorize their samples? What limitations might they have encountered regarding plastic breaking down in the beaker, or their sampling method? Lastly, students should attempt to explain the abundance of plastic in the oceans, especially their local areas and assess the potential impact of micro-debris on the health of the marine ecosystem. Any potential personal changes they can make to mitigate the impact of marine debris (plastic use).

DIVE DEEPER

For additional information about NAMEPA's educational programs and materials, visit www.namepa.net/education

NOAA's Marine Debris website: marinedebris.noaa.gov.

Adapted from SEAPLEX Plastic Micro-Debris lesson, "Investigating Plastic Micro-Debris in the Central North Pacific Gyre," by Beth Simmons and William Miller (2011)