North American Marine Environment Protection Association

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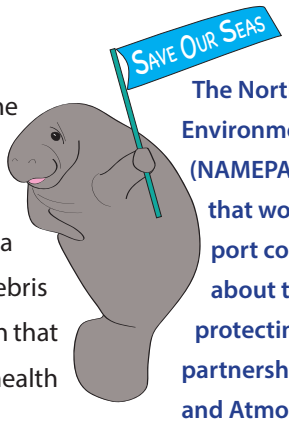
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE

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. By definition, marine debris is anything man-made that ends up in marine environments. 80% of debris comes from land-based sources, traveling to an aquatic environment via stormwater runoff, wind, or other means. In the past, marine debris was primarily considered an eyesore. Today, research has shown that debris also seriously impacts marine habitats, wildlife, human health and safety, navigation, and the economy.

Plastic bags, abandoned fishing nets and other debris can smother sensitive habitats such as coral reefs and eelgrass beds, along with benthic (bottom-dwelling) ecosystems. Each year, many marine mammals, birds, and other organisms become entangled in or ingest various forms of debris, leaving animals malnourished and in danger. Shipping and fishing industries are also impacted by marine debris, as debris can damage boats and hinder navigation. Ships must pay vessel repair costs and replace any damaged gear to continue working. Additionally, industries such as tourism and recreation fall victim to marine debris as coastal communities spend millions to clean 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 form 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 in grades K-12, with a focus on STEM objectives. These engaging lesson plans are aligned with the Next Generation Science Standards (NGSS).

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 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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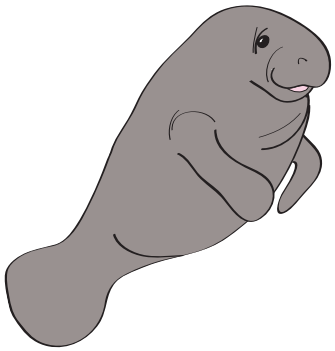

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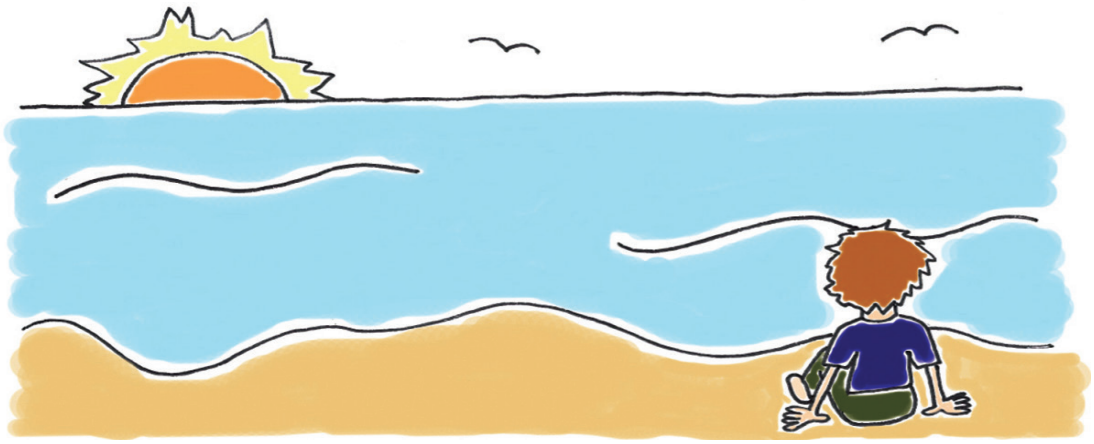
To access surveys to gauge student learning for this guide, check out www.namepa.net/education.



1 Let's Talk Trash

Grade Level: K-5
Time: 1 hour

SUMMARY

Students are introduced to marine debris and participate in a role-playing exercise acting as beachgoers, seafarers (or crewmembers on a boat), homeowners, factory managers, or managers of a waste disposal company. Students discuss their role and how they can manage or prevent marine debris. Students then make a commitment to decreasing their plastic consumption by signing the NAMEPA Plastics Pledge.

OBJECTIVES

- Identify different types of marine debris
- Categorize and tally different forms of marine debris, according to its prevalence, type, mode of travel, origin and degradability.
- Learn and use the term "marine debris"
- Assess their role in creating marine debris by playing members of society and industry
- Collaborate in the role-playing exercise to create a plan to prevent and reduce the impact of marine debris
- Students commit to reducing their plastic consumption with the NAMEPA "Plastics Pledge"

STEM APPLICATIONS

- Students identify and tally debris items (Math)
- Students learn about buoyancy and types of debris items (Science)

VOCABULARY

- **Marine:** Of, found in or produced by the ocean
- **Marine debris:** Any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. (NOAA, 2007)
- **Trash:** Discarded materials; garbage or waste
- **Buoyancy:** The ability to float in water

MATERIALS

- PowerPoint with marine debris definitions and images*
- Pieces of debris for students to see and touch.
- Optional: plastic tub with water
- NAMEPA Plastics Pledge (page 26)
- Optional: NAMEPA "Do You Know Where Your Litter Is?" Poster*

**Available on NAMEPA website*

SAFETY PRECAUTIONS

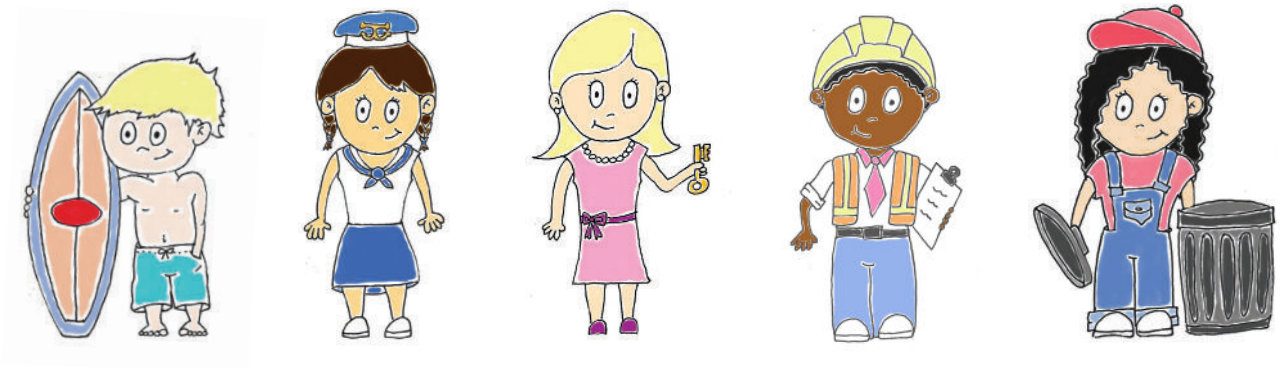
All trash objects should be cleaned and checked by teacher prior to being handled by students. Avoid sharp objects or materials containing harmful chemicals.

BACKGROUND

Marine debris is defined as 'any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes (NOAA, 2007). The most common categories of marine debris are: plastic, glass, rubber, metal, paper, wood, and cloth.

During the international coastal clean-up of 2012, the most commonly collected items during beach clean-ups were cigarettes, food wrapper/containers, plastic beverage bottles, bags, caps/lids, forks/knives/spoons, straws/stirrers, glass beverage bottles, cans, and paper bags (Ocean Conservancy, 2013).

Debris enters marine environments through improper disposal of trash on land and in the water (ships and other vessels, including offshore oil and gas platforms), storm drains, industrial facilities, waste disposal activities, etc. It travels to the oceans through waterways and wind, and once it has found its way into the ocean, it is very difficult to trace the source and can be expensive to remove. Massive amounts of marine debris end up in our oceans and affect marine wildlife and habitats. Education of civilians and various industries increases awareness about our roles in this issue, and encourages us to reduce the amount of trash we generate by using reusable materials, recycling, and properly disposing of our waste.



ACTIVITY

1. Engage (5 min):
Ask students to think about a time when they were at a beach, on the water, near a river, etc. Do they remember seeing anything that did not belong there? Ask them to create a list of debris items they have noticed, as well as their possible origins. Are these things that could harm wildlife or people? Choose volunteers to shawre their thoughts.

2. Explore (10 min):
Open the PowerPoint presentation and go the slide entitled "Activity." Have students identify different marine debris items in the photograph. What are these objects made from (plastic, glass, wood, etc.)? Have students tally items made from each type of material. What is most of the marine debris made out of (plastic)?

3. Explain (15-20 min):
Continue presenting the PowerPoint, describing a basic overview of marine debris and buoyancy. If you have examples, present actual marine debris items for students to see. Ask the students if they use any of the items you're showing them. How often do they use them? What effects can this debris have on the environment, wildlife, and people? Be sure to mention entanglement of and ingestion by wildlife, smothering of habitat (i.e. coral reefs), unsightliness, expensive clean up, ect.

Once you reach the slide entitled "Buoyancy," present the Optional Extension (below) if you are choosing to do so. If not, ask the students what types of debris they think are more buoyant (i.e. plastic) than others (rubber tires, fishing net, driftwood, etc.). Ask the students how they think these things become marine debris. Responses you are looking for include littering, transportation via water and wind, runoff to storm drains, trash getting dumped overboard from ships, and storms.

OPTIONAL EXTENSION
If you have physical examples of marine debris and a plastic tub, perform a buoyancy demonstration. Fill two thirds of the plastic tub with water. Ask students to make predictions, either on paper or verbally, about which items will sink and float. Place items in the water and have students come up to view the results. Which objects would travel greater distances than others? What objects would be most likely to impact remote areas uninhabited by people? Be sure to mention that because plastics are very buoyant, they often travel farther than other marine debris items.

4. Extend (20 min):
Present the last slide of the PowerPoint. Tell students they are going to participate in a role-playing exercise and divide them into groups. Assign each group one of the following roles: beachgoers, seafarers (or crewmembers on a ship), homeowners, factory managers and managers of a waste disposal company. For 7-10 minutes, they should discuss the impact they have on producing marine debris and what they can do to reduce or prevent marine debris.

Try asking each group the following questions to help get them thinking:

• Beachgoers: What are some things you can do when you go to the beach to help reduce/prevent marine debris (i.e. clean up the trash you see and don't leave trash behind)?

• Seafarers: What are some ways you can decrease the waste you produce onboard? If you were a crewmember on a cruise ship, what are some ways you can help get passengers to decrease their waste and not litter?

• Homeowners: What changes can you make everyday to help reduce the trash you produce? What products should you stay away from (i.e. single use water bottles)? What are some alternative products you can use?

• Factory Managers: How can you go about disposing of the waste your factory produces properly? What are some things you want to avoid (i.e. dumping/littering, sending things to landfill)? You may want to explain what a landfill is (a way to dispose of waste by burying it in the ground).

• Manager of a Waste Disposal Company: What are some things you want to make sure your employees are doing properly so that trash does not enter the environment or get sent to landfill (i.e. properly separating materials for recycling, ensuring materials aren't blown away by wind?

After, divide students so that each group has a member from each role. For the next 7-10 minutes, they should come up with a plan as a community to reduce and prevent marine debris. Each group should try to make a list of at least 5 things they plan to do to reduce their impact. Have students share their ideas as a class.

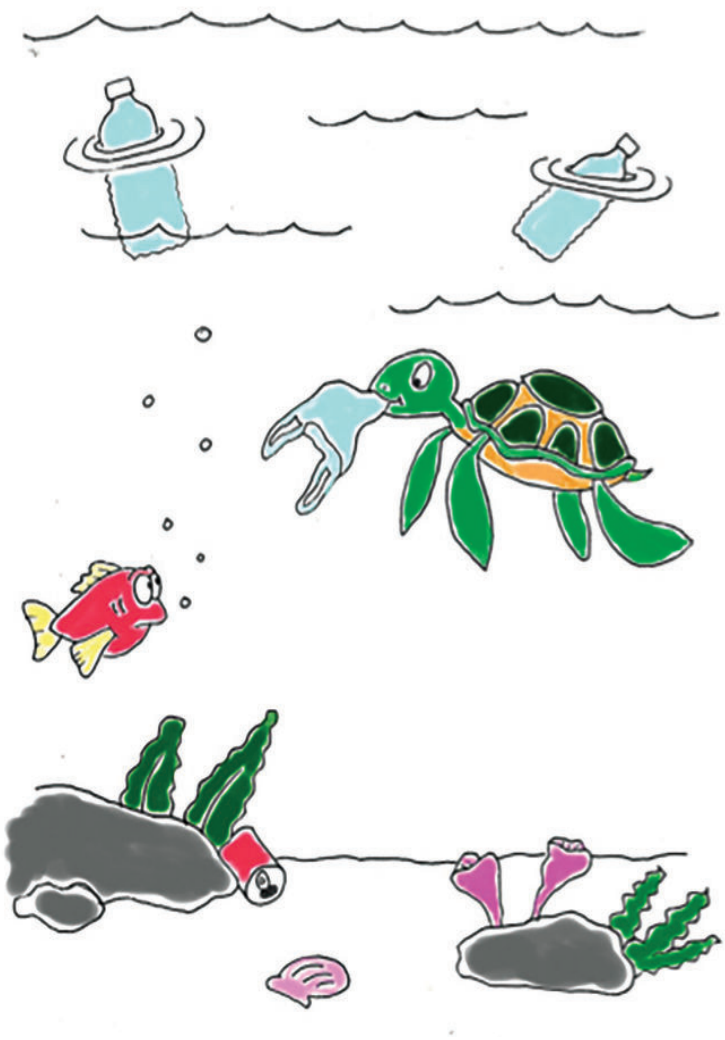
5. Evaluate/Wrap-Up (5 min):
To wrap up the lesson, mention some of the following ways the students can help prevent marine debris: reducing their waste, reusing materials, recycling, participating in cleanups, etc. Then, hand out copies of the NAMEPA Plastics Pledge (on page 26), and have students commit to decreasing their plastic consumption. You can also show the students the NAMEPA "Do You Know Where Your Litter Is" brochure to give them a better idea of how long it takes for certain debris items to break down (available on NAMEPA website).

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.

2 Trapping Trash

Grade Level: K-5

Time: 1 hour, can be done over multiple days



SUMMARY

Waste reduction and prevention is essential in mitigating marine debris. However, action needs to be taken to address the trash that has already accumulated in our oceans. This lesson plays on students' creativity by asking them to design a machine that collects debris in the ocean without impacting wildlife.

OBJECTIVES

- Design a device/structure to remove existing marine debris

STEM APPLICATIONS

- Designing a piece of machinery (Technology & Engineering)
- Laying out dimensions of a design (Mathematics)
- Understanding the buoyancy of various materials (Science)

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 marine environment or the Great Lakes (NOAA, 2007)
- **Photodegradation:** The process by which a substance or object is broken down via sunlight
- **Gyre:** A circular pattern of currents in an ocean basin
- **Buoyancy:** The ability to float in water
- **Recycling:** Converting waste into reusable material

MATERIALS

- Drawing paper
- Graph paper
- Drawing utensils: pencils, colored pencils, markers
- PowerPoint presentation on Marine Debris (on NAMEPA website)
- Rulers and protractors
- Compasses for drawing circles
- NAMEPA Plastics Pledge (page 26)
- Optional: Examples of debris and plastic tub with water for buoyancy test
- Additional options: Legos or materials to build models (If doing the lesson over multiple days, these materials can be catered specifically to student designs, and they can choose their materials)

SAFETY PRECAUTIONS

Clean and check all trash objects prior to being handled by students. Avoid sharp objects or materials containing harmful chemicals.

BACKGROUND

Marine debris is a global problem, impacting all of the world's oceans. It originates from a variety of sources, including beachgoers, wind, ships, etc. Marine debris entangles and is ingested by marine life and can smother habitats such as coral reefs. After entering the ocean, much of the drifting debris ends up in ocean gyres, which occur because of the circular ocean currents. We have not yet discovered an efficient way to remove debris from the world's waterways and oceans, which is the inspiration for this lesson. Despite how widespread marine debris is, it is something that each individual person can help to prevent through making informed purchasing decisions, properly disposing of trash, cleaning up litter, etc.

ACTIVITY

1. Elicit (7 min):
Ask the students if they have ever seen trash where it doesn't belong, and if so where? Answers should include on the street, storm drains, parking lots, beaches, etc. What types of debris have they seen? Take answers for a couple minutes after giving them a minute to think. Ask them how they think the debris ends up there. Answers include littering, wind and runoff, storms, etc.

2. Explore (10 min):
Open the PowerPoint and give a brief background of marine debris, engaging the students as you go. Once you get to the part of the presentation on buoyancy, if available, show the students the examples of debris you brought in and test the buoyancy of each in the tub of water. Ask them which items they think would travel the farthest, and what impact each item may have on marine habitat, wildlife and people. Answers may include entanglement of and ingestion by wildlife, suffocation of marine habitats (i.e. coral reefs), expense to coastal communities due to clean up, danger to boaters, etc.

3. Explain (~30 min):
Tell students that they are going to be designing their own trash collector to remove marine debris from oceans and beaches, or prevent it from entering waterways. Remind them that their devices should not harm or interfere with wildlife, such as seals and turtles. For the first few minutes, let the students sketch ideas. Have them write a few sentences about what they want their machine to do and to look like. Students should draw inspiration from images in the presentation, and for the rest of the time can work on their designs. Students can work individually or in groups.

Provide students with graph paper, drawing utensils, or any other materials you have decided to use. While the students are working, encourage them to think of things they may not have considered, i.e. how does the machine run? Where does it get its energy? How does it avoid harming wildlife? What happens to the trash after it's collected?

4. Extend (~10 min):
Allow students to share their drawings or models, explaining their concepts while other students ask questions. If you have not finished the PowerPoint, present the last two slides on solutions. For the last few minutes, discuss other ways to prevent marine debris from entering our oceans – properly disposing of trash, recycling, making more informed purchasing decisions, using reusable water bottles and bags, etc. You can also probe further and ask the students what they think can result from these actions**.**

5. Wrap-Up (5 min):
A great way to wrap up this lesson is to have the students sign the NAMEPA Plastics Pledge (page 26) to have them demonstrate their commitment to reducing their plastic consumption.

OPTIONAL EXTENSION
This can be turned into a multi-day activity where the students pick materials and actually build and test their models.

To adapt this lesson for 6th-12th grade, you can include discussion of accumulation rates and how many people over time it would take to remove the existing trash on beaches/shores.

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.

Did you know that most commonly used plastics do not go away, but instead break down into smaller and smaller pieces called microplastics?

3 It's All Downstream From Here...

Grade Level: K-5

Time: 1 hour (minimum)

SUMMARY

In this lesson, students make observations about what is in their classroom trash receptacle (or various trash items brought by instructor). Students then go outside to collect trash from the surrounding area and record what they find using the NAMEPA Trash Data form. The class then looks at the data they have collected and makes inferences about sources, origins and most common types of marine debris. This is a great lesson to do in a coastal area or near a waterway!

OBJECTIVES

- Collect data from 2 locations
- Analyze data to make inferences about sources, origins and most abundant types of debris
- Consider personal impact on marine debris
- Formulate a plan to reduce and prevent marine debris

STEM APPLICATIONS

- Collecting and analyzing data (Science, Math)
- Understanding marine debris origins and effects (Science)
- Creating a plan to address an identified problem (Engineering)

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 marine environment or the Great Lakes' (NOAA, 2007)
- **Data:** Facts or information, usually used to calculate, analyze, or plan something
- **Litter:** Trash, wastepaper, or garbage lying scattered about
- **3 R's:** Reduce, Reuse, Recycle
- **Biodegradation:** The process by which a substance or an object that came directly from a living thing is broken down, or decomposed, by living things (bacteria and invertebrates) and is turned back into a usable product
- **Photodegradation:** The process by which a substance or object is broken down via sunlight

MATERIALS

- PowerPoint presentation on marine debris (on NAMEPA website)
- Various trash items – go through ahead of time to make sure all of the items are safe and clean
- Gloves for every student
- Trash bags
- NAMEPA Trash Data Form (page 25)
- A clipboard and writing utensil for each group
- Area outside to collect trash
- Blackboard, whiteboard, or chart paper and appropriate utensil
- NAMEPA Plastics Pledge (page 26)

SAFETY PRECAUTIONS

All trash objects should be cleaned and checked by teacher prior to being handled by students. Avoid sharp objects or materials containing harmful chemicals.

A portion of this lesson requires students to go outside. Review with students the expectations about going outside. Remind the students that they should not handle sharp objects; do NOT touch broken glass or needles!! All students should wear gloves when handling trash.

ACTIVITY

1. Elicit (5 min):
Ask students if they have ever been to a beach, river or general coastal area and saw something that did not belong there (questions included in PowerPoint presentation). They can silently write their thoughts for a few minutes, or discuss with classmates in small groups. After a couple of minutes, ask if they have ever seen trash on the ground and where they think it comes from. How does it get transported from one location to another? After a minute of discussion, present the PowerPoint on marine debris. Once you get to the "You Can Make a Difference" slide, wait to present the next (last) slide until the end of the lesson. The last slide has the top ten marine debris items found in beach cleanups (data taken from the Ocean Conservancy). This will be compared to the debris the students collect.

2. Explore & Engage (30 min):
Take out the various trash items you brought, or take a look through the classroom trash can (make sure all items are safe). Have each student look at the items and write down what they see, making note of multiples. Then, as a class, make a master list of the items.

Tell the students you will all be going outside to collect trash from the surrounding area. This serves two purposes. First, data will be recorded on the types of items collected outside using the Trash Data forms and compared to those inside. Second, trash will be removed from the grounds!

Go over expectations with the students. Let them know they should stay within sight of an adult, stay away from trash that looks dangerous, and always wear their gloves.

Students can work in small groups of 2-3. Each group should have a trash bag and one student in each group should be recording what items are collected. After about 10 minutes, have the students come back inside to take a look at what was found.

3. Explain (15 min):
Each group should present the data they collected outside. A great way to do this is to have a student from each group put the totals for each item on the board, so that all the totals can be summed. Compare this data with what was found in the trashcan earlier. Most likely the results will be similar. Are there any items you expected to find but did not? What could be a reason for this? What items were recorded both indoors and outdoors? Based on the data collected, what do the students think are the most common types of marine debris found during cleanups? Present the last slide from the PowerPoint, which has the top ten debris items found in cleanups worldwide, based on data from the Ocean Conservancy. How does the class data compare to this list?

5. Wrap Up (5 min):
A great way to end this lesson is by having the students sign the NAMEPA Plastics Pledge (page 26) to demonstrate their commitment to reducing their plastic consumption.

DIVE DEEPER

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

Top Ten Items Over 25 Years

RANK	DEBRIS ITEM	NUMBER OF DEBRIS ITEMS	PERCENTAGE OF TOTAL DEBRIS ITEMS
1	CIGARETTES/CIGARETTE FILTERS	52,907,756	32%
2	FOOD WRAPPERS/CONTAINERS	14,766,533	9%
3	CAPS, LIDS	13,585,425	8%
4	CUPS, PLATES, FORKS, KNIVES, SPOONS	10,112,038	6%
5	BEVERAGE BOTTLES (PLASTIC)	9,549,156	6%
6	BAGS (PLASTIC)	7,825,319	5%
7	BEVERAGE BOTTLES (GLASS)	7,062,199	4%
8	BEVERAGE CANS	6,753,260	4%
9	STRAWS/STIRRERS	6,263,453	4%
10	ROPE	3,251,948	2%
	TOP TEN TOTAL DEBRIS ITEMS	**132,077,087**	**80%**
	TOTAL DEBRIS ITEMS WORLDWIDE	**166,144,420**	**100%**

SOURCE: OCEAN CONSERVANCY/INTERNATIONAL COASTAL CLEANUP

Did you know that cigarettes are the most commonly found trash item during the Ocean Conservancy's International Coastal Cleanup?

Did you know that cigarettes contain plastic?

4 Building a Watershed

Grade Level: 6-8

Time: 1 hour

SUMMARY

Students build a model showing how water flows through a system and evaluate different management practices to see how they might reduce the amount of marine debris that enters the marine environment. The models in this lesson could be used as a classroom demonstration or traditional lab investigation for students, depending on time efficiency of instructor and students. This lesson may also be shortened by showing students a pre-made model beforehand.

OBJECTIVES

- Construct a model of a localized watershed
- Identify various ways that marine debris is created
- Identify origins of marine debris
- Write a plan to reduce their own impact on marine debris and make extensions to help others reduce their impact
- Share and discuss their findings with the class
- Write a summary of the activity

STEM APPLICATIONS

- Design and build small-scale models of a watershed (Engineering and Science)
- Draw conclusions about ways debris enters waterways and marine environments (Science)
- Plan strategies to reduce and prevent debris from entering the systems and to remove existing marine debris (Engineering)
- Compare their predictions to the results of their experiments and assess any discrepancies (Science)

VOCABULARY

- **Watershed:** An area of land where all of the water flows to a common point. Streams flow into small rivers, which flow into bigger rivers, which flow into lakes or oceans and are determined by the shape and slope of the land. Watersheds can be small or large systems
- **Marine debris:** 'Any persistent, solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or Great Lakes' (NOAA, 2007)
- **Marine:** Of, found in, or produced by the ocean

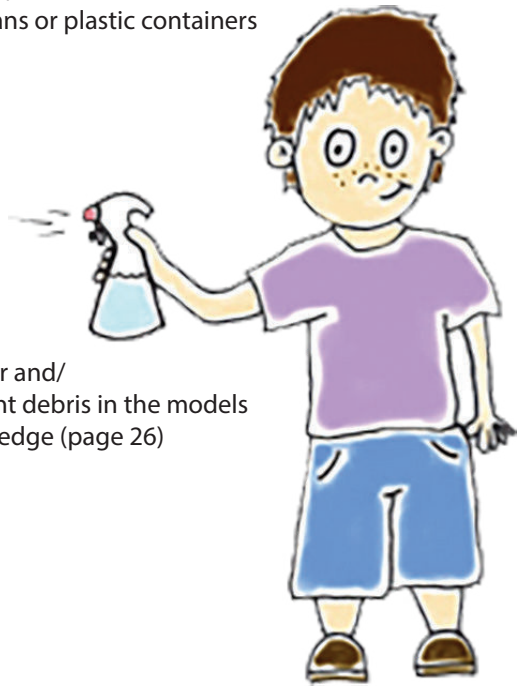
BACKGROUND

Marine debris enters coastal waters from both land and sea. Beachgoers often leave trash behind, intentionally or accidentally, and commercial and recreational fishermen may lose or abandon some of their gear at sea. Debris from land-based sources such as roads, schools, parks and picnic areas, landfills, etc. travels to the ocean via rivers, runoff and wind. Marine debris can also come from recreational and commercial boats such as charter boats, fishing vessels, ferries, etc. from people tossing trash overboard.

When trash is disposed of improperly, it often ends up in the ocean as marine debris. The majority of marine debris is comprised of plastic, which is problematic because many animals mistake these various plastic materials for food. For example, sea turtles commonly consume jellyfish, and plastic shopping bags floating in the water resemble this important food source. Additionally, birds can confuse plastic items with food and consume trash and feed it to their babies. Marine debris is a massive problem and is within our power to fix! Proper disposal of garbage, no matter where, is important. In addition to making sure our own trash is properly disposed of, we can pick up litter we see on the ground, and talk to our friends, families and neighbors about proper trash disposal. We can also use reusable materials to prevent so much trash from being created in the first place!

MATERIALS

- Dry erase markers
- Pre-made watershed model (optional)
- PowerPoint presentation on marine debris and watersheds (on NAMEPA website)
- Large aluminum pans or plastic containers – 1 per group
- Soil
- Sand
- Gravel
- Aluminum foil
- Spray bottles
- Water bottles
- Water
- Small pocket fan (if available)
- Tiny pieces of paper and/or plastic to represent debris in the models
- NAMEPA Plastics Pledge (page 26)



ACTIVITY

1. Engage (5-7 min):
Ask students if they have ever been to the beach or a river. What types of things have the students seen at these places? Did they ever notice any pollution, specifically trash or litter? What types of debris items have they seen? Make a list on the board.

2. Explore (25 min):
Ask students what some of the possible origins of this debris are (i.e. wind, beachgoers, ships, storms, etc.). How does it get into the marine environment? Try to steer them in the direction of runoff and watersheds. Do different types of debris travel in different ways? Ask the students what types of debris they think would travel the farthest and why (i.e. plastics because they're more buoyant than other types of debris). Give students a couple minutes to talk to a classmate, and then call on students to share their answers.

Present the PowerPoint, which provides background on marine debris and watersheds. You can present the entire PowerPoint now, or wait to talk about solutions toward the end of the lesson. For the remainder of the lesson, students should use the term "marine debris" instead of "trash" or "litter" – hold them to this!

INTRODUCE ACTIVITY
Students are going to build a model of a watershed to see how water flows and carries marine debris with it. Get students into groups of 3-4:

1. Students fill one third of a large aluminum pan or plastic container with the sand and/or dirt in an irregular manner to mimic the Earth's surface. Make sure students have high points and low points, preferably multiple "hills" or "mountains."

2. Students press a layer of aluminum foil over the dirt surface. Give each group a few markers to add/draw context to their models: cities, towns, farms, factories, roads, people, etc.

3. Using a spray bottle, students spray small amounts of water on the foil, or gently pour water on foil, representing rain. Students record their observations, i.e. direction of flow, pooling, etc. Review the definition of a watershed at this time. What is the common point to which the water has flowed? In real life, what are some common points to which water flows? A: Oceans and lakes, via rivers and streams.

4. Ask the students what they drew in their models that can create marine debris. Pass out the "marine debris" for their models and have students sprinkle it where "people" in their models live. Have students record what kind of debris the paper and plastic represent and predict how did it get there? Where is the debris going to go when it rains?

5. Students again spray and gently pour water on their models, this time observing what happens to the marine debris. Where does it go? Students record their observations.

6. If some groups finish early, have them take another batch of "debris" and place it at the source. This time students use a small fan to see what happens to the debris (if you don't have a fan, use water again).

7. Students clean up workstations, put materials away, and head back to their seats.

3. Explain (5 min):
Have each group write a summary of what they did. Summary should include:
• Made a model of a watershed where all the water pooled in one place
• Used little pieces of paper and plastic to show that litter from towns and cities flows with water through rivers to become marine debris in the oceans
• Any questions they still have
Walk around and observe groups. Pick volunteers to share their paragraphs after each group is finished. Take questions if you have time.

4. Elaborate (10 min):
Offer these prompts for a class discussion:
• Now that we know what marine debris is and where it comes from, what can we do to reduce and prevent it?
• How can we reduce our waste?
• What about within our communities?
• What about debris that is already on the beach?

5. Evaluate/Wrap-up (5 min):
Have the students brainstorm three things they are going to do to help mitigate marine debris. If you did not finish the PowerPoint, present the last two slides on solutions. A great way to end this lesson is by having the students sign the NAMEPA Plastics Pledge to have them commit to reducing their plastic consumption.

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.

5 Designing an Experiment

Grade Level: 6-8, can be adapted to high school

Time: 1 hour with possible multiday extensions to carry out research

SUMMARY

This lesson allows students to practice the scientific method. Students are presented with background information about marine debris – what it is, its origins, and current statistics. Students will engage in a brief discussion about its impacts. Afterward, students are given handouts to review the scientific process. Students are asked to come up with three research questions about the prevention or removal of marine debris. After instructor approval, the students choose one question and write a hypothesis and procedure for their experiment, as well as assess at least one obstacle to their research. Students should present to small groups about their question, what they hope to learn, how they arrived at their hypothesis, and their procedure. The lesson ends with a discussion about how to reduce marine debris via informed consumer purchases. This lesson is ideal for classes that already have some background knowledge of marine debris and the scientific method.

OBJECTIVES

- Write a research question
- Write a hypothesis
- Write an experimental procedure
- Share experimental process with a group
- Assess methods of reducing marine debris

STEM APPLICATIONS

- Design an experiment (Science, Technology)

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 marine environment or the Great Lakes' (NOAA, 2007)
- **Independent variable:** Variable that is changed in a scientific experiment to test the effects on the dependent variable
- **Dependent variable:** Variable being tested in a scientific experiment

MATERIALS

- PowerPoint with background on marine debris and the scientific method (on NAMEPA website)
- Student Survey (attached)
- NAMEPA Plastics Pledge (page 26)

OPTIONAL EXTENSION

This lesson can be extended into multiple days for the students to carry out their research plans. The teacher can also make arrangements for the student to conduct their research outside of school time.

ACTIVITY

1. Elicit (5-7 min):

Hand out the survey to the students to assess their knowledge of marine debris and the scientific method. You can also open up the PowerPoint and go through the slides with the eight survey questions. Have the students complete the survey before finishing the PowerPoint. After about 5 minutes, choose a few students to share their answers. Review the correct answers using the answer key provided.

2. Explain (10 min):

Tell the students they will be designing an experiment about removing or preventing marine debris, or assessing the impacts marine debris has on marine wildlife or habitat. After the presentation, they should brainstorm questions they have that they would like to research. Present the rest of the PowerPoint about marine debris and the scientific method. Students should take notes during the presentation – they will need these for the next activity.

4. Elaborate (20 min):

Students can work independently or in pairs. They should brainstorm at least three research questions about removing or preventing marine debris, or assessing the impacts marine debris has on marine wildlife or habitat. An example to use could be: "What is the most common type of marine debris in the U.S.?" or "How many people would it take to effectively clear a one mile stretch of beach?" Remember, research questions need to be specific and testable. Once the students have written at least one suitable research question, have them form a hypothesis. After, they should develop a procedure. Students should use the notes they took during the presentation to write their background information.

5. Extend (10 min):

Have students get into groups of 4-5 and briefly share their plans with each other. Students should remark on the strengths and weaknesses of each other's research plans. Are all of these experiments specific and testable? How could the data collected from these experiments be beneficial in helping to prevent marine debris?

6. Evaluate (5 min):

A great way to end this lesson is by discussing ways to mitigate marine debris (reducing your waste, reusing materials, recycling, cleanups, etc.) and by having the students commit to reducing their plastic consumption by signing the NAMEPA Plastics Pledge (page 26).

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.

STUDENT SURVEY

1. These items are commonly found on local beaches. Circle the items that you consider to be "marine debris:"
    a. Feathers
    b. Sticks
    c. Plastic Bottle
    d. Cigarette Butts
    e. Shells
    f. Food Wrappers
    g. Crabs
    h. Fishing Line
    i. Wood

2. True or False: Plastic…
    a. Is naturally occurring
    b. Completely biodegrades
    c. Is found in the ocean throughout the water column, from the surface to the floor
    d. Is not transported by rivers and ocean currents

3. How would you define marine debris?

4. Which of these are reasons marine debris is problematic?
    a. It's aesthetically displeasing
    b. It can transport invasive species
    c. It is dangerous to wildlife
    d. It can be dangerous to humans
    e. Animals mistake it for food and ingest it
    f. It transports toxins through the food chain
    g. All of the above
    h. None of the above

5. Put the following steps of the scientific method in order:
    a. Develop hypothesis
    b. Collect and record data
    c. Design the experiment
    d. Determine research question
    e. Draw conclusions
    f. Conduct background research
    g. Conduct the experiment

6. Finish this sentence: A testable question is one that is…

7. What are the two types of variables in a testable question?

8. Write a sentence frame for a hypothesis (Ex. If _____then _____because_____)

Answers on page 28

6 Cleanup Clues

Grade Level: 6-8, can be adapted for high school

Time: 1 hour

SUMMARY

First, the class reads a short write-up about the research. Students analyze the Ocean Conservancy's International Coastal Cleanup data to make inferences about which countries documented the most amount of marine debris and the types of debris found/collected. Students also answer prompts about why some states or countries had much higher amounts of marine debris reported than others. Middle school students can do this part as a guided activity and will focus on the domestic data. High school students can do it independently and focus on international data. This lesson is written for individual work but can easily be made into group work with assigned roles.

OBJECTIVES

- Interpret data collected from International Coastal Cleanup and portray their understanding in graph form (visual representation)
- Use data about marine debris to determine which types of marine debris are most and least prevalent in different places and possible reasons for this
- Use data to determine which countries reported the highest amounts of marine debris
- Compare and contrast the data from different states or countries and assess the similarities and differences
- Propose other reasons for the data results
- Present findings about assigned data set to the class and make inferences about the bigger picture
- Write a concluding paragraph explaining what the data they are working with tells them

STEM APPLICATIONS

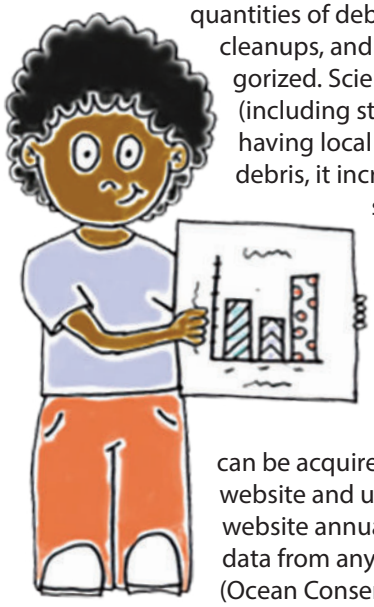
- Use an in-depth set of statistical numbers to make qualitative inferences (Math)
- Compute numbers from a data set into percentages and interpret them (Math)
- Assess the limitations of a data set (Math, Science)
- Make a visual representation of numerical data (Science, Math)
- Write a paragraph explaining conclusions (Science)

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 marine environment or the Great Lakes' (NOAA, 2007)
- **Sustainable:** Of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged
- **Photodegradation:** The process by which a substance or object is broken down via sunlight

BACKGROUND

The Ocean Conservancy (OC) is a nonprofit organization that mobilizes citizen advocates to facilitate change and protect the ocean for future generations. Every year, citizens from all around the globe participate the International Coastal Cleanup, volunteering their time to collect trash from coastal areas. During these coastal cleanups, an astounding amount of trash is removed from marine environments and is properly disposed of, either as trash or recycling. Types and quantities of debris are recorded during the cleanups, and the data is analyzed and categorized. Scientists, businesses, and citizens (including students!) can use this data. By having local volunteers clean up marine debris, it increases awareness about the severity of this problem and the role we all play in its prevalence and mitigation. Cleanups are one way to empower citizens to become a part of the solution, and inspire them to take preventative actions.



The data used in this lesson can be acquired from the Ocean Conservancy website and updated data is posted to their website annually. Additionally, any published data from any coastal cleanup can be used (Ocean Conservancy, 2014).

MATERIALS

- PowerPoint presentation (available on NAMEPA website)
- Printouts of The Ocean Trash Index for each student group or student: http://www.oceanconservancy.org/our-work/marine-debris/2012-icc-data-pdf.pdf (PDF also available on NAMEPA website)
- Global map and US map for each table for students to find their locations
- Calculator (if desired by instructor)
- Graph paper
- Projector

ACTIVITY

1. Engage (5-7 min):
Show students the introduction from the Ocean Conservancy's Ocean Trash Index. This can be printed out and handed to students, or taken from the PowerPoint presentation. This information includes how many years the data set comprises, a brief history of the research, a brief interpretation, and an introduction to terminology. It would be a good idea to read this aloud to students once during this intro activity. Students are to answer a few comprehension questions (in the PowerPoint presentation):

- "When did The Ocean Conservancy begin collecting data?"
- "Briefly describe (1-2 sentences) the three different types of cleanups conducted."
- "Who is responsible for collecting the debris?"
- "Who is responsible for counting the people collecting the debris?"
- "What does the data mean when it talks about 'miles'?"

Briefly have students share their answers with the class before moving on to the next activity.

2. Explore (15-20 min):
Here, middle school students will work with the domestic data (found on the last few pages of the data packet), while high school students will work with international data. Students should choose at least three geographical places and create a graph (bar, pie, or other) for the totals of each category. This way they can compare the totals between the three places. For middle school, their home state should be one of the states used, if the data is available. For high school, the US should be one of the countries used.

A good teaching tool is to do this once or twice to model the activity before having them do it on their own. All students should calculate the percentages. Middle school students should find the percentage for each category (how much of the debris collected was from shoreline/recreational activities? How much from ocean/waterway activities? How much from smoking-related activities?). Have the students locate states or countries they chose and write a short blurb about where the coastal cleanup took place (i.e. California has a long coastline on the Pacific, Michigan borders the Great Lakes, etc.). This helps the students contextualize the locations they chose.

OPTIONAL EXTENSION
Have students compute the percentage for each specific debris category for the location they chose with the highest results. Fast working students can compare/contrast the coastlines and areas they chose.

During this activity, walk around the classroom and observe the students' work, redirecting the students as needed. This activity gives the students a visual representation of the amounts, types and locations of debris found during these cleanups.

3. Explain (10 min):
Students are to write a paragraph explaining their graphs and make inferences about. Write a few sentences on the board to model the activity for the students. For example, "Connecticut had much higher levels of debris than Idaho, however Hawaii had the highest of the three. Idaho is inland so it makes sense that the two coastal states I looked at would have much higher levels of debris …" Students can go as in depth as time allows.

4. Extend (10 min):
Briefly review the research. Students should share their data/graphs with their peers, and answer the following questions:

- What are some things that could impact the results of the data?

- What can be done to reduce the amount of marine debris in our oceans and our shores?

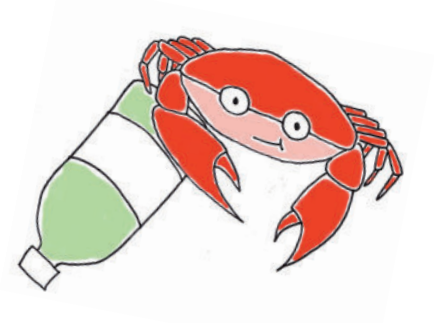
Give students a couple minutes for independent thought, 2-3 minutes to share with peers, and 3-5 minutes to discuss as a class.

5. Evaluate/Wrap-Up (5 min):
A great way to wrap up this lesson is by having a discussion about what inferences can be made from this data, i.e. what does this say about the products we are using? What lifestyle changes can we make to help prevent marine debris? How do you think technology could play a role in mitigating marine debris? Ask the students what things they plan on doing in their own lives to help prevent marine debris.

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.



7 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
- 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)

8 The Solution to Pollution

Grade Level: High School

Time: Varies, can take an hour – one day

SUMMARY

After instructor presents the PowerPoint on marine debris and disposable culture, students examine and discuss data from the Environmental Protection Agency's Waste Report from 2012 (also included in PowerPoint). After gaining a better understanding of types and volumes of waste discarded in the U.S. and how much of that is recovered, students get into groups and create a Public Service Announcement (PSA) designed to educate the public about single-use plastics and mitigating marine debris. The PSA can be a skit, video or poster.

OBJECTIVES

- Learn about "disposable culture" and marine debris origins, impacts and solutions
- Create a Public Service Announcement by performing a skit, making a video or creating a poster

STEM APPLICATIONS

- Discuss the meaning of graphs and charts about municipal waste and recycling (Science, Math)
- Create a Public Service Announcement urging others to increase use of reusable plastics (Technology)

NGSS ALIGNMENT:

- **Practice 4.** Analyzing and Interpreting Data
  - 9-12 – Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
- **Practice 8.** Obtaining, Evaluating, and Communicating Information
  - 9-12 – Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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 marine environment or the Great Lakes' (NOAA, 2007)
- **Disposable:** describes a product that is designed to be used once and then thrown away
- **Single-use plastic:** plastic items such as drink bottles, plastic wrap, disposable utensils, plastic bags, food packaging
- **PSA:** Public Service Announcement – Messages circulated to the public with the objective of raising awareness or changing public attitudes/behavior toward a certain issue
- **Municipal solid waste:** Also known as trash or garbage; consists of everyday items that are discarded by the public

BACKGROUND

According to the EPA, "in 2012, Americans generated about 251 million tons of trash and recycled and composted almost 87 million tons of this material, equivalent to a 34.5 percent recycling rate. On average, we recycled and composted 1.51 pounds of our individual waste generation of 4.38 pounds per person per day" (EPA, 2012). Thirty percent of the waste generated by the American public in 2012 was containers and packing. That means that about one third of the trash generated that year was single-use plastics. Unfortunately, some of that waste ends up in our oceans and waterways.

Prevention plays a major role in amending the pressing global issue of marine debris, and if we collectively move away from single-use disposable plastics, we can begin to reduce the amount of trash that has the potential to enter the marine environment. Some ways to reduce this presence of "disposable culture" are to buy fresh food that does not come wrapped in packaging, use reusable containers (for example, water bottles), use cloth instead of paper (diapers, towels and rags), buy in bulk, reusable bags, etc.

MATERIALS

- PowerPoint Presentation (available on NAMEPA website), includes EPA graphs on municipal waste generation
- Any materials needed to make the PSA, which can include poster boards and drawing utensils, laptops and cameras to make videos. If performing a skit, no other materials are needed.

ACTIVITY

1. Engage (5 min):
Ask the students to think about the types of items they most commonly dispose of. What material is most of their trash made out of? How much trash, in weight, do you think you generate everyday? Give students a few minutes to answer these questions and then share some ideas as a group.

2. Explore (10 min):
Open the PowerPoint presentation to display the pie graphs from the EPA Municipal Waste graphs about solid waste generation, how much waste gets recycled, etc. Review the definition of "municipal solid waste" with the class. Ask the students to write a few sentences about each graph describing what the graph means. Are they surprised by any of this data? After a few minutes, have the students share their responses with a neighbor. Then, have each group share their answers with the whole class. The main idea is that more than half of all waste generated by the American public is "thrown out" (encourage the students to think about where it goes), and a significant amount of that discarded waste is paper, plastic, and glass.

3. Explain (10 min):
Present the rest of the PowerPoint about plastics (specifically single-use plastics), marine debris, and prevention via the 3 R's – reduce, reuse recycle. The presentation will discuss that the average American creates 4.3 pounds of trash every day, and offers a foundation to get the students thinking about how to reduce the amount of single-use plastics they use. The presentation ties these aspects together and makes the connection between disposable products and marine debris.

4. Extend (20-25 min minimum – can continue through multiple days):
The last slide of the PowerPoint explains what the students will be doing. Working in small groups, students are to create a Public Service Announcement (PSA) that compels their audience (the public) to increase adoption of reusable items and decrease their plastic consumption. Encourage the students to get creative! A PSA can be a skit, something drawn on a poster, or designed on a computer.

In their PSAs, students should address these points:
- What is marine debris and what is it made of?
- How do we contribute to marine debris?
- Why should we care?
- What impact do single-use plastics have on marine debris? • How can we reduce that impact?

5. Evaluate/Wrap-Up (10-15 min):
Students should present their work. Their ability to address the prompts in their PSA is the evaluation of their understanding of this lesson.

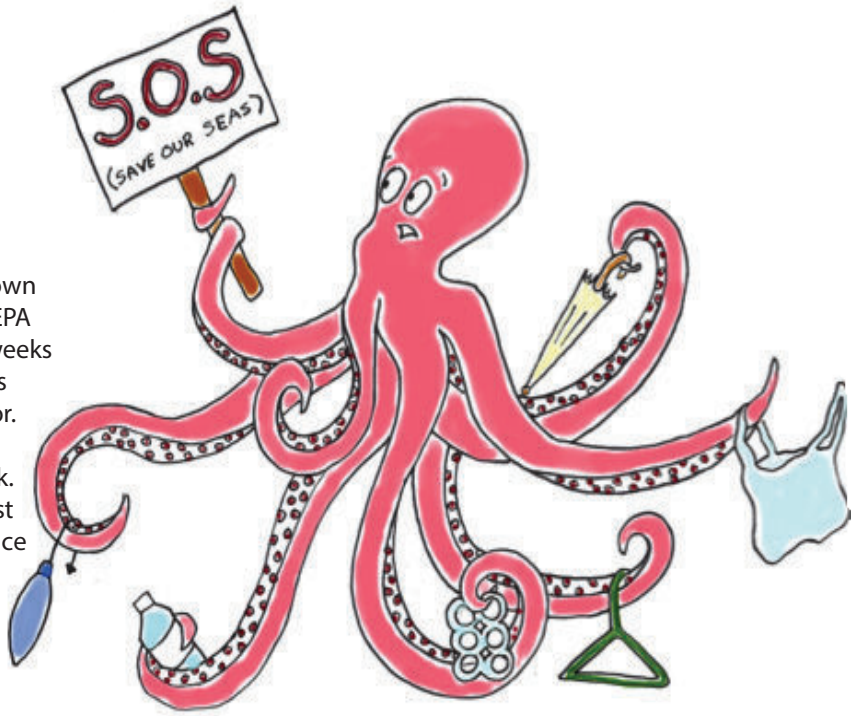
DIVE DEEPER

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

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

Did you know that a majority of the trash and debris that covers our beaches comes from storm drains and sewers, as well as from shoreline and recreational activities such as picnicking and beachgoing?

9 Trash Tracker



Grade Level: High School

Time: 1-2 weeks (time may vary)

SUMMARY

After a short PowerPoint presentation about disposable culture and marine debris that includes actual products (packaging, water bottles, etc.), students examine their own lives to see what they're throwing away. Using the NAMEPA Trash Tracker form, students record their waste for two weeks (time may vary). The first week, students record the items they throw away without changing their normal behavior. The second week, students attempt to reduce the waste they throw away and compare their data from each week. This lesson gives students insight into what they are most commonly throwing away and encourages them to reduce their waste.

OBJECTIVES

- Learn about the connection between disposable culture and marine debris
- Record items thrown away for 2 weeks using the Trash Tracker form (time may vary)
- Compare data from first week to second week and analyze what is being thrown away and determine how to best reduce waste

STEM APPLICATIONS

- Learn about marine debris, disposable culture and single-use plastics (Science, Technology)
- Record trash items thrown away and analyze data (Math)
- Discuss ways to reduce plastic consumption and prevent waste from becoming marine debris (Science)

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 marine environment or the Great Lakes' (NOAA, 2007)
- **Municipal Solid Waste**: Trash or garbage generated by people on a daily basis – does not include agricultural, industrial, etc.
- **Per capita:** Per person

MATERIALS

- PowerPoint Presentation (on NAMEPA website)
- Examples of common trash items (optional)
- NAMEPA Trash Tracker Form
- Calculator
- Print outs of the data sets being used

Background

Marine debris is a global problem that causes our oceans and waterways to become clogged with human trash. Marine debris is a major issue that has detrimental impacts on humans, animals, and ecosystem health, as well as the economy. It is believed that marine debris mostly consists of plastics, though the #1 most collected type of debris is cigarette butts and filters. The debris starts as trash that is either littered (onto land or in the water) or improperly disposed of (possibly a trash can knocked over or not covered, falls out of garbage truck, blown away from landfills, etc.) that usually makes its way into storm drains and streams and is carried through rivers to the oceans. Other marine debris comes from abandoned fishing gear at sea.

One step to reducing marine debris is increasing our rate of recycling. Not only does recycling decrease the amount of raw petroleum we need to create the products that we use in our daily lives, but it decreases the amount of plastic entering our landfills and trash incinerators. Reusing as much material as we can and avoiding single-use plastics (plates, eating utensils, water bottles, straws, diapers, wrappers, packaging) also reduces the amount of trash that can potentially become marine debris.

ACTIVITY

1. Engage (20 min):
Before presenting the PowerPoint, begin the lesson by asking the students what types of items they most commonly throw away. How much of these items are renewables? Open the PowerPoint and present to the students about how our "throw-away culture" affects marine debris. If you brought in examples of common trash items, show them to the students. How many of the students use these items on a daily basis? Do the students recycle these items? Finish the PowerPoint presentation and take any questions the students may have.

OPTIONAL EXTENSION (20 min)
A great way to make students really think about disposable culture and all of the things we throw away is to show them the "Story of Stuff" video (storyofstuff.org). The whole video is about 21 minutes long, however you can choose to show a portion of it. The link is available on the NAMEPA website and is in the PowerPoint presentation. This video discusses the supply chain and how our "stuff" goes from extraction and production to being thrown away. Instead of the supply chain being a "closed loop," it's a linear system from beginning to end, which is not sustainable on a finite planet (this is a great point to stress!). We live on a planet that has cyclical systems that never create any "waste."

3. Explain (5 min):
Hand out a Trash Tracker form to each student, and tell them they are going to be recording what items they throw away for the next week. Tell them to go about their daily lives as they normally would and not change their current behaviors, making sure to keep track of their waste.

At the end of that week, hand out a second form to each student, and this time ask them to make an effort to reduce the amount of trash they are throwing away, and record all the items thrown out.

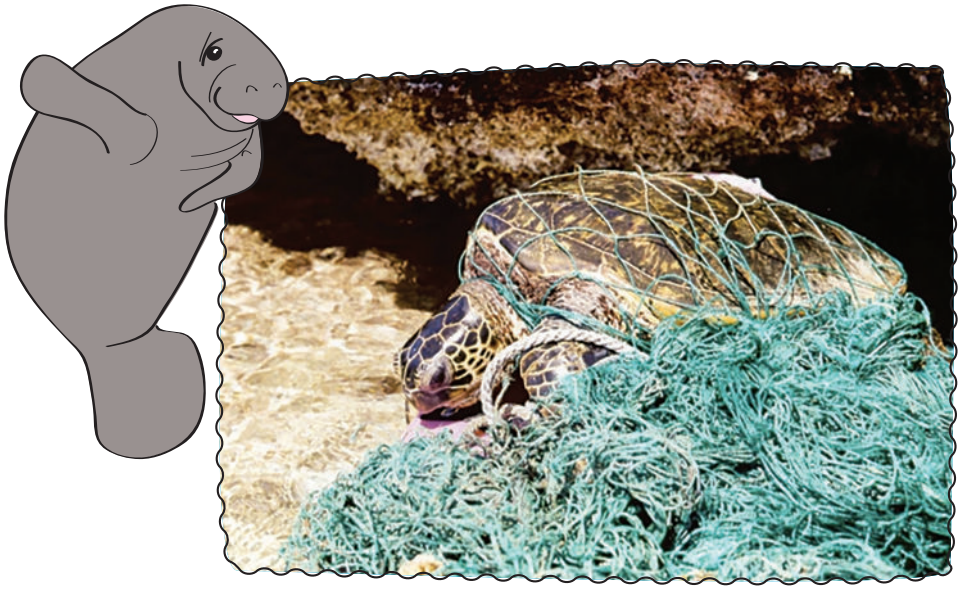
4. Explore (20 min):
At the end of the second week, the students should total all of the items they've thrown away for each week and calculate what percentage of their waste for each week was made up of renewables vs. non-renewables. What changes did they see from week to week? Have them discuss with their peers and select students to share with the class.

5. Evaluate/Wrap-Up (5 min):
Briefly review the main point from the lesson – Americans are using more and more plastic and very little of it is being recycled. Litter, trash blown from wind, and other improperly disposed garbage is carried to the oceans and poses a serious threat to animals, humans, ecosystems and economies. What other ways can we go about reducing our waste? What role do you think technology will play in helping us to decrease our waste?

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.



Did you know that at least 115 marine species are impacted by entanglement, including mammals, turtles, birds, fish and crab?

Trash Tracker

DATE									TOTAL
	NUMBER OF ITEMS								
Recyclables									
Paper									
Cardboard									
Aluminum Cans									
Steel Cans									
Glass									
Mixed Plastic									
Other									
								total number	
Compostable									
Food scraps									
								total number	
Trash Waste									
Food scraps									
Wrappers									
Other									
								Total Trash Waste	
								Total of Recyclables, Compost, and Trash	
								Percent of Renewable Material Tossed	

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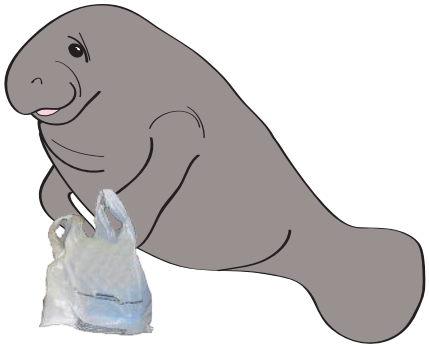
Trash Data Form

Record all trash items you find below using tally marks. Add up your totals at the end of each row.



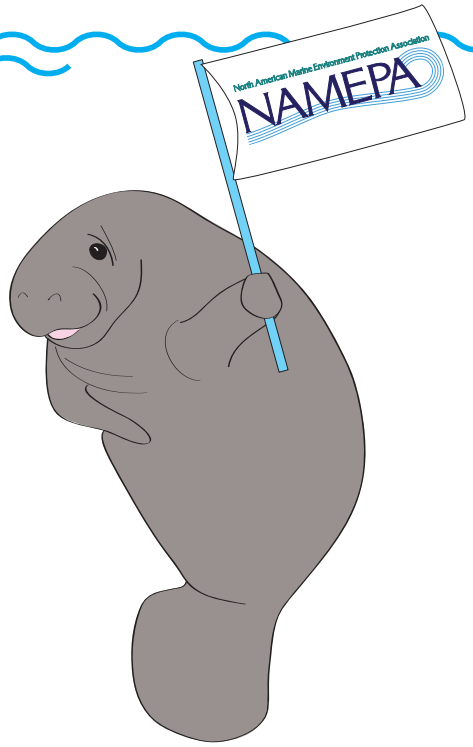
MOST LIKELY TO FIND ITEMS	TOTAL		TOTAL
Cigarette Butts:	_____	Beverage Bottles (Plastic):	_____
Food Wrappers:	_____	Beverage Bottles (Glass):	_____
Take Out/Away Containers (Plastic):	_____	Beverage Cans:	_____
Take Out/Away Containers (Foam):	_____	Plastic Bags:	_____
Bottle Caps (Plastic):	_____	Paper Bags:	_____
Bottle Caps (Metal):	_____	Cups & Plates (Paper):	_____
Lids (Plastic):	_____	Cups & Plates (Plastic):	_____
Straws/Stirrers:	_____	Cups & Plates (Foam):	_____
Forks, Knives, Spoons:	_____		

FISHING GEAR	TOTAL		TOTAL
Fishing Buoys, Pots & Traps:	_____	Rope:	_____
Fishing Net & Pieces:	_____	Fishing Line:	_____

PACKAGING	TOTAL		TOTAL
6-Pack Holders:	_____	Other Plastic Bottles:	_____
Other Plastic/Foam Packaging:	_____	Strapping Bands:	_____

OTHER ITEMS	TALLY	TOTAL
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

The Plastics Pledge



Help decrease your contribution to ocean pollution by reducing your plastic consumption. Taking small steps everyday can make a huge difference.

I, _____ ,

pledge to not trash the oceans by:

- Using a reusable tote or other bag at the grocery store
- Drinking water out of a glass or reusable, non-plastic water bottle
- Recycling plastics whenever possible
- Not littering and disposing of trash properly
- Encouraging my friends and family to reduce their plastics consumption

Glossary

Biodegradation: The process by which a substance or an object that came directly from a living thing is broken down, or decomposed, by living things (bacteria and invertebrates) and is turned into a usable product

Buoyancy: The ability to float in water

Data: Facts or information used usually to calculate, analyze or plan something

Disposable: Describes a product that is designed to be used once and then thrown away

Gyre: A circular pattern of currents in an ocean basin

Litter: Trash, wastepaper, or garbage lying scattered about

Marine: Of, found in, or related to the ocean

Marine Debris: "Any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes" (NOAA, 2007).

Mechanical Degradation: (Referencing plastic) 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

Municipal Solid Waste: Trash or garbage; everyday items that are discarded by the public
Per capita: Per person

Photodegradation: The process by which a substance or object is broken down via sunlight

PSA: Public Service Announcement – Messages distributed, broadcasted or circulated to the public in their own interest designed to raise awareness, change public attitudes, or behavior towards a certain issue

Recycling: Converting waste into reusable material

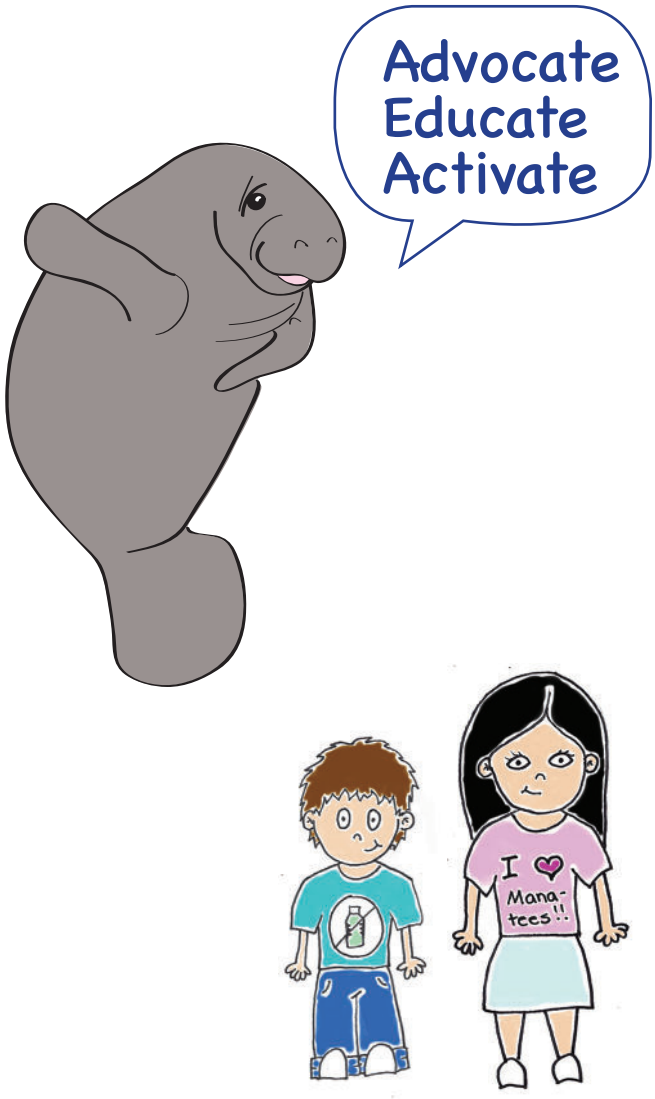
Single-use Plastic: Plastic items that are designed to be used once, i.e. plastic wrap, plastic bottles, disposable utensils, etc.

Sustainable: Capable of being maintained at a steady level without exhausting natural resources or causing severe ecological damage

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

Watershed: An area of land where all of the water flows to a common point. Streams flow into small rivers, which flow into bigger rivers, which flow into lakes or oceans and are determined by the shape and slope of the land. Watersheds can be small or large systems.



STUDENT SURVEY + ANSWERS

1. These items are commonly found on local beaches. Circle the items that you consider to be "marine debris:"
    a. Feathers
    b. Sticks
    c. Plastic Bottle
    d. Cigarette Butts
    e. Shells
    f. Food Wrappers
    g. Crabs
    h. Fishing Line
    i i. Wood (Tricky – some wood is considered debris, i.e. treated wood or wood with nails)

2. True or False: Plastic…
    a. Is naturally occurring FALSE
    b. Completely biodegrades False – it breaks down into tiny pieces but never truly biodegrades
    c. Is found in the ocean throughout the water column, from the surface to the floor TRUE
    d. Is not transported by rivers and ocean currents FALSE

3. How would you define marine debris?
Answers will vary. Marine debris is "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes" (NOAA).

4. Which of these are reasons marine debris is problematic?
    a. It's aesthetically displeasing
    b. It can transport invasive species
    c. It is dangerous to wildlife
    d. It can be dangerous to humans
    e. Animals mistake it for food and ingest it
    f. It transports toxins through the food chain
    g. All of the above
    h. None of the above

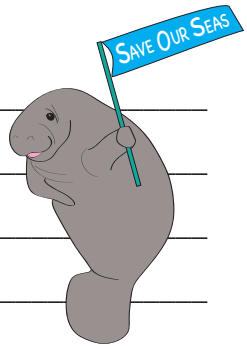
5. Put the following steps of the scientific method in order:
    a. Develop hypothesis 2
    b. Collect and record data 6
    c. Design the experiment 4
    d. Determine research question 1
    e. Draw conclusions 7
    f. Conduct background research 3
    g. Conduct the experiment 5

6. Finish this sentence: A testable question is one that is… measurable and specific.

7. What are the two types of variables in a testable question? Dependent and independent.

8. Write a sentence frame for a hypothesis (Ex. If _____then _____because_____)
– Varies: If (I do this), then (this will happen)…

NOTES



Marine Debris Survey

What is one thing that you were surprised to learn?

_____

_____

_____

_____

What did you find most interesting?

_____

_____

_____

_____

What would you like to learn more about?

_____

_____

_____

_____

What is one thing you can do to help?

_____

_____

_____

_____

NGSS Alignment

1 LETS TALK TRASH:

- **Practice 1.** Asking Questions and Defining Problems
  - K-2 –Ask questions based on observations to find more information about the natural and/or designed world(s).
  - 3-5 - Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
  - 3-5 - Ask questions about what would happen if a variable is changed.
- **Practice 3.** Planning and Carrying Out Investigations
  - K-2 – Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
  - K-2 – Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
  - 3-5 – Evaluate appropriate methods and/or tools for collecting data.
- **Practice 4.** Analyzing and Interpreting Data
  - K-2 – Record information (observations, thoughts, and ideas).
  - K-2 – Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
  - 3-5 – Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
  - 3-5 - Analyze data to refine a problem statement or the design of a proposed object, tool or process

2 TRAPPING TRASH:

- **Practice 2.** Developing and Using Models
  - K-2 – Distinguish between a model and the actual object, process and/or events the model represents.
  - K-2 – Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).
  - 3-5 – Develop and/or use models to describe and/or predict phenomena.
- **Practice 4.** Analyzing and Interpreting Data
  - K-2 – Record information (observations, thoughts, and ideas).
  - K-2 – Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
  - 3-5 – Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
  - 3-5 - Analyze data to refine a problem statement or the design of a proposed object, tool or process.

3 ITS ALL DOWNSTREAM FROM HERE:

- **Practice 3.** Planning and Carrying Out Investigations
  - K-2 – Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
  - K-2 – Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
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4 BUILDING A WATERSHED:

- **Practice 1.** Asking Questions and Defining Problems
  - 6-8 – Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
- **Practice 2.** Developing and Using Models
  - 6-8 – Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales
- **Practice 6.** Constructing Explanations and Designing Solutions
  - 6-8 – Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

5 DESIGNING AN EXPERIMENT:

- **Practice 1.** Asking Questions and Defining Problems
  - 6-8 – Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
- **Practice 6.** Constructing Explanations and Designing Solutions
  - 6-8 – Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

6 CLEAN-UP CLUES:

- **Practice 1.** Asking Questions and Defining Problems
  - 6-8 – Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
- **Practice 2.** Developing and Using Models
  - 6-8 – Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales
- **Practice 4.** Analyzing and Interpreting Data
  - 6-8 - Use graphical displays (e.g. maps, charts, graphs, and/ or tables) of large data sets to identify temporal and spatial relationships.
  - 6-8 - Analyze and interpret data to provide evidence for phenomena.

7 MICRO-PLASTIC INVESTIGATION:

- **Practice 2.** Developing and Using Models
  - 9-12 - Develop, revise and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
  - Practice 3. Planning and Carrying Out Investigations
  - 9-12 – Select appropriate tools to collect, record, analyze and evaluate data.
  - 9-12 – Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.
- **Practice 6.** Constructing Explanations and Designing Solutions
  - 9-12 – Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
  - 9-12 – Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

8 THE SOLUTION TO POLLUTION:

- **Practice 4.** Analyzing and Interpreting Data
  - 9-12 – Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
- **Practice 8.** Obtaining, Evaluating, and Communicating Information
  - 9-12 – Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

9 TRASH TRACKER:

- **Practice 4.** Analyzing and Interpreting Data
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- **Practice 6.** Constructing Explanations and Designing Solutions
  - 9-12 – Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
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