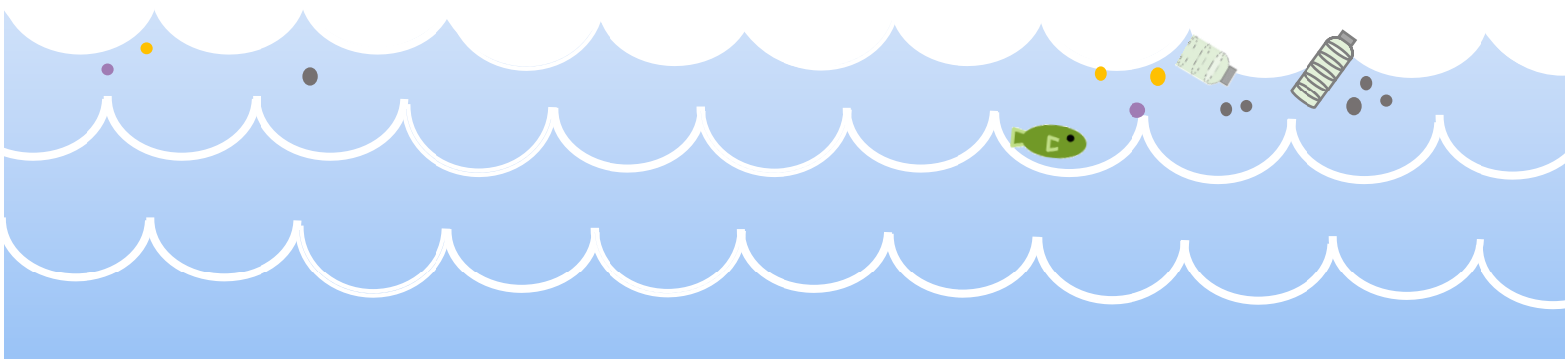
ORESU-E-16-001

Mitigating Microplastics Teacher Lesson Plans

A middle school curriculum about microplastics in our ocean

LESSON ① Bags, Bottles, and Beads: Sources of Microplastics



① Bags, Bottles, and Beads: Sources of Microplastics

Enduring Understandings

Everyone's actions have an impact (both positive and negative) on the environment.

Objectives

- Students will define marine debris and microplastics
- Students will explain sources of microplastics

Time

One 90-minute lesson

Materials

- Two sealing jars for each group/pair [Buy jars]
- Water (enough to fill each jar about half full)
- Liquid soap or face wash with microbeads
- Liquid soap or face wash with natural exfoliators

[Check this microbead product list for plastic and natural soaps]

- Student notebook: *Bags, Bottles, and Beads*
- Sink
- Coffee filters
- Jar/bucket for microbead disposal

Standards

Next Generation Science Standards

ESS3.C: Human Impacts on Earth Systems Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)

Patterns Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

Common Core

RST.6-8.1 – Cite specific textual evidence to support analysis of science and technical texts

Ocean Literacy

6.D Human activity contributes to changes in the ocean and atmosphere.

6.D.18 Pollutants move from the land into the ocean as water flows through watersheds via runoff and rivers.

Oregon Environmental Literacy Plan

1. Understand the physical and biological world, and our interdependent relationship with it

- **b.** Structure, function and interconnected nature of human systems to the environment and sustainability, such as human choices about consumption, production, distribution and disposal of goods and services and their effect on the sustainability of earth's natural, economic and social systems
- **c.** Interrelationships between people and the environment, such as how human activities and systems (social, cultural, political, and economic) change the environment including physical and living systems

Set-Up

- Divide students into groups of 2-3
- With enough jars for each group to have two, label half of the jars "A" and the other half "B"
- Place about a tablespoon of soap in each jar
  - Soap with microbeads in jar "A" (For an alternative activity without microbeads, see p. 6)
  - Soap with natural exfoliators in jar "B"
- Make copies of Student Notebook: *Bags, Bottles, and Beads*, pages 1-5
- Have a disposal jar/bucket for microbead soap when the activity is over

Lesson Outline

1. Hook

Say: *Look around the room and silently find as many plastic objects as you can in ten seconds…go!* Time students for 10 s., then have students share some of the objects they identified.

Ask: *Raise your hand if you agree that there is a lot of plastic in this classroom? If you agree that we use a lot of plastic in our daily lives?*

Say: *We use plastic every day, and many of the plastics are single-use. They are designed to be thrown away after being used once. We might not even realize all the products that have plastic, and we don't always know what happens to them after they are thrown away.*

2. Explore – "Soap suds and…plastic?"

*See "success story" below for alternative activities if no products with plastic microbeads are available

Say: *Some products with plastics might surprise you. First, we will talk a little about plastic itself, and then you will have a chance to investigate for yourself.*

- Students will complete the guided notes on page 1 of their notebooks.

Presentation slides include the text from the notebook with the blanks filled in (also see the student example for guided notes answers)

Say (referring to the image on page 1): *Polyethylene is the plastic most microbeads are made from, and you can identify products with microbeads by looking at the ingredients for polyethylene. Repeat after me, "polyethylene."*

Hand out two jars, labeled "A" and "B," to each student group, but don't tell them which soap is which.

- Students read and follow the directions in their notebooks.

Presentation slides also have activity directions for reference.

- Students first make observations of the two jars (color, texture, size and shape of the particles, etc.)

Shaken jars with natural exfoliators (left) and microbeads (right).

- Students fill jars halfway with water, close tightly, and shake the jars to dissolve the soap *(there shouldn't be any soap stuck to the bottom)*.
- Students write down what they observe and draw pictures in their notebooks of how the particles behave inside the soaps.
- Students answer the questions in their notebooks on page 2.

Ask: *What did you notice that was different between the two jars? How did the particles in the soaps behave? Which one do you think has plastic in it? What evidence do you have?*

Reveal the answer, that "A" has microplastics in it!

MISCONCEPTION ALERT!
Plastic microbeads will float in the water, but not all microplastics float! Microplastics can be found at many depths, including the ocean floor. Before moving on to the next part of the lesson, clarify that while the plastic microbeads in the investigation floated, not ALL microplastics float in the ocean.

- Students read the "newspaper clipping" on page 2 of their notebook and answer the question.

Discuss: *Why doesn't this law solve the problem of microplastics? Do you think this is a helpful law? Why or why not?*

3. Debrief – "How do microplastics make it to the ocean?"

Say: *One of the reasons the microplastics problem is not solved by this law is that there are many other ways microplastics get into the ocean.*
Presentation slide show slide #5. See the student example for notes.

- Students will complete guided notes on page 3 of their notebooks

Say: *There are two main ways that microplastics enter the ocean. One is directly as small pieces (show microplastics definition and have a student read it aloud). Plastics in toothpaste, face wash, and laundry lint can go directly into the ocean. Most microplastics are from larger plastic marine debris items that are fragmented once they get to the ocean (show marine debris definition and have a student read it aloud). Nurdles are small plastic pieces used in factories to make plastic products.*

4. Connect – "Real researcher: Angel White"

Say: *Now that we know about microplastics and where they come from, we are going to learn about a researcher who studies microplastics.*

- Students will read "Real researcher: Angel White" on page 4 of the student notebook as an introduction to her data.
- Students will answer the questions about Angel's data on page 5. See student example for correct responses. Answers are based on the data table and reading.

Say: *Why is it important to study the amount of plastic in the ocean?* Do a think-pair-share (students silently think about their response for 30 seconds, share with a partner, and then share with the class).
Ask: *Why do you think scientists study microplastics in the ocean? What should scientists like Angel do with their results?*

Clean Up

To keep microbeads from going down the sink drain, you can use a coffee filter to remove the microbeads from the soap. You can dry them and put them in a container to show the amount of plastic in the product!

Success Story: Banning Personal Care Products with Microbeads

Plastic microbeads in personal care products like face wash and toothpaste have been shown to enter drains and eventually the ocean, and have largely unknown consequences on the marine environment. After nine states banned the manufacture and sale of products with microbeads, Congress passed the *Microbead-Free Waters Act of 2015*, banning the manufacture and sales of personal care products with plastic microbeads starting in 2017.

Because of this ban, personal care products with plastic microbeads will not be available to purchase beginning in 2017. The plastic from previously used products, however, is still in the ocean and microplastics are still a problem. Microbeads contribute a small part of the total microplastics in the ocean. Synthetic fibers from clothes, as well as the fragmentation of large plastic marine debris, are important and present sources of plastic. Also, while products with plastic microbeads are banned in the U.S., there are many places around the world where microbeads are used. Microplastics is truly a global issue.

Alternative Activity
As an alternative to the first activity "soap suds and…plastic," consider completing the challenge using just face wash with natural exfoliators.

- Have students observe and draw the particles, and then explain that some soaps used to have plastic instead of the natural material.
- Ask students to imagine those particles were plastic, to get an idea of the number of microbeads that might enter the ocean from one product.
- Emphasize that there are other sources of microplastics that enter waterways, including plastic fibers from clothing, and that microplastics are generated all over the world.

Educator Background

Microplastics

Microplastics are very small pieces of plastic marine debris, less than 5 mm in size, that end up in the ocean.[1] **Marine debris** is anything that ends up in the ocean that doesn't belong there. The National Oceanic and Atmospheric Administration (NOAA) defines marine debris 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."[2] Marine debris can be found in the ocean and rivers worldwide, and most of the debris is made up of plastic.[3]

Properties of plastics[4]

Plastics are long chains of hydrocarbons called polymers. Hydrocarbons usually come from petroleum or natural gas. There are several types of plastics with different physical properties that are used for different purposes. Polyethylene is the largest volume of plastic used in the world. Polyethylene is the plastic that makes up microbeads in some personal care products, such as face wash and toothpaste.

Sources

Sources of marine debris. Plastics can enter the ocean from anywhere. Marine debris can come from sources on land or the ocean, not just coastal communities and beach-goers. It is estimated that most marine debris (80%) originates on land.[5] The following list describes some sources of marine debris:

- Individuals can be sources of marine debris if they do not manage their waste properly or if they litter
- Trash on the street (even in inland areas) can be blown into a nearby stream or washed down a drain
- Cities are potential sources of marine debris if there is insufficient infrastructure to capture debris on streets or landfills before it enters waterways
- Marine debris can originate in the ocean with lost fishing gear, dumping of trash, or abandoned boats
- Natural events can also create marine debris when storms wash debris into streams or the ocean[6]

Sources of microplastics. Microplastics mainly enter the ocean in two ways: (1) through the fragmentation of larger plastic marine debris and (2) when small plastics enter waterways and travel to the ocean.[7]

- Fragmentation of larger plastics – Plastics that enter the ocean have been found at the surface, on the bottom, and in between. Many plastic objects are buoyant and float at the surface of the ocean, being moved around by wind and surface currents. Plastics floating at the surface are exposed to sunlight. When they are exposed to UV waves, the plastic breaks into smaller and smaller pieces, or **fragments**. Plastics can also fragment when exposed to wind or wave action.

Marine debris that has the potential to fragment and become microplastics (Photo credit: Briana Goodwin)

- Small plastic pieces entering waterways – One sources of small plastics is industrial materials such as resin pellets (**nurdles**). Nurdles can be lost during transportation and become debris. Another source of microplastics is personal care products. Many face wash, body wash, and toothpaste products contain plastic **microbeads** that act as exfoliators. The plastic microbeads in these products are designed to wash down the drain and are too small to be captured by water treatment facilities. Synthetic fibers from clothing such as fleece also travel through waterways to the ocean. One study found synthetic fibers on 18 beaches around the world and determined that washing one clothing item can produce more than 1,900 fibers that enter the sewage system.[8]


Pre manufacture resin pellets (nurdles)

Sinks

Microplastics can be found not only in the ocean worldwide, but also in rivers and streams. Many plastics are buoyant and stay at the surface of the ocean. However, other **sinks** of microplastics include sand on beaches and offshore. A collaborative study published in 2014 combined data taken by researchers all over the world about the abundance of plastics in the ocean. The data set include 680 tows, in which nets are dragged along the surface of the ocean and then the contents are analyzed. The study estimates that there are about 5.25 trillion plastic particles on the ocean surface. The team also found that there were fewer microplastics particles than they had expected,[9] which may indicate that they are being removed by some process such as degradation, being eaten by animals, or sinking when small organisms attach. There is ongoing research about the sinks and potential impacts of microplastics in the ocean.


Dried microbeads

Glossary

Fragment – To break into smaller pieces

Marine debris – Anything man-made that ends up in the ocean or the Great Lakes and doesn't belong there

Microbeads – Small plastic beads used in personal care products as exfoliators. Microbeads are commonly made out of polyethylene.

Microplastics – Plastic marine debris that is less than 5 mm

Nurdles – Small, pre-manufacture resin pellets

Degradation – The process of objects breaking down; in the case of microplastics, by UV light

Photodegradation[10] – Destruction of a material by UV radiation

Plastic – Manufactured chains of hydrocarbons often derived from natural gas or petroleum

Resin pellets – Pre-manufacture plastic pellets that are used to manufacture plastic products

Sink – Where something ends up

Weathering[11] – Mechanical weathering is the process of breaking down materials into smaller pieces (by wind, waves, etc.)