Focus Question

Where can you find plastic in the water column and how might it affect the animals that live there?

Overview

What happens when plastics enter the ocean? Students find out by exploring the densities of different plastics. They then investigate feeding strategies and locations (surface, pelagic and benthic) of various ocean animals and predict how plastics will affect marine food webs. The activity ends with students brainstorming actions to reduce the amount of plastics that end up as waste.

Objectives

Students will be able to:

- Describe how the density of plastic affects its location in the ocean water column.
- Explain how food webs can be disrupted by marine debris.
- Take actions to reduce the amount of single-use plastic used in their households and/or classrooms.

Background

Plastics are materials composed of repeating chainlike-molecules called polymers, and are usually derived from fossil fuels. Many everyday objects are made out of plastic. It is a material that is often strong, lightweight, flexible and durable. Due to plastic’s chemical structure and durability, it doesn’t biodegrade. It does however photodegrade, which means plastics are broken down into smaller pieces by the absorption of light from the sun’s UV rays. Plastics of all shapes and sizes, including the small pieces, end up in the water column as marine debris and can entangle or are consumed by marine animals. It’s estimated than 90% of floating marine debris is plastic.

Some plastics float in sea water, others sink and some remain neutrally buoyant. Density is one factor that affects the buoyancy and location of the plastic debris in the water column. Density is the ratio of a material’s mass to its volume. Density is the same value for a certain type of material, regardless of the size of the object. Density can be calculated by dividing an object’s mass by its volume.
Density is an important property of all materials, whether solid, liquid, or gas. It measures a material's compactness, or how much mass is squeezed into a given space. If plastic is more dense than sea water, it will sink. If it’s less dense, it will float.

Marine animals feed in different oceanic zones. There is the surface zone which is where the water meets air and things float where they can be seen. There is the pelagic zone which is the open water column where fish swim and plankton drifts. Finally, there is the benthic zone which is on or near the ocean floor. Different plastics will impact different animals depending on the buoyancy of the plastic and the zone in which the animal feeds. Some animals may become entangled in it while others may consume it. One study showed that 267 species worldwide, including 86 percent of all sea turtle species, 44 percent of sea bird species and 43 percent of marine mammal species are impacted by marine debris (Laist, 1997). Sea turtles sometimes mistake plastics for jellyfish. Sea birds that dive into the pelagic zone to feed scoop up plastic fragments and may even feed them to their chicks.

According to the Environmental Protection Agency, over 30 million tons of plastics were thrown away in the United States in 2008. Some of this plastic ends up in the watershed and ultimately, the ocean. People can help marine animals by reducing the amount of single-use plastic they use. Taking reusable bags to the grocery store, buying a reusable water bottle and buying products with less packaging all reduce plastics in the waste stream. Supporting legislation that bans plastic bags is another way to reduce marine debris.

Materials

Per student:
- Ocean Feeder card
- Plastics in the Water Column student sheet (pages 6-7)

Per student group:
- Density Table (page 8)
- Tall bucket or other container (transparent is best) filled with water
- Various plastic objects with differing densities and buoyancies (plastic fork, plastic bag, DVD case, plastic bottle and so on)
- Hand lenses
- Towels (for clean up)
- Water Column Cross Section (page 12)

Teacher Preparation

1. Gather the materials. Ensure you have internet access on which to view the video “Synthetic Sea” (http://www.algalita.org/movs/pelagic_plastic_mov.html). Each student group should get a 1.5- to 2-foot tall transparent container filled with fresh water. (It needs to be tall enough for a plastic object to be completely submerged.) Bring in various rinsed-out plastic containers from a recycling bin. You may want to experiment with submerging items in water to ensure there are a variety that will sink and float.

2. Make copies of the Density Table (one for each group), Ocean Feeder Cards (enough for each student to have one cut-out card) and Plastics in the Water Column (copy for each student). Either make one copy of the Water Column Cross Section for each group or a transparency to project for the class.
3. Give students homework the day before the activity. In a science notebook or on a piece of paper have them look around their home and make a list of 10 plastic items or products and the resin identification codes (if the items have one).

Procedure

1. **INTRODUCE THE FOCUS QUESTION.**
   Share the question: *Where can you find plastic in the water column and how might it affect the animals that live there?* You may write it up on the whiteboard or have students add it to their science notebook. Give students time to write their initial thoughts down or discuss with a partner.

Part One: Density and Buoyancy

2. **STUDENTS EXPLOR E THE BUOYANCY OF A VARIETY OF PLASTIC OBJECTS.**
   Pass out the *Plastics in the Water Column* student sheets, the plastic objects and a large container of water to each student group. Have them look for the resin identification code (number in the recycling symbol) on the various objects (look on the bottom of the object, some may not have one) and predict whether each plastic object sinks or floats. Have them record their predictions in a science notebook or on the student sheet. Then have them submerge each object underwater and record their findings. (If an object is not completely submerged, it will appear to float due to surface tension.) *Which floated? Which sank? Why?*

3. **STUDENTS EXAMINE THE DENSITY OF THE PLASTIC OBJECTS.**
   Challenge students to figure out why the buoyancy of each object varied. *(certain plastics are more dense than water so they sink, others are less dense and float)* Pass out the *Density Table* of plastic densities. You may need to provide more information on density depending on students’ prior knowledge. *Density (D) is the mass (M) of an object divided by its volume (V).* Have students complete the *Plastics in the Water Column* student sheet.

Part Two: Impacts on Marine Food Webs

4. **INTRODUCE THE IDEA OF PLASTICS IN THE WATERSHED AND OCEAN.**
   Ask students how plastic may reach the ocean. Then show them “Synthetic Sea” (at [http://www.algalita.org/movs/pelagic_plastic_mov.html](http://www.algalita.org/movs/pelagic_plastic_mov.html)) and share statistics from Algalita Marine Foundation about plastics found in the watershed. How do they think plastics impact marine animals? *(consumption, entanglement)*

5. **STUDENTS EACH GET AN OCEAN FEEDER CARD.**
   Ask students where they think animals feed in the ocean. Introduce the concept of feeding zones (benthic=sea floor, pelagic=open water, surface=top of the water column). Pass out an *Ocean Feeder* card to each student or student group. Have them read about their animal and complete the rest of the *Plastics in the Water Column* student sheet.

6. **STUDENTS SHARE WHICH PLASTICS MAY IMPACT THEIR ANIMAL WITH THE CLASS.**
   Project the *Water Column Cross Section* of the ocean. Have students share information about their animal, plastics that could impact it and why those plastics could impact the animal. You may have them label the plastic code and name on the cross section. See the *Density Table Key* for which plastics float and sink.
7. **As a class, discuss impacts of plastics on marine animals.**
   If marine animals consume plastic, what might that do to the food web? (predators of marine animals that consume plastic indirectly consume plastic, individuals may die, populations may be impacted) How could plastic on the surface impact a benthic or pelagic animal? (toxins leach off of plastic into the water, an animal may feed in the surface zone and consume plastic but travel in other zones and be consumed by animals who feed there)

8. **As a class, brainstorm ways to reduce the amount of plastic consumed.**
   Discuss the alternative material students came up with on their student sheet. Then lead a discussion about pros and cons of plastic. How is it beneficial? (e.g., contact lenses, medical tubing, lightweight packaging and so on) What are the cons of plastic? (doesn't break down, uses fossil fuels, used in disposable products, becomes marine debris, etc.) Use student’s list of plastic items in their homes to make a class chart. Identify items intended for single use versus items intended to be durable. Challenge students to think of ways they can individually use plastic more wisely. (reusable water bottles, reusable bags at the store, keeping a cell phone until it wears out instead of upgrading every year) Challenge them to think of ways society can use less. (not buying as much, buying in bulk so less packaging and so on)

9. **Return to the focus question.**
   Now that students have investigated density and impacts on animals, have students revisit the focus question: Where can you find plastic in the water column and how might it affect the animals that live there? Students may think on their own or discuss with a partner. Then in their science notebook, you may have them draw a line of learning and under it add to their original thoughts about the question.

**Extensions**
Challenge students to create a public service announcement (PSA) or develop some other outreach tool to educate other classes about plastic pollution.

**Resources**

**Websites**

*Algalita Marine Research Foundation*  
[www.algalita.org](http://www.algalita.org)
Learn more about debris found in the Pacific Gyre as well as research reports and educational resources.

*Center for Microbial Oceanography (C-MORE)*  
Find several free activities exploring the cause, distribution and biological impacts of marine debris.

*Monterey Bay Aquarium*  
[www.montereybayaquarium.org](http://www.montereybayaquarium.org)
Find information on many marine consumers as well as other classroom activities.
The Story of Stuff Project  www.storyofstuff.com
Watch the story of bottled water and access free curriculum resources.

References

Standards
Next Generation Science Standards  www.nextgenscience.org

Performance Expectation
Relates to MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Common Core State Standards  www.corestandards.org

Science and Technical Subjects, SL.8.1
Reading Science and Technical Subjects: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)

Acknowledgements
1. Experiment with a variety of plastic objects.
   a. Record the name of the item and the RIC code (number on object) in the chart below.
   b. Predict whether it will sink or float and record your prediction in the chart below.
   c. Now submerge the items in the water and record your results below.

<table>
<thead>
<tr>
<th>Plastic Item</th>
<th>RIC code (number on object)</th>
<th>Prediction: Do you think this plastic sinks or floats?</th>
<th>Results: Did it sink or float?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Look at the **Density Table** to answer the following questions.
   - Compare the densities of fresh and salt water. Which is more dense? Which is less dense? Why do you think salt water is more dense than fresh water?
   - Which plastics will float in fresh water? Sea water? How do you know?
   - Does that match your findings? Explain. (Think about why you may have gotten different results.)
   - Bonus: Explain how you could make any floating object sink. (Remember that density equals mass divided by volume.)
### Plastics in the Water Column

3. Use your Ocean Feeder card to fill in the chart below.

<table>
<thead>
<tr>
<th>Name of Animal</th>
<th>Location of Feeding (surface, pelagic, benthic)</th>
<th>Diet</th>
<th>Feeding Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Refer back to the results of your plastic investigation and the Density Table to answer the following questions.

- Which plastics could affect your animal? Why? (Remember to take into account where your animal feeds and which plastics sink or float in sea water.)

- Would any of the plastic objects you experimented with affect your animal? Explain.

- How might the shape and size of a plastic object determine how your animal is affected? (Think of your animal’s feeding strategy and size of its mouth.)

5. Choose one single-use plastic object from your experiment. Answer the following questions:

- What kind of plastic is it?

- What is it used for?

- Are there alternative materials from which this object could be made? If it’s plastic packaging, are there ways you could obtain the product without plastic? Explain.

6. Are there ways to reduce our plastic consumption? Explain.
# Density Table

<table>
<thead>
<tr>
<th>Resin ID Code</th>
<th>Name</th>
<th>Density (g/mL)</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PETE</td>
<td>1.38-1.39</td>
<td>Soft drink and water bottles, peanut butter containers, salad dressing and vegetable oil containers</td>
</tr>
<tr>
<td></td>
<td>Polyethylene terephthalate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>HDPE</td>
<td>0.95-0.96</td>
<td>Milk jugs, detergents, household cleaners, motor oil containers, some garbage bags, butter and yogurt tubs</td>
</tr>
<tr>
<td></td>
<td>High-density polyethylene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PVC</td>
<td>1.16-1.45</td>
<td>Clear food packaging, medical equipment, siding, piping, windows, shampoo bottles</td>
</tr>
<tr>
<td></td>
<td>Polyvinyl chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>LDPE</td>
<td>0.92-0.94</td>
<td>Squeezable bottles, various bags (for bread, frozen food, shopping and dry cleaning), clothing, furniture</td>
</tr>
<tr>
<td></td>
<td>Low-density polyethylene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PP</td>
<td>0.90-0.91</td>
<td>Syrup bottles, ketchup bottles, caps, straws, medicine bottles</td>
</tr>
<tr>
<td></td>
<td>Polypropylene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PS</td>
<td>0.020-1.07</td>
<td>CD cases, meat trays, egg cartons, disposable plates and cups</td>
</tr>
<tr>
<td></td>
<td>Polystyrene (two kinds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Other</td>
<td>Varies</td>
<td>DVD cases, iPod packaging, signs and displays, nylons</td>
</tr>
<tr>
<td></td>
<td>Many kinds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Other Substances

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Water</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Sea Water</td>
<td>1.03</td>
<td></td>
</tr>
</tbody>
</table>
# Density Table Key

<table>
<thead>
<tr>
<th>Resin ID Code</th>
<th>Name</th>
<th>Density (g/mL)</th>
<th>Uses</th>
<th>Where in the Water Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PETE (Polyethylene terephthalate)</td>
<td>1.38-1.39</td>
<td>Soft drink and water bottles, peanut butter containers, salad dressing and vegetable oil containers</td>
<td>Sinks: benthic feeders (octopus, otter, bass)</td>
</tr>
<tr>
<td>2</td>
<td>HDPE (High-density polyethylene)</td>
<td>0.95-0.96</td>
<td>Milk jugs, detergents, household cleaners, motor oil containers, some garbage bags, butter and yogurt tubs</td>
<td>Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)</td>
</tr>
<tr>
<td>3</td>
<td>PVC (Polyvinyl chloride)</td>
<td>1.16-1.45</td>
<td>Clear food packaging, medical equipment, siding, piping, windows, shampoo bottles</td>
<td>Sinks: benthic feeders (octopus, otter, bass)</td>
</tr>
<tr>
<td>4</td>
<td>LDPE (Low-density polyethylene)</td>
<td>0.92-0.94</td>
<td>Squeezable bottles, various bags (for bread, frozen food, shopping and dry cleaning), clothing, furniture</td>
<td>Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)</td>
</tr>
<tr>
<td>5</td>
<td>PP (Polypropylene)</td>
<td>0.90-0.91</td>
<td>Syrup bottles, ketchup bottles, caps, straws, medicine bottles</td>
<td>Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)</td>
</tr>
<tr>
<td>6</td>
<td>PS (Polystyrene (two kinds))</td>
<td>0.020-1.07</td>
<td>CD cases, meat trays, egg cartons, disposable plates and cups</td>
<td>Sinks or Floats: surface (gull, albatross) or benthic feeders (octopus, otter, bass)</td>
</tr>
<tr>
<td>7</td>
<td>Other (Many kinds)</td>
<td>Varies</td>
<td>DVD cases, iPod packaging, signs and displays, nylons</td>
<td>Varies: potentially all feeders</td>
</tr>
</tbody>
</table>

**Other Substances**

- **Fresh Water**
  - 1.00
- **Sea Water**
  - 1.03
### Ocean Feeder Cards

<table>
<thead>
<tr>
<th><strong>Black-footed Albatross</strong></th>
<th><strong>Surface and Pelagic Feeder</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Phoebastria nigripes</em></td>
<td>size: wingspan up to 7 ft.</td>
</tr>
<tr>
<td></td>
<td>(215 cm) and 7.7 lbs. (3.5 kg)</td>
</tr>
<tr>
<td></td>
<td>This seabird spends three years at sea when it first leaves the nest. It lands on the water to sleep and eat. It locates prey with a keen sense of smell. Parents regurgitate their prey to feed their chicks.</td>
</tr>
<tr>
<td><strong>Diet</strong>: squid, fish, fish eggs, crustaceans</td>
<td><strong>Feeding Strategy</strong>: forages on the surface while swimming or dives underwater to catch food with beak</td>
</tr>
<tr>
<td><strong>Habitat</strong>: open ocean (sandy shore during breeding)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Giant Sea Bass</strong></th>
<th><strong>Pelagic and Benthic Feeder</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Stereolepus gigas</em></td>
<td>size: to 8.2 ft. (2.5 m), 562 lbs. (255 kg)</td>
</tr>
<tr>
<td>These fish are able to quickly and dramatically change colors. Often known as black sea bass, these large fish aren’t known for speed. Thus they often feed on the ocean floor.</td>
<td></td>
</tr>
<tr>
<td><strong>Diet</strong>: sting rays, skates, lobster, crabs, flatfish</td>
<td><strong>Feeding Strategy</strong>: catch prey by rapidly opening large mouth; hide in shadows of kelp to ambush some prey</td>
</tr>
<tr>
<td><strong>Habitat</strong>: open water</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Giant Pacific Octopus</strong></th>
<th><strong>Benthic Feeder</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Enteroctopus dofleini</em></td>
<td>size: to 50 lbs. (23 kg) and 15-ft. (4.5 m) wide</td>
</tr>
<tr>
<td>This octopus has over 2,000 suckers through which it grips, smells and tastes. It is able to change its color to camouflage into its surroundings.</td>
<td></td>
</tr>
<tr>
<td><strong>Diet</strong>: clams, abalone, rockfish, crabs, other octopuses</td>
<td><strong>Feeding Strategy</strong>: catches food with suckers and crushes with beak</td>
</tr>
<tr>
<td><strong>Habitat</strong>: reefs and pilings</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Ocean Sunfish</strong></th>
<th><strong>Pelagic Feeder</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mola mola</em></td>
<td>size: to 14 ft. (4.3 m), 5,000 lbs. (2,268 kg) (up to 1,000 lbs. in Monterey Bay)</td>
</tr>
<tr>
<td>This fish hatches from a tiny egg and grows up to be the size of a small pickup truck. Ocean sunfish live in almost all of the world’s oceans and often swim at the surface sometimes appearing to sunbathe!</td>
<td></td>
</tr>
<tr>
<td><strong>Diet</strong>: jellies, plankton, small fishes like anchovies</td>
<td><strong>Feeding Strategy</strong>: slurps food through fused teeth, shredding prey until its small enough to swallow</td>
</tr>
<tr>
<td><strong>Habitat</strong>: open water</td>
<td></td>
</tr>
</tbody>
</table>
### Black Sea Turtle
*Chelonia agassizii*  
**Size:** to 4 ft. (1.2 m)

This sea turtle is actually a type of green sea turtle. As a juvenile, it feeds in the open ocean on invertebrates, algae and jellies. As an adult, it becomes primarily an herbivore and moves closer to shore, eating sea plants.

**Diet:** jellies, invertebrates, sea plants, algae  
**Feeding Strategy:** uses sharp beak to cut and tear its food.  
**Habitat:** open water

### Western Gull
*Larus occidentalis*  
**Size:** 24-27 inches (61-70 cm)

To break open prey like clams and sea urchin, this seabird drops its food from high in the air to hard surfaces below. Often fed by humans, contaminants in people food can harm its health.

**Diet:** fishes, carrion (dead animals), marine invertebrates, birds, birds’ eggs, garbage  
**Feeding Strategy:** uses beak to catch small fish at the surface  
**Habitat:** coastal water

### Common Dolphin
*Delphinus delphus*  
**Size:** to 8 feet (2.5 m), 250 pounds (113 kg)

These dolphins travel in pods of up to 2,000 animals. They are extremely active and ride the waves of large ships and whales. They work together to herd schools of fish into a tight ball and then eat them.

**Diet:** fishes and squid  
**Feeding Strategy:** catches prey with beaklike mouth  
**Habitat:** open water

### Southern Sea Otter
*Enhydra lutris*  
**Size:** to 5.5 ft. (1.7 m)

An otter hunts on the seafloor but returns to the surface to eat. It uses its chest as a table. An otter has pockets of skin under each forearm where it can keep prey or tools to crack open its food.

**Diet:** crabs, snails, urchins, clams and other benthic invertebrates  
**Feeding Strategy:** uses paws to catch and open food  
**Habitat:** kelp forest
Some plastics float, some sink. However, all plastics may have an impact on marine animals if they make it into the ocean. Which kinds of plastics may impact which animals? (Hint: use the number on object that indicates the resin identification code.)
Does it Sink or Float?

1. Examine the plastic objects.

2. Choose one object and find the resin identification code (number on the bottom of the object).
   - Predict: do you think this item will sink or float? Why?

3. Place the object in the tank of water.
   - What happened?
   - Were you surprised? Why or why not?
   - Do you think the type of plastic relates to whether it sinks or floats? How?

4. Look at the cross section of the ocean.
   - Which animals feed at the surface?
   - Which are pelagic feeders?
   - Which are benthic feeders?

5. Discuss:
   - What would happen if the plastics you tested made it into the ocean? Would any of those animals be affected?
   - Which animals would be affected by which plastics? Why do you think that?
Focus Question
How do we use plastics? Are there better or worse uses of plastics?

Overview
From contact lenses to medical tubing to single-use disposable yogurt containers, plastics are ubiquitous in our daily lives. But how wisely are we using these durable, versatile materials produced from fossil fuels - a nonrenewable resource? In this activity, students examine different kinds of plastics and investigate what happens after plastic objects are thrown in the recycling bin. They are also challenged to think about whether some of the ways we use plastics are better than others.

Objectives
Students will be able to:
- Observe and describe the physical and chemical properties that can be used to identify different types of plastics.
- Differentiate single-use plastics from other plastics.
- Examine society’s use of plastics and recognize that plastic is made from a nonrenewable resource.

Background
In 2012, the United States generated almost 14 million tons of plastics as containers and packaging, about 11 million tons as durable goods such as appliances, and almost 7 million tons as nondurable goods, such as plates and cups. Only 9 percent of the total plastic waste generated in 2012 was recovered for recycling (www.epa.gov/osw/conserve/materials/plastics). Plastic is ubiquitous in our modern world. Plastic is used to make durable items like contact lenses, vehicle parts and electronics. It is also used to make items that are used just once like water bottles, plastic bags, straws and food containers. Plastic is lightweight, durable and relatively economical to manufacture. However, it does not biodegrade; instead it photodegrades into smaller and smaller pieces so it remains in the environment indefinitely. There is a high environmental cost to single-use, disposable plastic; wildlife ingestion and entanglement and habitat alteration are some of the side effects of discarded plastic. In addition, harmful human health effects have been linked to additives in plastics (phthalates and bisphenol A among others).
Plastics are primarily synthetic polymers made with chemicals that are derived from nonrenewable fossil fuels, specifically petroleum or natural gas. There are thousands of different kinds of plastics. Plastics can be differentiated by certain chemical and physical properties. These properties are surface appearance, transparency, rigidity, density and flammability. The Society of the Plastics Industry developed identification codes for six of the most common types and a seventh that includes a number of different plastic types. These are the numbers located in what has come to be called the “recycling symbol” on plastic objects. It is a misconception that this identification code means the object can be recycled. The codes were developed to help recyclers differentiate between various kinds of plastic. Some plastics are cheaper and less energy intensive to recycle (numbers 1 and 2) while others often don’t get recycled at all (number seven). Regardless, recycling is costly in terms of energy and other resources. It is much less costly, both economically and environmentally, to reduce the amount of plastic used. Every municipality and/or county is different in what it may or may not recycle. Contact your local waste management company for details on recycling in your community.

Materials
- Computer and projector
- Variety of clean plastic packaging and objects (enough for each student group to have 4-5 pieces)
- Plastics: Reduce Use or Recycle prezi (see link in procedure)
- How We Use Plastics cards (one set per student group)
- Plastics: Reduce Use or Recycle student sheet (one per student)
- Types of Plastics student sheet (one per student)

Teacher Preparation
1. A week before the lesson, ask students to bring in a variety of rinsed out plastic objects. Make sure you get a variety of resin identification codes (numbers on each object). Ideally, have five pieces per student group.
2. Make a set of How We Use Plastics cards (page 9 and 10) for each student group. You may want to laminate them for reuse with different classes.
3. Decide if you want copies of the Types of Plastics student sheet and Plastics: Reduce Use or Recycle student sheets or if you’ll have them use their science notebooks.
4. Check the prezi link to make sure it works. Use the presentation notes on page 7 to run through the presentation before class.

Procedure
1. In small groups, students write down everything in the room made of plastic. Give students 30 seconds to write down everything in the room made of plastics. What kinds of objects are made of plastic? How are they used? Are they used multiple times or only once? Does the plastic all look the same? Feel the same? How many of the items in the room are made of plastic compared to other materials (wood, metal, glass)?
2. **INTRODUCE THE FOCUS QUESTION TO THE CLASS.**

   Share the question: *How do we use plastics? Are there better or worse uses of plastics?* You may write it up on the whiteboard or have students add it to their science notebook. Give students time to write their initial thoughts down or discuss with a partner.

3. **STUDENTS CATEGORIZE ILLUSTRATIONS OF A VARIETY OF PLASTIC ITEMS ACCORDING TO HOW WE USE THEM.**

   Pass out a set of *How We Use Plastics* cards to every student group. Have them sort the cards into categories depending on how they are used. Depending on the level of the students, you may have them sort into “single-use” versus “multiple-use” or if they have more prior knowledge, “wise uses of plastics” versus “unwise uses of plastics.” In their science notebooks, ask them to record the item, what category they placed it in and their reasoning. You may want to model creating a three-column table with “item,” “single-use”/“multiple-use” or “wise”/“unwise” and “why.”

4. **STUDENTS EXAMINE AND DIFFERENTIATE A VARIETY OF PLASTIC PACKAGING.**

   Pass out a variety of rinsed plastic packaging with different resin identification codes (RIC). Pose the question: how do we tell different kinds of plastics apart? Give students time to sort them into categories of different plastics. Then solicit ideas from the class on how to tell plastics apart (may range between use, color, number, etc.). Discuss the resin identification codes and how they are an industry code for differentiating plastics but that doesn’t always mean the plastic objects are recycled.

5. **AS A WHOLE GROUP, DISCUSS THE OBSERVABLE PROPERTIES OF DIFFERENT PLASTICS.**

   Pass out *Types of Plastics* student sheet. Have students examine the plastic objects and record the observable properties of different plastics. If time, you may challenge them to plan an investigation(s) to distinguish between plastic types. The physical and chemical differences can be found by examining surface appearance (smooth, glossy, rough), how light travels through the plastic (transparent, translucent, opaque), rigidity (or flexibility), density and flammability. If you have time, you may choose to do Plastics in the Water Column activity which explores density of plastics. (See Resources.)

6. **SHARE THE PLASTICS: REDUCE USE OR RECYCLE PRESENTATION.**

   Challenge students to think about where plastics come from and how efficiently (in terms of energy and the environment) they are used while sharing the presentation at: [http://prezi.com/dsxiusp6vh9a/plastics-reduce-use-or-recycle-2014](http://prezi.com/dsxiusp6vh9a/plastics-reduce-use-or-recycle-2014). See page 8 for the presentation talking points.

7. **STUDENTS REASSIGN ILLUSTRATIONS OF PLASTICS INTO “WISE” AND “UNWISE” USES.**

   Now that students understand that plastics are versatile yet also ultimately nonrenewable and resource-intensive to recycle, ask them to go back and reorganize illustrations of plastics into “wise” and “unwise” uses. Have them explain what they mean by “wise” and why they categorized each illustration as they did. Be sure they understand the difference between single-use disposable plastic and durable uses of plastics.
8. **AS A CLASS, DISCUSS REDUCING AND REUSING VERSUS RECYCLING.**
   Ask your students about the “3Rs.” Make sure they understand that there is an intentional order to them (reduce, reuse, and then recycle). Ask them to come up with ways to reduce and reuse plastic products that they typically recycle. Discuss which plastics their municipality recycles or if they don’t know, brainstorm how to find out. You may even come up with sample questions to ask the local materials recovery facility (MRF) or waste management district.

9. **RETURN TO THE FOCUS QUESTION.**
   Now that students have examined what plastic is and how we use plastic, have them revisit the question: *How do we use plastics? Are there better or worse uses of plastics?* Students may think on their own or discuss with a partner. Then in their science notebook, you may have them draw a line of learning and under it add to their original thoughts about the question.

**Extensions**
Have students investigate which plastic types are more commonly recycled where they live and develop tips about how to better assist the recycling process (compacting plastics, rinsing them, putting all plastic bags and film in a plastic bag, etc.). Then develop a communications campaign to educate your school, community or city.

**Resources**

**Websites**
California's Department of Resources Recycling and Recovery (Cal Recycle)
http://www.calrecycle.ca.gov/

5 Gyres Project
http://5gyres.org

Monterey Bay Aquarium’s Plastics in the Water Column activity
http://www.montereybayaquarium.org/PDF_files/teaching_activities/Plastics_in_theWater_Column6-8.pdf

Society of the Plastics Industry
http://www.plasticsindustry.org

Story of Stuff: The Story of Bottled Water
http://storyofstuff.org/movies/story-of-bottled-water/

**Recommended Books**

---

African Proverb

*IF YOU THINK YOU ARE TOO SMALL TO MAKE A DIFFERENCE, TRY GOING TO BED IN A ROOM WITH A MOSQUITO.*
References


Standards
Next Generation Science Standards  www.nextgenscience.org

Performance Expectation
Supports MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Common Core State Standards  www.corestandards.org

Language Arts, SL.6-8.1
Speaking and Listening: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others’ ideas and expressing their own clearly.
1. List as many objects made of plastic in this room as possible.

<table>
<thead>
<tr>
<th>Item</th>
<th>Is it used multiple times?</th>
<th>Is it used once?</th>
<th>What alternative materials could it be made out of?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discuss:
- What did you notice?
- How did the number of objects made of plastics compare to objects made with other materials (wood, glass, metal, etc.)?
- What is plastic?

2. Sort the illustrated cards into categories of how plastics are used. Explain the criteria you used.

3. After the plastics presentation, answer these questions in your science notebook or on a separate piece of paper.

- Is plastic a renewable or nonrenewable resource? Explain.
- Explain what the number on each piece of plastics means.
- How might you figure out what plastics your community recycles (or if they do at all)?
- How could you personally reduce the amount of plastic you use?
- Explain what you consider wise and unwise uses of plastic. What criteria are you using?
# Types of Plastics

<table>
<thead>
<tr>
<th>Resin ID Code and Name</th>
<th>Types of Products</th>
<th>Surface Appearance (glossy, rough, smooth)</th>
<th>Rigidity (rigid, semi-rigid, flexible)</th>
<th>Transparency (transparent, translucent, opaque)</th>
<th>Density (sinks, floats, neutrally buoyant in fresh water)</th>
<th>Ways to Reduce Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PETE</td>
<td>Polyethylene terephtalate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 HDPE</td>
<td>High-density polyethylene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 PVC</td>
<td>Polyvinyl chloride</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 LDPE</td>
<td>Low-density polyethylene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 PP</td>
<td>Polypropylene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 PS</td>
<td>Polystyrene (two kinds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Other</td>
<td>Many kinds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Frame 2: Think-pair-share: What is plastic? Where does it come from?

Frame 3: Plastics are made using fossil fuels. Some are made using liquid petroleum and some are made using liquid natural gas. These fuels are what we use to power our cars and houses. Fossil fuels are a nonrenewable resource.

Frame 5: Plastics don’t biodegrade because during the manufacturing process, extreme temperatures in the presence of a catalyst link smaller molecules together to create strong bonds within large chainlike molecules called polymers. Organisms in nature don’t recognize the bonds created (not in all polymers, just in petroleum-derived plastics) and thus can’t break them down. See http://www.livescience.com/33085-petroleum-derived-plastic-non-biodegradable.html These chainlike molecules also make plastics strong and versatile.

Frame 6: Show the educreations animations depicting how monomers link to make polymers. Note: Students may not recognize molecular models yet.

Frame 7: There are thousands of different resins, or plastics. The plastics industry stamped the number on the bottom (a resin ID code) to quickly be able to distinguish broad groups. If you didn’t have those numbers, you can tell plastics apart using the physical and chemical properties that students observed earlier: surface appearance (smooth, glossy, rough), how light travels through the plastic (transparent, translucent, opaque), rigidity (or flexibility), density and flammability. You may want to hold up plastic objects to point out these characteristics.

Frame 8: Show the resin codes - ask which code they think soda bottles have (1) or iPhone cases (7) Show real examples of plastics with different resin codes. These are the resin identification codes (#1-7). Certain numbers are more often recovered for recycling than others. For examples, #1 and #2 are more often recovered. This has to do with infrastructure (factories and processing plants) as well as the chemical/physical properties of the plastic. And even though water bottles are often #1s and are more often recycled, additional materials/resources need to be added during the recycling process to make a new water bottle. Some plastics like the mix of #7 are often never recycled. In the U.S., only 8% of plastics used are actually recycled. Think-Pair-Share: If only 8% gets recycled where does the rest go?

Frame 9: The cost of disposable plastic to environmental health is enormous. Have you ever seen plastic waste on the beach? Note to teacher: you may want to Google image search ocean plastic entanglement to show the breadth of the issue. Animals may become entangled in the debris or even ingest it. They may also use it as unnatural habitat. This waterway is down near Los Angeles.

Frame 10: This video shows how turtles can mistake plastics for food.

Continued on next page...
Frame 11: Ask students: When you recycle something, what do you think it comes back as? Recycling plastics are better than not recycling. But it’s best to REDUCE our use of plastics by using less. Recycling has quite an economic cost. Many material recovery facilities (landfills, waste management agencies, etc.) in the U.S. ship our plastics to other places like China where they process the plastics and turn them into other items (like plastic yarn used in astro turf, lawn furniture and/or many other objects. Where is your waste management facility? Does your city use single-stream recycling or multiple-stream recycling? Single stream means you put all glass, plastics, paper, aluminum into one bin and it’s sorted at the facility. Multiple stream means families and businesses sort the recycling into different bins before it’s picked up.

Frame 12: Think-Pair-Share: How do you think plastic is recycled? What process might it go through? Show the video of the plastic bag recycling center. It takes a lot of energy to recycle. Again a good idea to use less especially when it comes to single-use disposable plastics.

Frame 13: So to recap, plastics are made from nonrenewable resources (fossil fuels), they cannot biodegrade and thus remain in the environment indefinitely, they are strong and versatile, they can be recycled but recycling uses a lot of energy and often additional plastic needs to be added to the process, only 8% of plastics in the U.S. are recycled and some of the rest ends up in the ocean and waterways. Think-pair-share: so how can we use plastic more wisely? Pack reusable utensils and containers for snacks, ask for no straw, reusable bags and water bottles, etc. It’s important to use less disposable plastic. Why use something made to last forever, only once?

Frame 14: There are many people, including youth/students raising awareness about the amount of single-use plastic we use. This is Milo Cress speaking at the Monterey Bay Aquarium (photo on left) about his Be Straw Free campaign. He has asked restaurant staff to ask people if they want a straw, before automatically putting one in a drink. The photo on the right is a school group who educated their school about single-use plastics and actually reduced the amount of disposable water bottles used at their school. Think-Pair-Share: What is one thing you could do to use less plastic?
## How Do We Use Plastics?

<table>
<thead>
<tr>
<th>Glasses/Contact Lenses</th>
<th>Fleece Sweatshirt/Jacket</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Glasses/Contact Lenses" /></td>
<td><img src="image2.png" alt="Fleece Sweatshirt/Jacket" /></td>
</tr>
<tr>
<td>Surfboard</td>
<td>Grocery Bag</td>
</tr>
<tr>
<td><img src="image3.png" alt="Surfboard" /></td>
<td><img src="image4.png" alt="Grocery Bag" /></td>
</tr>
<tr>
<td>Straw</td>
<td>Cell Phone</td>
</tr>
<tr>
<td><img src="image5.png" alt="Straw" /></td>
<td><img src="image6.png" alt="Cell Phone" /></td>
</tr>
<tr>
<td>Pen</td>
<td>Lip Balm/Lip Gloss</td>
</tr>
<tr>
<td><img src="image7.png" alt="Pen" /></td>
<td><img src="image8.png" alt="Lip Balm/Lip Gloss" /></td>
</tr>
<tr>
<td>Toy</td>
<td>Balloon</td>
</tr>
<tr>
<td><img src="image9.png" alt="Toy" /></td>
<td><img src="image10.png" alt="Balloon" /></td>
</tr>
</tbody>
</table>
### How Do We Use Plastics?

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>Take Out/Left Over Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Car" /></td>
<td><img src="image" alt="Take Out" /></td>
</tr>
<tr>
<td>Plastic Wrap</td>
<td>Yogurt Cup</td>
</tr>
<tr>
<td><img src="image" alt="Plastic Wrap" /></td>
<td><img src="image" alt="Yogurt Cup" /></td>
</tr>
<tr>
<td>Cleaning Products</td>
<td>Pacifier</td>
</tr>
<tr>
<td><img src="image" alt="Cleaning Products" /></td>
<td><img src="image" alt="Pacifier" /></td>
</tr>
<tr>
<td>Child Car Seat</td>
<td>Single-serving Chip Bag</td>
</tr>
<tr>
<td><img src="image" alt="Child Car Seat" /></td>
<td><img src="image" alt="Single-serving Chip Bag" /></td>
</tr>
<tr>
<td>Deodorant/Body Spray</td>
<td>Plastic Dinnerware</td>
</tr>
<tr>
<td><img src="image" alt="Deodorant/Body Spray" /></td>
<td><img src="image" alt="Plastic Dinnerware" /></td>
</tr>
</tbody>
</table>