Jean-Michel Cousteau OCEAN ADVENTURES

PBS

You Are What You Eat: Plastics and Marine Life

Just because you can't see it doesn't mean it isn't there. Whether it sinks or floats, plastics in the sea spell trouble for all the animals in the ocean. By matching animal cards to plastic risks, students find out the many ways marine life can be affected by plastics in their aquatic home.

SUBJECTS
Science

GRADE LEVEL
Grades 6 through 10

TIME
One class period

OBJECTIVES
Students will be able to
- understand that different types of plastics float, sink, or stay neutrally buoyant.
- learn where ten marine species feed in the water column.
- make connections between where a marine organism lives and feeds and the types of debris to which it is exposed.

MATERIALS
- Plastics and Their Uses handout
- You Are What You Eat handout
- Marine Animal Cards—one set per student or student group
- Marine Animal Feeding Habits and Plastics Risk Chart
- *Voyage to Kure* Viewing Guide, found at pbs.org/oceanadventures/educators (optional)
- Copy of *Voyage to Kure* episode of **Jean-Michel Cousteau: Ocean Adventures** series (optional)

Many animals that live in the ocean come into contact with discarded plastic. Because this plastic is not natural to their environment, the animals don't recognize it or know what to do about it. They encounter plastics most often as a result of their feeding behaviors. Often they get entangled in it, are cut and injured, or think it is food and try to eat it. The California Coastal Commission web site (http://www.coastal.ca.gov/publiced/marinedebris.html) notes that a recent study found an average of 334,271 pieces of plastic per square mile in the North Pacific Central Gyre, which serves as a natural eddy system to concentrate material. Results of more than 10 years of volunteer beach cleanup data indicate that 60 to 80 percent of beach debris comes from land-based sources. Plastic marine debris affects at least 267 species worldwide, including 86 percent of all sea turtle species, 44 percent of all sea bird species, and 43 percent of marine mammal species. (Note: this research has been documented by the Algalita Marine Research Foundation in Our Synthetic Sea, a video available at http://algalita.org/videos.html.

Plastics and Marine Life

The potential for ingestion of plastic particles by open ocean filter feeders was assessed by the Algalita Marine Research Foundation by measuring the relative abundance (number of pieces) and mass of floating plastic and zooplankton near the central high-pressure area of the North Pacific central gyre. (The gyre is a large recirculating area of water halfway between Los Angeles and Hawaii.) Plankton abundance was approximately five times higher than that of plastic, but the mass of plastic was approximately six times that of plankton. This area is far from land, and many types of marine life feed here.

The effects of plastics on marine life can be devastating. Aquatic animals may be harmed by plastic objects in a variety of ways, depending on the shape and buoyancy of the object. These animals may suffer injury or even death from their encounters with plastics. Animals can be harmed through entanglement, laceration, suffocation, and ingestion.

1. Moore, C. J., S. L. Moore, M. K. Leecaster, and S. B. Weisberg, 2001. A comparison of plastic and plankton in the North Pacific Central Gyre. In: Marine Pollution Bulletin 42, 1297-1300.

2. Laist, D. W., 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In: Coe, J. M. and D. B. Rogers (Eds.), Marine Debris—Sources, Impacts and Solutions. Springer-Verlag, New York, pp. 99-139.

STANDARDS

National Science Education Standards Grades 5-8 (http://www.nap.edu/catalog/4962.html)

Unifying Concepts and Processes:
Systems, order, and organization
Form and function

Physical Science - Content Standard B:
Properties and changes of properties in matter

Life Science - Content Standard C:
Structure and function in living systems

Science and Technology - Content Standard E:
Understandings about science and technology

Science in Personal and Social Perspectives - Content Standard F:
Natural Hazards

The buoyant properties of water allow some plastics to float, some to sink, and some to stay in the water column. The types of plastics marine animals may come into contact with depend upon where they live and eat: at the water's surface, its bottom, or floating in the water column between the surface and bottom. All we see are the plastics on the surface, but there are many different varieties and shapes of plastic objects below the surface. Because we can't see this pollution, we may forget that it exists. As cities grow and more plastics are produced and enter the marine environment, marine species will continue to be affected unless we make careful choices regarding plastic use and disposal.

PROCEDURE

1. **Introducing Marine Debris:** Use ideas from the *Voyage to Kure* Viewing Guide to set the scene. Pay particular attention to the Segment Suggestions for the marine debris theme (film clips from Laysan Island and Midway Atoll). If you do not have access to the *Voyage to Kure* episode, try to find pictures of marine debris to show to students and lead a discussion about the danger to animals and ecosystems. What do students think about plastics in the ocean? Where does plastic go? Does it go away? What types of animals are most affected?

2. **Class Discussion:** Continue class discussion by exploring the many ways we use plastics in our daily lives.

3. **Plastics Handout and Discussion:** Pass out Plastics and Their Uses student handout and discuss the different types of plastics. Note that most cities only accept Society of the Plastics Industry (SPI) codes 1 and 2 for recycling. Although many of the other types of plastic are labeled as "recyclable," in reality, this does not occur and the majority of plastics end up in landfills.

4. **List Types of Plastics:** From water bottles to computers, we rely on the convenience and availability of plastics to provide many of today's necessities. List on the board the shapes that plastic can come in, and have students give examples of what they are used for:
   One-dimensional objects (line, rope, strapping bands)
   Two-dimensional objects (sheets, bags)
   Reticulated (netting, six-pack rings)
   Hollow-bodied (bottles, fishing floats)
   Small particles (Styrofoam, pellets used in making plastic objects)
   Angular (boxes, crates)

5. **Discuss Marine Zones:** Discuss the marine zones in which animals feed (surface, pelagic, and benthic). Have students brainstorm what types of animals might live and feed in each of these zones.

Ocean Literacy: Essential Principles and Fundamental Concepts (http://coexploration.org/oceanliteracy/)

Essential Principle #5: The ocean supports a great diversity of life and ecosystems.

e. The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

f. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

6. **Form Groups, Distribute Handouts:** Either divide the class into small groups (3-4 students) or distribute materials to individuals. Distribute copies of the You Are What You Eat student handout, a set of the Marine Animal Cards, and a Marine Animal Feeding Habits and Plastic Risk Chart to groups or individuals.

7. **Student Worksheets:** Have students read You Are What You Eat and complete the worksheet activity, placing the marine animal cards on their charts. Keep in mind that there are many different possible "right" answers; students primarily need to have a rationale for their choices.

8. **Present Rationales:** After the groups or individuals have completed the activity, draw the chart on the board. Have each group or student choose one form of plastic (one-dimensional, two-dimensional, small particles, etc.) and present to the class their results and rationale of what species would be most affected. Allow time to propose different answers, discuss them, and wrestle with different conclusions.

9. **Reflection:** Conduct a class discussion on how to reduce the amount of plastics in the marine environment.

TEACHER NOTES

- Here are some possible worksheet answers. Your students may have additional answers with plausible rationales. This is an area of active scientific investigation; we have yet to learn the extent of devastation caused by plastic marine debris.

Answer Key: Marine Animal Feeding Habits and Plastic Risk

	One dimensional	Two dimensional	Reticulated	Hollow	Small	Angular
Surface Feeders	6	6	9	8	3,7,9	
Pelagic Feeders	4,5	6,8	4,8	1,2,4,5	10	2
Benthic Feeders	4	6	2	2	10	2

EXTENSIONS

- Have students bring different types of plastic trash from home, or use the trash from their lunches. Conduct buoyancy experiments to see which pieces float, which sink, and which are neutrally buoyant. Group like objects together based on buoyancy. Now check their recycle number on the bottom—the number in the triangle. Do all types of plastic with the same number have the same buoyancy? What might affect the buoyancy besides the type of plastic (e.g. the shape of the object)?

Essential Principle #6:
The ocean and humans are inextricably interconnected.

e. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

g. Everyone is responsible form caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

- Get a list from your local refuse agency that indicates what plastics they accept for recycling, and sort your plastic trash from the preceding extension activity accordingly. Are the recyclable plastics primarily floaters or sinkers? Do you think that the plastic that is more easily recyclable ends up in the ocean less often than those that are not recyclable in your area? Which ocean animals might recycling plastic help most?

FURTHER REFERENCES

Additional educator resources for **Jean-Michel Cousteau: Ocean Adventures** can be found at **pbs.org/oceanadventures**

Also, try:

- Algalita Marine Research Foundation: Plastic Debris Rivers to Sea http://www.plasticdebris.org/
- California Coastal Commission: The Problem with Marine Debris http://www.coastal.ca.gov/publiced/marinedebris.html
- The Ocean Channel: Ocean Pollution http://www.ocean.com/resource.asp?resourceid=1334&catid=&locationid=1
- The Smithsonian Institution: Ocean Planet—Pollution Solution http://smithsonianeducation.org/educators/lesson_plans/ocean/pollution/essay.html

CREDITS

Adapted with permission from *Waves, Wetlands, and Watersheds: California Coastal Commission Science Activity Guide*. For more information or to order copies, contact the California Coastal Commission, 45 Fremont Street, Suite 2000, San Francisco, CA 94105, (415) 904-5215, coast4u@coastal.ca.gov. The publication can be ordered or downloaded at http://www.coastal.ca.gov/publiced/waves/waves1.html

The California Coastal Commission originally adapted the activity from "Animals' Feeding Ranges and Plastics" in *Plastics Eliminators: Protecting California Shorelines* by the California Aquatic Science Education Consortium. Available at http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=21608

Jean-Michel Cousteau: Ocean Adventures is produced by KQED Public Broadcasting and Ocean Futures Society.

The exclusive corporate sponsor is The Dow Chemical Company.

Additional Major Support from: the William K. Bowes Jr. Foundation, Ann Bowers and The Robert Noyce Trust, the William and Gretchen Kimball Fund, the Harold K.L. Castle Foundation, and the National Marine Sanctuary Foundation.

Plastics and Their Uses

Name	SPI[1] Code	Description	Uses
PET, PETE Polyethylene terephthalate	1	High strength; transparent; barrier to gas and moisture, resistant to heat; sinks in water	Plastic soft drink and water bottles, beer bottles, mouthwash bottles, peanut butter and salad dressing containers, ovenable film and ovenable prepared food trays.
HDPE High density polyethylene	2	Tough; chemical and moisture resistant; permeability to gas; translucent or opaque matte finish; floats in water	Milk, water and juice containers, trash and retail bags, liquid detergent bottles, yogurt and margarine tubs, cereal box liners.
PVC Polyvinyl chloride	3	Hardy; chemical resistant; resistant to grease/oil; transparent, translucent or opaque; sinks in water.	Clear food packaging, shampoo bottles, medical tubing, wire and cable insulation.
LDPE Low density polyethylene	4	Tough; lightweight; barrier to moisture; can be nearly transparent or opaque; low to high gloss; floats in water.	Bread bags, frozen food bags, squeezable bottles, fiber, tote bags, bottles, clothing, furniture, carpet.
PP Polypropylene	5	Hard; resistant to chemicals; resistant to heat; barrier to moisture; resistant to grease/oil; transparent, translucent, or opaque; floats in water.	Ketchup bottles, yogurt containers and margarine tubs, medicine bottles
PS Polystyrene	6	Stiff; transparent or opaque; smooth surface; sinks in water.	Compact disc jackets, aspirin bottles
EPS Expanded polystyrene	6	Lightweight; heat resistant; insulating; opaque; foamed; floats in water.	Food service applications, grocery store meat trays, egg cartons, cups, plates.
Other	7	Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination. Characteristics dependent on resin or combination of resins.	Three and five gallon reusable water bottles, some citrus juice and catsup bottles.

1 Society of the Plastics Industry, Inc.

You Are What You Eat

Do different forms of plastic affect animals feeding in different parts of the ocean? Here is some information that will help you answer this question and fill out your Marine Animal Feeding Habits and Plastic Risk chart.

The Three Marine Zones
Scientists divide bodies of water into three basic areas:

1. **The surface zone:** the very surface of the water where it meets the air and things float where you can see them.
2. **The pelagic zone:** the open water below the surface where neutrally buoyant fish swim and plankton float.
3. **The benthic zone:** what lies beneath the bottom of the water; consists of mud, sand, or rock.

Where Marine Life Eats
Different forms of marine life gather their food in different zones. For example, some birds are surface feeders. They skim along just above the ocean's surface, and scoop up small bits of floating fish. Many fish are pelagic feeders. They swim about, eating smaller animals, plankton, and other food that share the water with them. Many whales, turtles, seals, and diving birds are pelagic feeders. Other kinds of fish, turtles, whales, and sea otters swim along the bottom to scoop up food from the ocean floor. They are called benthic feeders.

Animals that feed in different areas of the ocean often interact with different forms of plastic. For example, a bird skimming the ocean surface might accidentally scoop up bits of floating plastic pellets thinking they were food, but wouldn't scoop up a large, floating, angular object such as a Styrofoam ice chest, or a hollow object such as a plastic bottle.

Activity Directions

1. Arrange each card in your packet on the chart so that the animals are:
   - Located under the form of plastic they will have trouble with, and
   - Next to the zone where they feed

2. Then, take the card off of the square and write the animal's name in the square. One animal may be affected by more than one type of plastic, and may feed in more than one habitat, so there will likely be more than one animal name in a square.

3. You will compare charts with other students. Be sure to be able to explain your rationale for placement.

Marine Animal Cards

MARINE ANIMAL CARDS

Photocopy and cut along dotted lines. Each student receives one complete set of cards.

1

Bottlenose Dolphin feeds on surfperch in open water below surface, grabs with teeth.

2

Orca eats fish and marine mammals, grabs with teeth. Feeds in open water below surface.

3

Gull eats fish, inter-tidal org-anisms, beach debris. Feeds on shore, top of water, grabs food with beak.

4

Sperm Whale eats squid and fish below surface. Grabs food with long, narrow mouth.

5

Common Dolphin feeds below surface in open water. Grabs small squid, other small fish with teeth.

6

Loggerhead Sea Turtle eats jellies, fish, mussels, clams, crabs. Grabs them with toothless mouth.

7

Elegant tern feeds on anchovies and other fish. Floats or dive shallowly into the water.

8

Sea Bass feeds below surface in open water. Sucks herring, krill, and anchovies into its large mouth.

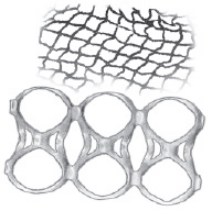
9

Forster's Tern feeds on various small fish. Floats along or dives shallowly into water.

10

Sea Otter feeds on benthic urchins and shellfish, bringing them to the surface to eat.

Marine Animal Feeding Habits and Plastics Risk Chart

	Surface Feeders	Pelagic Feeders	Benthic Feeders
One-Dimensional Objects 			
Two-Dimensional Objects 			
Reticulated Objects 			
Hollow Objects 			
Small Particles 			
Angular Objects