

# Plastic Pollution

## Curriculum and Activity Guide



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- ***Packaging Your Product***  
In this activity, students define and clarify a problem by understanding that packaging contributes vast amounts of trash and is often wasteful of natural resources. They consider how packaging can either be avoided or redesigned to alleviate these concerns and attempt to solve the plastic pollution problem.



# World of Waste

**Grade:** K-3<sup>rd</sup>

**Objectives:**

- Students will collect and record data of the trash they generate.
- Students will describe strategies for using resources wisely (reduce, reuse, recycle, and recover).

**Time Needed to Complete:** 60 minutes (more for the optional extensions)

**Materials Needed:**

- Various items made of plastic, glass, metal, and paper
- Student Lunches
- Recycling Bins
- Graph paper for class graph
- Copies of Student Pages:
  - Lunchtime Trash Tally
  - Crossword Puzzle
  - Exploring the World of Waste (for extension)
  - Home Trash Survey (for extension)

**Background:**

Students begin the lesson by examining items to determine what they are made of—glass, paper, plastic, or metal. Next, students collect data to determine what types of trash they produce at lunch time. After making a class graph of this information, students discuss what happens when trash is thrown away and discover four strategies for using resources wisely (reduce, reuse, recycle, and recover). As an extension, students learn more about recycling by exploring the web and display their new learning on a mini poster. And as a final extension, the lesson is brought home, where students analyze the trash they produce and brainstorm strategies for reducing waste.



Photo Credit: TreeHugger

**Procedure:**

1. Hold up some items from around the classroom for students to see. Ask the students if the items are made from paper, plastic, glass, or metal. Ask students to identify words or phrases to describe each of the materials and write the descriptors on the board (i.e. metal = hard, rigid, shiny...; plastic = see-through, shatter-proof...; paper = easy to tear and crumple)
2. Tell students that they are going to look for items made from paper, plastic, glass, and metal from the trash they generate at lunchtime. Be sure students understand that they will NOT be looking through any trash cans. Rather, students will eat their lunch as normal, but before disposing of any of the material, they will take notes of all the trash they have generated. Provide students with a tally sheet (Lunchtime Trash Survey below). Prior to cleaning up, ask students to tally the number of paper, plastic, glass, or metal items they have collected as trash from their meal. Refer them to the words or phrases on the board to help identify each material. Encourage students to place the sorted items into an appropriate recycling bin. (Note: If recycling bins are not yet available at your school, provide students with labeled boxes in which to place the recyclables.)
3. Create a class graph (bar graph, pictograph, or circle graph) to show the amounts of paper, plastic, glass, and metal generated from the lunchtime trash. Analyze and discuss the graph as a class. What type of trash was generated most by the students' lunches?

4. Discuss the concept of a treasure. (e.g. A treasure is something valuable. Sometimes a treasure is hidden. You may not see a treasure right away, but when you find it, there is great value.) Discuss how many of the items that people throw away are actually quite valuable. Many of these items can be recycled or used for energy. Could any of these items be used again before being thrown away or recycled? For example, could a plastic yogurt cup be rinsed out and used as a water cup? Are there other items in your lunch that could be reused and considered valuable?
5. Discuss the importance of using scarce resources wisely. As natural resources become scarce, recycling is more important than ever (however, reducing waste and reusing that which we already have are the first and second lines of defense, respectively). Recycling saves landfill space. It generally takes less energy to make recycled products. Thinking creatively about waste can help save energy.
6. Write the vocabulary words on the board (Reduce, Reuse, Recycle, and Recover). Explain each term to the students.
  - a. Reduce refers to using less of an item.
  - b. Reuse refers to using an item more than once before discarding it.
  - c. Recycle refers to taking out useful materials that otherwise might be thrown away so that they can be used again (often in a different form.)
  - d. Recover refers to changing waste into useful products like compost or energy.

Read the following examples to students. Students should shout out the correct vocabulary word to match each example. Ask students to explain their thinking.

Example	Answer
Using a cloth bag at the grocery store instead of plastic	REDUCE the number of plastic bags
Using composted soil for gardening	RECOVER
Using newspaper for gift wrapping	REUSE
Mashing up a paper carton and using the paper fibers to make tissue	RECYCLE

7. Students complete the Student Page – World of Waste Crossword Puzzle and check their knowledge



**Extensions:**

1. 3<sup>rd</sup> Grade: Allow students to explore the web to research what happens to our waste and solutions to reducing waste. Provide students with the Student Page - Exploring the World of Waste to help them organize their notes and guide their research. Then students make a small poster showing facts about waste in their communities, and about reducing, reusing, recycling and recovering waste to solve the problem. Finally, students share their poster with the rest of the class.
2. K-1<sup>st</sup> Grades: Provide students with some common items found in student lunches (aluminum foil, yogurt cups, napkins, bottle caps, bottles, etc), scissors and glue and encourage them to reuse this “trash” by making it into art. Visit [www.kid-at-art.com](http://www.kid-at-art.com) for ideas.
3. K-3<sup>rd</sup> Grade: Students collect data from home to compare with the data collected at school. What types of trash are produced when preparing and eating one meal at home? Remind students again that they will NOT need to go through any trash cans to complete this assignment. Rather, students should take note of any items before they are discarded. Encourage students to recycle if they already do so at home. If not, students can encourage their families to investigate how they might participate in any local recycling programs.

**Standards Correlation:**

This lesson may be used to address the National Science Education Standards listed below.

NSES 4FSPSP3.3: The supply of many resources is limited



*Adapted from “What Is In Our Trash?” developed by ThinkGreen and Discovery Education*

## Student Page – Lunchtime Trash Survey

*Directions:* After eating your lunch, what trash is left behind? Count the different types of trash you've made from your lunch on the chart below

Type of Trash	How Many?
Paper	
Plastic	
Metal	
Glass	
Other (describe)	



## Student Page – World of Waste Crossword Puzzle

Can you find all of the words below in the crossword puzzle?

COMPOST  
GLASS  
LANDFILL  
METAL  
PAPER

PLASTIC  
RECOVER  
RECYCLE  
REDUCE  
RESOURCE

REUSE  
SCARCE  
TREASURE  
WASTE

K O F Q K O N G N S X T E N T  
C I T S A L P N E L O C O C S  
E C R U O S E R R E U S E I O  
R S L A S Y G E L C Y C E R P  
E T A U C K X B O S I N K L M  
V H T B A U H X S E W W L S O  
O N E J R S Q A W K T I L C C  
C T M X C G L E E S F S T E Y  
E R P B E G W L M D H O A K R  
R E E T D T O I N P B T Y W T  
P A C X E T L A V A D A M O V  
M S U P T S L Y H P T X X V D  
C U D Q F K C M G E V I M R V  
X R E C R H N O S R H F Q C L  
H E R R J Q X G N U W N O G B



## Extension #1

### Student Page – Exploring the World of Waste

What do you know about waste in your community? How does your community deal with their waste? Use the questions below to guide your research, and come up with at least 2 of your own. Some helpful websites that can help you find your answers are listed below.

- Where does my trash go once I put it in the trash bin?
- What does my city do with all that trash (is it burned? Is it buried?)
- How much of my city's waste is recycled?
- What is composting? Does my city compost?

#### Helpful Websites to Guide My Research:

United States Environmental Protection Agency

<http://www.epa.gov/waste/index.htm>

Earth 911

[www.earth911.com](http://www.earth911.com)

My City's Public Works Department

(Google search "[your city] public works department")



## Extension #3

### Student Page – Home Trash Survey

1. How much trash does one meal at home make? Record your findings below.

Type of Trash	How Many?
Paper	
Plastic	
Metal	
Glass	
Other (describe)	

2. Are there ways you can reduce your trash/waste at home? How?



# There Is No “Away”

Buy it, try it, throw the trash away!  
Take it, break it, throw the trash away!  
Get it, use it, finish it, lose it.  
Wear it, tear it, throw the trash away!  
Soda pop, box top, once you start you can't stop.  
Buy it, show it, nothing left but to throw it!  
Throw the trash away! (Oh, no—where is “away”?)  
*-Written by Betty Miles, Save the Earth Ecology Handbook for Kids, 1974.*

## Background:

Garbage, also called solid waste, is generated by people at home, at work, on vacation—well, everywhere! Americans generate over 280 million tons of trash each year, which amounts to about 4.5 pounds per person per day. Of that that we create, only about 34% is recycled. What we don't recycle or reuse is either buried in landfills or burned in an incinerator<sup>1</sup>.

An unknown amount of garbage is disposed by people illegally dumping their garbage in rural or abandoned areas and by burning their garbage in their fireplaces or on their property. Illegal dumping is punishable by a fine. The practice of burning or burning certain types of materials is illegal in some areas. This practice is discouraged by environmental and human health agencies because of the hazards it poses. Burning waste releases dangerous chemicals and metals into the air, often releases unpleasant odors into the neighborhood or community. Most importantly, burning poses serious health threats to people breathing the fumes.

Certain types of materials are banned from most municipal landfills and should not be placed in your garbage. Items like flammable materials, paints, electronics, batteries and light bulbs are considered "household hazardous waste" and are discouraged from being placed in the garbage because they can injure solid waste workers and cause serious threats to the environment. Improper handling and disposal of hazardous substances can result in the release of “persistent bioaccumulative toxins” (PBTs) such as polychlorinated biphenyls (PCBs), mercury, and many pesticides, herbicides, and insecticides.

Most PBTs are known or probable human carcinogens (cancer-causing agents). The best way to deal with potentially hazardous substances is to use safer alternatives and use all of the product as it was intended, whenever possible. The following is a list of materials that should be disposed of at hazardous waste facilities or community special collection events whenever possible:

- pesticides, weed killer, moth balls, flea killers, herbicides
- pool/spa chemicals
- batteries - lead acid or nickel-cadmium types (contain acids and heavy metals)
- electrical equipment containing polychlorinated biphenyls (PCBs) such as older televisions, refrigerators, hydraulic fluid, or coolant liquids
- paints/solvents
- products containing mercury such as thermometers, thermostats, fluorescent light tubes
- harsh chemical cleaners such as bleach, oven cleaner, drain cleaner
- materials that are flammable, reactive, corrosive or toxic

**Grade:** K-3

## Objectives:

Students will:

- Recognize that there is no “away” in “throw it away”
- Identify the destination of the waste the generate at home and at school
- Identify the negative aspects of dumping or burning trash
- Learn the “solid waste hierarchy” for best management of our trash

**Time Needed to Complete:** 40 minutes

## Materials Needed:

- “Cynthia Sylvia Stout” from Where the Sidewalk Ends by Shel Silverstein
- Transparency or handouts of “Where Trash Goes”
- Copies of Worksheet #1 “Landfill”
- Copies of Worksheet #2 “Mining the Landfill”

Contact your local city or county Solid Waste or Public Works Department to find out how to properly dispose of potentially dangerous items in your area or visit [www.earth911.com](http://www.earth911.com) to find a collection center in your neighborhood.

**Procedure:**

1. Read and discuss the poem, "Sarah Cynthia Sylvia Stout" by Shel Silverstein. Some questions to ask could include:
  - a. What do you think happened to Sylvia Stout? Why is it important to take the garbage out? Once it is out, where does it go--Where exactly is "away"? How do you think trash is disposed?
  - b. Is it okay to dump your garbage out in open areas, ditches, ravines or forests? NO! Why not? Students should conclude reasons like: it looks ugly, it can pollute the environment, or hurt animals or people that might come in contact with the garbage.
  - c. Does anyone's family burn garbage at home? Explain to the children that fumes and gasses coming from a trash fire are unhealthy. Fumes can hurt your eyes and your lungs. Especially fumes from burning plastics--never, ever burn plastics. Never get close to the fire or breathe the smoke! Point out that some chemicals cannot be seen or smelled, so it is not always obvious when something is harmful. Also, let them know that they should never set things on fire because it is bad for the air and for people and animals who breathe the polluted air.
2. Show and discuss transparency, "Where Trash Goes." What might happen if the landfill gets filled up? Where would we put the trash? Near your home, school, or baseball field? Finding new land to build a new landfill is very expensive and difficult and usually no one wants it in their backyard or neighborhood. And no matter how careful we are, sometimes landfills still cause pollution after many years, so we need to keep using the ones we have as long as we can.
3. Discuss with students what they might do to create less waste. Students should mention things like: not taking or using more items than you need (like paper in class or napkins in the cafeteria), returning soda cans and bottles for deposits, recycling newspaper and plastic, repairing broken objects instead of buying new ones, giving used clothes to others, etc.
4. Draw "The Waste Hierarchy" on the board.

Reduce

Reuse

Recycle

Compost

Disposal

Most municipalities have a waste hierarchy for lessening the flow of waste to landfills. Teach students about the 3 Rs: reduce, reuse, and recycle. (A good lesson can be found in "World of Waste" in this curriculum guide). We want people to reduce first, reuse all they can, and recycle what is possible. Only then, once we've minimized waste in this way, should we dispose of what's remaining.

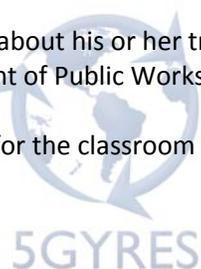
**Reflection/Response:**

What would happen if the garbage truck stopped coming? Have younger students illustrate a story. Older students can write an imaginative essay about such a story.

Have students complete the worksheet "Landfill!" and "Mining the Landfill."

**Extensions:**

1. Invite the school custodian to class and ask about his or her trash removing duties.
2. Visit a landfill (contact your local Department of Public Works for information about landfills in your community)
3. Go on a virtual field trip to a landfill (visit [www.earth911.com](http://www.earth911.com))
4. Have students design a motivations poster for the classroom illustrating their solutions for reducing waste in their community.



**Common Curriculum Goal**

English: Reading and Writing

Demonstrate inferential comprehension of a variety of printed materials.

Use a variety of modes (e.g. narrative, imaginative, expository, persuasive) in appropriate context.

**Grade 3 Benchmark**

Identify cause and effect relationships and make simple predictions.

Write in a variety of modes (e.g. narrative, imaginative, expository, persuasive).

*Adapted from "Where is Away?" from the Oregon Department of Environmental Quality*

<sup>1</sup> United States Environmental Protection Agency, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010"



## Where Trash Goes

Waste goes in a curb-side bin at your house or apartment.

It's picked up by garbage trucks...

...then taken to a transfer center where trash is separated from recycling.

Trash is taken to a landfill...

...where it's buried in the Earth.

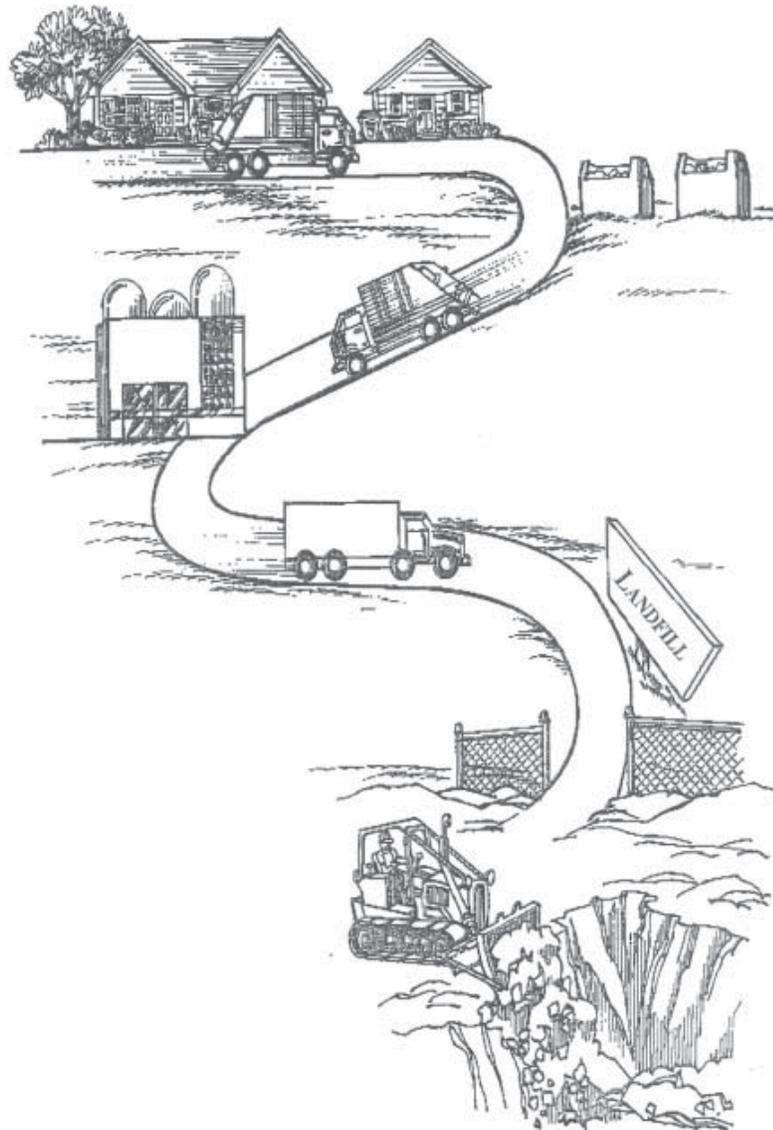


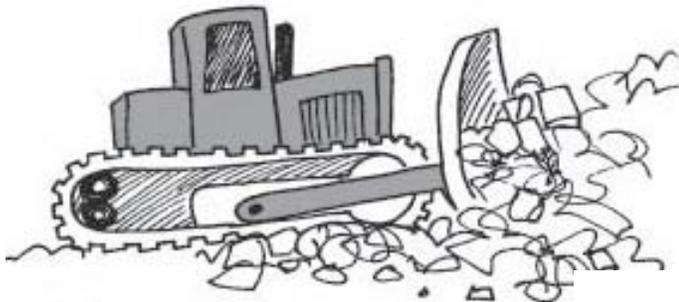
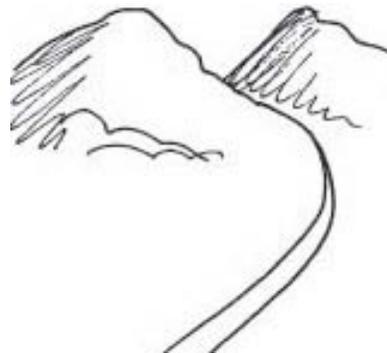
Image Source: South Carolina Department of Health and Environmental Control: *Action for A Clea*



# Worksheet #1

## Landfill

Draw arrows to show each step from first, throwing a juice box away to finally, and the juice box going into a landfill. Number and label each of the steps from first to last to show what is happening.



## Worksheet #2

### Mining the Landfill

Help! Some very valuable things are on their way to the landfill.

Save them from being thrown away. Circle in blue, the things that can be recycled. Circle in green, things you could reuse. Some items may be both! Be sure to look for:

newspaper  
crayons  
margarine tub  
brush

tin cans  
bottles  
blank paper  
motor oil

plastic bag  
grocery bags  
old toys  
aluminum

cardboard  
pencils  
box  
plates

jars  
milk jugs  
art paper  
sock

Can you find some bonus words too? What do they tell you? \_\_\_\_\_

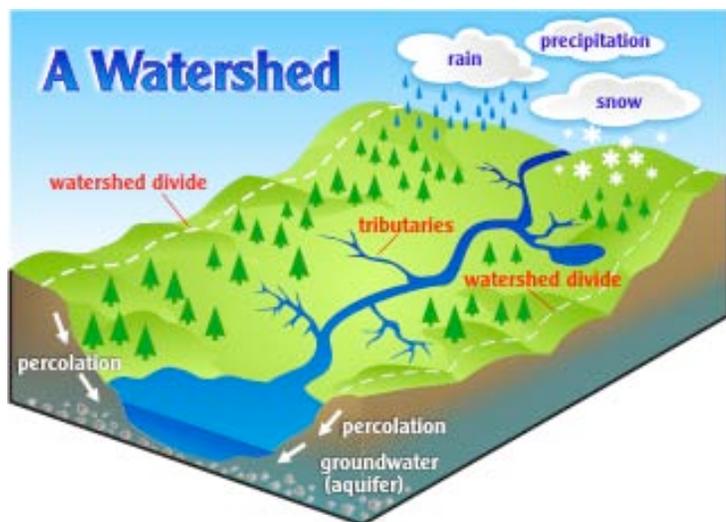
S O C K Y A R E D U C E L M N O P  
V W X Y Z L X R E P A P K N A L B  
G H I T B U T E N I R A G R A M J  
F T X I P M I L K J U G S S Q R S  
L P E N C I L S C O L D T O Y S A  
U N E C V N R E U S E I C X M D X  
N I T A M U S A V E C R A Y O N S  
C E B N C M A B C B N Q R S T E R  
H O W S U X P Q A T O M D R O G E  
B A R S Z P Y G B S I X B L R A C  
A R E L P L R M R O T B O X O B Y  
G T U Z J A R S U P U O A K I R C  
S P S K R T P K S M L T R D L A L  
F A E L M E P E H O L T D M L G E  
R P X Y Z S O P R C O L D O N T M  
O E C Y T N E V E R P E W A S T E  
G R O C E R Y B A G S S E R O X J



# What is a Watershed?

## Background:

A *watershed* is the area of land where all of the water that is under it or drains off of it goes into the same place. It is delineated by the high points in a geographical area, like a mountain or hill side. On one side of the mountain, water drains down the east side into a lake. On the west side of the mountain, water drains into the ocean. Each side of the mountain is a different watershed because water drains into two different locations. Debris, in the form of litter or runoff, within a given watershed also drains into that body of water. In this activity, you and your students will create a watershed and simulate a rainy day, illustrating how pollution drains into our water bodies, lakes, streams, bays, and oceans.



**Grade:** K-3

**Objectives:** Students will be introduced to the concept of a watershed and the effects of pollution.

**Time Needed to Complete:** 40 minutes

## Materials Needed:

- Construction paper (4x4ft)
- Spray bottle
- Rocks or large objects, like boxes, of varying sizes and heights
- NON water-proof markers
- Food coloring (to represent pollution)
- Towels for cleanup

## Procedure:

1. Tell students that today you are going to build a mountain.
2. Bring students outside to a large, level area (teacher should designate an area before beginning and section off a 4x4 ft area).
3. Have them lay down the large rocks or large boxes within the designated area.
4. Next students place the smaller rocks or boxes within the designated area.
5. Together the teacher and students lay the piece of construction paper over the rocks or boxes. Push the paper into the grooves or valleys between the rocks.
6. Pass out different colored markers to each student and ask them to color the tops of the mountain. They should draw lines around the tops, outlining them.
7. Explain to the students that what they have just created is a model landscape – the tall points are the mountains and the shallow points are the valleys. But today is a cloudy day, and the forecast calls for rain.
8. With the spray bottle, spray “rain” over the landscape (have a couple of bottles ready and have a few students help you). What happens to the landscape?
  - a. The blue ink on the mountain top travels downstream to make a blue lake on one side. The green ink on the other side pools down the other side to make a green lake on the other side.
  - b. Explain to students that the areas between the mountains are called watersheds, the area of land where all of the water that is under it or drains off of it goes into the same place.

9. Tell the students that someone has been littering in this community. What do they think will happen when someone leaves their trash in the street, or outside on the blacktop after lunch at school? With the food coloring in a different color from the markers, leave drops of “trash” around the community. Then simulate a rainy day again by spraying “rain” over the landscape with the spray bottle. What happens to the lake? (the trash drains to the lake and pollutes it) Use a couple different colors so that the lake turns brown to really simulate pollution.
10. Ask your students: would you want to live in this community or swim in this lake? If there are fish swimming there, would you want to fish there and eat the fish?



## Searching Out Storm Drains

### Background:

In some old cities, the sewage system and the storm drain system are connected and together are called a combined sewer system. During heavy rains, the old systems are overwhelmed and usually both the storm water and sewage do not receive adequate treatment and are discharged into a local waterway.

Other cities have a sewer system made up of two different networks of pipes. One network handles sewage coming from sources such as kitchen sinks, toilets, and washing machines. These pipes carry waste materials to a larger network of pipes leading to a sewage treatment plant where sewage is separated into sludge (solid waste material) and water. The sludge is compacted then landfilled, incinerated, or marketed as an environmentally

beneficial product, while the water is discharged into a river or other nearby waterway free of any solid waste.



**Grade:** K-3

**Objectives:** Students will be able to

1. Understand that storm drains are connected to water systems and can become a significant source of marine debris and
2. Identify storm drains around their school and/or community

**Time Needed to Complete:** 50 minutes

**Materials Needed:**

- Book All the Way to the Ocean by Joel Harper
- "Storm Drains as a Source of Plastic Pollution" diagram (see worksheets)

The other network of street gutters and pipes carry runoff storm water from streets to nearby bodies of water such as streams, rivers, and oceans. There is generally no screening process associated with this system, so litter that is carried into the pipes with storm water will also end up in the receiving body of water. These pipes are obviously designed to carry storm water runoff from one point to another and are not meant to transport street litter and other types of debris. Storm drains, then, are a source of water pollution to the extent that people use them as receptacles for inappropriate waste.



**Procedure:**

1. Take your class on a walk around school. Identify and locate the storm drains with your students.
2. Have students give their own descriptions of what storm drains are designed to do. Pose questions that will help them formulate ideas on the function of storm drains and help them understand the connection that exists between storm drains and streams, rivers, etc.
3. Is there litter near the storm drain that you and your students have located? Can you look into the drain and see any trash? Have your students consider how the trash got there and what would happen to it over time, especially if it rained.
4. Back in the classroom, read the book All the Way to the Ocean by Joel Harper. Then, hand out copies of the storm drain diagram for your students to color.

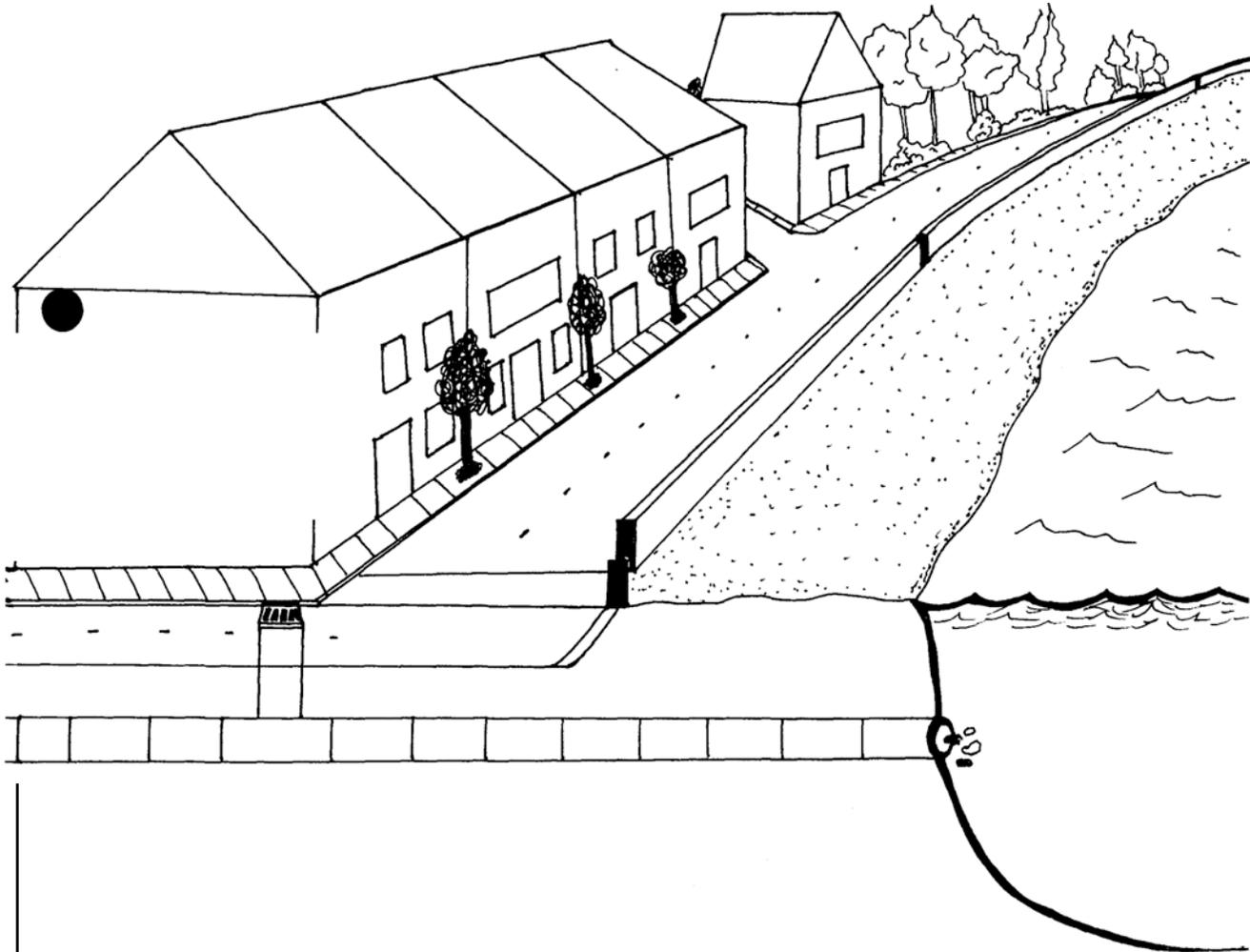
**Assessment:**

Have your students diagram the path of litter from the street into the storm drain and eventually to a body of water.

*Adapted from "The Storm Drain Connection" developed by The Center for Marine Conservation and the California Coastal Commission in the Save Our Seas curriculum guide*

# Searching Out Storm Drains

## Coloring Sheet



## Plastic Pollution: It Can Be Deadly

### Background:

The Great Lakes--Michigan, Superior, Huron, Erie, and Ontario--form the largest surface freshwater system in the world. Together, they hold nearly one-fifth of the earth's surface freshwater. The Great Lakes have over 10,000 miles of shoreline and serve as a drain more than 200,000 square miles of land ranging from forested areas to agricultural lands, cities and suburbs.

The Great Lakes watershed includes some of North America's more fascinating wildlife such as the [gray wolf](#), [Canada lynx](#), moose and [bald eagle](#). The lakes themselves are home to numerous fish, including lake whitefish, walleye, muskellunge and trout. Millions of migratory birds pass through the region during their spring and fall migrations. The Great Lakes region has been home to Native Americans for nearly 10,000 years. The first Europeans arrived in the 1600s and began to utilize the region for animal furs. It wasn't long before more settlers were drawn to the region seeking farmland.

Today, over 35 million people live in the Great Lakes basin in Canada and the United States. The Great Lakes are important sources of drinking water, irrigation, transportation and recreation opportunities such as fishing, hunting, boating, and wildlife watching. The Great Lakes are a critical component of the regional economy on both sides of the border.

Today there are many threats to the water quality and quality of life for wildlife in the Great Lakes. The amount of water entering and leaving the lakes each year is less than one percent of the total in the lakes. Persistent chemicals that enter the lakes can remain for many years, with many building up in the food web. The source of toxic pollutants includes decades of industrial waste, raw sewage overflows, runoff from cities, and mining operations. Excess nutrients that throw the ecosystem out of balance enter the lakes from agricultural runoff and untreated sewage. Additionally, solid waste in the form of litter and specifically, plastic pollution, threatens the wildlife that call the Great Lakes home. Animals like the river otter, trout, sturgeon, salmon and bird species like the bald eagle, as well as many other endangered bird species become can become tangled in plastic pollution like plastic fishing line, plastic strapping bands, six-pack rings, or other plastic trash that ends up in the Great Lakes. Once tangled, they spend energy trying to get free, may become sick or weak, and even die. Certain animals also mistake plastic trash for food and eat it. Many animals have difficulty digesting plastic, so the plastic remains in the animal's stomach causing a feeling of fullness. The animal, feeling satiated, stops eating and eventually starves to death.

This deadly trash is known as plastic pollution. It is trash found in the lakes or along its shores. An estimated 80% of this pollution comes from land-based sources in the form of litter, illegal dumping, and poor waste management practices.

**Grade:** K-3

**Objectives:** Students will be able to

1. Experience in a simulated setting the negative effects that plastic, in particular, can have on the feeding activities and health of marine animals, and
2. Consider the effects of plastic debris in the oceans and on the beaches from an animal's perspective

**Time Needed to Complete:** 40-50 minutes (game for K-1); 60 minutes (game for 2-3)

**Materials Needed:**

For grades K-1:

- Pictures of marine wildlife (included in this guide)
- One rubber band for each child
- A tray or shoe box for every three children
- Plastic foam pieces (from packaging, beanbag chairs, or potting soil) ½ cup per tray
- Bird seed, white beans, or popcorn 1 ½ cups per tray
- A spoon and cup per child

For grades 2-3:

- Pictures of marine wildlife (included in this guide)
- Tape
- Multi-colored beads or any other small multi-colored items
- A calorie chart and score card, included in this guide



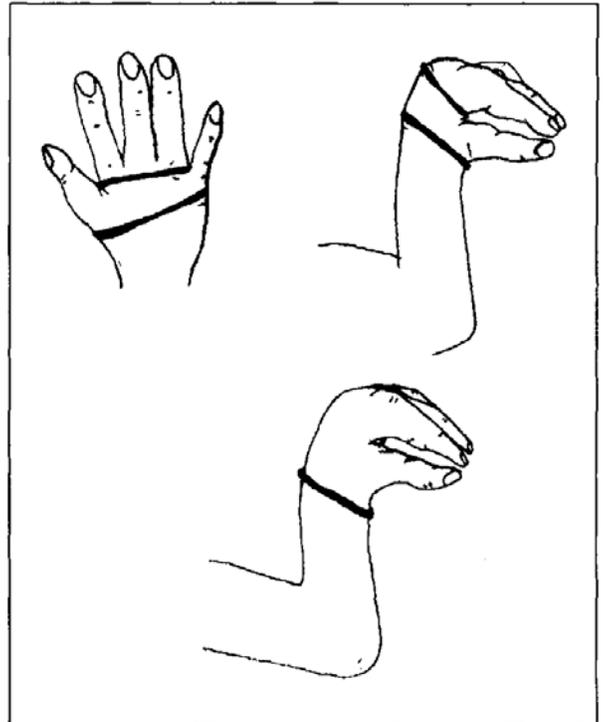
## Procedure:

Part 1: Before playing the games that follow, talk about “who’s who” in the Great Lakes ecosystem, using the supporting pictures of the various animals.

### Part 2: Grades K-1

“Getting Out of A Bind” is a simple activity that teaches empathy for wildlife by simulating an animal’s entanglement in plastic litter. The procedure is as follows:

1. Use a volunteer to demonstrate. Put a rubber band around the back of his or her hand, catching the thumb and the little finger (see diagram). Have the child try to remove the rubber band without using the other hand or teeth or rubbing it against something.
2. Hand out rubber bands for everybody to try. Tell each child to pretend his or her hand and arm is a bird entangled in plastic. For example, the hand is its head, the fingers its beak and the forearm its neck. Cup elbow with free hand. Place rubber band around the “beak” or “neck”. Allow children only 30 seconds to free themselves. No helpers!
3. Is everyone successful in untangling themselves? Many animals don’t get free, of course, and starve, strangle, or suffocate.
4. Discuss the following with the children: What plastic or other material could the rubber band represent in a natural setting (fishing line, plastic six-pack rings, fishing nets, packing straps)? How could an animal get into a situation in which fishing line, strapping bands, six-pack rings, or a net would entangle it? (By swimming into plastic accidentally. Also, a bird might eat the bait on a fishing line, then become entangled or take the line back to a nest of vulnerable babies. Some students might have rubbed their hands against the table to remove the band. In the natural environment, what would animals rub their heads against? Probably a rock. What would happen to an animal that rubbed its head against a rock until the band came off?

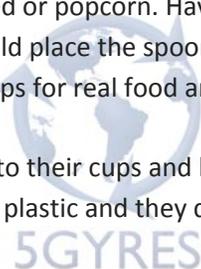


### Part 3: Grades K-1

#### “The Early Bird Gets the...Plastic?”

This activity helps children understand how animals can mistake plastic for food.

1. The object of this game is to collect as much food as possible in the time allotted. Because of the collection method and the short time allowed, some plastic will be gathered also.
2. In each tray, mix plastic pieces with bird seed or popcorn. Have three children “feed” at each tray for 30 seconds, using their spoons as beaks. Each child should place the spoonfuls of food into his or her cup or “stomach”. When time’s up, the children will examine their cups for real food and plastic. Help the children count and record the pieces in two columns on a sheet of paper.
3. Have the students return the plastic pieces to their cups and begin the feeding exercise again. Continue the exercise until the birds’ stomachs are full of plastic and they don’t feel like eating anymore.



4. Ask the children what they think will happen to birds that eat plastic. (Since plastic is difficult to digest, it can build up in the birds' stomachs taking the place of real food. The birds feel satiated, gradually stop eating, and slowly starve.)

## Part 2: Grades 2-3

### “The Feeding Game: A Simulation of the Perils of Plastics”

This game simulates the negative effects plastic trash can have on the feeding and survival of animals. Through several rounds of play, players collect colored beads that represent the food of animals in the Great Lakes. In the first round, the players determine the number of calories their animal needs to stay alive. In the subsequent rounds, the players are physically hindered in some way from gathering food in their normal way.

#### Round #1:

1. Read the second to last paragraph of the background information (“Today there are many threats to the water quality...”) aloud to the group, and explain that they will be playing a game that simulates the way animals can be harmed by plastic debris in the Great Lakes.
2. Remove all of one color of beads from the bag (e.g. all the white beads) and set them aside for later.
3. Have the players stand along one wall or on the side of the playing area. Designate an equal number of the players as double-crested cormorants, bald eagles, river otter, and trout. Pin or tape a picture of the corresponding animal on the front of each student. Tell the players that they will soon find out how much they need to eat each week in order to stay alive.
4. Explain that one round of the game represents a week of feeding and that when the round begins they should collect as much food as they can in 30 seconds. Warn them to move safely and not to run into other players.
5. Scatter two handfuls of beads around the room (approximately 6-10 players). Say “go!” and then 30 seconds later call out “Stop!” The players should return to their positions along the wall with the beads they have collected.
6. Players should then count the number of beads they collected and calculate the “calories” by color according to the chart (attached). Each player’s total is the number of calories required by their animal each week and is the amount they will need to collect in the following rounds in order to stay alive. Have each player, one by one, call out the number of calories they will require in the following rounds and enter their names and the calories they gathered under Round #1 on the score card.

#### Round #2:

1. Collect the beads from the players, scatter them again, and explain the following:

The river otters were curious about something they saw floating in the water and got tangled in a plastic strap. To symbolize this, the players who are river otters must crouch down, grab their ankles with their hands, and waddle in this position, instead of walking or running, during the next round of play. (They can still use their hands to pick the beads up.)

The trout swam into a six-pack ring and got stuck. To symbolize this, the players who are trout must keep their little fingers clasped together behind their backs at all times during the next round of play, even while picking up the beads.

The bald eagles tried to eat a plastic bag, which got caught in their throats, so now it is very hard to swallow anything else. To symbolize this, the players who are bald eagles must put one hand around their throat and may only use their free hand to pick up AND hold their beads once they’ve collected them.

The double-crested cormorant’s feet got caught in plastic fishing line that was left on the beach. To symbolize this, the players who are double-crested cormorants must hop on one foot during the next round.

2. Just before beginning the second round of play, designate one or two of each type of animal and tell them that they were lucky enough to have recovered from ingesting or becoming entangled in the plastic trash, and can play the game unhindered. Then circle the Y or N on the score card to indicate which players are or are not impaired.
3. Call out the beginning and end of the 30-second feeding period. Players should again return to the sidelines and calculate their calories according to the calorie chart. Enter the number of calories each player collected under Round 2 on the score card. Compare and discuss the differences between calories collected in Rounds 1 and 2 for the hindered and unhindered animals.

Round #3:

1. Collect the beads from all players, this time quietly adding the white beads that had been previously removed. Scatter them again in preparation for the final round.
2. Tell the players who were hindered last round that they remain hindered by the plastic debris, and those who were unhindered remain so as well.
3. Call out the beginning and ending of the 30-second period.
4. Players should return to the sidelines and calculate their calories. Explain that the white beads represent plastic pieces that have no nutritional value, but instead the animal wasted energy finding and foraging on the plastic items. For each white bead collected, each player must subtract 10 calories. Enter the number of calories each player collected under Round 3 on the score card.

Discussion – Discuss which players did and did not meet their caloric requirements. Find out if any of the hindered players improved their collection rate in the third round. If any did, explain that this may be due to them growing accustomed to their hindrance. Explain that danimals could also become accustomed to their hindrance, but that they many also weaken and die.

**Assessment:**

Ask your students what kinds of trash represent a danger to animals in the Great Lakes, either through ingestion or entanglement. Where does this trash come from? Have students glue the trash from the entanglement and ingestion activities onto the class collage made the previous day.



*Adapted from "Marine Debris: It Can Be Deadly" developed by The Center for Marine Conservation and the California Coastal Commission in the Save Our Seas curriculum guide*



			Y N		
			Y N		
			Y N		
			Y N		
			Y N		
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			Y N		



## “The Feeding Game: A Simulation of the Perils of Plastics”

### Calorie Chart

*Each colored bead represents an item of food for each animal*

*Each color represents a different amount of calories.*

Color	Number of Calories
Yellow	3
Red	5
Green	10
Orange	20

## “The Feeding Game: A Simulation of the Perils of Plastics”

### Calorie Chart

*Each colored bead represents an item of food for each animal*

*Each color represents a different amount of calories.*

Color	Number of Calories
Yellow	3
Red	5
Green	10
Orange	20



## Wildlife of the Great Lakes



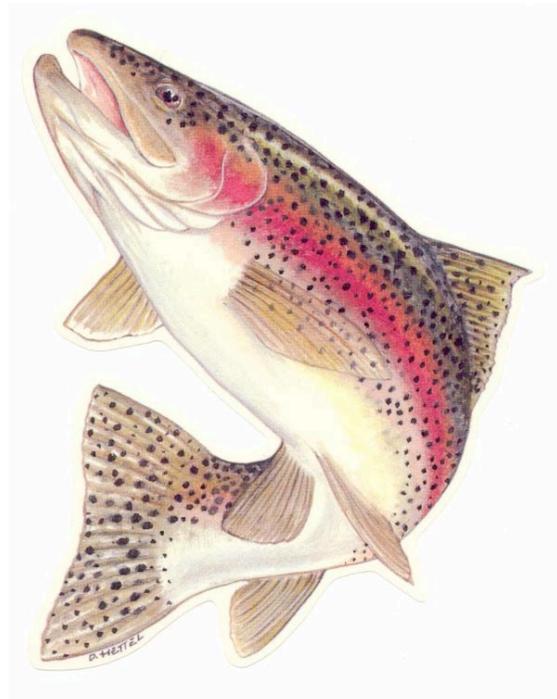
River Otter



Double-Crested Cormorant



Bald Eagle



Trout



## Landfill in a Bottle

### Background:

Consumers can make a significant impact on the environment simply by the choices that they make at the store. Much of what we buy quickly becomes waste and is thrown away. Approximately one-third of this waste comes from packaging according to the Clean Air Council. All of this waste requires armies of dump trucks (which burn fossil fuels) to collect it in towns and cities all over the world and take it “away”. According to a report by Environmental Defense called “Trash in the City, “ Manhattan uses diesel trucks to carry garbage 7.8 million miles every year. That would be the equivalent of circling the Earth 312 times every year. The Clean Air Council estimates that Americans throw away an average of 230 million tons of garbage per year and about 2.5 million plastic bottles every hour. Some of this waste gets recycled, but most of it ends up in landfills or in the ocean. The good news is that you and your students can do something right now to reduce your impact on the environment and protect its inhabitants.

### Procedure:

1. Before beginning the project get students thinking about waste by asking some or all of the questions below
  - a. What do people throw away?
  - b. What do you throw away?
  - c. Can pollution come from the trash that you throw away? (Yes, pollution to the environment can come from many sources.)
  - d. What can pollution affect? (Pollution affects both plants and animals, including humans. It can even affect the way an ecosystem functions. Pollution, such as carbon dioxide emissions, also affects the Earth’s climate.
  - e. How does pollution affect humans and animals? List specific ways such as causing plants and animals to become threatened or endangered or even decreasing biodiversity by causing plants or animals to become extinct from specific areas.
2. To help students gain a better understanding of how household/school waste breaks down in a landfill, have students bring a few pieces of trash from home (such as paper, plastic, steel, aluminum, cardboard, etc) or collect trash from your own school (a cleanup after lunch will yield enough for this experiment). Be sure to include a few food items. Provide students with exact lists of garbage to bring to class so as to avoid any health concerns.
3. Explain to students that they will be creating a miniature landfill using a few pieces of garbage and a 2-liter bottle.
  - a. Cut the top off of a 2-liter bottle (1-liter bottles work as well)
  - b. Cover the sides of the bottle with a light eliminating shield (such as a paper bag or other opaque item.) This will keep any extra light from getting into the “landfill” and only allow it to hit the surface (as the sun naturally would).
  - c. Alternatively layer dirt (from the yard, not from a bag) with the pieces of garbage.
  - d. Mist the top of the dirt with approximately 1/8 cup of water.
  - e. Set the bottle near a window so that it will receive exposure to the sun or if possible set bottles outside.
  - f. Be sure to add water to your landfill daily or as necessary to keep the soil lightly moist.

### Grade: 4-6

**Objectives:** By the end of this activity, participants will:

- Understand how household/school waste breaks down in a landfill
- Recognize the impact of waste on the environment
- Be informed and empowered on ways to reduce, reuse and recycle

**Time Needed to Complete:** Set-up = 30 minutes; entire project will take 1 month. It is up to the teacher how often students will observe their landfills during the course of that month.

### Materials Needed:

- 2 liter soda pop bottle per students
- Paper bags
- Dirt (from a yard, not a bag)
- Newspaper to cover the tables
- Spray bottle with water
- Pieces of trash (i.e. aluminum, lint, paper, orange peel, plastic bag, straw)

4. Ask students, “where do items in the landfill come from?” Answers should include that people generate waste, including themselves.
5. Have students make and record observations about their landfills at least once a week. You may also consider having students hypothesize about which items may break down the fastest or not at all.
6. Over the course of the month, as students are observing their landfills, introduce supplemental lesson plans, such as “Pollution and Waste Audit” (included on the pages that follow) to reinforce the concept of waste reduction.
7. Once students have made a few observations ask them the following questions.
  - a. What simple changes can you make in order to keep items that don’t break down out of landfills or ways to keep harmful items out of landfills? Answers might include: recycling, produce less trash, produce trash that will not stick around as long, use cloth shopping bags, etc
  - b. How can you reduce trash and pollution by making wiser purchases? Have the students brainstorm different ideas and write them down. You might choose to make copies of the list for the students to take home. Below are some examples that you can provide:
    - i. Buy products with less packaging or products that have reusable or recyclable packaging.
    - ii. Buy products that are packaged in materials that are made with recycled products.
    - iii. Purchase organic foods, which are grown without the use of pesticides and synthetic fertilizers which are harmful to the environment.
    - iv. Take a reusable lunch box and containers to work or school instead of a paper lunch bag and wrappers that get thrown away.
    - v. Check out books from the library instead of buying your own.
    - vi. Purchase items in bulk. This usually uses less packaging and is cheaper.
    - vii. Buy or make your own household cleaners that are environmentally friendly.
    - viii. Start a recycling program at home or school. If recycling *everything* is not possible, begin by recycling the waste that you produce the most of and move forward from there.
    - ix. Use cloth shopping bags.
    - x. Do not purchase one-use/disposable items
    - xi. Support local farmers by purchasing locally grown produce
    - xii. Support local companies by purchasing locally made items
  - c. After 1 month, have students take apart their landfill to see how the items have changed. If possible, make this a quarter or semester-long project. Students record their observations over the course of many months and finally take apart their landfills for further observations at the end of the quarter or semester.

#### **Extensions:**

1. After completing this activity follow up with your students by creating a recycling program at your school or home. Remember, even small steps can make a big difference! Simply recycling all the aluminum or plastic your school or home produces can save fossil fuel and keep tons of trash out of our landfills and waterways. Educating your fellow classmates and even adults is a great first step! Below are a few ideas along with the ideas that students generate to get you started.
  - a. Sign a Reduce, Recycle, Reuse Pledge.
  - b. Create graphs showing the class results vs. the average American.
  - c. Survey teachers or students within the school to find out if they reduce, reuse or recycle. Post the results in a hallway at school.
  - d. Create a public service announcement (via a poster or podcast) on why you should reduce, reuse and recycle.
  - e. Encourage your school or area businesses to reduce, reuse and recycle.
  - f. Have each student research a specific habitat or animal that has been affected by waste pollution and share the projects with the class or school.

2. Arrange a field trip with your class to a waste management facility. Before your trip, brainstorm different questions to ask. While you are there, have the students write about their experiences and thoughts in a journal. You may also choose to include photos and drawings.

**National Science Education Standards:**

Science as Inquiry

Nature of Science

Science and Technology in Society

Populations, Resource and Environment

Evidence, Models and Explanation



## Waste Audit Worksheet

How much waste do you produce in 1 week or 1 month? The answers may surprise you. One of the first steps in reducing waste and creating a good recycling program at your house or school is to conduct a waste audit, so you know what your starting point is and can measure your progress against it.

1. Number of people in your school or household
2. How many plastic shopping bags do you acquire in one week?
3. How many plastic bottles of water does your family drink in one week?
4. How many plastic bottles of soda pop does your family drink in one week?
5. How many soda pop cans does your family go through in one week?
6. How many glass bottles does your family use in 1 week?
7. How many metal cans (food cans) does your family use in 1 week?
8. How many cardboard boxes does your family use in 1 week? (Be sure to include boxes of food, etc.)
9. How many bags of trash does your family produce in 1 week?
10. How many magazines does your family receive in 1 month?
11. How many newspapers does your family receive in 1 week?
12. Does your household recycle? If so, what items?
  
13. Does your family have old cell phones lying around? (Many places accept cell phones and recycle or reuse them.)



# Pollution and Waste Audit

## For the Home and/or Classroom

Total number of persons accounted for in data below: \_\_\_\_\_

Material	# of items/week	# of items/month	# of items/year	Comments
Plastic Shopping/Grocery Bags				
Plastic Water Bottles				
Plastic Soda Bottles				
Aluminum Cans				
Glass				
Metal Cans (food, etc)				
Cardboard Boxes				
Magazines				
Newspapers				
# of Bags of Trash				



# Wrap It Up

## Background:

According to the EPA , in 2006, Americans produced 251 million tons of trash. 80 million tons, or 32% of the trash came from packing and containers. Of the total trash, only 32% of the volume was recycled. All of this trash adds up and presents many problems. One of those issues is where to put the trash. Landfill space is running out and landfills present ecological problems to the community surrounding them.

The Model T Ford provides an example of rethinking trash and packaging. The box that the car was shipped in was to later be used as the floorboards inside the car. This activity will look at the amount of packaging used relative to the product it's used for, and will encourage students to consider packaging as part of product purchases.

**Grade:** 4-6

**Objectives:** Students will examine the role of product packaging and resource waste

**Time Needed to Complete:** 50 minutes

### Materials Needed:

- 6-7 different brands of gum, each with unique packaging
- Scale
- calculators

## Procedures:

1. Record the different brands of gum and their prices in the appropriate columns of the handout.
2. Find the total mass of your group's package (gum + packaging). This may be printed on the package; if not, use a balance or scale.
3. Record the printed gum mass. This may not be present; use balance if necessary.
4. Calculate the mass of the packaging:  
 $\text{Total mass} - \text{gum mass} = \text{packaging mass}$
5. Unwrap all of the gum in your package. Measure the mass of gum. Record actual gum mass.
6. Measure the packaging mass. Record actual packaging mass.
7. Calculate and record the packaging percentage of the total mass:  
 $\frac{\text{Actual gum mass}}{\text{Total packaging mass}} \times 100$
8. Calculate and record the cost per gram of gum:  
 $\frac{\text{Price}}{\text{actual gum mass}} \times 100$
9. Graph the percentage of packaging on the bar graph on the handout. Get the information from the other groups and complete your bar graph.

## Possible Interactive Questions:

- What types of materials are used in the packaging of the gum?
- Are any of the materials recyclable? If not, are the materials waste or can they be reused?
- Did higher cost relate to more packaging?
- Why do we need packaging?
- Does the packaging affect which gum you buy?



**Extension:**

Have the students rethink the gum packaging and challenge them to design a new way to package the gum that is less wasteful and more cost effective.

**What Happened/What's Going On:**

The manner in which the products we buy are packaged is very important in regards to garbage. According to the Southwest Health Sciences Center, the packaging of products represents 35% of all solid waste. Looked at from a different angle, one out of every 11 dollars spent by consumers pays for the packaging of a product. When a consumer buys a product like a frozen dinner, they are not only buying the food but also the cardboard box, tray and plastic covering in which the food is packaged. That consumer pays once more for the package when they pay for it to be disposed of in a landfill.

You can reduce the amount you spend on packaging by following these helpful tips provided by the University of Florida's Institute of Food and Agricultural Sciences:

1. When practical, buy in bulk: Products packaged in bulk produce less waste and cost less. For example, examine the difference between a 48 ounce jar of applesauce and 48 ounces worth of applesauce packaged in six smaller plastic containers.
2. Choose reusable or recyclable packages: Familiarize yourself with your local recycling program. Purchase products that come in packages that can be recycled in this program.
3. Avoid excess packaging: You greatly reduce the amount of packaging that is purchased and turned into waste by choosing to buy whole fruits and vegetables. When pre-cut and packaged vegetables are bought, the consumer pays on average 45 percent more.
4. Pay for the product, not the package: Often identical products can be packaged in different ways. For example, instead of traditional toothpaste packaging, some toothpaste is packaged in new pump style packaging. The toothpaste costs the same but overall the complete pump package is more expensive and contains less toothpaste.



*Adapted from "Garbology," from the Center of Science and Industry (COSI), and developed by the Southwest Environmental Health Sciences Center, University of Arizona*

## Wrap It Up!

Record your pack's brand name and packaging in the table below:

Brand Name of Package	Price of Package

Pick one pack of gum and complete the following directions.

Find out the total mass of your group's package (gum + packaging). This may be printed on the package; if not, use a balance or scale.

**Mass of Package =** \_\_\_\_\_

Record the printed gum mass. This may not be present; use balance if necessary.

**Mass of Gum =** \_\_\_\_\_

Calculate the mass of packaging: Total mass – gum mass = packaging mass

\_\_\_\_\_ - \_\_\_\_\_ = \_\_\_\_\_

Unwrap all of the gum in your package. Measure the gum mass.

**Actual Gum Mass =** \_\_\_\_\_

Measure the packaging mass. Record.

**Actual Packaging Mass =** \_\_\_\_\_

Calculate and record the packaging percentage of the total mass:

Actual gum mass x 100

Total packaging mass

**Percentage of Total Mass =** \_\_\_\_\_

Calculate and record the cost per gram of gum:

Price x 100

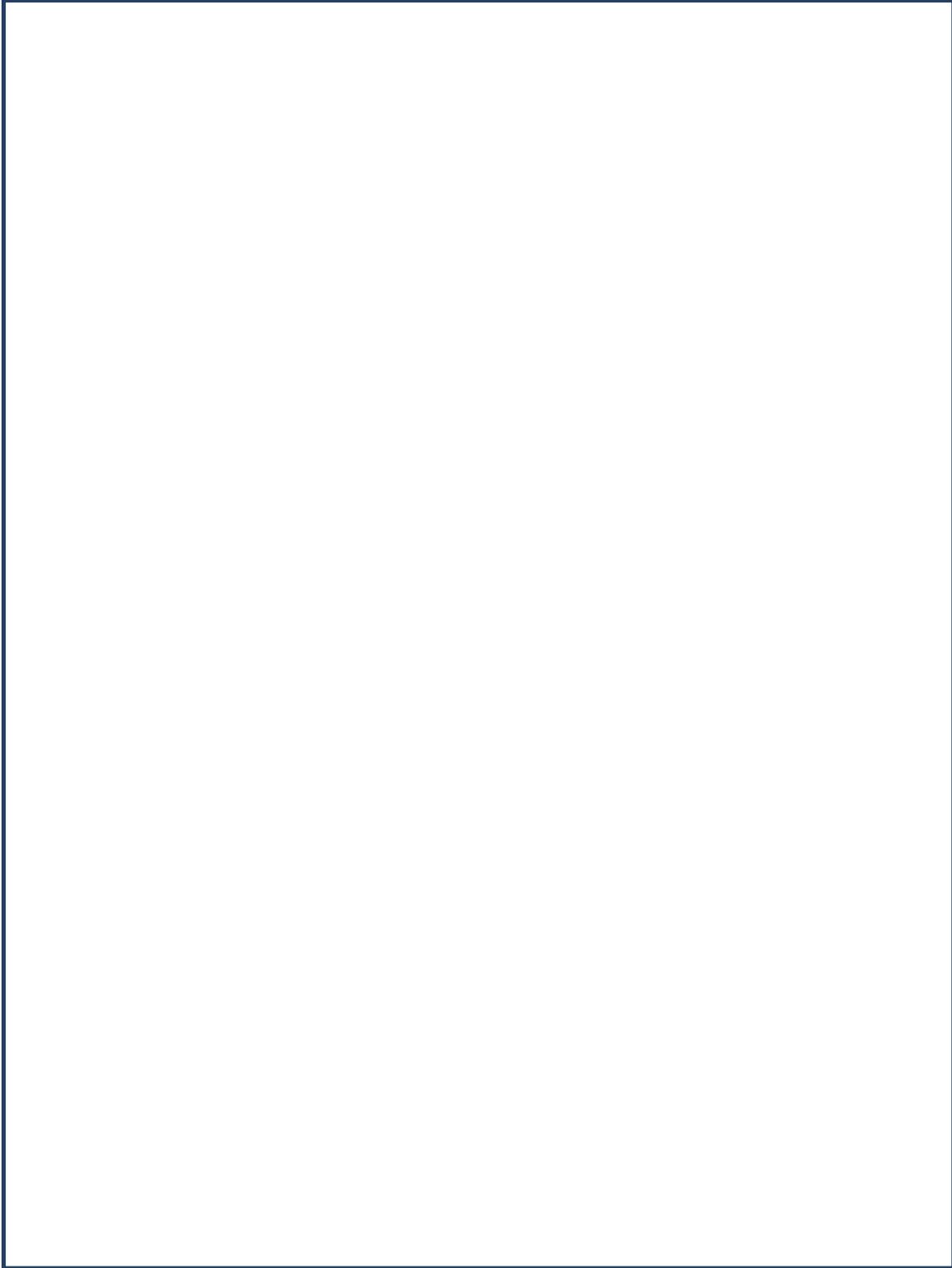
Actual gum mass

**Cost of Gram of Gum =** \_\_\_\_\_



## Wrap It Up!

Graph the percentage of packaging on a bar graph in the space provided below. Get information from other groups and, on the same graph, include their gum's percentage of packaging to show a visual comparison of the gums and their packaging. Don't forget to label your graph's x and y axes.



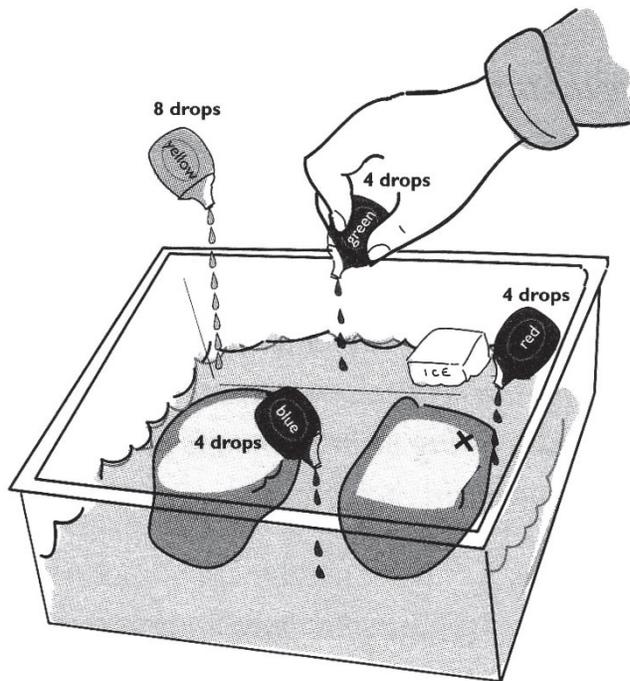
# Spill Spread

## Background:

Water currents carry oil spills, sewage, pesticides and factory waste far beyond where they begin. Explore how currents spread all kinds of pollution in the ocean

## Procedures:

1. Cover your work surface with newspaper. Fill the tray or container with water 1" deep. Place your rocks or cups in the water (not touching each other). They represent the continents in your experimental "ocean".
2. Add the ice to the water first. Then, add the drops of food coloring to the water, as shown in the picture b



**Grade:** 4-6

**Objectives:** By simulating how currents are affected by temperature, students learn how pollution is transported away from our shores.

**Time Needed to Complete:** 45 minutes

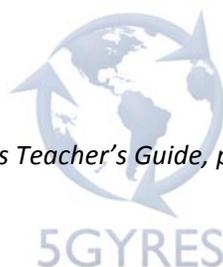
## Materials Needed:

- Clear, shallow tray or salar container (1 ½ " to 2" deep)
- Water
- 2 Rocks (about ¼ the size of a brick) or upside down coffee cups
- Measuring cup for pouring water
- Food coloring (blue, red, yellow, green)
- One large ice cube or several small ones
- Newspaper

The drops are the different sources of "pollution". Ask your students what kind of pollution could be represented here (runoff from streets and storm drains, agricultural waste or runoff, illegal dumping directly into the water body, etc). As the ice melts, changes in the water temperature will create currents that spread this pollution. Be careful not to jiggle or blow on your tray.

3. Which part of your ocean ended up with the least pollution? Which part ended up with the most pollution? Which spread the farthest? How did the continents affect the currents and the spread of pollution?

*Adapted from "Spill Spread" from Ocean Currents Teacher's Guide, published by Lawrence Hall of Science Great Explorations in Math and Science (GEMS)*



# Synthetic Sand

**Background:** Plastic and other materials foreign to the coastal ecosystem are often found on our beaches. Aside from being unsightly, they can wreak havoc for wildlife that live there. Foraging birds can mistake the colorful plastic fragments for food or become tangled in fishing line or nets. Understanding what types of materials and how much are found on our beaches can help develop solutions for curbing the flow of trash, mostly plastic, that ends up on our shores.



## Procedure:

1. Select site. Collect all materials and travel to beach.
2. Select collection sites on the high tide debris deposit line, also known as the “wrack-line”. Make a detailed map of the site with the exact location identified using GPS. This is just in case you come back later to replicate sampling.
3. Take the 4-meter rope grid and stretch the loop to make a perfect square 1m x 1m over the high tide wrack-line. Use pencils or sticks as stakes to hold down the corners.
4. Remove big pieces of natural debris, like seaweed, leaves and wood. Brush them off and throw them away. We don’t need them in this study.
5. Measure the 10-liter mark, or halfway point, on the large plastic bucket. Mark this point with a line around the bucket using a permanent marker.

**Grade:** 7<sup>th</sup> and up

**Objectives:** In this activity students conduct a transect of an area of beach to identify and catalogue the various materials collected there.

**Time Needed to Complete:** 60 minutes

## Materials Needed:

1. One five-gallon bucket
2. 2 metal scoops
3. 1 colander with 1mm sieve
4. 1 loop of rope with a 4-meter circumference
5. Box or bag to hold sample





6. Using the small shovel, scoop an inch of the surface of the grid into the 5-gallon bucket. Scrape the surface **EVENLY!** Do not dig a hole in the sand. We are measuring the quantity of plastic over a square meter of area. This is the total amount of sand that you will collect.

7. Use the colander to sieve the 10 liters of sand in the bucket.
8. Transfer the contents of the colander to the collection bag or box.
9. Fill out the label in APPENDIX A and place it with the sample.
10. Sort the sample. Empty the bag into a pan and sort items into the seven categories listed on the data sheet below.



**Extension:**

Make a graph (pie, bar, graph of your choosing) of your findings. Return to the location another day to conduct a second transect and see how it compares to your initial results. Track the debris on a weekly, monthly, quarterly, or annual basis to see how the quality of your beach changes over time.



APPENDIX A: SAND SAMPLE LABEL

Synthetic Sediment Sample	
Location of collection site GPS	
Date	
Collected by:	



**APPENDIX B : DATA SHEET**

Data Sheet: Sorting by Type of Plastic				
Type of Plastic Debris	Count <5mm	Count >5mm	Weight <5mm	Weight >5mm
<b>Pellets</b> Pre-production plastic pellets, also known as "nurdles."				
<b>Fragment</b> Pieces of hard plastic debris that is unrecognizable.				
<b>Film</b> Flat and flexible plastic debris, such as pieces of bags or wrappers.				
<b>Foam</b> Expanded polystyrene used for insulation or packaging, sometimes called "Styrofoam"				
<b>Filament</b> Examples of filament include: fishing line, rope, synthetic cloth.				
<b>Cigarette butts</b>				
<b>Other</b> Includes: glass, rubber, metal or tar				
<b>TOTAL</b>				



# Identifying Plastics

**Background:** In our everyday life, we encounter many polymeric materials (plastics), many of which are in the form of disposable containers used for many household products. As our natural resources are diminished and our landfills become filled, we are finding that it is better to recycle much of our waste materials than to dispose of them or burn them.

Most of the polymers we encounter in our daily lives are the six polymers listed in Table 1. To make recycling of these polymers easier, the plastics industry has adopted the codes shown. Since compliance in labeling is voluntary, not all plastics are labeled for identification. Identification, simply by appearance, is difficult; however, there are a few types that are readily identifiable. Clear, colorless containers that are used for soft drinks are most often polyethylene terephthalate (PETE). Opaque, translucent (and often white in color) plastics used for containers such as milk cartons are usually high-density polyethylene (HDPE). Bottles used for shampoos or cleaning materials are usually made from polyvinyl chloride (V or PVC). Plastic bags and some plastic wrap are often made from low-density polyethylene (LDPE).

In this experiment, we will examine some common plastics and perform several tests to identify them. A flow chart for the tests is given below:

**Grade:** 7<sup>th</sup> and up

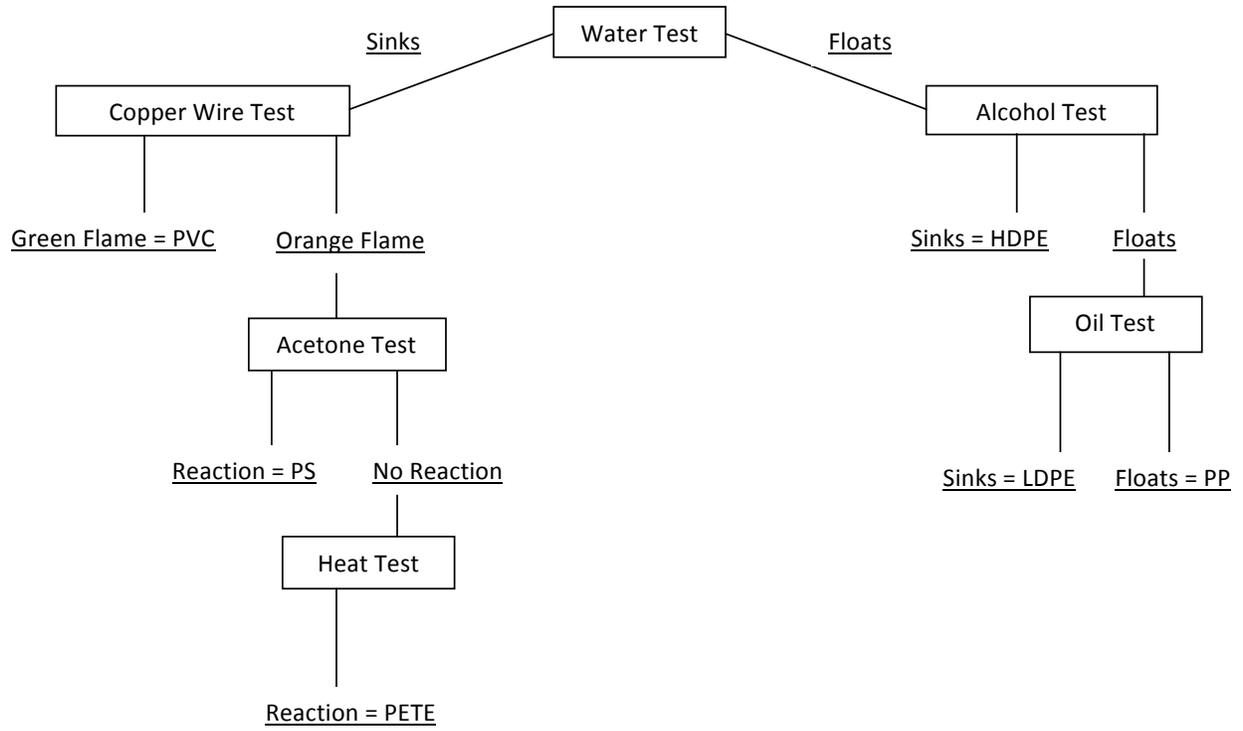
**Objectives:** Students learn that plastics are made of different chemical structures and learn how to identify each type by subjecting it to a variety of tests.

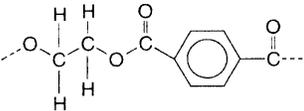
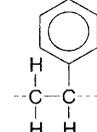
**Time Needed to Complete:** 60 minutes

**Materials Needed:**

1. Samples of plastic pieces labeled 1 through 6
2. 2 Unknown samples of plastics (These are in vials labeled 7 through 12)
3. Isopropyl alcohol solution,  $\text{CH}_3\text{CHOHCH}_3$ , 45.5% by volume. This solution is made by diluting 45.5 mL isopropyl alcohol to 100 mL with water. (Also, by diluting 65 mL 70% isopropyl rubbing alcohol to 100 mL with water.)
4. Mazola corn oil
5. Copper wire
6. Corks to fit 18 mm test tubes
7. Acetone
8. Test tubes, 18 x 150 mm Stirring rod, glass Bunsen burner
9. Beaker, 50 mL Beaker, 250 mL
10. Tongs or forceps
11. Ring stand and ring with wire gauze





Symbol	Chemical Structure	Applications
 <b>PETE</b>	 Polyethylene Terephthalate	Soft drink bottles, mouthwash bottles, peanut butter and salad dressing containers
 <b>HDPE</b>	 High Density Polyethylene	Milk, water and juice containers, grocery bags, toys, liquid detergent bottles
 <b>V</b>	 Polyvinyl Chloride	Clear food packaging, shampoo bottles
 <b>LDPE</b>	 Low Density Polyethylene	Bread bags, frozen food bags, grocery bags
 <b>PP</b>	 Polypropylene	Ketchup bottles, yogurt containers, margarine tubs, and medicine bottles
 <b>PS</b>	 Polystyrene	Videocassette cases, compact disc jackets, coffee cups, tableware (knives, spoons and forks), cafeteria trays, grocery store meat trays, and fast-food sandwich containers.

**Figure 1.** Common polymers, their structures and packaging applications. (Source: **Hands On Plastics: A Scientific Investigation Kit**, American Plastics Council and National Middle Level Science Teachers Association.)



**Safety Precautions**

Isopropyl alcohol is flammable and the vapors are considered to be toxic. Keep containers closed and cover any open containers, such as a beaker, with a watch glass. Avoid flames.

Acetone is flammable and the vapors are considered toxic. Keep containers closed and cover any beakers of acetone with a watch glass. Work in a well ventilated area. Avoid flames.

The copper wire will get hot when heated in a flame. Hold the wire with tongs or forceps to avoid burns.

**Disposal**

Dispose of alcohol waste and acetone waste according to local regulations.

Mazola corn oil can be reused if it is not dirty or contaminated. Dispose of any waste oil according to local regulations.

Waste pieces of plastic can be disposed in the recycling bin.

Copper wire can be reused.

**Procedure:**

1. Obtain a set of vials containing the six kinds of recycled plastic resin pellets (or collect each type of plastic from a recycling bin). Note that each type of resin is a different color. This allows for visual identification in this experiment. Actual resins may be almost any color depending on colorants added during its initial formulation.
2. Obtain samples of two different "unknown" polymers. These will be small pieces of polymer, not pellets.

**Test #1: The Water Test**

1. Place approximately 5 mL of water in a test tube.
2. Start with one of the six plastic resin pellets. Place two of the pellets of the resin in the test tube containing water. Poke each of the pellets with a stirring rod to remove any air bubbles adhering to the surface of the resin pellet and try to make it sink. Note whether the pellets sink or float. If both pellets do not behave in the same manner, test a third pellet of the same type and use the results of two that behaved the same way. Remove the pellets, dry them and save them for later use.
3. Repeat the water test with each of the remaining resin samples and with small pieces of the two unknown samples.
4. Save the samples that sank in the water for the copper wire test. Use the samples that floated for the isopropyl alcohol test.



## Test #2: The Isopropyl Alcohol Test

1. Place 5 mL of isopropyl alcohol solution in a test tube
2. Using one of the resins that floated in the water, add two pellets to the test tube containing the alcohol solution. Poke each pellet with a stirring rod to remove any air bubbles adhering to the surface of the resin pellet and try to make it sink. Note whether the pellets sink or float. If both pellets do not behave in the same manner, test a third pellet of the same type and use the results of two that behaved the same way. Remove the pellets, dry them and save them for later use.
3. Repeat the isopropyl alcohol test with each of the remaining resin samples and unknowns that floated in the water.

## Test #3: The Oil Test

1. Place 5 mL of Mazola corn oil in a test tube
2. Using one of the resins that floated in the isopropyl alcohol solution, add two pellets to the test tube containing the alcohol solution. Poke the pellets with a stirring rod to remove any air bubbles adhering to the surface of the resin pellets and try to make them sink. Note whether the pellets sink or float. If both pellets do not behave in the same manner, test a third pellet of the same type and use the results of two that behaved the same way. Remove the pellets, dry them and save them for later use.
3. Repeat the oil test with each of the remaining resin samples and unknowns that floated in the isopropyl alcohol.

Substance	Density g/mL
Water	1.0
PETE	1.38-1.39
HDPE	0.95-0.97
PVC	1.16-1.35
LDPE	0.92-0.94
PP	0.90-0.91
PS	1.05-1.07

## Test #4: Copper Wire Test

1. This test uses the plastic samples that sank in the water. (They were denser than water.)
2. Obtain a piece of copper wire about 5 cm long. Push one end of the wire into a small cork. (The cork is used as a handle so you are not touching a hot wire.)
3. Place one pellet or plastic sample near your Bunsen burner. This is the sample you will be testing.
4. Hold the free end of the copper wire in the burner flame until it is red hot and the flame no longer has a green color.
5. Remove the wire from the flame and touch the hot wire to the plastic pellet or sample you will be testing. A small amount of the plastic should melt onto the wire. If the wire sticks to the plastic sample, use a pair of tongs to remove it. (You do not want to burn a large piece of plastic.)
6. Place the end of the wire, with the small amount of plastic on it, into the flame. You should see a slight flash of a luminous flame (a yellow-orange color). If the flame turns green in color, then the sample contains chlorine.
7. Repeat this test for each of the remaining plastic samples that sank in the water.



### **Test #5: The Acetone Test**

1. There should be a beaker of acetone located under the hood. If not, place about 10 mL of acetone in a 50 mL beaker. Work under a fume hood to minimize vapors in the room.
2. For this test, use samples of plastics that did not give a green colored flame.
3. Using tongs, place a pellet of the plastic in the acetone for 20 seconds. Remove the pellet and press firmly between your fingers. A positive reaction has occurred if the polymer sample is soft and sticky. Scrape the sample with your fingernail to see if the outer layer has softened.
4. If the sample has a positive reaction, discard it in the trash as the conclusion of this test.
5. Repeat this test for each of the remaining plastic samples that did not give a green colored flame.

### **Test #6: The Heat Test**

1. Place approximately 100 mL of water in a 250-mL beaker and heat to boiling.
2. For this test, use the samples of plastics that did not have a positive acetone test.
3. Using tongs, place a pellet of the plastic in the boiling water for 30 seconds. Remove the pellet and press it between your fingers to see if it has softened. A positive reaction has occurred if the polymer sample is softened.
4. If the sample has a positive reaction, discard it in the trash as the conclusion of this test.
5. Repeat this test for each of the remaining plastic samples that did not have a positive acetone test.

### **Clean Up**

Recycle all plastic resins in their appropriate containers.

Return all liquid solvents for reuse or dispose them according to local regulations. (Your instructor will advise you on this.)



*Adapted from "Identification of Polymers", David Katz and Plastics Analysis Lab, Hands On Plastics: A Scientific Investigation Kit, American Plastics Council and National Middle Level Science Teachers Association.*

# Sources & Solutions

## Background:

Land-based marine pollution can either be from a “point source” or a “nonpoint source.” Point source pollution originates from a specific place such as an oil refinery or a paper mill. Nonpoint source pollution, on the other hand, is contaminated runoff originating from an indefinite or undefined place, often a variety of places (e.g., farms, city streets and parking lots, yards and landscaping, construction sites, and logging operations). The soot, dust, oil, animal wastes, litter, sand, salt, pesticides and other chemicals that constitute nonpoint source pollution often come from everyday activities such as fertilizing lawns, walking pets, changing motor oil, and driving. With each rainfall, pollutants from these activities are washed from lawns and streets into storm drains that often lead directly to nearby bodies of water such as streams, rivers, and oceans.

While rarely visible, nonpoint source pollution is a chronic and ubiquitous form of water contamination. The U.S. Environmental Protection Agency estimates that the primary cause of the pollutants in the ocean is not from point sources, but from various forms of contaminated runoff. The table provided in this guide outlines examples of nonpoint source pollutants, their sources, and their effects. Finding solutions to nonpoint source pollution is difficult, even if the sources can be identified and located. Often solutions involve major changes in land-use practices at the local level and expensive methods to minimize runoff. However, nonpoint source pollution does offer individual citizens an ideal opportunity for combating water pollution. There are actions we can take every day that can help—by changing some of our habits, we can help reduce nonpoint source pollution. The first step is understanding what some of the common types of pollutants are that we let drain into our water bodies every day. The next step is to look for alternatives to use in place of those pollutants. Using these alternatives, we can still have clean houses and luxuriant yards—and clean water!

**Grade:** 7-12

**Objectives:** Part 1 - Students will identify nonpoint source pollution and how it affects both water quality and water organisms. Students will understand how consumer choices can reduce nonpoint source pollution.

Part 2 - Students will be able to utilize a cooperative problem solving process designed to reduce marine debris. Students will implement their solution.

**Time Needed to Complete:** Part 1 - 50 minutes; Part 2 – 60 minutes

## Materials Needed:

- Local map of the community, photocopied for each student
- Map of community’s storm drain system from the local Department of Public Works (optional)
- “Nonpoint Source Pollution” and “Safe Substitutes” handouts
- Overhead transparency of “Brainstorming Tips”



## Procedure:

### Part 1: Identifying the Source

1. Ask students what they know about nonpoint source pollution, and write their answers on the board. Have they heard of the term? Do they know what it means? What are some examples? (*Nonpoint source pollution is contaminated runoff originating from an indefinite or undefined place, often a variety of places, see list in the "Background" section above.*)
2. Next, ask students what types of nonpoint source pollution they think could be originating from their school and their community. Write this on the board.
3. Pass out the "Nonpoint Source Pollutants" and "Safe Substitutes" handout. Go over the list as a group.
4. Pass out a copy of a map of your community. Each student will now study the map and locate possible sources of nonpoint source pollution in your community. Some examples could include:

#### Schools

- Playground, football field (trash, fertilizers, pesticides)
- Sewage system, including restrooms, cafeteria, science classes (trash, excess nutrients, detergents, chemicals, pathogens)
- Parking lot (trash, heavy metals, dripping oil)
- Sidewalks and outdoor hallways (trash)

#### Community

- Farmland (sediments, excess nutrients, fertilizers, pesticides)
- Construction sites (trash, sediments)
- Residential areas (trash, fertilizers, pesticides, detergents from car washing)
- Parking lots (trash, heavy metals, dripping oil)
- Parks (trash, fertilizers, pesticides, animal waste)

5. Brainstorm with students about actions they *or their parents and caregivers* can take to reduce pollutants entering the marine environment. (*Note: Many of these are activities that adults would likely undertake; students would need to advocate these suggestions to their parents. Brainstorm with your students how they can approach adults in a helpful manner.*) Ideas could include:
  - Properly dispose of trash in garbage cans. Storm drains empty into local waterways and can carry litter.
  - Never dump chemicals on the ground or down storm drains because they may end up in the local stream, river, or bay.
  - Walk pets in grassy areas or parks. Pet wastes on pavement can be carried into streams by storm water. Pick up after your pets.
  - Do not pour chemicals down drains or toilets because they may not be removed in sewage treatment and can end up contaminating water bodies. Use non-hazardous alternatives whenever possible (see "Safe Substitutes").
  - Keep cars well maintained and free of leaks. Recycle used motor oil (contact local public works department or call (800) CLEANUP, for how to store and where to take waste oil).
  - Don't dispose of leaves or grass clippings in your storm drain (this clogs the drain, preventing rain water from being able to flow through and can flood your street. Additionally, storm drains usually lead to a body of water, and excess nutrients are a type of pollution. Instead, try composting yard waste.)
  - Landscape your yard to prevent runoff. Use as few pesticides as possible. Try "natural" (non-toxic) approaches to pest control wherever possible and use organic gardening techniques.



6. Students locate their homes or neighborhoods on the maps. Then, draw on maps with a colored pencil or crayon the nonpoint source pollution originating from their homes and community, and track where it may go. Does it empty into a nearby waterway? Does it enter the lake, or ocean?
7. On the other side of the paper, students will list some possible solutions to reducing nonpoint source pollution from their homes and community.

Nonpoint source pollution presents a significant challenge to address on a large scale, as it is pervasive and difficult to control. However there is much we can do to reduce nonpoint source pollution at its source, beginning at home, extending to our schools, and out in our community.

## Part 2: Developing Solutions

1. Hold a class discussion on the problem solving process.
2. Tell students that they are now going to use the problem solving process to address the issue of plastic pollution and other water pollution. Write on the board the different steps and explain them:
  - a. Understand and define the problem(s)
  - b. Brainstorm solutions
  - c. Analyze the solution suggestions
  - d. Evaluate which solutions would be most effective and select the best solution.
3. Divide students into small groups (3-4 students). In the groups, assign roles or have students choose a role: recorder, discussion leader, spokesperson.
4. Display “Brainstorming Tips” on the overhead projector for students to refer to in their groups. Tell students they will now use the problem solving process discussed earlier to create solutions to problems associated with water pollution.
5. Each group presents their problem definition and solution plan to the class. Ask for questions and comments. Ask that students note the ways their proposal could be improved.
6. The class selects the best plan by voting.
7. Elaborate on the best solution—describe it clearly. Would graphs, charts, or time lines help? Help the students design a graphic presentation of the classes’ chosen solution. Then, have students create an action plan with timeline for implementation of their class solution.
8. Help students implement the action plan or send the recommendation to the appropriate city, county, or state agency. Consider the following for implementation: Which groups need to know about the proposal?
9. Which groups will initially oppose it and how can their concerns be satisfied? What persuasive and educational techniques will be needed?
10. Who will perform each task? Depending upon the age of your class, you may need to have suggestions ready for them to choose (e.g., local Department of Public Works, EPA, California Coastal Commission, Harbormaster, etc.). Assist students in defining tasks and draw up a plan of action with names, tasks, and dates.



**Extensions:**

1. Using the maps and information from this activity, create a nonpoint source pollution display for your school and/or community.
2. Find out what types of pollutants your school is generating (detergents, pesticides, fertilizers) and make a list. Discuss with school staff nonpoint source pollution, and suggest alternative products.
3. Conduct a storm drain stenciling activity around your school to alert people about the hazards of nonpoint source pollution. Contact your local public works department to see if they have a stenciling program.
4. Write to local or state representatives to find out what measures are being taken (or considered) to reduce nonpoint source pollution in your community.
5. Invite an administrator from the school to evaluate students' proposals and presentations developed in Part 2.

*Adapted from "Searching Out Non-Point Sources of Pollution", from Waves, Wetlands, and Watershed, a curriculum guide developed by the California Coastal Commission*

## Non Point Source Pollutants

Pollutant Types	Sources	Effects
Plastic Pollution	Runoff from roads, landfills, and parking lots into storm drains; sewer systems, shoreline and boating activities.	Can harm wildlife by entanglement or ingestion
Sediments	Construction sites; agricultural lands; logging areas	Clouds water, decreases plant productivity; suffocates bottom-dwelling organisms
Excess nutrients (e.g. fertilizers, animal wastes, sewage, yard waste)	Livestock; gardens; lawns; sewage treatment systems; runoff from streets	Prompts phytoplankton or algal blooms; causes eutrophication (depleted oxygen) and odor
Acids, salts, heavy metals	Runoff from roads, landfills, and parking lots; salt from roadway snow dumping sites	Toxic to wildlife and can be taken up by organisms and bioaccumulate in their tissues
Organize chemicals e.g. pesticides, oil, detergents)	Forests and farmlands; anti-fouling boat paints; homes (lawns); golf courses; sewage treatment systems; street runoff	Chronic and toxic effects on wildlife and humans, possibly carcinogenic (cancer causing)
Pathogens (e.g. coliform bacteria)	Municipal and boat sewage; animal wastes; leaking septic/sewer systems	Causes typhoid, hepatitis, cholera, dysentery



# Safe Substitutes: Reduce Nonpoint Source Pollution

## At Home

### Air Fresheners

- For sink disposal odors, grind up used lemons.
- For surface odors on utensils and chopping blocks, add a few drops of white vinegar to soapy water.

### Deodorizers

- For carpets, mix 1 part borax with 2 parts cornmeal; spread liberally and vacuum after an hour.
- Sprinkle baking soda in the bottom of cat boxes and garbage cans.

### Dish Detergents

- Use mild, biodegradable, vegetable oil-based soap or detergent.
- For dishwashers, choose a detergent with the lowest phosphate content.

### Disinfectants

- For disinfecting tasks, use ½ cup borax in 1 gallon hot water.

### Drain openers

- Pour boiling water down the drain once a week.
- For clogs, add a handful of baking soda and ½ cup white vinegar to your drain, cover tightly and let sit 15 minutes while carbon dioxide bubbles work on clog. Finish with 2 quarts boiling water, follow with a plunger.

### Floor cleaners

- For plain wood floors, use a damp mop with mild vegetable oil soap and dry immediately.
- For painted or varnished wood floors, combine 1 teaspoon of washing soda with 1 gallon of hot water. Rinse and dry immediately.
- For vinyl floors, combine ¼ cup white vinegar and ¼ cup washing soda with 1 gallon of warm water, and mop.
- For scuff marks on linoleum, scrub with toothpaste.

### Furniture polish

- For finished wood, clean with mild vegetable oil soap.
- For unvarnished wood, polish with almond, walnut, or olive oil; be sure to remove excess oil.
- Revitalize old furniture with linseed oil.

## Glass cleaner

- Combine 1 quart water with ¼ cup white vinegar.

### Laundry detergent

- Avoid products containing phosphates and fabric softeners.

### Bathrooms

- Combine ½ cup borax in 1 gallon of water for cleaning and disinfecting toilets.
- Clean toilets frequently with baking soda.
- Tub and sink cleaners: Use baking soda or a non-chlorinating scouring powder.

## For the Garden

### Garden fertilizers

- Use organic materials such as compost, either from your own compost pile or purchased from the store.

### Garden weed and fungus control

- Use less-toxic soap solutions for weed killers.
- For fungus, use less-toxic sulfur-based fungicides.
- To control powdery mildew on roses, spray both sides of rose leaves (in the morning, weekly) with a mixture of 2 tablespoons mild liquid soap, 2/3 teaspoon baking soda, and 1 gallon water.

### Pest control

- For outdoor ants, place boric acid in problem areas.
- For indoor ants and roaches, caulk entry points. Apply boric acid dust in cracks and insect walkways. Be sure it's inaccessible to children and pets (it's a mild poison to mammals).
- For garden aphids and mites, mix 1 tablespoon of liquid soap and 1 cup of vegetable oil. Add 1 teaspoon of mixture to a cup of water and spray. (Oil may harm vegetable plants in the cabbage family.)
- For caterpillars in the garden, apply products containing *Bacillus thuringiensis* to the leaves when caterpillars are eating.
- For mosquitoes in the yard, burn citronella candles.

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**Source:** *Take Me Shopping: A Consumers Guide to Safer Alternatives for Household Hazardous Products.* Published by the Santa Clara County Hazardous Waste Management Program.



## Brainstorming Tips

1. Don't Criticize Others' Ideas  
They will lose their train of thought and stop generating ideas.
2. More is Better  
Write down as many ideas as you can. At this stage, don't worry about spelling, repetition, etc.
3. Connect Ideas When Possible  
If something someone says sparks a thought, say your idea. Connect parts of your ideas with theirs when possible.
4. Be Free Wheeling and Don't Be Afraid to Express Crazy Ideas  
A crazy idea now may seem plausible and original after more thought and research.

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## The Problem Solving Process

(Format for a class discussion)

Why is it important to understand and define the problem(s) before beginning to explore solutions? The more accurately and specifically a problem is defined, the easier it is to come up with effective solutions.

What are some examples of how different problem definitions might lead to different solutions? One problem definition might focus on the large numbers of cigarette butts found on beaches; another might focus on a lack of trash receptacles in public area. If your students have participated in a shoreline or beach cleanup, remind them about the data they gathered and analyzed during the cleanup, and the problems they identified. Is there anything else you observed at the shoreline that could help define the problems? If your students did not do a shoreline cleanup, discuss the problems identified in Part 1 of this lesson above.

As a group, identify some examples of problem definitions for which the students will explore solutions. Discuss some possible solutions. The solutions could be as simple as initiating a letter writing campaign or as complex as working to get a law passed. For example, students in Massachusetts helped pass a law banning mass balloon releases.



# You Are What You Eat

## Background:

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. Find out the many ways marine life can be affected by plastics in their aquatic home.

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 behavior. Often they get entangled in it, are cut and injured, or think it's food and try to eat it. The number of marine mammals that die each year due to ingestion and entanglement approaches 100,000 in the North Pacific Ocean alone (Wallace, 1985). Worldwide, 82 of 144 bird species examined contained small debris in their stomachs, and in many species the incidence of ingestion exceeds 80% of the individuals (Ryan 1990).

**Grade:** 7-12

**Objectives:** Students will:

- 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.

**Time Needed to Complete:** 60 minutes, including video

**Materials Needed:**

1. Video—*Synthetic Sea: Plastics in the Ocean*. Borrow from California Coastal Commission education web site: [www.coastforyou.org](http://www.coastforyou.org)
2. "You Are What You Eat" worksheet
3. "Marine Animal Feeding Habits and Plastic Risk" chart
4. "Marine Animal Cards"
5. "Plastics and Their Uses" handout

## Plastics and Marine Life

The potential for ingestion of plastic articles 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.

Plastics don't go away, they just go somewhere else where we can't see them. The effects 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. 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 the bottom. All we can 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. Marine animals know by first hand experience the devastating effects of plastics pollution in the ocean, but they aren't talking. As cities grow and more plastics are produced and enter the marine environment, marine species will continue to be affected unless we make wise choices regarding plastic use and disposal.

## Procedure:

1. Watch the video *Synthetic Sea: Plastics in the Ocean* with your class. Conduct a whole class discussion on what students think about plastics in the ocean. Does plastic just go away? What types of animals are most affected?
2. Next, conduct a whole class discussion on the many ways we use plastics in our daily lives.
3. Hand out “Plastics and Their Uses” and discuss the different types of plastics. Note that most cities only accept SPI 1 and 2 for recycling; though 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. 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 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.
6. Either divide the class into small groups (3-4 students) or distribute materials to individuals. Distribute copies of the “You Are What You Eat” worksheet, “Marine Animal Feeding Habits and Plastic Risk” chart, and the “Marine Animal Cards” to groups or individuals.
7. Have students complete the worksheet activity. Keep in mind that there are many different possible “right” answers. What is important is that students have a rationale for their choices.
8. 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 (i.e., one-dimensional, two-dimensional, small particles, etc.) and present to the class their results and rationale of what species would be most affected.
9. Allow time to propose different answers, discuss them, and wrestle with different conclusions.
10. Conduct a whole class discussion on how to reduce the amount of plastics in the marine environment.

## Extensions and applications

1. Have students bring from home different types of plastic trash, or use the trash from their lunches. Conduct buoyancy experiments to see which pieces float and 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).
2. Get a list from your local refuse agency that indicates what plastics they accept for recycling, and sort your plastic trash from #1 above 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?

*Adapted from “You Are What You Eat- Plastics and Marine Life,” from the Waves, Wetlands and Watersheds curriculum guide, California Coastal Commission*

# You Are What You Eat – Handout #1

## 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 of water; consists of mud, sand, or rock.



### Where Marine Life Eats

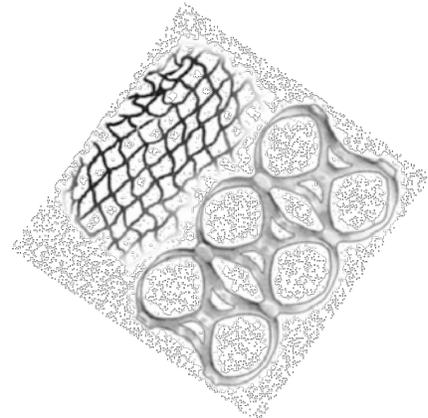
Different forms of marine life gather their food in different zones. For example, some birds are surface feeders. They skim along just above the ocean's surface, and scoop up small bits of floating fish. Many fish are pelagic feeders. They swim about, eating smaller animals, plankton, and other food 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.



## You Are What You Eat – Handout #2

### Marine Animals Feeding Habits and Plastic Risks

	One-dimensional Objects	Two-dimensional Objects	Reticulated Objects	Hollow Objects	Small Particles	Angular Objects
						
<b>Surface Feeders</b>						
<b>Pelagic Feeders</b>						
<b>Benthic Feeders</b>						



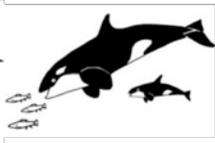
## You Are What You Eat – Handout #3

### You Are What You Eat Marine Animal Cards

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



**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.



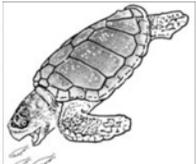
**3. Gull:** eats fish, inter-tidal organisms, beach debris. Feeds on shore, top of water, grabs food with beak.



**4. Sperm whale:** eats squid and fish below surface. Grabs food with long, narrow mouth.



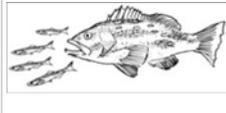
**5. Common dolphin:** feeds below surface in open water. Grabs small squid, other small fish with teeth.



**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 dives shallowly into the water.



**8. Sea bass:** feeds below surface in open water, sucks herring, krill, and anchovies into its large mouth.



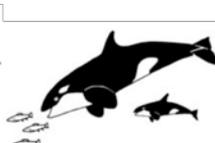
**9. Forster's tern:** feeds on various small fish floats along or dive shallowly into water.



**10. Sea otter:** feeds on benthic urchins and shellfish, bringing them to the surface to eat.



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



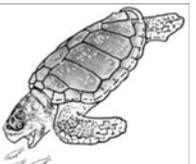
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**9. Forster's tern:** feeds on various small fish floats along or dive shallowly into the water.



**10. Sea otter:** feeds on benthic urchins and shellfish, bringing them to the surface to eat.

## You Are What You Eat – Handout #4

For use with Activity 8.2: You Are What You Eat: Plastics and Marine Life

Plastics and Their Uses			
Name	SPI Code	Description	Uses
PET (Polyethylene terephthalate)	1	High strength; transparent; barrier to gas and moisture, resistant to heat; <b>sinks in water.</b>	Plastic soft drink and water bottles, beer bottles, mouthwash bottles, peanut butter and salad dressing containers, ovenable pre-prepared food trays.
HDPE (High density polyethylene)	2	Tough; chemical and moisture resistant; permeability to gas; translucent or opaque matte finish; <b>floats in water.</b>	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; <b>sinks in water.</b>	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; <b>floats in water.</b>	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; <b>floats in water.</b>	Ketchup bottles, yogurt containers and margarine tubs, medicine bottles
PS (Polystyrene)	6	Stiff; transparent or opaque; smooth surface; <b>sinks in water.</b>	Compact disc jackets, aspirin bottles.
EPS (Expanded polystyrene)	6	Lightweight; heat resistant; insulating; opaque; foamed; <b>floats in water.</b>	Food service applications, grocery store meat trays, egg cartons, cups, plates.

# Plastic Ingestion by Laysan Albatross

**Grade:** 7<sup>th</sup> and up

**Objectives:** In this activity students will dissect a regurgitated bolus from a Laysan albatross in order to determine what they eat and perhaps why. Note: if not able to obtain a dried bolus, this activity can still be completed using the images of items inside four Albatross boluses provided at the end of this activity.

**Time Needed to Complete:** 1 hour 30 minutes

**Materials Needed:**

1. Dried bolus (or images of bolus contents)
2. Dissecting tray and forceps
3. Data sheet
4. Gram scale
5. 3 large Petri dishes
6. 10 small Petri dishes

**Preparation:** Before you begin this activity read "TRASHED" by Captain Charles Moore so that you better understand the problem of pelagic plastics in the marine environment.

**Background:** Seabirds that feed on the surface of the ocean (dippers and scavengers), such as Black footed Albatross and Laysan

Albatross often mistake plastic pieces as food and also feed plastics to their chicks. Birds that feed by diving for their food also eat plastic ; however, surface feeders eat more plastic than divers. Albatross chicks usually regurgitate a bolus right before they leave the nest and go to sea (fledge).

Seabirds are ecological indicators in marine ecosystems and diet studies can highlight shifts in prey types and changes in abundance and distribution of prey. Seabirds can also be used to quantify changes in threats caused by increased human use of coastal and open ocean ecosystems (e.g. plastic pollution).

The Black-footed Albatross eat flying fish eggs, squid, crustaceans, fish, and pelagic barnacles and take their food by scavenging and dipping at the surface. Laysan Albatross also eat squid and both species feed their chicks by regurgitating squid, flying fish eggs, and fish larva into the chick's mouth. The chitinous beaks of squid resist digestion; undigested beaks, along with other indigestible items fed to chicks (e.g. plastic and fishing line) are retained in their stomach which chick regurgitate as a compacted mass, the bolus. Albatross chicks regurgitate a bolus when they reach a certain age or size, usually just before they fledge (leave the nest site to venture out to sea).

Unfortunately, if the chicks consume too many plastic items before they are able to regurgitate them; they become more vulnerable to starvation. Note : cause of death is generally related to physiological stress due to blockage and satiation). By studying the contents of boluses, much information can be learned about seabird diets, however, we can also learn important information about human impacts on the pelagic, open ocean marine system, far from land.



Left:: Laysan Albatross adult feeding it's chick on Kure Atoll, Northwest Hawaiian Islands.  
Right: Stomach contents of an albatross chick found dead on Kure Atoll. Weight of stomach was 370 grams, of which 270 grams were plastic (including two cigarette lighters visible in photo).

*Photo courtesy of Irene Kinan.*

**Procedure:**

1. Collect all supplies and empty bag with bolus into the dissecting tray.
2. Using forceps, sort into three large separate dishes.

Dish One: Plastic

Dish Two: Squid Beaks

Dish Three: Pumice (rocks that float).

All contaminating debris (grass, sand, wood, heavy pebbles) will go back in the bag.

*These samples were collected on the grass or beach on Midway Atoll, therefore some non-bolus material may have been collected. Although some albatross may swallow pebbles while they walk on land, we cannot distinguish what they swallowed from what we mistakenly collected with the sample, therefore we will omit heavy pebbles. Albatross will sometimes consume pumice from the ocean surface. We want to document this, so if you're not sure if it's pumice, drop it in water. If it floats, then we can assume that the albatross consumed this while foraging for food on the ocean surface.*

3. Weigh each of the three dishes and write data on the Worksheet #1 (line 1). By adding these three weights together, you will be able to determine the total weight of the bolus.
4. Sort the plastic debris into five types and count them. Write data on Worksheet #1 (line 2). The five types of plastic debris are: line, fragments, film foam, pellets.
5. Sort the plastic debris into nine color categories and count them. Write data on Worksheet #1 (line 3). On Worksheet #2, create a bar graph representing the number of different colored plastic pieces found inside the Albatross bolus.
6. Count squid beaks and divide by two. This is the total number of whole squid in the bolus. Record your findings on Worksheet #1.
7. Using data from another group, calculate the Percent Similarity Index (PSI) on Worksheet #3 (see the example PSI on Appendix A).
8. Answer all questions.





## Worksheet #2

Quantity of Colored Debris in Albatross Bolus					
100					
75					
50					
25					
20					
15					
10					
5					
0					
	Blue/green	Black/Gray	White/Yellow	Red/Orange	Brown/Tan

## Worksheet #3

### Percent Similarity Index (PSI)

How similar is one bolus to another?

**Step 1.** Calculate % numerical abundance (NA) for each item in a pair of boluses.

$$\%NA = \text{count} / (\text{total} \times 100)$$

**Step 2.** Calculate PSI by choosing smallest value (%) for each item.

**Step 3.** Add totals at bottom of each column.

	BOLUS #1		BOLUS #2		
	How many of each?	%NA	How many of each?	%NA	PSI
Squid Beaks					
Line					
Film					
Fragment					
Foam					
Pellet					
Pumice					
Total	Total number of objects _____		Total number of objects _____		Total PSI _____

### Questions to Answer

1. How similar/dissimilar were the boluses? Explain why.
  
2. Why would a researcher want to know how similar boluses are to each other?

Remember, a PSI value of 100 indicates 100% similar boluses, which is unlikely. A PSI value greater than 80 can be considered to be similar.

## APPENDIX A:

### Example of how to calculate Percentage Similarity Index

Percent Similarity Index (PSI)					
How similar is one bolus to another?					
<b>Step 1.</b> Calculate % numerical abundance (NA) for each item in a pair of boluses.					
%NA = count / (total x 100)					
<b>Step 2.</b> Calculate PSI by choosing smallest value (%) for each item.					
<b>Step 3.</b> Add totals at bottom of each column.					
	BOLUS #1		BOLUS #2		
	How many of each?	%NA	How many of each?	%NA	PSI
Squid Beaks	47	37.00	63	43.44	37
Line	4	3.15	3	2.06	2
Film	4	3.15	6	4.13	3.1
Fragment	62	48.81	55	37.93	37.9
Foam	3	2.36	4	2.75	2.3
Pellet	5	3.93	8	5.51	3.9
Pumice	2	1.57	5	3.44	1.5
Total	Total number of objects <b>127</b>		Total number of objects <b>145</b>		Total PSI <b>88</b>
<b>Questions to Answer</b>					
<p>1. How similar/dissimilar were the boluses? Explain why. Similarity or dissimilarity is normal. Not all birds eat alike. Some birds may have different preferences, body sizes, and may have regurgitated boluses recently. We also do not know how variable food availability is across the Pacific.</p> <p>2. Why would a researcher want to know how similar boluses are to each other? It is poor science to make generalizations about an entire species by studying only one specimen. A larger sample size gives the researcher a better chance to observe patterns and make conclusions that are applicable to the entire species.</p>					

**APPENDIX B:**  
**Laysan Albatross bolus #1**



**APPENDIX C:  
Laysan Albatross bolus #2**





**APPENDIX E:**  
**Laysan Albatross bolus #4**



## Resources:

Algalita Marine Research Foundation [www.algalita.org](http://www.algalita.org)

*AMRF is dedicated to the preservation of the marine environment. With the help of its chartered research vessel, The Oceanographic Research Vessel (ORV) Alquita, AMRF is actively engaged in innovative research, education and restoration of the marine environment.*

Oikonos [www.oikonos.org](http://www.oikonos.org)

*Oikonos increases ecosystem knowledge through science, art, technology, education, and applied conservation.*

## Activity Adapted From:

“Fishing for a Living,” curriculum developed by Carol Keiper for Cordell Bank National Marine Sanctuary ([www.cordellbank.noaa.gov](http://www.cordellbank.noaa.gov)) and “NWHI Albatross Bolus Dissection,” curriculum developed by the University of Hawai’i Hilo.



# Packaging Your Products

## Background:

In previous activities, students identified and analyzed different types of trash. They've learned about solid waste issues and some of the hazards they pose, for example in the form of plastic pollution. Now students can begin to tackle the plastic pollution as well as other solid waste problems by developing new or alternative types of packaging and by making consumer choices.

Manufacturers consider a number of factors when designing a package for their products. They prefer a package that most economically meets a number of requirements such as preservation of product quality, compliance with governmental regulations (Food and Drug Administration laws require that packaging for many products be designed to prevent spoiling and harmful tampering), appeal to the consumer, and promotion of their product.

Manufacturers know that consumers can be persuaded to buy a product if they are attracted to its package. Consumers look at the package size, shape, written messages, convenience of use, and color combinations to identify the product and select the one they want. In stores, packaging serves to advertise products and identify contents, and may be required for ease of transport and product protection. Unfortunately, most packaging is disposable.

Discarded packaging is the single largest component of household waste. It makes up approximately one-third of the nation's trash, using up a major portion of our limited landfill space. The production of packaging alone uses tremendous amounts of valuable natural resources.

As consumers, we play an important role in determining the types of materials used in packaging. If we buy more of a product in a certain type of box, then the box stays. If we stop buying a product, the first thing to change is the package. We can influence types of materials used in packaging by buying products that are packaged properly but not excessively. It means considering the package when selecting products and avoiding those with excessive and disposable packaging. If we shop environmentally, manufacturers will need to respond by modifying their product's package to reflect these new concerns.

We can also voice our concerns about over-packaging. The fast food industry is an example of how consumers have affected business decisions. Consumers complained about the fast food industry's use of disposable and wasteful packaging

**Grade:** 7-8

**Objectives: Students will be able to**

1. Define and clarify a problem by understanding that packaging contributes vast amounts of trash and is often wasteful of natural resources.
2. Consider how packaging can either be avoided or redesigned to alleviate these concerns
3. Judge information related to the solid waste problem and distinguish between fact and opinion
4. Attempt to solve a problem and draw conclusions

**Time Needed to Complete:** Part 1 – 15 minutes;  
Part 2 – 60 minutes

**Materials Needed:**

- A collection of packaged products such as pump toothpaste container, lipstick, toy (unopened), laundry soap, disposable pens, and cereal box
- Trash collected from student lunches or around the school to display what kind of trash ends up outside, as litter (or, if your group has done a beach or shoreline cleanup recently, trash from the cleanup to show what ends up on our shores)
- Materials for design and construction of improved prototype packages (non-toxic markers, cardboard, newspaper, crayons, construction paper, white glue or paste, tape and/or staplers, and paperboard, like old cereal boxes)
- One copy per group of the "packaging" handout

and the industry reacted. McDonald's has stopped using foamed plastic hamburger containers, and now uses unbleached paper bags. Burger King paper bags contain post-consumer recycled paper. In turn, other fast food restaurants have also changed their packaging. We, as consumers, can help influence and change the type of materials used for packaging products.

**Procedure:**

**PART 1: Packaging Demonstration and Discussion**

1. Describe various examples of packaging.
2. Ask the class for other examples of packaging. List the examples on the board. Discuss the list. Could less packaging be used?
3. Discuss alternative packaging methods for these items. Could the product be packaged in recyclable or reusable materials? Could the packaging be made from a renewable resource in place of a non-renewable resource?
4. Broaden the discussion to other products, such as newspaper or foamed plastic stuffed in a shipping box; milk bottles, paper milk cartons, and plastic milk jugs; candy boxes, candy wrappers, and plastic bags of candy; butcher paper or foamed plastic with plastic wrap for meats; toys in individual plastic hanger display cases and toys sold from a large container; fast food and canned food; foamed plastic and paper egg cartons, etc. identify the most wasteful and the least.
5. Packaging makes up the largest single component of household solid waste. What will happen to packaging that is not reusable or recyclable? Can your students think of any products that do not require any packaging at all?
6. Ask your students if they can think of any packaging that their families already reuse (shoe boxes, some plastic bags). How can they reuse or recycle other types of packaging after using the product? Can they think of ways to acquire less packaging when shopping?

**PART 2: Packaging Study, Design, and Presentation**

1. Divide students into groups and have them select an item from the trash display. Give each group a copy of the "Packaging" handout. Discuss the functions, benefits, and drawbacks of packaging including information on purposes, use of natural resources, recyclability, shelf life, biodegradability, disposal, and production of pollutants. Use products displayed in each category to illustrate your discussion. Ask someone from each group to identify one benefit and one drawback of the packaging for the products assigned to their group.
2. Supply each group with scratch paper – one to write on and several to sketch on.
3. Ask each group to describe if it can be recycled and/or reused. For instance, an oatmeal box can be reused as a household container and then recycled to make paperboard. A glass bottle can be reused as a vase, then recycled to make new glass. Plastic-coated paperboard packages could be reused, but not recycled (because the paper is lined with plastic and the two materials are difficult to separate).
4. Have students answer the following questions:
  - a. Why do they think the producer packaged the product this way?
  - b. Is the product breakable?
  - c. Will the product spoil?
  - d. Do consumers need to see the inside of the package in order to decide to buy the product?
  - e. Is the packaging necessary only during shipping (fruits and vegetables) or just until the product is purchased (plastic wrap on DVD) or must it last until the product is used up (milk carton)?
  - f. Is the packaging needed to protect the public from harm (child-proof bottle)?
  - g. Is it light-weight for low cost shipping?
  - h. Is the package designed for consumer convenience (individual instant soups)?
  - i. Is the package bulky, making it more noticeable?

- j. Is the packaging material costly or inexpensive?
  - k. What are the most important purposes of the packaging (to protect the product from breaking, to keep the product sanitary)?
5. Have students design a package for their chosen product which is less wasteful of natural resources than the original package, with justification for how the new packaging is less wasteful (i.e. is it made of a different, more recyclable material? Is it the same material, but less of it?) Have them develop additional design specifications for the packaging such as whether the packaging will be reusable or recycled. Have them describe what their package will be made of and what will be written on their outside. The package design should include information explaining how the consumer can reuse and/or recycled the package. And, it must serve all the important purposes of packaging for their chosen product. Allow time for students to create these new packages. Encourage creativity. Students can produce a three-dimensional model, a drawing, or a package label to illustrate their idea for improved packaging.

**Assessment:**

Ask students to present their prototype packaging to the class. Have them explain the reasoning behind their design.

**At-Home Learning:**

Have each student write a letter to the manufacturer of a poorly packaged product explaining that your class does not support the practice of over-packaging and make suggestions for better packaging. Write a second letter to the manufacturer of one of the products identified as having a better package and congratulate them on the packaging, explaining why your class preferred their package over the competitor. Mail the letters.



**Extensions:**

1. Conduct an informal survey of plastic packaging versus other packaging material commonly used for commercial products. Visit one or more stores and look at the products on the shelves. Is plastic used widely? Which types of plastic are the most common? Are the amounts and types of packaging appropriate for the products? Evaluate a shelf of products for the appropriateness of the packaging used.
2. Make a display of alternative packaging. Have students bring examples of poorly packaged products and similar products in more appropriate packages (for example, a tiny bottle of shampoo and a large bottle of shampoo). Have the students write a short explanation of the benefits and drawbacks of the packaging on 3x5 cards to display next to each example.

*Adapted from "Packaging Your Product" from Save Our Seas, a curriculum guide by the Center for Marine Conservation and the California Coastal Commission (1993)*

# Packaging

## Benefits of Packaging

- Preservation of contents
- Protects contents from damage
- Sanitation
- Safety
- Identification of contents
- Prevention of theft
- Instructions for product use
- Compliance with regulatory standards
- Convenience

## Drawbacks of Packaging

- Disposable packaging is rapidly filling our landfills (we have fewer places to put all this garbage!)
- Production of packaging consumes energy
- Production of packaging often produces toxic wastes
- Disposable packaging consumes and wastes our natural resources
- Packaging can mislead consumers as to the quantity contained inside of a product
- Packaging increases the cost of the product to the consumer
- Some types of packaging if disposed of improperly endanger wildlife.

## Less Waste vs More Wasteful

No packaging

Excessive packaging

Large quantity of product per package

Small quantity of product per packaging

Recyclable material (plastic, glass  
metals, paper)

New materials from virgin sources

Renewable resource

Non-renewable resource



# Plastic Pollution & the Great Lakes

## Curriculum and Activity Guide

**Developed by The 5 Gyres Institute**

For information about this curriculum please contact the 5 Gyres Institute at [info@5gyres.com](mailto:info@5gyres.com) or visit [www.5gyres.org](http://www.5gyres.org).



This curriculum was made possible by a grant from the Burning River Foundation ([www.burningriverfoundation.org](http://www.burningriverfoundation.org)).

