EDUCATOR'S GUIDE

A Collection of Lessons, Activities and Supporting Materials

trash trunk

A KIT FOR LEARNING ABOUT MARINE DEBRIS

TRASH TRUNK

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CONTENTS

ABOUT THE CENTER FOR GREAT LAKES LITERACY (CGLL)

CGLL is the umbrella group of education and outreach professionals who work for the seven Great Lakes Sea Grant programs.

The purpose of CGLL is to develop a community of Great Lakes-literate educators, students, scientists, environmental professionals and citizen volunteers dedicated to improved Great Lakes stewardship.

The CGLL program originated as the Center for Ocean Sciences Education Excellence (COSEE) Great Lakes, which was funded for five years by the National Science Foundation and NOAA Sea Grant. This program has connected thousands of educators with hundreds of researchers across the basin. CGLL continues to broaden its efforts to sustain and expand its community of practice by engaging Great Lakes educators, scientists, students and citizen science groups. Our end goal is for them to join us in stewardship of our greatest freshwater resource. As such, CGLL is well positioned to help disseminate materials, knowledge and resources across their geographic range, which includes Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin. Visit cgll.org for more information.

ABOUT SEA GRANT

Sea Grant is a federal/university partnership program that brings science together with communities for solutions that work.

The National Sea Grant College program was established by the U.S. Congress in 1966 and works to create and maintain a healthy coastal environment and economy. The Sea Grant network consists of a federal/university partnership between the National Oceanic and Atmospheric Administration (NOAA) and 34 university-based programs in every coastal and Great Lakes state, Puerto Rico and Guam. The network draws on the expertise of more than 3,000 scientists, engineers, public outreach experts, educators and students to help citizens better understand, conserve and utilize America's coastal resources. Visit seagrant.noaa.gov for more information.

INTRODUCTION

Across the Great Lakes basin, many educators are interested in the topic of marine debris but lack the resources needed to explore this topic with their students.

Welcome to the Trash Trunk: A Kit for Learning About Marine Debris! In addition to this Educator's Guide with lessons and activities, the kit contains display cards, equipment and materials needed to perform the activities (see list of materials on page 7). Note that not all equipment needed to perform each activity is included. The activity descriptions identify both included supplies and additional needed materials. We hope the Trash Trunk provides educators with the items that are more difficult to obtain.

The fourteen activities are presented in three sequential sections addressing the origins of marine debris, its impacts, and what can be done. Browse activity summaries in this guide (pages 9 to 19) to determine which are best for your group and start learning about marine debris. Summaries include time estimates, recommended age ranges, activity descriptions, extensions and supplemental resources. Full activity descriptions, as they were printed by the original source, begin on page 29.

The display cards included within the Trash Trunk are recommended for specific activities, but you can use them to introduce a concept, support additional activities, or simply display them in your educational setting. They are durable and waterproof so feel free to use them outdoors. An online PDF version of the display cards is available at cgll.org/documents/trash-trunk-display-cards.pdf and thus can be easily used as a student reference handout.

Trash is found in all aquatic environments, ponds, lakes, rivers, streams and oceans. The National Oceanographic and Atmospheric Administration (NOAA) specifically includes the Great Lakes watershed in its definition of marine debris. "Marine debris is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes" (Public Law 109–449 Marine Debris Research, Prevention and Reduction Act, 2006). This Educator's Guide therefore uses the term "marine debris." Note that other educational resources may use the term "aquatic debris." If the original source of an activity used the term "aquatic debris," that term has been retained.

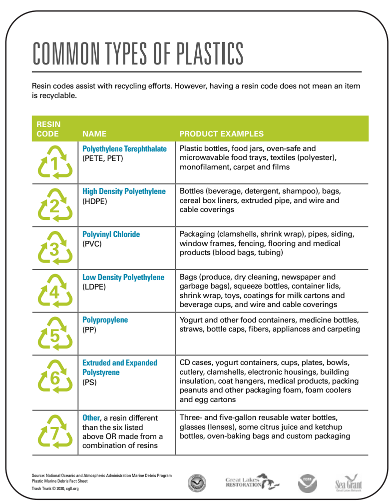
ABOUT THE LESSONS, ACTIVITIES AND SUMMARIES

The lessons and activities included in this kit will introduce learners to concepts associated with marine debris. Activities are divided into three sections by topic, and each section includes curated lessons and activities for a variety of age groups and teaching situations. Browse the following descriptions to determine which activities are best for your group, and then see the activity pages beginning on page 29 for the full directions.

Activity descriptions include the following:

- Title
- Time estimate
- Recommended grade alignments/ages
- A brief description
- Supplies provided
- Supplies needed
- Activity source
- Extensions/supporting resources

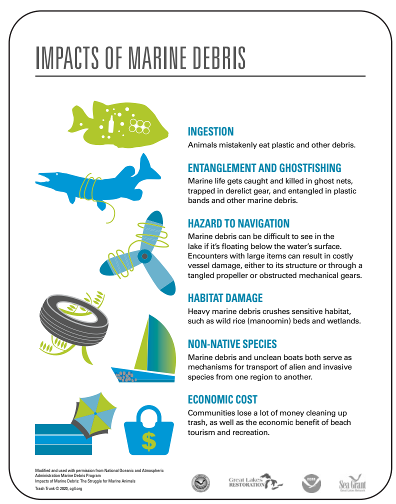
Supporting resources may include links to additional activities, videos, posters, presentations or fact sheets. The supporting resources are not printed within the Trash Trunk Educator's Guide.


COMMON TYPES OF PLASTICS

Resin codes assist with recycling efforts. However, having a resin code does not mean an item is recyclable.

RESIN CODE	NAME	PRODUCT EXAMPLES
1	Polyethylene Terephthalate (PETE, PET)	Plastic bottles, food jars, oven-safe and microwavable food trays, textiles (polyester), monofilament, carpet and films
2	High Density Polyethylene (HDPE)	Bottles (beverage, detergent, shampoo), bags, cereal box liners, extruded pipe, and wire and cable coverings
3	Polyvinyl Chloride (PVC)	Packaging (clamshells, shrink wrap), pipes, siding, window frames, fencing, flooring and medical products (blood bags, tubing)
4	Low Density Polyethylene (LDPE)	Bags (produce, dry cleaning, newspaper and garbage bags), squeeze bottles, container lids, shrink wrap, toys, coatings for milk cartons and beverage cups, and wire and cable coverings
5	Polypropylene (PP)	Yogurt and other food containers, medicine bottles, straws, bottle caps, fibers, appliances and carpeting
6	Extruded and Expanded Polystyrene (PS)	CD cases, yogurt containers, cups, plates, bowls, cutlery, clamshells, electronic housings, building insulation, coat hangers, medical products, packing peanuts and other packaging foam, foam coolers and egg cartons
7	Other, a resin different than the six listed above OR made from a combination of resins	Three- and five-gallon reusable water bottles, glasses (lenses), some citrus juice and ketchup bottles, oven-baking bags and custom packaging

Source: National Oceanic and Atmospheric Administration Marine Debris Program Plastic Marine Debris Fact Sheet
Trash Trunk © 2020, cgll.org



To encourage a sense of student empowerment, we recommend incorporating civic engagement opportunities from lessons in the ***What Can We Do About Marine Debris?*** *section beginning on page 17.*

TRASH TRUNK LIST OF MATERIALS

- ☐ **EDUCATOR'S GUIDE BINDER**
- ☐ **DISPLAY CARDS**
  - ☐ Top 10 Great Lakes Basin Litter Items
  - ☐ Top 10 Items Collected Internationally
  - ☐ Litter Composition by Water Body
  - ☐ Litter Composition by State
  - ☐ Common Types of Plastic
  - ☐ Microplastic Identification
  - ☐ Impacts of Marine Debris
  - ☐ 10 Things You Can Do for Trash-Free Lakes
  - ☐ The 8 Rs
- ☐ **ACTIVITY CARDS**
  - ☐ Talking Trash grey playing card Debris Deck, 24 cards
  - ☐ Talking Trash white playing card Debris Deck, 40 cards
  - ☐ What Is the Impact of Beach Litter? More/Less Cards, 40 cards
  - ☐ What Is the Impact of Beach Litter? Science and Social Concern Cards, 39 cards
  - ☐ What Is the Impact of Beach Litter? Beach Litter Starter Card, 1 card

Your Trash Trunk sponsor may have modified the contents. Please check for any updated list of materials.

- ☐ **EQUIPMENT**
  - ☐ reusable bag
  - ☐ reusable mug
  - ☐ cup holder ashtray
  - ☐ pocket ashtray
  - ☐ reusable lunch tote
  - ☐ cloth napkin
  - ☐ cutlery (includes straw)
  - ☐ reusable sandwich bags (also used as containers for activity cards)
  - ☐ beeswax wrap
  - ☐ digital microscope
  - ☐ 2 luggage locks or zipties
  - ☐ 2 funnels
  - ☐ 4 meters of rope
  - ☐ sieve set (5 pieces)
  - ☐ 2 metal scoops
  - ☐ rubber bands
  - ☐ fishing line
  - ☐ 2 plastic shoe boxes
  - ☐ 2 pieces netting or screen
  - ☐ thermometer
  - ☐ 100-meter measuring tape
  - ☐ manual luggage scale

TRASH TRUNK USE SURVEY

To help us evaluate how the Trash Trunk is being used and what resources would be helpful to include in future kits, please complete and return the Trash Trunk survey found at bit.ly/CGLLresourceevaluation.

LOOKING AHEAD

Curriculum and supporting materials continue to be developed and revised. We encourage users of this Trash Trunk Educator's Guide to check the original source's websites for updated materials. NOAA's Marine Debris Program, Office of Response and Restoration, Marine Debris website marinedebris.noaa.gov/activities-and-curricula, the Great Lakes Marine Debris Portal greatlakes-mdc.diver.orr.noaa.gov/educational-resources and the Center for Great Lakes Literacy website cgll.org/curriculum are excellent portals to additional resources.

Photo: Meaghan Gass

LESSONS, ACTIVITIES AND SUMMARIES

What Is Marine Debris? Where Does it Come From?

1. Top 15 Marine Debris Items

See page 31

30-45 minutes, ages: K-adult

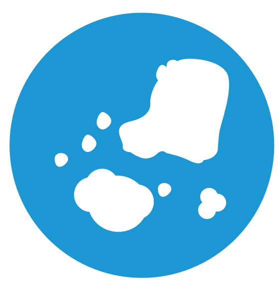
Participants discover which trash items are most commonly collected on beaches and waterways, and they will explore the items' composition and possible origin.

Supplies provided: Talking Trash and Taking Action grey playing card Debris Deck, Top 10 Great Lakes Basin Litter Items display card, Top 10 Items Collected Internationally display card, Litter Composition by Water Body display card

Supplies needed: May need pictures for younger learners

Source: Ocean Conservancy and National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. Talking Trash and Taking Action curriculum
marinedebris.noaa.gov/talking-trash-and-taking-action

Extension (supporting resource): Alliance for the Great Lakes, Can You Top This? Adopt-a-Beach™ 2016 Data Report
greatlakes.org/2017/04/adopt-beach-2016-data-report



2. Matching Trash

See page 36

30-45 minutes, ages: K-adult

Participants learn the sources of marine debris as well as the different materials that constitute marine debris by grouping types together.

Supplies provided: Talking Trash and Taking Action grey playing card Debris Deck, Talking Trash and Taking Action white playing card Debris Deck, Litter Composition by Water Body display card, Litter Composition by State display card

Supplies needed: May need pictures for younger learners

Source: Ocean Conservancy and National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. Talking Trash and Taking Action curriculum marinedebris.noaa.gov/talking-trash-and-taking-action

3. Synthetic Sand

See page 43

60 minutes to half-day field trip, ages: Middle to high school

Recommend conducting with Adopt-A-Beach™ activity (see page 123)

Participants conduct a transect of an area of beach to identify and catalogue the various materials collected there.

Supplies provided: Microplastic Identification display card, 2 metal scoops, colander with 1 mm sieve and loop of rope with a 4-meter circumference

Supplies needed: Five-gallon bucket and box or bag to hold sample

Source: 5 Gyres Institute. Plastic Pollution Curriculum and Activity Guide
5gyres.org/educators

Extensions (supporting resources):
1. Exploring Along a Line of Micro Particles from Georgia Sea Grant, Participants use a sand/bead mixture to simulate a transect study; ideal when access to actual microplastics in real sand is not available.
bit.ly/2JFdTRs

2. Micro Particle Graph Data Sheet Activity from Georgia Sea Grant, Participants use an Excel spreadsheet to tabulate number, volume and density of micro particles and create graphical representations.
bit.ly/3aOTuW1

4. Identifying Plastics

See page 46

60 minutes to three class periods, ages: Middle to high school

Participants learn that plastics are made of different chemical structures and how to identify each type by subjecting it to a variety of physical and chemical tests. An abbreviated version of the activity identifies only resin codes #2 HDPE, #4 LDPE and #5 PP because they require only a simple physical test, making it appropriate for less-advanced students or settings without access to laboratory equipment and supplies.

Supplies provided: Common Types of Plastics display card

Supplies needed for full activity: Copper wire, corks, acetone, test tubes or small beakers, glass stirring rods, Bunsen burners, fume hood, tongs or forceps, water, isopropyl alcohol solution (see directions for concentration), corn oil, samples of plastic pieces labeled 1 through 6 (corresponding to resin codes #1 PETE, #2 HDPE, #3 PVC, #4, LDPE, #5 PP and #6 PS, one set for each group) and one or more numbered "unknown" samples per group. Select the resin code for the unknown sample per group to be identified based on the level of the students. Resin code #2 HDPE is the easiest; resin code #1 PETE is the most difficult. Don't forget to keep track of the actual resin codes of the samples you've chosen, and label them with unique numbers (7-12 for one unknown per group or 7-18 for two unknowns per group).

Supplies needed for abbreviated activity: Water, isopropyl alcohol solution (see directions for concentration), corn oil, samples of plastic pieces labeled 1 through 3 (corresponding to resin codes #2 HDPE, #4, LDPE and #5 PP, one set for each group) and one or more numbered "unknown" samples per group. Don't forget to keep track of the actual resin codes of the samples you've chosen, and label them with unique numbers.

Source: 5 Gyres Institute. Plastic Pollution Curriculum and Activity Guide
5gyres.org/educators

Extension (supporting resources):
1. National Oceanic and Atmospheric Administration (NOAA). Plastic Marine Debris Fact Sheet
marinedebris.noaa.gov/sites/default/files/2018_Plastics_Fact_Sheet.pdf

2. PBS Wisconsin. Wisconsin Biographies: Milly Zantow: Recycling Revolutionary video, 5:31 minutes. Zantow's numbering system, identifying plastics for recycling, is still seen on containers today, making recycling easier all over the world. She and Jenny Ehl started E-Z recycling in 1979. Zantow also helped to write Wisconsin's recycling laws.
pbswisconsineducation.org/series/episode/milly-zantow-recycling-revolutionary

3. PBS Wisconsin. Wisconsin Biographies: Milly Zantow: Recycling Revolutionary portal
pbswisconsineducation.org/biographies/zantow

4. University of Wisconsin Extension. Plastics One Through Seven video, 8:26 minutes. Interview by Liese Dart of Millie Zantow, the Sauk County woman who devised the plastics recycling numbering system and worked to get the national recycling movement started.
youtube.com/watch?v=AM6-NqmzI1I

5. Different Types of Plastic

See page 56

45 minutes, ages: Middle to high school

Participants take on the roles of carbon, hydrogen and chlorine atoms and build plastic monomers and polymers to learn the chemistry of plastic.

Supplies provided: Common Types of Plastic display card, Microplastic Identification display card

Supplies needed: Production template cards for each type of monomer to be built (page 59). Eight 4-inch diameter circles labeled "C" for carbon. Twenty 2-inch diameter circles labeled "H" for hydrogen. Two 3-inch diameter circles labeled "Cl" for chlorine. Plastic items made from different types of polymers (see Common Types of Plastic chart on page 62).

Source: Wisconsin Sea Grant, Chazen Art Museum and Wisconsin Water Library. Plastic Entanglements: Ecology, Aesthetics, Materials: Educator's Guide: Pre-Visit Activities
waterlibrary.aqua.wisc.edu/plastics-uploads/previsit.pdf

Extensions (supporting resources):

1. National Oceanic and Atmospheric Administration (NOAA) Trash Talk video, What Is Marine Debris? 2:08 minutes
oceantoday.noaa.gov/trashtalk_whatismarinedebris/

2. National Oceanic and Atmospheric Administration (NOAA) Trash Talk video, Where Does Marine Debris Come From? 2:07 minutes
oceantoday.noaa.gov/trashtalk_wheredoesmarinedebriscomefrom/

3. Micro Particle Graph Data Sheet Activity from Georgia Sea Grant. Participants use an Excel spreadsheet to tabulate number, volume and density of micro particles and create graphical representations.
bit.ly/3aOTuW1

4. Plastic Debris Along the Georgia Coast Marine Debris brochure from Georgia Sea Grant
bit.ly/3c2vXBy

What Are the Impacts of Marine Debris?

6. All Tangled Up

See page 64

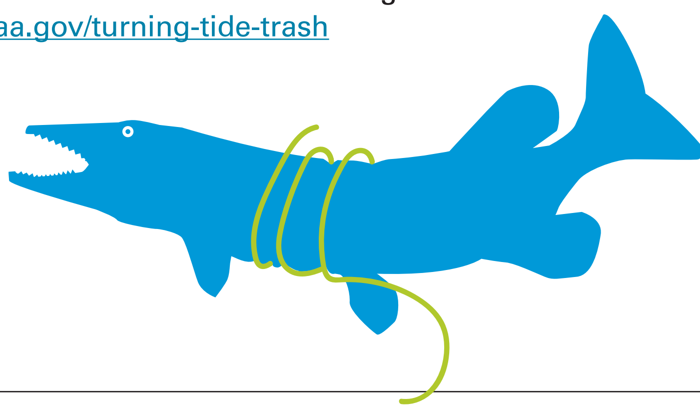
20 minutes, ages: K-adult

Participants will gain an understanding of entanglement by simulating what restriction may feel like for marine wildlife.

Supplies provided: A small- to medium-sized thin rubber band for each student and one copy of the "Animal Entanglement" handout on page 66

Supplies needed: May need smaller rubber bands for younger learners

Source: National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. Turning the Tide on Trash: A Learning Guide on Marine Debris
marinedebris.noaa.gov/turning-tide-trash



7. How Harmful Is Marine Debris?

See page 67

60 minutes, ages: Upper elementary to middle school

Participants determine the types of marine debris that are most harmful by ranking and discussing the severity of different types of marine debris on animals, people, vessels and habitat.

Supplies provided: Impacts of Marine Debris display card and How Harmful Is It? handout (page 69)

Supplies needed: Examples of the different types of debris to be discussed, including fishing line, a paper cup, six-pack ring, resin pellet, plastic grocery or trash bag, broken glass bottle. CAUTION — use care when handling this material

Source: National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. Turning the Tide on Trash: A Learning Guide on Marine Debris
marinedebris.noaa.gov/turning-tide-trash

8. Plastic in the Water Column

See page 72

45 minutes, ages: Middle to high school

Participants investigate the density of plastics, how it affects the location of different types of plastic in the water column and how plastics affect aquatic food webs.

Supplies provided: Microplastic Identification display card, Plastics in the Water Column student sheet (page 77), Density Table (page 78), Ocean Feeder card (page 80), and Water Column Cross Section (page 82)

Supplies needed: Various plastic objects with differing densities and buoyancies (e.g., plastic fork, plastic bag, DVD case, plastic bottle and so on), hand lenses, towels for clean-up, and tall bucket or other container (transparent is best) filled with water for each student group

Source: Monterey Bay Aquarium Foundation
montereybayaquarium.org/for-educators/curriculum-and-resources/curriculum/plastic-in-the-water-column

9. What Is the Impact of Beach Litter?

See page 84

30-45 minutes, ages: Middle school to adult

Participants construct a web of things that may increase or decrease as a result of beach litter.

Supplies provided: Impacts of Marine Debris display card, 1 activity card labeled "Beach Litter," 40 activity cards labeled "More" on one side and "Less" on the other side, and 35-40 scientific and social impact activity cards

Supplies needed: Blank wall, bulletin board or a few large tables pushed together, tape (for a wall) or push pins (for a bulletin board)

Source: Ohio Sea Grant
ohioseagrant.osu.edu/products/ff6e9/what-is-the-impact-of-beach-litter

10. A Degrading Experience

See page 102

Two months, minimum, ages: Middle to high school

Allow two 40-minute periods for discussion, set up and clean up; five minutes every day (for at least two months) to record weather observations; 10 to 20 minutes every week (for at least two months) to record degradation observations. Note: The longer that the experiment is continued, the more dramatic the evidence that degradation has occurred will be.

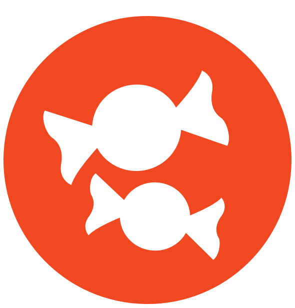
Participants perform an experiment to learn how different types of debris degrade and how weather and sunlight affect the rate of degradation.

Supplies provided: Microplastic Identification display card, 10 Things You Can Do for Trash-Free Lakes display card, 8Rs display card, two plastic shoe boxes, two pieces of netting or screening (to cover the containers so that materials do not blow away) and an outdoor thermometer

Supplies needed: Newspaper, two pieces of rope or string, and assorted pairs of trash items. The following pieces of trash are recommended in pairs: apple cores, paper bags, plastic bags, candy wrappers, plastic cups, waxed-paper cups, drink boxes and straws, paper egg cartons, foamed plastic egg cartons, pages of newspaper, foamed plastic packing peanuts, starch packing peanuts, six-pack rings, steel soup cans and glass bottles

Source: National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. Turning the Tide on Trash: A Learning Guide on Marine Debris
marinedebris.noaa.gov/turning-tide-trash

Extension (supporting resource): National Oceanic and Atmospheric Administration (NOAA) Trash Talk video, How Does Marine Debris Impact the Ocean, Animals and Me? 1:33 minutes
oceantoday.noaa.gov/trashtalk_impacts



What Can We Do About Marine Debris?

11. Prevention Corners

See page 110

30 minutes, ages: Elementary to high school

Participants examine different prevention methods as they pertain to particular items of marine debris and think creatively on multiple options for marine debris prevention.

Supplies provided: Talking Trash and Taking Action grey playing card Debris Deck activity cards, Talking Trash and Taking Action white playing card Debris Deck activity cards, 10 Things You Can Do for Trash-Free Lakes display card and the 8 Rs display card

Supplies needed: None

Source: Ocean Conservancy and National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. Talking Trash & Taking Action curriculum
marinedebris.noaa.gov/talking-trash-and-taking-action

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12. Earth Day Bag Project

See page 111

60 minutes, ages: Elementary to high school

Participants decorate paper grocery store bags to raise community awareness about marine debris and the importance of refusing single-use plastics.

Supplies provided: The 8 Rs display card, reusable bag, reusable mug, cup holder ashtray, pocket ashtray, reusable lunch tote, cloth napkin, cutlery and straw, reusable sandwich bags (also used as containers for activity cards) and beeswax wrap

Supplies needed: Paper grocery bags, markers or crayons, and optional printed labels

Source: Northeast Michigan Great Lakes Stewardship Initiative
bit.ly/NEMIEDBP

Extension (supporting resource): Erie Government and Matt Urban Hope Center. Rags to Bags! How to Make T-Shirt Tote Bags.
bit.ly/3bjUdOE

13. Plastic Use Audit

See page 115

1 hour, ages: Middle to high school

Participants investigate what types of plastic are used the most and ways to reduce the use of single-use plastics.

Supplies provided: The 8 Rs display card, manual luggage scale, reusable bag, reusable mug, cup holder ashtray, pocket ashtray, reusable lunch tote, cloth napkin, cutlery and straw, reusable sandwich bags (also used as containers for activity cards) and beeswax wrap

Supplies needed: Large tabletop or floor space, tarps, buckets for liquids, rubber gloves, soap and water or disinfectant wipes for handwashing, recycling/waste bin contents and graphing program or paper

Source: Monterey Bay Aquarium Foundation
montereybayaquarium.org/for-educators/curriculum-and-resources/curriculum/plastic-use-audit

Extension (supplemental resource):
1. PBS Wisconsin. Wisconsin Biographies: Milly Zantow: Recycling Revolutionary video, 5:31 minutes. Zantow's numbering system, identifying plastics for recycling, is still seen on containers today, making recycling easier all over the world. She and Jenny Ehl started E-Z recycling in 1979. Zantow also helped to write Wisconsin's recycling laws.
pbswisconsineducation.org/series/episode/milly-zantow-recycling-revolutionary

2. PBS Wisconsin. Wisconsin Biographies: Milly Zantow: Recycling Revolutionary portal.
pbswisconsineducation.org/biographies/zantow

3. University of Wisconsin Extension. Plastics One Through Seven video, 8:26 minutes Interview by Liese Dart of Millie Zantow, the Sauk County woman who devised the plastics recycling numbering system and worked to get the national recycling movement started.
youtube.com/watch?v=AM6-Nqmzl1I

14. Adopt-a-Beach™

See page 123

60 minutes to half-day field trip, ages: Middle school to adult

Recommend conducting with Synthetic Sand activity (see page 43)

Participants collect and analyze data while completing a beach clean-up. Note that this activity can be completed on school grounds, a park or other location of your choice.

Supplies provided: Top 10 Great Lakes Basin Litter Items display card, Top 10 Items Collected Internationally display card, Litter Composition by Water Body display card, Litter Composition by State display card, Microplastic Identification display card, 10 Things You Can Do for Trash-Free Lakes display card, the 8 Rs display card, sieve set (5 pieces), 2 metal scoops, 100-meter measuring tape, manual luggage scale, cup holder ashtray and pocket ashtray

Supplies needed: gloves, safety vests, traffic cones or stakes to mark designated collection area and plastic buckets with lids or garbage bags to contain collected debris

Source: Alliance for the Great Lakes
greatlakes.org/wp-content/uploads/2016/09/Lesson-4.9-Adopt-a-Beach.pdf

Extensions (supporting resources):
1. Alliance for the Great Lakes Litter Monitoring Form
greatlakes.org/wp-content/uploads/2020/06/AGL_LitterForm_final.pdf

2. Alliance for the Great Lakes Can you top this? Adopt-a-Beach™ 2016 Data Report
greatlakes.org/2017/04/adopt-beach-2016-data-report/

3. National Oceanic and Atmospheric Administration (NOAA) Trash Talk video, Why Is Plastic Marine Debris So Common? 2:22 minutes
oceantoday.noaa.gov/trashtalk_plastics

4. National Oceanic and Atmospheric Administration (NOAA) Trash Talk video, What Can We Do? 2:23 minutes oceantoday.noaa.gov/trashtalk_whatcanwedo

Photo: Meaghan Gass

GLOSSARY

biodegradable: Capable of being broken down by microorganisms (bacteria) into compounds that can be reused in the environment. The amount of time this process takes is highly variable.

buoyant: Capable of floating in water.

debris: Discarded items, trash and litter, materials and solid wastes that are released accidentally or intentionally into the environment.

degradable: Capable of being broken down into smaller pieces by natural forces. See biodegradable and photodegradable.

disposal: The permanent storage or removal of trash from the environment.

ecosystem: A natural community composed of biotic (living) creatures that live in connection with each other and abiotic (non-living) elements like sun, soil and water. An ecosystem can be as big as a planet or as small as a puddle.

entanglement: In terms of marine debris, "entanglement" is the looping of a piece of debris around part of an animal's body. Entanglement may impair swimming and feeding, cause suffocation, decrease ability to elude predators and cause open wounds.

estuary: An area of water and wetland found where rivers meet the sea. Freshwater estuaries occur where rivers meet the Great Lakes.

foamed plastic: A type of plastic that is generally made from polystyrene (resin code #6) and consists of small spheres that are fused together. Foamed plastic is very light and easily breaks into smaller pieces. It is frequently used in disposable cups for hot beverages.

food chain: A series of animals and plants, each depending on the next for food. A food chain usually forms part of a much larger, more complex food web.

food web: A network of living things that depend on each other for food.

garbage: Spoiled or waste food that is thrown away. It is also a general term for all products discarded.

gyre: A circular pattern of currents in an ocean basin.

ingestion: The process of consuming food, liquids or other substances. When animals ingest marine debris, mistaking it for food, the debris may cause blockages in the digestive tract, suffocation or a false feeling of fullness that can lead to malnutrition or starvation.

litter: Improperly discarded waste; see debris.

marine: Relating to the ocean.

marine debris: Any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes.

microbeads: Tiny pieces of polyethylene plastic added to health and beauty products, such as some cleansers and toothpastes.

microfibers: A type of microplastic. They include small fibers that enter the water from washing clothing made of synthetic materials, like polyester or nylon.

microplastics: Plastic pieces less than five millimeters long that can harm aquatic life.

mitigation: The act of reducing harm. In a marine debris context, projects may attempt to mitigate the negative effects of pollution or waste on a natural resource such as a stream, wetland, endangered species, archeological site, paleontological site or historic structure.

municipal solid waste: Garbage or refuse that is generated by households, commercial establishments, and industrial offices; includes durable goods, non-durable goods, containers and packaging, food waste and yard trimmings.

nondegradable: Incapable of being broken down into simple compounds or components.

nurdle/plastic resin pellets: Small, round plastic pellets that serve as the raw material in the manufacture of other plastic products. The pellets (nurdles) resemble fish eggs and can be mistaken for food by marine animals and sea birds.

persistent: In the environment this refers to the ability of a substance or material to remain in the environment for long periods of time without being broken into smaller components.

photodegradable: Capable of being broken down by ultraviolet radiation. Chemical bonds or links in the polymer or chemical structure of a plastic are broken by exposure to sunlight.

plastic resins: Material used in making plastics; usually petrochemical-based.

recycling: The collection and reprocessing of materials so they can be used again in a similar or different form.

solid waste: Any solid, semi-solid, liquid or contained gaseous materials discarded from industrial, commercial, mining or agricultural operations, and from community activities. Solid waste includes garbage, construction debris, commercial refuse, sludge from water supply or waste treatment plants, or air pollution control facilities, and other discarded materials.

trash: Materials that have been made or used by people and discarded. Also referred to as waste, garbage and solid waste.

Source: National Oceanic and Atmospheric Administration (NOAA). Turning the Tide on Trash: A Learning Guide on Marine Debris

ACKNOWLEDGEMENTS AND REFERENCES

5 Gyres Institute for permission to reprint the following activities:

- Synthetic Sand
- Identifying Plastics

5 Gyres Institute (n.d.). Next Generation Science Standards (NGSS) Educational Curriculum: Plastic Pollution Curriculum and Activity Guide
5gyres.org/educators

Alliance for the Great Lakes for permission to reprint the following activity:

- Adopt-A-Beach™

Alliance for the Great Lakes. (2009). Great Lakes in My World. Unit 4: Human Communities. Lesson 9: Adopt-A-Beach™
greatlakes.org/wp-content/uploads/2016/09/Lesson-4.9-Adopt-a-Beach.pdf

Monterey Bay Aquarium Foundation for permission to reprint the following activities:

- Plastic in the Water Column

Monterey Bay Aquarium Foundation. (2014). Plastic in the Water Column
montereybayaquarium.org/for-educators/curriculum-and-resources/curriculum/plastic-in-the-water-column

- Plastic Use Audit

Monterey Bay Aquarium Foundation. (2019). Plastic Use Audit
montereybayaquarium.org/for-educators/curriculum-and-resources/curriculum/plastic-use-audit

National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program

- Impacts of Marine Debris: The Struggle for Marine Animals
  blog.marinedebris.noaa.gov/impacts-marine-debris-struggle-marine-animals
- Plastic Marine Debris Fact Sheet
  marinedebris.noaa.gov/what-we-know-about-plastic-marine-debris

National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program for permission to reprint the following activities:

- All Tangled Up
- How Harmful Is Marine Debris?
- A Degrading Experience

National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program. (n.d.). Turning the Tide on Trash: A Learning Guide on Marine Debris
marinedebris.noaa.gov/turning-tide-trash

National Oceanic and Atmospheric Administration (NOAA) Ocean Services

- What Is Marine Debris? fact sheet
oceanservice.noaa.gov/facts/marinedebris.html

Northeast Michigan Great Lakes Stewardship Initiative for permission to reprint the following activity:

- Earth Day Bag Project

Northeast Michigan Great Lakes Stewardship Initiative. (2019). Earth Day Bag Project
bit.ly/NEMIEDBP

Ocean Conservancy for permission to reprint the following activities:

- Top 10 Marine Debris Items
- Matching Trash
- Prevention Corners

Ocean Conservancy and NOAA Marine Debris (n.d.). Talking Trash and Taking Action
marinedebris.noaa.gov/talking-trash-and-taking-action

Ohio Sea Grant for permission to reprint the following activity:

- What Is the Impact of Beach Litter?

Ohio Sea Grant. (2013). What Is the Impact of Beach Litter?
ohioseagrant.osu.edu/products/ff6e9/what-is-the-impact-of-beach-litter

PBS Wisconsin. (2020)

- Wisconsin Biographies: Milly Zantow: Recycling Revolutionary video, 5:31 minutes
  pbswisconsineducation.org/series/episode/milly-zantow-recycling-revolutionary

- Wisconsin Biographies: Milly Zantow: Recycling Revolutionary portal
  pbswisconsineducation.org/biographies/zantow.html

Science History Institute. (2019)

- Conflicts in Chemistry: The Case of Plastics—The History and Future of Plastics
  sciencehistory.org/the-history-and-future-of-plastics

United States 109th Congress. (2006)

- United State Public Law 109-449 Marine Debris Research, Prevention, and Reduction Act
  congress.gov/109/plaws/publ449/PLAW-109publ449.pdf

University of Wisconsin Extension. (2012)

- Plastics One Through Seven video
  youtube.com/watch?v=AM6-NqmzI1I

University of Wisconsin Sea Grant for permission to reprint the following activity:

- Different Types of Plastic

  University of Wisconsin Sea Grant, Chazen Art Museum, Wisconsin Water Library (2019). Plastic Entanglements: Ecology, Aesthetics, Materials: Educator's Guide: Pre-Visit Activities
  waterlibrary.aqua.wisc.edu/plastics-uploads/previsit.pdf

SUGGESTED ADDITIONAL RESOURCES

OTHER CURRICULA, LESSONS AND WEB PORTALS

5 Gyres and Burning River Foundation

Plastic Pollution and the Great Lakes Curriculum and Activity Guide
5gyres.org/educators

California Coastal Commission

Waves, Wetlands, and Watersheds
coastal.ca.gov/publiced/waves/waves1

Consortium for Ocean Sciences Exploration and Engagement (COSEE)

Educator's Guide to Marine Debris
issuu.com/bgirsh/docs/sea_grant_pages

National Oceanographic and Atmospheric Administration (NOAA) Great Lakes Marine Debris Collaborative

greatlakes-mdc.diver.orr.noaa.gov

National Oceanographic and Atmospheric Administration (NOAA) Marine Debris Program

- Marine Debris Monitoring Toolkit for Educators
  marinedebris.noaa.gov/curricula/marine-debris-monitoring-toolkit-educators
- Understanding Marine Debris: Games and Activities for Kids
  marinedebris.noaa.gov/understanding-marine-debris-games-and-activities-kids-all-ages

North American Marine Environment Protection Association (NAMEPA) and NOAA

An Educator's Guide to Marine Debris
marinedebris.noaa.gov/educators-guide-marine-debris

New Day Films

Bag It Curriculum (see link to associated film below)
newday.com/sites/default/files/resources/Bag It Curriculum Packet.pdf

Ocean Conservancy

Fighting for Trash Free Seas portal
oceanconservancy.org/trash-free-seas/outreach-education

Oregon Sea Grant

Mitigating Microplastics: Teacher Lesson Plans
seagrant.oregonstate.edu/sgpubs/mitigating-microplastics-teacher-lesson-plans-curriculum

Oregon State University

Marine Debris STEAMSS Curriculum
oregoncoaststem.oregonstate.edu/marine-debris-steamss

University of Colorado Boulder

Microplastic Extraction of Exfoliating Beads from Cleansers
teachengineering.org/activities/view/uok-2216-microplastic-extraction-cleanser-beads-filter-design

DOCUMENTARY FILMS AND VIDEOS

Trash Talk videos

A series of 2-4 minute videos by the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program, 15:12 minutes total. Available for free on NOAA's website.
oceantoday.noaa.gov/trashtalk_specialfeature/welcome.html

Plastics 101

A video by Ella M. White Elementary River Raiders 5th graders in Alpena, Michigan, 5:34 minutes.
bit.ly/Plastics101

Bag It (see link to associated curriculum above)

A documentary film from New Day Films lasting 74 minutes. Available for purchase on Amazon, iTunes or from your local library.
bagitmovie.com

Straws

A film by Linda Booker, 33 minutes. Available for purchase. It includes curricula for elementary, middle and high school students.
strawsfilm.com

PRESENTATIONS

Let's Talk Trash PowerPoint

This PowerPoint was developed by Ohio Sea Grant and Stone Laboratory. It provides a general overview of marine debris in the Great Lakes with a focus on plastics.
pub-data.diver.orr.noaa.gov/marine-debris/greatlakes/MD%20General%20PowerPoint.pptx

Marine Debris and Microparticles

This PowerPoint was developed by the University of Georgia Marine Extension Service and Georgia Sea Grant. It provides a general overview of marine debris with a focus on microplastics.
gacoast.uga.edu/wp-content/uploads/2016/05/MarineDebris101.pdf

Microplastics: What's the BIG deal?

Originally created by Florida Sea Grant as part of the Florida Microplastic Awareness Project in April 2015. The presentation was last updated in July 2020, and continues to be updated as research emerges. This is a very large file (41,000 KB) so allow significant time for download.
https://sfyl.ifas.ufl.edu/flagler/marine-and-coastal/microplastics/multimedia-and-outreach/

FACT SHEETS, REPORTS AND POSTERS

Earth Science Journal for Kids (upper elementary and middle school)

Where Did My Plastic Go?
sciencejournalforkids.org/wp-content/uploads/2019/08/plastic-article.pdf

National Oceanographic and Atmospheric Administration (NOAA), National Ocean Service, Office of Response and Restoration, Marine Debris Program

- Great Lakes Marine Debris Action Plan
  marinedebris.noaa.gov/great-lakes-land-based-marine-debris-action-plan
- Microplastic Marine Debris Fact Sheet
  marinedebris.noaa.gov/fact-sheets/microplastic-marine-debris-fact-sheet
- What We Know About Plastic Marine Debris Fact Sheet
  marinedebris.noaa.gov/sites/default/files/2018_Plastics_Fact_Sheet.pdf

New York Sea Grant

Plastic Microbeads in the Great Lakes

seagrant.sunysb.edu/Images/Uploads/PDFs/MicrobeadsInTheGreatLakes-FactSheet-0214.pdf

Ocean Conservancy

The International Coastal Cleanup Report

oceanconservancy.org/trash-free-seas/international-coastal-cleanup/annual-data-release

South Carolina Sea Grant and South Carolina Department of Health and Environmental Control

Marine Debris From Land and Sea: In the environment a long, long time, poster

scdhec.gov/sites/default/files/docs/HomeAndEnvironment/Docs/ SC_MARINE_DEBRIS_POSTER.pdf

United Nations Environment Programme and GRID-Arendal

Marine Litter Vital Graphics

grida.no/publications/60

DO IT YOURSELF PLASTIC ALTERNATIVES

Erie Government and Matt Urban Hope Center

Rags to Bags! How to Make T-Shirt Tote Bags

bit.ly/3bjUdOE

Sea Earth Atmosphere

Do it Yourself DIY Beeswax Wraps

manoa.hawaii.edu/sealearning/grade-5-earth-science-topic-3-activity

ACTIVITIES

A KIT FOR LEARNING ABOUT MARINE DEBRIS

WHAT IS MARINE DEBRIS? WHERE DOES IT COME FROM?

ACTIVITY: TOP 15 MARINE DEBRIS ITEMS

OBJECTIVE: Participants will discover which trash items are the most common marine debris items collected on beaches and waterways, and they will explore the items' composition and potential origin.

MATERIALS:

- Grey Debris Deck
- Top Marine Debris Items List (included at the end of the activity)

** This activity can be done without cigarette butts. Follow the same instructions below but exclude the "cigarette butt" card.*

INSTRUCTIONS:

1. **SAY: Now that we understand what marine debris is, let's determine what the most common types of marine debris are.**
2. Give one marine debris item card (or the actual item, cleaned) to15 volunteers if you have a large group or give one to every participant if your group has 23 or less participants.
3. Instruct participants to work together to determine what they think the most common collected marine debris items are. Instruct them to line up in order, from the most common item to the 15th-23rd (depending on number of participants) most common item. Make sure participants are holding their items or cards for the entire group to see.
4. Have each participant in line state his or her item and, if time allows, why he or she is in that spot (i.e., "I have plastic grocery bags and we think this is the number one item because we use them every day and see a lot of them on the street and in parks."). Start at what they believe the most collected item is and proceed down the line.
5. Using the Top Items list, arrange the participants in the actual order of the top marine debris items to see how close their guesses were.

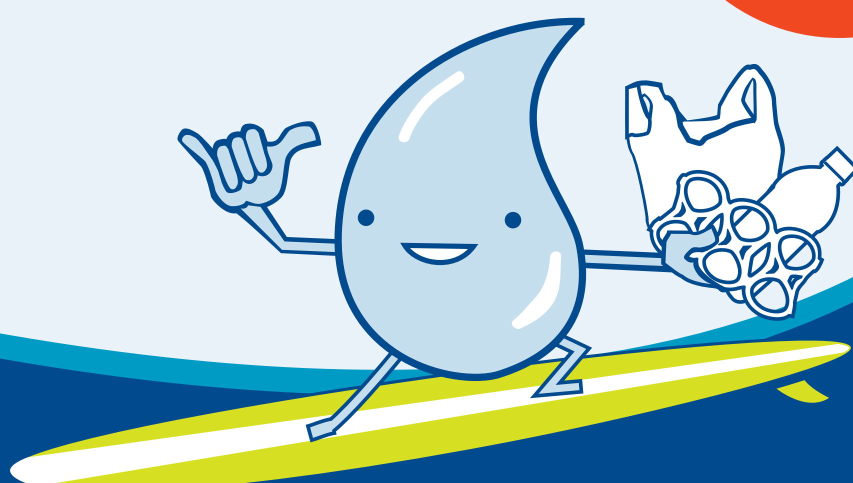
   ** If you excluded cigarettes butts: Reveal to the group that, in fact, cigarette butts/cigarette filters are the number one marine debris item collected. The order of the list is still the same, only cigarettes/cigarette filters are at the top, and this bumps the other items down a spot.*

DISCUSSION: Ask participants these questions about the Top 15 list:

- Are you surprised by any of the items on the list?
- Where do you think these items came from?
- What are these items made of?
- How many are plastic?
- Do you use any of these items on a daily basis?

When this activity is over, have the participants hold onto their cards for the next activity.

1



TOP 15 MARINE DEBRIS ITEMS

RANK	MARINE DEBRIS ITEM	TOTAL COLLECTED	FUN FACT
1	Cigarette Butts	2,043,470	That's enough cigarettes that when laid end to end, they are the same length as 4,257 school buses. Did you know these butts (the filters) are actually made from type of plastic called cellulose acetate?
2	Food Wrappers	1,685,422	Did you know that most food wrappers, including chip bags and candy wrappers are actually plastic? (See Marine Debris Composition to learn more.)
3	Plastic Beverage Bottles	940,170	That's enough beverage bottles to give every fan attending the Super Bowl 11 sodas.
4	Plastic Bottle Caps	847,972	That is enough bottle caps that when laid end to end, they would cover 3 football fields.
5	Straws/Stirrers	555,007	In the United States alone, 500 million straws are used and thrown away every single day. **(www.ecocycle.org/bestrawfree).**
6	Plastic Grocery Bags	441,493	That's enough grocery bags that when combined, they weigh more than a pickup truck.
7	Glass Beverage Bottles	394,796	All glass bottles can be beautiful and are great for reusing as vases or for other craft projects.
8	Other Plastic Bags	389,088	These include garbage bags, sandwich bags, clothing store bags, newspaper bags and more.
9	Paper Bags	368,746	It is estimated Americans consume more than 10 billion paper bags each year **(www.inteplast.us/ibs/InteGreen/facts.html)**. That's a lot of bags!
10	Beverage Cans	339,170	Did you know once recycled, an aluminum can becomes a new can in as little as 60 days **(www.kab.org/site/PageServer?pagename=recycling_facts_and_stats)**?
11	Plastic Lids	312,996	This category includes lids for to-go drinks such as soda and coffee.
12	Metal Bottle Caps	304,638	Metal bottle caps are great for crafts. Collect metals caps to use as decorations for picture frames or games like checkers.
13	Plastic Cups and Plates	282,743	That is enough cups and plates to host a block party for every single person in Newark, New Jersey.
14	Plastic Takeout Containers	234,692	Next time, think about reusing these to-go food containers for storing things such as baseball cards or craft supplies.
15	Other Plastic/Foam Packaging	233,595	This category includes plastic tarps, crates, fishing bait containers and the foam packaging that surrounds new appliances and electronics. While it may seem crazy, even foam is a type of plastic!

Source: 2013 International Coastal Cleanup.
Please visit www.oceanconservancy.org/our-work/international-coastal-cleanup/ for the most up to date Top 10 List or www.coastalcleanupdata.org to find out your local top debris items found.

Cigarette Butts	Beverage Cans
Food Wrappers (candy, chips, etc.)	Straws, Stirrers
Plastic Bottle Caps	Glass Beverage Bottles
Plastic Beverage Bottles	Metal Bottle Caps

Plastic Grocery Bags	Foam Cups & Plates
Other Plastic Bags	Plastic Cups & Plates
Plastic Lids	Plastic Take Out Containers
Other Plastic/Foam Packaging	Fishing Line

Forks, Knives, Spoons

Paper Bags

Foam Take Out Containers

Balloons

Rope

Other Plastic Bottles (milk, bleach, etc.)

Paper Cups & Plates

	Top Items Collected (2013)	
1	Cigarette Butts	2,043,470
2	Food Wrappers (candy, chips, etc.)	1,685,422
3	Plastic Beverage Bottles	940,170
4	Plastic Bottle Caps	847,972
5	Straws, Stirrers	555,007
6	Plastic Grocery Bags	441,493
7	Glass Beverage Bottles	394,796
8	Other Plastic Bags	389,088
9	Paper Bags	368,746
10	Beverage Cans	339,170
11	Plastic Lids	312,979
12	Metal Bottle Caps	304,623
13	Plastic Cups & Plates	282,735
14	Plastic Take Out Containers	234,689
15	Other Plastic/Foam Packaging	233,584
16	Forks, Knives, Spoons	193,288
17	Foam Take Out Containers	179,147
18	Foam Cups & Plates	170,414
19	Paper Cups & Plates	132,307
20	Rope	119,833
21	Fishing Line	111,357
22	Other Plastic Bottles (milk, bleach, etc.)	105,228
[illegible]	[illegible]	[illegible]

ACTIVITY: MATCHING TRASH

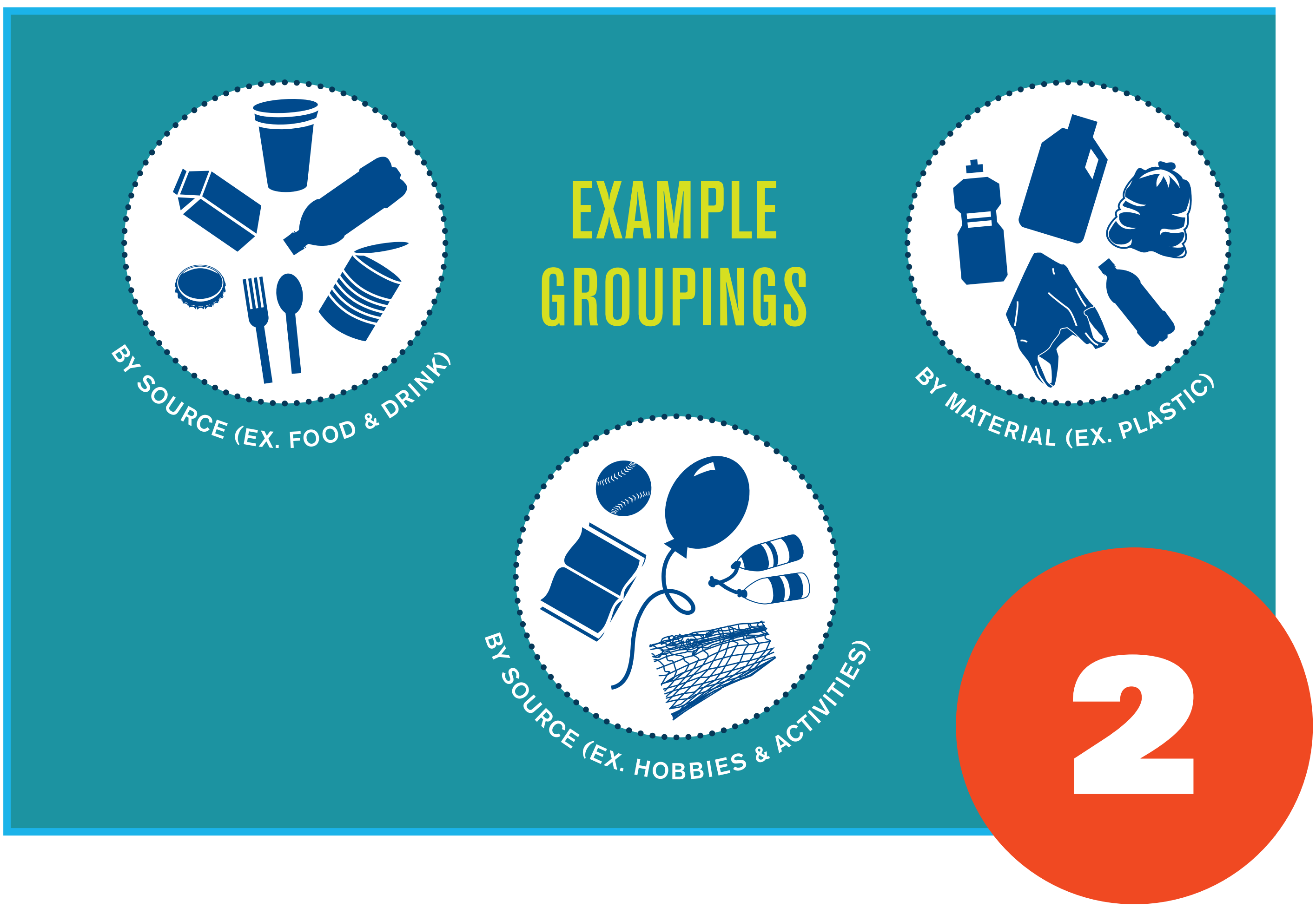
OBJECTIVE: Participants will learn the different sources of marine debris as well as the different materials that marine debris is comprised of by grouping different types of marine debris together.

MATERIALS:

- Grey and/or White Debris Decks (some participants already have these in hand from previous activity)

INSTRUCTIONS:

1. Participants should now understand the most common types of marine debris and where they originate.
2. **SAY: Now let's look deeper into how items become marine debris and the different sources of ocean trash.**
3. Make sure all participants have a card from the Debris Deck (some will already have cards from the previous activity). If there are more than 23 participants, pass out the additional item cards from the white Debris Deck.
4. Participants will have 2 minutes to group themselves based on what type of marine debris card they have. Participants can group themselves in any way they think makes sense. Examples include: fishing gear, food, made from plastic, land-sources, ocean-sources, etc. The possibilities are endless!
5. After the allotted time, have each group explain why they grouped together.
   PROMPT, if necessary: **Was it based on the source of the item? What the item was made of? What the item was used for?**
6. (Optional) Participants will have an additional 2 minutes to group themselves based on different criteria. This gives participants a chance to be creative and shows how many different possibilities there are to match trash.



MARINE DEBRIS SOURCES

OBJECTIVE: Participants will discover the main sources of marine debris.

Define the term *source* with participants.

ASK: Where do you think marine debris comes from? *or* What is the source of marine debris?

Marine debris sources are broken into two main categories: ocean-based and land-based. The majority of marine debris originates on land.

1. Ocean-Based Sources:

- Fishing Vessels: Fishing gear such as fishing lines and traps can be lost from fishing boats (referred to as derelict fishing gear).
- Recreational Boaters: Trash and fishing gear can fall overboard if not stored properly.
- Stationary Platforms (Oil and gas drilling platforms): Hard hats, gloves, pipe protectors and 55 gallon drums can all be lost from platforms.
- Cargo and Other Vessels: Ships caught in rough seas can lose a variety of items that are being transported, including entire shipping containers. Shipping containers carry many products long distances from where they were made to where they will be sold. Products from sneakers to bath toys have been lost from cargo ships.

2. Land-Based Sources:

- Litter: Any trash that is not properly disposed of can end up in waterways and eventually in the ocean.
    - Trash cans or recycling containers may not be readily available, which can lead to inappropriate disposal. Some people simply do not put trash where it belongs. Examples of littering include: leaving food wrappers at the park, throwing fishing line from a boat, or releasing balloons into the sky.
    - Littering can also be accidental. Examples include: a plastic grocery bag flying out of a car window or losing a ball at the beach.
- Dumping: Disposal facilities for large or hazardous items may be difficult to find, or they may charge fees. Rather than pay these fees, people may dump large materials such as construction materials, appliances, furniture, mattresses and hazardous waste near creeks or rivers.
- Storm Water Discharges: Storm drains carry litter and runoff to waterways that lead to the ocean. Any trash left along the street can easily wash into storm drains and eventually make it to the ocean.
- Poor Waste Infrastructure: In some parts of the world, there are no landfills or recycling centers for peoples' trash. In fact, in many places, trash cans do not exist and trash is simply piled on the street or in dry riverbeds. Without a confined place for trash, it is very easy for waste to end up in the ocean.
- Natural Disasters: Events such as tornados, hurricanes, floods and tsunamis can scatter debris into the marine environment.

Mattress	Puzzle Piece
Candle	Shopping Cart
Credit Card	Sleeping Bag
Bike Pedal	Vacuum Cleaner

Rain Boot	Rubber Chicken
Battery	Kite
Wig	Gas Tank
Toothbrush	$5 Bill

Restaurant Menu	Teddy Bear
Baby Doll	Hula Hoop
Fishing Pole	Kitchen Sink
Ballerina Tutu	Light Bulb

Pacifier	Hammer
Toy Car	Laundry Basket
Book	Frisbee
Computer Keyboard	Toilet Seat

Guitar	Traffic Cone
Marker	Car Bumper
Top Hat	Toaster
Umbrella	Bowling Ball

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.

Grade: 7th 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

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.

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: SYNTHETIC SAND LABEL

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

Data Sheet:

Sorting by Type of Plastic

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

Identifying Plastics

How can we use physical and chemical properties to identify different types of plastics?

BACKGROUND
In our everyday life, we encounter many polymeric materials (plastic), many of which are in the form of disposable containers used for household products. As our natural resources are diminishing and our landfills become full, we are finding that we need to find better systems for designing products, and that it is better to recycle our waste materials than to dispose of them or burn them. This only works, however, when these products are designed to be easily recycled.

Most of the polymers we encounter in our daily lives are the six listed in the flow chart (page xx). To make identification of these polymers easier, the plastic industry has adopted a numerical system. Many people think that these symbols with a recycling code number mean that a product is recyclable, which is not always the case. Since compliance in labeling is voluntary, not all plastic is labeled with this identification.

Identification simply by appearance is difficult; however, there are a few types of plastic that are readily identifiable. Clear, colorless containers that are used for soft drinks are most often polyethylene terephthlate (PETE). Opaque, translucent (and often white in color) plastic used for containers (such as milk cartons) are usually high-density polyethylene (HDPE). Bottles used for shampoos or cleaning materials are often made from polyvinyl chloride (V or PVC). Plastic bags and some plastic wrap are often made from low-density polyethylene (LPDE). Styrofoam and many flimsy straws are made of polystyrene (PS).

OBJECTIVE
In this investigation, students will conduct tests to learn about how physical and chemical properties vary between different types of plastics. This method illustrates one strategy scientists might use for determining the type of an unknown piece of plastic.

VOCABULARY
polymeric materials   PETE   HDPE   PVC   PS   LDPE

GRADE LEVELS
9-12 Biology, Chemistry or Environmental Science

TIME REQUIRED
Approximately 2 -3 class periods
Teachers can demonstrate each of the tests for the known plastics to save time and materials. Having stations with directions prepared ahead of time can improve the efficiency of testing.

4

MATERIALS

Item	Quantity
6 labeled vials each containing a different type plastic resin pieces (ideally each type of resin would be a different color for easy visual identification)	1 set per student/group
unknown resin samples (could be any type of plastic found in a waste bin that does not have an identifying recycling symbol on it, preferably all the same color)	2 per student/group
5 cm copper wire with a cork attached (for holding hot wire)	1 per student/group
test tubes or small (50-100 ml) beakers	4 per student/group
5 ml water	1 per student/group
5 ml isopropyl alcohol CH3CHOHCH3, 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.)	1 per student/group
5 ml corn oil (or other neutral oil)	1 per student/group
10 ml acetone	1 per student/group
stirring rod, tongs, Bunsen burner	1 set per student/group
Testing Protocols sheet (attached)	1 per student/group
Density of Plastic chart (attached)	1 per student/group
Plastic Packaging Resins sheet (plastics.americanchemistry.com/Plastic-Resin-Codes-PDF)	1 per student/group
variety of items as representative samples of each type of plastic	varies

SAFETY

- Student workspaces MUST have a ventilated hood; otherwise, do this experiment outdoors. Do NOT conduct the copper wire flame test or heat test until all chemicals are put away.
- Isopropyl alcohol is flammable, and the vapors are considered toxic. Keep containers closed and cover any open containers (such as a beaker) with a watch glass. Work in a well ventilated area and 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 and avoid flames.
- Copper wire will get hot when heated in a flame. Hold the wire with tongs or forceps to avoid burns.

CLEAN UP

- Dispose of alcohol waste and acetone waste according to local regulations.
- Dispose of any waste oil according to local regulations.
- Waste pieces of plastic can be placed in the recycling bin.
- Copper wire can be reused.

NEXT GENERATION SCIENCE STANDARDS ALIGNMENT

SEP: Carry out an investigation, analyze data, engage in argument from evidence; developing models and constructing explanations

CCC: Structure and function, energy and matter, systems and systems models, stability and change, cause and effect

DCI: PS1.A: Structure and Properties of Matter - Any pure substance has characteristic physical and chemical properties (from any bulk quantity under given conditions) that can be used to identify it

PE: MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred

PE: MS-PS1-3: Gather and make sense of information in order to describe the fact that synthetic materials come from natural resources and impact society

PRIOR TO THE LESSON

1. Assemble testing supplies at student work spaces, including copies (laminated, if possible) of the Testing Protocols sheet and Density of Plastic chart.
2. Determine the plastics you will use for the "unknown" samples and label each with a letter. Example: Use types 2 (HDPE), 4 (LDPE) and 6 (PS) as the unknown samples. Label one Sample A, one Sample B and the last Sample C. Make sure to note which letter represents each type.

LESSON

1. Engage students with a variety of items that represent each type of plastic out where they can see. Samples of all one type can be kept together or a mixture of items can be scattered around students' desks or tables.
2. Pose questions that have students describe various characteristics of the different types of plastics. Draw their attention to thickness, malleability, hardness, opacity, and typical uses, as well as other physical and/or chemical properties that are testable. Produced by the American Chemistry Council, Plastic Packaging Resins (plastics.americanchemistry.com/Plastic-Resin-Codes-PDF) can serve as a reference.
3. Provide students with the investigation handout. Explain and model the protocols for tests used to identify plastic resins.
4. Be sure to review all safety precautions and locations of flammable liquids and waste containers.

Investigation Part 1: Known Types of Plastics

5. Confirm the plastics of each known type using the testing flow chart and appropriate protocols. This could be done by the teacher as a demonstration (to save time) or students can conduct the tests.
6. Students should record testing results in the appropriate data table.

Investigation Part 2: Unknown Types of Plastics

7. Have students select and test the unknown plastics.
8. Students should record testing results in the appropriate data table.
9. Students provide evidence and reasoning to support the identification of the unknown plastic samples.

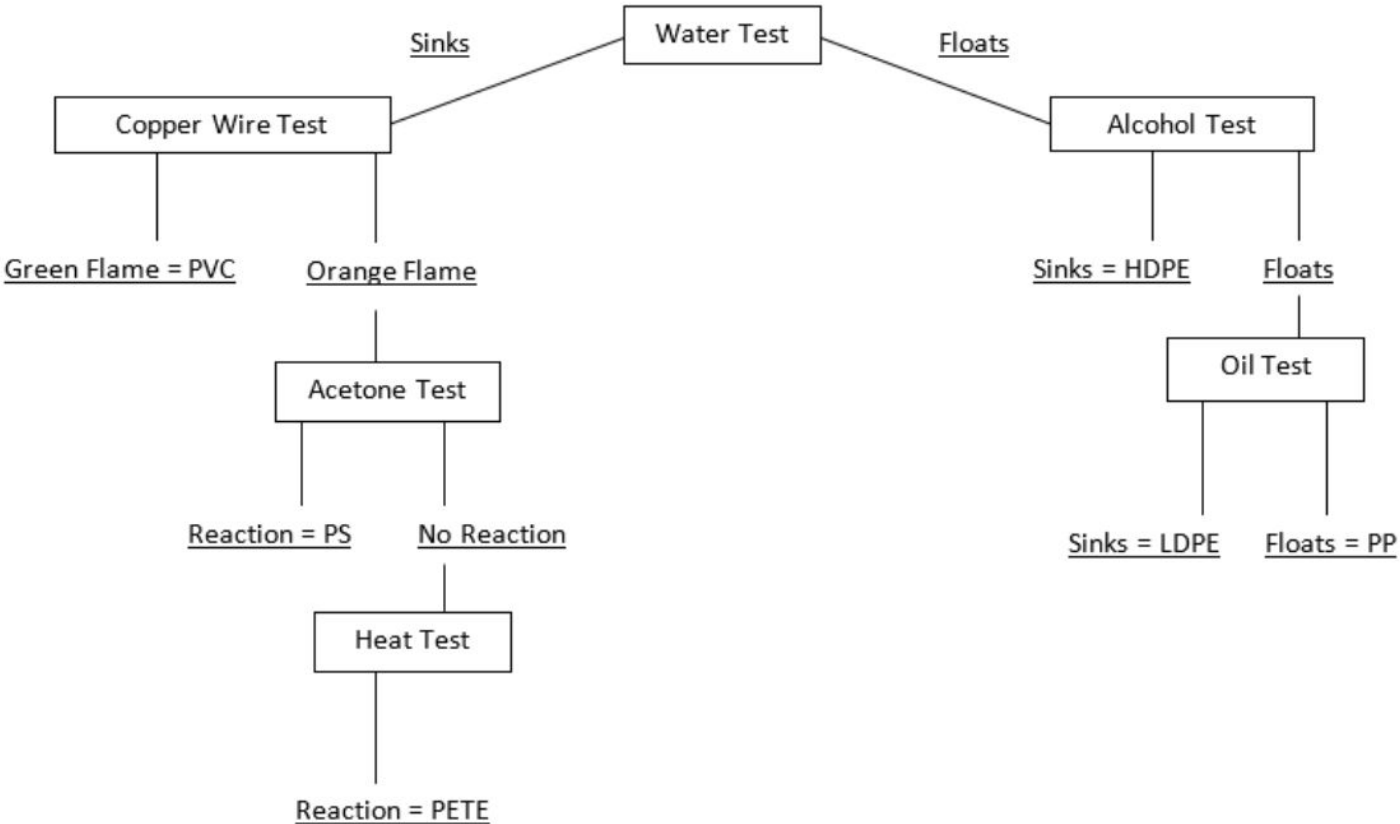
10. A variety of extension and evaluation questions are provided for application of students' understanding of plastic types.

SOURCE

Modified from *Lesson Eight: Identifying Plastics*, 5 Gyres, 2016 (www.5gyres.org/educators)

Identifying Plastics

Testing Protocols



Water Test

1. Place approximately 5 mL of water in a test tube.
2. Place two pellets of the same type in the test tube. 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 the two that behaved the same way. Remove the pellets, dry them and save them for later use.

Isopropyl Alcohol Test

1. Place 5 mL of isopropyl alcohol solution in a test tube.
2. Place two pellets of the same type in the test tube. 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 the two that behaved the same way. Remove the pellets, dry them, and save them for later use.

Oil Test

1. Place 5 mL of corn oil (or other neutral oil) in a test tube.
2. Add two pellets of the same type to the test tube. 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 the two that behaved the same way.
3. Remove the pellets, dry them, and save them for later use.

Copper Wire Test

NOTE: You MUST have a proper ventilation hood in order to complete this activity.

1. 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.)
2. Place one pellet or sample near your Bunsen burner. This is the sample you will be testing.
3. 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.
4. Remove the wire from the flame and touch the hot wire to the plastic pellet 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.)
5. 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.

Acetone Test

NOTE: Testing with acetone should take place under a fume hood or outdoors to minimize vapors in the room.

1. Using tongs, place a pellet 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.
2. If the sample has a positive reaction, discard it in the trash at the conclusion of this test.

Heat Test

1. Place approximately 100 mL of water in a beaker and heat to boiling temperature.
2. Using tongs, place a pellet or sample in the boiling water for 30 seconds. Remove the pellet/sample and press it between your fingers to see if it has softened. A positive reaction has occurred if the polymer sample softens.
3. If the sample has a positive reaction, discard it in the trash at the conclusion of this test.

Identifying Plastics

Density Chart

Floats or Sinks?

Plastic Density Chart

Density of: Sea water 1.02-1.03g/ml, Fresh water <1.015g/ml

			Polymer Density grams/cubic cm.	
1 PETE	**Thermoplastic polyester – polybutylene terephthalate (PET and PBT)** Carbonated drink bottles and oven-ready meal trays.		(PET) 1.29-1.40 (PBT) 1.30-1.38	SINKS
2 HDPE	**High-density polyethylene (HDPE)** Bottles for milk and dishwashing liquids.		0.94-0.96	FLOATS
3 V	**Polyvinylchloride (PVC)** Food trays, cling film, shampoo bottles.		1.30-1.58	SINKS
4 LDPE	**Low-density polyethylene (LDPE)** Grocery bags and bin liners.		0.89-0.94	FLOATS
5 PP	**Polypropylene (PP)** Margarine tubs, microwaveable meal trays.		0.89-0.91	FLOATS
6 PS	**Polystyrene (PS)** Yoghurt cups, foam meat or fish trays, egg cartons, vending cups, plastic cutlery, and packing material.		1.04-1.08	SINKS
7 OTHER	**Polycarbonate** CDs and DVDs, tail lights on cars, hard plastic canteens.		1.2	SINKS

Name ____ Date ______________ Period_______________

Identifying Plastics

How can we use physical and chemical properties to identify different types of plastics?

BACKGROUND

In our everyday life, we encounter many polymeric materials (plastic), many of which are in the form of disposable containers used for household products. As our natural resources are diminishing and our landfills become full, we are finding that we need to find better systems for designing products, and that it is better to recycle our waste materials than to dispose of them or burn them. This only works, however, when these products are designed to be easily recycled.

Most of the polymers we encounter in our daily lives are one of six types. To make identification of these polymers easier, the plastic industry has adopted a numerical system. Many people think that these symbols with a recycling code number mean that a product is recyclable, which is not always the case. Since compliance in labeling is voluntary, not all plastic is labeled with this identification.

Identification simply by appearance is difficult; however, there are a few types of plastic that are readily identifiable. Clear, colorless containers that are used for soft drinks are most often polyethylene terephthlate (PETE). Opaque, translucent (and often white in color) plastic used for containers (such as milk cartons) are usually high-density polyethylene (HDPE). Bottles used for shampoos or cleaning materials are often made from polyvinyl chloride (V or PVC). Plastic bags and some plastic wrap are often made from low-density polyethylene (LPDE). Styrofoam and many flimsy straws are made of polystyrene (PS).

In this activity, you will use a flowchart and specific protocols to conduct a series of tests to identify characteristics of known types of plastic. You will then use the same protocol to determine the types of plastic resin in unknown samples.

PROCEDURE

Investigation Part 1: Known Types of Plastics

1. Use the flowchart and testing protocols to confirm the characteristics of the known plastic samples.
2. Begin with the water test. Place each known plastic sample in the water. Record your observations in the appropriate data table by indicating the result for each plastic type.
3. Continue to use the flowchart and testing protocols to further confirm the characteristics of each known plastic sample.

Investigation Part 2: Unknown Types of Plastics

4. Now that you are familiar with the characteristics of various types of plastic, use the flowchart and testing protocols to determine the identities of the unknown plastic samples.
5. Record the testing results in the appropriate data table.

6. Complete the conclusion questions after determining the identities of the unknown samples.

Characteristics of Different Types of Plastic - Results of Testing Known Samples

Water Test	
Floats	Sinks

Alcohol Test	
Floats	Sinks

Oil Test	
Floats	Sinks

Copper Wire Test	
Green Flame	Orange Flame

Acetone Test	
Reaction	No Reaction

Heat Test	
Softens	No Change

Characteristics of Different Types of Plastic - Results of Testing Unknown Samples

Sample: _______ Plastic Type: _______

Test	Results

Sample: _______ Plastic Type: _______

Test	Results

Sample: _______ Plastic Type: _______

Test	Results

CONCLUSIONS

1. Identify **EACH** sample of unknown plastic. Be sure to explain the testing evidence that supports your conclusion. A sample sentence starter is provided.

   Sample ____ is plastic type ____ otherwise known as ________________. Testing showed that . . . .

2. A Great Lakes freighter is carrying plastic pellets in containers labeled "RECYCLED PLASTIC #3." A spill occurs in the port of Chicago on Lake Michigan. What will you see on or in the water around the ship? Explain.

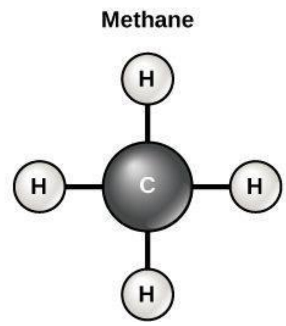
3. A local water park has a new ride called the Slime Flume. The slime used in the ride has a density of 1.15 g/mL. What types of plastic could potentially be used for making floats for the ride? What one type of plastic would be best? Be sure to explain your reasoning and support your answer with data from your investigations and what you know about the characteristics of different plastic types.

4. A group of students participates in a beach clean up. They collect more than 100 pieces of plastic. Rather than put them in the trash can, one student suggests they recycle them. Another student says that only plastic types 1 and 2 can be recycled. A third student walks down to the ocean and comes back with a pail of sea water and suggests testing the plastics to see if any float. Given what you know about the characteristics of different plastics, what would say to each of the three students? With whom would you agree and why? With whom would you disagree and why?

Background - The chemistry of plastic

The word “plastic” is used to describe a category of materials made up of polymers. The capacity to be shaped and molded is a characteristic of the chemistry of plastics. The actual properties of the various plastics differ widely. Some, like ketchup and shampoo bottles, are “squeezable.” Others, like food wrap, are thin and somewhat stretchable. Still other plastics, like plumbing pipes, are fairly rigid and strong. What makes these diverse materials the same — all plastics — yet so different in their physical properties? The answer is the chemistry of the materials.

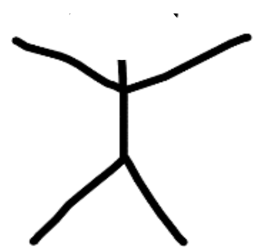
Most plastics are made by humans. The raw material to produce plastics is typically oil. Natural gas and coal, and less commonly corn and other natural products, are also used. The chemistry of plastics has two atoms at its core: carbon and hydrogen atoms.



The carbon atom can link to other atoms with up to four chemical bonds. The simplest carbon molecule (a molecule has two or more different types of atoms) is methane. To create the methane molecule (figure on the right), a carbon atom is linked to four hydrogen atoms.

A jack (figure to the left) has a similar structural shape to a methane molecule. Imagine a hydrogen atom located at each sphere at four ends of the jack. The carbon is represented by the central axis of the jack (the one without the spheres on the ends).

Another somewhat analogous structure to a methane molecule is a headless stick figure (right). Imagine the figure’s body as the carbon atom, two hands as hydrogen atoms and two feet as the remaining two hydrogen atoms.



Plastics are created from building blocks called monomers that are joined together to form polymers (more on this later). Each of the monomer building blocks has a distinct pattern of how the carbon and hydrogen atoms are arranged when forming the molecule. Methane is one type of monomer. Any of the hydrogen atoms within the methane molecule can be replaced. Within plastics, replacement atoms typically include carbon, oxygen, nitrogen, chlorine and sulfur. When another carbon atom replaces two hydrogen atoms, the second carbon atom covalently bonds to the first carbon atom to from a double bond.

5

Student Activity

Variation 1: Students take on the roles of various atoms (carbon, hydrogen, chlorine) as they build various monomers and polymers of plastic.

Variation 2: Students conduct a variety of tests to determine the physical and chemical properties of plastics.

Variation 1

Objective: Students learn that plastics are made of different chemical structures that typically contain carbon and hydrogen atoms.

Materials needed: Eight 4-inch diameter circles labeled “C” for carbon. Twenty 2-inch diameter circles labeled “H” for hydrogen. Two 3-inch diameter circles labeled “Cl” for chlorine. Production template cards for each type of monomer to be built. (For the production cards, see page 20.) Plastic items made from different types of polymers (see resin chart on page 7 or individual production cards for guidance).

Space requirements: This activity requires sufficient space for students to physically position themselves into the monomer configurations and then ideally link together to form polymers.

Note: Depending on grade level and time available, it may be appropriate to be selective regarding which monomers and polymers students are introduced to through this activity.

Steps for activity

1. Distribute five carbon circles and 20 hydrogen circles to students within the class. Display the methane production card to the class. Allow the students time to think critically and then have students stand and physically arrange themselves to form five molecules of methane. Read the back of the methane production card aloud.
   Tip: If the students need a hint as to how to arrange themselves, the easiest way to represent a methane molecule is for the student representing the carbon atom to extend his/her arms and legs away from their body core and have the students representing hydrogen atoms position themselves at each of “carbon’s” hands and feet.

2. Display the ethene (ethylene) production card to the class. Have two methane molecules combine to form ethene. Allow the students time to think critically and then have students stand and physically arrange themselves to form the ethene molecules.
   Tip: If students need a hint, point out that the carbon atoms come together to form a double bond.
   Have the students representing carbon position one of each of their hands and one of each of their feet next to that of the other carbon atom. In order to do this, four hydrogen atoms (two from each carbon) need to get out of the way. The molecule is left with just four hydrogen atoms (two for each carbon-one at a hand and one at a foot position.)

   Note that because five methane molecules were built in step one—you will have an “extra” methane molecule that doesn’t have another methane to pair up with. Not to worry, they’ll join in step four!

3. Display the vinyl chloride production card to the class. Allow time for critical thinking.
Tip: Result should be to have the previously formed ethene molecules (from step 2) remove a hydrogen atom and replace it with a chlorine atom to form two vinyl chloride molecules.

4. Display the propene production card to the class. Allow time for critical thinking.
Tip: Result should be to have the previously formed vinyl chloride molecules (from step 3) remove a chlorine atom and replace it with the methane molecule (from step one and you'll need to create one more methyl group) to form two propene molecules.

5. Display the butene production card to the class. Allow time for critical thinking.
Tip: Each of the propene molecules (step 4) will need to remove a hydrogen atom and replace it with one more methyl group. Depending on where the methyl groups are positioned (two feet, two hands or one foot and one hand) the butene will either be cis-butene or trans-butene.
Tip: The "trans" molecule is the one with the methyl group locations diagonally across from each other. Think of "transportation," a trip across a distance.

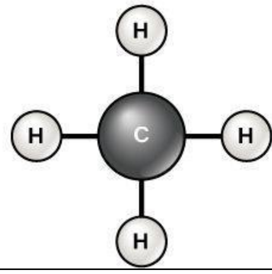
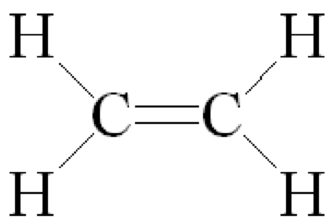
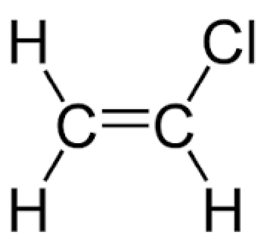
6. Display the benzene production card to the class. Allow time for critical thinking.
Tip: If students need a hint, point out that producing this molecule will require students to move from a linear format used for the previous molecules, to a hexagonal structure. It will also require six carbon atoms and six hydrogen atoms per benzene molecule, so it may be necessary for some students to trade the type of molecule they were previously representing for a new molecule (e.g., carbon instead of hydrogen).

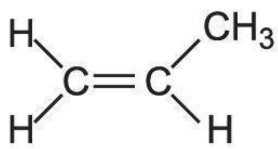
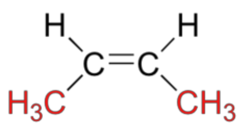
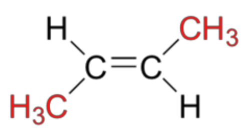
7. Display the styrene production card to the class. Allow time for critical thinking.
Tip: if students need a hint, point out that styrene is similar in structure to ethene but instead of having four atoms of hydrogen attached, there are three atoms of hydrogen and a benzene molecule.

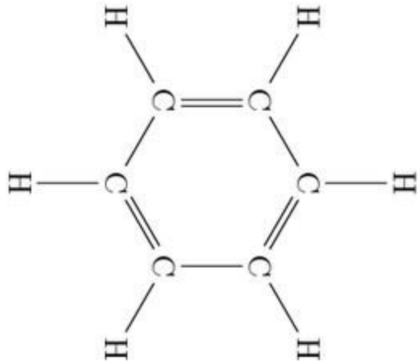
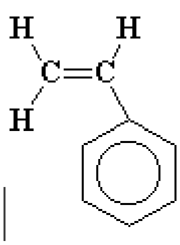
8. Point out that if multiple monomers of the same type are linked together, then a polymer is formed. Many times, the polymer has the name poly________ . For example, if ethylene (ethene) molecules are linked together to form a polymer we call the resulting plastic polyethylene. If multiple vinyl chloride molecules are linked together to form a polymer we call the resulting plastic polyvinylchloride. If multiple propylene (propene) molecules are linked together to form a polymer we call the resulting plastic polypropylene. What do they think multiple styrene molecules that are linked together to form a polymer called? Yes! Polystyrene!

9. Display the common types of plastic image (page 7). Keep this image displayed while step 10 is completed.

10. Read the back of each production card one-by-one. As each card is read an example product made from that particular polymer can be shown.

Front of Production Card	Back of Production Card
Methane 	*Methane* The simplest carbon molecule (a molecule has two or more different types of atoms) is methane. To create the methane molecule, a carbon atom is linked to four hydrogen atoms.
Ethene (Ethylene) 	*Ethene* The simplest monomer, or building block of plastics, is ethene (also called ethylene). The chemical formula for ethylene is C_2H_4. Ethylene is the building block for three different types of plastics. The first type, polyethylene terephthalate (PETE or PET for short) is used to produce plastic bottles, food jars, microwaveable food trays, textiles (polyester), monofilament and carpet, among other products. The second type of plastic for which ethylene is the building block is high-density polyethylene (HDPE). This type of plastic is used to produce bottles (beverage, detergent, shampoo), bags, cereal box liners, and wire and cable covering, among other products. The third type of plastic for which ethylene is the building block is low-density polyethylene (LDPE). This type of plastic is used to produce bags (produce, dry cleaning and garbage), squeeze bottles, container lids, shrink wrap, toys, coatings for milk cartons and beverage cups and wire and cable coverings, among other products.
Vinyl Chloride 	*Vinyl chloride* If one of the hydrogen atoms from an ethene molecule is replaced with chlorine, then the molecule is called a vinyl chloride. The chemical formula for this is C_2H_3Cl. If many vinyl chloride molecules are linked together, the resulting plastic is called a polyvinyl chloride (PVC). This type of plastic is used to produce packaging, pipes, siding, window frames, fencing, flooring and medical products such as the bags and tubing used for intravenous therapy (IV).

Propene 	*Propene* If one of the hydrogen atoms from the original ethylene molecule is replaced with a methyl group, then a new molecule, another monomer, called propene (propylene) is created. The chemical formula for propylene is C_3H_6. If many propene (propylene) molecules are linked together, the resulting plastic is called polypropylene (PP). This type of plastic is used to produce yogurt and other food containers, medicine bottles, straws and more.
Butene  *cis*-2-butene  *trans*-2-butene	*Butene* A third type of monomer, in which yet another hydrogen atom is replaced with another methyl group, is butene. The chemical formula for butene is C_4H_8. Whether the replaced hydrogen atoms are on the same side of the molecule (cis-2-butene), or opposite sides of the molecule (trans-2-butene), determines the structure and alters the chemical properties such that the carbon atoms can subsequently react to form polymers. It is possible to form polybutene, but more commonly butene is combined with other monomers (such as ethylene) to form specialized plastic resins such as hot-melt adhesives.

Benzene   Benzene	*Benzene* If two propene molecules are put together, and the extra hydrogen atoms are removed so that once again double bonds between the carbon atoms can form, then a molecule called benzene is made. The formula for benzene is C_6H_6. Note that instead of the carbon and hydrogen forming a long chain (as in polypropylene), a benzene molecule takes on a hexagon structure. Benzene is not only used to produce plastics, but it is also found in detergents, drugs and pesticides. Besides synthetically produced benzene, benzene can be produced naturally by volcanoes and forest fires.
Styrene 	*Styrene* A fourth type of monomer is styrene. In styrene the original hydrogen group from an ethylene molecule is replaced with a molecule of benzene. The chemical formula for styrene is C_8H_8 or $C_6H_5CHCH_2$ Styrene when linked together forms polystyrene (PS). Polystyrene is found in two forms: extruded and expanded. These materials are used to produce CD cases, plates, bowls, building insulation, coat hangers, medical products, packing peanuts and egg cartons among other products.

Plastic Recycling

Because plastics are so durable, managing this waste stream is challenging. In the 1980s the plastics industry led an influential drive to promote recycling "encouraging municipalities to collect and process recyclable materials as part of their waste-management systems" (Science History Institute, 2019). In 1988, the Society of the Plastics Industry (now the Plastics Industry Association) developed resin codes. Resin codes make it easier to sort and separate differing types of plastic items so that they might be re-purposed.

To be clear, just because a plastic item has a resin code does not mean it is recyclable in your community. Additionally, just because a plastic item does *not* have a resin code (for example, many bottle caps do not have a resin code number) doesn't mean the item is *not* recyclable in your area. So, while resin codes can be helpful when considering what to recycle, they often do not provide the complete picture. The best way to know what is recyclable in your community is to check with your local waste hauler or government entity.

Common Types of Plastic

Resin Code	Name	Product Examples
1	Polyethylene Terephthalate **(PETE, PET)**	Plastic bottles, food jars, ovenable and microwavable food trays, textiles (polyester), monofilament, carpet, and films.
2	High-Density Polyethylene **(HDPE)**	Bottles (beverage, detergent, shampoo), bags, cereal box liners, extruded pipe, and wire and cable covering.
3	Polyvinyl Chloride **(PVC)**	Packaging (clamshells, shrink wrap), pipes, siding, window frames, fencing, flooring, and medical products (blood bags, tubing).
4	Low Density Polyethylene **(LDPE)**	Bags (produce, dry cleaning, newspaper, and garbage bags), squeeze bottles, container lids, shrink wrap, toys, coatings for milk cartons and beverage cups, and wire and cable coverings.
5	Polypropylene **(PP)**	Yogurt and other food containers, medicine bottles, straws, bottle caps, fibers, appliances, and carpeting.
6	Extruded and Expanded Polystyrene **(PS)**	CD cases, yogurt containers, cups, plates, bowls, cutlery, hinged takeout containers (clamshells), electronic housings, building insulation, coat hangers, medical products, packing peanuts and other packaging foam, foamed coolers, and egg cartons.
7	Other is a resin different than the six listed above, or made from a combination of resins.	Three- and five-gallon reusable water bottles, glasses (lenses), some citrus juice and ketchup bottles, oven-baking bags, and custom packaging.

WHAT ARE THE IMPACTS OF MARINE DEBRIS?

LESSON TWO

6

All Tangled Up

Grade Level:
Grades 1 – 4

Subjects:
Language Arts, Science

Overview:
Students perform an experiment in which they wrap a rubber band around their fingers and across the back of their hand and try to disentangle themselves. As a class, students discuss their thoughts and reactions and relate to real animals. Older students will write a short story about an entangled animal.

Objective:
To learn about wildlife entanglement by experiencing what it might be like to be a marine animal trapped in debris.

Vocabulary:
abandoned net, entanglement

Materials:
- A small- to medium-sized (thin) rubber band for each student
- One copy of the "Animal Entanglement" Handout

Learning Skills:
Analyzing, Experimenting, Visualizing, Writing

Duration:
20 minutes

Activity

1. Discuss how animals need a healthy environment in which to live, just like we do. This includes a habitat that is free from pollution. Litter that becomes marine debris can harm the animals that live in or near the ocean.

2. Distribute the rubber bands to students and have them follow the procedure below. (Note: As an alternative, you may want to have one or two students come up to the front of the room to perform the exercise with rubber bands as a demonstration; then include the entire class in the discussion.)
- Hold your hands up in front of your face, with the back of your hands towards your face.
- Hold the rubber band in your right hand and hook one end of it over the little finger of your left hand.
- Hook the other end of the rubber band over the left-hand thumb. The rubber band should be taut and resting across the bottom knuckles on the back of your left hand (see photo above).
- Place your right hand on the bottom of your left elbow, and keep it there.

LESSON TWO


All tangled up

- Try to free your hand of the rubber band without using your right hand, teeth, face or other body parts.

3. While students are struggling, ask the class to imagine that they are seagulls that have gotten pieces of fishing line, abandoned net or other debris wrapped around their beaks or necks. Tell them the birds are unable to eat until they are free from the debris. Ask the students the following questions:

- How would you feel after struggling like this all morning?
- How would you feel after missing breakfast?
- What would happen if you continued to miss meals and spent all of your strength fighting to get free?
- What would happen if a predator were chasing you?

Encourage students to share their thoughts and feelings about being entangled.
Remind them that their experience is similar to that of a bird or other marine animal that becomes entangled in debris.

4. For Grades 3 and 4: Post the "Animal Entanglement" handout at the front of the class. Ask students to select one of the animals pictured and write a paragraph from that animal's point of view telling how it feels to be entangled in marine debris. Students should include as many details from the illustration as possible in describing their experience. Encourage students to use a range of senses and feelings in their descriptions, and to be as imaginative as possible.

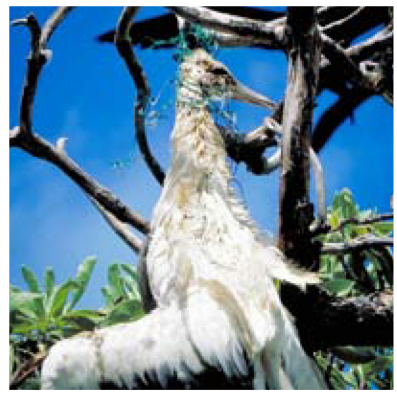
EXTENSIONS

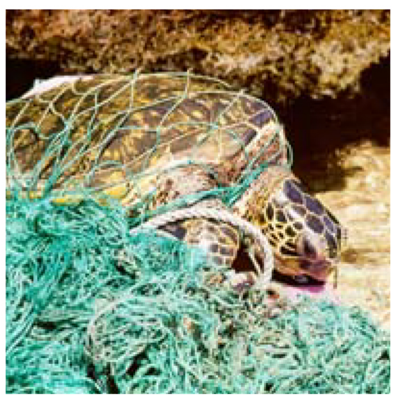
Have a volunteer come up to the front of the room and experiment with entangling his or her hands or arms in a six-pack ring. This activity should be carefully guided by the teacher. Have the student remove the six-pack ring, or help him or her to do so. Then cut the loops of each ring with a scissors. Have another volunteer experiment with becoming entangled in the cut ring. Have students compare the two experiences. Then discuss why cutting six-pack rings is a good practice.

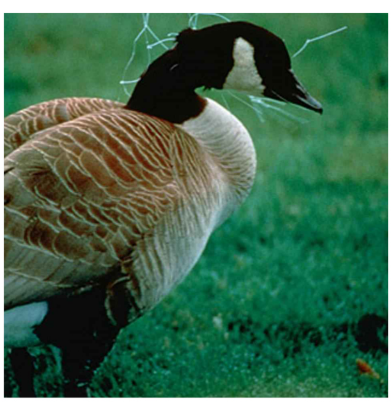
Have students discuss how balloons and balloon ribbons can present problems to fish, birds, turtles and seals. Using the Internet, older students can investigate whether your state has a law against the mass release of balloons. Students can make posters, or write letters to the editors of newspapers to help increase knowledge about the need to keep balloons and balloon ribbons from becoming marine debris.

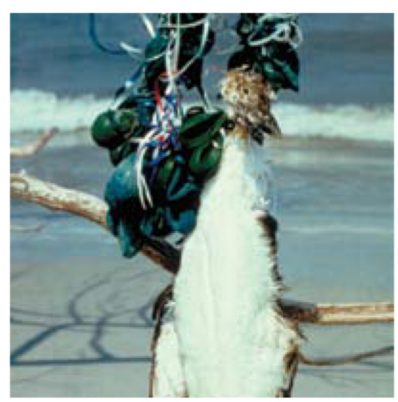
Animal Entanglement











Modified from original

Canada Goose photo courtesy of PIXNIO

7

LESSON THREE

How Harmful Is Marine Debris?

Grade Level:
Grades 3 – 7

Subjects:
Language Arts, Science, Social Studies

Overview:
Students complete a form that requires them to make decisions about how severely different types of marine debris affect animals, people, vessels, and habitat. As a class, results are totaled and analyzed to determine which types of marine debris are most harmful to the different categories.

Objective:
To explore the effects of marine debris on animals, people, vessels and habitats.

Vocabulary:
ghost fishing, medical waste

Materials:
- Enough copies of the "How Harmful Is It?" handout for the entire class. This is a three-page handout.
- Examples of the different types of debris to be discussed (to accompany the handout above):
  - -Fishing line
  - -Paper cup
  - -Lobster or crab pot
  - -Six-pack ring
  - -Resin Pellet
  - -Plastic grocery or trash bag
  - -Broken glass bottle [CAUTION – use care when handling this material]
  - - Section of a fishing net

Learning Skills:
Analyzing, Calculating, Classifying, Comparing and Contrasting, Decision-Making

Duration:
30 minutes to complete tally; 30 minutes (preferably the next day) to analyze and discuss results

Activity

1. Distribute the "How Harmful Is It?" (three-page) handout to the class. Make sure students are familiar with the types of debris presented in the handout. If possible, label and display examples of the actual debris or use sample debris images provided at the end of this lesson. Review with students the instructions at the top of the handout. Then have students complete the table.

2. Collect the handouts and calculate class subtotals for each type of debris on the handout (add together the students' subtotals and divide by the number of students in the class). NOTE: You can do this with the class or on your own and present the totals the next day. Pass back to students their original handouts.

3. Write the class subtotals on the board. As a class, analyze the results of the tally. Initiate discussion by asking questions such as the following:

- According to class results, which types of marine debris are most harmful to seals? Sea turtles? Seagulls? Which type or types of debris seem to be most harmful to animals in general? (Repeat this series of questions for people, vessels and habitats.)
- According to class results, which types of marine debris are the most harmful? Do you agree? Why or why not?
- According to class results, which type of debris is the least harmful? Do you agree? Why or why not?
- Are there any types of debris that received a low grand total, yet are very harmful on the list? Which ones?

4. Discuss with students how their individual results might have varied from the class results. Help them to understand that people may have had different opinions about how harmful certain debris is based on their own attitudes and experiences.

The discussion also should introduce the concept that the abundance of certain types of debris may make them more harmful on a large scale than other types that appear to be more dangerous. For example, bottles and cans may be abundant forms of debris, but they are not as potentially harmful as other forms of debris such as discarded fishing line and abandoned nets. One fishing net can continually maim or kill unsuspecting wildlife, while a hundred soda cans on the beach are primarily an eyesore and will not intentionally harm marine and coastal animals and communities.

NOTE: The numbers that students arrive at by doing this exercise do not represent objective data on marine debris effects. Instead, they help students explore the many ways that debris can harm the different components of marine and coastal communities. Students should come away with the knowledge that certain types of debris may have a greater effect on specific animals, people, vessels and habitats, but that almost all marine debris can be harmful to these different communities.

EXTENSIONS

Have students design a “Most Wanted” poster for the type of marine debris that they think is the most dangerous. The poster should include an illustration of the debris and list some of its “crimes.” Students might also mention a “reward” on the poster for the person who finds this type of debris and disposes of it properly or identifies it to the proper authorities for disposal.

Have students find articles and papers about marine debris written by scientists, and compare the data in these publications with the results from the class exercise. Have the students compare and contrast the two sets of information, and indicate what they found most interesting from the scientific publications about marine debris.

DIVE DEEPER:

Other Resources on Marine Debris

- NOAA’s Marine Debris 101: www.marinedebris.noaa.gov
- EPA’s Marine Debris site: http://water.epa.gov/type/oceb/marinedebris/index.cfm

HANDOUT

How Harmful Is It?

Instructions: Decide how harmful each type of marine debris would be if it came into contact with the animals, people, vessels and habitats listed below. Write the number that best reflects your opinion in the appropriate box. (For example, if you think fishing line would be very harmful to a seal, write the number "3" in the spaced provided.) When you have completed the chart, calculate the subtotals for each type of debris. Then calculate the grand totals at the bottom of the page.

1 = rarely or never harmful
2 = sometimes harmful
3 = very harmful

Animal	Fishing Line	Paper Cup	Lobster Trap	Six-Pack Ring	Resin Pellet	Plastic Bag	Broken Glass Bottle	Lost Fishing Net
Crab or Lobster								
Fish								
Sea turtle								
Seagull								
Seal								
Subtotal								

People	Fishing Line	Paper Cup	Lobster Trap	Six-Pack Ring	Resin Pellet	Plastic Bag	Broken Glass Bottle	Lost Fishing Net
Beachgoer								
Boater								
Diver								
Fisherman								
Subtotal								

HANDOUT

How Harmful Is It?

1 = rarely or never harmful
2 = sometimes harmful
3 = very harmful

Vessels	Fishing Line	Paper Cup	Lobster Trap	Six-Pack Ring	Resin Pellet	Plastic Bag	Broken Glass Bottle	Lost Fishing Net
Boat with motor								
Canoe or Kayak								
Personal watercraft (example: jet ski)								
Sailboat								
Subtotal								

Natural Environments	Fishing Line	Paper Cup	Lobster Trap	Six-Pack Ring	Resin Pellet	Plastic Bag	Broken Glass Bottle	Lost Fishing Net
Beach								
Coral reef								
Oyster bed								
Open water								
Wetland or Marsh								
Subtotal								

Grand Total								

HANDOUT

How Harmful Is It?


Fishing Line

Paper Cup

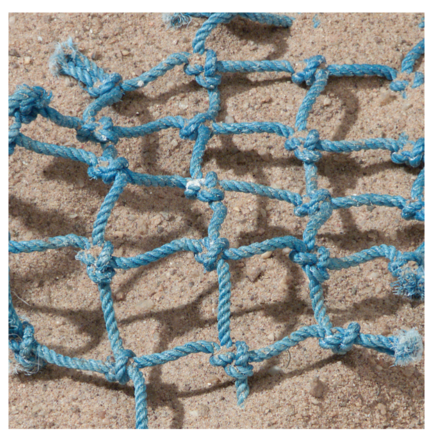

Lobster Trap


Six-Pack Ring

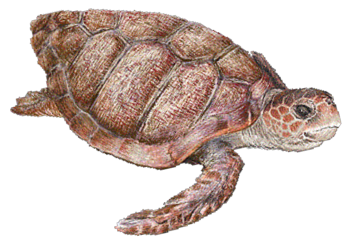

Resin Pellet


Plastic Bag


Broken Glass Bottle


Lost Fishing Net

Plastic in the Water Column



Topics
Density, Plastics

Grades
6-8

Site
Indoors

Duration
45 min

Materials
See page 2

Vocabulary
benthic, buoyancy, density, pelagic, plastic, surface

8

Next Generation Science Standards

Practices
Developing and using models
Core Ideas
ESS3.C Human impacts on Earth systems
Crosscutting Concepts
Cause and effect
Performance Expectations
See page 5

Focus Question

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

Overview

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

Objectives

Students will be able to:

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

Background

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

Some plastics float in sea water, others sink and some remain neutrally buoyant. Density is one factor that affects the **buoyancy** and location of the plastic debris in the water column. **Density** is the ratio of a material's mass to its volume. Density is the same value for a certain type of material, regardless of the size of the object. Density can be calculated by dividing an object's mass by its volume

(D=M/V). Density is an important property of all materials, whether solid, liquid, or gas. It measures a material's compactness, or how much mass is squeezed into a given space. If plastic is more dense than sea water, it will sink. If it's less dense, it will float.

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

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

VOCABULARY

Benthic: on or near the bottom of an ocean or lake

Density: mass divided by the volume of an object, or the amount of matter in a given volume

Pelagic: the open waters or sea, not the surface or the bottom

Plastic: durable material made of chained molecules, doesn't biodegrade

Surface: on or near the top of the water

Materials

Per student:

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

Per student group:

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

Teacher Preparation

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

2. Make copies of the **Density Table** (one for each group), **Ocean Feeder Cards** (enough for each student to have one cut-out card) and **Plastics in the Water Column** (copy for each student). Either make one copy of the **Water Column Cross Section** for each group or a transparency to project for the class.

3. Give students homework the day before the activity. In a science notebook or on a piece of paper have them look around their home and make a list of 10 plastic items or products and the resin identification codes (if the items have one).

Procedure

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

Part One: Density and Buoyancy

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

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

The mission of the Monterey Bay Aquarium is to inspire conservation of the oceans.

Part Two: Impacts on Marine Food Webs

4. **Introduce the idea of plastics in the watershed and ocean.**
Ask students how plastic may reach the ocean. Then show them "Synthetic Sea" (at www.algalita.org/video/synthetic-sea-plastic-in-the-open-ocean-by-bill-macdonald/) and share statistics from
Algalita Marine Foundation about plastics found in the watershed. How do they think plastics impact marine animals? *(consumption, entanglement)*

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

6. **Students share which plastics may impact their animal with the class.**
Project the **Water Column Cross Section** of the ocean. Have students share information about their animal, plastics that could impact it and why those plastics could impact the animal. You may have them label the plastic code and name on the cross section. See the **Density Table Key** for which plastics float and sink.

7. **As a class, discuss impacts of plastics on marine animals.**
If marine animals consume plastic, what might that do to the food web? *(predators of marine animals that consume plastic indirectly consume plastic, individuals may die, populations may be impacted*) How could plastic on the surface impact a benthic or pelagic animal? *(toxins leach off of plastic into the water, an animal may feed in the surface zone and consume plastic but travel in other zones and be consumed by animals who feed there)*

We ourselves feel that what we are doing is just a drop in the ocean. But the ocean would be less because of that missing drop.

Mother Theresa

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

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

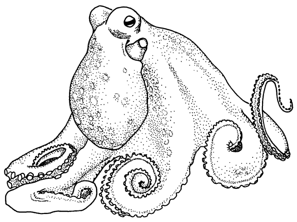
Extensions

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

Resources

Websites

Algalita Marine Research Foundation www.algalita.org
Learn more about debris found in the Pacific Gyre as well as research reports and educational resources.



Center for Microbial Oceanography (C-MORE)
http://cmore.soest.hawaii.edu/education/teachers/science_kits/marine_debris_kit.htm
Find several free activities exploring the cause, distribution and biological impacts of marine debris.

Monterey Bay Aquarium www.montereybayaquarium.org
Find information on many marine consumers as well as other classroom activities.

The Story of Stuff Project www.storyofstuff.com
Watch the story of bottled water and access free curriculum resources.

References

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

Standards

Next Generation Science Standards www.nextgenscience.org

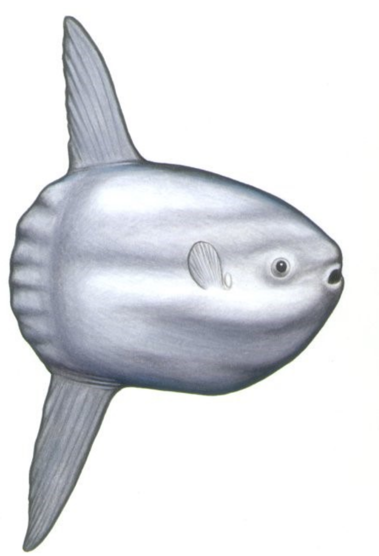
Performance Expectation
Relates to MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Common Core State Standards www.corestandards.org

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

Acknowledgements

Adapted from the activity, "You Are What You Eat" pp. 110-116 in *Waves, Wetlands, and Watersheds*, 2003 California Coastal Commission Science Activity Guide.



Name:

Plastic in the Water Column

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

	Plastic Item	RIC code (number on object)	Prediction: Do you think this plastic sinks or floats?	Results: Did it sink or float?
1.				
2.				
3.				
4.				
5.				

2. Look at the **Density Table** to answer the following questions.

- Compare the densities of fresh and salt water. Which is more dense? Which is less dense? Why do you think salt water is more dense than fresh water?
- Which plastic will float in fresh water? Sea water? How do you know?
- Does that match your findings? Explain. (Think about why you may have gotten different results.)
- Bonus: Explain how you could make any floating object sink. (Remember that density equals mass divided by volume.)

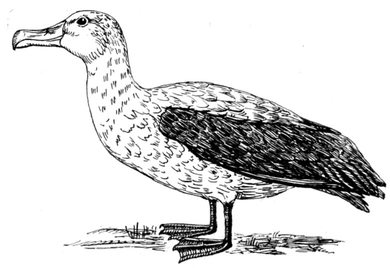
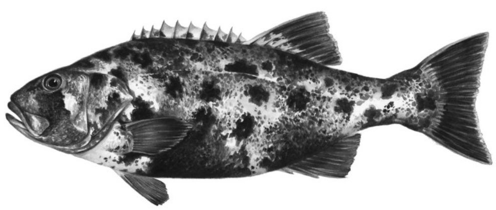
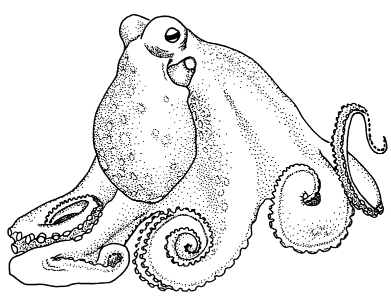
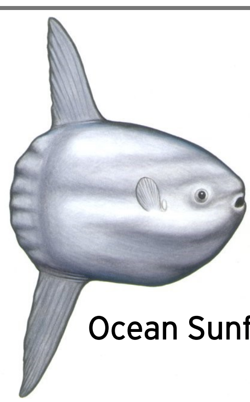
Density Table

Resin ID Code	Name	Density (g/mL)	Uses
	Plastic		
1	**PETE** Polyethylene terephthalate	1.38-1.39	Soft drink and water bottles, peanut butter containers, salad dressing and vegetable oil containers
2	**HDPE** High-density polyethylene	0.95-0.96	Milk jugs, detergents, household cleaners, motor oil containers, some garbage bags, butter and yogurt tubs
3	**PVC** Polyvinyl chloride	1.16-1.45	Clear food packaging, medical equipment, siding, piping, windows, shampoo bottles
4	**LDPE** Low-density polyethylene	0.92-0.94	Squeezable bottles, various bags (for bread, frozen food, shopping and dry cleaning), clothing, furniture
5	**PP** Polypropylene	0.90-0.91	Syrup bottles, ketchup bottles, caps, straws, medicine bottles
6	**PS** Polystyrene (two kinds)	0.020-1.07	CD cases, meat trays, egg cartons, disposable plates and cups
7	**Other** Many kinds	Varies	DVD cases, iPod packaging, signs and displays, nylons
	Other Substances		
	Fresh Water	1.00	
	Sea Water	1.03	

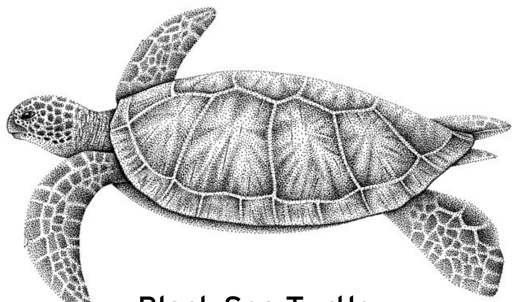
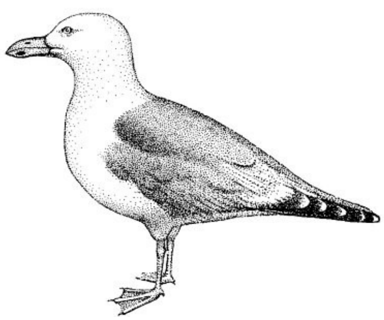
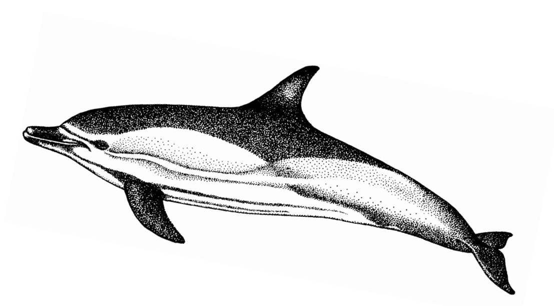
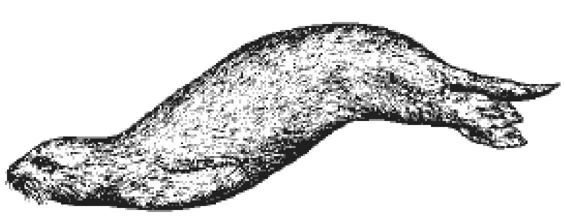
Density Table Key

Resin ID Code	Name	Density (g/mL)	Uses	Where in the Water Column
	Plastic			
1	**PETE** Polyethylene terephthalate	1.38-1.39	Soft drink and water bottles, peanut butter containers, salad dressing and vegetable oil containers	Sinks: benthic feeders (octopus, otter, bass)
2	**HDPE** High-density polyethylene	0.95-0.96	Milk jugs, detergents, household cleaners, motor oil containers, some garbage bags, butter and yogurt tubs	Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)
3	**PVC** Polyvinyl chloride	1.16-1.45	Clear food packaging, medical equipment, siding, piping, windows, shampoo bottles	Sinks: benthic feeders (octopus, otter, bass)
4	**LDPE** Low-density polyethylene	0.92-0.94	Squeezable bottles, various bags (for bread, frozen food, shopping and dry cleaning), clothing, furniture	Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)
5	**PP** Polypropylene	0.90-0.91	Syrup bottles, ketchup bottles, caps, straws, medicine bottles	Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)
6	**PS** Polystyrene (two kinds)	0.020-1.07	CD cases, meat trays, egg cartons, disposable plates and cups	Sinks or Floats: surface (gull, albatross) or benthic feeders (octopus, otter, bass)
7	**Other** Many kinds	Varies	DVD cases, iPod packaging, signs and displays, nylons	Varies: potentially all feeders
	Other Substances			
	Fresh Water	1.00		
	Sea Water	1.03		

Ocean Feeder Cards

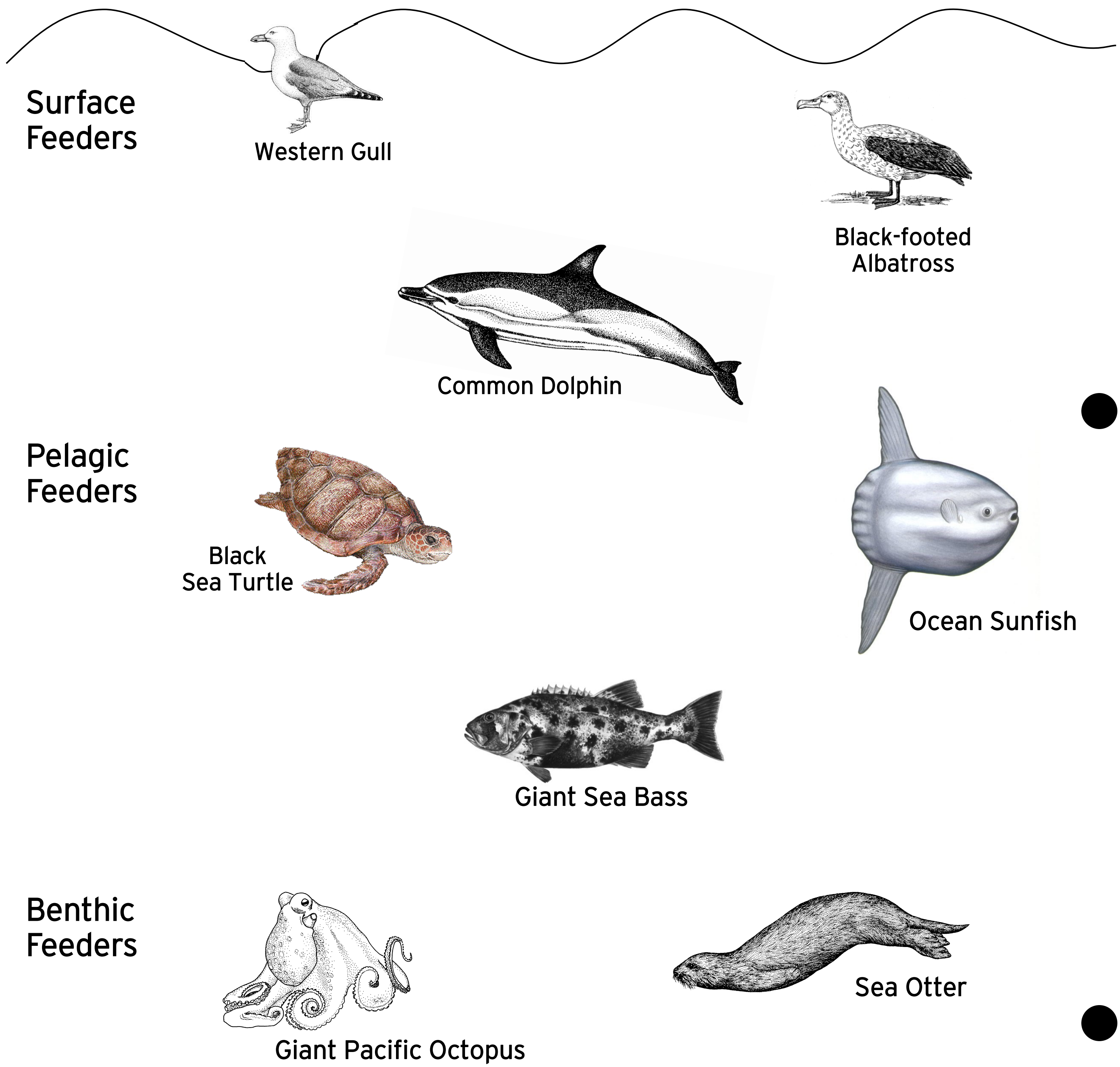
 Black-footed Albatross	**Black-footed albatross** **Surface and Pelagic Feeder** *Phoebastria nigripes* size: wingspan up to 7 ft. (215 cm) and 7.7 lbs. (3.5 kg) This seabird spends three years at sea when it first leaves the nest. It lands on the water to sleep and eat. It locates prey with a keen sense of smell. Parents regurgitate their prey to feed their chicks. **Diet:** squid, fish, fish eggs, crustaceans **Feeding Strategy:** forages on the surface while swimming or dives underwater to catch food with beak **Habitat:** open ocean (sandy shore during breeding)
 Giant Sea Bass	**Giant sea bass** **Pelagic and Benthic Feeder** *Stereolepus gigas* size: to 8.2 ft. (2.5 m), 562 lbs. (255 kg) These fish are able to quickly and dramatically change colors. Often known as black sea bass, these large fish aren't known for speed. Thus they often feed on the ocean floor. **Diet:** sting rays, skates, lobster, crabs, flatfish **Feeding Strategy:** catch prey by rapidly opening large mouth; hide in shadows of kelp to ambush some prey **Habitat:** open water
 Giant Pacific Octopus	**Giant Pacific octopus** **Benthic Feeder** *Enteroctopus dofleini* size: to 50 lbs. (23 kg) and 15-ft. (4.5 m) wide This octopus has over 2,000 suckers through which it grips, smells and tastes. It is able to change its color to camouflage into its surroundings. **Diet:** clams, abalone, rockfish, crabs, other octopuses **Feeding Strategy:** catches food with suckers and crushes with beak **Habitat:** reefs and pilings
 Ocean Sunfish	**Ocean sunfish** **Pelagic Feeder** *Mola mola* size: to 14 ft. (4.3 m), 5,000 lbs.(2,268 kg) (up to 1,000 lbs. in Monterey Bay) This fish hatches from a tiny egg and grows up to be the size of a small pickup truck. Ocean sunfish live in almost all of the world's oceans and often swim at the surface sometimes appearing to sunbathe! **Diet:** jellies, plankton, small fishes like anchovies **Feeding Strategy:** slurps food through fused teeth, shredding prey until its small enough to swallow **Habitat:** open water

Ocean Feeder Cards

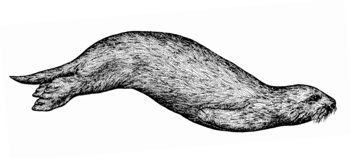
 Black Sea Turtle	Black sea turtle Pelagic Feeder *Chelonia agassizii* size: to 4 ft. (1.2 m) This sea turtle is actually a type of green sea turtle. As a juvenile, it feeds in the open ocean on invertebrates, algae and jellies. As an adult, it becomes primarily an herbivore and moves closer to shore, eating sea plants. **Diet:** jellies, invertebrates, sea plants, algae **Feeding Strategy:** uses sharp beak to cut and tear its food. **Habitat:** open water
 Western Gull	Western gull Surface Feeder *Larus occidentalis* size: 24-27 inches (61-70 cm) To break open prey like clams and sea urchin, this seabird drops its food from high in the air to hard surfaces below. Often fed by humans, contaminants in people food can harm its health. **Diet:** fishes, carrion (dead animals), marine invertebrates, birds, birds' eggs, garbage **Feeding Strategy:** uses beak to catch small fish at the surface **Habitat:** coastal water
 Common Dolphin	Common dolphin Pelagic Feeder *Delphinus delphus* size: to 8 feet (2.5 m), 250 pounds (113 kg) These dolphins travel in pods of up to 2,000 animals. They are extremely active and ride the waves of large ships and whales. They work together to herd schools of fish into a tight ball and then eat them. **Diet:** fishes and squid **Feeding Strategy:** catches prey with beaklike mouth **Habitat:** open water
 Southern Sea Otter	Southern sea otter Benthic Feeder *Enhydra lutris* size: to 5.5 ft. (1.7 m) An otter hunts on the seafloor but returns to the surface to eat. It uses its chest as a table. An otter has pockets of skin under each forearm where it can keep prey or tools to crack open its food. **Diet:** crabs, snails, urchins, clams and other benthic invertebrates **Feeding Strategy:** uses paws to catch and open food **Habitat:** kelp forest

Water Column Cross Section

Some plastic floats, some sinks. However, all plastic may have an impact on marine animals if they make it into the ocean. Which kinds of plastic-may impact which animals? (Hint: use the number on object that indicates the resin identification code.)



Does it Sink or Float?



1. Examine the plastic objects.

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

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

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

5. Discuss:
    - What would happen if the plastic you tested made it into the ocean? Would any of those animals be affected?
    - Which animals would be affected by which type of plastic? Why do you think that?

What is the impact of beach litter?

9

BACKGROUND

Although marine debris is a major pollution problem of the 21st century, it is a solvable problem. Beach litter can be comprised of marine debris that has been washed ashore, or it can be deposited along the coast by inland storms or human activities. Understanding the causes and effects of beach litter helps us to make environmentally responsible decisions with waste. As we consider the impacts of beach litter, there are a number of ways of visualizing those changes.

Objectives: In this activity, students will construct a web of things that may increase or decrease as a result of beach litter.

After completing this activity, students will be able to:

- List and explain many potential impacts of beach litter.
- Discuss various interpretations of the possible debris impacts.

Materials: Blank wall, bulletin board or a few large tables pushed together
1 per group
Tape or push pins if using a blank wall or board
50-75 per group
1 card labeled "BEACH LITTER"
1 per group
40 cards labeled "MORE" on one side and "LESS" on the other side
1 set per group
35-40 scientific and social impact cards
1 set per group

Subject/Grades Levels: Environmental Science/Grades 5-12 and adult learners

Time required: 1 class period

TEACHER'S NOTES

- Because of space, this activity can be done as a whole class or in large groups (i.e., 3 groups of 10 students in a class of 30). If used with small groups, impact cards and MORE/LESS words can be put on 3 X 5 note cards or small pieces of paper. This avoids the problem of students having to wait for their turn at the table/board, and it also results in many different maps that can be compared in group discussion.
- Use one color paper for the MORE/LESS words and another color for the impact cards.
- While a variety of impact items are provided, feel free to add other scientific and social impacts as appropriate.
- Materials can be laminated for continuous use.

ALIGNMENT

Next Generation Science Standards (for grade 5, middle school and high school):
Disciplinary Core Idea ESS3.C Human Impacts on Earth Systems
Crosscutting Concept CC2 Cause and Effect

Great Lakes Literacy Principles:
#6b,e,f: The Great Lakes and humans in their watershed are inextricably interconnected.
#8f: The Great Lakes are socially, economically and environmentally significant to the region, the nation and the planet.

This activity can be used at various stages of a unit. For instance, it can introduce a new topic and relate it to previous ones or it can be a culminating activity to draw all aspects of a study together.

ENGAGE

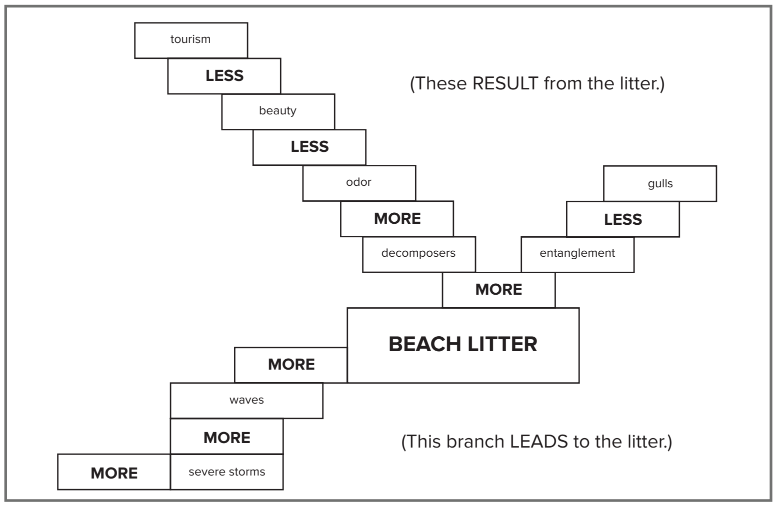
Pose to and discuss with students the following broad questions: How does litter get onto a beach? What do you think the most common type of litter on a beach is? What is the most interesting piece of litter you have ever seen wash ashore on a beach? Have you ever picked up litter on a beach?

This activity can be done on a beach. You may want to make cards using heavier tag board or use rocks to help hold cards in place so they do not blow away. Remember to remove any materials from the beach when you are finished.

EXPLORE

1. Determine whether the activity will be done as a whole class or in large groups.

2. Assemble materials by placing the MORE/LESS cards in a pile and spreading out the impact cards. Place the BEACH LITTER label in the center of a large table or board.



3. Invite students to come forward one at a time to select an impact card which is a direct result of a previously placed card. They should then select either MORE or LESS as a connector between the two impacts and place them in the web to show a sequence of events. For example, the first student may decide that BEACH LITTER (center card) leads to MORE ENTANGLEMENT or that WAVES (impact card) cause MORE BEACH LITTER. Students must be able to justify the position of the cards they add and their choices of MORE or LESS impact.

EXPLAIN

4. As students use these cards, it will become apparent that there are various interpretations of the impacts. Lead the class in a discussion of all interpretations.

5. If there are multiple groups completing the activity simultaneously, have groups prepare a written or oral presentation of their maps, analyzing the thinking about interrelationships that produced the array.

EXTEND

Lead a class discussion about additional impact cards that could be added to the web.

Lead a class discussion identifying the factors that have an economic impact attached to them. For example, *less tourism* or *more severe storms* might suggest a loss of revenue or increase in expenses.

Have students access the Ocean Trash Index in *Working for Clean Beaches and Clean Water*, the Ocean Conservancy's report summarizing data from the 2012 International Coastal Cleanup. Have them use Excel or other graphing software to create a pie chart that depicts the Top Ten Things Found as percentage values.
http://www.oceanconservancy.org/our-work/international-coastal-cleanup/icc-2013-report.pdf

Participate in a beach cleanup and record data about the items collected. Compare your data with those reported by the Ocean Conservancy. Are your top ten items collected similar to those in the Ocean Trash Index?

EVALUATE

A suggested way to use this activity is as a pre- and post-assessment for a unit. Have students construct the web prior to any discussion or activities and then again after learning. Students can take a picture of the concept map created at the beginning of a unit and compare it with the map produced at the end.

Sample evaluation questions

1. Select a chain of at least eight cards. Diagram the chain and give a possible explanation for the links illustrated. Then, trade chains with a partner and have them add two or three additional links.

2. List and discuss potential scientific and social factors which may be affected by beach litter.

ADDITIONAL RESOURCES

The Alliance for the Great Lakes (***www.greatlakes.org***) facilitates Adopt-a-Beach™ clean-up programs across the Great Lakes.

The Ocean Conservancy facilitates the International Coastal Cleanup, a unified global effort to clean up marine debris, every September. Access past years' data and find out more about participating at ***www.oceanconservancy.org***.

REFERENCES

Ocean Conservancy. 2013. International Coastal Cleanup: Working for Clean Beaches and Clean Water. Available online at ***http://www.oceanconservancy.org/our-work/international-coastal-cleanup/2013-trash-free-seas-report.pdf***

BEACH LITTER

MORE

LESS

MORE

LESS

LESS

MORE

LESS

MORE

shipping

odor

biological diversity

severe storms

shoes

flooding

recreation

water pollution

smoking

longshore current

gulls

beauty

recycling

shoreline development

oxygen

lake levels

lakefront property

rain

injuries

disease

biodegradation

combined sewer overflow

decomposers

entanglement

people

sun

waves

cooperation

fish

law

ugliness

debate

plastic

tourism

water

swimming

LESSON THREE

10

A Degrading Experience

Grade Level:
Grades 5 – 8

Subjects:
Language Arts, Science

Overview:
Students perform an experiment to learn how different types of debris degrade and how weather and sunlight affect the rate of degradation.

Objectives:
- To examine the degradation of debris and learn how degradation affects the persistence of debris in the marine environment.
- Students will learn that debris made from natural materials, while biodegradable, can still be considered a pollutant, and can still be harmful to the marine environment.

Vocabulary:
degradable, biodegradable, persistent, photodegradable

Materials:
Assorted pairs of trash items. The following pieces of trash are recommended: two apple cores, two paper bags, two plastic bags, two candy wrappers, two plastic cups, two waxed-paper cups, two drink boxes and straws, two paper egg cartons, two foamed plastic egg cartons, two pages of newspaper, two foamed plastic packing peanuts, two starch packing peanuts, two six-pack rings, two steel soup cans, and two glass bottles.

NOTE: All containers should be empty.

- Two large, shallow, containers (such as large dishpans)
- Two pieces of netting or screening (to cover the containers so that materials do not blow away)
- Two pieces of rope or string
- An outdoor thermometer
- Newspaper
- One copy of the “Degradation Data – Outside” handout for every month of the experiment (This includes a place to write weather observations.)
- One copy of the “Degradation Data – Inside” handout for every month of the experiment

Learning Skills:
Analyzing, Classifying, Collecting Data, Comparing and Contrasting, Experimenting, Hypothesizing, Observing.

Duration:
Two 40-minute periods for discussion, set up, and clean up; five minutes every day (for at least two months) to record weather observations; 10 to 20 minutes every week (for at least two months) to record degradation observations (Note: The longer that the experiment is continued, the more dramatic the evidence that degradation has occurred will be.)

SAFETY PRECAUTIONS
All trash objects should be cleaned and checked by the teacher before being handled by students. Avoid any sharp objects or materials containing harmful chemicals.

LESSON THREE

Activity

1. Explain to students that they will be performing an experiment to learn how trash degrades in the marine environment. Discuss the concept of degradation with students, and explain that some important signs of degradation are changes in shape, color, and size of an item. (Note: The loss of an item's ability to withstand being pulled apart also is an important sign of degradation, but this only should be evaluated at the end of the experiment so that the natural degradation process is not accelerated.)

2. Next, set up the experiment. Fill the containers half way with water. Put one of the pieces from every pair of trash in each container. Cover one container with netting or screening, and secure the covering with the rope or string. Take the covered container outdoors, and place it in an area that receives sun for as much of the day as possible. Keep the other container inside the classroom, and put it in an undisturbed area. (Note: You may want to put signs near the containers that say, "Science experiment – Do not touch!" Be sure to inform your school's employees about the importance of not disturbing the containers.)

3. Every day, have a different student record the weather conditions in the "Weather Watch" handout. Record the outdoor temperature, the type of cloud cover there is (to determine how much sunlight the experiment is receiving), and whether or not there has been any rain or other precipitation.

4. Every week (for a minimum of two months) have the class observe the changes in the trash items, both in the indoor and the outdoor containers. Have different students fill in the "Degradation Data" handouts every week. (Note: You may want to use a camera to take pictures of the degrading trash on a weekly basis to monitor and display changes as accurately as possible. When taking pictures, place a card with the date on it in the upper right hand corner of the photograph to keep a precise record of when the photograph was taken.)


Assorted microplastics

LESSON THREE

EXTENSIONS

Six-pack rings are now made of photodegradable plastic (plastic that degrades when exposed to sunlight). Conduct an experiment to observe photodegradation. (Note: This experiment should be conducted over at least a three-month period.) Place 12 six-pack rings in an area of the classroom that will not be disturbed. Then, fasten the same number of six-pack rings outside in an area that is usually in the sun and will not be disturbed. Make sure all rings are separated, do not touch one another, and are not blocked from the sun. Every week take a six-pack ring from both locations and compare how they look and how much they stretch when pulled. Discuss the differences.

If your school is near the coast or a body of freshwater, conduct an experiment to see if trash degrades faster in water or on land. Place several trash items in a mesh bag or sack. Take these netted items to a pier, marina, or other site where the mesh bag can be tied onto a fixed object so that it hangs in the water. Make sure the trash cannot escape and that the net is tied securely so that you are not generating marine debris! (Note: If the site privately owned, be sure to check with its owner before proceeding.) Place identical pieces of trash in a plastic net and tie it to a post on land. Make sure the trash is securely fastened. Periodically compare the degradation using the procedure outlined in this lesson.

5. At the end of the experiment, spread newspaper over a large table. Divide the table into two sections and label one side "indoor" and the other "outdoor." Retrieve both containers and place them on the appropriate sides of the table. Take each pair of trash pieces out of the containers one at a time and compare the visible differences between the "indoor" and "outdoor" pieces of trash. Then have a student try to pull apart the pieces of trash to determine if there is a difference in strength between the "indoor" and "outdoor" pieces. Ask the students the following questions.

- Which pieces of trash have degraded?
- Does whether the piece of trash was indoors or outdoors affect how much it has degraded? How?
- Which types of trash were degradable? Which types were persistent?
- Does the ability of an item to degrade affect whether it is found in the marine environment? Based on this experiment, hypothesize how degradability affects marine debris.

6. Compare the completed "Weather Watch" and "Degradation Data" handouts. Ask the class the following questions:

- Did the weather seem to affect the rate of degradation? How?
- What weather conditions increase degradation rates?

DIVE DEEPER:

Other Resources on Marine Debris

- NOAA's Marine Debris website: www.marinedebris.noaa.gov
- EPA's Marine Debris site: http://water.epa.gov/type/oceb/marinedebris/index.cfm

HANDOUT

Degradation Data – Outside

Month: ______________________

Teachers: customize this handout based on the trash items you have in your experiment.

Item	Week 1	Week 2
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

Weather Watch - Week 1

Date	Temperature	Cloud Cover	Precipitation

Weather Watch - Week 2

Date	Temperature	Cloud Cover	Precipitation

HANDOUT

Degradation Data – Outside

Month: ______________________

Item	Week 3	Week 4
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

Weather Watch - Week 3

Date	Temperature	Cloud Cover	Precipitation

Weather Watch - Week 4

Date	Temperature	Cloud Cover	Precipitation

HANDOUT

Degradation Data – Inside

Month: ____________________

Teachers: customize this handout based on the trash items you have in your experiment.

Item	Week 1	Week 2
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

HANDOUT

Degradation Data – Inside

Month: ____________________

Item	Week 3	Week 4
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

WHAT CAN WE DO ABOUT MARINE DEBRIS?

ACTIVITY: PREVENTION CORNERS

OBJECTIVE: Participants will examine different prevention methods as they pertain to particular items of marine debris and think creatively on multiple options for marine debris prevention.

MATERIALS:

- White Debris Deck, can also use Grey Debris Deck, if needed
- Open space or room to clearly divide into four corners
- (Optional) Half sheets of paper to make "signs" to label the four categories: Reduce, Reuse, Recycle, Other

INSTRUCTIONS:

1. Pass a marine debris item card to each participant.
2. In an open space, designate four separate spaces or corners and label these the 3 R's: "Reduce", "Reuse" and "Recycle" plus one "Other" spot.
3. Explain the "Other" corner includes any of the ideas listed a few minutes ago and provides the chance to be creative when thinking about marine debris prevention.
4. Explain to participants that they must choose one of the corners as an alternative outcome for their item, instead of becoming marine debris. For instance, someone with "grocery bag" might choose the "Reduce" corner while someone with "beverage bottle" might choose the "Recycle" group.
5. Provide participants with about 2–3 minutes to move to their desired outcome corner, based on their individual items.

DISCUSSION:

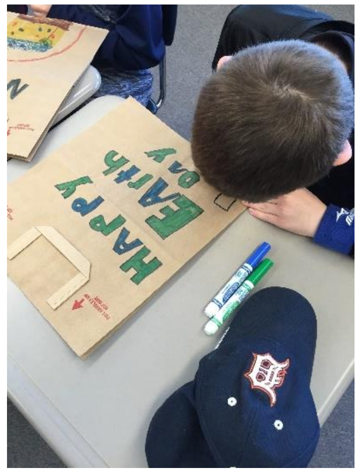
- Ask each participant to explain his or her choice for that marine debris item. Start in one corner and work around to all four categories. You can prompt students with these questions:

  ASK:

  - **What is your item?**
  - **Why did you choose this corner?**
  - **If you chose "Reduce" or "Reuse," how would you reduce/reuse that item in a different way?**
  - **If you chose "Other," what outcome did you come up with for your item?** This can be as simple or creative as participants wish. For instance, someone with "microwave" may simply state "dispose of responsibly" or a participant with cigarette butts may say "outlaw smoking."
- Explain to participants there is no right or wrong answer. All of the items could go into multiple categories.
- (Optional) Provide students an additional 2 minutes to choose a new category for their item and repeat the discussion prompts with a couple of the participants.

11

EARTH DAY BAG PROJECT LESSON PLAN



Grades: 3-5 | Time: 60 minutes | http://bit.ly/NEMIEDBP

PURPOSE: This lesson helps youth explore the impacts of single-use plastics and be part of the solution by raising awareness about the issue and importance of refusing to single use. Choosing to be stewards of our Great Lakes and ocean is a personal decision and should not be forced. However, youth should have opportunities to explore and learn.

OBJECTIVES: Students will be able to...

- Explain multiple ways to be a part of the solution and refuse single-use plastics
- Share their knowledge of the impact of plastics on the Great Lakes and ocean in their community with decorated grocery bags
- Identify ways that plastics are negatively affecting our community, the Great Lakes, and ocean
- Learn more about being a better steward of the Great Lakes and ocean

MATERIALS: Crayons or Markers | Paper grocery bags | Printed Labels | Videos

Google drive link to videos (http://bit.ly/2019EDBPvideos)

BACKGROUND INFORMATION:

Oosthoek, S. (March 24, 2017). Deep-sea dump: Trash is collecting on the Arctic seafloor. *Science News for Students.* Retrieved from: http://bit.ly/trashocean

Yeager, A. (Dec. 16, 2016). Food-like smell on plastic may lure seabirds to eat it. *Science News for Students.* Retrieved from: http://bit.ly/seabirdsplastic

12

PROCEDURE

*Before launching the lesson, reach out to a local grocery store to partner with you for this effort. You will use paper grocery bags from the store, and once decorated, these bags will return to the grocery store on **Earth Day (4/22)** to raise awareness about the impact of plastic pollution and solutions to this growing problem.*

1. Ask youth - what are single-use plastics?
    - Brainstorm where you might find single-use plastics.
2. Ask youth - do you think single-use plastics are a problem for our Great Lakes?
    - Quickly ask each student to respond yes or no. Do not comment!
    - Then, ask a couple youth, who responded yes, to explain why plastics are a problem.
        - Look for personal connections (e.g. I cut my foot on a piece of plastic at the beach).
    - Then, ask a couple youth, who responded no, to explain why plastics are not a problem.
        - Many people do not think about the impact of plastic on our Great Lakes.
3. Today, we are going to explore the impact of single-use plastics on our Great Lakes and ocean.
4. Watch *How Much Plastic is in the Ocean?* (http://bit.ly/howmuchplasticinocean) and discuss video referencing the guiding questions below.
    - How did plastic animals that were spilled in the Pacific Ocean end up in the British Isles?
        - Ocean currents transport water, nutrients, and plastic pollution all over the earth.
    - When trash and plastic enter our storm drains in northeast Michigan, where does it eventually end up?
        - Most of our storm drains flow directly into local streams or rivers and sometimes into the Great Lakes.
        - When trash enters our storm drains, that trash flows into a local stream or river.
        - All but two rivers in Michigan lead to the Great Lakes, and the Great Lakes eventually flow to the ocean.
        - Once in the Great Lakes or ocean, wildlife, like birds and fish, can confuse this plastic as food and eat it.
    - What happens when plastic enters our rivers, lakes, and ocean?
        - In the water, plastic breaks down into smaller and smaller pieces when exposed to sunlight and UV radiation. While breaking down, these plastics act like sponges and absorb toxins found in the water, like PAH, DDT, and PCBs. Plastics break into small enough pieces and are commonly mistaken for food by marine life. When plankton or fish eats plastic; the plastic enters the food web.
    - Discuss the 6 “R’s”.
        - Reduce, Reuse, Recycle, Rethink, Refuse, Repair
    - Where does plastic make sense?
        - Hospital/doctor/medical, longer-use plastics like in vehicles to make them lighter, etc.

5. Watch *The Problem with Plastics* (http://bit.ly/problemwithplastics) and discuss video referencing the guiding questions below.

- Ask youth again - Do you think single-use plastics are a problem for our Great Lakes?
- What are the risks to wildlife with plastic pollution?
  - ◦◦ Entanglement, ingestion, death
- How many Great Lakes species of fish had microplastics in them, in their study?
  - ◦◦ All 25 species that were studied had plastics in them
- If plastics are affecting wildlife, do you think they are affecting humans too?
  - ◦◦ Yes, plastics can move up the food chain as we eat animals that have ingested plastics. Recent studies have found microplastics in our drinking water
- What are some ways the Shedd Aquarium is cutting down on plastic use?
  - ◦◦ No straws, no plastic lids, no plastic bags in café and gift shop.

6. Watch *Nature's Child- No More Plastic* (http://bit.ly/natureschildnomoreplastic) and discuss video referencing the guiding questions below**.**

- How does Ray catch our attention and make her point in the video?
  - ◦◦ Allow youth time to share their understanding from the video.
- How many plastic bags do you think you use in a single year?
  - ◦◦ Every time we go shopping and choose to use a plastic bag, that number goes up. Americans use on average 500 plastic bags each year.
- What methods did Ray talk about for reducing our plastic pollution?
  - ◦◦Skip the straw!
  - ◦◦Reusable plastic bags
  - ◦◦Reusable water bottles
- What are a couple of alternative materials for drinks like soda and juice? Why are those better than plastic?
  - ◦◦Glass and aluminum, they are easily recyclable and reusable and break down in a biodegradable way
- This video was made by an 8 year old and her mom to educate us about plastic pollution.
  - ◦◦Brainstorm ways we can raise awareness about this issue in our community (e.g. tell family and friends about the harm of plastics on our environment, make posters, decorate paper bags!)

7. Today, we are going to decorate paper bags with messages about the impact of plastic pollution on our Great Lakes and solutions to this problem. These bags will be given out to customers at the local grocery store on Earth Day (4/22), and they will help our community to understand how plastic impacts our Great Lakes and what we can to refuse to single use.

STANDARDS ALIGNMENT AND BRIEF CONNECTION

The Earth Day Bag Project is a conversation about the changes to our environment due to plastics and how we (our community and students) can be the solution. Plastics in our ocean have impacted wildlife and research on its impact in the Great Lakes is just beginning.

3-LS4-4- Biological Evolution: Unity and Diversity - Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* | http://bit.ly/3-LS4-4

The Earth Day Bag Project is an opportunity to help youth explore the impact of plastics on our Great Lakes ecosystem through a conversation about the organisms that eat plastics and why they mistake plastic for food.

4-LS1-2- Molecules Organisms: Structures and Processes - Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. | http://bit.ly/4-LS1-2

The Earth Day Bag Project may spark a conversation about energy use – otherwise a loose connection as plastic is a petrochemical product (i.e. made from oil).

4-ESS3-1- Earth and Human Activity - Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. | http://bit.ly/4-ESS3-1

The Earth Day Bag Project is a great way for youth to be part of a solution as they explore ways individuals and their communities can work together to protect and preserve our Great Lakes and other natural resources.

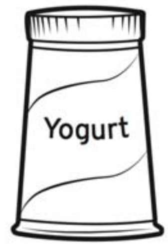
5-ESS3-1- Earth and Human Activity - Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. | http://bit.ly/5-ESS3-1

As demonstrated in the Plastics 101 video, plastics are changing an aspect of our ecosystem leading to a much broader impact.

5-LS2-1- Ecosystems: Interactions, Energy, and Dynamics - Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. | http://bit.ly/5-LS2-1

Optional: Add labels to the bags to explain the project and link to the school or partner website.

Plastics Use Audit



13

Topic
Plastics

Grades
6-12

Site
Indoors, Outdoors

Duration
One hour plus

Materials
See page 3

Vocabulary
audit, plastic, recycling, waste

Next Generation Science Standards

Practices
Planning and carrying out investigations

Core Ideas
ESS3.C Human impacts on Earth systems

Crosscutting Concepts
Cause and Effect

Performance Expectations
See page 5

Focus Question

What types of plastics do we use the most? How can we reduce our use of single-use plastics?

Overview

How much plastic do we consume? In this activity, students design an investigation and conduct an audit of waste (trash and recycling) at home or in their schools to discover the types and quantities of plastics that are consumed. They use their findings to raise awareness about which items show up most frequently. Then they conduct a follow-up audit and provide information on whether increased awareness influenced people's behaviors with regard to plastic use.

Objectives

Students will be able to:

- Conduct an investigation to determine the types and quantities of plastic waste generated in the classroom, home and/or school-wide.
- Gather and make sense of information that plastics, which are made from natural resources, can have positive and negative effects on the environment.
- Design, evaluate and refine a solution for reducing the amount of plastic waste generated.

Background

Nearly all plastic ever produced, whether disposed of responsibly or not, still exists today (www.sustainablecommunications.org). In 2011 alone, Americans discarded approximately 32 million tons of plastic waste with only 8% of that recovered for recycling (Environmental Protection Agency). The remainder ends up in landfills or the environment, especially the ocean. Plastic pollution has become a global dilemma requiring resolution.

What is Plastic?

Plastic is an easily shaped substance, composed of polymers typically made from fossil fuels. Plastics can be malleable or rigid, flimsy or nearly indestructible. It is

VOCABULARY

Audit: an unbiased examination and evaluation of something like finances or, in this case, waste

Plastic: a readily-molded substance made from fossils fuels through chemical reactions

Recycling: processing an existing material or product into a different material or product, uses energy and additional raw materials

Waste: unwanted and discarded materials

also relatively economically inexpensive to produce. Due to this versatility, plastics are everywhere, used in electronic devices, tools and food packaging. While some uses of plastic are both practical and beneficial, an estimated 50% of plastics used daily are single-use disposable items. This is problematic as plastic is too valuable and long-lasting a material to be used once and discarded.

Plastic Problems

Producing plastics is energy intensive. According to the U.S. Energy Information Administration, in the U.S. production of plastics required an estimated 191 million barrels of liquid petroleum gases and natural gas liquids in 2010 (about 2.7% of total U.S. petroleum consumption) (http://www.eia.gov/tools/faqs/faq.cfm?id=34&t=6). Made from nonrenewable resources and chemicals, plastics are not biodegradable. They are photodegradable, breaking into smaller fragments when exposed to the sun's UV rays. Plastic objects or small plastic fragments can contaminate soil and water and are easily ingested by many organisms. This is particularly concerning in the ocean, where millions of tons of plastic debris is accumulating. The majority of this debris consists of small plastic particles resulting from the break down of larger plastic items over time by wind, wave and UV action.

These tiny plastic particles can pack a toxic punch. Most plastics are composed of many types of toxic chemicals, while persistent organic pollutants (POPs) found in ocean waters adsorb to certain plastics, increasing their toxicity. Due to their small size and abundance, these toxic plastic pieces are mixed with the plankton at the very base of the marine food web. Evidence is accumulating that these toxic chemicals work their way up the food chain, potentially affecting the top consumer in the ocean food web, humans. Removing this plastic debris is not practical, so preventing the continuous flow of plastic waste from land to sea is the way to resolve this problem.

Action

Fortunately, there are many ways to reduce plastic waste and help maintain healthy ocean animals and ecosystems. First, increase awareness of your own plastic waste by tracking the amount of disposable plastics you use. Then attempt to reduce disposable plastics whenever possible. You can also refuse to use plastic utensils and instead carry a personal set of reusable utensils when you go out to eat. You can also buy foods like crackers, pretzels and other snacks in bulk and store them in reusable containers, rather than purchasing smaller, individually wrapped portions. You can also use reusable containers to store classroom tools like paper clips, markers, pencils, pens, etc. Recycling plastic waste is important but requires additional energy and materials. Reducing the amount of plastic waste generated is the most effective way to reduce plastics in the waste stream. While plastic pollution, especially in the ocean, is a global threat, increasing awareness of this problem at individual and community levels is the first step in reducing its proliferation.

Materials

- Large tabletop or floor space
- Tarps
- Buckets for liquids
- Rubber gloves
- Bathroom or digital scale(s)
- Access to soap and water or disinfectant hand wipes
- Recycling/waste bin contents
- Copies of the Plastics Audit Data sheet and Plastics Audit Analysis sheet (pages 6-9)
- Graphing program or paper

The mission of the Monterey Bay Aquarium is to inspire conservation of the oceans.

Teacher Preparation

Gather the materials for each student group to conduct an audit on an ongoing basis. See materials first and read over procedure to determine amount of materials you will need. Make desired number of student sheets.

Procedure

1. INTRODUCE THE ISSUE OF PLASTIC POLLUTION AND FOCUS QUESTION TO STUDENTS.

   Use the Gyre in a Bottle activity (on the Aquarium website) or show a movie like *Bag it!* (see Resources) to introduce the issue of plastic pollution and illustrate its scale. Ask students to respond to this focus question as a quick write in their notebooks: *What types of plastics do we use the most? How can we reduce our use of single-use plastics?*

2. AS A CLASS, DETERMINE A QUESTION OR PROBLEM TO INVESTIGATE WITH A PLASTICS AUDIT.

   Discuss what an audit is (an unbiased observation using data) and what you want to investigate (e.g., How big is our plastics problem? How much plastic waste will we find in the cafeteria?) The class may want to reduce plastic school-wide, take a census of their household's plastics use or just assess how much plastic they use in various settings. Pass out the Plastics Audit Analysis student sheet. Have students write in the investigation question and a prediction for that question.

3. DESIGN THE INVESTIGATION AS A CLASS.

   Depending on the class question, discuss the plastic audit procedure. How will you measure plastic consumption? Will you measure plastics found in trash bins and/or recycling bins? Will you compare plastics to other trash and/or recycling? Consider things like the duration of the audit, location of recycling/trash bins to examine (i.e., if you want to see how much plastic the school cafeteria uses, then include all bins where lunch waste may be discarded) and the number of people who use the bins. To start small, you may choose to begin with an audit of your classroom. Students will need to gather information on variables that can affect the data, such as regular collection time (when is waste collected in your locations?), special events happening, etc. Collecting data more than once will give you more accurate results. After gathering this information, have students decide when and where they will collect the recycling/trash. Have students use the Plastics Audit Analysis sheet to record the procedure and revise their initial prediction.

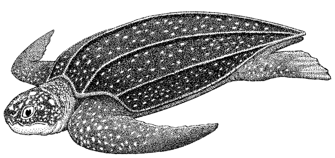
4. Conduct the audit.

For the actual audit, see Materials for what to have on hand. Generally, for each bin, spread a tarp on a large floor or outdoor space. Small student groups (three to six is ideal) should choose roles. Roles may include sorters to differentiate plastics from nonplastics, researchers to look up unknown materials, measurers to count quantity of plastic items and assess weight or volume and data recorders. Pass out the Plastics Audit Data Sheet for ideas. Students should wear gloves and avoid sharp objects, biological hazards such as blood, or anything else that may cause injury. (Avoid bathroom waste bins and exercise caution if auditing kitchen waste bins.) Return all nonplastics to waste or recycling bins.

NOTE: Repeat the audit more than once to generate multiple samples (for methodological precision) and to collect an accurate representation of the type of waste being generated.

5. Analyze audit data.

Ask each group to create a graph of their results to display. As a class discuss: *What is the total number of items and their weight/volume? What patterns did you notice? Were there any surprises? What more do you want to know? What other questions do you have? How much plastic is used each week? Each month? Per year?* You may want to compare the amount of plastic or other waste items discarded at your site to the national average or to other countries around the world. See the EPA's website for recent statistics: http://www.epa.gov/osw/nonhaz/municipal/pubs/MSWcharacterization_508_053113_fs.pdf



6. Students formulate a conclusion.

Students can write conclusions on the Plastics Audit Analysis sheet. They should include evidence to show whether their prediction is accurate or not. Have them go back and add to their original answer to the question: *What kinds of plastic do we use the most? How can we reduce our use of single-use plastics?*

7. Propose an awareness campaign or message about plastic consumption for your school, classroom or student households.

See the Use Less Plastic: Inspiring Conservation Behavior activity (on the Aquarium website) for more information about targeting specific plastic consumption behaviors. Share your audit data with the school and other classes. Come up with a few specific actions for people to take to reduce the amount of plastics used. For example, encourage students to come up with more creative solutions than a reusable water bottle and a bag. Have them think about things like individual packaging, straw use, disposable dinnerware.

8. CONDUCT A FOLLOW-UP AUDIT AND COMPARE RESULTS WITH INTIAL AUDIT.
Have students follow the same investigation procedure (collect, record and analyze data). Then have your students analyze the effectiveness of their awareness campaign or message by comparing the initial and follow-up audit. *How did the data change or stay the same? What was surprising? What seems to be the most effective strategy for using less plastic? How are you going to continue these actions after this class is over?*

9. RETURN TO THE FOCUS QUESTION.
Now that students have collected data about their plastic use and discussed their results, have them again revisit the question: *What kinds of plastic s do we use the most? How can we reduce our use of plastics?* Students may think on their own or discuss with a partner. Then in their science notebook, you may have them draw a line of learning and under it add to their original thoughts about the question.

PLASTICS: MADE TO LAST FOREVER, DESIGNED TO THROW AWAY.

5 GYRES

Resources

Websites

Environmental Protection Agency (EPA) www.epa.gov/osw/
Learn about different kinds of waste and how you can take action to reduce waste.

Monterey Bay Aquarium www.montereybayaquarium.com
Find curriculum about conservation issues like plastic pollution and many other themes.

Plastic Oceans http://www.plasticoceans.net/the-facts/what-a-waste/
The Plastics Ocean Foundation is a nonprofit based in the United Kingdom dedicated to research, policy and fundraising regarding plastic pollution in the oceans.

5Gyres http://5gyres.org/what_is_the_issue/the_problem/
This organization's mission is to conduct research and communicate about the global impact of plastic pollution in the world's oceans and employ strategies to eliminate the accumulation of plastic pollution in the 5 subtropical gyres.

Videos
Bag it! Is Your Life Too Plastic?
http://www.bagitmovie.com/

Standards

Next Generation Science Standards www.nextgenscience.org
Performance Expectations
Relates to MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Plastics Audit Data Sheet

Name(s):

Location of waste bins (specify if recycling or trash):	
Description of location (e.g., class-room, cafeteria, close to high use areas? etc.)	
Frequency of collection (when are the bin contents collected?)	

Type of Plastic	Number		Weight	
Date & Day of Week:	My Data	Class Data	My Data	Class Data
Bottles				
Food packaging				
Non-food Packaging				
Other				
Total				
Date & Day of Week:				
Bottles				
Food packaging				
Non-food Packaging				
Other				
Total				
Date & Day of Week:				
Bottles				
Food packaging				
Non-food Packaging				
Other				
Total				
Average of all audit totals:				
Average # bottles				
Average # food packaging				
Average # non-food packaging				
Average # other items				

Plastics Audit Analysis

Name(s):

QUESTION/PROBLEM
What do you want to investigate about plastic use? Where? (home/school/community)

PREDICTION
What do you think you'll find?

PROCEDURE
How are you going to conduct your investigation? What evidence will you collect?

ANALYZE RESULTS
Graph and discuss your data (e.g., The data show...)

Plastics Audit Analysis

CONCLUSION
Was your prediction accurate? What is the evidence? Do you need more information? What other questions do you want to investigate?

SOLUTION
What actions can you take to address the issue/problem? How might you communicate your findings and solution?

NEXT STEPS
Repeat the audit after implementing your solution and graph that data here. Did your actions have an effect?

INVESTIGATE

9 | Adopt-a-Beach™

GRADE LEVEL

4-8

ongoing: field trips plus classroom work

Developmental Modifications: Adopt-a-Beach™ can be done with younger students. Young children will need close supervision at the beach and should exercise extreme caution with sharp objects. When picking up garbage, always wear gloves.

summary

Students adopt a beach along the Great Lakes shoreline and visit it two to five times to collect litter and other data. Students enter their data into an online database. Students complete a project to further improve their beach.

*Note: Contact the Alliance for the Great Lakes to get involved with the Adopt-a-Beach™ program.

See http://www.greatlakes.org/adoptabeach for more information.

objectives

- Discuss how people can help their community.
- Reflect on why beaches are a special amenity.
- Collect data on litter, water quality and physical characteristics at a beach.
- Analyze data for trends and patterns.
- Create solutions based on identifiable concerns.

prerequisite

Garbage Investigation and Beach Mysteries

vocabulary

None

setting

INDOORS OUTDOORS

Adopted beach and in classroom

subjects

Environmental Science, Social Studies, Math

standards

This Great Lakes in My World activity is aligned to the Common Core State Standards and to state learning standards in:

Illinois
Indiana
Michigan
Minnesota
New York
Ohio
Pennsylvania
Wisconsin

This alignment is available on your Great Lakes in My World CD in the "Standards" folder and on-line at http://www.greatlakes.org/GLiMWstandards.

materials

- See Adopt-a-Beach™ checklist (on cd)
- Other Adopt-a-Beach™ materials (also on cd)

14

background

The Alliance for the Great Lakes' Adopt-a-Beach™ program is a service learning and citizen science program. Through this program, groups collect data on litter and water quality during a series of, ideally, five visits. They then use the data to create positive change at the beach.

Service learning integrates community service into curriculum, and connects schools with agencies and neighborhoods. These experiences build an understanding of a community, enrich learning and help youth develop personally, socially and academically. Service learning incorporates such steps as: research, investigation, analysis, action, reflection and celebration.

The Alliance for the Great Lakes' Adopt-a-Beach™ program is an easy and fun way for groups to connect with part of the Great Lakes' shoreline: their favorite beach. Adopters generally commit to five visits per year. During the visits, adopters use special forms to collect data on three different aspects of their beach.

procedure

Part One: Collecting and Analyzing Data

1. Gather information on Adopt-a-Beach™ through www.greatlakes.org and email questions to: adoptabeach@greatlakes.org
2. Select a beach to adopt and send your visit schedule to the Alliance for the Great Lakes. They will send you a participation form to fill out. If your group cannot commit to all five visits, consider asking another group to share the beach visits and data collection.
3. Use the equipment checklist (on cd) to gather the necessary supplies.
4. Pre-visit Reflection: Have the students answer the first set of journal questions.
5. Go to your adopted beach and collect data on the three forms:
   - Beach Assessment (once per year): During the first visit of each year, groups take a careful look at the existing physical characteristics of the site.
   - Litter Monitor (each visit): At each visit, litter is collected, recorded, and recycled or disposed of properly.
   - Water Quality Monitor (each visit): Using a simple test, investigate bacteria levels in the water. High bacteria levels can cause beach closings and swimming bans.
6. Once back from each beach visit, have students answer the second set of journal questions. Provide one copy of this page for each visit. Discuss as a class.
7. Tally all data and, if your beach is on a Great Lake, enter it into the Adopt-a-Beach™ database. The database allows groups to compare findings and reflect on improvements. This data is available to the public as well. Use online database to respond to question #6.
8. Review and analyze the data over the course of your visits, looking for trends and issues on your beach. Graph the data in order to gain a greater understanding of beach garbage issues. Find creative ways to display your data, through graphs, posters and presentations. Ideas for ways to help the beach will surface as students analyze their data.

Part Two: Taking Action

1. Use the information gathered to help create positive change at the beach by asking: What are some of the problems this beach has? How could we help solve beach problems? What solutions do the students come up with for issues they encounter? *Solutions may range from educating others within the school about keeping beaches healthy to trying to get additional garbage cans or educational signage at the beach. This could involve educating others, writing a letter with suggested improvements to your municipality or a community leader, or many other positive actions.*
2. After at least two visits, have students complete and share the third journal page. Use this as an opportunity to teach students about choosing projects carefully. Many projects are bigger than groups realize, and fail because of it. Teach students to select a manageable project that they can succeed at.

wrap-up

1. Have students share their knowledge and experiences with others in the school and community.
2. Stage a celebration that includes others who will appreciate learning about your adopted beach and what the students did for it.

assessment

Rubric on page 311

9 | Adopt-a-Beach™

GRADE LEVEL
4-8

journal pages

FIRST NAME	
LAST NAME	

Answer these questions BEFORE your first beach visit.

[1] How often do you visit the beach?

[2] When you visit the beach, what do you do there?

[3] What do you like best about the beach?

[4] What factors determine beach conditions?

[5] When was the last precipitation (rain, snow, hail) and how might this impact the beach?

[6] What ideas do you have for creating positive change at the beach?

[7] What are you looking forward to as part of Adopt-a-Beach™?

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9 | Adopt-a-Beach™

GRADE LEVEL
4-8

journal pages

FIRST NAME	
LAST NAME	

Answer these questions AFTER each beach visit.

[1] Describe how the beach looked when you arrived.

[2] What did you like best about your beach visit?

[3] What surprised you about the visit to the beach?

[4] What did you learn from the data you collected?

[5] What was the most frequently found trash item?

[6] How does your data compare to past visits you have made, or to data other groups around the lake have collected?

[7] Based on your data, what ideas do you have for creating positive change at this beach?

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9 | Adopt-a-Beach™

GRADE LEVEL
4-8

journal pages

FIRST NAME																				
LAST NAME																				

Answer these questions after at least 2 visits.

[1] What are your favorite ideas for ways to create positive change at the beach?

[2] Choose one you would like to carry out.

[3] What resources (time, money, etc.) are needed for this project?

[4] What challenges might you face while working on this project?

[5] How will you overcome these challenges?

[6] List the first steps you think the class should take.

APPROVED BY	

TRASH TRUNK USE SURVEY

To help us evaluate how the Trash Trunk is being used and what resources would be helpful to include in future kits, please complete and return the Trash Trunk survey found at bit.ly/CGLLresourceevaluation.

LOOKING AHEAD

Curriculum and supporting materials continue to be developed and revised. We encourage users of this Trash Trunk Educator's Guide to check the original source's websites for updated materials. NOAA's Marine Debris Program, Office of Response and Restoration, Marine Debris website marinedebris.noaa.gov/activities-and-curricula, the Great Lakes Marine Debris Portal greatlakes-mdc.diver.orr.noaa.gov/educational-resources and the Center for Great Lakes Literacy website cgll.org/curriculum are excellent portals to additional resources.