Alice Ferguson Foundation's

BRIDGING THE WATERSHED

TALKIN' TRASH

Make a Litter Difference

An outreach program of the Alice Ferguson Foundation in partnership with the National Park Service and area schools that offers secondary school students opportunities to study real-world science in national parks.

Teacher's Guide & Resources

TALKIN' TRASH

Make a Litter Difference

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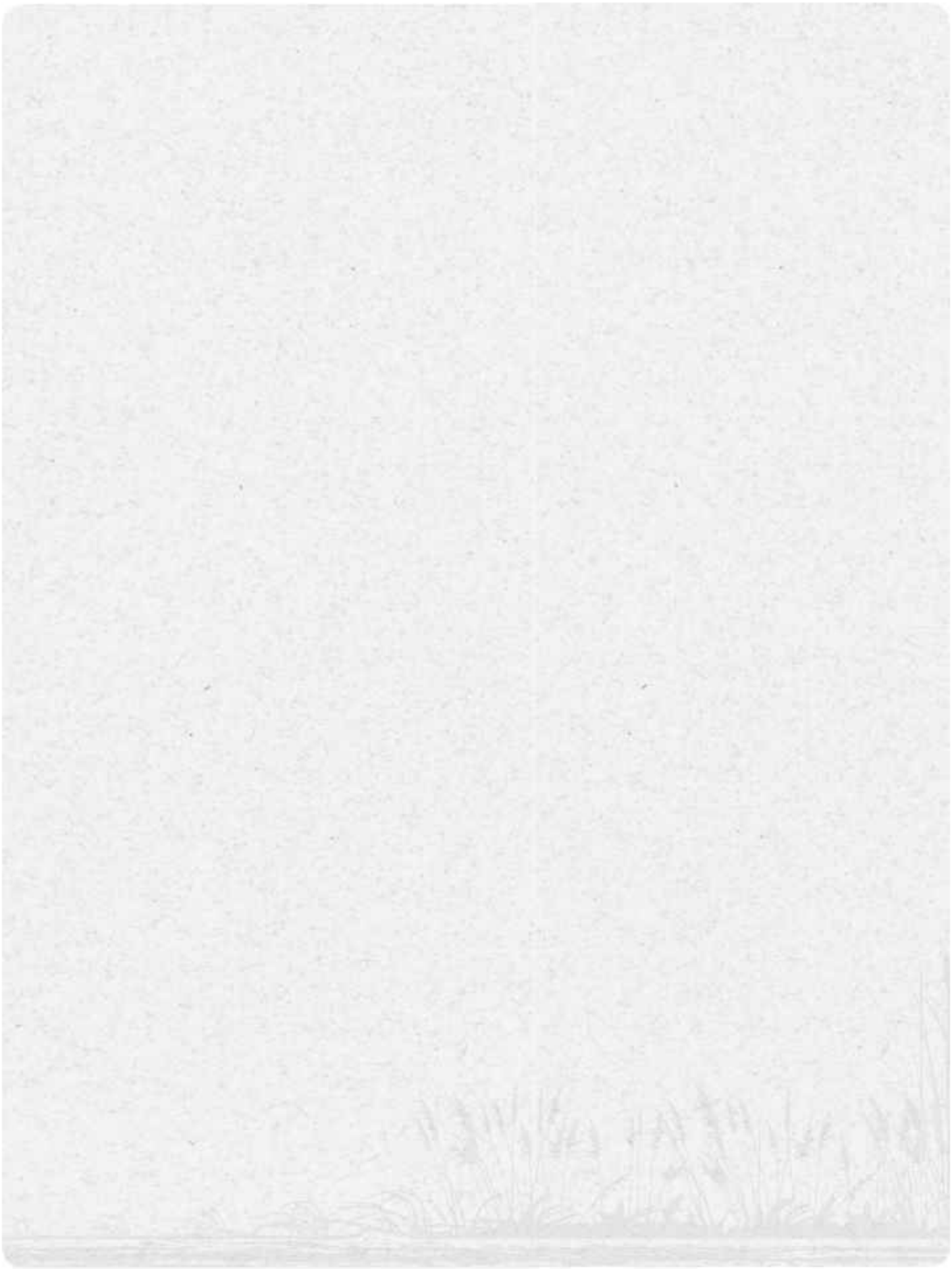


MODULE ORGANIZER

This module is divided into three sections: activities completed prior to the park visit (Pre-Field Study), activities conducted in the park (Field Study), and the activities completed subsequent to the park visit (Post-Field Study). In the Pre-Field Study activities, students learn about sources of trash and how trash moves into waterways as litter. Then your students will observe and collect data during an on-site visit to a national park in the watershed to investigate the impact of litter. When students return to the classroom, they will complete their data sheets as well as a Performance List to score their group's work in the park. Then they will consider ways to address the trash problem both school-wide and through personal action. Finally, students complete an action project that addresses an environmental issue in their community and school. Completing all parts of this module will achieve a Meaningful Watershed Educational Experience (MWEE), a learner-centered framework that focuses on investigations into local environmental issued and leads to informed action. This module is designed to ensure that MWEE is done thoughtfully to increase student environmental literacy.

Note: The teacher guide includes all the lessons, including student sheets. The student materials are included with the supplementary materials and can be printed out as needed.

TITLE	GOAL(S)	MATERIALS LIST
	PRE-FIELD STUDY	
Introduction	• To explore the issue of solid waste management. • To consider litter as a form of nonpoint source pollution in a watershed and to make the connection between litter and its impact on local streams, rivers, the bay and ultimately the world's oceans.	• Copies of introductory reading
Trash Tag	• To investigate vectors by which solid waste becomes litter in waterways. • To explore best management practices for reducing and eliminating litter.	Outdoor version: • Flags or field chalk to establish boundaries on the field for the game. • Blank sticker name tags labeled with BMP Indoor version: • Game board • Playing pieces • Task cards
Garbage Pizza	• To sort and identify the different categories and amounts of trash diverted from landfills. • To create a model of the amount of waste that is not removed from the municipal solid waste stream.	• 3 cardboard or salt/flour pizzas • School glue • Red food coloring • Paint brush • Pizza "toppings" representing the categories of solid waste: > scrap paper (for paper and paperboard) > leaves/twig (yard waste) > old keys (metals) > dry cereal (food waste) > beads, soda bottle lids (plastics) > rubber bands, scraps of fabric textiles, (tires, etc.) > safety glass from auto shop (glass) • Permanent marker

TITLE	GOAL(S)	MATERIALS LIST
	PRE-FIELD STUDY	
Plastic Jellyfish	To understand the environmental impact of litter in aquatic environments.	• Plastic waste from home • Shallow tray or box • Re-sealable plastic sandwich bags (one for each pair of students) • Soil (enough to cover the bottoms of all the trays) • 1 tablespoon of 1-5mm diameter multicolored beads for each pair of students placed in sandwich bags • Clock • Paper towels
	FIELD STUDY	
What Kinds of Litter Trash the Park?	To collect and analyze litter.	• Appropriate clothing • Adequate food and drink • All other materials will be provided
	POST-FIELD STUDY	
Data Analysis	To classify the litter students pick up on their field study and understand its significance.	• Computer with Internet access
Trash Free Schools	To apply understanding of litter as nonpoint source pollution to a practical policy discussion.	• Materials may vary
Student Action Project: Take Action!	To increase awareness of the need for individual environmental action.	• Internet access
	RESOURCES	
These resources will provide additional information on the subjects of all the activities. Teachers may use them as a personal reference, or may assign them to students as further reading.		

NOTE: The overview module, "Potomac River Watershed: Water, Water, Everywhere" contains several activities that introduce the concept of a watershed and nonpoint source pollution that are excellent supplements to this module. "Who Polluted the Potomac," also in the overview module, provides the basic understanding of nonpoint source pollution.

Next Generation Science Standards (NGSS)

Bridging the Watershed curriculum is correlated to Next Generation Science Standards (NGSS). The table below demonstrates performance expectations and the three dimensions of NGSS: science and engineering practices, disciplinary core ideas, and crosscutting concepts.

Performance Expectations	
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's system
HS-LS2-6	Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• Constructing Explanations and Designing Solutions • Using Mathematics and Computational Thinking • Engaging in Argument from Evidence • Constructing Explanations and Designing Solutions	• ESS3.C Human Impacts on Earth Systems • LS2.C Ecosystem Dynamics, Functioning, and Resilience	• Cause and Effect • Stability and Change

Introduction to Talkin' Trash

ENGAGEMENT

BACKGROUND INFORMATION:

This module and the field study in the park are designed to heighten students' awareness and to help them understand the important role they play in the health of the watershed. The title of this module, Talkin' Trash, suggests that each person can take an active role in the care and protection of Earth's environment. The focus of this module is on the importance of understanding and reducing the litter problem.

After reading the introduction to Talkin' Trash, discuss the ways trash is generated. Engage students by soliciting current knowledge of the trash problem and how each one of them might be contributing to the problem.

> Treat the Earth well.
> It was not given to you by your parents.
> It was loaned to you by your children.
>
> —Kenyan Proverb

A watershed is an area of land from which runoff (surface water from precipitation and springs) drains into a body of water. At one time, the Potomac watershed's environment was hardly affected by the people living there. As the human population has increased, so has the waste we produce. **Waste** -or trash- is what people throw away from homes, businesses, government agencies, schools, and hospitals. It is generally considered dry material, and is synonymous with garbage, rubbish, or refuse.

Currently, Americans produce more than 292 million tons of **municipal solid waste** each year (2018 US EPA) Although only 10 -15 percent of **solid waste** is technically "hazardous," all of it can harm people, wildlife, and the environment if not handled properly. Waste that starts in a trash can usually ends up buried in a **landfill** or burned in an incinerator. Waste that is not properly disposed of becomes **litter**.

Today, the main issue is what to do with all this waste. How can we reduce the amount generated? Where do we put it? How can we process it without harming the environment, including ourselves? Solving these problems requires action by everyone. In this module, you will learn about litter in your watershed. In the field study activity of this module, you will visit a national park to collect litter in the park. Finally, you will have an opportunity to create a trash free school plan, to develop an action plan for other projects to improve the health of streams and rivers in your community, and to learn about best management practices (BMPs) to reduce or limit pollution.

Goal:

- To explore the issue of solid waste management.
- To consider litter as a form of non-point source pollution in a watershed and to make the connection between litter and its impact on local streams, the river, the bay, and ultimately the world's oceans.

Class Time:

20 minutes

New Terms and Topics:

- Trash
- Garbage
- Litter
- Solid waste
- Municipal solid waste
- Landfill
- Dump

Trash Tag

ENGAGEMENT

BACKGROUND INFORMATION

Trash becomes litter when people dispose of it improperly. Once discarded, often along streets and sidewalks, litter is really ugly and can threaten plants and wildlife. When it rains, litter washes directly into waterways or through storm drain systems that empty into waterways.

In addition, researchers have discovered that neighborhoods in decline tend to attract crime – the "broken windows" theory. So, homes that aren't kept up, or vacant lots that have litter piling up, tell outsiders that the residents don't really care about their neighborhood. Alice Ferguson Foundation research finds that people say the most important reason they litter is simple "laziness" or "convenience." A strong contributor to litter is existing litter. Litter on the ground sends a message that littering is acceptable, so people add more litter.

Litter doesn't come cheap. Litter cleanup is estimated to cost the United States $11.5 billion each year. Businesses pay about $9 billion each year to clean up litter, but schools, governments and other organizations pay for the rest.

Best management practices (BMPs) seek to reduce sources of pollution or limit the effects of pollution. BMPs often are activities started by our local governments, but there are also BMPs that a citizen can use to help support government efforts. BMPs for litter pollution include ways to prevent litter from reaching waterways like:

- Public education emphasizing the harm litter causes and encouraging proper disposal of trash;
- Engineering solutions, such as installing trash screens on storm drains to allow water to flow through while preventing litter from passing;
- Cleanup efforts like trash pickups and street sweeping to prevent litter from reaching storm drains;
- Enforcement of litter laws, which put a price on littering. Litterers make clear that enforcement would deter them, but very few people think there is a chance of getting caught.
- Policy which includes new legislation that encourages decreased use, and recycling, of commonly found litter items like plastic bags, beverage containers, and Styrofoam™.

Questions to ask your students:

- Why do litter and littering matter?
- What does litter say about a community?
- Have you littered? What? Why?
- How can you reduce litter?

Goal:

- To investigate vectors by which solid waste becomes litter in waterways.
- To explore best management practices for reducing and eliminating litter.

Class time:

At least 30 minutes. Game could continue indefinitely.

Group Size:

Entire class or up to 30 students.

Materials:

- Flags or field chalk to establish boundaries on the field for the game.
- Blank sticker name tags labeled with BMP.

Special Considerations:

Play in an open area such as a gymnasium or athletic field free of obstacles and safety hazards.

New Terms and Topics

- Best management practices (BMPs)
- Storm drains
- Litter laws
- Broken windows theory

Trash Tag

ENGAGEMENT

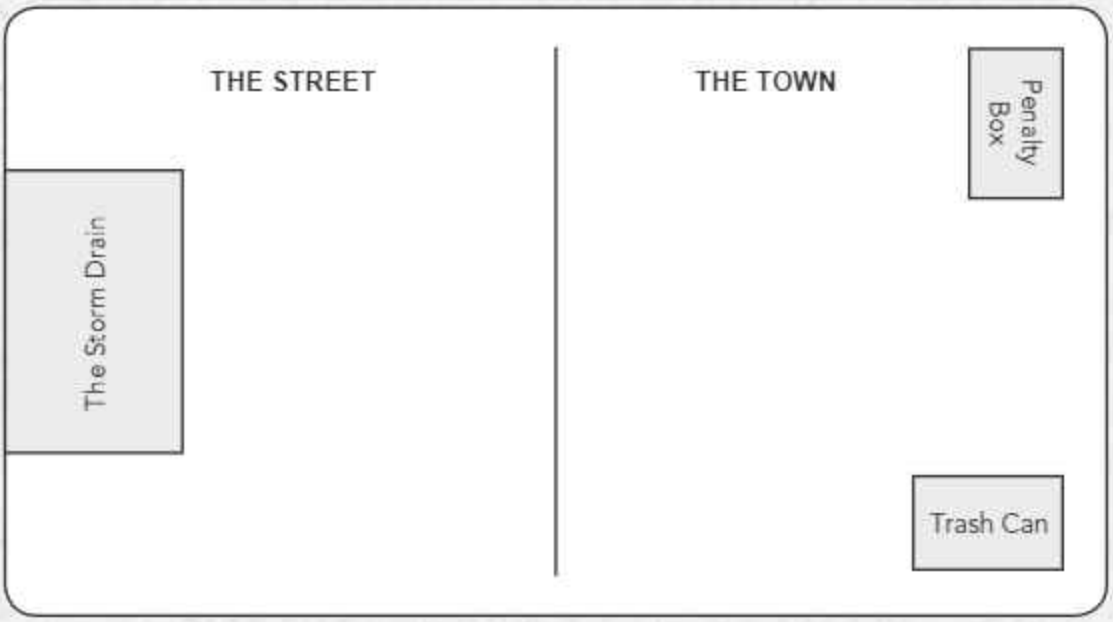
This game can be played two ways: like classic tag, outdoors; or as a board game, indoors. The outdoor version requires at least 15 players, or it should be altered to accommodate smaller groups.

OUTDOOR VERSION: TRASH TAG

PROCEDURE:

1. **Divide the playing field in half. In a gym, the center court line would be a good marker.**

2. **Designate one side of the field to be "the street." Inside the street area, designate an area of roughly 20' x 20' as "the storm drain" (large enough that one player cannot "guard" the entire area).**



3. **Designate the other side of the field to be "the town." Inside the town area, designate two roughly 5' x 5' areas as "the penalty box" and "the trash can." An example playing field is shown above.**

4. **All but five students will represent litter and will begin the game on the far side of the town near the penalty box and trash can. As pieces of litter, they will be carried by wind and stormwater runoff to the storm drain. Their objective is to reach the storm drain without getting tagged by a Best Management Practice (BMP). The litter may occupy any part of the playing field. Once the litter reaches the storm drain, it will flow with water into the Potomac River and its tributaries.**

5. **The five remaining students will each represent a different BMP to prevent litter from entering streams:**
   - Reusable shopping bag – may only patrol the town. When tagged by a reusable shopping bag, litter must go to the trash can.

Trash Tag

ENGAGEMENT

- Education – may only patrol the town. When tagged by education, a piece of litter becomes any BMP they chose.
- Street sweeper – may patrol only the street. When tagged by a street sweeper, litter must go to the trash can.
- Trash screen on storm drain – may only patrol the street. When tagged by a trash screen, litter must go to the trash can.
- Litter Laws – may patrol the entire area of the playing field. When tagged by enforcement, litter must go to the penalty box.
- Each student who represents a BMP will receive a sticker name tag indicating what BMP they are, where they are allowed to patrol (street or town), and where the person goes once tagged.

For example:

Street Sweeper
(Street)
---> trash can

The "Education" BMP will need a sheet of pre-labeled name tags containing all the BMPs to hand out to each piece of litter they tag. If a student is tagged by "Education," that student becomes another BMP and wears a name tag indicating the chosen BMP. If a student chooses to become "Education" they will also need a sheet of pre-labeled name tags.

6. **The goal of the BMPs is to convert all litter into BMPs or send them to the penalty box.**
7. **Once five pieces of litter reach the storm drain, they cause a new storm, which allows all litter held in the trash can to blow free and re-enter the game.**
8. **Once in the penalty box, litter stays out of the game.**
9. **The game ends when all litter reaches the storm drain or when the BMPs have the rest of the litter in the penalty box or convert all the litter to a BMP.**
10. **The game can be altered in several ways:**
    - Size of playing field
    - Decrease the number of people needed to reach the storm drain
    - Decrease the number of BMP players

Trash Tag

ENGAGEMENT

TRASH TAG BOARD GAME:

MATERIALS NEEDED:

- Trash Tag Board Game (11" x 17"), one for each group of four students
- A set of Trash Tag game cards, one set for each game board
- Procedure (below)

PROCEDURE:

1. **Get students thinking about litter. You might start the game by asking your students about their observations of people littering.**

   Why do they think that people litter? Have they ever littered? If so, where and when have they littered? Are litter and water quality related in some way?

2. **Pass out the board games, playing pieces and cards. Have students cut the cards apart and place them face down.**

3. **The community service cards should be in a separate stack from the litter and BMP cards.**

4. **Play begins when the first player draws a card, reads it aloud and then follows the instructions. Turns move clockwise. If you land on a round storm drain, you go into the river. A community service action gets you out but you have to start over.**

   NOTE: There are a few cards where the group has to make a decision about how to address a litter issue. For example, when a student has to speak with an adult about tossing cigarette butts out the car window.

ASSESSMENT:

When students have completed the game, have them discuss ways in which they can reduce littering. You might ask them about other instances of littering that were not addressed in the game. If time permits, you might have them create new litter card scenarios for the next group of students who will play the game.

Trash Tag

ENGAGEMENT

CUT CARDS APART ALONG SOLID BLACK LINES

Community Service	Community Service
Organize a stream clean-up. Talk with your group about what that would involve. Go back to start and continue the game.	Pick up trash in your neighborhood before it gets in the creek. Go back to start and continue to play.
Community Service	**Community Service**
You decide to sell special reusable "no-litter" water bottles and use the proceeds to buy better recycling containers for your local park. Go back to start and continue the game.	Remind your friends to bring a reusable mug when you go out for coffee together. Go back to start and continue the game.
Community Service	**Community Service**
Organize an anti-litter campaign in your neighborhood. Go back to start and continue to play.	You start a trash-free lunch campaign at school. Go back to start and continue to play.
Community Service	**Community Service**
You organize a "storm drain stenciling" day in your neighborhood. Storm drains are stenciled with the words, "Don't Dump - Chesapeake Bay Drainage." Go back to start and continue the game	You convince your school administrators to sanction a "Green Team" of teachers and students at your local school. Go back to start and continue the game.
Community Service	**Community Service**
You engage members of a local dog park to put up signs reminding others to pick up after their pet. Go back to start and continue the game.	You organize a neighborhood yard sale and donate all unsold items to a local thrift store. Go back to start and continue the game.

Trash Tag

ENGAGEMENT

CUT CARDS APART ALONG SOLID BLACK LINES

Litter and BMP

You see somebody else drop a plastic bag on the sidewalk and approach them politely to educate them about litter. Move ahead 3 spaces.

Litter and BMP

You educate a friend about reusable bags and they change their behavior because of what you tell them. Go forward 4 spaces.

Litter and BMP

At the store you purchase a small/single item and tell the cashier "no thanks" when she tries to put it in a plastic bag. Go ahead 2 spaces and take an extra turn.

Litter and BMP

You receive a bag from a restaurant for leftovers and decide to recycle/reuse it. Move ahead 3 spaces.

Litter and BMP

You get your family to use reusable bags whenever they shop at any store. Move ahead 3 spaces.

Litter and BMP

You start bringing your lunch in a reusable sack instead of a paper bag. Move ahead 2 spaces.

Litter and BMP

You need an outfit for an upcoming party. Instead of buying a new one, you go to a thrift store and find a gently used one. Move ahead 3 spaces.

Litter and BMP

You educate your family's lawn service business on the benefits of grass clippings and they initiate a comprehensive yard waste program. Move ahead 4 spaces.

Litter and BMP

You notice a nearby construction site does not have any silt screens in place to prevent soil, dirt, and debris from washing out of the area. You contact the site manager, who installs screens the next day. Move ahead 3 spaces.

Litter and BMP

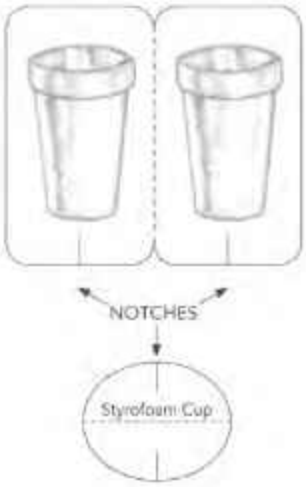
While walking your dog, you notice that many people have not picked up after their pets. You return later and clean up the area. Move ahead 3 spaces.

TRASH TAG:

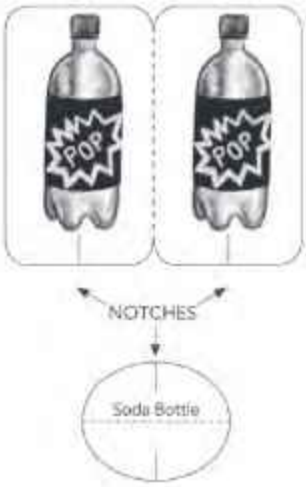
KEEP THE POTOMAC RIVER WATERSHED TRASH FREE!

GAME PIECES

Cut out pieces along solid black lines. Fold along dotted lines. Cut notches along solid black lines. Interlock game piece into base stand.



BASE STAND



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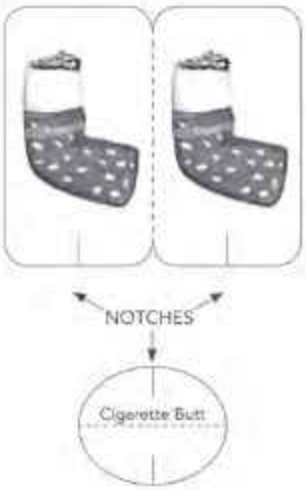

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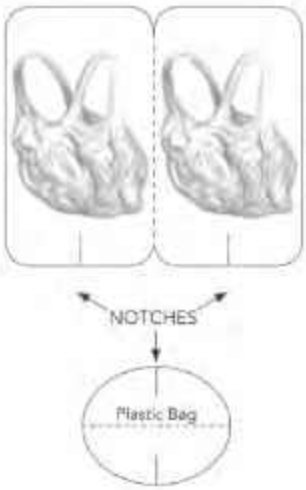

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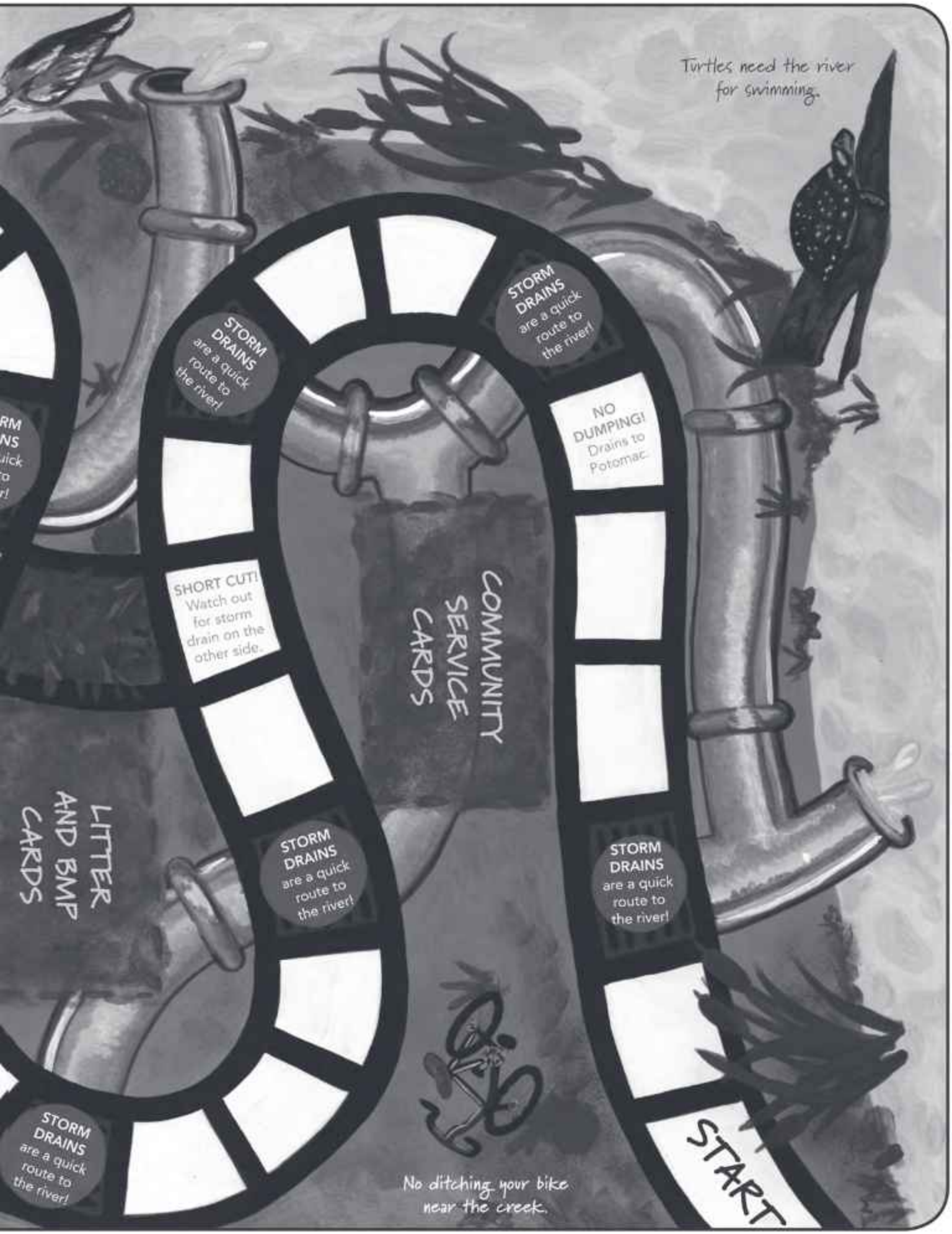


Garbage Pizza

EXPLORATION

(Used with permission from Keep America Beautiful: Waste in Place.)

PROCEDURE:

THE CRUST

Option 1: Cut disks from a piece of corrugated cardboard.

Option 2: Before class, prepare 3 "Garbage Pizza" crusts using the following recipe:

1. Mix 2 cups of flour, 2 cups salt, and 1 cup water (adjusting water for altitude and/or humidity) until a stiff dough forms. Knead as you would a bread dough.

2. Flatten the dough into a well greased round 12" deep dish pizza pan, pressing the edges up the inside of the pan. Flatten out slightly until it looks like a pizza pie.

3. Cut the pizza into the same slices or sections to look like the Municipal Solid Waste by weight pie chart template included in this lesson.

4. Using a fork or knife, puncture each slice several times before baking to avoid expanding air pockets. Bake at 350° F for 40-45 minutes, or until golden brown. Check the pizza every 10 minutes or so and re-cut the sections.

   NOTE: If you do not cut the pizza before cooking, it's nearly impossible to cut after it's done. If you want your students to do the calculations for the different categories, they can simply use a permanent marker to divide the pizza up afterwards.

5. Remove from the oven and let cool completely. Dough should be hard and dry.

6. Mix approximately 4 oz. of white school glue with approximately 2 oz. of red food coloring (adding a drop of blue food coloring will darken the red, but is not necessary for a successful "sauce") until you achieve the desired red tomato sauce look. Have students apply the sauce with a small paint brush in the classroom. Allow to dry thoroughly.

MUNICIPAL SOLID WASTE

1. **Ask the students to define the words GARBAGE and TRASH.**

   Garbage refers to only the organic or food waste thrown away. Trash represents broken, discarded or worthless things, usually dry waste material (e.g., rubbish and other forms of refuse other than food). Brainstorm with students and list on the chalkboard all the waste items

Goals:

- To identify the different categories and amounts of trash.
- To create a model of the amount of waste that is not removed from the municipal solid waste stream.

Method:

Students will construct a garbage pizza (a three-dimensional pie chart) representing categories of materials recycled in the United States, and a category for all materials that enter the solid waste stream.

As an extension, students can also complete garbage pizza representing recyclables in their county as well as the materials that enter the solid waste stream.

Materials:

OPTION 1:

- Cut circles from cardboard and proceed as directed.

OPTION 2:

For each pizza dough:

- Mixing bowl
- Spoon
- Rolling pin
- Pizza pan
- 2 cups flour
- 2 cups salt
- Oil or shortening for greasing the pan

Garbage Pizza

EXPLORATION

thrown away at home or school. Use the following categories: paper, yard, waste, metals, glass, plastics, wood, food wastes, and other.

2. **Introduce the concept of Municipal Solid Waste (MSW).**

   MSW is made up of trash and garbage from household, commercial (business), and institutional (schools and hospitals) sources in a community. Ask the class if the items listed on the board would also be found in a community's MSW.

3. **Draw a circle on the board. Explain to students that all the waste thrown away in the United States will fit into this circle. This circle is filled with waste from all of the categories (paper, yard waste, metals, glass, plastic, wood, food waste, and other waste).**

   Show students how much paper is thrown away by drawing a slice for paper (see chart included in this lesson). Repeat this demonstration for all eight categories. Reinforce the fact that the biggest slice, marked "paper," means that there is more paper than any other item in MSW. The next largest slice is yard waste, etc. Ask the students why it might be important to know the amount and kinds of waste thrown away. By knowing what kinds and amounts of things are in MSW, communities can plan better programs to reduce the amount of waste disposed (*e.g.*, office paper recycling, telephone book recycling, yard waste composting), and plan better waste handling options (*e.g.*, waste-to-energy incineration, sanitary landfill).

4. **Announce that the class is going to make a garbage pizza (with garbage and trash). Collect the items you need for the toppings, or have the students bring them from home.**

   Ideas of trash to use:

   - paper: old newspaper and magazines, construction paper scraps
   - yard waste: leaves, grass clippings, fake flowers
   - food: pasta, cereal, beans
   - plastics: beads, cut up grocery bags
   - metals: paper clips, old house keys
   - other: rubber, leather, textiles, rubber bands, cloth scraps
   - wood: crafts sticks, toothpicks, twigs
   - glass: beads, mini Christmas tree lights, shatterproof glass from auto body shop.

PIZZA "SAUCE"

- Craft glue
- Red food coloring
- Small paint brush

TOPPINGS– should include items from these categories:

- Paper
- Yard waste (leaves/twigs)
- Wood
- Metals (old keys, nuts/bolts)
- Glass (you might be able to find shattered safety glass from an auto body repair shop)
- Food waste (dry cereal works well here)
- Plastics (lids from jars and bottles)
- Other waste (e.g., rubber, leather, textiles, misc. inorganic waste)
- Polyurethane or lacquer, optional to seal the pizza

New Terms and Topics:

- Volume
- Weight
- Generation
- Recovery
- Recycle

Garbage Pizza

EXPLORATION

5. **Show the students the "pie chart" pizza dough. Glue the waste items onto their corresponding pizza slices with uncolored glue or a hot glue gun.**

   For an added touch after the glue has dried, spray the garbage pizza with polyurethane or lacquer, available at your local hardware store. Share the garbage pizza model with other classes or the entire school. Have students team up and teach students in other grades about the MSW using the garbage pizza model.

6. **Set up a table with items from the eight categories of MSW: paper, yard waste, metals, glass, plastics, wood, food wastes, and other. Make signs for each category and have students separate the waste items into the appropriate piles.**

7. **Students can make pizzas using the municipal solid waste figures for their county and city. Compare these to the national garbage pizza.**

EXTENSION: TURNING PERCENTAGES INTO DEGREES.

The percentage of waste becomes a decimal — so 37.9% becomes .379 which is multiplied by 360° to become 136°.

(.369 x 360° = 136°)

Students can continue with the rest of the waste to determine the sizes of the slices of garbage pizza, and then use a protractor to get the correct measurement.

QUESTIONS TO ASK:

- How are these different? What might account for the differences? (For instance, cities with government services might produce more paper waste than cities in rural areas.)

MUNICIPAL SOLID WASTE COMPARISONS

Type of Municipal Solid Waste	United States (1995)	United States (2018)	Your Local Jurisdiction (you provide the data)	What might account for the change in MSW composition for this category?
Paper	37.9%	23.%		
Yard Waste	14.6	12.1		
Metals	7.6	8.8		
Glass	6.3	4.2		
Plastics	9.5	12.2		
Wood	7.0	6.2		
Food Waste	6.7	21.6		
Other	9.4	11.9		

Plastic Jellyfish

EXPLORATION

(Used with permission from Council for Environmental Education: Project WILD Aquatic K–12 Curriculum and Activity Guide.)

BACKGROUND

The United States disposes of more than 300 million tons of trash each year, and the amount continues to increase. The amount of waste generated per person has increased from 2.68 pounds in 1960 to 4.9 pounds in 2018. Some materials are found to be more easily recycled. For example, the percent of paper and paperboard recycled has risen from 20% in 1980 to 68% in 2018. While the amount of plastics recycled has gone from 2% in 1990 to only 9% in 2018. Recycling plastics is difficult because of the large number and complexity of the resins, the difficulty in separating the various types of plastics, and the lack of market for mixed plastics. Use of plastics over the decades has swelled from 17.3 tons in 1990 to more than 35.7 million tons in 2018 as more and more manufacturers benefit from its use.

Leatherback turtles often mistake plastic bags or balloons floating in the

The use of plastics creates a significant problem in the environment because they do not decompose but only breakdown into smaller and smaller pieces that remain in the environment. When this enduring material becomes litter it can persist on the ground, in soil or in our waterways and be a hazard for wildlife and human health.

Thousands of birds, fish, turtle, seals, whales, and other aquatic life are killed each year after ingesting plastic or getting entangled in it. For example, Leatherback turtles can mistake plastic bags or balloons floating in the sea for jellyfish, one of their favorite foods. As plastic accumulates in the intestines of such animals, starvation occurs slowly.

Over time larger pieces of plastic get weathered, degrade and break into smaller and smaller pieces. In water, small pieces of plastic will either float or sink. These small pieces can be perceived as food and consumed by birds, animals, fish and other marine life. Ingested plastic fills an animals stomach causing starvation.

Microplastics are pieces of plastic that are less than 5mm in size. They can be no larger than a grain of rice to where they need to be seen under a microscope. There is a growing body of research showing us that microplastics are now found in oceans, lakes, waterways, soil, air, and even in our food.

Once very small pieces of plastic get into the environment, it is very difficult to separate them back out.

Goals:

Students will (1) describe the potential effects of plastic waste on aquatic wildlife and habitat, and (2) identify specific actions they can take to help remedy the problem.

Class time:

20- to 60-minute session or longer

Group Size:

Any

Method:

Students monitor the plastic waste production in their own households, research the effects of plastic waste on fresh water and marine life and propose various ways to lessen the problem.

Materials:

- Plastic waste from home
- A shallow tray or box (2 to 3 ft^2 in area) for each pair of students
- Soil or birdseed (enough to cover the bottoms of all of the trays)
- Re-sealable plastic sandwich bags, one for each pair of students
- 1 tablespoon of tiny (1–5 mm diameter) multicolored beads for each pair of students (be sure that many are clear) placed in sandwich bags
- Clock
- Paper towels

Plastic Jellyfish

EXPLORATION

Strategies to reduce the problem involve eliminating plastics getting into the environment as litter or waste. Reducing use of plastics will reduce the amount of materials to be managed, disposed or recycled. Individuals can make everyday choices to reduce their use of plastics by choosing reusable over disposable containers and purchasing in bulk.

Efforts are being made to encourage the use of reusable containers and bags and discourage single use plastic containers.

How much plastic waste do you create everyday? Are there choices you could make to reduce your waste? Where does your trash go? Is it recycled? Does your trash ever become litter?

New Terms and Topics

- Pollution
- Litter
- Plastic
- Biodegradable
- Microplastic

PROCEDURE

1. **Ask the students to collect and save every piece of plastic waste produced in their homes for a 2-day period.**
   - Instruct the students to clean the items so they are free of leftover food or drink. Have students ask an adult to help them clean out containers that held household cleaners such as ammonia, chlorine bleach, and such. These containers should be emptied and rinsed completely.
   - Either ask the students to bring these materials from home or make a list of their plastic waste.
2. **Ask the students to separate the plastic containers into categories.**
   - Have students classify waste in terms of how the materials might affect aquatic animals if they were not disposed of properly and ended up in an aquatic environment. That is, might the items be perceived as food? Might an animal become entangled in an item? Which ones are more likely to cause a problem for wildlife and which ones are less likely to cause a problem?
3. **Discuss the breakdown of plastics overtime into microplastics and how these small pieces of plastic persist in the environment.** Because they are very small, there are not good ways to get them out of the environment. Ask the students to suggest ways this item might affect habitats and wildlife. Which animals do they think might be most affected?

Plastic Jellyfish

EXPLORATION

4. **Show the students the beads, and explain that they are meant to represent microplastic in the environment. Divide the class into pairs, and give each pair a sandwich bag containing a heaping tablespoon of beads and a tray of soil.**
   - Ask the students to sort the beads by color on a paper towel, label the color of each pile created, and count the number of each color. Consider the different colors of different types of plastics.
   - Have the students record the number for each color on the paper towel beside the corresponding pile of beads. Also record these amounts on a class data chart displayed on the board or flip chart.

5. **Direct each pair of students to sprinkle the beads evenly over the soil in the tray. When all beads are in the soil, tell the students to jiggle their tray vigorously for 30 seconds. Emphasize that they must not lift the tray, but keep the tray on the table.**

6. **Ask the students to try to find all of the beads. Allow the students to look for exactly 3 minutes, placing the beads back on the paper towel in the original labeled piles. Time the students. When the time is up, have the students count the colors.**
   - Record these numbers on the paper towel and on the class data chart.
   - Have students total the numbers of each color of bead.

   NOTE: Older students may also be able to create a bar graph of these results. Have them list the colors.

EXTENSIONS:

1. Have the students investigate the difficulty of recovering beads or microplastics from different media such as water, sand, and different shades of soil. Allow two or three teams to investigate each media type. Compare the results.
2. Invite the students to survey their school grounds or community for plastic litter, including microplastics. Investigate its potential negative effect on animals in the community. Ask students to create an action plan that will increase public awareness of the problem and help take care of it (*e.g.*, have a social media education campaign and hold a litter collection day). Help the students put the plan into effect!
3. Establish a litter patrol. Designate specific targets such as nearby beaches, lakes, and streambeds. Establish scheduled tours of these areas to pick up plastic and other forms of litter.
4. Write a plastic-consumption conservation plan. How much plastic do you use? How much is disposed? How can you reduce the amount of plastic you use? What reusable products can you substitute for the disposable plastic options (e.g., reusable drink container, fabric shopping bag). How might your choices damage or protect wildlife?
5. Take various types of plastic and put the items outdoors where they will not be disturbed for 1 month. Set up an observation schedule and a means of recording the date and the changes you observe in the plastic samples. What conclusions can you draw from your observations?
6. Research the latest technology for making plastic biodegradable. What progress is being made in this innovation?
7. Research any laws in your city, county, or state that attempt to address the problem of plastic pollution. Look into bags laws. Are there any bills before the state legislature? Before the U.S. Congress?

along the bottom of the graph (X axis) and the number of beads up the left side (Y axis). Make two bars for each color: the original number of beads and the number of recovered beads.

7. **Discuss the students' findings. Did they recover all of the beads? If not, why not? Which colors were the most difficult to recover? Why?**

8. **Tell the class that microplastics are found in all colors and types of plastic. Shapes vary from small chunks to particles of film or fibers. How could the characteristics of the microplasitcs contribute to their being picked up by birds? How do the characteristics of the microplasitcs contribute to difficulties in separating them from the water, soil or sand?**

9. **Have the class brainstorm actions the plastics industry might be able to take to minimize plastics in the environment. Do students think it would be easier for them to recover plastic litter or prevent the problem in the first place? Why? What actions could government take? Have the students brainstorm ways they might help reduce all types of plastic waste in the environment.**

10. **Make sure that the students wash their hands after working in the soil.**

    - Ensure all beads have been removed from soil before disposing outdoors.

TECHNOLOGY CONNECTIONS

- Use the Internet to research the effects of plastic waste on aquatic life.
- Use a spreadsheet program to create an electronic chart for the class data. Graph the results.
- Use the Internet to research the latest technology for making plastic biodegradable.

EVALUATION

1. **Give three examples of ways that plastics could enter an aquatic food web.**

2. **Describe the effects of plastic waste on aquatic animals.**

3. **List two things you can do to prevent harm to wildlife from plastic litter.**

4. **What are two ways that governments or industries can reduce the amount of plastic that enters aquatic environments**

ADDITIONAL RESOURCES

Additional resources are available on the AFF website, fergusonfoundation.org, and in the supplementary materials.

Plastic Jellyfish

EXPLORATION

SAMPLE CLASS CHART

	Teams										
	1	2	3	4	5	6	7	8	9	10	
Color											**Totals**
Red											
Starting number											
Recovered number											
Blue											
Starting number											
Recovered number											
Clear											
Starting number											
Recovered number											
Green											
Starting number											
Recovered number											
Purple											
Starting number											
Recovered number											
Yellow											
Starting number											
Recovered number											

Plan Wisely for Your Students' Field Study

ENGAGEMENT

BACKGROUND INFORMATION:

It is crucial that all students be prepared for the field study in the park. For many students, working outdoors will be an unusual and challenging experience. You should review the information in this section carefully with your students to help them prepare mentally for the field study, and to ensure that they have the appropriate dress and supplies to be comfortable in the park. You may have to review this information several times before the park field study to be sure all students understand the required preparations and plan well for their visit. Listening to the weather and developing a what-to-wear list for the day is a great homework assignment or class discussion in advance of the field study. Some teachers do a dry run a few days in advance of the field study by having their students come to school wearing their field study clothes with their backpacks packed as if for the field study.

Before the site visit, review the directions for data collection and completion of the Talkin' Trash Data Sheet. Students can read the resource section that provides the information they will use in the park.

The AFF educator and National Park Service Ranger will have all the supplies for the field study activities.

PARK INFORMATION:

Students can review information about the park and its history through the park link on the Bridging the Watershed website at fergusonfoundation.org.

THINGS TO BRING:

- There won't be a place to buy food. Students must bring a bag lunch and plenty to drink, preferably water. For students on a school lunch plan, let the cafeteria manager know about the field trip a few days in advance to ensure that a bagged lunch will be available.
- The hotter the weather, the more students should bring to drink. Have students pack their lunch and drinks in a backpack or bag that they can easily carry into and out of the park study site.
- Keeping in the ecology-minded spirit, suggest that students make their lunch as trash free as possible. Some areas and parks do not have trash cans. What is packed in must be packed out.
- Make sure that students bring their own sunscreen and insect repellent if desired.

Goal:

To help students plan and prepare for their field study in a **local national park.**

Plan Wisely for Your Students' Field Study

ENGAGEMENT

PARK STEWARDSHIP:

- Remind students that collecting of any kind is not permitted in National Parks.
- Remind students to take only photographs and leave only footprints.

TIPS ABOUT CLOTHING:

- Students should wear comfortable clothing that allows them to easily move, hike, bend, and climb. Students may have to gather data in a wet and muddy environment, so they should choose clothes they don't mind getting wet and dirty.
- Dress for the weather. In cool weather, encourage students to wear layers of clothing to keep them warm in the early morning, but that they can remove later in the day or while working. If the forecast calls for possible rain, students should wear a waterproof jacket, hat, and shoes, and bring a plastic bag for materials.
- Even in warm or hot weather, encourage students to wear long pants and a long-sleeved shirt for protection from poison ivy and briars. Students may be in a wooded area or may walk through tall grass to get to their field study site.

The data sheets your students will use on their field study are included here so they can be well-prepared for what they will be asked to do in the park. You will not need to bring these with you. Your AFF educator will have all the materials you will need for your field study.

Plan Wisely for Your Students' Field Study

ENGAGEMENT

Bridging the Watershed

Talkin' Trash Datasheet

Date:

Teacher:

Park:

Study Site:

Park Rangers & Educators: (one per row)	Group Members: (one per row)

Latitude: North ____ ° Longitude: West ____ °

Why is it important to know the latitude and longitude?

	Yesterday	Today
Air Temperature	____ ° C	____ ° C
Cloud Cover	☐ Clear ☐ Partly Cloudy ☐ Cloudy	☐ Clear ☐ Partly Cloudy ☐ Cloudy
Precipitation	☐ None ☐ Rain ☐ Other	☐ None ☐ Rain ☐ Other

How could weather affect today's field study?

Data Collection

Type of Litter	# Bags	Mass in kg
Recyclable (Plastic and glass bottles, aluminum and steel cans, plastic containers)		
Non-Recyclable Plastic (stryofoam, rubber, shopping bags, plastic packaging)		
Recyclable Paper (Cardboard, newspaper, paper towels, looseleaf paper)		
Non-Recyclable Flexible Packaging (chip bags, plastic film, candy wrappers)		
Special/Other (Anything else you find that will fit in your bag)		

Gram (g) to kilogram (kg) conversions

1000 g= 1 kg

Example: 2000 g = 2 kg

Example 2: 500 g = .5 kg

List any Special items found:

Bridging the Watershed • www.fergusonfoundation.org

What Kinds of Litter Trash the Park?

EXPLORATION

BACKGROUND INFORMATION:

In this activity, students will work in groups to collect litter in a specified area within a park. As they collect the items, they will sort them by type of litter. Then students will determine the number of bags and mass for each category of litter collected by their group. When the students return to the classroom, they will combine their data with the data collected by other groups to complete their analysis. By collecting and analyzing the litter in the park, students will be performing a service for the park on two levels: removing the actual trash and reporting their trash analysis to the park managers.

Goal:

To collect and analyze litter at a national park.

Class Time:

The field study will be completed in a single 4-hour visit to a national park.

Group Size:

Students will work in groups of 4-5 students.

PROCEDURE:

1. **Work in assigned groups. One person will be the group recorder.**
2. **Complete the first half of the data sheet.**
3. **Get six trash bags and label them with the categories from the Data Collection table on the data sheet.**
4. **Choose a specific item you see that interests you and label your sixth bag with the name of this item. Examples include balls, shoes, straws or children's toys. Keep a count of the number "special" items found.**
5. **As you pick up each piece of litter, put it into the appropriate bag. Use the spaces under "other" to note any unexpected items you may find.**

SAFETY WARNING

- **DO NOT PICK UP** needles or other sharp objects, aerosol cans, soda containers that are unopened and bulging, or anything else that is not safe to handle.
- **NOTIFY** the park ranger if you encounter any of these items.
- The AFF Educator will discuss the types of objects you should avoid collecting.

What Kinds of Litter Trash the Park?

EXPLORATION

6. **When you have collected all of your litter, count the number of bags in each category. The group recorder should record the total on the Data Collection table.**

7. **Use the spring scale to measure the mass of all the litter found in each category. Record the mass on the Data Collection table.**

8. **What happens to the litter you have collected?**

   If this litter had not been outdoors, it could be disposed of properly. Recyclable items would be disposed of in a recycle container. Reusable items would be put to good use. However, because this litter has been outside, it is too dirty to go through the recycling equipment. Park personnel will put all the litter in the trash.

Data Analysis

EXPLANATION

BACKGROUND INFORMATION:

Using the data collected, each group will prepare a summary report assessing the litter situation in the park. This report should be similar to a lab report. When they have completed their written report, group members will use the evaluation form to rate their own work.

Groups can also access data from other classes on the Bridging the Watershed website at fergusonfoundation.org. This database offers an ongoing accumulation of comparative data about litter.

PROCEDURE, QUESTIONS AND POSSIBLE RESPONSES:

1. **While you were in the park, your group gathered data on litter.**

2. **Share your group data from the park with other groups by Completing Tables I and II:**
   Complete Table I: Class Summary for Litter Volume and Table II: Class Summary for Litter Mass. Calculate the percentage of waste volume and percentage of waste mass for each of the five categories of litter.

Goal:

To classify the litter students picked up on their field study and understand its significance.

Class Time:

90 minutes

Group Size:

Students will work in groups of 4-5 students.

Materials List for Each Group:

Computer with Internet access

Data Analysis

EXPLANATION

TABLE I: CLASS SUMMARY FOR LITTER VOLUME (Sample)

Type of Litter	Bags Per Group					Total Bags	% of Total Litter Volume
	A	B	C	D	E		
1. Recyclable Drink Containers (glass, metal, narrow-necked plastic bottles)	1	3	2	2	1	9	23.7
2. Recyclable Paper (newspaper, office, cardboard)	1	1	1	2	1	6	15.8
3. Non-Recyclable Plastic (including Styrofoam)	2	1	1	1	2	7	18.4
4. Non-Recyclable Paper	1	1	2	1	1	6	15.8
5. Other (tire, toy truck, shoe)	1	1	1	1	1	5	13.2
6. Special	1	1	1	1	1	5	13.2
					Total	38	100%

TABLE II: CLASS SUMMARY FOR LITTER MASS (Sample)

Type of Litter	Kilograms Per Group					Total kilograms	% of Total Litter Mass
	A	B	C	D	E		
1. Recyclable Drink Containers (glass, metal, narrow-necked plastic bottles)	1.2	4.0	3.4	2.8	1.4	12.8	23.8
2. Recyclable Paper (newspaper, office, cardboard)	1.2	1.4	1.1	0.9	1.6	6.2	11.5
3. Non-recyclable Plastic (including Styrofoam)	1.7	1.2	1.3	1.2	1.0	6.4	11.9
4. Non-Recyclable Flexible Packaging	2.1	1.4	1.2	1.1	2.5	8.3	15.4
5. Other (tire, toy truck, shoe)	7.0	0.5	1.2	0.9	1.4	11	20.4
6. Special	2.5	1.0	1.7	2.5	1.4	9.1	16.9
					Total	53.8	100%

Data Analysis

EXPLANATION

3. **Calculate the percentage for recyclables of total litter. What percent of the total volume of litter was recyclable? What percent of the total mass of the litter was recyclable?**

% Recyclable	
Volume	39.5%
Mass	35.3%

4. **Note the most common type of litter your class found. Give possible explanations for why you think this was the most common type of litter.**

5. **For your "special" category, write a paragraph describing how you think it got to the park and why it may be harmful to the watershed.**

   An example might be a Styrofoam cup, which floats and is not biodegradable, so it is very likely to be washed up on shore and stay there a long time.

6. **Fill in the following histogram to show the relative amounts of each group's "special" item collected.**

Group	Item	1-9	10-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
1	Soda Straws										
2	Fishing line										
3	Balls										
4	Styrofoam cups										
5	Shoes										

7. **Examine your data sheet to review weather conditions 24 hours prior to your field study. Begin your report by assessing the possible effects of those conditions on the amount and the location of the litter you saw.**

8. **Students will construct a final garbage pizza from the data collected in their field study.**

9. **Provide students with the Performance List. Use this list to evaluate your group's final report, as well as your group's data collection efforts in the park.**

   Using Performance Lists to Assess Student Work:

   Performance lists are often used to assess and evaluate student work. Performance lists consist of criteria that define the essential elements of the performance and/or product and are used to "paint the target" for both students and teachers. Because of the design and intent of performance lists, feedback to students is analytical in that both strengths and weaknesses of the performance can be delineated. In the classroom,

Data Analysis

EXPLANATION

performance lists have proven to be the easiest assessment tools for the teacher to design and for the student to use. Typically, they are the first and most important steps toward building other assessment tools, such as holistic and analytical rubrics.

The essential performance criteria provided in the performance list are defined in clear, concise, descriptive, and unambiguous language so that all audiences understand that target performance lists are often best used for self-assessment.

Once the criteria have been defined, you can "weight" the various elements of the performance by assigning different point values. This serves to draw attention to the most important criteria for a particular performance. For example, suppose you decide to assign a scale of 0–5 points to element #1, which states, "All group data are entered, and totals are accurately determined." Element #1 clearly defines one essential component of the performance and can be scored anywhere between 0 and 5 points. Element #2 states, "All class data are entered, and the totals and percentages for each type of litter for the class data are accurately determined." By contrast, this task is assigned a 0 -10 point value. Obviously, element #2 receives greater emphasis for this particular performance. Thus, the various elements of the performance can be "weighted" depending upon the goals of the teacher. Points for all criteria can be totaled at the end and used for student revision and/or assignment of grades entered and an average total index.

Performance List

EVALUATION

Group Members _____ Date _____

Performance Criteria	Assessment		
	Points	Group	Teacher
1 All group data are entered, and totals are accurately determined.			
2 All class data are entered, and the totals and percentages for each type of litter for the class data are accurately determined.			
3 The histogram for the special category is completed and accurate.			
4 The report begins with a detailed description of the study area and weather conditions.			
5 The harmful effects of the special litter have been described.			
6 The summary is clear and concise, and accurately reflects the findings of the study.			
7 Scientific terminology and concepts are accurately explained and applied to illustrate major points of the report.			
8 Visual aids (photographs, charts, graphs, and drawings, etc.) enhance understanding of the text.			
9 Visuals are clearly titled, labeled, and referenced within the text.			
10 Language used in the report is purposeful, descriptive, and appropriate for the intended audience.			
Total			

Teacher Comments:

Become a Trash Free School

ELABORATION

BACKGROUND

The Trash Free Schools project was developed by the Alice Ferguson Foundation to address the gap between environmental education and the litter problem in the Potomac River watershed. A guidebook on AFF's website will aid schools in reducing, reusing, recycling, as well providing education on these topics. Schools can become examples of the best management practices students have learned about in this module. This activity is intended to introduce the idea of becoming a trash free school – reducing source materials, managing solid waste responsibly, and eliminating litter - by allowing students to envision creating a Trash Free School.

Scenario: Your school district is asking schools to implement measures to reduce solid waste as an environmental and cost-saving measure. Less waste means a reduction in the cost of the solid waste hauling contract. You've challenged your students to create a plan for a Trash Free School to comply with the district request. In order to create the plan, students need to talk with various stakeholders to understand how this new plan will affect the various staff and administrators at your school.

Your students might want to talk with the people in these jobs to get a feel for how a more aggressive recycling program would impact their jobs. The jobs include (but aren't limited to):

- **Principal** – Will we need additional recycling containers? If so, who will pay for these? Are there other costs involved? Will this require more time of the custodial and office staff? How will teachers be informed about the new program? How will this program be sustained after the current students (who have initiated this effort) leave the school?
- **School office staff** – Will this involve the office staff in any way? If so, what will we need to do?
- **Custodian** – Will I have more trashcans to empty? My day is already filled with a lot of tasks to do. What happens if some of the recycle containers have garbage in them; will I be required to sort the materials?
- **Kitchen staff representative** – Will there be changes in the way the kitchen handles waste?
- **Student** – Will the Student Council Association be involved? How will students be informed of the Trash Free School initiative?

Goal:

To apply understanding of litter as non-point source pollution to a practical policy discussion.

Time:

2-3 class periods.

Trash Free Schools

ELABORATION

- **Teacher representative** – What is the role of the teaching staff in the Trash Free School program? Will we need to be sorting trash in our classrooms? Will white paper and all other paper be handled in the same way?

- **Athletic department** – We generate a lot of single-use bottles at sporting events, primarily from our concession stand. Will there be additional recycle containers at events? Who will empty those recycle containers after each event?

- **School district representative** – Since we are asking for schools to reduce their waste, what will you need from the district to make this happen at your school?

- **Waste management company** – You probably need to talk with us about how recyclables are collected. Each county, city, and jurisdiction handles waste in a slightly different way, depending on the markets they have for various recyclable materials.

Students who are not researching a position can do some research on trash free school programs and start developing questions to ask the various stakeholders at the town-hall style meeting.

PROCEDURE FOR TOWN HALL–STYLE MEETING

1. **Provide students with enough time to research their roles. Encourage them to speak with the people who do these jobs, to understand how a trash free school program would impact the jobs of these people. You can have several students work together for each of the roles above.**

2. **Have each of the stakeholders prepare a pro/con chart for their presentation.**

3. **To start out the Trash Free School town hall meeting, have your designated student organizer make the argument for a Trash Free School program. You can then have the various stakeholders respectfully ask questions about how the program will impact their jobs.**

4. **Any students who weren't assigned to a particular position can ask the stakeholders questions when it is the stakeholder's time to present their concerns or support.**

You should decide ahead of time how to accept audience questions addressed to each of the stakeholders.

Student Action Project: Take Action!

ELABORATION

BACKGROUND INFORMATION:

Your students have looked at the problems caused by litter in the Potomac River watershed. Recognizing a problem is the first step to solving it. The next step is to take what they've learned and apply that knowledge at the local level in the community.

During the field study in the park, students investigated a portion of their local watershed. This module and the field experience in the park were designed to heighten students' awareness and help them understand the important role they play in the health of their watershed. The choices they make about how to interact with their environment make a long-term difference, not only to the area in which they live, but also to the watershed as a whole.

Goals:

To increase awareness of the need for individual environmental action.

What Your Class Can Do:

When students are ready to take the challenge, there are many great ways they can get involved. The first step is to head to the Resource Library at the Ferguson Foundation website to check out potential student-led action projects.

TAKE ACTION!

There are many ways to help to reduce waste, recycle and stop litter. Work with your school, community group or on your own to make a difference.

Here are some ideas for what you can do. What other ideas can you think of? Decide to make a change today in your own actions.!

Reduce: Go plastic free: try not using any single-use plastic items for an entire week! If you've been successful, try going a whole month to decrease your plastic usage and waste.

Reuse: Use only nonplastic washable containers for drink. Put stickers on your water bottle and take it with you!

Recycle properly. If you do generate trash - review the rules for your local collection system and recycle right! This saves money and helps market the recyclables at a higher value.

Refuse: refuse to buy items or food products that are unnecessarily packaged in a way that creates an exorbitant amount of waste. Tell the restaurant you don't need all of those plastic take out containers.

Do not litter: if it is not possible to avoid using sing-use plastic products, be sure to dispose of them properly. Remind others to do the same.

Educate: Share you knowledge with your friends and family so they also understand the importance of reducing waste and properly taking care of the materials we do generate.

Visit the Ferguson Foundation website to find information on how to take on a student-led MWEE action project

Resources

EPA Key Terms and Definitions

Trash: Material considered worthless or offensive that is thrown away. Generally defined as dry waste material, but in common usage it is a synonym for garbage, rubbish, or refuse.

Marine debris: Persistent solid material that is manufactured or processed and directly or indirectly, disposed of or abandoned into the marine environment.

Solid Waste: Non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid waste also refers to liquids and gasses in containers.

Municipal Solid Waste: Common garbage or trash generalized by industries, businesses, institutions, and homes.

Litter: 1. The highly visible portion of solid waste carelessly discarded outside the regular garbage and trash collection and disposal system. 2. Leaves and twigs fallen from forest trees.

Landfills: 1. Sanitary landfills are disposal sites for non-hazardous solid wastes spread in layers, compacted to the smallest practical volume, and covered by material applied at the end of each operating day. 2. Secure chemical landfills are disposal sites for hazardous waste, selected and designed to minimize the chance of release of hazardous substances into the environment.

Plastic: A large family of synthetic polymers that are created by linking together repeating chains of carbon-based united known as monomers.

Microplastic: Plastic particles that are less than 5 mm in size and can be divided into two categories: primary and secondary microplastics. Primary microplastics are plastic particles that are manufactured to be smaller than 5 mm in size. Secondary microplastics are formed as a result of the fragmentation or break up of larger plastic pieces.

Aquatic Trash excerpts from the Environmental Protection Agency (EPA)

EPA's Trash Free Waters (TFW) program refers to the garbage polluting United States rivers, lakes, streams, and creeks as "aquatic trash." Most of the garbage that ends up in waterways comes from land-based activities. Garbage can easily become aquatic trash if it is not properly disposed of or securely contained. When garbage is littered on the ground rather than placed in a recycle, compost, or trash bin, rain and wind often carries it into storm drains, streams, canals, and rivers. For example, a cigarette butt tossed on the ground might wash into a storm drain and travel through the stormwater system, which in some cases, leads directly into waterways. Cigarette butts contain plastic that will remain in the environment for many years.
Trash also enters waterways as a result of illegal dumping in or near waterways. Illegal dumping of household waste may be more common if there is a lack of regular trash pickup services or publicly available dumpsters. Additionally, trash can blow out of overfilled trash bins or off of trash collection vehicles.

o trash enters cree s and ater ays. Credit anta Clara alley rban uno ollution revention ro ram

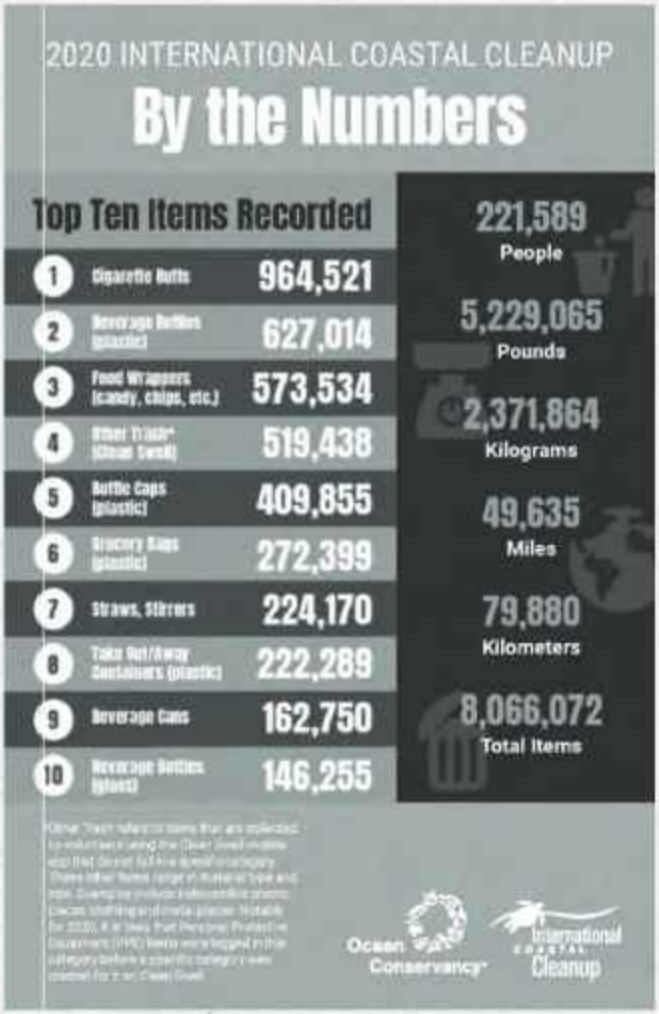
Once in the environment, trash can travel long distances via wind, stormwater conveyances, streams, and rivers. Aquatic trash becomes marine debris, or marine litter, once it reaches the ocean. trash affects water quality, endangers plants and animals, and pollutes the outdoor spaces that we depend on for tourism and recreation. Though all types of aquatic trash can have potentially harmful impacts, plastic waste is particularly concerning because of its tendency to persist in the environment and its widespread production, use, and disposal.

Environmental Impacts

When exposed to trash pollution, wildlife in aquatic and terrestrial environments face physical hazards from ingestion and entanglement. The impact that trash has on wildlife depends on a diverse range of factors, including the debris size, type, shape, and quantity, the type of organism that is exposed, and the type and frequency of exposure. Animals that become entangled in debris risk suffocating or drowning. Many species mistake plastic debris for food or inadvertently ingest plastic debris while feeding or swimming. Once ingested, this debris can damage their digestive tract and interfere with an animal's ability to feed, leading to starvation or other negative health effects. Scientists have found that at least 558 species, including turtles, seabirds, and marine mammals are reported to have ingested or become entangled in plastic waste. Rather than biodegrading,plastic waste often breaks down into tiny pieces known as microplastics (less than 5 mm in size), which are nearly impossible to clean up once they are in the environment. Microplastics can contain or absorb toxic chemicals potentially presenting toxicological risks for organisms that ingest them. When aquatic organisms eat these plastic particles, microplastics – and the chemicals they carry – can make their way up the food chain.

Plastic Pollution

Plastic pollution is particularly dangerous because it does not fully biodegrade in the environment. Plastic pollution has been found in a wide range of organisms and habitats, including coral reefs, estuaries, beaches, and the deep sea. Since plastic does not decompose, it continually accumulates in landfills and in the environment. Plastics are used to make a wide range of products, including appliances, furniture, clothing, beverage and food packaging, and cigarette butts. Americans produce over 36 million tons of plastic waste per year, which is about 12.2% of all municipal solid waste generated in the United States. Packaging is the largest market for plastic and the largest source of plastic waste. In 2018, over 14.5 million tons of plastic packaging and containers were disposed of as municipal solid waste. Often, plastic pollution fragments into increasingly smaller plastic particles known as "microplastics." Ingestion of microplastic particles can expose organisms to the chemicals used to produce the plastic material itself as well as persistent organic pollutants in the environment that tend to accumulate on plastic particles.



Top ten items collected on beaches in the 2020 International Coastal Cleanup. Credit: Ocean Conservancy

Social and Economic Impacts

No one likes to see litter in their community. Its presence detracts from the beauty of a landscape or neighborhood. When litter accumulates in or near a community, it can create health and safety risks for those living there. Litter can serve as a breeding ground for bacteria and can spread disease through direct or indirect contact with humans. Mismanaged trash may also attract pests or cause fires.

Aquatic trash can also have negative impacts on recreation, tourism, and the economy. Once trash escapes into the environment, cleaning it up is expensive, and this economic burden often falls on local governments and their residents.

Aquatic trash can lead to declining fish populations, which might hurt communities that rely on fisheries for subsistence, employment, income, and tourism. Furthermore, trash reduces the aesthetic and recreational value of waterfront destinations because trash washed up on shorelines or floating in the water is unappealing and possibly unsafe. Trash pollution can also cause damage to boats if the material tangles propellers or clogs vessel intakes.

Wheely cool: Baltimore's Trash Wheel family ate a million pounds of trash last year

By Rohan Mattu, excerpt from CBS News

BALTIMORE -- Baltimore's favorite family of trash-eating robots, the Trash Wheels, reached a major milestone last year: the collection of over one million pounds of litter and debris in 2023.

The Waterfront Partnership of Baltimore credits the historic milestone to a second consecutive year of operating four wheels, as well as an increase in winter rainfall helping aid collection.

Mr. Trash Wheel was installed in the Inner Harbor in May 2014, and in the last 10 years, the program has expanded to include Professor Trash Wheel, Captain Trash Wheel, and the newest, Gwynnda the Good Wheel of the West.

The larger trash hauls don't mean there is more trash in the water, the Waterfront Partnership said.

Since Baltimore's plastic bag and foam container bans took effect, the wheels have seen a 72% and 90% reduction in the collection of these items, respectively the organization said.

Mr. Trash Wheel in Baltimore Harbor. Credit: Stock Photos from SMEREKA/Shutterstock

Microplastics were found in D.C. rivers. Researchers want to find why.

by Justin Wm. Moyer, excerpt from the Washington Post

At the Anacostia Park boat ramp in Southeast Washington on a recent fall morning, the waterfront's beauty was on full display. The sun glinted off the Anacostia River as a freight train rolled by. Boats bobbed in choppy water at a nearby boathouse as an unseasonably warm breeze swirled around Nationals Park. Ducks quacked.
The water itself was less lovely. Bits of trash collected beside the boat ramp, caught in an eddy. Though water-quality studies have shown the Anacostia may soon be swimmable, a plastic hang tab floating by — the kind that might be attached to a product on a convenience store rack — was a reminder that the river isn't pristine yet. Some pollution was invisible to the naked eye, but with $90,000 in new grant money, a team of researchers was on hand to find it. The researchers weren't looking for garbage bags or discarded bottles but hidden microplastics embedded in river sediment.

Peering at a handful of muck dredged from the river bottom using a petite ponar dredge — a metal tool not unlike those in truck-stop claw machines — Barbara Balestra, a lecturer in American University's department of environmental science, said the sediment would be taken to a lab and scoured for microplastics that are almost certainly there. "I live here," she said. "It's important to try to see if we can make a better environment."
Researchers said their findings should inform policymakers seeking to ensure the river remains clean as it fails water-quality assessments amid efforts to address decades of pollution.

Though scientists say it's not clear yet what concentrations of microplastics are considered dangerous, the study said that identifying the source of these pollutants in the Anacostia watershed may help to improve waste management strategies. It is very difficult to remove microplastics, which are smaller than 5 millimeters, from water even with filtration systems, Balestra said.

"People shouldn't pretend that the illusion of recycling that's been promoted will work, when after 50 years of putting this burden on individuals and small towns we've achieved 9% recycling at most," Anastas, who is also director of the Center for Green Chemistry and Green Engineering at Yale, wrote in an email. "Instead, plastic companies should stop making the problem plastics and adopt the green chemistry solutions. They can make even larger profits by solving the problem than they can by manufacturing it."

Determining the source of D.C. pollution will require more study. MacAvoy said that the Anacostia's headwaters are in Maryland, where District officials have no control over pollution. Meanwhile, researchers found that most of the Anacostia's microplastics were made of high-density polyethylene, a chemical commonly found in household products such as shampoo bottles and soap dispensers.

Holding Producers Responsible for Plastic Packaging

by Jennie Romer. excerpts from the Surfrider Foundation

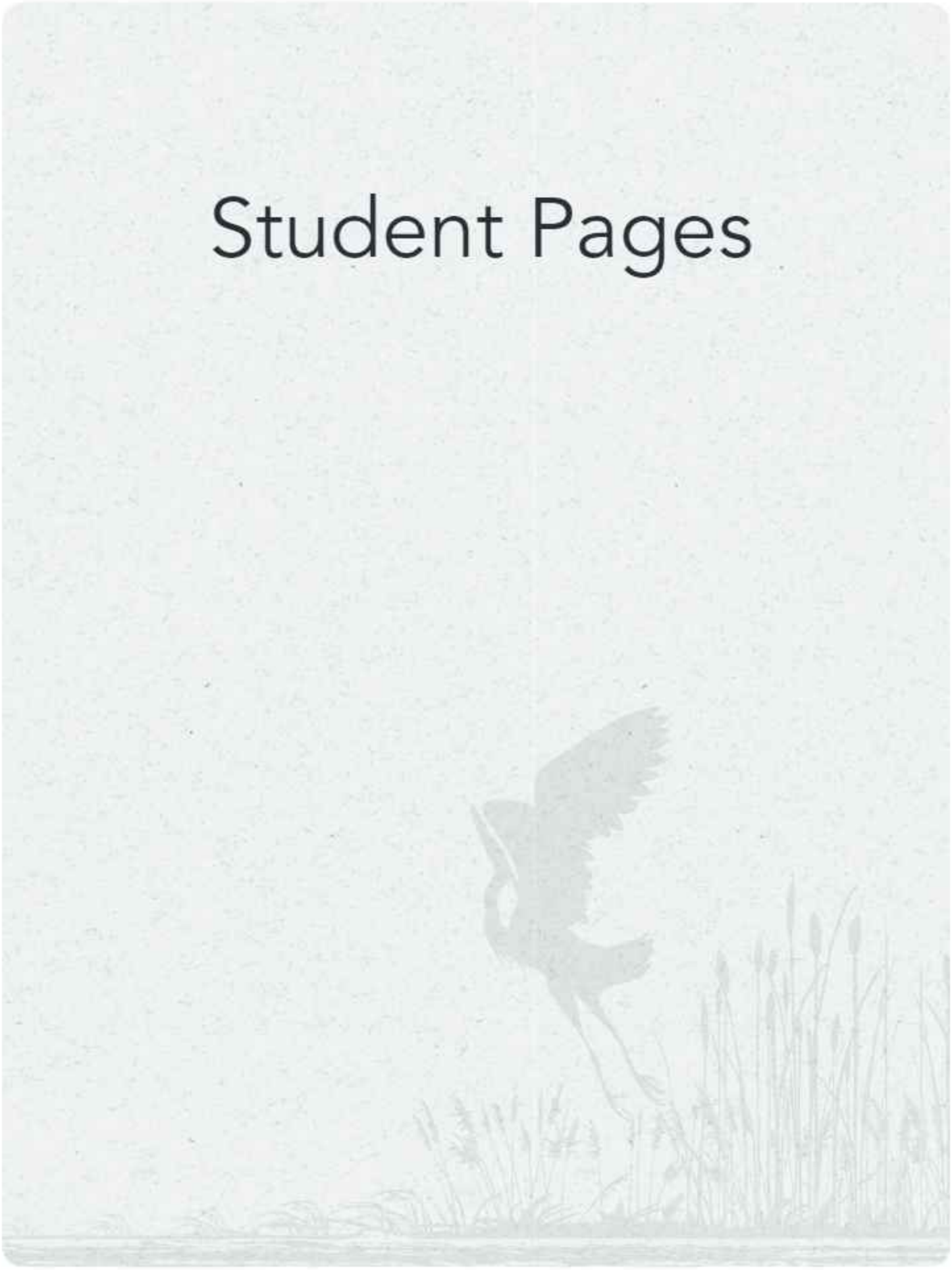
After bags, foam, straws, and other foodware have been addressed there is still a lot of plastic packaging in circulation, including much of the packaging on store shelves. This includes yogurt cups, chip bags, bread bags, films that cover perishable goods, like hummus, and so much more. Much of that packaging is difficult for consumers to avoid and mostly not recyclable. In order to address and mitigate that packaging we need a comprehensive policy that goes beyond bans and fees on specific items, while still preserving space for source reduction laws for certain items.

One solution for addressing this packaging is Extended Producer Responsibility, also known as EPR or producer responsibility. EPR for packaging laws ensure that producers — meaning manufacturers and brands — bear the responsibility for the cost of recycling and waste disposal, as well as for cleanup, of their packaging. Right now that financial burden mostly falls on ratepayers and local governments, and sometimes volunteers doing clean-ups. That's not only unfair, it leads to more waste. Hard or impossible-to-recycle packaging is what we get when manufacturers aren't incentivized to consider sustainability or the costs of managing waste when designing packaging for their products.

The EPR concept isn't wishful thinking, in the U.S. we have at least 118 EPR laws that have been adopted across 33 states. The laws cover 14 product areas, including electronics, needles (or "sharps"), pharmaceuticals, batteries, paint, mattresses and mercury-containing thermostats and lamps, among others. EPR for packaging is already happening and working well in Europe and parts of Canada, and in some instances, has been for more than 30 years!

Under an EPR system for packaging, producers must pay into a fund for the recycling, disposal and cleanup of the producer's packaging. The more wasteful their packaging, the more the producer must pay. As a simplified example, an EPR system might require a producer to pay 2¢ into a fund for each piece of packaging (or by weight), and they would also have to meet the minimum requirements for packaging design. However, the producer would have the option to pay less (maybe 1¢) if they improved their product design by specific actions that result in less trash and fewer non-recyclable materials, like by reducing the amount of packaging they use per product, or by using recycled content. The result is that less waste is produced, the packaging put on our shelves is more sustainable, and local governments no longer bear the financial burden of dealing with low-value plastics.

Student Pages



Garbage Pizza Table

MUNICIPAL SOLID WASTE COMPARISONS

Type of Municipal Solid Waste	United States (1995)	United States (2009)	Your Local Jurisdiction (you provide the data)	What might account for the change in MSW composition for this category?
Paper	37.9%	23%		
Yard Waste	14.6	12.1		
Metals	7.6	8.8		
Glass	6.3	4.2		
Plastics	9.5	12.32		
Wood	7.0	6.2		
Food Waste	6.7	21.6		
Other	9.4	11.9		

Bridging the Watershed

Talkin' Trash Datasheet

Date:

Teacher:

Park:

Study Site:

Park Rangers & Educators: (one per row)	Group Members: (one per row)

Latitude: North ____ ° Longitude: West ____ °

Why is it important to know the latitude and longitude?

	Yesterday	Today
Air Temperature	____ ° C	____ ° C
Cloud Cover	☐ Clear ☐ Partly Cloudy ☐ Cloudy	☐ Clear ☐ Partly Cloudy ☐ Cloudy
Precipitation	☐ None ☐ Rain ☐ Other	☐ None ☐ Rain ☐ Other

How could weather affect today's field study?

Data Collection

Type of Litter	# Bags	Mass in kg
Recyclable (Plastic and glass bottles, aluminum and steel cans, plastic containers)		
Non-Recyclable Plastic (stryofoam, rubber, shopping bags, plastic packaging)		
Recyclable Paper (Cardboard, newspaper, paper towels, looseleaf paper)		
Non-Recyclable Flexible Packaging (chip bags, plastic film, candy wrappers)		
Special/Other (Anything else you find that will fit in your bag)		

Gram (g) to kilogram (kg) conversions

1000 g= 1 kg

Example: 2000 g = 2 kg

Example 2: 500 g = .5 kg

List any Special items found:

Bridging the Watershed • www.fergusonfoundation.org

Data Analysis Procedure and Tables

TABLE I: CLASS SUMMARY FOR LITTER VOLUME

Type of Litter	Bags Per Group					Total Bags	% of Total Litter Volume
	A	B	C	D	E		
1. Recyclable Drink Containers (glass, metal, narrow-necked plastic bottles)							
2. Recyclable Paper (newspaper, office, cardboard)							
3. Non-Recyclable Plastic (including Styrofoam)							
4. Non-Recyclable Film							
5. Other (tire, toy truck, shoe)							
6. Special							
					Total		

TABLE II: CLASS SUMMARY FOR LITTER MASS

Type of Litter	Kilograms Per Group					Total kilograms	% of Total Litter Mass
	A	B	C	D	E		
1. Recyclable Drink Containers (glass, metal, narrow-necked plastic bottles)							
2. Recyclable Paper (newspaper, office, cardboard)							
3. Non-recyclable Plastic (including Styrofoam)							
4. Non-Recyclable Film							
5. Other (tire, toy truck, shoe)							
6. Special							
					Total		

Data Analysis Procedure and Tables

1. **Calculate the percentage for recyclables of total litter. What percent of the total volume of litter was recyclable? What percent of the total mass of the litter was recyclable?**

PERCENT RECYCLABLE OUT OF TOTAL LITTER

	% Recyclable
Volume	
Mass	

2. **Note the most common type of litter your class found. Give possible explanations for why you think this was the most common type of litter.**

3. **For your "special" category, write a paragraph describing how you think it got to the park and why it may be harmful to the watershed.**
   An example might be a Styrofoam cup, which floats and is not biodegradable, so it is very likely to be washed up on shore and stay there a long time.

4. **Fill in the following histogram to show the relative amounts of each group's "special" item collected.**

HISTOGRAM: SPECIAL ITEM CLASS TOTALS

Group	Item	1-9	10-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
1											
2											
3											
4											
5											

Group Members_____ Date _____

Performance Criteria	Assessment		
	Points	Group	Teacher
1 All group data are entered, and totals are accurately determined.			
2 All class data are entered, and the totals and percentages for each type of litter for the class data are accurately determined.			
3 The histogram for the special category is completed and accurate.			
4 The report begins with a detailed description of the study area and weather conditions.			
5 The harmful effects of the special litter have been described.			
6 The summary is clear and concise, and accurately reflects the findings of the study.			
7 Scientific terminology and concepts are accurately explained and applied to illustrate major points of the report.			
8 Visual aids (photographs, charts, graphs, and drawings, etc.) enhance understanding of the text.			
9 Visuals are clearly titled, labeled, and referenced within the text.			
10 Language used in the report is purposeful, descriptive, and appropriate for the intended audience.			
Total			

Teacher Comments: