



TRASH TALK: HOW TO TACKLE PLASTIC POLLUTION

Mara Walters

Virginia Institute of Marine Science

Grade Level

High School

Subject Area

Environmental Science

VA SEA is a collaborative project between the Chesapeake Bay National Estuarine Research Reserve, the Virginia Institute of Marine Science's Marine Advisory Program, and Virginia Sea Grant. The VA SEA project is made possible through funding from the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.



Title Trash Talk: How to Tackle Plastic Pollution

Focus Students will carry out a cleanup of their school campus, collecting and graphing data about the trash they find and learning about problems associated with plastic pollution along the way. Then, based on their observations from the cleanup, students will have the opportunity to complete an action project by planning and implementing a behavior change campaign to reduce plastic waste at their school.

Grade Level High School Environmental Science

VA Science Standards

ENV.1 The student will demonstrate an understanding of scientific and engineering practices by:

c) interpreting, analyzing, and evaluating data

- Construct, analyze, and interpret graphical displays of data
- Use data in building and revising models, supporting an explanation for phenomena, or testing solutions to problems
- Analyze data using tools, technologies, and/or models to make valid and reliable scientific claims or determine an optimal design solution

ENV.8 The student will investigate and understand that Earth's resources should be conserved. Key content includes:

- The trend in human consumption of energy will affect future availability of nonrenewable resources;
- The effects of natural and human-caused activities may either contribute to or challenge an ecologically sustainable environment;
- Individuals can alter their own behavior to reduce their environmental impact

ENV.9 The student will investigate and understand how human actions impact the environment. Key content includes:

- Advantages and disadvantages of balancing short-term interests with long-term welfare of society;
- Individual activities and decisions can have an impact on the environment

Note: This lesson plan also qualifies as a "MWEE" (Meaningful Watershed Educational Experience) and would therefore satisfy this requirement.

Learning Objectives

Students will...

- Collect data on the types of trash they pick up during a cleanup of their school grounds (or a nearby neighborhood or park).
- Formulate and then evaluate a testable hypothesis using their cleanup data.
- Create graphs of their cleanup data by determining the best type of graph and categories that illustrate their data, both in groups and as a class.
- Interpret the graph created by their class to identify the most common types of plastic pollution in their cleanup area.
- Collaborate as a class to devise a plan for the prevention of plastic pollution at their school based on the most common types of plastic trash that were identified.

Total Length of Time Required For The Lesson Three 45-50 minute class periods, two block classes of about 1.5 h each, or about 2.5 h plus extra time for making campaign materials

Key Words, Vocabulary

- Plastic pollution – plastic that enters the environment and causes harm, such as by negatively impacting the health or habitat of wildlife
- Single-use plastic – a plastic product designed to be used only once before it is thrown away; examples include plastic packaging, plastic straws, and plastic grocery bags
- Microplastic – a piece of plastic that is smaller than 5 mm (about 1/5”) and that typically forms from the breakdown of a larger piece of plastic, but can be manufactured at that size
- “Four R’s” – stands for “refuse, reduce, reuse, recycle”; a slogan commonly used to educate audiences about how to decrease the amount of plastic waste our society generates; historically, “recycle” has been emphasized as the best solution, but it is increasingly recognized that “refuse”, “reduce”, and “reuse” are the “R’s” that are better solutions to the plastic pollution problem
- Behavior change campaign – an effort, conducted through advertising and/or the creation of incentives, to encourage people to make positive changes that will benefit others and/or the environment; these typically target a deep-seated, long-term issue in society that is not solved easily

Background Information

Plastic is a material that we all use every day. It is cheap to make and can be used to make a huge variety of different products. Products made from plastic make our lives more convenient and also give us all access to products that we would not be able to afford otherwise. However, use of so much plastic comes with consequences. Plastics are made from byproducts of petroleum refining, contributing

to our society's reliance on oil. Unlike natural materials, plastic takes hundreds of years to decompose. Over time, plastic sheds into smaller and smaller pieces, forming microplastics.

When plastic enters the environment, it becomes pollution—that is, it can cause harm by negatively impacting organisms and their habitats. Large plastic pollution can be ingested by marine animals, leading to malnutrition and possibly starvation. Marine animals can also become entangled in plastic pollution that is large enough, potentially causing suffocation and impaired movement leading to starvation or death. Microplastics, which range in size from 1 μm (microscopic) to 5 mm (about the size of a pencil eraser), can be ingested by marine animals and contribute to malnutrition and starvation. An additional concern is that microplastics can be small enough to translocate from the stomach to other organs in the animal's body, potentially causing more severe damage.

The solution to plastic pollution is not simple. It will require change in government policies, manufacturing practices, and more. There are several actions, however, that anybody can take to decrease plastic pollution. One action is investing time in cleaning up plastic pollution. Anyone can organize or take part in a cleanup, and can even be involved in efforts like the International Coastal Cleanup, run by the Ocean Conservancy. The International Coastal Cleanup organizes groups of people all over the world to conduct cleanups of beaches, parks, parking lots, and more. Cleanups can be doubly effective by collecting data on the trash collected. This data can be used by scientists to determine the most common types of plastic products that end up as pollution, identifying targets for change. Such data can also be used to monitor how the amount of plastic found in a particular location changes over time. Therefore, collecting data on trash during a cleanup is valuable in addition to cleaning up the trash itself.

Another way that plastic pollution can be tackled is through changing our own habits. The four R's—refuse, reduce, reuse, and recycle—elegantly express the types of changes we can make to our own behavior to decrease the amount of plastic pollution we each generate. Historically, “recycle” has been emphasized, but the reality in our society is that “refuse”, “reduce”, and “reuse” are more effective in decreasing the amount of plastic waste—and thus plastic pollution—that is generated. This is due to the fact that only 9% of the plastic placed in the recycling stream is actually recycled. However, recycling processes continue to be improved, so recycling is still an important practice. In encouraging more and more people to change their behavior to reflect the four R's, “behavior change” campaigns are important tools. In these campaigns, materials such as posters, verbal statements, and incentives in the form of material rewards or positive peer pressure are used to encourage positive behaviors benefiting society as a whole as well as the environment. Anyone can encourage positive change in their school, workplace, or community by planning and carrying out a behavior change campaign.

Materials & Supplies

- Printed handouts:
 - 1 Data Collection Sheet per group
 - 1 Graphing Worksheet per student
 - 1 Behavior Change Campaign Worksheet per student
 - 1 Reflection Worksheet per student
- Computer and projector for PowerPoint slides + PowerPoint file

- At least one smartphone, classroom tablet, or computer per group of 2-3 students (or you may choose to enter data once for the entire class; if you choose this option, you may ignore this item)
- Gardening gloves [or disposable gloves if only option] for cleanup
- Trash bags or buckets for cleanup
- Clipboards for data sheets during cleanup (one per group of 2-3 students)
- Dry erase board, large easel with paper, or smartboard for class graphing activity
- Supplies needed for behavior change campaign project (e.g. poster paper with drawing & coloring supplies, access to printers for printing computer-generated posters, tape or sticky tack to hang up posters)

TIP: To get free informational posters on cleanup safety and Clean Swell, the cleanup app that can be used in this activity, as well as free gardening gloves and trash bags for the outdoor cleanup activity, sign up as a cleanup Site Captain with Clean Virginia Waterways at <https://www.longwood.edu/cleanva/VolunteerSiteCaptain.html>. You can register your class cleanup as a private group cleanup event as part of the International Coastal Cleanup hosted by the Ocean Conservancy, which takes place every Fall. By registering your cleanup, you will receive these free materials and join an international effort to tackle plastic pollution!

Teacher Preparation

If you plan to conduct the outdoor cleanup activity on the grounds of your school, reach out to the custodial staff ahead of time to let them know that they do not need to clean the school grounds for 1 or more days before your cleanup (depending on their typical cleaning schedule). This will ensure that there is trash for your students to clean up on their school grounds. In addition, if you have multiple classes, decide how you will split up the school grounds so that each class has a different area to clean up.

If you plan to conduct the outdoor cleanup activity at an adjacent neighborhood or park, you may not need to reach out to anyone there but feel free to do so if you think it would be a good idea.

The day before the cleanup, advise students to wear closed-toed shoes and long pants to class the next day to ensure their safety during the cleanup.

Print out enough data collection sheets such that there will be enough for every 2-3 students in your class. Print out enough graphing worksheets for each student in the class to have one and place on their desks so they have them during the beginning of class, before the cleanup (they will need them to record their group hypotheses). Assemble all of the supplies you will need for the outdoor cleanup activity—the gloves, buckets or trash bags, and clipboards—and arrange these for easy student access.

Arrange the classroom such that students can work in groups of 2 or 3 on the graphing activity once they come back inside from the outdoor cleanup activity.



For the class period in which the Elaboration phase will be carried out, print out enough behavior change campaign worksheets for every student in the class. Also have crafting materials such as paper, scissors, and markers available for students to use to make their behavior change campaign materials.

For the reflection two weeks after you conduct the cleanup and behavior change campaign, print out enough reflection worksheets for every student in the class.

Procedure

Engagement (5-10 min.)

Open with a class discussion about how your students use plastic and what they know about plastic pollution at their school. Ask the following questions (included on slide 3 in the slide deck):

1. Have you used or thrown away any plastic today?
2. What is single-use plastic? What are some examples?
3. Do you notice a lot of trash on the ground around your school? How about in your neighborhood? How do you think that trash got there?

After your class discussion, let the students know that they will be tackling plastic pollution today by participating in an outdoor trash cleanup activity. They will not only be cleaning up their assigned area but will also be collecting data on the trash that they find as citizen scientists. The data that they collect will go into an international database used by scientists studying plastic pollution. They will also use their own data to evaluate an original hypothesis and design a behavior change campaign to reduce plastic pollution at their school.

Exploration (45 min.)

Introduce the class to the logistics of the outdoor cleanup activity. Use Slide 4 of the provided PowerPoint presentation to guide students through how to fill out the data collection worksheet.

Next, go over the safety information that they should be aware of on Slide 5 of the provided PowerPoint presentation. In addition, if you wish to point out the boundaries of where students can go using a screenshot of a map from Google Earth/Maps, insert that map on Slide 6 and present it to the class.



Then, place students in groups of 2 or 3. First, have each group come up with an original, testable hypothesis for their group that they will evaluate with the data that they collect during the cleanup. Have each group record their hypothesis at the top of their graphing worksheets.

Then, assign one person per group to be the data recorder, and the other 1-2 students to be trash pickers. All trash pickers should have a pair of gloves and either a 5-gallon bucket or trash bag. All data recorders should have a clipboard with a data collection sheet and a writing utensil.

TIP: If any students forget to wear closed-toed shoes or long pants, have them be data recorders to prevent any scrapes or scratches from entering overgrown areas (if any are present).

Finally, lead students to the area where they will be conducting their cleanup. Divide the area into sections so that each group of 2-3 students is picking up trash in a different area. Have students report back once they are finished. After verifying that each group's data have been collected using the worksheet, dispose of the collected trash (if you see a glaring error in the worksheet, have students redo it by counting the trash again before it is disposed of). If using buckets, you can pour the trash into trash cans in the area or pour trash from the buckets into a common trash bag.

TIP: If you are going to an area without trash cans, figure out where your trash can be disposed of at your school (e.g. a dumpster) on your way back to the classroom by asking your school's custodial staff.

On your way back to the classroom or once in the classroom, ensure students wash their hands thoroughly with soap and water. Collect any equipment (gloves, buckets, clipboards, etc.) from students once back in the classroom.

Explanation (45 min.)

Go through Slides 9-23 of the provided PowerPoint presentation ("Plastic Pollution and its Marine Impacts") to provide students with context about the problem of plastic pollution and about why their cleanup was important. You may look at the "Notes" section of the PowerPoint file for talking notes for each slide, or read them in Appendix A below. If you wish to use it, Appendix B includes a note-taking sheet for students to follow along with the presentation. The presentation covers the following topics:

- A brief history of plastic
- What plastic is made from
- How much plastic makes its way to the ocean each year
- How plastic gets to the ocean

- How plastic harms marine life
- What microplastics are
- The four R's and why refuse, reduce, and reuse are most effective

Next, have students review their group's data collection sheet from the cleanup and read the instructions on their graphing worksheets, which they will each complete individually while working with their group. Have students answer all of the questions and tell you when they are finished. They will construct graphs based on their group's data, using the categories provided or making their own categories for their graphs as well as deciding on what type of graph they should use. They will also enter their data into the "Clean Swell" app using their smartphones or a classroom tablet (one per group), or the TIDES database using a computer (again, one per group). [Alternatively, you can have students skip this page of the worksheet and you can enter the data into the app or database website for the entire class later.] Then, bring the class back together to discuss as a class:

1. What type of graph did your group choose? Why?
2. Did your group use the categories provided or your own categories? Explain your choice.

Then, determine as a class whether your class should use the categories provided on the data collection sheet or categories of your own invention. Use these categories to draw a table on the board. Have one student be the class recorder, then have each group call out their numbers to be added to the table. Finally, based on class consensus about the best type of graph to use (bar graph or pie chart), make a class graph with this data. Involve students as much or as little in the actual drawing of the graph as you wish. You may choose to use the blank graphs on Slides 24 and 25 in the slide deck to construct your class graph.

If you will conduct the Elaboration phase in the next class period, make sure you take a photo of the class graph or retain it in some other way for the Elaboration phase. Collect the graphing worksheets that the students have completed.

Elaboration (45+ min)

NOTE: Look into what approvals are needed from administrators at your school for materials like posters and announcements to be posted around your school, since students are likely to choose materials of this nature for their behavior change campaign based on the data from their cleanup.

Direct the attention of the class to the graph they constructed together using the data they collected from the cleanup. Discuss as a class, using the behavior change campaign worksheets for guidance:

1. What are the three most common **plastic** items our class collected during the cleanup? Compare these to the most common trash items collected worldwide (not all of which are plastic). *(Students have this question and a graphic displaying worldwide trash data from the International Coastal Cleanup at the top of their behavior change campaign worksheets, so this question is intended as a written warm-up.)*
2. Based on how close the cleanup site was to the school, do you think students were the most likely source of this plastic pollution? Why or why not?
3. Let's suppose that students are the original sources of the trash. Is it likely that these items were brought from home or purchased at your school? Why do you think so?
4. Is recycling an option at your school? If so, what are your school's recycling rules? *(Look these up as a class or review posted recycling rules, if needed.)*
5. State that, "Our goal today is to figure out how to prevent plastic pollution at our school by refusing, reducing, reusing, or recycling better as a school. We are going to come up with and carry out a behavior change campaign at our school to encourage positive change." Brainstorm ideas as a class on how to organize a campaign to prevent plastic pollution at your school. Give your students as much room for creativity as possible. If helpful, here are some ideas to get you started:
 - a. Make posters or flyers to campaign for students to start **reusing** a particular item to **reduce** plastic waste (e.g. water bottles, food containers, plastic cutlery). Write an announcement to send out to the school in support of this campaign.
 - b. Make posters or flyers about **recycling** rules at your school if none exist. Post them around the school near recycling bins.
 - c. Make a map of areas that you noticed had more litter than others on your school grounds and ID where more trash cans should go to **reduce** plastic litter.
 - d. Campaign to ban the sale or purchase of a particular single-use plastic item in your school to **reduce** single-use plastic consumption.

Finally, give students the time they need within the class period to use the provided idea organizer in the behavior change campaign worksheets to make a campaign plan. You may choose to have each group plan and implement a campaign, or you may have the class vote to select one campaign plan for the class to carry out, then divide tasks and let each group handle one part of the campaign plan. Have students implement their plan so that they will learn that their actions can have a real impact on plastic pollution prevention!

Evaluation (15 min., ~2 weeks after the original activities)

A couple of weeks or so after the students implement their "behavior change" campaign for plastic pollution prevention, discuss with the class how effective their campaign has been. Use the questions in the reflection worksheets to spark your discussion. The questions in the worksheet are as follows:

- Have you noticed changes in the habits of your fellow students based on your class campaign? How have your own habits changed?
- Do you think there is anything you could have done that would have made your campaign more effective? Why or why not?

Assessment

Students will turn in data collection sheets for a completion grade and graphing worksheets for evaluation (see rubric). The behavior change campaign worksheets and reflection worksheets are meant to be for a completion grade. The effort that students put into the behavior change campaign project can be another opportunity for assessment.

Acknowledgements

First and foremost, I would like to thank the organizers and teachers of the Virginia Scientists & Educators Alliance for their support and feedback during the development of this lesson plan. Next, special thanks to the Ocean Conservancy's International Coastal Cleanup for developing the data collection sheet used in this activity as well as the "Clean Swell" app. Special thanks also to Clean Virginia Waterways for the valuable logistical and safety information for outdoor cleanup events included in this lesson plan (see <https://www.longwood.edu/cleanva/VolunteerSiteCaptain.html>). Attributions for photographs in the PowerPoint are included on all pictures. Data presented in the PowerPoint came from the following sources:

- <https://www.sciencemuseum.org.uk/objects-and-stories/chemistry/age-plastic-parkesine-pollution>
- <https://www.navalaviationmuseum.org/wp-content/uploads/2020/06/Aircraft-Carrier-Teachers-Guide.pdf>
- <https://ourworldindata.org/plastic-pollution>
- <https://www.science.org/doi/10.1126/science.aba3656>
- <https://education.nationalgeographic.org/resource/great-pacific-garbage-patch/>
- <https://www.oecd.org/environment/plastic-pollution-is-growing-relentlessly-as-waste-management-and-recycling-fall-short.htm>
- https://oceanconservancy.org/wp-content/uploads/2021/09/2020-ICC-Report_Web_FINAL-0909.pdf


Group Members: _____

Data Collection Worksheet

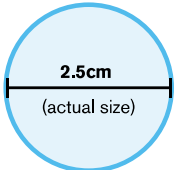


TRASH COLLECTED

Citizen scientist: Pick up all trash and record all items you find below. No matter how small the items, the data you collect are important for Trash Free Seas.[®]

EXAMPLE:	TOTAL #	Please DO NOT use words or check marks. Only numbers are useful data.
Plastic Bags: 	= 8	

MOST LIKELY TO FIND ITEMS:		TOTAL #
Grocery bags (plastic):	=	
Other bags (plastic):	=	
Beverage bottles (glass):	=	
Beverage bottles (plastic):	=	
Beverage cans:	=	
Beverage sachets/pouches:	=	
Bottle caps (metal):	=	
Bottle caps (plastic):	=	
Cigarette butts:	=	
Cups, plates (foam):	=	
Cups, plates (paper):	=	
Cups, plates (plastic):	=	
Food containers (foam):	=	
Food containers (plastic):	=	
Food wrappers (candy, chips, etc.):	=	
Lids (plastic):	=	
Straws/stirrers (plastic):	=	
Utensils (plastic):	=	
FISHING & BOATING:	TOTAL #	TOTAL #
Line, nets, traps, rope, etc.:	=	
Foam dock pieces:	=	
PACKAGING MATERIAL:	TOTAL #	TOTAL #
6-pack holders:	=	
Foam packaging:	=	
Other plastic bottles (oil, bleach, etc.):	=	
Strapping bands:	=	
PERSONAL HYGIENE:	TOTAL #	TOTAL #
Condoms:	=	
Cotton bud sticks (swabs):	=	
Diapers:	=	
Gloves & masks (PPE):	=	
Syringes:	=	
Tampons & applicators:	=	
OTHER ITEMS NOT LISTED:	TOTAL #	TOTAL #
1.	=	
2.	=	
3.	=	
4.	=	
5.	=	
ILLEGAL DUMPING:	TOTAL #	TOTAL #
Appliances:	=	
Construction materials:	=	
Tires:	=	
OTHER ITEMS/DEBRIS:	TOTAL #	TOTAL #
Balloons:	=	
Clothing:	=	
E-cigarettes:	=	
Electronic waste (phones, batteries):	=	
Footwear (shoes/slippers):	=	
Paper bags:	=	
Tobacco products (lighters, cigar tips, wrap):	=	
Toys:	=	
Other plastic waste:	=	
Other waste (metal, paper, etc.):	=	
TINY TRASH LESS THAN 2.5CM	TOTAL #	TOTAL #
Plastic/foam pieces:	=	
DEAD/INJURED ANIMAL		
Type of animal:		
Status: dead/injured Entangled: yes/no		
Type of entanglement item:		



Name: _____ Date: _____

Trash Talk: Let's Tackle Plastic Pollution!
Graphing Worksheet

Make sure your group can all see your data collection sheet, as you will each need it to complete the first part of this worksheet. Even though you should each complete a worksheet, discussing your answers with your group members is encouraged.

1. Record your group's original and testable hypothesis, which you will evaluate using the data you collect during the cleanup:

2. Fill out the following table with the data from your group's data collection sheet:

Categories	Total number of trash items collected
Most Likely to Find Items	
Fishing & Boating	
Packaging Material	
Personal Hygiene	
Illegal Dumping	
Other Items/Debris	
Tiny Trash Less Than 2.5 cm	
Other Items Not Listed	



3. Consider the hypothesis your group came up with before the cleanup. Was your hypothesis supported by your data? Why or why not?

4. Did you find trash that fit into all of the categories included on the data collection sheet? If not, in how many categories did you find at least one item?

5. Do you think that these categories describe the trash that you found well? Why or why not?

9. Your next task is to log your data in an international database called TIDES (Trash Information and Data for Education and Solutions), which was developed by a nonprofit organization called the Ocean Conservancy. This database contains data on the types and amounts of trash collected all over the world in places like beaches, parks, and parking lots during cleanups such as yours. Only one person per group needs to log the data, since only one entry should be created per data set, but you should all watch how the data is input into the database.

You can use an app called “Clean Swell” to enter your data, or you can use the TIDES database website. Your teacher will let you know which you should use.

Follow these steps to enter your group’s data in the database using the “Clean Swell” app:

1. Download the “Clean Swell” app on your smartphone (or a classroom tablet). You might find the QR codes below helpful:



pp Store



2. Create an account in the app using your email or an existing social media account.
3. On the home page, tap “Start a new cleanup.”
4. Make sure the details on the screen that you are taken to is correct, including the number of people in your group, that the cleanup type is set to “Land”, and that the location is set to the name of your city. You can skip the “Group Name” section, or put in the name of your class.
5. Tap the “Start a new cleanup” button when you are ready.
6. You will be taken to a screen that includes all of the same categories included on the data collection sheet that you filled out. Enter the number of trash items you found in each category into the app:
 - a. Tap on the item icon once to log one piece of trash of that type at a time.
 - b. You can also tap and hold on any icon to input the total for that category all at once, or to change the number for that item type.

7. When you are done logging all of the trash that you recorded on your data collection sheet, tap “Finish this cleanup” to close out your entry.

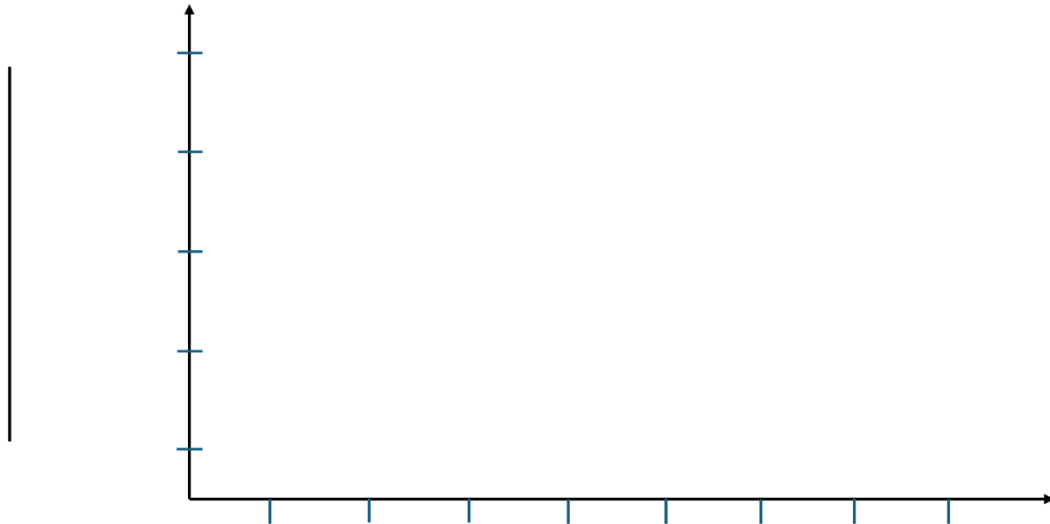
Follow these steps to enter your group’s data in the database using the TIDES database website:

1. Navigate to <https://www.coastalcleanupdata.org/> in your browser.
2. Create an account on the website using your name and email.
3. On the homepage, click on “Enter Data”.
4. Select the location where your class did your cleanup by zooming in on the map and clicking on the correct location. Click “Enter Cleanup Data”.
5. You will notice that the webpage that comes up matches your group’s data collection sheet, with the addition of some boxes at the beginning for your group’s name, information on your cleanup site, information about the number of people in your group, and the weight of the trash you collected as well as the distance you walked during your cleanup. Do your best to fill out all of these boxes, in addition to the ones that exactly match your group’s data collection sheet.
6. When you are done logging all of the trash that you recorded on your data collection sheet, click “Submit and Finish” to close out your entry.

When you are finished logging your data, let your teacher know that you are all done.

Optional: Blank graph (bar graph or pie chart) for use with Question #6:

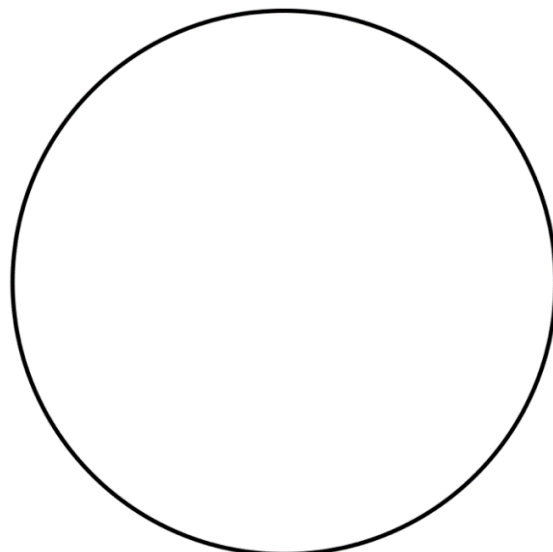
Title: _____



Title: _____

Legend

<input type="checkbox"/>	_____	<input type="checkbox"/>	_____
<input type="checkbox"/>	_____	<input type="checkbox"/>	_____
<input type="checkbox"/>	_____	<input type="checkbox"/>	_____
<input type="checkbox"/>	_____	<input type="checkbox"/>	_____



Name: _____

Date: _____

Trash Talk: Let's Tackle Plastic Pollution!
Behavior Change Campaign Worksheet



1. Warm-Up: What are the three most common **plastic** items your class collected during the cleanup? Compare these to the most common trash items collected worldwide (not all of which are plastic), which are shown in the graphic on the left. Do you see any similarities? Any differences?

Brainstorm some ideas for your campaign:

Here are some questions to inspire you: What problem related to plastic pollution do you want to tackle at your school? How might you solve it? Who is your target audience?

1.

2.

3.

How will you implement your plan?

Some ideas to get you started: a flyer, a poster, a display table, an announcement...

What content should your behavior change campaign materials include?

Write down some statements you want to include and/or ideas for graphics you will use.

Name: _____ Date: _____

Trash Talk: Let's Tackle Plastic Pollution!
Graphing Worksheet RUBRIC
(25 points total)

Make sure your group can all see your data collection sheet, as you will each need it to complete the first part of this worksheet. Even though you should each complete a worksheet, discussing your answers with your group members is encouraged.

1. Record your group's original and testable hypothesis, which you will evaluate using the data you collect during the cleanup:

(2 points) Ensure that students have recorded their hypothesis and that their hypothesis is truly testable based on the data they are planning to collect.

2. Fill out the following table with the data from your group's data collection sheet:

Categories	Total number of trash items collected
Most Likely to Find Items	
Fishing & Boating	
Packaging Material	
Personal Hygiene	
Illegal Dumping	
Other Items/Debris	
Tiny Trash Less Than 2.5 cm	
Other Items Not Listed	

(2 points) Verify that the students have filled out the table.

3. Consider the hypothesis your group came up with before the cleanup. Was your hypothesis supported by your data? Why or why not?

(3 points) Look for students to state whether or not their hypothesis was supported, the portions of their data that contributed to their evaluation, and why or why not those parts of the data set support their hypothesis.

4. Did you find trash that fit into all of the categories included on the data collection sheet? If not, in how many categories did you find at least one item?

(2 points) Students should write that all of the categories had at least one trash item found or list a specific number of categories that the trash they collected fell into.

5. Do you think that these categories describe the trash that you found well? Why or why not?

(2 points) Students should write at least 1-2 sentences about how many trash pieces they collected did or did not fit well into the categories provided on the data collection sheet. Look for them commenting on characteristics of the trash that the categories didn't cover, or types of trash that are not common enough to have been easily placed into a category.

6. Suggest some changes to the categories listed on the worksheet. Which categories would you add? Which would you take away?

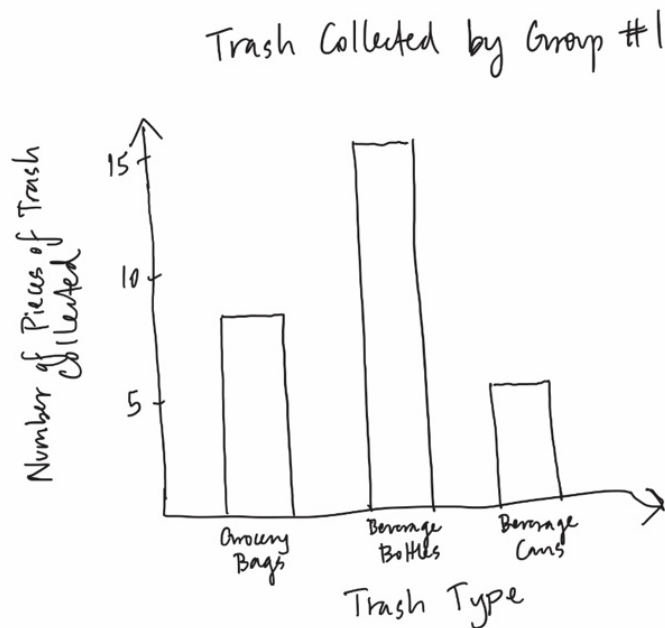
(2 points) Students should offer at least one new category to add—such as a category that would describe any of the trash their group found in the “other” category—and at least one category to take away—a category for which their group did not collect any trash, for example.

7. Look back to your group's data collection sheet. Do you think these data would best be shown as a line graph, a bar graph, or a pie chart? Explain your choice.

(3 points) Ideally, students will comment here on the fact that a line graph is best for data that needs to be displayed over time, which their data does not fit. Both a bar graph and a pie chart are acceptable forms that their graph can take. A bar graph is best for simply illustrating the number of trash items per category. A pie chart is best for showing what the most abundant and least abundant types are as a proportion of all of the trash their group collected.

8. Draw a graph of your data below, using the type of graph you chose in #4 and either the categories that you suggested in #3 or the categories from the data collection sheet (whichever you think are better). Make sure to include a title, labels for all categories, and, if appropriate, axis titles and/or a legend.

(7 points) Students should draw a bar graph or pie chart, matching their answer to question #4. Students may choose to use the categories given on the data collection sheet or the categories they came up with themselves, as described in the prompt for this question. All categories for which trash was found on the group's data collection sheet should be included, and proportions or numbers should be accurate to the numbers on the data collection sheet for the group. Students should also be graded on whether they included a title and appropriate category and axis titles, if applicable. For example, see below:



9. Your next task is to log your data in an international database called TIDES (Trash Information and Data for Education and Solutions), which was developed by a nonprofit organization called the Ocean Conservancy. (...)

When you are finished logging your data, let your teacher know that you are all done.

(2 points) Ensure that the students tell you that they are finished entering their data in the app or on the website as a participation check.

Appendix A: Talking Notes for Each Slide in PowerPoint Presentation ("Plastic Pollution and its Marine Impacts")

Slide 10:

- The story of plastic began in 1862, when celluloid, the first partially-synthetic plastic, was developed. This plastic was only partially synthetic because cellulose made up part of its structure.
- Then, the first fully synthetic plastic—fully man-made—came in 1907, when Leo Baekeland invented a plastic called Bakelite. It was a huge commercial success, since it came in many colors and shapes and allowed people to afford products they could not before. Bakelite products were cheaper than products made from natural products like elephant ivory.

Slide 11:

- Following the invention of the first plastics, chemical and petroleum companies had a problem. They had large quantities of chemical byproducts from fossil fuel refining, but nothing to do with them. They wondered, "how can we make a profit from these unused chemicals?"
- They realized maybe plastic could be the answer to their problem, so they invested money in the invention of new plastics. This effort was a huge success.
- In the 1930's alone, four new plastics were invented: Perspex, Polyethylene, Nylon, and Teflon. Since then, many more plastic types have been invented.
- Still today, most plastics are made from these fossil fuel byproducts that have few other uses. That is why they are so cheap to make. It also means they are nonrenewable, just like fossil fuels themselves are.

Slide 12:

- In 1950, as plastic began to become popular, about 2 million tons of plastic were made worldwide.
- This image from a Life magazine article in August 1955 reflects the excitement that people had about plastic at that time. Plastic was going to make their lives so much easier and more convenient.
- This same convenience is a large part of why plastic is still so widely used today.
- Since the 1950s, plastic production has only grown.

Slide 13:

- In 2019 alone, more than 460 million tons of plastic were produced globally. That is 230 times more plastic than what was produced in 1950!

Slide 14:

- And to give an idea about just how much plastic that is, one million tons of plastic weighs more than ten aircraft carriers!
- An aircraft carrier weighs over 100,000 tons!
- An aircraft carrier is three times the length of a football field!
- And keep in mind that an aircraft carrier is made of dense and heavy materials like metal and concrete. Plastic is much lighter, and so one million tons of plastic would take up much more space than an aircraft carrier does!
- This means that in 1950, 20 aircraft carriers worth of plastic were produced.
- Then in 2019, that number had risen to about 4,600 aircraft carriers worth of plastic.

Slide 15:

- To put the enormous amount of plastic that has been produced another way, over 9.5 billion tons of plastic have been produced since the beginning of plastic production.
- That's 95,000 aircraft carriers worth of plastic!
- That's also the equivalent of more than one ton of plastic for every person alive today.
- Since plastic does not break down like natural materials do, that means that a lot of this plastic is likely still present on our planet in one form or another.

Slide 16:

- Focusing in on the marine environment, the data shows that in 2016 alone, more than 20 million tons of plastic entered waterways.
- Again, that's about 200 aircraft carriers by weight, but not size. The size is MUCH larger. This is about 11% of world plastics production in 2016.
- 1950 – 20 aircraft carriers or 2 million tons...so 10 times the amount of plastics produced in 1950 are entering the oceans every year ☹️
- And sadly, that number continues to rise.

Slide 17:

- A good question to ask is: how does all this plastic get to the ocean in the first place?
- Most plastic gets to the ocean from the land. Litter makes its way to waterways, which can eventually lead to the ocean.
- Plastic can reach waterways by leaking out of trucks on the way to landfills and from landfills themselves if they are not secured properly. Also, the wind can blow them or the rain can wash them away from these places.

- Another source can be overflowing trash cans. If trash cans get to the point that they are overflowing without being bagged up and disposed of properly, wind and rain can make that trash litter—even though it was thrown away like it should have been at first.
- Of course, when trash is littered or illegally dumped, it can eventually reach waterways or even be placed directly into waterways. From the waterways, the trash can then reach the ocean.

Slide 18:

- Another way trash can make its way to waterways and the ocean is by washing into storm drains. You may have noticed symbols like this one on storm drains? That means that particular storm drain goes directly into a waterway. So any trash on roadways or sidewalks will make it into storm drains when it rains.
- Wastewater can be another source of plastic, since treated water from wastewater treatment plants typically drains directly into waterways or the ocean itself. Wastewater treatment plants are not designed to remove all of the small particles of plastic—called microplastics—from the water, making treated wastewater a source of plastic to waterways. More on microplastics later!
- Now, can anyone guess how much of the plastic in the ocean comes from land-based sources? Good guesses! The correct number is 80%!

Slide 19:

- Plastic can also make its way to the ocean through human activities that take place on the ocean, or “maritime” activities.
- One activity such as this is shipping. You’ve probably noticed that a lot of the plastic products that we use daily are made in other countries that are long distances away, like China. For those products to get to us, they have to be shipped across the ocean on container ships.
- Sometimes, accidents can happen during transport when storms come, causing ships with tall stacks of containers to tip over. These containers then fall into the ocean and can break up, releasing large amounts of plastic into the water. This plastic pollution can then wash up thousands of miles away, leading to incidents where many of the same plastic product can wash up on a beach at once.
- Another activity that can produce plastic pollution is fishing, when lost or forgotten fishing nets, lines, and traps end up as pollution. These are also called “ghost gear.” Ghost gear can trap non-target animals and cause other damage.
- Now that you know the amount of plastic pollution that ends up in the ocean from land and how plastic pollution can get to the ocean from human activities on the ocean, what percentage of plastic pollution in the ocean comes from maritime sources? That’s right! 20%.

Slide 20:

- Now, how does plastic pollution in the ocean harm marine life?

- First of all, marine life can ingest plastic. Scientists have found that at least 332 species of different marine animals have ingested—that is, eaten—plastic.
- Can you guess what happens to marine life after they ingest plastic? (Give students chance to figure it out.)
- Once marine animals ingest plastic, the plastic can block the digestive tract of the animals, keeping them from getting nutrients from their food.
- This gives them a false feeling of being full, keeping them from eating good food.
- Unfortunately, this can eventually result in starvation and death for these animals.

Slide 21:

- Another way plastic pollution can harm marine life is through entanglement.
- Scientists have found that at least 341 species of marine animals have become entangled in plastic pollution.
- (Again, ask what the impact of entanglement would be)
- Answer: Choking and suffocation
- Answer: Impaired locomotion and ability to forage, leading to malnutrition, impaired reproduction, and possibly starvation ☹️

Slide 22:

- Now, one of the last things we're going to talk about today is a form of plastic pollution that is in the ocean and elsewhere called "microplastics." Who has heard of microplastics? (Have students raise hands)
- Microplastics are plastic particles that are less than 5 mm in size, or less than about 1/5 of an inch in size. Microplastics can be formed in a couple of different ways.
- First of all, microplastics can be made to be small. One type of microplastics, which this person is holding in their hands in the photo, are called "nurdles". These are the form that plastic comes in when it is first made and before it is molded into new shapes. Nurdles become plastic pollution when there are spills of them in the environment on their way to factories.
- Another good example of microplastics made to be small would be glitter. Most glitter is actually made of plastic.
- Even though microplastics can be made small, the microplastic pollution in the environment is generally not formed this way. Most microplastics come from big plastic pieces as they break down over time. When a larger piece of plastic pollution bakes in the sun, is buffeted by waves, and is colonized by microbial and animal life, it breaks down into smaller and smaller pieces instead of breaking down completely. As a result, microplastics are formed.
- For example, if you have a plastic bottle floating in the ocean, over time it will break down into smaller microplastics.

Slide 23:

- Now that you've learned all about plastic pollution in the ocean, you might be wondering what is to be done about this huge problem?
- Well, we can all play a role in decreasing the amount of plastic pollution that makes it to the ocean! Who has heard of "the four R's"? Can you say them with me? Reduce, reuse, recycle.
- Now, generally we emphasize recycling over the other two "R's". But I have an unfortunate statistic to share with you. In reality, only 9% of plastic that enters the recycling stream globally is actually recycled. This is because the recycling system in its present state is not as efficient as it ought to be. Improvements are being made to it all the time, but at present, it is actually more effective to reduce and reuse plastic.
- This does not mean that we shouldn't recycle, it just means that we should put more of an emphasis on reducing the amount of plastic that we use and reusing what plastic products we are using. The less plastic you use, the less can make its way to become pollution. And the more times you reuse plastic items, the more plastic items you are keeping from potentially becoming plastic pollution.
- Alright, now let's go back to the data we collected during our cleanup...

**Appendix B: Optional Note Sheet for Students to Follow Along with PowerPoint Presentation
("Plastic Pollution and its Marine Impacts")**

Plastic Pollution and its Marine Impacts Note Sheet

A Brief History of Plastic:

- 1862 - _____, the first partially-synthetic plastic, was developed.
- 1907 – Leo Baekeland invents _____, the first fully synthetic plastic. It was a huge commercial success.
- In the 1920's, huge quantities of byproducts from _____ were sitting unused. Chemical and petroleum companies desired to make something profitable and useful out of it.
- _____ was the answer.
- Most plastics today are still made from _____.
- In 1950, about _____ million tons of plastic were made worldwide.
- In 2019 alone, more than _____ million tons of plastic were produced globally.
- One million tons of plastic weigh more than _____.
- Since the beginning of plastics production, over _____ billion tons of plastic have been produced.
- That's more than _____ of plastic for every person alive today.
- In 2016 alone, more than _____ of plastic entered waterways.
- This number continues to rise.

How does plastic get to the ocean?

- _____ → _____ → _____
- Leakage from trucks and landfills

- Litter from overflowing trash cans
- Littering and illegal dumping of trash
- Drains to ocean
- Wastewater
- About _____% of ocean plastic comes from land-based sources.
- Loss in _____
- “Ghost Gear” – Lost or forgotten _____ and _____ that can trap non-target animals
- The remaining _____% comes from maritime sources

How does plastic pollution harm marine life?

- _____ can...
 - Block the _____ tract
 - “Trick” animals into thinking they have eaten _____ food
 - Result in _____
- _____ can lead to...
 - _____ and suffocation
 - Impaired _____ leading to lack of ability to forage
 - Starvation

What are microplastics?

- Microplastics are defined as being smaller than _____
- Some microplastics are made to be small
 - “_____” – the form that plastic comes in before it is molded into different shapes to make different products
 - Another example of microplastics that are made to be small would be _____
- Most microplastics come from _____ that have broken down over time

What can YOU do to decrease plastic pollution?

- Only _____% of recycled plastic is actually recycled.
- _____ our plastic use, _____ plastic items at stores and restaurants, and _____ plastic items are more effective strategies.
- This does NOT mean we should not _____!
- It DOES mean we should emphasize refusing, reducing, and reusing.