

Teacher/Facilitator Guide



WAVE OF PLASTIC

Meaningful Watershed Educational Experience

LESSON THREE: FROM HAND, TO LAND, TO SEA

Sources and destinations of plastic pollution

- How do we describe, quantify, and communicate about issues related to plastic waste?
- What are the causes and effects of pollution?
- What are the sources of plastic pollution?
- How and why does plastic pollution enter our waterways?
- How can we communicate our ideas, inform perspectives, and inspire action?

Unit Driving Question:

How do human choices regarding the consumption and disposal of plastics impact ecosystems and our communities and what actions can we take to minimize those impacts?

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Wave of Plastic MWEE Unit Next Generation Science Performance Expectations

Earth and Human Activity

1. **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 systems. Add evidence and clarification statements
2. **MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Lesson Three Key Ideas

- Human-caused pollution plays causal roles in changing Earth’s systems.
- Pollution refers to any substance or energy (for example, heat and light) that is foreign to an environment, and/or is present in quantities that cause harm to natural systems and the living things within them.
- Plastic items become pollution when they enter natural environments.
- There are many properties of plastic that allow it to be easily transported by wind and rain runoff across land and into waterways.
- Plastic pollution harms living things and is accumulating in the environment because of increases in per-capita consumption and because plastic persists for very long periods of time.
- Sharing information visually, such as through infographics, can be an effective way to reach and engage diverse audiences and inspire behavior change.

Lesson Three Overview

	Goal	Description	Activities
Part 1 Introduction	Building Understanding	Make sense of pollution as any substance that is foreign to an environment, and/or any substance or energy that is present in quantities that cause harm to natural systems and the living things within them.	1. Read, Review, & Respond: Students analyze a variety of resources to make sense of pollution, participate in a “jigsaw” activity to organize information, and respond to questions in their Student Workbooks
Part 2 Investigation	Integrating Information and Ideas	Investigate the properties of plastic that allow it to be easily moved across land and into waterways. Engage in outdoor field investigations to determine how runoff will move waste across local surfaces. Collect data about plastic pollution within local	2. Activity: “Plastic Waste Sort!” Students sort plastic items first by properties of their choice and then by properties that they think contribute to its ability to travel across landscapes and waterways. 3. Read, Review, & Respond: Students analyze a variety of resources to make

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		communities and make predictions about how and where the pollution might be transported (for example to storm drains, then local streams, to rivers, and the Chesapeake Bay).	<p>sense of plastic pollution and respond to questions in their Student Workbooks</p> <p>4. Outdoor Field Experience A: <i>How Does Water (Runoff) Move Across Our School Grounds?</i> Students will explore and map ways that water moves across the surfaces of their school grounds</p> <p>5. Outdoor Field Experience B: <i>What Plastic Pollution Do We Observe on Our School Grounds?</i> Students will survey the plastic pollution found on their school grounds and make predictions about where and how it might travel to other destinations.</p> <p>6. Outdoor Field Experience C: <i>What Plastic Pollution Do We Observe in Our Neighborhoods?</i> (OPTIONAL) Students will survey the plastic pollution found in their neighborhoods and make predictions about where and how it might travel to other destinations.</p>
Part 3 Application	Applying What We Learned Through Informed Action	Engage communities by designing conceptual models to represent the sources and destinations of plastic pollution in our community.	<p>7. Read, Review, & Respond: Students will review and discuss:</p> <ul style="list-style-type: none"> ○ NGSS Science & Engineering Practice, Developing and Using Models. ○ A variety of infographics related to plastic pollution <p>8. Engaging Others: Students will work individually or in teams to develop a model in the form of an infographic that represents the possible sources, movement, and destinations of plastic pollution in their communities.</p>
Part 4 Assessment	Demonstrating Our Understanding	Complete a constructed response using the <i>Claim, Evidence, Reasoning</i> model.	9. Construct an argument supported by evidence: Students describe how plastic pollution can enter an environment and how it might travel to other environments.

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Part 1- Introduction: Building Understanding

Objectives:

- We will obtain, evaluate, and communicate information about the types of pollution and the negative impacts it can have on the environment and living things.

1. Activity: Read, Review, & Respond

Students will:

- Review a resource about pollution and how it can negatively impact and alter many of Earth's systems including the atmosphere, land, waterbodies, and living things.
- Participate in a team "jigsaw" activity in which each member of the team focuses on understanding one type of pollution and shares that information with the group.
- Use the pages in the Student Workbook to collect, organize, and synthesize information.

Whole Group Discussion Questions:

- *Review & discuss student responses to the questions in the Student Workbook as a whole group*

Materials & Resources

- Lesson One: Student Workbook
- Article:** "What is Pollution"
 - **Source:** UMCES Wave of Plastic
 - **Description:** What pollution is, the different types, and what its effects are.



Photos courtesy of Jenna B. Linhart

Part 2- Investigation: Integrating Information & Ideas

Objectives:

- We will explore the different properties of plastics by sorting plastic waste items.
- We will read informational text about how plastic pollution moves across land and into water.
- We will investigate how water (runoff) moves across our school grounds.
- We will conduct a survey of the plastic pollution found on our schoolgrounds and in our neighborhoods.

2 . Activity: Plastic Waste Sort!

Students will:

- Sort plastic items first by properties of their choice and then by properties that they think contribute to its ability to travel across landscapes.
- Students discuss their observations and reasoning for their selections.

Materials & Resources

- A variety of plastic waste items.

Whole Group Discussion Questions:

- How did each of you choose to sort items?
- What observations were you able to make about the sorted items and their properties?

Activity: “Plastic Waste Sort!”

Description: Students sort plastic items first by properties of their choice and then by properties that they think contribute to plastic’s ability to travel across landscapes and waterways. Students discuss their observations and reasoning for their selections. This activity should take 10-15 minutes, with discussion. *(Note: may need to discuss that properties are distinguishing qualities of an object made of matter, such as its color, shape, weight, size or temperature).*

Prior to Beginning the Activity:

1. Bins of plastic trash/waste should be available throughout this unit. The collection can be the material the group has collected or items that the teacher has provided. *(Note: it will be beneficial to be able to access these bins during discussion questions and activities).*

Procedures:

1. Invite students to observe different items of plastic waste and ask them to sort the plastics based on their properties. *(Note: Students should choose the properties- for example. color, weight, etc.)*
2. Engage in a second sort specifically focusing on properties that allow plastics to travel easily. Ask students to think about where they have seen plastic trash and what properties allowed it to travel to that place (for example, it may be lightweight, durable, buoyant, sturdy, resistant to corrosion).
3. “Share your Sort.” Students share their sort categories with the class.

Wrap Up and Making Connections:

- How did each of you choose to sort items?
- What observations were you able to make about the sorted items and their properties?

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3. Read, Review, and Respond

Students will:

- Analyze a variety of resources to make sense of plastic pollution and respond to questions in their Student Workbooks

Whole Group Discussion Questions:

- *Review & discuss student responses to the questions in the Student Workbook as a whole group*
- **Additional Discussion Question:** Why you think the authors decided to title the article, “From Hand, to Land, to Sea?”

Materials & Resources

- **Article: “From Hand, to Land, to Sea”**
 - **Source:** UMCES Wave of Plastic Team
 - **Description:** Sources and Destinations of Plastic Pollution
- **Video: “What are microplastics” (2 min, 6 sec)**
 - **Source:** NOAA National Ocean Service
 - **Description:** Microplastics are small plastic pieces less than five millimeters long which can be harmful to our ocean and aquatic life..
 - **Link:** <https://oceanservice.noaa.gov/facts/microplastics.html%5C>
- **Sample Infographic: “Rains can lead to an increased amount of marine debris.”**
 - **Source:** NOAA Marine Debris Program (Office of Response and Restoration)
 - **Description:** Example of the use a creative visual to convey a pollution related concept
 - **Link:** [https://marinedebris.noaa.gov/multimedia/infographics#prettyPhoto\[field_image_image\]/5/](https://marinedebris.noaa.gov/multimedia/infographics#prettyPhoto[field_image_image]/5/)
- **Sample Infographic: “Microplastics on National Park Beaches”**
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4. Outdoor Field Experience A

How Does Water (Runoff) Move Across Our School Grounds?

**Note: This may be a separate outdoor experience or may immediately precede the next investigation, Plastic Pollution Survey.*

Students will:

- Sketch a map of their school grounds, make predictions about water flow, and then test their predictions on their school grounds.

Whole Group Discussion Questions:

- What features of the land seem to influence the direction that water flows? Do those features seem to be natural or man-made? Why do you think that is?

Materials & Resources

- Map of the school grounds and surrounding areas
Note: the map should indicate local waterways, landforms, and anthropogenic features.
- Containers (cups, buckets, bottles) of water

Outdoor Field Experience A

“How Does Water (Runoff) Move Across Our School Grounds?”

Description: Students will sketch a map of their school grounds and make predictions about the way that water will flow. They will test their predictions by pouring water in strategically chosen places on the school grounds and update their maps accordingly.

Procedures:

1. Display electronic and/or satellite imaging of the school grounds and ask the students to sketch the site in their Lesson 3 Student Workbooks. Students should attend to the closest waterway (stream, river) as well as natural and manmade features such as shrubbery, pavement, etc.
2. As a group, discuss predictions as to how water will move in the form of runoff (direction, flow, speed) on the school grounds. Ask students to consider and identify the factors might influence the way runoff moves across the site. (*For example, paved surfaces might be intentionally sloped toward storm drains, grassy areas might absorb water and thus limit runoff, etc.*).
3. Chose a site on the school grounds for the students to explore. Ask the students to bring containers of water with them. They will use the water to make observations and test their predictions for how runoff will move across your school grounds.
4. Once outside, work with students to locate the storm drains on the property and add them to your map. Make any other adjustments that might be necessary.
5. Ask the students to continue to make predictions about how runoff will flow at particular points on the site, using the natural and manmade features of the land as evidence to support their predictions.
6. Invite students to pour water onto the ground to test their predictions about the direction that runoff flows. (*Note: the students will be limited in the amount of water they are able to bring with them, thus decisions about where to test should be strategic*).
7. Students should share their results with the class and once again update their maps, this time using arrows to indicate the direction that runoff will flow on your school grounds map

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Wrap Up and Making Connections:

The following are suggested discussion questions as whole group:

- What features of the land seem to influence the direction that water flows? Do those features seem to be natural or man-made? Why do you think that is?
- What did you notice about the location of storm drains on our school grounds?
- What are some of the advantages of runoff traveling to and entering storm drains?
- What are some of the negative effects of runoff traveling to and entering storm drains?
- How do you think the ways that water flows may influence the locations and types of waste that we will observe in our plastic pollution survey?
- What other factors might influence the locations and types of waste that we will observe in our plastic pollution survey?



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5. Outdoor Field Experience B

What Plastic Pollution Do We Observe On Our School Grounds?

**NOTE: This may be a separate outdoor experience or may immediately follow the first investigation into runoff.*

**NOTE: Students should not pick up the waste they observe unless directed. If they are to pick up the waste, they should use gloves and/or tongs.*

Students will:

- Students will conduct surveys of the plastic pollution on their school and use what they've learned to draw conclusions about the movement and destinations of plastic waste.

Whole Group Discussion Questions:

- How do you think the amount of plastic waste we observed compares to other schools? How about to other neighborhoods and communities?
- How would you describe the amount of plastic waste that enters our local waterways (*considering all the sources in our area*)?
- Considering the *per-capita* amounts generated, why is plastic waste harmful to ecosystems?

Materials & Resources

- Plastic Pollution Survey* data collection sheet (found in the Lesson 3 Student Workbooks)
- “*Types of Plastic Trash*” handout (also found in the Lesson 3 Student Workbooks)
- Gloves, tongs* (if plastic waste will be collected)

Outdoor Field Experience B

“What Plastic Pollution Do We Observe On Our School Grounds?”

Description: Students will conduct surveys of the plastic pollution that they observe on their school grounds (and, optionally, in their neighborhoods – *See Outdoor Field Experience C*). Students will use what they've learned about the properties of plastic and the ways that runoff moves across land and into waterways to draw conclusions about the movement and destinations of plastic waste.

Procedures- Part A, School Grounds Pollution Survey:

1. Review the Plastic Pollution Survey in the Lesson 3 Student Workbooks.
2. Display & discuss the “Types of Plastic Trash” handout. Ask students what other kinds of plastic items they might find that are not listed on the chart. Students should predict what kinds of plastic trash they are most likely to find and why. Students should use what they learned about the ways that water runoff flows on their school grounds as evidence to support their predictions.
3. Discuss the current weather as well as recent weather conditions that may influence the types and locations of plastic pollution that might be observed. For example, recent rain events may have already carried plastic pollution to storm drains or moved it from the places where it was originally discarded.

Procedures- Part B, Neighborhood Pollution Survey:

1. Review the *Neighborhood Trash Survey*. Point out that they will be doing the same survey they just conducted on the school grounds in the area near their homes.

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2. Ask students to make predictions regarding how their neighborhood survey might differ from their school survey.

Wrap Up and Making Connections:

The following are suggested discussion questions:

- How do you think the amount of plastic waste we observed compares to other schools? How about to other neighborhoods and communities?
- How would you describe the amount of plastic waste that enters our local waterways (*considering all the sources in our area*)?
- Considering the *per-capita* amounts generated, why is plastic waste harmful to ecosystems?

Extension:

- Students may create graphs of the data that they collected in the schoolyard survey. This may be done individually or in groups with *graph paper or using electronic graphing resources*.



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6. Outdoor Field Experience C (OPTIONAL)

What Plastic Pollution Do We Observe in Our Neighborhoods?

<p>Students will:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Conduct a plastic pollution survey in their neighborhood. 	<p>Materials & Resources</p> <ul style="list-style-type: none"> <input type="checkbox"/> Plastic Pollution Survey data collection sheet (found in the Lesson 3 Student Workbooks) <input type="checkbox"/> “Types of Plastic Trash” handout (also found in the Lesson 3 Student Workbooks)
<p>Whole Group Discussion Questions:</p> <ul style="list-style-type: none"> ▪ How did your neighborhood survey compare to the schoolyard survey? Why? 	

Part 3 – Application: Applying What We Learned Through Informed Action

Objectives:

- We will explore how conceptual models are used in science.
- We will review examples of conceptual models in the form of infographics that explain concepts related to plastic pollution
- We will work individually or in teams to develop a model in the form of an infographic that represents the possible sources, movement, and destinations of plastic pollution in our communities.

7. Activity: Read, Review, & Respond

<p>Read, Review, & Respond</p> <p>Students will:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Review and discuss the Science & Engineering Practice, Developing and using models. <input type="checkbox"/> Review sample infographics and answer a set of questions to demonstrate their understanding of how to create an effective infographic. <input type="checkbox"/> Students will review and discuss the infographic on the sources and destinations of plastic pollution on Solomons Island, Maryland, that was created through the <i>PlasticWatch</i> project. This will serve as inspiration for their own models. 	<p>Materials & Resources</p> <ul style="list-style-type: none"> <input type="checkbox"/> Video: “NGSS Practice 2, Developing and Using Models” <ul style="list-style-type: none"> ▪ Source: Bozeman Science (8m 21sec) ▪ Description: How scientists use models. ▪ Link: http://www.bozemanscience.com/ngs-developing-using-models <input type="checkbox"/> Infographic: “How Do Plastics Get into the Chesapeake Bay?” <ul style="list-style-type: none"> ▪ Source: UMCES CBL PlasticWatch Project ▪ Description: Sources of plastic pollution that enter the Chesapeake. ▪ Link: https://www.umces.edu/plasticwatch <input type="checkbox"/> Sample Infographic: “Threats to Coral Reefs, Land-based Sources of Pollution” <ul style="list-style-type: none"> ▪ Source: NOAA ▪ Description: How sources of pollution from land enter waterways, how they cause harm and how you can help. ▪ Link: https://oceanservice.noaa.gov/facts/coral-pollution.html <input type="checkbox"/> Sample Infographic: “Plastics in the Ocean” <ul style="list-style-type: none"> ▪ Source: NOAA Marine Debris Program (Office of Response and Restoration)
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Whole Group Discussion Questions:

- How and why do we use models in science?
- What are examples of models?
- What are infographics?
- What makes infographics effective and/or ineffective? If appropriate, students may review online resources that discuss effective infographics.

- **Description:** Example of the use a creative visual to convey a pollution related concept.
- **Link:**
[https://marinedebris.noaa.gov/multimedia/infographics#prettyPhoto\[field_image_image\]/7/](https://marinedebris.noaa.gov/multimedia/infographics#prettyPhoto[field_image_image]/7/)
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8. Engaging Others

Students will:

- Develop models in the form of an infographic that demonstrates the possible sources and destinations of plastic pollution in their communities.

Whole Group Discussion Questions:

- *Review & discuss student responses to the questions in the Student Workbook as a whole group*

Materials & Resources

- *Online software programs* such as Canva.com, Microsoft Publisher, or <https://piktochart.com/>, Google Slides, Wixie
- *Posters, paper, markers, and other art supplies* for creating flyers and posters
- *Action/Infographic/Optional Infographic Websites:*
 - *Easel.ly:* a fairly easy way to create an infographic, a visual depiction of information. The tool offers set themes that can be dragged onto a blank canvas to give students somewhere to start. It won't do the work for you, and it forces students to represent what they know at the end of a research project, while giving some creative license.
 - *Infogr.am:* another tool to visually represent information. It has templates that allow you to throw in your facts and build beautiful charts to represent the information.

The following resources discuss the effectiveness of infographics and give students information on the power of information visualizations:

- The beauty of data visualization - TED Talk by David McCandless
- Infographics in Education
- 10 Tips for (journalists) Designing Infographics
- *Link:* <https://piktochart.com/blog/using-infographics-classroom/>

HOW DO PLASTICS GET INTO THE CHESAPEAKE BAY?

An estimated 8 million tons of plastic enters the water from land globally every year! This includes many single-use items, like plastic straws, bags, bottles and take-out containers.

Plastic doesn't just enter waterways through boat-based activities. Most plastic marine pollution comes from activities on land. Strong rain or winds can blow over trash cans and wash litter from roads directly into local waterways or into storm drains that flow into rivers.

Here, small streams and rivers flow into the Patuxent River, which leads to the Chesapeake Bay, and the Atlantic Ocean.

WHY SHOULD WE CARE?

Plastics can harm and kill wildlife, pollute our beaches and waterways, and cost millions of taxpayer dollars to cleanup every year. Chemicals are also within and on plastics and as these chemicals interact with our environment, they may accumulate in the things we eat.

WHAT CAN YOU DO?

- ⊘ Skip the straws, plastic bags, and plastic take-out items!
- ♻️ Reduce, Reuse, and Recycle...or just Refuse to Use!
- 👤 Participate in beach and community greenspace cleanups!

PLASTICWATCH
 Visit our website to learn more
www.umces.edu/plasticwatch

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 CHESAPEAKE BIOLOGICAL LABORATORY

The PlasticWatch project is a local water pollution issue, under grant number NA40404015 from NOAA, U.S. Department of Commerce. The straws, fishing gear, and fishing nets are those of the artist and do not necessarily reflect the views of NOAA or the U.S. Department of Commerce.

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Part 4- Assessment: Demonstrating Our Understanding

Objectives:

- Students describe how plastic pollution can enter an environment and how it might travel to other environments.

Claim/Evidence/Reasoning Writing Rubric				
	0	1	2	3
Claim – statement or conclusion that answers the original question/problem.	Does not make a claim.	Makes an inaccurate claim.	Makes an accurate but incomplete claim.	Makes an accurate and complete claim.
Evidence – scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.	Does not provide evidence.	Only provides inappropriate evidence (Evidence that does not support the claim.).	Provides appropriate, but insufficient evidence to support claim. May include some inappropriate evidence.	Provides appropriate and sufficient evidence to support claim.
Reasoning – justification that links the claim and evidence and includes appropriate and sufficient scientific principles to defend the claim and evidence.	Does not provide reasoning	Only provides reasoning that does not link evidence to claim.	Repeats evidence and links it to some scientific principles, but not completely.	Provides accurate and complete reasoning that links evidence to claim. Includes appropriate and sufficient scientific principles.

Use the Claim, Evidence, Reasoning model.

Construct an argument supported by evidence to describe how plastic pollution can enter an environment and how it might travel to other environments.