

Teacher/Facilitator Guide



WAVE OF PLASTIC

Meaningful Watershed Educational
Experience

LESSON FOUR: IMPACTS ON AQUATIC ECOSYSTEMS

- How do we describe, quantify, and communicate about issues related to plastic waste?
- What causes disruptions to the stability of ecosystems?
- How can we use models to make predictions about the impacts of plastic pollution on ecosystems?
- How can personal choices and behaviors reduce the impacts of plastic pollution on ecosystems?

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

- [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.
- [MS-ESS3-3](#). Earth and Human Activity Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Lesson 4: Impacts of Plastic on Ecosystems Performance Expectation

Ecosystems: Interactions, Energy, and Dynamics

- [MS-LS2-4](#). Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Lesson Four Key Ideas

The Wave of Plastic Unit explores phenomena related to plastic waste. Lesson Four specifically focuses on the following Key Ideas:

- An ecosystem is a biological community of interacting organisms and their physical environment. Disruptions to any physical or biological component of an ecosystem can have effects and outcomes and can lead to shifts in all populations of organisms within that ecosystems.
- Plastic pollution can have multiple effects on individuals and populations of animals within aquatic ecosystems. For example:
 - Entanglement: Plastic pollution can directly kill or harm animals if they become entangled in it.
 - Ingestion: Plastic pollution can directly kill or harm animals when they mistake it for food and eat it.
 - Bioaccumulation: Plastics can bioaccumulate over time within an individual as they continue to eat more plastic.
 - Biomagnification: Predators feeding on individuals containing plastics can suffer from biomagnification as the concentration of plastic increases up the food web.



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Lesson Four Overview			
	Goal	Description	Activities
Part 1 Introduction	Building Understanding	Make sense of how the abiotic and biotic components of a system exist and rely on each other in complex, interconnected relationships.	1. Read, Review, & Respond: Students analyze a variety of resources about ecosystems as biological communities of interacting organisms and their physical environments. Students respond to questions in their Student Workbooks
Part 2 Investigation	Integrating Information and Ideas	Investigate how plastic pollution disrupts and/or compromises elements of ecosystems. Students will read and answer questions about plastic ingestion and entanglement and the impact on organisms. Students will also engage in activities to model the impacts of plastics on organisms' abilities to grow and survive.	2. Read, Review, & Respond: Students analyze a variety of resources to understand the ways that plastic pollution contributes to marine debris and respond to questions in their Student Workbooks 3. Activity: "You Are What You Eat!" Students will model how plastic pollution can impact the extent to which different organisms are able to get the nutrition they need to grow, survive, and reproduce.
Part 3 Application	Applying What We Learned Through Informed Action	Make and share personal pledges to reduce the impacts of per-capita consumption and plastic pollution on ecosystems.	4. Activity: "I Make a Difference"
Part 4 Assessment	Demonstrating Our Understanding	Complete a constructed response using the <i>Claim, Evidence, Reasoning</i> model.	5. Construct an argument supported by evidence: Students describe how plastic pollution can cause changes to physical or biological components of an ecosystem.

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Part 1- Introduction: Building Understanding

Objectives:

- We will obtain, evaluate, and communicate information about ecosystems as biological communities of interacting organisms and their physical environments.

1. Activity: Read, Review, & Respond

Students will:

- Review a variety of resources about ecosystems as biological communities of interacting organisms and their physical environments.
- Use the pages in the Student Workbook to collect, organize, and synthesize information.

Whole Group Discussion Questions:

- What are ecosystems?
- What does it mean for an ecosystem to be healthy and stable?
- Why do you think that scientists use an ecosystem’s biodiversity as one of the measures of the health and stability of that ecosystem?
- What sorts of things can cause disruptions to the stability of ecosystems? Explain the possible effects of those disruptions on the health of that ecosystem.

Materials & Resources

- **Video:** “Ecosystem biodiversity” (4m, 13 sec)
 - **Source:** Khan Academy; Video by California Academy of Sciences.
 - **Description:** This video explores regional ecosystems as having their own assemblages of species and contributing uniquely to global biodiversity. Explore why ecosystem diversity is important for conservation decisions.
 - **Link:** <https://www.khanacademy.org/science/high-school-biology/hs-ecology/hs-community-ecology/v/ecosystem-biodiversity>
- **Video:** “Exploring Ecosystems: Coastal Food Webs?” (4min, 14sec)
 - **Source:** California Academy of Sciences
 - **Description:** How do changes in the ecosystem effect the community? Enter an underwater forest of kelp and explore the various threads that connect species together that help maintain diversity and balance in food webs.
 - **Link:** <https://www.youtube.com/watch?v=LVJ5BKcAhAg>
- **Article:** “Ecosystem” Encyclopedia Entry
 - **Source:** National Geographic Society
 - **Description:** Descriptions and definitions of ecosystems
 - **Link:** <https://www.nationalgeographic.org/encyclopedia/ecosystem/>

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Part 2- Investigation: Integrating Information & Ideas

Objectives:

- We will model and describe how plastic pollution in ecosystems affects organisms.

2. Activity: Read, Review, & Respond

Students will:

- Analyze a variety of resources to understand the ways that plastic pollution contributes to marine debris.
- Respond to questions in their Student Workbooks

Whole Group Discussion Questions:

- How might plastic pollution enter an ecosystem?
- What are some ways that plastic pollution might impact ecosystems?

Materials & Resources

- **Video:** NOAA Marine Debris Program: “Trash Talk Video: What is marine debris” (2 min, 6 sec)
 - **Source:** NOAA.gov
 - **Description:** An introduction to marine debris.
 - **Link:** https://oceantoday.noaa.gov/trashtalk_whatismarinedebris/welcome.html
- **Video:** “What is marine debris” (1 min, 55 sec)
 - **Topic:** Marine debris
 - **Source:** Pew Trust
 - **Description:** An introduction to marine debris
 - **Link:** <https://www.pewtrusts.org/en/research-and-analysis/video/2016/what-is-marine-debris-a-cartoon-crash-course>
- **Video:** NOAA Marine Debris Program: “Trash Talk Video: How does marine debris impact the ocean, animals, and me?” (1 min, 33 sec)
 - **Source:** NOAA.gov
 - **Description:** Discussion of how plastic pollution and marine debris affect organisms and their habitats.
 - **Link:** https://oceantoday.noaa.gov/trashtalk_impacts/

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3. Activity: “You Are What You Eat!”

Students will:

- Model how plastic pollution can impact the extent to which different organisms are able to get the nutrition that they need to grow, survive, and reproduce.

Whole Group Discussion Questions:

- What are some ways that plastic pollution can impact the overall health and stability of an ecosystem?
- What are some actions that people can take to help prevent plastic from harming individuals and populations of animals?
- Describe the effect that plastic pollution had on your food intake (and therefore the amount of nutrition each organism was able to extract from its habitat).
- Describe the effect of being entangled in plastic AND ingesting plastic pieces on the food intake of each species. (For example, did those who were entangled have to work harder to collect food items?)

Materials & Resources

- A tray/shoebox for each group of students (to represent the organisms’ habitat)
- *Small cups/paper bags for each student* (to represent the organisms’ stomachs)
- *Rubber bands* (to represent the effect of entanglement)
- *4 different colored beans/beads- 10 of each color/per kid* (one to represent uncontaminated food items, three to represent items of plastic pollution)
- *Data tables* (in the Student Workbooks)
- *Optional: Picture of food web* (if extensions to food webs will be made)
- *Optional: A tool such a spoon or tweezers* (to remove the ‘food’ from the habitat)



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Activity: “You Are What You Eat”

Description: Students will model how plastic pollution can affect individuals and populations of animals within aquatic ecosystems.

- Students work in groups that represent an organism from the food web. Depending on the number of students, there should be enough groups to represent at least one predator-prey relationship (e.g. for a group 9 students, 3 represent horseshoe crabs, 3 represent turtles, and 3 represent clams). All students within each group will represent the same species.
- Trays or shoeboxes with different-colored beads or beans in them will represent sources of nutrition within the ecosystem habitat.
- Different colored beans/beads will represent both food sources and plastic pollution that *resembles* food (for example, painted/colored beans may represent items of uncontaminated food and white beans may represent pieces of plastic pollution).
- The nutrition obtained will be determined by the number of beads/beans representing uncontaminated food items that each student is able to collect. Beads/beans representing plastic particles will have no nutritional value and will limit the amount of nutritional food an organism can ingest.
- Students model obtaining food from their habitats by using their fingers (or another tool such as spoons or tweezers) to remove beans/beads from the trays. (*Note: make sure that students are only removing one item at a time*).
- Rubber bands wrapped around the fingers of some students will model “entanglement” in plastic debris.
- Some students will experience *aggregate* effects by suffering from two effects of plastic pollution at once: ingestion of plastics (beads/beans representing plastic particles in their tray) and entanglement in plastics.
- Do not tell students which color represents plastic until the end of the all three rounds.*
- Students record data from their simulation in their *Student Workbooks* and then draw conclusions from their experience.

Prior to Beginning the Activity:

1. Separate the students into groups that represent organisms in the food web.
2. Fill each of the trays/shoeboxes (one for each group) with four different colored beans/beads. Trays should include a mixture of different colored beans (equal proportion of each color for each tray, e.g. a handful of each color) that represent pieces of plastic pollution and uncontaminated food (each round the teacher decides which color is plastic without telling the students).
3. Each group should have one rubber band in which one student (an organism) will become entangled.
4. Make sure that each student has a cup/paper bag (to represent the organism’s stomachs) and the data table from their Workbook.

Procedures – Basic Version, 3 Rounds:

1. Review and discuss the relationships between living things in a given food web.

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2. Explain to students:
 - Each of the groups represent organisms of one species (in other words, a population).
 - During the activity, one individual in the group will wrap a rubber band around his/her fingers to restrict movement, simulating *entanglement* in plastic pollution. (*Note: The individual who is entangled will remain entangled throughout all three rounds.*)
3. Introduce the goals of the activity to the students:
 - Have students write down the color names of their beans/beads (e.g. “red”, “white”, “blue”)
 - Students will have *30 seconds* to pick food items from the group’s tray habitat *one at a time* and put them in their cup/bag ‘stomach.’ The more food items, the higher nutrition your animal was able to get and the healthier it is!
 - When time is up, each student/organism *counts* the number of ‘food items’ of each color that they were able to ‘consume’ (collect) and record the data in the Round 1, 2, or 3 row of their table, as applicable. Then students add up the *total* number of items consumed in the round and record the number to their data table. (*Note: at this point, the students do not know which color beans represent food and which represent plastic pollution.*)
 - Have students repeat this step for two more rounds.
4. Have students add up the total number of pieces of each color that they consumed in all rounds. Record this number for each color in the “Total Consumed” row (A).
5. Choose which color represents plastic pollution. Students should copy the total number of pieces that they ‘consumed’ (collected) of that color into the box titled “Total Plastic” (box B).
6. Students should subtract the total number of plastic pieces (box B) from the number of food items they were able to ‘consume’(collect) (box A) in order to determine the amount of nutrition that they obtained from their food or the “Total Food” (box C).
7. Have students put their beans back into their species’ group trays habitats.
8. At the end of three rounds, all student-organisms who were able to collect 30* or more pieces of uncontaminated food items have survived! The others have (unfortunately) perished. (**Note: teachers may decide to adjust the number of food items according to the needs and abilities of the students.*)

Wrap Up and Making Connections:

The following are suggested discussion questions to conclude the activity with the whole group:

- What do you think would happen if a predator species (such as a sea turtle) ate a prey species (such as the horseshoe crab) that had plastic in its body? What do you think would happen if this sea turtle ate *many* horseshoe crabs that had plastic in their bodies?
- What are some ways that plastic pollution can impact the overall health and stability of an ecosystem?
- What are some actions that people can take to help prevent plastic from harming individuals and populations of animals?

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

Objectives:

- We will discuss how small changes in one part of a system might cause large changes in another part.
- We will apply what we’ve learned about per-capita consumption, plastic pollution, and the effects on ecosystems to develop a personal pledge for behavior change.

Activity: “I Make a Difference!”

Students will:

- Develop individual pledges that they share with their peers and communities and encourage others to pledge to make change as well.

Whole Group Discussion Questions:

- What is an example of something happening to one species/organism or in one place that affects something else or another place(s)?
- Consider our own individual choices when it comes to using and discarding plastic. How might our choices affect other aspects of Earth’s systems?

Materials & Resources

- “I Make A Difference” Brainstorm Guide & Pledge Worksheet (located in the Lesson Four Student Workbook)
- Individual student waste inventories from Lesson 1
- *Optional:* Art paper/poster board for finished pledges
- *Supporting Resources for Student Pledge Research*
 - National Geographic Society:
 - Planet or Plastic Personal Pledge: <https://www.nationalgeographic.com/environment/plasticpledge/>
 - “You Can Help Turn the Tide on Plastic. Here’s How” [.https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-solutions-waste-pollution/](https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-solutions-waste-pollution/)
 - Baltimore Beyond Plastic:
 - Personal Pledge: <http://www.bmorebeyondplastic.org/pledge.html>
 - #OneLessBottle.org:
 - Personal Pledge <https://www.onelessbottle.org/pledge/>

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Activity: “I Make a Difference”

Description: Students extend their understanding of the impacts of plastics on ecosystems by examining their own choices and pledging to make a change. Students develop individual pledges that they share with their peers and communities and encourage others to pledge to make changes as well.

Procedures:

1. Engage students in a whole group discussion around the following ideas:
 - The world we live in is a complex and ever-changing connected system made up of smaller inter-connected systems.
 - What happens in one place, whether it’s good or bad, can have effects on many other parts of the system.
 - What we each do in our daily lives impacts many other things and depending on our choices and behaviors, these impacts can be positive or negative.
2. Using the supporting resources from this lesson, past lessons, other resources, and students’ *Personal Waste Inventory* (from Lesson 1) for inspiration, have students complete the personal pledge brainstorm worksheet in their workbooks. See prompt below.
 - Space on the right side of the Personal Pledge worksheet is provided for each student to trace their hand representing personal ownership of their pledges.
 - Pledges may be hung in the classroom, in a public space at the school, taken home or displayed at other locations.

Prompt:

I _____, pledge to protect ecosystems from the harmful effects of plastic pollution by _____.

My actions matter because _____.

Wrap Up and Making Connections:

- *Communicate with others:* Once students have identified their pledges, encourage them to share their pledges with their friends, families, and communities. Encourage students to be creative in the ways that they share their pledges (*For example, sharing through videos, infographics, flyers, t-shirts, essays, etc.*)

Extensions:

Encourage students to monitor the impact of their pledges. Students could consider the following:

- How can we monitor our progress on keeping our pledges?
- How can we encourage others to make their own pledges to take action?

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Part 4- Assessment: Demonstrating Our Understanding

Objectives:

- Students describe how plastic pollution can cause changes to physical and biological components of an ecosystem.

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 cause changes to physical and biological components of an ecosystem.