

I PLASTICS: FROM POLLUTION TO SOLUTIONS

Welcome! Whether you have already begun teaching this unit or are previewing it in preparation for the future, this document will give you a deeper understanding of this unit’s primary content, its project-based structure, and the pedagogical approaches underlying its design.

BIG IDEAS

In this unit, students explore the plastics crisis in our ocean and the many solutions being developed to address the problem. Driven by the question, *How can humans solve our plastics problem in the ocean?*, students work in publishing teams to create a *National Geographic*-style magazine to inform their communities about the sources of and solutions to the plastics crisis. In the development of their magazines, students learn about the chemical characteristics of plastics, the global forces that affect the movement of plastics, and the advantages and disadvantages of different scientific, political, and behavioral interventions that aim to solve the plastics crisis. Students take on the work of ecologists, cartographers, science writers, and activists in order to analyze, communicate, and combat the causes and effects of marine plastic pollution. Key skills in this unit include developing models, engaging in argument from evidence, and communicating information through the creation of infographics and articles.

The first half of the unit focuses on understanding the plastics problem: what are plastics, where do they come from, and how do they get into the ocean? Students work in publishing teams to model how wind, water, the Coriolis effect, and human behaviors transport plastics into the marine environment. Then, students take a deeper dive into marine ecosystems to understand the impacts of biomagnification and bioaccumulation. Publishing teams create a food web and write a profile of a specific marine organism to explain the impacts of plastic on individual species and ecosystems.

The second half of the unit focuses on solutions. Publishing teams evaluate different proposed solutions to the plastics crisis to select a winner for their magazine’s *Ocean Plastics Pollution Solutions Contest*. Teams then choose a target audience in their communities and propose an action step that can address the plastics crisis. Finally, publishing teams compile their research and recommendations into a digital or printed magazine that can be distributed to members of their community, including their target audience.

UNIT DRIVING QUESTION

How can humans solve our plastics problem in the ocean?

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CHALLENGES AND OPPORTUNITIES

What are the challenges your students may face in this unit? In this section, you will find guidance and ideas to support your students' understanding of content and/or practices that might be challenging.

Challenges

Prepare for possible challenges that students may have with particular concepts, as well as for opportunities to make connections to students' ideas and authentic disciplinary practices as they engage with this unit.

1. Students may feel overwhelmed by the scale and negative impacts of the plastics crisis, reacting with fear, anxiety, despair, anger, and/or emotional paralysis.

Guidance:

Acknowledge that the problem is real, and that students' negative emotions are valid and reasonable responses to the problem.

Reassure students that their knowledge and advocacy can have a positive impact on the problem, and that all around the world, communities are mobilizing together to take action. For example, [Bye Bye Plastic Bags](#) is a campaign started by two sisters who successfully

implemented a ban on plastic bags on the island of Bali, and is starting new youth-led chapters around the world.

Remind students that humans have solved big global problems in the past, including the eradication of diseases such as polio and smallpox, the regulation of dangerous chemicals such as CFCs and DDT, and the expansion of civil rights in many places around the world for women and minority groups.

2. With a few exceptions, students work together in publishing teams of four for the entire unit, which can lead to interpersonal conflicts.

Guidance:

Before beginning the unit, establish a safe and respectful classroom culture that supports and values collaborative work. For more guidance, see the article [Building a Collaborative Culture: From Inspiration to Application](#) from Getting Smart and read one teacher's perspective on creating a positive classroom environment in [5 Innovative Ways to Create Positive Classroom Culture](#).

Spend time carefully considering how to form teams but also on how you will support teams as they navigate the project. Whether you assign students to publishing teams or invite students to form their own teams, be sure to model and teach strategies for equitable and productive group work, such as these suggestions from Edutopia, highlighted in the article [Group Work that Works](#).

Check in with publishing teams frequently to monitor their group dynamics.

Opportunities

What opportunities are present in this unit that you can leverage to create a rich learning environment? Read below to understand how this unit foregrounds students' prior knowledge and experiences and connects to authentic disciplinary practices.

1. Elicit and leverage students' prior knowledge about the sources and impacts of plastic in their own communities, which can enrich their understanding of the [Ocean Plastics Movement Model](#) and to deepen their authentic connection to their target audience and [Call to Action for Readers](#).

LESSON DRIVING QUESTIONS

Lesson 1:
Plastics, Plastics, Everywhere

Lesson 2:
Plastics in the Plankton, Plastics on Your Plate

Lesson 3:
Pollution Solutions

Lesson 4:
Knowledge + Action = Power



2. Elicit students' prior experiences of what makes magazines engaging to read, in order to maximize their creative ownership over key magazine elements, including the front cover, the [Featured Marine Organism Profile](#), and the [Call to Action for Readers](#).

PRACTICE-FOCUSED SUPPORT

This section highlights a few of the key pedagogical practices found throughout this unit. Leveraging these practices as you teach will support students in becoming critical thinkers that can effectively collaborate, communicate, and connect with global issues. Use the external resources provided here to help support you in learning more about each of these practices.

Support Student Inquiry with Initial Explanatory Models

Every student has a sense of how the world works, even if there are gaps in their understanding. Educators can elicit prior understanding in a low-stakes way through having students create initial explanatory models. By revising their models over time, students can see and show how their thinking changes. Learn more about structures for models from [Ambitious Science Teaching](#) and how models serve as tools for students' sensemaking from [Model-Based Inquiry](#).

Use the Jigsaw Structure to Promote Student Discourse and Expertise

As a cooperative learning strategy, a jigsaw increases student engagement by making each group member responsible for explaining what they learned. Watch [a video from Cult of Pedagogy](#) about best practices for structuring a jigsaw, see a jigsaw in action in a real classroom via [Ambitious Science Teaching](#), or [read more about the benefits of the jigsaw strategy at TeachHub.com](#).

Engage Students in Scientific Argumentation Practices

Claim/Evidence/Reasoning is one structure for engaging students in scientific argumentation practices. Read [Supporting Classroom Argumentative Talk about Investigations](#) by STEM Teaching Tools, explore resources to dig into each component of a scientific argument with the [Argumentation Toolkit](#), or watch an example from Teaching Channel, [Engaging in Argument from Evidence](#).

Teach Across Perspectives and Scale to Engage with Interdisciplinary Issues

For today's students to become the next generation of

planetary stewards, they must learn to grapple with complex and interdisciplinary issues in productive ways, as explained in this SERC article [Why Teach with an Interdisciplinary Approach?](#) At National Geographic, this approach is integral to developing geographic understanding. For additional educator tips, read [Teaching Across Perspectives](#) and [Teaching Multiple Scales](#). Watch interdisciplinary instruction in action in [this video from Edutopia](#).

LEVERAGING PBL FOR SUCCESSFUL TEACHING AND LEARNING

Project-Based Learning (PBL) is a teaching approach in which students gain knowledge and skills by working to investigate and respond to a complex problem or challenge. Driven by the project, students explore a variety of resources that will help them understand essential content and perspectives for tackling the challenge. Student learning is presented in a culminating product that showcases disciplinary skills and knowledge as they apply to a local or global solution. The sections below outline how this unit is guided by a PBL approach.

In this unit, publishing teams create and publish their own National Geographic-style magazine to raise awareness about ocean plastics and inspire readers to take action to address the crisis. The magazine includes a compelling, informative, and artistically original front cover; an *Ocean Plastics Movement Model*; a *Featured Marine Organism Profile*; a *Food Web Infographic*; a [Letter from the Editors](#); a *Call to Action for Readers*; a glossary; and a profile of their magazine's *Ocean Plastics Pollution Solutions Contest* winner.

Leading with Engagement

This unit begins by engaging students through eliciting their prior knowledge and introducing an authentic problem and Driving Question. This creates a reason for learning that drives students through the arc of the unit.

1. The unit launches by asking students to close their eyes and imagine being on Midway Island, near Hawaii in the middle of the Pacific Ocean. Students share their ideas about what such a remote island would look, sound, and smell like. Then they watch an eye-opening trailer for [ALBATROSS](#) (3:49) about the effects of plastic pollution on the albatrosses of Midway Island.
2. The cognitive dissonance of Midway's apparent isolation, contrasted with the inescapably human impact

of plastic litter, demands that students grapple with the question of how plastic could have ended up in such a remote and pristine environment.

- As students discuss and respond to each other’s hypotheses, they begin to develop a mental model of how plastic enters and moves through the ocean. In order to illustrate and explain this model, each publishing team is given a copy of the Ocean Plastics Movement Model, a large blank map of the world’s oceans to which students will add their developing knowledge about the life cycle of plastics and the forces that move plastics and their impacts through the global ecosystem.
- Students will be introduced to the unit project, and will familiarize themselves with the [Final Project Checklist and Rubric](#) and complete a *Know and Need to Know* chart to assess their current and future knowledge about the unit driving question.

Learning Together: Collaboration Structures

This unit includes several opportunities for collaboration. Consider the collaboration structures that will work best in your classroom.

- In the majority of the activities in this unit, students work in publishing teams of four members to create the elements of their magazines. Before beginning the unit, take the time to build a positive classroom culture and determine how you will provide support for publishing teams to maximize their success throughout the project.
- In order to facilitate broad, nuanced learning about the causes and effects of the plastics crisis, students also occasionally engage in jigsaw structures in the following activities: [Plastics Aplenty](#), [Under the Sea](#), and [Seaworthy Solutions](#). Jigsaw grouping not only allows publishing teams to cover more content quicker than could have been done otherwise, it also encourages accountability among team members and builds scientific communication skills.
- As students assemble the magazine that comprises their final project, they collaborate to conduct research, make maps, and design infographics and cover art. Additionally, students are expected to serve as peer editors for at least one other publishing team, providing further opportunities for feedback and collaboration.

ENGAGING IN AUTHENTIC PRACTICES AND IMPACTS

Throughout the unit, students engage in authentic disciplinary practices and skills through their project work, enabling them to develop disciplinary expertise and identities. Additionally, consider expanding the impact of students’ learning beyond the classroom by providing opportunities such as the ones listed below.

Disciplinary Skills and Practices:

- Scientific communication
- Civic engagement
- Constructing an argument based on evidence
- Evaluating competing design solutions based on agreed-upon criteria

Ideas for Impact:

- Digitize your students’ magazines and share them with other educators and students around the world: Sharing your students’ work has many positive effects. Publishing work online lends extra legitimacy and urgency to students’ calls to action. Furthermore, seeing their work as part of a global movement can empower students. The plastics crisis is a global problem, and local solutions may seem small and insignificant until students understand that local actions are being implemented and contributing to cumulative impact around the world.
 - Conduct a schoolwide waste audit: A schoolwide plastic waste audit is ambitious, messy, and incredibly informative. Often, an audit is used as a first step in creating a schoolwide plan for reducing waste. It requires time, space, materials, and significant planning and communication with students, families, administration, and custodial staff. In spite of these challenges, many schools have successfully completed schoolwide plastic waste audits—and your school can, too. Here are some lesson plans that can help your planning process:
 - [Eco-Schools USA Consumption and Waste Audit](#)
 - [Monterey Bay Aquarium Plastic Use Audit](#)
 - Many inspiring video examples are available, including these two:
 - [Pinole Valley High School Waste Audit \(2:02\)](#)
 - [Pierce County School Solid Waste Audit \(3:44\)](#)
- Organize a plastics cleanup day: Choose a location such as a street, park, or beach. Invite students, families, and other community members to clean up plastic trash

in the area. Be sure to bring plenty of gloves and trash bags, as well as trash-pickers if available. Take pictures of the site before and after cleanup so you can share your impact with others! Consider posting photos to appropriate social media accounts with the hashtag #trashtag.

Constructing Solutions:

Arc of the Project

In line with the Project-Based Learning approach, project work is structured to unfold over the course of the unit, as students learn content that addresses their questions elicited during the launch of the unit.

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Assessing the Learning

Units intentionally assess student learning over time, through informal and formal assessments. This table highlights assessments you can use to inform your instruction and ensure students can demonstrate their learning of disciplinary content, skills, and practices.

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CONSTRUCTING SOLUTIONS: ARC OF THE PROJECT

PBL PHASE	ACTIVITY	WHAT STUDENTS ARE DOING
Engagement with an authentic, local problem provides a need to know.	Lesson 1, Activity 1: Autopsy of an Albatross	Students watch the trailer for ALBATROSS (3:49), which shows albatrosses who have died with plastics in their stomachs. They begin developing an Ocean Plastics Movement Model to answer the question, How do plastics get into and move around the ocean?
	Lesson 1, Activity 2: Plastics Aplenty	Students create and then revise a definition of <i>plastics</i> . They conduct a plastics audit in their classrooms to understand the variety of materials that fall into this broad and ubiquitous category.
Relevant knowledge is explored and applied to the problem through disciplinary skills and practices.	Lesson 1, Activity 3: Follow the Friendly Floatees	Through readings, videos, experiments, and kinesthetic activities, students learn about the global forces that affect the movement of plastics into and throughout the ocean. They then apply this learning to improve their <i>Ocean Plastics Movement Models</i> .
	Lesson 1, Activity 4: The Life Cycle of Plastics	
	Lesson 2, Activity 1: Under the Sea	Students work as ecologists to study the effects of plastics, including microplastics, in the marine food web. They use this knowledge to develop a <i>Food Web Infographic and Featured Marine Organism Profile</i> , describing these effects.
	Lesson 2, Activity 2: Biomagnification and Bioaccumulation	
Lesson 3, Activity 1: Seaworthy Solutions	Students learn about solutions from around the world addressing the plastics crisis, including those developed by engineers, corporations, individual consumers, and local and national governments. They create a rubric to assess the strengths and weaknesses of each solution, use the rubric to select the most promising solution, and write a profile of their chosen winner.	
Lesson 3, Activity 2: The Ocean Plastics Pollution Solutions Contest		

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Learning is applied to the development of a discipline-appropriate product.

Lesson 1, Activity 5:
[Magazine Design Workshop I](#)

Lesson 2, Activity 3:
[Magazine Design Workshop II](#)

Lesson 4, Activity 2:
[Magazine Design Workshop III](#)

In each magazine design workshop, publishing teams collaborate on the various elements of their magazines, including *Ocean Plastics Movement Model*, a *Featured Marine Organism Profile*, a *Food Web Infographic*, a *Call to Action for Readers*, a profile of the winner of the *Ocean Plastics Pollution Solutions Contest*, and more.

Lesson 3, Activity 3:
[Choose an Audience](#)

Lesson 4, Activity 1:
[Turning Knowledge into Power](#)

In these activities, students choose a target audience for their magazine, brainstorm a specific action that the audience can make to address the plastics crisis, and write a *Call to Action for Readers*, addressed to this target audience, about how they can make a difference.

Lesson 4, Activity 3:
[Publication Presentations and Reflections](#)

Teams present their magazines to a target audience, advocating for their readers to take up their call to action and respond to feedback from the community.

ASSESSING THE LEARNING

ACTIVITY	ASSESSMENT OPPORTUNITY	NGSS STANDARD(S) ADDRESSED
Lesson 1, Activity 1: Autopsy of an Albatross Lesson 1, Activity 2: Plastics Aplenty	The <i>Ocean Plastics Movement Model</i> assesses students' ideas about creating and revising models.	SEP: Developing and Using Models , Constructing Explanations and Designing Solutions CCC: Systems and System Models
Lesson 1, Activity 3: Follow the Friendly Floatees	As the <i>Ocean Plastics Movement Model</i> develops, it assesses students' understanding of the global forces that cause patterns of atmospheric and oceanic circulation. The Coriolis Mini-Lab and exit ticket also assess this topic.	PE: MS-ESS2-6
Lesson 1, Activity 4: The Life Cycle of Plastics	The Journey of a Plastic Bottle skits assess students' understanding of the flow of matter through systems and the construction of their explanations using models.	SEP: Developing and Using Models , Constructing Explanations and Designing Solutions CCC: Systems and System Models
Lesson 1, Activity 5: Magazine Design Workshop I	The <i>Ocean Plastics Movement Model</i> and glossary assess students' ability to write informative and explanatory texts about technical processes with well-chosen facts and domain-specific vocabulary.	CCSS: CCSS.ELA-LITERACY.WHST.6-8.2 , CCSS.ELA-LITERACY.WHST.6-8.2.B , CCSS.ELA-LITERACY.WHST.6-8.2.D
Lesson 2, Activity 1: Under the Sea	The trophic level card sort, discussion, and exit ticket assess students' understanding about the cycling of matter in marine ecosystems.	DCI: LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Lesson 2, Activity 1: Under the Sea	The Plastic Impacts handout assesses students' ability to determine the main ideas in scientific texts, such as the impacts of plastics on marine ecosystems and organisms, and implications for human health.	SEP: Obtaining, Evaluating, and Communicating Information

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<p>Lesson 2, Activity 2: Biomagnification and Bioaccumulation</p>	<p>The <i>Food Web Infographics</i> assess students' understanding of the cycling of plastic particles through marine ecosystems.</p>	<p>DCI: LS2.B: Cycles of Matter and Energy Transfer in Ecosystems PE: MS-LS2-3</p>
<p>Lesson 2, Activity 2: Biomagnification and Bioaccumulation</p>	<p>Student participation in the discussion about the impact of microplastics on human health demonstrates their ability to make claims and support them with evidence.</p>	<p>SEP: Engaging in Argument from Evidence CCC: Cause and Effect</p>
<p>Lesson 2, Activity 3: Magazine Design Workshop II</p>	<p>The <i>Featured Marine Organism Profile</i> demonstrates students' ability to use accurate, relevant data and credible sources to support claims about the negative impacts of plastics on their chosen organism.</p>	<p>SEP: Engaging in Argument from Evidence CCSS: CCSS.ELA-LITERACY.WHST.6-8.1, CCSS.ELA-LITERACY.WHST.6-8.1.B</p>
<p>Lesson 3, Activity 1: Seaworthy Solutions Lesson 3, Activity 2: The Ocean Plastics Pollution Solutions Contest</p>	<p>Students' analysis and summaries of different solutions assess their ability to evaluate competing design solutions using systematic processes and jointly agreed-upon criteria.</p>	<p>SEP: Engaging in Argument from Evidence DCI: ETS1.B: Developing Possible Solutions</p>
<p>Lesson 3, Activity 3: Choose an Audience Lesson 4, Activity 1: Turning Knowledge into Power</p>	<p>The Call to Action Graphic Organizer and <i>Call to Action for Readers</i> assess students' ability to integrate qualitative and quantitative information into written text, to present a written argument in support of a solution to the plastics crisis, and to produce clear and coherent writing appropriate for their target audience.</p>	<p>SEP: Obtaining, Evaluating, and Communicating Information, Engaging in Argument from Evidence CCSS: CCSS.ELA-LITERACY.WHST.6-8.4</p>
<p>Lesson 4, Activity 2: Magazine Design Workshop III</p>	<p>The <i>Letter from the Editors</i> assesses students' ability to construct evidence-based arguments about changes in ecosystems.</p>	<p>PE: MS-LS2-4</p>

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Lesson 4, Activity 2:
[Magazine Design Workshop III](#)

Peer feedback assesses students' ability to respectfully provide and receive feedback about their scientific communication, and an opportunity to strengthen their writing through revision.

SEP: [Engaging in Argument from Evidence](#)

CCSS: [CCSS.ELA-LITERACY.WHST.6-8.5](#)

Lesson 4, Activity 3:
[Publication Presentations and Reflections](#)

Students' presentations and discussions of each other's work assess their understanding of environmental impacts of plastic waste, and how small, local actions can cause larger ripple effects that can turn the tide against the global plastics crisis.

DCI: [MS-ESS3-3](#)

CCC: [Stability and Change](#)
