RESOURCE LIBRARY
LESSON

Plastics, Plastics, Everywhere

Students learn basic background information about the plastics crisis, including what defines plastics, where plastic pollution comes from, and how it gets into the ocean. Working together as part of a publishing team, they synthesize a variety of multimedia resources to create their own Ocean Plastics Movement Model explaining the forces that affect plastics on a global scale. This lesson is part of the *Plastics: From Pollution to Solutions* unit.

GRADES

6 - 8

SUBJECTS

Biology, Ecology, Chemistry, Conservation, Earth Science, Climatology, Oceanography, English Language Arts, Experiential Learning, Geography, Human Geography, Storytelling

CONTENTS

5 Activities

In collaboration with

ACTIVITY 1: AUTOPSY OF AN ALBATROSS | 50 MINS

DIRECTIONS

***Plastics: From Pollution to Solutions* unit driving question:** *How can humans solve our plastic problem in the ocean?*

***Plastics, Plastics Everywhere* lesson driving question:** *How do plastics get into and move around the ocean?*

1. Ignite students' curiosity about plastic pollution in the ocean.

- Organize students into their publishing teams, which should be formed in advance of this activity (see the Setup section).
- Project a map of Midway Island using *MapMaker Interactive* and zoom in on Kure Atoll, northwest of Hawaii. Then zoom out to see the entire Pacific Ocean. Tell students it is called Midway Island because it is midway between North America and Asia, near the middle of the Pacific Ocean.
- Ask students to close their eyes and imagine being on Midway Island. What would they see, hear, and smell? What would be on the beach?
- Introduce students to the trailer for *ALBATROSS* (3:49), a film by Chris Jordan about the effects of plastic pollution on the albatrosses of Midway Island.
- Before showing the trailer, warn students that the video will contain graphic and upsetting images of dead animals.
- Ask students how the video of Midway Island differs from what they had imagined.

2. Guide students through the process of developing an *Ocean Plastics Movement Model* that shows how plastics can reach Midway Island.

- Remind students that scientific questions are often sparked by surprising observations, like finding plastics in the middle of the ocean. Emphasize that when scientists begin inquiry into a new problem, they often create a model using words, pictures, or a combination of both.
- Distribute one *Ocean Plastics Movement Model* template to each publishing team. Instruct them to begin sketching a model to explain how plastics could reach Midway Island.
  - Point out that this model is a rough draft that will change and grow as they learn more in this unit, so they should use pencils and draw lightly.
  - Jump-start student thinking by asking questions such as:
    - *Where might the plastics be coming from?*
    - *What forces could be making the plastics move?*
    - *What else could be happening to the plastics that we could not directly observe?*
    - *How can you illustrate these concepts on your template?*
  - If students are having trouble getting started, display this *Water Cycle Model*. Explain that students' *Ocean Plastics Movement Model* should take a similar approach, but with plastics instead of water as its focus.

- Encourage students to share and discuss their models with their publishing teams or the class. Point out commonalities and differences between the hypotheses presented in the models. For example, different models may emphasize the role of waves, wind, albatross migration, or humans who travel in the vicinity of the island.
- Take care not to correct inaccurate hypotheses at this point; students will be applying what they learn and refining their models as they become more knowledgeable about ocean plastics.

- Ask for examples of evidence that would support a particular model. For example, if a group hypothesizes that waves carry plastics to Midway from Hawaii, an example of evidence to support this hypothesis could be obtained by tracking pieces of plastic, either by boat or with GPS technology, from Hawaii to Midway.

3. Present additional evidence to help students refine their *Ocean Plastics Movement Model*.

- Remind students that scientists often revise their models based on new data, which is why they will now watch a second video. Tell students that although the video is short, it contains a lot of new and important information for their models.
- Introduce the class to a word wall where you will track key vocabulary words throughout the unit (see the Tips section for strategies about setting up an effective word wall).
- Then define and add the following terms to the word wall:

  - *disperse*
  - *concentrated*
  - *ingest*
  - *benign*

- Have students discuss, in small groups or as a class, what new evidence they learned from the video and how they will refine their *Ocean Plastics Movement Model* as a result.

4. Introduce the unit project and create a *Know and Need to Know* chart.

- Ask: *Do you think most people consider the ocean plastic pollution problem in their everyday lives?*
- Conclude the discussion by explaining that in order to solve the problem, people need to be aware of plastic pollution and how to solve it. In this unit, publishing teams will create and publish their own *National Geographic*-style magazine to raise awareness about ocean plastics and help readers take action to address the crisis.
- Introduce and distribute the *Final Project Checklist and Rubric* and answer any questions about it. Also distribute a folder to each publishing team, which they will use as a portfolio to store the various elements of their magazine throughout this unit.

- Ask students to think about and discuss the following questions with a partner:
  - *What do you already know about the problem of ocean plastics?*
  - *What do you need to know about the problem in order to create a magazine that effectively raises readers' awareness?*

- When students are ready to share out, record their answers in a class *Know and Need to Know* chart. Explain to students that they will revisit this chart during the unit to see what they have learned and update their questions.

5. Encourage students to explore *National Geographic* magazines to generate ideas for their projects.

- Guide students' explorations by asking them to note observations and ideas for their own magazines.
- Distribute a selection of *National Geographic* magazines to students.
- Conclude the activity with the following two questions on an exit ticket:
  - *What information about plastic pollution concerns you the most right now?*
  - *What do you most want to learn about this problem?*

TipTeacher Tip

- **Step 1:** You can add an ocean currents layer to MapMaker Interactive. Go to the Layers tab on the right side, click Add Layer, select Water, select Ocean Surface Currents, and click Done.
- **Step 2:** Read more about facilitating development of initial models in science from *Ambitious Science Teaching*.
- **Step 3:** There are many strategies that teachers use to set up word walls in their classrooms. To learn more about some of these options, read these resources:
  - *Interactive Word Walls Enliven Vocab Learning* for an in-depth view of one teacher's use of word walls with English Language Learners
  - *The Science Toolkit* for visual examples of a wide variety of science word walls
- **Step 4:** To read more about supporting ongoing changes in student thinking, visit this resource from *Ambitious Science Teaching*.
- **Step 5:** To learn more about facilitating a *Know and Need to Know* chart in project-based learning, *this PBL Works blog* provides an explanation and examples

Modification

Depending on your classroom's access to and experience with online resources, you may elect to have publishing teams create digital magazines instead of printed magazines. Online production has the advantages of supporting collaborative work, and teams can more easily share their final projects with a wider audience. The resources in this unit can all be easily modified for online work.

Informal Assessment

The initial model, revised model, and *Know and Need to Know* chart provide insights into students' current understanding and ideas about ocean plastics and their movement around the globe.

Extending the Learning

An albatross bolus is similar to an owl pellet. National Geographic has a *Laysan Albatross Virtual Bolus Dissection* available online, including a student worksheet PDF.

It may be possible to obtain real albatross boluses (or boli). The nonprofit *Oikonos* provides free boli from Hawaii, subject to availability. Albatross boli are also available from the *U.S. Fish and Wildlife Service, Pacific Islands External Affairs Team*.

OBJECTIVES

Subjects & Disciplines

Biology

- Ecology
- Conservation

Earth Science

- Oceanography

Geography

Storytelling

Learning Objectives

Students will:

- Develop and revise an initial model to hypothesize how plastics reach Midway Island.

- Question how plastic pollution can be transported vast distances across the ocean to distant ecosystems.
- Generate ideas for their unit project by examining issues of National Geographic magazine.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Visual instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Media Literacy
- 21st Century Themes
  - Global Awareness
- Geographic Skills
  - Asking Geographic Questions
- Science and Engineering Practices
  - Developing and using models

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

- **Standard 1:**

How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 4:**
Systems and system models
• **Science and Engineering Practice 1:**
Asking questions and defining problems
• **Science and Engineering Practice 2:**
Developing and using models

Preparation

BACKGROUND & VOCABULARY

Background Information

Scientists estimate that there are over five trillion pieces of plastic floating in the ocean, with a dump truck's worth of plastics entering the oceans every minute.

Students (and adults) often forget that throwing something away just means moving it somewhere else. In places with well-developed waste management systems, this can mean burying plastics in a landfill, recycling them, or incinerating them—each of which has its own issues. In places with less-developed waste management systems, plastics are often simply dumped. Estimates vary widely depending on environmental factors and the type of plastics involved, but studies have shown that many types of plastics can persist in the environment for hundreds of years or more. Because of its longevity, plastics disperse around the globe, carried by wind, water, animals, and—of course—human activity.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
benign	*adjective*	not harmful
concentrated	*adjective*	items gathered closely together in one place.
disperse	*verb*	to scatter or spread out widely.
hypothesis	*noun*	statement or suggestion that explains certain questions about certain facts. A hypothesis is tested to determine if it is accurate.
ingest	*verb*	to take material, such as food or medicine, into a body.

ACTIVITY 2: PLASTICS APLENTY | 2 HRS 5 MINS

DIRECTIONS

***Plastics: From Pollution to Solutions* unit driving question:** *How can humans solve our plastic problem in the ocean?*

***Plastics, Plastics Everywhere* lesson driving question:** *How do plastics get into and move around the ocean?*

1. Activate students' prior knowledge by posing a deceptively simple question: What is plastic, and where does it come from?

- Instruct publishing teams to work together to brainstorm a list of everyday items made of plastics. Have teams share their lists with the whole class, highlighting points of agreement, disagreement, and uncertainty.
- Once the class list is complete, instruct teams to write their own definition of plastics. Emphasize that this definition can and should change as they learn new information.
- After teams share their definitions, ask a final question to activate students' prior knowledge about the topic of the video they will watch in Step two: Where do all the plastics come from? (Student answers will vary; take care not to correct inaccurate responses, as the upcoming video will provide information.)

2. Deepen students' understanding of plastics with an explanatory video.

- Prepare students to watch the video Science 101: Plastics (5:45) by introducing key vocabulary they will hear in the video. Briefly introduce the following words and add them to the word wall.

- synthetic
- polymer
- fossil fuel
- extraction
- detrimental
- biodegradable
- sustainable

- Show the video and address any questions raised by students.
- Prompt teams to update their definitions of plastics and then share their new definitions with the class.

3. Conduct a plastics audit in the classroom in order to understand the extent to which the modern world relies on plastics.

- Distribute the *Classroom Plastics Audit* handout. Make sure each team selects a certain area of the classroom in which to search for plastics, as described on the handout.
- Caution students that they may not always be able to tell if a material is a type of plastic or not. Plastics can often look and feel similar to rubber, fabric, foam, glass, wood, or metal. Some materials (including treated paper products) that don't look or feel like plastic may have a plastic coating or lining. Students can share their uncertainties with the class and discuss whether they think questionable materials should be classified as plastics or not.
- Explain the difference between single-use and durable plastics: single-use, or disposable, plastics are designed to be used once and then thrown in the trash, whereas durable plastics are designed to be used many times.
- After students have completed a comprehensive list of the plastics in their designated area, ask:

    - *Did the amount of plastics in our classroom surprise you?*
    - *Were there any materials that sparked debate in your team about whether they were made of plastic or not?*
    - *What do you think will happen to all of this plastic? Where will it be 10 years from now, or 100 years from now?*
    - *If you collected all of your plastic trash for a day, how much space would it take up? What if you did this for a week, a month, or a year?*

- In conclusion, remind students that their magazine will contain an explanation of what plastics are, how they are made, and how they are used.

4. Facilitate a jigsaw reading activity about sources and impacts of ocean plastic.

- Divide the class into new jigsaw groups. Jigsaw groups should contain four students, each from a different publishing team.

  - Prior to assigning these jigsaw groups, familiarize yourself with the four resources and their reading guides. The four resources are not all equal in terms of their reading levels and visual complexity:

    - Resource A: What Happens to the Plastic We Throw Out
    - Resource B: 10 Shocking Facts About Plastic Pollution
    - Resource C:Ocean Trash: 5.25 Trillion Pieces and Counting
    - Resource D: Sailing Seas of Plastic

  - To each of these new jigsaw groups, assign one of the four resources. (If you have more than four groups, two jigsaw groups may be assigned the same resource.)
  - Tell each group that their job is to become experts on this particular resource.
  - Caution groups that these resources are not all typical articles; for instance, Resources A and D contain several interactive maps, and Resource B is mostly made up of photographs and numbers. Resource C is available in multiple reading levels from third to 12th. Later, when they return to their publishing teams, they will be responsible for sharing new information from their jigsaw resource to incorporate into their publishing team's updated *Ocean Plastics Movement Model,* which they began in the previous activity, *Autopsy of an Albatross*.
  - Distribute appropriate Reading Guides to each jigsaw group:

    - Reading Guide A:What Happens to the Plastic We Throw Out
    - Reading Guide B:10 Shocking Facts About Plastic Pollution
    - Reading Guide C:Ocean Trash: 5.25 Trillion Pieces and Counting
    - Reading Guide D:Sailing Seas of Plastic

  - Ensure each group has online access, then instruct students to begin reading and answering the questions.

- Prior to the conclusion of the jigsaw activity, remind students that they are responsible for sharing information about their jigsaw resource with their publishing team. This information should help their publishing team refine their *Ocean Plastics Movement Model*.
- If some groups finish their Reading Guides before others, those groups can begin updating their Ocean Plastics Movement Model with the new information they have learned.

- When the *Reading Guides* are complete, use the *Reading Guides Answer Key* to assess students' understanding.
- After assessment, Reading Guides should be placed in each publishing team's folder, where they can be consulted when publishing teams are working on other elements of their magazines.

5. Guide students to update their Ocean Plastics Movement Models.

  - Bring students back into their publishing teams. Instruct them to take out their *Ocean Plastics Movement Models*. Remind students that the final version of this model will be a central part of their unit project, but it is still under development. They have now learned a lot of new information, from many different resources, which they can use to update their models.
  - Instruct students to take turns in their publishing teams sharing information from their jigsaw resources that will improve their *Ocean Plastics Movement Models*. While one student is sharing information about their jigsaw resource, another student in their publishing team should add drawings to the model, while a third student writes a verbal explanation.

    - Because they will continue to revise their *Ocean Plastics Movement Models* over the course of this unit, remind students to use pencils. In addition, having different colored pencils for successive layers of revisions and additions may prove helpful.

Tip

Step Four: To read more about facilitating successful jigsaw activities, visit The Jigsaw Classroom.

Modification

- **Step Two:** To support linguistically diverse learners, consider providing tangible examples of different types of plastics, including not only bottles and bags but also some less familiar examples.
- **Step Four:** The jigsaw resources have varying levels of complexity. Take some time to familiarize yourself with these resources, as well as the Reading Guides, before assigning students to jigsaw groups.

- Resource A is densely packed with information, including text, world maps, and infographics. Also note that for this resource, the visual infographic shows that the vast majority of mismanaged plastics come from South, East, and Southeast Asia.
- Resource B consists of 10 photographs with associated statistics. The questions on the reading guide are largely mathematical and visual in nature.
- Resource C offers multiple reading levels and hyperlinked vocabulary words. The questions on the reading guide correspond with the sixth-grade version of the article.
- Resource D is a fully interactive world map showing a detailed view of ocean plastic pollution. The amount of information contained is substantial, and navigating the site while answering the questions will require good time-management skills.

Informal Assessment

Students' participation in discussions, their changing definition of plastics, their plastic audit handouts, and their *Reading Guides* responses all provide insights into students' current understanding about plastics as synthetic materials that come from natural resources, with impacts on society.

Extending the Learning

A school wide plastic waste audit is ambitious, messy, and incredibly informative! Often, an audit is used as a first step in creating a school wide 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 school wide plastic waste audits—and your school can, too. Here are some resources that can help in your planning process.

- Eco-Schools USA Consumption and Waste Audit Lesson Plan
- Monterey Bay Aquarium Plastic Use Audit Lesson Plan
- Many video examples are available on the Internet, for example:
    - Pinole Valley High School Waste Audit
    - School Solid Waste Audit

In step four, one of the jigsaw resources, 10 Shocking Facts About Plastic Pollution, refers to incineration of plastic waste. Students reading this resource may be intrigued by incineration as a possible solution to the problem of plastic pollution. Scientists and policymakers have debated for decades whether burning plastics is any better for the environment than sending it to landfill. Meanwhile, advocates of zero waste and a circular economy would argue that our fundamental goal should be reducing the amount of plastic waste as much as possible so that none of it needs to be burned or buried at all. These four articles summarize the debate between burning or burying waste plastics.

- Is burning plastic waste a good idea? (National Geographic)
- What's worse, burning plastic or sending it to a landfill? (Grist.org)
- Should we burn or bury waste plastic? (BBC)
- Incineration versus Recycling: In Europe, a Debate over Trash (Yale Environment 360)

OBJECTIVES

Subjects & Disciplines

- Chemistry

  Earth Science

  - Oceanography
- Experiential Learning

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Experiential learning
- Jigsaw

Skills Summary

This activity targets the following skills:

- 21st Century Themes
  - Environmental Literacy
  - Global Awareness

- Critical Thinking Skills
  - Applying
- Geographic Skills
  - Asking Geographic Questions
- Science and Engineering Practices
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **MS-PS1-3:**
Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
• **Standard 11:**
The patterns and networks of economic interdependence on Earth's surface
• **Standard 14:**
How human actions modify the physical environment

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.1.A:**
Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
• **CCSS.ELA-LITERACY.SL.7.2:**
Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 4:**
Systems and system models
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions

• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information.

Preparation

BACKGROUND & VOCABULARY

Background Information

Before “plastic” became a noun, it was an adjective referring to a material’s ability to deform without breaking. The first plastic was invented in 1869, when John Wesley Hyatt combined plant-based materials to manufacture billiard balls. Hyatt developed more than 200 patents for plastics, with applications from dentistry to photography and beyond.

Plastic is not one material, but a family of materials, including the seven classes of recyclable plastics. What do all plastics have in common? All are synthetic: Although made from natural materials, notably the vast majority from crude oil and natural gas, plastics do not occur in nature. And they are all polymers: long chains of atoms, mostly carbon. (Silk and DNA are two naturally occurring polymers.)

The unique properties of synthetic carbon polymers make plastics both useful and harmful. Because carbon atoms bond to each other, they can form strings of nearly any length. And because carbon also bonds to many other atoms, these strings take on properties of other elements, too. Plastics (specifically thermoplastics) are moldable and recyclable because polymer chains bond to each other at low temperatures. At higher temperatures, the chains remain intact, but the weaker forces between chains break down, allowing the material to reform without losing its properties.

But these long, strong, synthetic bonds make plastics hard to break down. So the polymers that were designed to last a long time on the supermarket shelf continue to last a very long time in the ocean!

Prior Knowledge

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Recommended Prior Activities

- Autopsy of an Albatross

Vocabulary

Term	Part of Speech	Definition
biodegradable	*adjective*	able to decompose naturally.
detrimental	*adjective*	harmful.
entrenched	*adjective*	firmly established
extraction	*noun*	process by which natural resources are extracted and removed from the earth.
fossil fuel	*noun*	coal, oil, or natural gas. Fossil fuels formed from the remains of ancient plants and animals.
molecular	*adjective*	having to do with the smallest physical unit of a substance.
polymer	*noun*	compound of high molecular weight derived by the addition of many smaller molecules.
sustainable	*adjective*	able to be continued at the same rate for a long period of time.
synthetic	*adjective*	manufactured by people, not occurring naturally.
ubiquitous	*adjective*	existing or seeming to exist everywhere.
versatile	*adjective*	able to adjust to different conditions.

ACTIVITY 3: FOLLOW THE FRIENDLY FLOATEES | 1 HR 15 MINS

DIRECTIONS

***Plastics: From Pollution to Solutions* unit driving question:** *How can humans solve our plastic problem in the ocean?*

***Plastics, Plastics, Everywhere* lesson driving question:** *How do plastics get into and move around the ocean?*

1. Introduce students to the story of the Friendly Floatees.

- Show a rubber duck, which may be made of rubber or plastic.
- Explain the story of the Friendly Floatees: In 1992, a cargo ship in the North Pacific lost a shipping container on its way from China to the United States that spilled nearly 29,000 rubber ducks and other bath toys into the ocean.
- Show the location of the spill.

  - Project the *Marine debris map from ArcGIS*.
  - In the field that says *Find address or place* in the upper right corner, type the coordinates of the Friendly Floatees spill: 44.7 N, 178.1 E. When the point appears on the map, click the link that says *Add to Map Notes*. A marker should appear, indicating the spot.
  - On the left side of the screen, you should now see the *Content* menu, with *Map Notes* and *Major Ocean Currents* checked. (If you do not see the *Content* menu, click *Details* in the upper left corner and then select *Content*.)
  - Ensure that *Major Ocean Currents* is not checked. The only *Content* layer that should have a check is *Map Notes* showing the location of the spill. Once everything else is unchecked, zoom out so that you can see the whole map, including the pin showing the location of the spill.

- Ask students to predict, based on what they know about the movement of plastic in oceans, where these 29,000 ducks would end up.
- Tell students that although the ocean is large and always changing, there are certain predictable patterns of water movement that scientists have studied. These patterns are not perfect, and the path of the Friendly Floatees has shown us that we still have a lot to learn about ocean currents. However, one of the main forces driving ocean current patterns is the rotation of the Earth, which produces the Coriolis effect.

2. Guide students in a demonstration of the Coriolis effect through a mini-lab.
- Briefly show the *Prevailing Winds* layer of the map by finding the *Details* menu on the left side of the page, selecting *Content*, and checking the box next to *Prevailing Winds*.
- Zoom in on the Northern Hemisphere. Ask students to describe the direction of the prevailing winds. (Answer: clockwise)
- Then zoom in on the Southern Hemisphere and ask students to describe the direction of the prevailing winds. (Answer: *counterclockwise*)
- Explain that this phenomenon is known as the Coriolis effect, which students will explore through a mini-lab to see how it works.
- Distribute the *Coriolis Earth* and *Coriolis Mini-Lab* handouts.

- First, have students cut out the Northern and Southern Hemispheres, tape them together, and stick a pencil through the poles so that the Earth can spin like a top. Before beginning the mini-lab, check students' tops to ensure that they are lined up correctly.
- Once you have ensured that all tops are correctly assembled, tell students to complete the mini-lab according to the directions on the sheet, answering the questions as they work.

- When all groups have completed the mini-lab and worksheet, ask students to summarize the results of their investigations. Ask: *How could this information apply to the spilled rubber ducks?*

  - Possible responses: Water currents generally move clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. Therefore, spilled rubber ducks would likely follow a clockwise path since they were spilled in the Northern Hemisphere.

- Remind students that the Coriolis effect holds true for both wind and water currents.
- Add the terms *Coriolis effect* and *ocean gyre* to your word wall.

3. Prompt students to incorporate data from the *Coriolis Mini-Lab* handout into their *Ocean Plastics Movement Models.*

- Project the *Marine debris map from ArcGIS*. From the *Content* tab on the left side of the page, check the box next to *Prevailing Winds*. Ask students if this map agrees with their findings about the Coriolis effect.
- Next, check the box next to *Major Ocean Currents*.

  - First, ask students if they notice any similarities between the *Major Ocean Currents* and the *Prevailing Winds*.

    - Possible responses:

      - *Both tend to move clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.*
      - *However, there are exceptions to these general patterns, especially as water approaches the polar latitudes, both North and South.*

  - Remind students that these are only the major currents, and that the actual path of debris in the ocean can vary widely based on many other factors. Ask what other factors might affect debris as small as a rubber duck or a piece of plastic.

        - Possible responses: *waves, storms, wind, passing ships, migrating animals, tides, landforms creating physical barriers*

- Have students update their *Ocean Plastics Movement Models* with this new information.

    - Emphasize that they should depict information visually as well as verbally, including an explanation of what happens to surface water currents and why.
    - When groups have finished adding to their *Ocean Plastics Movement Models*, have them return the *Ocean Plastics Movement Models* and their *Coriolis Mini-Lab* sheets to their project folder.

- Ask students to make a final prediction using this new information about where the rubber ducks would end up.

4. Reveal the actual locations where Friendly Floatees were found.

- Show the TED-Ed video, *How Do Ocean Currents Work?* (4:33). After the video is finished, go back to 0:33 and pause to show the locations where Friendly Floatees have been identified.
- Ask students: *Do the actual locations of the Friendly Floatees agree with your predictions? If not, what could explain the difference between your hypothesis and the results of this natural experiment?*

    - Possible responses:

        - Other forces are not yet included in the model, including waves, storms, wind, passing ships, migrating animals, tides, and landforms creating physical barriers.
        - The forces included in this model are large and global in scale. Since rubber ducks are small, they are sensitive to much smaller, local variations in water direction.

- Add that the Friendly Floatees did not reach the east coast of the United States or the United Kingdom until the early 2000s, taking over 20 years to complete this journey. Thousands of Friendly Floatees are assumed to be still lost at sea, with many of them presumably floating in the Great Pacific Garbage Patch—the subject of the next activity.
- Emphasize to students that while models are useful, they are also theoretical. When empirical results disagree with a model, the model is updated. Reality is generally much more complex and less predictable than the simple models that humans create. Models are meant to be simplified versions of reality; if a model were as complex as the real world, it would cease to be a model.

- As an exit ticket, ask students to summarize what they learned in this activity by answering the following questions:
    - *What is the Coriolis effect, and how does it work?*
    - *How did your Ocean Plastics Movement Model change after you learned about the Coriolis effect?*
    - *What other questions do you have about the movement of plastics in the ocean?*

Informal Assessment

Students' lab sheets, their participation in discussions, their developing *Ocean Plastics Movement Model*, and their responses to the exit ticket questions provide insights into their current understanding and ideas about oceanic circulation, and the relationships between models, data, and predictions.

Extending the Learning

Use these resources after students have developed their *Ocean Plastics Movement Model* to provide more information about the story of the Friendly Floatees and what they teach us about ocean currents.

- *'Moby-Duck': When 28,800 Bath Toys are Lost At Sea (NPR)*
- *How Lego Figures and Rubber Ducks Reveal Ocean Secrets (BBC)*

The Geography of Ocean Currents is an activity that uses these concepts to predict the impacts of major oil spills.

Ocean Currents and Climate is a video resource that relates the concepts in this activity to climate change. This will help ensure students address all components in the MS-ESS2-6 Performance expectation, as this unit does not address the connection between oceanic circulation and regional climates.

OBJECTIVES

Subjects & Disciplines

- Conservation

  Earth Science
    - Climatology

- Oceanography

  Geography

Learning Objectives

Students will:

- Observe how the rotation of Earth affects surface ocean currents.
- Apply knowledge of current patterns to predict the destinations of floating rubber ducks.

Teaching Approach

- Project-based learning

Teaching Methods

- Hands-on learning
- Inquiry
- Lab procedures

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding
- Geographic Skills
  - Acquiring Geographic Information
  - Analyzing Geographic Information
  - Answering Geographic Questions
  - Asking Geographic Questions
  - Organizing Geographic Information
- Science and Engineering Practices

- Analyzing and interpreting data
- Constructing explanations (for science) and designing solutions (for engineering)
- Developing and using models
- Planning and carrying out investigations

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 1:**
How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2: Cause and Effect:**
Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• **Crosscutting Concept 4:**
Systems and system models
• **HS. Earth's Systems:**
HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
• **Science and Engineering Practice 1:**
Asking questions and defining problems
• **Science and Engineering Practice 3:**
Planning and carrying out investigations

Preparation

BACKGROUND & VOCABULARY

Background Information

In 1992, a cargo ship carrying approximately 29,000 bath toys (mostly rubber ducks) spilled in the northern Pacific Ocean. These so-called Friendly Floatees have been drifting ashore for over 20 years, sometimes in surprising parts of the world—not only Alaska, but also Hawaii, Australia, Indonesia, and Chile. By the early 2000s, a few had even been found as far away as Maine and the British Isles. It is presumed that many Friendly Floatees are still adrift at sea, including in the infamous North Pacific Gyre (the location of the so-called Great Pacific Garbage Patch). The destinations they have reached, and the time it took for them to wash ashore, have helped scientists better understand the complex dynamics of ocean surface currents.

Rubber (including both natural and synthetic rubber) and plastics are related in that both are carbon-based polymers that can be made from either plant-based materials or fossil fuels, although the vast majority currently come from fossil-based fuels. In fact, different kinds of plastics are often combined in various ratios to create materials that have hybrid properties. In general, additives in synthetic rubbers make them more flexible and stretchable at room temperature, while some other plastics tend to be harder and more brittle. Rubbers, whether natural or synthetic, are a special group of polymers known as elastomers, whose long-chain molecules have stronger chemical cross-linkages that plastics lack. Like plastics, synthetic rubber does not biodegrade, and though recycling rubber is possible, it is not always easy.

Prior Knowledge

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Recommended Prior Activities

- Autopsy of an Albatross
- Plastics Aplenty

Vocabulary

Term	Part of Speech	Definition
Coriolis effect	*noun*	the result of Earth's rotation on weather patterns and ocean currents. The Coriolis effect makes storms swirl clockwise in the Southern hemisphere and counterclockwise in the Northern Hemisphere.
decompose	*verb*	to decay or break down.
marine debris	*noun*	garbage, refuse, or other objects that enter the coastal or ocean environment.
microplastics	*noun*	piece of plastic between 0.3 and 5 millimeters in diameter.

Term	Part of Speech	Definition
ocean gyre	*noun*	an area of ocean that slowly rotates in an enormous circle.

ACTIVITY 4: THE LIFE CYCLE OF PLASTICS I 1 HR 40 MINS

DIRECTIONS

Plastics: From Pollution to Solutions **unit driving question:** *How can humans solve our plastic problem in the ocean?*

Plastics, Plastics, Everywhere ***lesson driving question:*** *How do plastics get into and move around the ocean?*

1. Elicit students' prior knowledge about the Great Pacific Garbage Patch.

- Ask if any students have heard of the Great Pacific Garbage Patch. Some may recall that it was mentioned in their jigsaw resource and in videos used in this unit, but they have not yet learned a formal definition.
- Prompt students to sketch a picture in their notebooks of what they think the Great Pacific Garbage Patch looks like. They should include details such as what kind of garbage is found there, whether any animals live there, where the patch is located in the Pacific Ocean, and how large they think it is.
- Have students read *The Great Pacific Garbage Patch Isn't What You Think It Is* independently or with a partner to find out if their description was accurate.
- Encourage students to select the appropriate reading level (third, sixth, 11th, or 12th).
- Ask: *How does the reality of the Great Pacific Garbage Patch differ from the way you first imagined it?*
  - Possible responses:
    - It is mostly fishing nets and microplastics.
    - It covers an area larger than Texas.
    - The plastics come from at least 12 different countries.
    - It is not an island of trash.
- Instruct students to add a depiction of microplastics to their drawings of the Great Pacific Garbage Patch.

2. Address misconceptions about the idea that plastics do not break down.

- Define *microplastics* as pieces of plastic between 0.3 millimeters and five millimeters in diameter. Ask: *How big is a millimeter?*
    - Possible responses:
        - About the width of a grain of rice
        - About the width of a pencil lead
        - A millimeter ruler can be used to show this as well.
- Contrast microplastics with macroplastics, which are larger than 5 millimeters.
- Tell students that many people believe that plastics never break down. Clarify with the following information that this is a misconception:
    - It is true that plastics do not easily biodegrade. Biodegradation occurs when a material is digested by decomposers such as fungi, invertebrates, and bacteria. The end result of biodegradation is particles add to the nutrients of the soil and cycle back into the food chain.
    - There are very few plastics that can biodegrade in the right environmental conditions.
- Ask: *What kinds of factors might affect a plastic's ability to biodegrade?*
    - Possible responses:
        - *The type of plastic*
        - *Temperature*
        - *Humidity or moisture*
        - *Length of time*
        - *Kinds of organisms in the environment*
- Explain photodegradation: The vast majority of plastics do not biodegrade, but they can degrade by other processes. Sunlight, specifically UV radiation, plays a major role in degrading ocean plastics. This is known as photodegradation. Waves and salt also contribute to physical and chemical degradation of plastics.
- Prompt students to compare this process to biodegradation.
    - Possible response: *Unlike biodegradation, photodegradation does not result in harmless particles that can cycle back into the food chain. Rather, it results in smaller pieces of plastic, known as microplastics.*

3. Conduct a kinesthetic activity to demonstrate photodegradation on microplastics at the molecular level.

- Tell students that in order to visualize the photodegradation process, they will form a chain.
- Gather the 11 placards created in advance of this step (see Setup).
- Choose eight students to form a chain. Give each of these students the placard that reads *Macroplastic Polymer*. Have them hold up the placard so the class can read this.
    - Tell these students to link arms.
    - Remind the class that all plastics are made from polymers, which are long, chain-like molecules made from fossil fuels.
    - Explain that the chemical bonds between each link in the chain are very strong, which is what makes plastics useful, but also so hard to break down.
    - Add that when bacteria encounter plastic, because it is made by people, the bacteria usually do not have any way to digest the plastic like they would digest a natural substance such as wood or keratin, the natural polymer that makes up hair, fingernails, wool, feathers, and horns.
- Choose a student who is not part of the polymer chain to be the waves. Give them the placard that says *Waves* and tell this student to gently demonstrate the motion of waves breaking apart the students in the middle of the *Macroplastic Polymer* chain, creating two smaller chains.
    - Explain that waves can break apart macroplastics, but only slightly. Have the *Waves* student sit back down.
- Choose another student who is not part of the polymer chain to be salt. Give them the placard that says *Salt*.
    - Ask this student to gently demonstrate the chemical reaction of salt breaking apart the two *Macroplastic Polymer* chains into four smaller chains.
    - Have the *Salt* student sit back down.
- Finally, choose a final student who is not part of the polymer chain to be *UV Radiation (sunlight)*.
    - Give them the corresponding placard and have this student gently demonstrate the ability of sunlight to photodegrade macroplastics, breaking up the four chains into eight separate particles.

    - Have this student sit back down.

- At this point, all eight of the polymer students should be floating separately. Tell them to turn their placards around to the side that says *Microplastic Polymer*.

    - Emphasize that microplastics are small, sometimes even microscopic, but they are still synthetic polymers that are not small enough to be considered nutrients for the food chain. Nevertheless, many animals, large and small, eat microplastics.

- Thank all the volunteers and ask the students holding placards to return to their seats.
- Request that the class help you add the following words and their definitions to the word wall by drawing on what they have just learned in this activity:

    - microplastics
    - macroplastics
    - biodegradation
    - photodegradation

- Remind students that one of the important pieces of their magazine project is a glossary that contains terms like these.

4. Guide students through the process of telling the full story of the life cycle of plastic.
- Ask students for a brief summary of each of the first four activities in this unit.

    - Possible responses:

        - Autopsy of an Albatross activity: Plastic pollution can reach remote ocean habitats far away from human settlements.
        - Plastics Aplenty activity: Plastics are a large family of synthetic chemicals made from oil used in almost every aspect of modern life.
        - Follow the Friendly Floatees activity: Ocean surface currents tend to move in circular patterns affected by Earth's rotation.
        - So far, in this activity, we have learned that plastics do not biodegrade, but they do break down into microplastics.

- Students' next task will be to summarize the entire story of plastics, with each team performing a brief skit about one stage in its life cycle.
- Distribute the resource *Journey of a Plastic Bottle*, which features Story Points from the *Plastic: Sea to Source* StoryMap. Assign each team one of the Story Points on to six. Tell

teams to read their Story Point and then create a brief skit in which team members act out what happens to plastics in their Story Point. Explain the roles they may choose:

  - Two narrators per group
  - One actor to play a piece of plastic (who also is responsible for explaining the data visualization that the group creates together)
  - One actor to play other roles, such as sunlight, landforms, or organisms

- Give students time to read their Story Point and decide which role each group member will play. Monitor each team's progress to ensure that the actors understand their roles and have practiced making appropriate movements.
- Beginning with Story Point One, present the skits of each team.

5. Conclude the story of the life cycle of plastics with questions that relate to the unit project.

- After the last skit, ask students if any stages of the life cycle of plastics are missing.

  - Possible responses:

    - There is not a Story Point about the production of plastics, which requires extracting oil and/or natural gas from the ground, refining it, and chemically combining molecules into polymers that can be molded into various forms.
    - There is also not a Story Point about the future of plastics, because they last a very long time in the environment and scientists still don't know exactly where they go or how they affect the animals that eat them.

- Summarize that students have just described the life cycle of plastics, from cradle (production) to grave (disposal).
- Ask: *Do you think life cycle is an appropriate term for this process, and if not, what would a better term be?*

  - Possible responses:

    - No, plastics are not alive.
    - No, the journey of plastics is rarely a cycle because 91 percent of plastics are never recycled.
    - No, because in a life cycle an organism's body is recycled by decomposers into particles that are used by other organisms to grow.
    - Students may have several ideas for a better term.

- Tell students to take out their *Final Project Checklist and Rubric*. In the next activity, they will work on their unit project. Tell them to mark the elements that they will focus on:
  - an introduction to what plastics are, how they are made, and the many ways in which they are used;
  - an *Ocean Plastics Movement Model* showing how plastics reach the ocean and what happens to plastics in the ocean; and
  - a glossary of related vocabulary used in the magazine
- In the remaining time, answer students' questions about the unit project and tell teams to assign roles for various parts of the unit project, which team members will work on during the following activity.

Modification

For students who benefit from having clear physical boundaries, inform them at the beginning of this lesson that it will involve an active and fun opportunity for acting out plastic processes. While they are encouraged to enjoy themselves by fully participating in the kinesthetic learning process, they should remember that they are still in a classroom space surrounded by peers.

Tip

- **Step One:** When reading *The Great Pacific Garbage Patch Isn't What You Think It Is*, decide on the best format for reading this article with your class. You may decide to project the internet-based article from your computer and read it as a whole class, to print out the article for individuals or pairs to read, or to provide computers for students to access the article online. If printing, be sure to select the appropriate reading level version.
- **Step Two:** Role-playing and kinesthetic learning are strategies that have great educational and entertainment value in a science classroom, but strong classroom management during these activities is essential. Read more from the *Association for Supervision and Curriculum Development* and *Stanford Teaching Commons.*
- **Step Four:** The Story Points focus on China, primarily because of China's large population and relatively underdeveloped solid waste management infrastructure. However, it is worth emphasizing to students that this story could take place anywhere across the globe. Also, depending on your students' sensitivity to cultural differences, you may want to remind students that they are not role-playing Chinese people, but rather that plastics, water, and natural forces exist everywhere on our planet.

Informal Assessment

Students' skits, their participation in discussions, and their developing ideas about their unit project provide insights into their current understanding about modeling the flow of matter (plastics) through systems (the hydrosphere).

Students' skits should include descriptions, both verbal and nonverbal, of the many forces that transport and degrade plastics.

Extending the Learning

To extend students' learning about marine debris, explore resources provided by the NOAA Marine Debris Program, especially those created for World Ocean Day in 2016. The Ocean Today *Trash Talk Special Feature* video (15:11) can be watched in its entirety or as shorter segments; consider showing the *Great Pacific Garbage Patch* (2:11) portion to help students understand how marine garbage patches are more like plastic soup than an island. Also check out the *Trash Talk Webinar* for educators.

OBJECTIVES

Subjects & Disciplines

- Chemistry

  Earth Science

  - Oceanography

  Storytelling

Learning Objectives

Students will:

- visualize and quantify the difference between macroplastics and microplastics;
- understand the difference between biodegradation and photodegradation; and
- synthesize information learned about plastic production, disposal, and movement into a cohesive storyline.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Reading
- Role playing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- 21st Century Themes
  - Environmental Literacy
- Critical Thinking Skills
  - Creating
- Science and Engineering Practices
  - Constructing explanations (for science) and designing solutions (for engineering)
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 8:**
The characteristics and spatial distribution of ecosystems and biomes on Earth's surface

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 4:**
Systems and system models
• **LS2.C: Ecosystem Dynamics, Functioning, and Resilience:**

When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)

Preparation

BACKGROUND & VOCABULARY

Background Information

The degradation of plastics by biological, physical, and chemical processes is a complex topic that requires significant background knowledge in organic chemistry. Different plastics with varying properties break down differently, depending on their environment. In addition to microplastics and macroplastics, some researchers have begun to characterize mesoplastics (in between micro and macro) and nanoplastics (smaller than micro). However, there is no universally agreed-upon technical definition of these terms.

The last several years have seen a significant movement toward developing and using biodegradable and plant-based plastics. While this is an encouraging trend, it is far from a silver bullet to the plastic pollution problem. Simply put, many of these supposedly biodegradable and/or compostable plastics do not actually biodegrade in the environment, because they require temperatures as high as 50°C(122 °F) to break down.

On the other hand, some scientists are researching organisms, including bacteria, fungi, and insects, that can digest certain forms of plastics. This research is promising, but also raises the specter of genetically engineered microbes being released into the environment to clean up plastics, with enormous potential for unintended consequences. Other researchers have proposed that microbes in the natural environment may already be evolving to digest plastics, but this hypothesis remains unproven.

Prior Knowledge

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Recommended Prior Activities

- Autopsy of an Albatross
- Follow the Friendly Floatees
- Plastics Aplenty

Vocabulary

Term	Part of Speech	Definition
biodegradation	*noun*	process of a material being broken down by decomposing organisms into harmless particles.
macroplastics	*noun*	pieces of plastic larger than 5 mm in size.
marine debris	*noun*	garbage, refuse, or other objects that enter the coastal or ocean environment.
microplastics	*noun*	piece of plastic between 0.3 and 5 millimeters in diameter.
photodegradation	*noun*	process by which a substance is broken down by exposure to light.

ACTIVITY 5: MAGAZINE DESIGN WORKSHOP I I 1 HR 15 MINS

DIRECTIONS

Plastics: From Pollution to Solutions **unit driving question:** *How can humans solve our plastic problem in the ocean?*

Plastics, Plastics, Everywhere **lesson driving question:** *How do plastics get into and move around the ocean?*

1. Prepare students for focused teamwork.

- Use personal reflection to remind students that their project is meaningful, and to ensure that limited teamwork time will be well spent. Discuss the following questions:
  - *How have the activities in this unit impacted you personally?*
    - Possible responses may include:

        - Increased awareness or personal reduction in plastic use;
        - Recycling;
        - Communication with family, friends, or community; or
        - Independent research into related issues.

- *How will your final project help address the problem of plastic pollution?*

    - Possible responses:

        - *Raising awareness about the issue*
        - *Helping us become experts*
        - *Inspiring people to become a part of the solution*

- What *are examples of good teamwork in the classroom?*

    - Possible responses:

        - Every student participates.
        - Space and materials are shared.
        - Class time is valued and not wasted.
        - Work is divided fairly.
        - Students attempt to resolve their own conflicts before they escalate.

2. Facilitate productive work time as teams develop three project elements.

- Tell students that they will now have time to work in their publishing teams on a few key elements of their magazines.
- Ensure all teams have their *Final Project Checklist and Rubric* with two key items highlighted:

    - An *Ocean Plastics Movement Model* showing how plastics reach the ocean and what happens to plastics in the ocean.

        - Emphasize that this model must include both drawings and written explanations for each step.

    - A glossary of related vocabulary used in the magazine.

- Distribute the *Glossary Organizer* and tell teams to spend a few minutes as a team deciding if the words on this list are the most important for their magazine readers to understand. Tell them to choose 12 to 15 words as a team, but not to write definitions or sentences yet.

- Emphasize that this *Glossary Organizer* is not the final copy that will go in their magazine, but a working draft. (See Tips for more on how to frame this as an intellectual task.)

- Instruct publishing teams to spend a few more minutes discussing general ideas and compiling notes as a team, and then quickly move on to dividing tasks between team members. Since teams have four members and there are two elements in progress, each team will decide how to allocate their members' time most efficiently.
- Allot plenty of time for teams to work on their projects independently. Circulate through the room to check in with each team and individual members about their progress. Answer any clarifying questions they have about the rubric or project expectations.
- Narrate positive examples of teamwork as you witness them.

3. Wrap up with a gallery walk that allows students to demonstrate their progress.

- Tell students to clean up their project work areas, clearing away all materials and notes except for the physical products of their teamwork.
- Acknowledge that these products are still works in progress, but that every team is getting closer to their goal.
- Explain to students that they will spend a few minutes walking around the room quietly to view their peers' work, then return to their seats.
- Ask students for examples of teams whose work they admired. Tell students to refer to the *Final Project Checklist and Rubric* so they can provide meaningful feedback, both positive and constructive.
- Have students update the class *Know and Need to Know* chart using their *Final Project Checklist and Rubric* as a reference to indicate what else they still need to know in order to finish the rest of their final project.

    - Possible responses:

        - We still need to know how macroplastics and microplastics affect ecosystems, food webs, and one featured marine organism.
        - We still need to write survey questions about community members' attitudes and behaviors regarding plastics, administer the survey, and analyze results.
        - We still need to write a profile of the winner of the 2019 Ocean Plastic Innovation Challenge and a *Call to Action* for readers.

- Finally, remind students to return all project materials (including their introduction to the definition of plastics, *Ocean Plastics Movement Model*, *Glossary Organizer*, and *Final Project Rubric and Checklist*) to their project folders for safekeeping.

Modification

In teamwork settings, extroverted students often shine, and introverted students can feel neglected or shut out. PBL Works published *this blog post* with recommendations about how to ensure introverted students' unique skills and voices are valued.

Tip

- **Step One:** To read more about structuring time and expectations for teamwork, read *5 Strategies for Making Project Work Time More Productive* from the PBL Works blog.

- **Step One:** To read more about assigning roles to team members, read *Roles in PBL: 3 Approaches For Organizing Group Tasks* from the PBL Works blog. For teams that benefit from extra time management scaffolding, read *The Ultimate Teamwork Management Tool: Kanban Boards* from the PBL Works blog

- **Step Two:** Although the glossary may at first appear less intellectually demanding than other elements of the magazine, the role of students working on the glossary is not to be taken lightly. They must curate an ever-growing list of words, craft student-friendly definitions for each, and write a meaningful sentence that shows the meaning of the word. They must remain in constant communication with their teammates to ensure that their glossary accurately reflects the terminology used in other elements of the magazine. It may be appropriate to provide a computer with internet access to students working on the glossary so they can search for definitions and refer back to previously cited resources.

Informal Assessment

Students' progress on their *Ocean Plastics Movement Model*, introduction to plastics, and glossary provide insights into their current ability to articulate scientific concepts in words and visual models. Their feedback to other teams and their reflection of gaps in their knowledge provide further evidence of their scientific communication skills.

OBJECTIVES

Subjects & Disciplines

- Chemistry
  Earth Science
  - Oceanography
- English Language Arts
  Geography
  - Human Geography
  Storytelling

Learning Objectives

Students will:

- synthesize information from notes to make progress toward unit project goals; and
- celebrate the progress of their team and their class.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Reflection
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation

        - Critical Thinking and Problem Solving
    - Life and Career Skills
        - Initiative and Self-Direction
        - Leadership and Responsibility
        - Productivity and Accountability
- Critical Thinking Skills
    - Creating
- Geographic Skills
    - Answering Geographic Questions
    - Organizing Geographic Information
- Science and Engineering Practices
    - Constructing explanations (for science) and designing solutions (for engineering)
    - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

NATIONAL GEOGRAPHY STANDARDS

• **Standard 1**:
How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **WHST.6-8.2**:
Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
• **WHST.6-8.2.A**:
Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

NEXT GENERATION SCIENCE STANDARDS

• **MS-ESS2-6**:

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

• **Science and Engineering Practice 2:**
Developing and using models

Preparation

BACKGROUND & VOCABULARY

Background Information

This activity nominally focuses on group work toward project goals, but don't underestimate the importance of other objectives, too. Articulating a personal connection helps make project-based learning more meaningful. Regularly celebrating team and class progress toward final project goals helps students stay motivated. Reflecting on past and future knowledge is a form of metacognition that helps students synthesize and retain information. The first lesson in this unit is packed with scientific content as well as emotional processing about the plastic crisis. Students need time to process these facts and feelings before they can move on and apply their knowledge to the following lessons.

Prior Knowledge

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Recommended Prior Activities

- Autopsy of an Albatross
- Follow the Friendly Floatees
- Plastics Aplenty
- The Life Cycle of Plastics

Vocabulary

Term	Part of Speech	Definition
macroplastics	*noun*	pieces of plastic larger than 5 mm in size.
marine debris	*noun*	garbage, refuse, or other objects that enter the coastal or ocean environment.

Term	Part of Speech	Definition
microplastics	*noun*	piece of plastic between 0.3 and 5 millimeters in diameter.
pollution	*noun*	introduction of harmful materials into the environment.
waste	*noun*	material that has been used and thrown away.