Do we have the power to solve the plastic problem?

Supporting Questions

1. How are human use of plastics impacting the natural environment in Maui County?
2. Why are plastics so hard to eliminate and how do they get to Maui beaches?
3. How are communities, the government and individuals taking action to address the plastic problem?
4. How can we apply scientific principles to design solutions to the plastic problem?
Impacts of Humans on the Environment

8th grade Science Inquiry

Do we have the power to solve the plastic problem?

<table>
<thead>
<tr>
<th>Standards and Content</th>
<th>SS.6-8.5.4 Create an action plan to address a solution to the problem or issues and demonstrate evidence of implementation.</th>
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<tbody>
<tr>
<td></td>
<td>ME-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment</td>
</tr>
</tbody>
</table>

Staging the Compelling Question

Guest Speaker: Conservation and Education Director of Trilogy Expeditions, shares background information about micro and macro plastics and guides students to collect data on the amount of micro and macro plastics found at two Maui County Beaches, one on the north shore and one on the south shore.

Supporting Question 1

How is the human use of plastics impacting the natural environment in Maui County?

Formative Performance Task

Make graphs for the amount of plastic found on the beach.

Identify patterns and ask questions on the amount of plastic found at each of the shores.

Free write: My first impressions of plastic while watching a series of photos

Supporting Question 2

Why are plastics so hard to eliminate and how do they get to Maui beaches?

Formative Performance Task

Graphic organizer that defines; What are plastics made from? Why are they not decomposable? What is the trend of plastic use? What can we do to solve the plastic problem?

Supporting Question 3

How are communities, the government and individuals taking action to address the plastic problem?

Formative Performance Task

Students work through stations identifying the actions the government, community and individuals have and can take to solve the plastic problem.

Plastic Journal: record the plastic that you use in one day and write a reflection

Supporting Question 4

How can we apply scientific principles to design solutions to the plastic problem?

Formative Performance Task

Design thinking: Students redesign products that use plastic or design systems to reduce the amount of plastic that is reaching the ocean.
Part 2: Field Trip to Ka‘ehu Bay
In the classroom: students sort and count and analyze data for the amount and kind of micro and macro plastics found on the beach.

Thank you letters to the guest speakers and volunteers that shows what you have learned about how plastics are impacting the environment.

Featured Sources

Source A: Hokule‘a and Plastic Pollution
Source B: Creating Graphs
Source C: Images to inspire ideas in free write
Source D: Field trip to Ka‘ehu Bay with not-for profit groups collect data on the amount of plastic that is present on the beach.

Featured Sources

Featured Source A: Plastic 101
Featured Source B: Introduction to density that is used with density blocks
Featured Source C: Lab on the effects of temperature and salinity on density and the movement of water
Featured Source D: Plastic in the Galapagos

Featured Sources

Featured Source A: excerpts from the Hawaii State Constitution and Single Use Plastic Ban in Maui County Plastic Bag Ban
Featured Source B: Adidas shoes, The Ocean Cleanup, Redesigned Styrofoam by using mycelium and Papahānaumokuākea.
Featured Source C: Individual Journal
Featured Source D: Mālama ‘Āina reflection.

Featured Sources

Featured Source A: Free write
Featured Source B: interviewing a classmate
Featured Source C: graphic organizer and brainstorm
Featured Source D: Individually design a prototype for the solution
### Summative Performance Task

**ARGUMENT:** Do we have the power to solve the plastic problem? Construct an argumentative essay that evaluates if we have the power to solve the plastic problem. Students must incorporate scientific explanations and evidence in their argument.

**NGSS Science Practices:**

*Engaging in argument from evidence:* Do we have the power to solve the plastic problem?

**EXTENSION.**

### Taking Informed Action

<table>
<thead>
<tr>
<th>UNDERSTAND</th>
<th>What is our classmate’s chief complaint about the plastic problem?</th>
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<tbody>
<tr>
<td>ASSESS</td>
<td>How might we design a solution to that problem?</td>
</tr>
<tr>
<td>ACT</td>
<td>Students will construct and test prototypes and present to their classmates and the greater community.</td>
</tr>
</tbody>
</table>

**Construct and Test design system.**

*Featured sources are suggested, and links are provided. It may be that these links are broken, and we apologize in advance for the inconvenience.*
Overview

Inquiry Description

This inquiry leads students through an investigation of the impact human’s use of plastic have on the environment. By investigating the compelling question “Do we have the power to solve the plastic problem?” students explore and apply scientific concepts to assess the complex impact plastics have on the marine environment. They conduct investigations to understand how plastic debris impacts and arrives at different beaches in Hawai‘i, explore how society is addressing the plastic problem and determine how to design solutions to the plastic problem. The formative performance tasks build on knowledge and skills through the course of the inquiry and help the students engage in NGSS science standards and practices, develop arguments based on evidence and design thinking. At the end of the inquiry, students apply scientific concepts and data collected through this inquiry unit to write an evidence-based argument that addresses “Do we have the power to solve the plastic problem?” Students take action in developing and testing a prototype that addresses how we might solve the plastic problem and present it to the school community.

This inquiry highlights the following standards and NGSS science practices:

- SS.6-8.5.4 Create an action plan to address a solution to the problem or issues and demonstrate evidence of implementation.
- ME-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
- **NGSS Science Practices:**
  - *Analyze and Interpret Data*
  - *Asking questions (for science) and defining problems (for engineering)*
  - *Planning and carrying out investigations*
  - *Obtaining, evaluating and communicating information*
  - *Constructing explanations (for science) and designing solutions (for engineering)*
  - *Engaging in argument from evidence*

Note: It is important to note that this inquiry requires prerequisite knowledge of basic concepts of lab work. Note: This inquiry is a comprehensive unit and is expected to take fifteen 50-minute class periods. The inquiry time frame could expand if teachers think their students need additional instructional experiences (e.g., supporting questions, formative performance tasks, featured sources, writing). Teachers are encouraged to adapt the inquiry to meet the needs and interests of their students. This inquiry lends itself to differentiation and modeling of scientific phenomenon and real-world application of science concepts while assisting students in data collection and analysis, obtaining, evaluating and communicating information from a variety of sources and designing solutions to address real world problems.
Structure of the Inquiry

In addressing the compelling question “Do we have the power to solve the plastic problem?” students work through a series of supporting questions, formative performance tasks and featured sources in order to construct an argument supported by evidence collected throughout the inquiry. Students taking action through designing and testing a prototype to address the plastic problem.

Staging the Compelling Question

In staging the compelling question, “Do we have the power to solve the plastic problem?” guest speaker, Conservation and Education Director of Trilogy Expeditions provide students with background information on microplastics in the marine environment. The guest speaker presents a series of slides on the impact plastics are having on the marine environment including the gyres, the Great Pacific Garbage patch, bioaccumulation of plastics in the marine food chain and data collection process. Students collect meaningful data on the quantity of plastic found at beaches facing different cardinal directions on Maui. Students identify patterns and create questions to explain the differential impact plastic has on the beaches in Maui. Teachers will have to collect 2-3 five-gallon buckets of sand from the north shore and the south or west side beaches, preferably from the high tide line where micro and macro plastic is deposited.

The featured sources for this lesson are outlined in this lesson plan: comparing the amount of microplastics on the beaches of Maui.

This is a hands-on activity that includes scaffolding for all students built into the lesson to support comprehension. Visual supports for ELL students are provided in the slideshow and the data collection process. If a guest speaker is not able to visit the class, the same instruction can be provided by the teacher. A slide show to present the background information listed above helps set the stage for students to understand the greater impacts and distribution of microplastics in the ocean.

If this lesson is conducted online, students can go to their local beaches during low tide to collect sand from the high tide line and obtain real world data about the impact plastics have on the marine environment. Teachers may provide sand from other parts of the island for a comparison. Data collection protocol should be created by the teacher to ensure accurate data can be complied by all students. The background of microplastics could be conducted through Google Slides or video Smog in the Sea.

Smog in the Sea.
Supporting Question 1

The first supporting question, “How is the human use of plastics impacting the natural environment in Maui County?” provides students with an opportunity to acquire an understanding of how plastics are impacting beaches on Maui through collecting and analyzing data. In the staging the compelling question, students learned about plastics in the ocean and collected data. To answer supporting question 1, students make graphs from the data collected and identify patterns of the impact plastic has on the different beaches. Students then create questions they need to answer in order to explain this pattern.

The formative task A: Set the stage: watch video: Hokuleʻa Sailed Around the World but Couldn’t Escape Plastic | Ocean Stories.

The formative task B: Analyze and Interpret Data: Make graphs for the amount of plastic found on the beach. Students analyze the data to identify patterns that occur in the distribution of plastic on the beach. Students create questions to further understand these patterns.

The formative task C: 10-minute free write: My first impressions of plastic. While watching a series of photos, students reflect on their initial impressions.

The formative task D: Kaʻehu Bay Field Trip: Students rotate through various stations with different not-for-profit organizations sharing their experience. At one of the stations, students do a beach clean-up where they pick up and record data on the amount of debris collected from the beach. At another station, students set up 30’x10’ plots to collect microplastics. Students design tools to help them more effectively collect microplastics from the beach. All microplastics are brought back to the classroom for sorting and counting. I encourage the teacher to collect an equal amount of sand from Kaʻehu Bay so the students can collect data and compare the amount of plastic at Kaʻehu Bay to the other beaches that were explored in the first activity.

Teachers may implement formative task C with the following procedures:

1. Students review safety around the ocean and where the plots can be created.
2. Students worked in teams of 11 students to measure and mark the perimeters of a 30’ x 10’ plot in which they will collect plastic from the beach.
3. Students design tools to collect microplastics from the beach. Materials include; buckets, screen, twine and plastic shoe boxes.
4. Students collect micro plastics from the beach within their plot.
5. Teacher collects an equal amount of sand (from the high tide line) that was collected for the staging the compelling question activity to ensure students in the classroom can compare the amount of plastic at Kaʻehu Bay with the other two beaches on Maui. Keep this separate from the mass of plastics being collected in the plots.
6. In the classroom, students count and sort the plastics and measure the total weight of micro and macro plastics collected at Kaʻehu Bay.
7. Write thank you letters to the volunteers that expresses their understanding of the impact of plastics on the marine environment from our experiences on the beach and in the classroom.

Guide to planning and conducting a field trip with 100+ students

This activity is hands-on, and the students are able to compare the amount of plastic that is at Ka’ehu Bay (a northeastern facing shore) to those that are familiar to the students. Scaffolds for all students are intertwined in this activity.

The following sources were selected to provide students with a hands-on, exploratory experience to address the real-world impact plastics are having on the marine environment on Maui.

- **Featured Source A**: Video: [Hokule‘a Sailed Around the World, But Couldn't Escape Plastic | Ocean Stories](#).
- **Featured Source B**: *Analyze and Interpret Data*: Make graphs for the amount of plastic found on the beach. Students analyze the data to identify patterns that occur in the distribution of plastic on the beach. Students create questions to further understand these patterns.
- **Featured Source C**: is a series of pictures that students watch as they do a 10-minute free write to reflect on their first impressions of plastic. Teachers can use any photos that are of interest.
- **Featured Source D** is a field trip to the northeast coast of the island. Students take a field trip to Ka’ehu Bay in which students observe and collect data on the amount of plastic that is present on the beach.

If a field trip is not possible, sand can be collected and brought to the school to compare three different facing shores. In the winter, the northeastern currents and the strong surf deposit marine debris on the northeast shores more than any other shore in Hawaii.

NGSS Practice addressed in this investigation: *Analyze and Interpret Data and Asking Questions*
Supporting Question 2

The second supporting question, “Why are plastics so hard to eliminate and how do they get to Maui beaches?” provides students with an opportunity to conduct scientific investigations to explain how salinity, temperature and density all influence the circulation of water throughout the world in the global conveyor belt. Students obtain, evaluate and communicate information explaining how the circulation of oceans play a major part of plastic from other places washing up on beaches in Hawaii. Students will be able to explain why this is particularly detrimental since plastics are impossible to eliminate once they are made.

The featured sources for this question are two videos and a series of density labs.

**Formative Task A:** Students watch video Plastic 101 and communicate information in a graphic organizer that explains: What are plastics made from? Why are they not decomposable? What is the trend of plastic use? What can we do to solve the plastic problem?

**Formative Task B: Introduction to density:** students explore the concept of density by comparing different blocks of similar volume but different mass.

**Formative Task C: Density, Salinity and Temperature Lab:** Students explain how density, salinity and temperature affect the global ocean currents and the movement of plastic worldwide. The first lab investigates how temperature affects the density of the water. The second investigates how salinity affects the density of the water. The third lab investigates how temperature and salinity affect the density of water which models how the layers form in the ocean.

**Formative Task D:** Students watch the video: Plastic in the Galapagos and take notes. Students apply what they learned in the lab to explain how plastic from around the world arrives on the beaches of the Galapagos.

Teachers may implement Task B with the following procedures.

**Introduction to Density Part 1:**

1. Teacher draws four boxes on the board, three the same size and one larger.
2. Use an analogy about population density, because students can relate to that. For the three similar sized boxes, compare the three locations with different population density, for example Oahu, Manilla and Maui. Draw symbols in the box that represents the density of the population (Oahu (10 stars) Manilla (20 stars) and Maui (2 stars)).
3. The large box is a very rural place, where very few people for example the island of Hawaii (2 stars)
4. Assign the three smaller boxes a volume of 1 and the larger box a volume of 2.
5. Give the students the equation to find density and tell them if the population was equal to the mass of each box then what would the density of each box be?
6. Students complete the worksheet comparing the squares drawn on their paper.
Introduction to Density Part 2:

1. Give each student pair a beaker half full of water and a set of density blocks. Have the students explore the densities of the different blocks that have the same volume but different masses.
2. Students groups work through the worksheet comparing a wood block and a metal block.
3. Question #3 of Part two asks students to GENTLY place the metal block into the beaker of water, model this so the beakers do not break.
4. Lastly provide the students with a piece of plastic collected earlier in this unit. Have them compare the density of the plastic to the water and explain how that can influence the plastic reaching the shores of Hawaii.

Labs: The effect of temperature and salinity on the density of water.

These labs are broken into 3 different labs. They build upon each other, scaffolding the students’ ability to explain the relationships between density, temperature, salinity and the movement of water. Instructions and materials are included in the links in the featured sources.

Scaffolds and other materials may be used to support students as they work with sources. This learning segment on density and how temperature and salinity cause fluids to move is a hands-on exploration which has scaffolding already built in. Students are approaching these concepts through a variety of modeling and exploration which provide visual and tactile representations. Students learn the vocabulary of volume, mass, salinity, density and global conveyor belt as they are interacting with these concepts.

The following sources were selected to provide students with hands-on exploration of why plastic is so hard to eliminate and how plastic reaches beaches throughout the world due to the global conveyor belt.

- **Featured Source A** is a video *Plastic 101* that can be taught through a think aloud process.
- **Featured Source B** is an *introduction to density* that is used with *density blocks*
- **Featured Source C** is a *lab on the effects of temperature and salinity on density*: Understanding how the ocean currents work.
- **Featured Source D** is a video *Plastic in the Galapagos* that asks students to apply what they learned in the lab to explain how plastic from around the world arrives on the beaches of the Galapagos.

NGSS Practice addressed in this investigation: *Planning and carrying out investigations and Obtaining, evaluating and communicating Information*
Supporting Question 3

The third supporting question, “How are communities, the government and individuals taking action to address the plastic problem?” asks students to identify what governments, communities and individuals are currently doing to address the plastic problem. The formative assessment tasks ask students to identify actions taken by different sectors of society to address the problem.

**Formative Task A:** (Station 1) students read excerpts from the Hawai‘i state constitution and Maui county laws that address actions or the responsibility of government to address the plastic problem

**Formative Task B:** Students watch videos and read short articles of business and community members who are taking action to address the plastic problem by using recycled polyester from marine debris, redesigning items to reduce the use of plastic and design machines to address the plastics that are in the ocean.

**Formative Task C:** Students conduct a plastic journal in which they record all plastic items that they use in a 24-hour period. They reflect on their plastic use and determine what actions they could take in their daily lives to address the plastic problem.

**Formative Task D:** Students explore the deeper meaning of Mālama ʻĀina and the action that is required to make this a practice. It is not just a nice phrase to say, it is an action that requires the kānaka to take action for the welfare of the group. Students reflect on the actions taken by the government, community and themselves and determine how we are doing mālama ʻāina and how we can improve.

Scaffolds and other materials may be used to support students as they work with the different readings. Choose reading that is grade level appropriate.

The following sources were selected to provide examples of actions that are taken by the different sectors of society.

- **Featured Source A** are excerpts from the Hawai‘i State Constitution and Single Use Plastic Ban in Maui County older articles include: Plastic Bag Ban.
- **Featured Source B** are examples of the public sector of society that are redesigning items to reduce plastic use. Adidas shoes use marine debris in place of new plastic, A teenager invented The Ocean Cleanup to address the problem and an engineer redesigned styrofoam by using mycelium and NOAA cleaning plastic from uninhabited beaches in Papahānaumokuākea.
- **Featured Source C:** is an Individual Journal: How do I use plastic in a 24-hour period?
- **Featured Source D:** Mālama ʻĀina reflection.

NGSS Practice addressed in this investigation: Analyze and Interpret Data and Asking Questions
Supporting Question 4

The fourth supporting question, “How can we apply scientific principles to design solutions to the plastic problem?” asks students to design a solution to the plastic problem by addressing a classmate's concerns through a design thinking process. Working in small groups of about four, students interview one of their classmates to determine how they feel, think, and use plastic. In their small groups, students identify the chief complaint their classmate has about plastic and design four different solutions to the problem.

Design Thinking

Formative Task A: Students do a 15-minute free write on the impacts of plastic. This will provide students time to think and articulate their ideas prior to being interviewed.

Formative Task B: Students break into groups of 4-5 and select roles (1 interviewer, 1 interviewee and 2-3 note takers.) Students take time to develop questions they want to ask. They can use questions from the free write. The student that is being interviewed goes to another group to be interviewed. The other three people remain to interview a classmate from another group and write down all of the interviewee’s responses, one sticky note per response.

Formative Task C: The original group of 4-5 students, organize the responses into a graphic organizer. They identify what their classmate thinks and feels about plastic, how they use plastic and their major concerns about plastic. They look for what the student brought up the most to design a “How might we” statement.

Formative Task D: As a group, students brainstorm ideas to solve the problem identified in the “How might we” statement, and each student designs their own unique solution to their classmate’s problem. The goal is to create solutions that will evoke change in the use of plastic, in redesigning a product or a system that uses a lot of plastic, or a mechanism to clean plastic debris. Solutions must use scientific principles.

Teachers may implement this task with the following procedures

The scaffolds are embedded into the lesson through graphic organizers and the free writing. If one group has a lot of EL students, the teacher can help take notes during the interview for that group.

The following sources were selected to scaffold the design thinking process and to make students agents of change, designing solutions to the impact plastic has on the environment in Hawai‘i.

Featured Source A is a free write on the plastic problem to allow students to get their ideas about the plastic problem down on paper.

Feathered Source B is interviewing a classmate on their thoughts, feelings, ideas, about the plastic problem.

Featured Source C: Organizing the “client’s” communication into the graphic organizer to understand their chief complaint and what the students should be designing for. In a small group students will ideate or brainstorm ideas on how to address the problem.
**Featured Source D:** Individually design a prototype for the solution to the plastic problem that addresses the classmates concerns and implements scientific practices that they have learned in the unit.

NGSS Practice addressed in this investigation: *Asking questions (for science) and defining problems (for engineering) and Constructing explanations (for science) and designing solutions (for engineering)*
Summative Performance Task

At this point in the inquiry, students have examined the impact that plastic has on the environment through a variety of lenses. They have experienced the impacts at the beaches in their own community, investigated how plastic comes to remote islands from all over the world, and seen examples of peoples who are taking action to redesign products and clean plastics. Students are embarking on their own design projects in which they design solutions to their classmates’ concerns about plastic.

Students should be expected to demonstrate the breadth of their understanding and their abilities to use evidence from multiple sources and scientific reasoning to support their claims. In this task, students will write an argument using evidence and reasoning from this unit to argue if we have the power to solve the plastic problem.

Students’ arguments will likely vary, but could include any of the following:
- We do have the power with evidence and reasoning to support
- We do not have the power with evidence and reasoning to support
- We do have the power, but all of the people are not in agreement to take action with evidence and reasoning to support.

To support students in their writing they are allowed to use their notes to develop well supported arguments.

Taking Informed Action:

Students will take informed action by constructing prototypes of their design created in supporting lesson #4. Students will test their project and reflect how they can better improve it. This is an open-ended activity that is driven by students’ creativity. If they are solving a problem at the school, they will present it to the administration. Students will share their design in a gallery walk which allows them to share their projects with classmates one on one. If possible, invite community members that are working to address the impact plastic has on the environment and government workers to hear the solutions that are coming from our haumāna.

NGSS Practice addressed in this investigation: Engaging in argument from evidence and Constructing explanations (for science) and designing solutions (for engineering)