

## High School Marine Debris Lesson 3 – Making it Disappear

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**Summary:** In this lesson students will use creativity, engineering skills, and knowledge of the scientific process to create a solution for removing existing plastics from the oceans and beaches. Students will also design their own methods of experimentation to produce reliable results for determining the success of their invention.

### Instructional Objectives:

1. Students will be able to correctly identify and use independent, dependent, and control variables to plan and carry out a reliable and fair experiment.
2. Students will collect and analyze personal data.
3. Students will draw conclusions and make recommendations based on collected data.
4. Students will be able to discuss the economic impacts of marine debris removal.

### Ocean Literacy Principles:

<http://oceanliteracy.wp2.coexploration.org/ocean-literacy-framework/>

1. The Earth has one big ocean with many features.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.

### National Science Standards

High School Life Science

- [Matter and Energy in Organisms and Ecosystems](#)
- [Interdependent Relationships in Ecosystems](#)

High School Earth and Space Science

- [Earth's Systems](#)
- [Human Sustainability](#)

High School Engineering Design

- [Engineering Design](#)

### AP Environmental Objectives:

<http://media.collegeboard.com/digitalServices/pdf/ap/ap-environmental-science-course-description.pdf>

#### I. Earth Systems and Resources

C. Global Water Resources and Use

#### VI. Pollution

A. Pollution Types

3. Water pollution

B. Impacts on the Environment and Human Health

1. Hazards to human health

(Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)

2. Hazardous chemicals in the environment

(Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

**Background Information:**

The National Oceanic and Atmospheric Administration defines marine debris as “any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes”. According to the National Marine Debris Monitoring Program (NMDMP) about 49% of the debris is from land based sources and 18% from ocean sources. Marine debris poses many threats to humans and wildlife. Once in the environment, plastic can break down through abrasion, oxidation, and photodegradation by the sun. Plastics break down in to smaller pieces often referred to as micro-plastics. Often marine wildlife will ingest smaller pieces of plastics and microplastics that can ultimately lead to suffocation and or starvation of these organisms. Additionally, various chemical toxins are released from the plastics and can bio-accumulate within the bodies of organisms, including humans. For more information about ocean plastics and microplastics please visit the following websites <http://marinedebris.noaa.gov/info/plastic.html> and <http://marinedebris.noaa.gov/research/detecting-microplastics-marine-environment> .

While awareness of the marine debris issue is increasing and efforts to reduce the sources of marine debris are increasing in popularity in the United States, the issue of removing the plastics and micro-plastics from the ocean proves to be costly and time prohibitive, leaving the problem still largely unaddressed. This activity will ask students to use creativity, engineering skills, and knowledge of the scientific process to create a solution for removing existing plastics from the oceans and beaches.

**Time:**

2- 3, 50 minute class periods

**Materials:**

1. Class copies of article <http://www.hngn.com/articles/11969/20130909/teen-invents-ocean-clean-up-device-remove-1-3-plastic.html>
2. Experimentation Planning Sheet
3. For each group: 1 10 gallon fish tank (or similar container) filled  $\frac{3}{4}$  full with 40% salt water to represent the ocean, small pieces of plastic of plastics of varying composition (resin numbers 1-7). Each group should receive the same amount of water and plastics. *Note- Collecting plastics and cutting them into small pieces will need to be done in advance.*
4. Class materials for marine plastics removal- String, pipets, Dixie cups, plastics spoons, foil, weigh boats, straws, cotton pads, cotton balls, coffee filters, pipe cleaners, scissors, tape, duct tape, glue gun and glue, stockings, toothpicks, screens, buckets, play sand, electronic balance.
5. *Optional materials* – weighted packing peanuts to represent fish and other wildlife in the water column will add an additional level of complexity to designing a device that recovers the plastic pieces but not the wildlife.

**Procedure:**

Part 1- An Introduction

*Option – Before beginning the experimentation phase have students complete the Monterey Bay Aquarium Lab “Plastics in the Water Column” to explore the density and buoyancy of different plastics.*

1. Have students read the article <http://www.hngn.com/articles/11969/20130909/teen-invents-ocean-clean-up-device-remove-1-3-plastic.htm> and watch the associated video.
2. Independently have students write out several ideas or draw diagrams of devices and techniques they think could remove plastics from the water column in the ocean.

## Part 2 – Research and Development

3. Give students a list of available class materials they will be able to use in the experimentation phase of the lesson. In groups of 2 or 3 have students share their ideas to design a plastic removal method that could be used to remove plastics from the water column.
4. Give each group of students a tank with simulated ocean water and allow students time to conduct some preliminary trials with the materials develop technique they are satisfied with. Students should complete the **Micro-plastics Removal Student Research and Development Notes sheet** as they complete this phase of the lesson.

## Part 3 - Experimentation

5. Once students have come up with a satisfactory design have students design an experiment and data tables to determine the effectiveness of their plastic removal device or technique. Students should complete the **Experimentation Planning Sheet**.
6. Once students are satisfied with their method design and experimentation procedure they may conduct their experiment to determine the effectiveness of their method.

## Part 4 – Competition

7. Once students have conducted their experiments and refined their plastic removal method, host a competition among the students to see 1- who can remove the most amount of plastics from the water, and 2 – who can remove the most plastic in the shortest time. Give awards for students who win.
8. Once the trials and competition are complete have the students decide which technique is the most efficient at collecting marine debris. Students should reflect on why one device is better than the others using data to support their answers.

## Possible Extensions:

1. EXTENSION: Give students a budget and price each of the materials available for creating the plastics removal technique. Students must not only create an efficient and effective plastics removal technique, but must also stay within a budget.
2. EXTENSION: Repeat the activity or include in the activity designing a device that will remove the micro-plastics from sand also.
3. EXTENSION: Writing across the curriculum- Have students write a proposal for funding for the creation and use of their invention.
4. EXTENSION: One way to solve the issue with marine debris is to clean it up, but the best way is to prevent it from occurring. Have students create and implement a plan for your school or community that will educate citizens about marine debris sources and what can be done to prevent the introduction of potential marine debris into the environment.

## Micro-plastics Removal Student Research and Development Notes

Team member names \_\_\_\_\_

1. Provide a summary of the technique and/or drawing of the device created to remove the plastics from the water.

2. As you experiment with your technique and device take notes on how well it collects plastics and changes that need to be made to create the most efficient removal method.

Trial	Changes made to design	Mass of plastics removed	Observations/notes of removal technique
1			
2			
3			
4			

3. After you have conducted your research and development phase summarize what worked and did not work about your plastics removal technique and the process of developing a technique for removing plastics. Some questions to answer are: 1- What problems were encountered trying to remove the plastics with your technique? 2- What changes led to successful plastics removal? 3- Why is the research and development phase important in developing new techniques?



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3. Create the data table(s) needed for your experiment.

4. Is it possible to remove all plastics particles? What amount of plastics removal will be considered effective?

5. Once you have received verification from your teacher that your experimentation method is acceptable carry out your procedure to determine the effectiveness of your plastic removal method.

5. Conduct your own data analysis (must include data processing and graphs).

6. Based on your data analysis write a conclusion regarding the effectiveness of your plastic removal method. Be sure to determine what level of removal is considered effective.