

KEEPING OUR COASTLINES CLEAN

A U.S. Virgin Islands
Marine Debris Curriculum





Old City Mangrove Lagoon, St. James, and Compass Point
Marine Reserves and Wildlife Sanctuaries

SOLUTIONS

Links to the Next Generation Science Standards, Quick Reference Guide

| Curricula by Sub-Section | | Middle School | | | | | | High School | | | | | Sci & Engineering Practices |
|-------------------------------------|---------------------------------------|---------------|---------|---------|---------|---------|---------|-------------|---------|---------|---------|---------|-----------------------------|
| | | ESS 3-1 | ESS 3-2 | ESS 3-3 | ESS 3-4 | ETS 1-1 | ETS 1-2 | ESS 3-1 | ESS 3-3 | ESS 3-4 | ETS 1-1 | ETS 1-2 | |
| Composition & Abundance | Beach Box Exploration | | | ✓ | | | | | | | | | ✓ |
| | Investigating Oceanic Garbage Patches | | | ✓ | | | | | ✓ | | | | ✓ |
| | A Degrading Experience | | | ✓ | | | | | ✓ | | | | ✓ |
| Sources & Transportation | Watershed Walk | ✓ | | ✓ | | | | ✓ | | | | | ✓ |
| | Sources of Microplastics: Microbeads | | | ✓ | | | | | | | | | ✓ |
| Impacts | Entanglement Problems | | | ✓ | ✓ | | | | ✓ | ✓ | | | ✓ |
| | Natural Disasters and Marine Debris | | ✓ | ✓ | ✓ | | | ✓ | | | | | ✓ |
| Solutions | Linked Beach-Ghut Clean Ups | ✓ | | ✓ | | | | | ✓ | | | | ✓ |
| | Mitigating Microplastics | | | ✓ | | | | | ✓ | | | | ✓ |
| | Upcycling Plastic Bags | | | | | ✓ | ✓ | | | | ✓ | ✓ | |
| | Making Connections Through Art | | | ✓ | | | | | ✓ | | | | ✓ |

LESSON: Mitigating Microplastics

This lesson was inspired by Oregon Sea Grant's "Mitigating Microplastics" lesson from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum. It is used with their permission (<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/mitigatingmicroplasticscurriculum.pdf>).

Grade Levels: 5-12

Subject Areas: Marine Biology: Debris Sources, Ecology

NGSS Connections:

- MS-ESS3-3:
 - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
 - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
 - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
 - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- HS-ESS3-4:
 - ESS3.C: Human Impacts on Earth Systems - Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
 - ETS1.B: Developing Possible Solutions - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (*secondary*)
- Appendix F: Science & Engineering Practices

Time: 60 min + implementation time

Description & Objectives: Use scientific data to craft a way to reduce microplastics. Students will talk about the costs and benefits of their solutions to the marine environment and the people who use it.

Guiding Questions:

- What are microplastics?
- How are microplastics made?
- What are ways we can reduce microplastics?

Key Ideas & Concepts:

- Marine debris is any persistent solid material manufactured or processed and then disposed of or abandoned in the marine environment.
- Microplastics come from personal care products, laundry lint, or from larger plastics that degrade and break up into smaller pieces.
- Microplastics are any plastic marine debris that is less than 5 millimeters and larger than 1 nanometer.

Pre-Requisite Skills: Students will need to have an understanding of microplastics, what makes up plastics and some ideas about preventing marine debris.

Teacher Preparation:

- Inside 4-5 folders write the questions: What's the problem with microplastics? Can we stop using plastic? Why or why not? Do you think plastics are good or bad? Why? How does plastic affect the ocean? Do you think we can clean up all the plastic in the ocean? Why or why not?
- Put students in groups of 2-4 (this may vary depending on the project). Make copies of Student Solutions Guide pages (included at the end of this lesson) for each group of students, and place each set in a folder for easier distribution. Make copies of "Designing Solutions to Microplastics: Graphic Organizer", for each student (included at the end of this lesson).

Materials Needed:

- Notebooks
- Folders/large paper
- Markers/crayons/colored pencils
- Chart paper
- Folders with printed "Student Solutions Guide" and "Designing Solutions to Microplastics: Graphic Organizer" (1 for each student)

Teacher Instructions:

Define the problem:

1. Place the folders with questions open around the room.
2. Tell the students that there are five folders around the room with discussion questions. They are going to have a silent discussion (similar to a silent auction) about microplastics. Take a pencil and respond to the question on the folder. If someone else has already responded, write a response to that person or write a separate thought. Make sure to read everything before choosing how to respond.

3. Have your students circulate around the room, responding to the question or a comment made by another student. Give students 3-4 minutes at each question, depending on their pace.
 - **Teacher Note:** *If you prefer students to discuss, each group can discuss aloud before writing on the folder.*
4. Give students time to revisit their first station and read the responses, then debrief with the class.
 - **Guiding questions:** What surprised you? Is plastic in the ocean an easy problem to solve? What makes it easy or difficult? Why is it important to discuss issues like microplastics with people who have different opinions? How do you feel about this problem?

Group solution project design:

1. Next, give each group the “Student Solutions Guide” folders with existing projects and actions people have taken to reduce microplastics in the ocean. (Feel free to mix up the groups at this point).
2. Challenge the groups to develop a solution to the problem of microplastics. Remind students that every individual, no matter their age, is able to make a change in their environment, and your actions regarding plastics can contribute to or reduce the amount of microplastics in the environment.
3. In their groups, have the students review some solutions from the folders, and then come up with their own ideas to reduce microplastics. It is important that the solutions that the group develops are effective and that you are able to actually make this change (e.g., building a machine to clean up the gyre may not be feasible for this project). Teachers are encouraged to help students choose projects that are feasible but ambitious.
 - Students can use the “Designing Solutions to Microplastics: Graphic Organizer” (included at the end of this lesson) to guide their conversation about a feasible, actionable solution to microplastics.
 - Students should discuss each section of the graphic organizer, and each student writes the group’s thoughts in his or her notebook.
4. Have students create a presentation for their solution and explain it to the other groups.
 - **Teacher Notes:**
 - Presentations can be formal or informal, depending on the amount of time you have to spend on this lesson
 - Students can give feedback on each other’s ideas.
5. Optional extension: Have your students implement their ideas, or choose one idea to implement as a group! The solutions can be implemented within the classroom or community. This can be done in a variety of ways, depending on your school. The implementation phase gives students a sense of empowerment around the issue of microplastics, which can seem daunting. Building community, promoting awareness, and taking concrete actions help students think about their world differently.

Debrief: Have a discussion with your students when they are done sharing their project ideas.

- **Guided questions:** What are some challenges in designing a solution to microplastics? What were the challenges in implementing your solution? What was easy about it? What was challenging? Why do you think it’s important to think about issues like microplastics?

Additional activities for grades 9-12: Have your students research how microplastics are being replaced with natural alternatives or removed around the world. Have them determine if any of these methods are feasible in the U.S. Virgin Islands. If they are not currently feasible, have students research what would need to be done to make these methods a reality in the territory.

- Students can present their findings to their classmates and other classes. This could be a good project to team up with a class in a different content area. Have your marine science students work with chemistry and business students to determine what would need to be done to have the mitigation methods become a reality.

Teacher Note: For inspiring stories of local solutions to marine debris read the Spotlight: Community Transfer Projects: Turning New Knowledge into Action at the Local Level in the U.S. Virgin Islands, and the five associated spotlights.



Designing Solutions to Microplastics: Graphic Organizer

Use the graphic organizer below to help you develop a possible solution to microplastics. Think about the plans costs and benefits as well as it's feasibility (if it's possible).

| The Problem | | |
|--|--|--|
| <i>What are microplastics?</i> | <i>How do microplastics get in the ocean?</i> | <i>What is the problem with microplastics?</i> |
| Our Solution | | |
| <i>What solution did your group decide on?</i> | <i>What made you decide on this solution?</i> | |
| Evidence to Support our Solution | | |
| <i>What evidence supports your solution?</i> | <i>What evidence does not support your solution?</i> | |
| Costs and Benefits | | |
| <i>Costs of your solution:</i> | <i>Benefits of your solution:</i> | |

Student Solutions Guide

Glossary

- Dilute – Less concentrated because water has been added to it
- Degradation – The process of objects breaking down; in the case of microplastics, by UV waves (photodegradation)
- Ecosystem – All the living organisms and non-living things in an environment
- Estuary – An area where freshwater and salt water mix
- Fragment – To break down into smaller pieces Impacts – The effects of something, either positive or negative
- Manta trawl – A net with floats and a bottle at the end to capture small particles at the surface of the ocean
- Marine Debris – Any trash or other solid material that ends up in the ocean or the Great Lakes without a purpose
- Microbes – Tiny organisms that live everywhere on Earth
- Microbeads – Tiny plastic particles added to many types of personal care products
- Microplastics – Plastic marine debris that is less than 5 mm
- Nurdles – Small, pre-manufacture plastic pellets
- Plastic – Manufactured long chains of hydrocarbons, often derived from natural gas or petroleum
- Polyethylene – The most common type of plastics, with a wide variety of uses, including packaging, shopping bags, and clothes
- Prey – An animal that is eaten for food
- Organism – A living animal, plant, or single-celled creature
- Sink – Where something ends up
- Surface Area – The area of the outermost layer of an object
- Toxin – Poisonous substance
- Weathering – Mechanical weathering is the process of breaking down materials into smaller piece

Solution: Individual Actions

Recycling, placing waste in the proper place, and using reusable bags are all examples of actions people can take to reduce the amount of plastic entering rivers and the ocean. These are not the only possible actions!

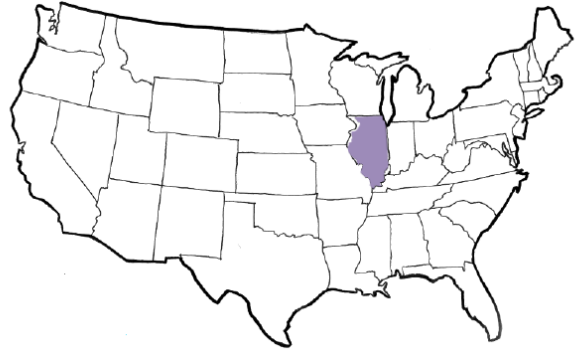
Things to think about:

- What other things can individuals do to reduce the amount of plastic entering the ocean?
- Will individual actions make a difference?
- What are you already doing to reduce the amount of plastic entering the ocean?
- How can you use individual actions to start bigger group actions?

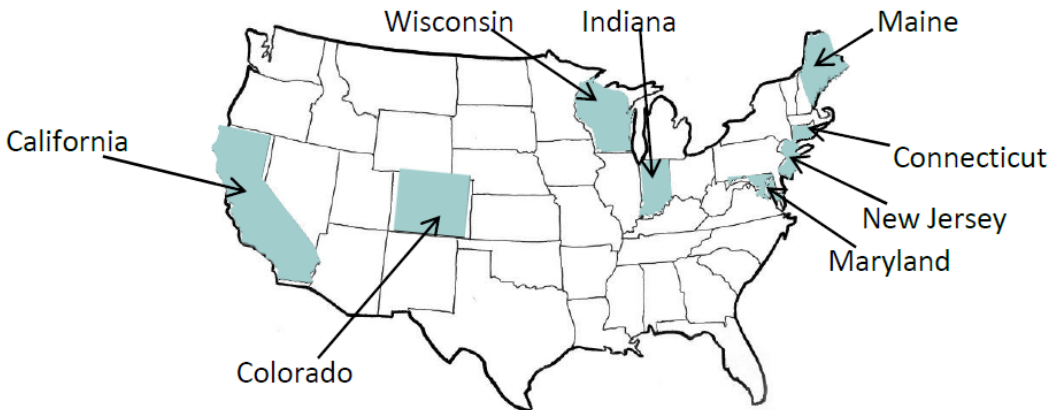
Solution: Making Laws

A possible solution to microplastics is to make laws that stop companies from making and selling microplastics. If we don't use them, they won't go into the ocean, right?

In June 2014, Illinois was the first state to pass a law banning the manufacture and sale of microbeads in personal care products (face wash, soaps, etc.).



These states have also passed laws that restrict products with microplastics.



President Obama Signs *Microbead-Free Waters Act of 2015*

December 28, 2015

Washington D.C. – A federal law was passed and signed by President Obama that bans the production and sale of personal care products with plastic microbeads. Some personal care products, such as toothpaste and face wash, have plastic microbeads that can go down the drain and into the ocean. Scientists are not sure how these small plastic beads affect the ocean environment. To stop more plastic from entering the ocean, Congress decided to ban personal care products with microbeads, starting in 2017. Nobody will be allowed to make or sell personal care products with microbeads anywhere in the United States.

Things to think about:

- How will this help the problem with microplastics?
- How can students help with this?
- Why is it important for many people to work together to stop microplastics from entering the ocean?

Solution: Education

From the Field



Photo Credit: Marcus Eriksen

Name: Marcus Eriksen

Career: Director of Research and Co-founder of 5 Gyres, an organization that works to end plastic pollution in the ocean. They study marine debris, educate people about the issue, and work with people making laws.

Education: PhD in science education from the University of Southern California

Research: Marine debris

Notes: In 2014, Marcus was part of a team that published a paper about the amount of plastic in the ocean. They estimated that there were more than 5 trillion pieces of plastic floating in our ocean! Marcus says a big part of his job is “myth-busting.” Many people think there is a big garbage patch floating in the ocean, but Marcus has said it’s more like “plastic smog.” As with air pollution, it’s a difficult task to clean up plastic in the ocean. That means that we will have to work together to come up with creative solutions to plastic marine debris. 5 Gyres works to stop marine debris through educating students, decision-makers, and people who can help reduce marine debris (that’s everyone!). Marcus feels that his job is rewarding, and that working to prevent marine debris is the right thing to do.

Advice:

1. Explore your core values to find what is important to you
2. Be part of a team
3. Commit to your cause

Things to think about:

- Why is it important to work as part of a team?
- How can you get people to understand microplastics?
- What is the most important thing people need to know about microplastics?