9-12 Litter-free: Human Impact is Key

South Carolina Aquarium

Overview

Focus Questions
What impacts do ocean plastics have on animals? How do macroplastics lead to microplastics? What are some lifestyle changes that could be made to reduce our litter, waste and overall ecological footprint?

Activity Synopsis
Students will participate in a scientific investigation in which they read a case study about why animals might ingest ocean plastics. They will then differentiate between macroplastics and microplastics. Students will read a second case study about microplastics affecting coastal South Carolina. They will discuss the impact microplastics may have on our food. Students will hypothesize what will be the most common micro- or macroplastic collected around their school, record data from their collection, graph data to analyze, and generate solutions to litter pollution and their own ecological footprint.

Time Frame
1.5 - 2 hours

Objectives
The learner will be able to:

- Determine why marine animals may ingest ocean plastic
- Conceptualize how macroplastic litter leads to microplastics in our water sources
- Explain the trophic levels of a food chain
- Define the different between bioaccumulation and biomagnification
- Make a personal connection to microplastics impacting a South Carolina beach through a case study
- Understand the impact microplastics may have on our seafood
- Hypothesize what is the most common macroplastic or microplastic found in their school area or community
- Collect litter or sample microplastics as a team to investigate their hypothesizes
- Sort and group litter or microplastics to record their data quantitatively
- Graph data collected
- Generate solutions to litter pollution
- Communicate ways to reduce their ecological footprint to their school, neighborhood, or community

Student Key Terms

- Absorption
- Bioaccumulation
- Biomagnification
- Citizen science
- Ecological footprint
- Hypothesis
- Microplastic
- Macroplastic

Teacher Key Terms

- Exfoliants
- Nurdles
- Quantitative data

Standards

South Carolina College- and Career-Ready Science Standards 2021

Biology: B-LS2-2, B-LS2-6, **B-LS2-7, B-LS4-6**
Earth and Space Science: E-ESS3-4

*** Bold standards are the main standards addressed in this activity**

2014 Academic Standards and Performance Indicators for Science

Biology: H.B.1A.1, **H.B.1A.2**, **H.B.1A.3**, **H.B.1A.4**, H.B.1A.5, H.B.1A.6, **H.B.1A.7**, **H.B.1A.8**, **H.B.6C.1**, **H.B.6D.1**

*** Bold standards are the main standards addressed in this activity**

South Carolina College- and Career-Ready Science Standards 2021

Biology Performance Expectations
B-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
B-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem.
B-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
B-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Earth and Space Science Performance Expectations
E-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

2014 Academic Standards and Performance Indicators for Science

High School Biology Performance Indicators
H.B.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims.
H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
H.B.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses based on credible scientific information, (2) identify materials, procedures, and variables, (3) use appropriate laboratory equipment, technology, and techniques to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.
H.B.1A.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.
H.B.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, and (3) use grade-level appropriate statistics to analyze data.
H.B.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
H.B.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.
H.B.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

H.B.6C.1 Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
H.B.6D.1 Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

Next Generation Science Standards
HS-LS2-2, HS-LS2-7

Cross Curricular Standards

South Carolina College and Career Standards for Math
Probability and Statistics - Interpreting Data – PS.SPID.1, PS.SPID.3

South Carolina College and Career Standards for ELA
Inquiry-Based Literacy Standards (I) –
E1-1.1, E1-2.1, E1-3.1, E1-3.2, E1-3.4, E1-4.1, E1-4.3
E2-1.1, E2-2.1, E2-3.1, E2-3.2, E2-3.4, E2-4.1, E2-4.3
E3-1.1, E3-2.1, E3-3.1, E3-3.2, E3-3.4, E3-4.1, E3-4.3
E4-1.1, E4-2.1, E4-3.1, E4-3.2, E4-3.4, E4-4.1, E4-4.3

Reading Informational Text - Meaning and Content (MC) – E1-5.1, E2-5.1, E3-5.1, E4-5.1

Communication-Meaning and Context (MC) –
E1-1.1, E1-1.2, E1-1.4**,** E1-3.1
E2-1.1, E2-1.2, E2-1.4**,** E2-3.1
E3-1.1, E3-1.2, E3-1.4**,** E3-3.1
E4-1.1, E4-1.2, E4-1.4**,** E4-3.1

Background

Key Points
Key Points will give you the main information you need to teach the activity.

- **Litter** is trash, debris, and other items discarded in places they don't belong, such as roadsides, waterways or parks.
- **Macroplastics** are plastic pieces that are over five millimeters in size.
- The majority of ocean plastic comes from land. Once it is in the ocean it provides a surface for bacteria, algae, and other microorganisms to grow. This could help explain why marine animals are ingesting ocean plastic.
- Plastics act like sponges and can **absorb** toxins from the surrounding water.
- **Microplastics** are small plastic pieces less than five millimeters in size.
- Microplastic litter comes from an assortment of sources including macroplastics, which degrade into smaller and smaller pieces. Another source is microbeads, very tiny pieces of manufactured polyethylene plastic that are added as **exfoliants** to health and beauty products. **Nurdles**, manufactured plastic pellets used to create plastic products, can also be found as a source of litter.
- A trophic level is an organism's position in its food chain in relation to acquiring energy. The trophic levels are producer, primary consumer, secondary consumer and tertiary consumer.
- **Bioaccumulation** is when an individual animal's pollutant concentration increases over time.
- **Biomagnification** is when pollutant concentrations increase as they are passed up the food chain.
- The South Carolina Aquarium is leading the way to empower citizens to make a positive impact while generating scientifically useful data available to the general community and scientific community though its **citizen science** project, Litter-free Digital Journal.
- The goal of the Litter-free Digital Journal is to promote collaborative solutions by removing and tracking litter, plastics specifically, from habitats throughout South Carolina. Students can clean up an environment and be part of the solution.

- An **ecological footprint** is the impact a person or a community has on the land around it. It is usually looked at in terms of how much land it would take to sustain their use of the land's natural resources.

Detailed Information
Detailed Information gives more in-depth background to increase your knowledge, in case you want to expand the activity or you are asked detailed questions.

Litter is trash, debris, and other items discarded in places they don't belong, such as roadsides, waterways or parks. Deliberately throwing items on the ground or leaving items outside of a trash bin is littering. Sometimes it can be accidental, such as materials being blown out of a trash can or truck bed.

According to the 2009 KAB National Litter Survey Study, the most common roadside litter articles include tobacco products, unclassified trash, miscellaneous paper, packaging, miscellaneous plastic, and beverage containers. The study also found that the quantity of plastic litter observed has increased over the past 40 years. In fact, over 300 million tons of plastic are made every year. Plastic does not degrade or does so slowly with time. Also, being lightweight, plastics tend to be transported by wind and water to other locations, which adds to a growing marine debris issue (trash in the ocean). According to a 2014 review of scientific literature conducted by the IUCN, at least 8 million tons of plastic end up in our ocean every year and plastic makes up around 80% of all marine debris found in the ocean.

Macroplastics are pieces of plastic that are larger than 5 mm. These include the plastic products such as water bottles, straws, bags, etc. However, because plastic does not degrade, or does so slowly, the large plastic waste that ends up in our water ways and oceans degrades into smaller and smaller pieces. If in the ocean or another body of water, macroplastics can eventually turn into **microplastics**, classified as plastics that are less than 5mm long**.** Most microplastics come from the degradation of plastic products into smaller fragments these are known as secondary microplastics. This breakdown can be a result of UV exposure, wave or wind energy, heat, and/or animal grazing. An example from closer to home can be found in our washing machines. When we wash synthetic fabrics they release microfibers that can eventually head into our waterways. Primary microplastics are purposefully manufactured as small beads, pellets, or fragments. One example is the tiny pieces of manufactured polyethylene plastic that are added as **exfoliants** to health and beauty products, known as microbeads. Microbeads can easily pass through water filtration systems and end up in our waterways and ocean. A second example is **nurdles**. Nurdles are manufactured plastic pellets used to create plastic products. These can enter an ecosystem when there is an accident in transport (vehicle or boat).

Most plastic enters the ocean from the land, with more than half being single-use plastics. These contaminants pose a potential threat to aquatic life through entanglement or as mistaken food. Plastic that has been in the ocean for a few weeks starts to develop a "living film." This film is made up of bacteria, algae, and other microorganisms. A research team at the University of North Carolina discovered that this film causes ocean plastic to smell like food to sea turtles. The researchers suggested that this might help explain the amount of plastic that has been seen in marine animals. However, as the plastic degrades into microplastics, they pose even more threats lower down on the food chain as smaller marine organisms mistake microplastics as food.

When plastic breaks down, it can release toxins into the environment that are trapped inside from the plastic manufacturing process. These could include bisphenol A (BPA), styrene, and phthalates. Plastics also act as a sponge in the environment **absorbing** and concentrating the both natural and human-made toxins that are present in the water.

Despite research being conducted, there's still much we don't know about the potential negative impact microplastics pose on the oceans, wildlife and humans. One way this impact is being studied is by looking at food chains and trophic levels. The food chain looks at how energy moves from one organism to another. The producers, plants, are the first trophic level, getting their energy from the sun. Next are the primary consumer that consume the producer for energy. Next the secondary consumers, who eat the primary consumers, sometimes followed by the tertiary consumer. Most food chains have 3-5 levels of passing energy. The animal at the top of a food chain is called the apex consumer. Unfortunately, microplastics in the ocean are available for ingestion by a wide range of

animals in the aquatic food web, which humans have the potential to eat as apex consumers. It is estimated that approximately 90% of the plastics in the open ocean marine environment are microplastics. This is worrisome as microplastics have been shown to bioaccumulate in an organism and biomagnify across the food web. **Bioaccumulation** refers to an individual animals whose pollutant concentration increases over time. An example would be a fish's toxin concentration increasing over time as it continues to eat contaminated krill. **Biomagnification** refers to the food chain as a whole. The pollutant magnifies in strength as it climbs the food chain. Therefore, the apex or top, consumer of the food chain would carry the heaviest pollutant load because all the toxins from its prey's prey are combined within the apex consumer.

Solutions to plastic litter include citizen science, reducing and reusing waste as well as recycling when reducing and reusing is not an option.

Citizen Science

Defined by the Oxford Dictionary, **citizen science** is the collection and analysis of data relating to the natural world by members of the general public. Citizen science occurs when ordinary people help to conduct real scientific research. People can share and contribute to data monitoring and collection programs, usually as a volunteer. Participants have varying degrees of expertise. Modern technology makes citizen science accessible to anyone interested in participating, however, the success of the project depends on the creation of a well-devised monitoring program and participant dedication.

Many citizen-science projects have a national or local focus. Some projects are created by scientists, who need widespread data with the help of public observation. There are also projects community-based groups organized to generate ideas and involve scientists for advice and coordination. One of the oldest examples of citizen science in the National Audubon Society's Christmas Bird Count, which began in 1900. From December 14-January 5, birder groups collect information about local bird populations, which can be used for conservation efforts.

The South Carolina Aquarium has a citizen science application and an Anecdata website called the Litter-free Digital Journal for collecting trash data from the people of South Carolina. Community members are urged to collect trash from the environment and log the data on the app. Data is placed into categories and pictures can be downloaded as well as the location in South Carolina. This data is being used to change policy. Folly Beach and Mt. Pleasant, SC are two towns who have already had plastic bag bans put into effect. Aquarium staff have been a part of that change using the data from the app. It's an exciting time to see all people be able to make an impact to better the environment. Get your students involved as well through this activity!

Reduce and Reuse

The most effective way to prevent litter is to not create it in the first place. Reducing and reusing materials prevents new products from being made and transported. Americans generate over 4 pounds of trash every day, which mostly gets sorted into landfills. These landfills create the second largest source of human-related methane emissions in the country. Reducing and reusing also saves energy, saves money, prevents pollution caused by making new products, and allows products to be used to their fullest purpose.

Approximate Time it takes for Garbage to Decompose in the Environment:

*This data is from *The Educator's Guide to Marine Debris* from SC Sea Grant, DHEC, COSEE and NOAA. The decomposition rates may change over time due to more research. Go here for a printable poster http://www.scdhec.gov/HomeAndEnvironment/Docs/SC_MARINE_DEBRIS_POSTER.pdf

Garbage Item	Decomposition Time
Glass Bottle	Undetermined
Monofilament Fishing Line	600 years
Plastic Beverage Bottle	450 years
Disposable Diapers	450 years
Aluminum can	200 years
Foam plastic cup	50 years
Plastic bag	1-20 years
Waxed milk carton	3 months
Apple core	2 months

Newspaper	6 weeks
Paper towel	2-4 weeks

Plastic never fully biodegrades once it is in water. Instead, it breaks down into smaller and smaller pieces. Microplastics are pieces of plastic that are less than 5mm long. Macroplastics are pieces of plastic that are larger than 5 mm.
Different ways to reduce and reuse:

- Do not use single-use plastics, which include plastic bags, plastic water bottles, take-out containers, take-out cups, eating utensils and straws
- Use reusable products instead, such as a reusable shopping bag, thermos or reusable water bottle, reusable food containers, a personal cup, reusable eating utensils and just don't use a straw or use a stainless steel/reusable/paper straw
- Buy products that use less packaging. Buying in bulk can also reduce packaging and save money
- Borrow, rent, or share items used infrequently
- Maintain and repair products, so they aren't discarded frequently
- Buy used things, which are often less expensive and just as good as new

Recycle
When materials can't be reduced or reused, recycling is a great option. Recycling materials reduces the amount of waste sent to landfills. Natural resources are conserved by turning old products into new products, which prevents pollution by reducing the need to collect new raw materials. Recycling increases economic security by using a domestic source of resources, creating more jobs in manufacturing industries in the United States.

What can be recycled?

<u>Plastic</u>

- Water bottles
- Soda bottles
- Milk jugs
- Liquid containers
- Jars and tubs (yogurt, margarine tubs, etc.)
- Detergent and all-purpose cleaner bottles
- Soap and shampoo bottles
- Plastic cups

- Rigid plastic product packaging, such as clean rigid clamshell containers (Remove any plastic film or aluminum

Approximately 300 million tons of plastic is produced globally each year and only 10 percent of it recycled. An estimated 7 million tons of plastic that is trashed ends up in the ocean each year, where it breaks down into microplastics. The smaller the pieces, the easier they are to be swallowed by fish. Plastics are derived from natural, organic materials such as cellulose, coal, natural gas, salt and crude oil.

What do the symbols mean on the bottom of plastic bottles and containers? These symbols were created by plastic manufacturers to help people identify the kind of plastic resin used to make the container. This can help you determine if the container can be accepted by your local recycling program. Plastics #1-7 can be recycled in Charleston County, however plastic bags cannot be included into mainstream recycling bins, but instead must be taken to a store. Check with your county to see which plastics can be recycled.

Paper

- Magazines
- Newspapers
- Office paper
- Envelopes
- Junk mail/envelopes
- Greeting cards
- Catalogs
- Books/textbooks
- Coupons
- Posters
- Sticky notes
- Paper bags
- Wrapping paper

Paperboard and cardboard

- Corrugated cardboard boxes (flattened)
- Soda/beverage boxes
- Shoe boxes
- Gift boxes
- Clean food boxes (cereal boxes, microwave meals, boxes of rice, etc.)
- Paper towel rolls
- Paper egg cartons

Paper typically makes up a third of the trash produced each year in the United States. Recycled paper is used to make new paper products, which saves trees and other natural resources.

Glass

- Jars and caps (labels can be left on containers)
- Bottles and bottle caps (labels can be left on containers)

Glass can be recycled again and again and again. Making new glass from recycled glass is cheaper than using raw materials. Glass is made from a mixture of sand, lime and soda heated together, to form liquid glass. This liquid glass is made into sheets by cooling and flattening. To make objects like vases, craftsmen blow into a glob of liquid glass with the help of a long tube. Typically, at least a quarter of the glass discarded in the United States each year is recycled.

Aluminum and steel cans

- Aluminum cans and caps/lids
- Steel and tin cans
- Empty aerosol (spray) cans
- No foil or trays

Cans are made from aluminum and trace amounts of other metals, including magnesium, iron, and manganese. Aluminum is one of the only materials that can be recycled over and over again! There is no limit to the number of times you can recycle it, making it one of the most valuable recyclables.

Batteries

Look for in-store recycling bins or community collection events to dispose of batteries. According to the EPA, in 2014, about 258 million tons of municipal solid waste (MSW) was generated in the United States. Over 89 million tons of MSW were recycled and composted, equivalent to a 34.6 percent recycling rate.

Other: Plastic bags, ink cartridges, old phones, corks, etc.

There is some waste that can be recycled, but not through mainstream recycling. Materials in this category take more time and effort to be recycled. Lots of grocery stores have plastic bag recycling. Cell phone carriers and electronic stores typically recycle or even buy old phones and tablets. Ink cartridges can be recycled at office supply stores. Lots of health food stores recycle corks. Just looking up an alternative to throwing waste away can make a difference.

Composting

Compost is organic material, including food scrapes and yard waste, which can be added to soil to help plants grow. Making compost keeps these materials out of landfills where they take up space and release methane. The following can be composted:

- Fruits and vegetables
- Eggshells
- Coffee grounds and filters
- Tea bags
- Nut shells
- Shredded newspaper
- Cardboard
- Paper
- Yard trimmings
- Grass clippings
- Houseplants
- Hay and straw
- Leaves
- Sawdust
- Wood chips
- Cotton and Wool Rags
- Dryer and vacuum cleaner lint
- Hair and fur
- Fireplace ashes

How to do Backyard Composting:

- Select a dry, shady spot near a water source for your compost pile or bin.
- Add brown and green materials as they are collected, making sure larger pieces are chopped or shredded.
- Moisten dry materials as they are added.
- Once your compost pile is established, mix grass clippings and green waste into the pile and bury fruit and vegetable waste under 10 inches of compost material.
- When the material at the bottom is dark and rich in color, your compost is ready to use. This usually takes anywhere between two months to two years.

How to do Indoor Composting:

If you do not have space for an outdoor compost pile, you can compost materials indoors using a special type of bin, which you can buy at a local hardware store, gardening supplies store, or make yourself. A properly managed compost bin will not attract pests or rodents and will not smell bad. Your compost should be ready in two to five weeks.

How to make a Worm Bin: https://www.epa.gov/recycle/how-create-and-maintain-indoor-worm-composting-bin

More information: https://www.epa.gov/recycle/composting-home

Ecological Footprint

One way to look at how a person or community affects the earth is to look at its ecological footprint. An ecological footprint is the impact a person or a community has on the land around it. It can be looked at in terms of how much land it would take to sustain their use of the land's natural resources. Or, how many earths would it take if everyone lived their life like you. Things that are taken into consideration are the foods you eat (how much meat, how much is processed), your house (type, size, materials used to build), electricity (solar, low energy), trash produced (recycling, compost), vehicle use (how many per family, gas mileage, carpooling), travel (how much flying) and shopping (online, in store, products packaging).

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South Carolina Aquarium

It's important to remember that the life style choices we make effect the earth and we can make choice to help if we make a few changes to how we live. For example, we could carpool to work or school, eat less meat, buy local products and recycle. Visit this site to see how many earths it will take to sustain your ecological footprint https://www.footprintcalculator.org/

Procedure

Teacher preparation - Microplastics:

- If collecting from freshwater, prepare bags with 800 g of Salt for each group
- Create 0.25 x 0.25 m2 transects
- We would recommend collecting a sample earlier in the day and combining it with the salt and water and letting it settle prior to class.

Teacher preparation - Macroplastics: Here are the instructions for how to use the Litter-free Digital Journal app and website in order to input your student's data. Either and/or both data entries can be used depending on if you want to use your smart device or a computer. The website will allow for more options when looking at the data (graphing, lists, downloads,…). The app seems to work easiest for data entry.

To download the Litter-free Digital Journal app on your smart device:

- Search for South Carolina Aquarium in your App store on your smart device
- Open the SC Aquarium Citizen Science App in your App store and download it for free
- Create an account with your email and a password
- Click on the Litter-free Digital Journal
- Add a picture to your profile and include information about yourself if desired
- You are ready to input your student's data!

To use the Litter-free Digital Journal anecdata website:

- Go to: www.anecdata.org
- Set up an account (or use the same information if you set up an account on your smart device)
- You can use either the website or the app to input data.

Intro Materials:

- Intro Powerpoint
- Case Study 1
- Case Study 2
- Paper/poster (one per group)
- Colored pencils

Microplastics Lab (materials needed per group):

- Microplastic Report
- 0.25 x 0.25 m2 transects
- Ruler
- 800 g of salt (NaCl) if collecting from freshwater
- 4 L waters (from site)
- Large bucket
- Serving spoon/scoop
- Measuring beaker for up to 4 L
- Metal kitchen strainer (mesh approximately 1mm in size)
- Timer
- 500 mL glass jars (one for each group)
- 500 mL rinse bottes (one for each group)
- Dissecting scope

- Small petri dish or crystalizing dish with grid on the bottom
- Tweezers

Macroplastic Lab

- Litter Report
- IPad or smart phone to input data into Litter-free Digital Journal
- Gloves
- 2 Trash bags per group (1 color for trash and 1 color for recycling)

Intro Procedure

1. Begin the Intro PowerPoint. It introduces the concept of where plastics come from and the types of plastic.

2. Introduce Case Study 1. Read it aloud or have the students read it silently. Have a discussion about the impact of ocean plastics on marine animals, how it would affect the ecosystem, and how it could impact us.

3. Continue the PowerPoint to introduce students to the concept of microplastics and how they can absorb toxins from their environment. Remind students of food webs and trophic levels, and introduce the concepts of bioaccumulation and biomagnification. Bioaccumulation refers to the accumulation of toxic substances an organism ingests and accumulates at a faster rate than the organism can excrete. Bioaccumulation of plastics in sea organisms has an impact on the marine food chain, which has an impact on the seafood humans eat. Biomagnification is an increase in toxins as trophic level increases due to the ingestion of plants and animals that contain the toxins.

4. Introduce Case Study 2. Read it aloud or have the students read it silently. Have a discussion about the impact microplastics and macroplastics in the ocean may have on animals, the environment, and even themselves?

5. At this point, decide whether you class will take part in the microplastics lab or the macroplastics litter clean-up citizen science project. Inform the students they will be making an impact and cleaning up the oceans today. No matter where your school is, all litter has the potential to make it downstream to the ocean.

6. After conducting either the microplastic lab or macroplastic litter clean-up have the students come up with solutions to the problems they found.

7. Have students work in teams to create a poster or brochure campaign to reduce the plastic/litter that enters the environment. This could be focused on their school, neighborhood, or community.

Microplastics Lab

1. Communicate that while the class conducts an investigation finding out how much (quantitative data) of certain types of microplastics are in their community, scientists from the College of Charleston and the Citadel are conducting similar experiments in ecosystems around the state. The information is then used to make positive changes in the community.

2. Assign students to groups of 4. Give each group a Microplastic Report, transect, bucket, ruler, measuring beaker, salt (if needed), and spoon. Designate the role each student will perform or allow the students to decide who will be in charge of:

Collector: Pours mixture through sieves and rinses them into the correct jars, helps look through the sample in lab
Mixer: Adds salt and water from the site and mixes, helps look through the sample in lab
Sampler: Collects top 2 cm of sediment and places in large bucket, helps look through the sample in lab
Seeking: Decides where to place transect, helps look through the sample in lab

3. Have each group review the materials and the procedure written on the Microplastic Report.

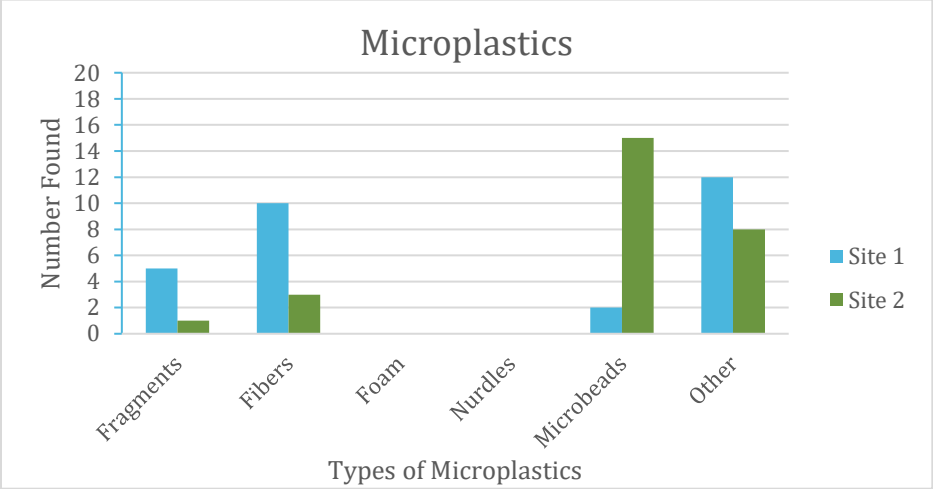
4. Provide a few minutes for each group to formulate their hypothesis in the Microplastic Report. As a group, they should discuss which microplastic will be the most common.

5. GO FOR IT!!! Collect their sample. Help the collectors rinse their sieves into the sample jars.

*Note- If classroom management is challenging outside, students can just pick up the sample and collect the water. The mixing and pouring can be done in the classroom.

6. After samples have settled, have the groups look at their samples under the microscope and identify any pieces of microplastic they find.

7. Ask the students to analyze the data. Discuss their findings as a group. They can graph the microplastics collected to help analyze their data. Example:



Note: You could make a class graph first to model how bar graphs are created before individual groups make theirs on their Microplastic Report.

8. Discuss their findings and conclusions using these questions.

- **Results with Evidence:** Discuss their results with evidence from their data.
- **Potential Error:** What are some potential errors that could have affected the results? What ways could the errors be prevented if the experiment was conducted again?
- **Potential Application**: Why are the results of their experiment important? How can the results be applied to actions to help with the problem? How can reducing macroplastics reduce microplastics?
- **Reflection:** Why is it important to have habitats free of micro and macroplastics? How can they affect wildlife? Where do the micro and macroplastics come from? Do our actions have impacts outside of where we live?

Macroplastics Clean Up Lab

1. Communicate that while the class conducts an investigation finding out how much (quantitative data) of certain types of plastic litter is on their school ground, scientists from the South Carolina Aquarium are conducting similar experiments in ecosystems around the state. You can explain that their data will sent to Aquarium scientists to analyze through a special Litter-Free Digital Journal app. The information is then used to make positive changes in the community. The information has been used to ban plastic bags in parts on Folly Beach and Mt. Pleasant, SC, and can be used to make more positive change. If desired, display pictures and graphs from the Litter-free Project through the Anecdata website (https://www.anecdata.org/projects/view/122/about) to get the students excited.

2. Discuss what is considered trash and what can be recycled. Although the focus is plastic litter, the goal is to pick up all of the litter that is found! Anything paper, most plastics, glass, or aluminum can be recycled. Food waste, snacks and lunch food left outside, will be put in the trash, however, could be composted. Personal belongings, such as jackets, hats, water bottles, lunchboxes, will go in the trash or the school's lost and found if salvageable. Trash, such as rope, wrappers, and straws will go into the trash bag. Explain which bag is trash and which is recycling so they sort correctly.

3. Assign students to groups of 4. Give each group a Litter Report, Litter Datasheet and trash/recycle bags. Designate the role each student will perform or allow the students to decide who will be in charge of:

Recording: inputs data into the Litter-free Digital Journal or the hardcopy litter list
Materials: holds the trash bag and recycling bag with gloves on, helps sort litter
Litter Gathering: picks up the litter and puts litter in the appropriate bag with gloves on, helps sort
Seeking: on the lookout for litter and decides where to look, helps sort

4. Have each group review the materials and the procedure written on the Litter Report.

5. Provide a few minutes for each group to formulate their hypothesis in the Litter Report. As a group, they should discuss which macroplastic will be the most common.

6. GO FOR IT!!! Collect litter on the schoolyard for 15-30 minutes or whatever time is allowed. Help the recorders to input data into the Digital Journal or on their Litter Report. If manageable, take some pictures to upload with your data. Or, have students take pictures.

*Note- If classroom management is challenging outside, students can just pick up litter and put it into one bag. Sorting can be done in a more confined place together outside or inside, with gloves. Data can be put into the Digital Journal inside of the classroom if that is more manageable for your class.

7. Find a place to discard the litter and recycling and invite the students back inside to discuss their findings.

8. Ask the students to analyze the data. Discuss their findings as a group. They can graph the macroplastics collected to help analyze their data.

Note: You could make a class graph first to model how bar graphs are created before individual groups make theirs on their Litter Report.

9. Discuss their findings and conclusions using these questions.

- **Results with Evidence:** Discuss their results with evidence from their data.
- **Potential Error:** What are some potential errors that could have affected the results? What ways could the errors be prevented if the experiment was conducted again?
- **Potential Application**: Why are the results of their experiment important? How can the results be applied to actions to help with the problem? How can reducing macroplastics reduce microplastics?
- **Reflection:** Why is it important to have habitats free of micro and macroplastics? How can they affect wildlife? Where do the micro and macroplastics come from? Do our actions have impacts outside of where we live?

Assessment

Grade the Litter Report or Microplastic Lab Report and their campaign. Instructions from the Solutions sections on the Report says to:

Take the ecological footprint calculator quiz found at: https://www.footprintcalculator.org/

Design a poster or pamphlet campaign to educate your school, neighborhood, or community on how many earths your current lifestyle requires. Using the solutions found on the website, describe 10 changes they could make to decrease their ecological footprint. (You can play around with the calculator using the solutions suggestions to see ways you can decrease your footprint and use fewer earths).

Scoring rubric out of 100 points

Complete Litter Report or Microplastic Lab Report (use scale grading):	0-25 points
For a well-designed campaign poster or pamphlet (use scale grading):	0-25 points
Each change suggested in the campaign (10 changes total):	5 points (50 pts total)

Cross Curricular Extensions

STEM Extension
Begin a discussion about ways to reduce food waste. Make a worm bin for the class to collect food scraps for a month and see the transformation of waste to vermicompost!

Directions on making a worm bin: https://www.epa.gov/recycle/how-create-and-maintain-indoor-worm-composting-bin

STEAM Extension
Create recycled art collages using litter collected outside or "trash" collected in the classroom.

STEAM Extension
Have students explore the most common food packaging designs. Then challenge the students to create more sustainable food packaging designs. Students should include a justification of how their packaging is more sustainable and include specification regarding material type, recyclability, etc. Have students share out and provide feedback on each other's designs.

ELA Extension
Write an editorial to the local newspaper describing the amount of macroplastics your class collected. Describe how these plastic items can degrade to become microplastics, which have the potential to contaminate our food chain. Submit it to the newspaper!

Math Extension
Repeat the micro or macroplastic investigation 3-5 more times during the school year. Have the students graph the data throughout the school year and interpret the trends. Students can determine the mean and standard deviation for each type of litter and determine if their data includes any outliers.

STEM Extension
Have students create their own research question they would like to answer using the Litter-free Digital Journal data set. Download the complete data set for free at https://www.anecdata.org/projects/view/122

Field Trip Extension
Take your class to the recycling center or waste management facility. Most centers have tours available for students to visit.

Resources

Teacher Reference Books
Appelhof, Mary Arlene (2003). *Worms Eat My Garbage.* Flower Press.

Humes, Edward (2013). *Garbology: Our Dirty Love Affair with Trash.* New York, New York. Penguin Group.

Johnson, Bea (2013). *Zero Waste Home: The Ultimate Guide to Simplifying Your Life by Reducing Your Waste*. New York, New York. Scribner.

Teacher Reference Websites

South Carolina Aquarium – Anedata website
This site is where trash data can be inputted as well as all data can be accessed. Shows pictures and has the ability to graph data. Data can also be inputted on the South Carolina Aquarium's Litter-free Digital Journal app by searching South Carolina Aquarium in your smart phones app store.
https://www.anecdata.org/projects/view/122/about

5 GYRES: Science to Solutions
This site offers information about plastic pollution and solutions to the problem.
https://www.5gyres.org/

Citizen Science Center
Learn how you can make a difference by doing real science to help solve our planet's most pressing problems.
http://www.citizensciencecenter.com

NOAA's Marine Debris Program
This site has information about marine debris, as well as activities and curricula.
https://marinedebris.noaa.gov

South Carolina DHEC – Marine Debris
This site has information on marine debris in South Carolina.
http://www.scdhec.gov/HomeAndEnvironment/docs/marine_debris.pdf
http://www.scdhec.gov/HomeAndEnvironment/Docs/SC_MARINE_DEBRIS_POSTER.pdf

Keep America Beautiful
Keep America Beautiful inspires and educates people to take action every day to improve and beautify their community environment.
https://www.kab.org

National Geographic
This National Geographic site offers beautiful pictures and captions of citizen science projects, as well as projects to get involved in.
https://www.nationalgeographic.org/encyclopedia/citizen-science/

United Stares Environmental Protection Agency
These government sites provide basic information on ways to reduce and reuse materials, as well as information about microplastics.
https://www.epa.gov/recycle/reducing-and-reusing-basics
https://www.epa.gov/trash-free-waters/toxicological-threats-plastic

Global Footprint Network
This site goes through the demand on and supply of nature.
https://www.footprintnetwork.org/our-work/ecological-footprint/

The Big Microplastics Survey
This site introduces a citizen science project related to microplastics
https://microplasticsurvey.org/