MICROPLASTICS *in the Estuary*

INTERACTIVE LESSON PLAN

TBEP
TAMPA BAY ESTUARY PROGRAM
PARTNERSHIP FOR A HEALTHY BAY

LESSON OVERVIEW

This curriculum includes an interactive microplastics lesson plan, assessment, sediment sampling activity, and craft intended to engage 4th-9th grade students with the issue of marine debris and microplastics in the ocean, analyzing both the complexity of the matter and potential solutions. The lesson is structured to include opportunities for student discussion, inquiry, exploration, and engagement in scientific sampling.

Learning Objectives

Students will:

- Increase knowledge of plastic impact in marine and estuarine environments.
- Discuss large-scale environmental impacts resulting from human activity and predict the impact of individuals on environmental systems.
- Promote stewardship of the local environment and consider action plans to help mitigate the effects of microplastics.
- Practice in-field sediment sampling techniques.

Problem with Plastic

Marine debris is any man-made material that ends up polluting our oceans. One of the most abundant forms of marine debris is plastic pollution. Plastic materials have existed for over a century, and have grown increasingly prevalent in modern life. Take 10 seconds to look around you: How many plastic items do you see? Plastic is all around us—it makes up a large portion of everyday items including household products, food packaging, and clothing. Unfortunately, the increase in plastic production and use has resulted in plastic polluting our environment. Over the last 10 years, we have produced more plastic than during the entire last century. It is estimated that each year nearly 335 million tons of plastic are produced globally, half of which is anticipated to be used just once. Consequently, a staggering percentage of that plastic enters our oceans each year, persisting in some form in the environment forever and leaving lasting effects. The issue of marine debris is a complex and growing problem and the solution begins with us!

What are Microplastics?

Consider a discarded piece of plastic, such as a Styrofoam cup. In the ocean, this cup is worn by wave energy and exposure to sunlight. After some time, that cup breaks into smaller pieces. These tiny pieces of degraded plastic are known as microplastics. By definition, microplastics are plastic particles 5 mm or less in size. Plastics can take nearly 450 years to completely degrade, or break down, and continue to pose threats for thousands of years.

There are two classifications of microplastics. Primary microplastics include raw plastic such as plastic pellets, microbeads, or nurdles (very small pellets of plastic that serve as raw material in the manufacturing of plastic products). These are plastics intentionally made small. Secondary microplastics are pieces of degraded larger plastic items, usually made from polyethylene, such as plastic bottles, Styrofoam, nylon fabrics, etc. Microplastics in our oceans come from a variety of sources including: rubber tires, road markings, boat paint, synthetic textiles (fibers), personal care products, and plastic pellets.

Microplastics are found in every ecosystem on our planet, and unfortunately, the Tampa Bay Estuary is no exception. A 2017 study reported the presence of microplastics in water released into the environment by local wastewater treatment facilities and in surface water throughout the Bay. Scientists also found a significant amount of microplastics ingested by zooplankton (copepods) and manatees inhabiting the Bay. In 2019, scientists estimated nearly four billion particles of tiny plastics polluting the Tampa Bay Estuary.

Microplastic scale true to size (5 mm in diameter)

Did You Know?

- More than 60 countries have introduced laws to reduce single-use plastic waste.
- If any of your personal care products, such as deodorant or makeup, contain polyethylene, that is plastic.
- The Microbead-Free Waters Act of 2015 prohibits the manufacturing of "rinse-off" cosmetic products that contain microbeads, including face wash and toothpaste.
- The city of St. Petersburg voted to ban single-use plastic straws and Styrofoam in 2019.
- Unlike glass or paper, most plastics can only be recycled once or twice into a new product.

Examples of plastic pollution found in the environment.

Single-use plastic straw buried in beach sand.

- There is no regulatory requirement for the use of the term "biodegradable." If a product claims to be biodegradable, that does not necessarily mean that it is.
- The top 10 items found in 2019 International Coastal Clean-up include: cigarette butts, food wrappers, straws, plastic cutlery, plastic bottles, bottle caps, grocery bags, other plastic bags, plastic lids, plastic cups and plates. Note that all are plastic.

Lasting Impacts

Plastic pollution has detrimental effects on terrestrial and aquatic ecosystems, wildlife, and even human lives. Research indicates that all marine organisms, from microscopic plankton to the largest whale, are impacted by marine debris. Animals are known to accidentally ingest plastic materials and even absorb the toxic chemicals of plastics resulting in fatal outcomes. Chemicals can build up in animal tissue and transfer up the food chain, further posing threats to apex predators. Marine species are also impacted by entanglement in fishing line and nets. These impacts are even greater in estuarine environments where wildlife is extremely diverse.

Plastic in the environment affects us too. Studies show that the chemicals found in plastic, Bisphenol-A (BPA) for example, have negative human health effects as they are harmful to many biological processes. The persistent pollutants left by plastic also bioaccumulate, or build up, in seafood humans might possibly consume. Scientists and health care professionals continue to study the probable effects of plastic on human beings. Of course, pollution also affects human wellbeing and our coastal economy. Marine debris presents environmental hazards impacting beach tourism and recreation, property values, commercial fishing, and other businesses.

Be a Part of the Solution

Removing plastic from the ocean has proved difficult by many scientists. However, beach clean-ups have been effective in helping to keep our oceans clean. You can participate in a coastal clean-up any day and **track your findings!** You can even become a citizen scientist and contribute to live data through **sediment** or **water** sampling, or collecting **nurdles** along the beach. This data is used by scientists across the globe in order to best approach the issue of marine debris. Of course, as individuals, our best option is to limit using disposable items and instead buy sustainable options.

As such a valuable resource, it is essential that we eliminate marine debris in order to preserve our oceans. Though the Tampa Bay Estuary is affected by marine debris and the accumulation of microplastics, the community is hard at work contributing to coastal clean-ups and effective waste management programs. Marine debris affects us all and is a problem that we as a global community can solve. Every single effort goes a long way in protecting our estuary and oceans around the world.

You Can Make a Difference!

- Pick up trash when you are at the beach to prevent marine debris.
- Try a reusable water bottle instead of a disposable one.
- Consider using reusable bags for your shopping and request paper bags if you have forgotten your reusable bags.
- Consider refusing a straw or carry-out container from restaurants. You can even bring your own reusable straw and container.
- Limit purchasing disposable products (e.g. plastic bottles, plastic cutlery, straws, individually wrapped snacks, etc.) when shopping or ordering takeout.
- Discard used fishing line in a monofilament tube used for line recycling.

Reusable bags help transport other reusable items.

- Recycle plastic products—check your local **recycling guidelines**!
- Try to buy second-hand when possible. Many clothing items contain plastic fibers.
- When buying new clothing or towels, try buying those made with natural materials such as 100% cotton.

TEST YOUR KNOWLEDGE

Multiple Choice

1. How many millions of tons of plastic are produced each year?
   - a. 335
   - b. 450
   - c. 2019
   - d. 250
2. Plastic particles are considered "microplastics" when they are what size or smaller?
   - a. 10 mm
   - b. 5 cm
   - c. 5 mm
   - d. 10 cm
3. According to a recent study, how many microplastics were estimated to be in the Tampa Bay Estuary?
   - a. 4 billion
   - b. 40 million
   - c. 4 million
   - d. 40 billion
4. Which of the following is NOT a threat to marine organisms resulting from plastic pollution?
   - a. Ingestion
   - b. Biodegradation
   - c. Entanglement
   - d. Absorption
5. What is the name for plastics intentionally made small?
   - a. Bisphenol-A
   - b. Secondary microplastics
   - c. Persistent pollutants
   - d. Primary microplastics

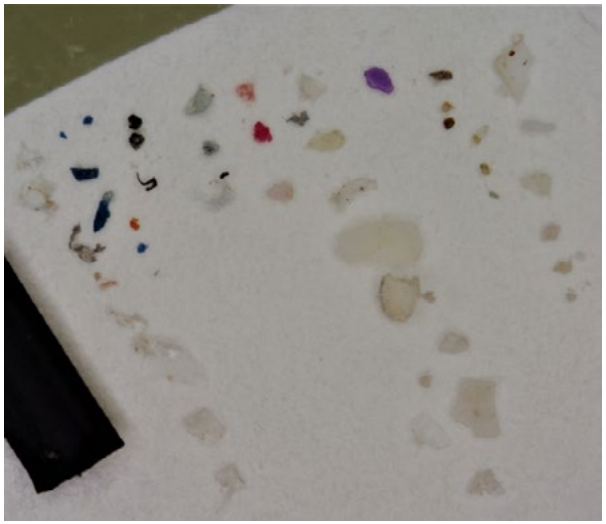
Fill-in-the-Blank

6. The _____ (3 words) prohibits companies from manufacturing cosmetic products that contain microbeads, including face wash and toothpaste.
7. Secondary microplastics, usually made of _____, are plastics that break down from larger plastic items like water bottles or nylon fabrics.
8. Toxins left behind from plastics can _____, or build up the food chain, posing threats to apex predators and top consumers like humans.
9. The top three plastic debris items found from clean-ups in 2019 were: _____, _____, and _____.

Short Response

10. In 5-10 sentences, please discuss four ways to create a personal positive impact on the issue of microplastics in our oceans. Be sure to mention how each of your positive impacts are mitigating the present threats and concerns being faced.

ANSWER KEY



Examples of microplastics extracted from water samples.

Multiple Choice

1. A
2. C
3. A
4. B
5. D

Fill-in-the-Blank

6. The **Microplastic-Free Waters Act** (3 words) prohibits companies from manufacturing cosmetic products that contain microbeads, including face wash and toothpaste.
7. Secondary microplastics, usually made of **polyethylene**, are plastics that break down from larger plastic items like water bottles or nylon fabrics.
8. Toxins left behind from plastics can **bioaccumulate**, or build up the food chain, posing threats to apex predators and top consumers like humans.
9. The top three plastic debris items found from clean-ups in 2019 were: **cigarette butts**, **food wrappers**, and **straws**.

Short Response

10. **Answers will vary.** *Example Answer: To combat the issue of marine debris and microplastics in our oceans, I already make an effort to use reusable items. Whether they are reusable water bottles or straws, I am doing my part to reduce my single-plastic use, which can reduce the amount of pollution ending up in our oceans. Additionally, I plan to pick up more trash whenever I go to the beach, to reduce the marine organism casualties via ingestion or absorption. I don't fish often, but when I do, I will be sure to discard my monofilament line properly and in one of the provided monofilament tubes. Lastly, I will be more conscious of the products I am purchasing at the store. I will be sure to buy products using minimal single-use materials and purchase clothing items made out of sustainably-sourced, natural fabrics.*

DIVE DEEPER: SAMPLING SEDIMENT FOR MICROPLASTICS

Overview: This activity brings the world of microplastics into greater focus and investigates what particles can be found right amongst the wrack lines of our beaches. The wrack line, or high tide line, is where organic debris collects on the shore. Oftentimes this is where algae, seagrass, and shells, but also ocean pollutants, can be found. By exploring the wrack lines, we can find the obvious "plastic offenders" that contaminate our coastal waters.

There are two versions of this sampling activity, one that can be conducted entirely at the beach and the other that can be performed at home after a beach visit.

Materials:

Toolkit #1: At the Beach

- 0.25 x 0.25 m quadrat (see building instructions in the "Procedure" section below)
- Tweezers
- Container to hold plastics
- Data sheet
- Writing utensil
- Mason jar, film canister, or other small container
- Fresh water

Toolkit #2: Beach Visit/At Home

- 0.25 x 0.25 m quadrat
- Garden trowel or large spoon
- Large tupperware container with lid
- Newspaper or paper plates
- Sieve or kitchen sifter with fine mesh
- Bucket
- Tweezers
- Container to hold plastics
- Several large cups
- Tap water
- Data sheet
- Writing utensil

Procedure:

Building Your Quadrat

Quadrats are used by researchers and scientists to determine the abundance or density of their target within a given area, and then using that data to make predictions. For example, trying to count every blade of grass in your lawn would be impractical; a quadrat could help you count a specific area so that you may predict how many blades of grass may be present in your entire lawn. Quadrats also help to standardize data collection by making sure the same size area is observed each time. Quadrats come in various sizes, but the most common sizes include 25 cm^2, 50 cm^2, and 1m^2 areas. Most importantly, the key to success is picking the appropriately-sized quadrat for your project. We will be constructing a 0.25 x 0.25 m quadrat to best sample wrack lines.

1m^2 quadrat (This photo shows a 1m^2 quadrat with lines dividing it into .025 m sections.)

Materials:

- 4 feet of PVC pipe. Alternative materials: instead of PVC pipe, fairly straight twigs, an old yard stick, or long crafting dowels could be used.
- PVC pipe 90-degree elbows of the same diameter as the PVC pipe
- Tape measure
- Duct tape
- Hacksaw

Instructions:

1. With the help of an adult, using the hacksaw, cut the PVC pipe into four pieces, each 25 cm in length. If working with twigs, dowels, etc., cut them into four pieces, each 30 in length. This additional length will account for overlap when fixing them together.
2. To form a square, attach the PVC elbows to the ends of the PVC pipe, making sure they are in the same plane. Alternatively, use duct tape to fix the ends of the twigs, dowels, etc. together at 90-degree angles, overlapping no more than 2 cm at each end.
3. The inside dimensions of the finished quadrat should measure 25 cm x 25 cm, or 0.25 m x 0.25 m.

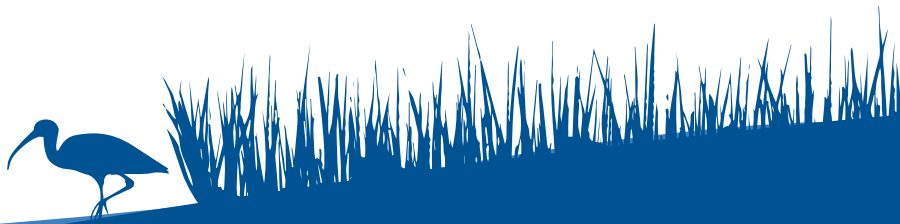
Sampling at the Beach

1. At the sampling location, locate the wrack line and place the quadrat within the wrack line area at random.
2. Determine a number of steps to take along the wrack line, between 1 and 10. This will determine how many steps to take away from the previous sampling before conducting another sample. This will also keep your data sampling locations random along the wrack line.
3. Using tweezers, pluck out any plastics within the boundaries of the quadrat.
4. Place any found plastics into a container. Make sure to record all items from the quadrat onto the data sheet, using tally marks. Measure the size of smaller items against the 5 mm circle on the data sheet to determine if the pieces qualify as "microplastics."
5. After collecting all visible plastic debris, pick up the quadrat and walk the predetermined number of steps along the wrack line to the next sampling location and place the quadrat.
6. Repeat steps 3-5 for a total of 16 times, to replicate sampling a $1m^2$ area.
7. After all 16 samples have been conducted, add up the total number of plastics found.

**Tip from the Experts: It can be tough to differentiate between a shell and a piece of plastic. A simple way to tell the difference is to add the item in question to water. Fill a mason jar, film canister, or other small container ¾ full with fresh water. Using the tweezers, suspend the item halfway submerged into the water and let go. Plastic items will bob to the surface while shells will sink to the bottom.*

Sampling at Home

1. At the sampling location, locate the wrack line and place the quadrat within the wrack line area at random.
2. Determine a number of steps to take along the wrack line, between 1 and 10. This will help to determine how many steps to take away from the previous sampling before conducting another sample. This will also keep your data sampling locations random along the wrack line.
3. Using a garden trowel or large spoon, scoop the top layer of sediment (about 1 cm) from within the quadrat boundaries into a large tupperware container.
4. After collecting the top sediment layer, pick up the quadrat and walk the predetermined number of steps along the wrack line to the next sampling location and place the quadrat.
5. Repeat steps 3 and 4 for a total of 16 times, to replicate sampling a $1m^2$ area. Add all sediment to the same large tupperware container and then seal the container.
6. At home, pour the sediment in a thin layer onto newspaper or paper plates to dry. Let it dry completely, preferably overnight. If the sediment was dry when it was collected, disregard this step.
7. Over a bucket, pour the sediment through the sieve or kitchen sifter to collect the sediment and return it back to the beach, if possible.
8. Sort through what remains in the sieve. Remove any plastics with tweezers and place in a container. Use the data sheet to tally how many total pieces are found. Measure the size of the smaller items against the 5 mm circle on the data sheet to determine if the pieces qualify as "microplastics."
9. After looking through the sieve for obvious plastics, take the remaining sediment and pour it into large cups. Fill the large cups ¾ with tap water. Stir well.
10. Pick out any plastics that float to the surface and add to the data sheet. If there is organic material like algae or seagrass, it will float along with the plastics. If desired, let the sediment/water mixture soak overnight to allow the organic matter to absorb water and sink, leaving only plastics at the surface.
11. Add up the total number of plastics found from the sediment sample and record.



DATA SHEET

Use this data sheet to record your findings. For each sampling, you will note separately the number of plastic items collected that are NOT 5 mm or less in size (larger plastics) and the number of plastic items that are 5 mm or less in size (microplastics).

Quadrat No.	# Larger Plastics	# Microplastics	Quadrat No.	# Larger Plastics	# Microplastics
1			9		
2			10		
3			11		
4			12		
5			13		
6			14		
7			15		
8			16		
Subtotals:			Subtotals:		

Total # of Plastics:	

Plastics that are 5 mm or less are considered "microplastics."

Use the circle below to determine which of your collected items can be classified as microplastics.

Microplastic scale true to size (5 mm in diameter)

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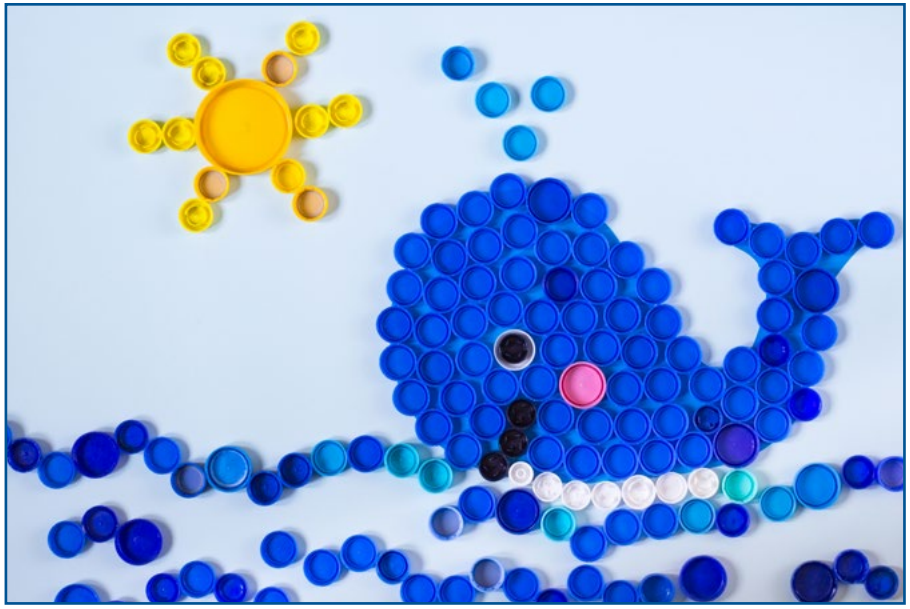
GET CREATIVE

Microplastics Mosaic

Overview: Create a beautiful piece of upcycled art using microplastics you find during your very own beach clean-up or sediment sampling. Share your creation with us on Facebook and Instagram **@TampaBayEstuaryProgram** with a short description of your art piece for a chance to be featured on our social media. **Mosaic** inspired by artist Anne Marie Price out of California.



Materials:

- Microplastics or other form of marine debris
- Hot glue
- Canvas or cardboard
- Paint (optional)

Instructions:

1. Clean all plastic pieces so they are free of dirt or dust. Dry them thoroughly.
2. If desired, paint any pieces you wish to be a different color. You can also paint the canvas/cardboard a desired background color. Let them dry.
3. Arrange plastic pieces onto canvas/cardboard to create an image or pattern of your liking.
4. With the help of an adult, carefully glue each piece to the canvas/cardboard with a hot glue gun.
5. Let sit until the glue is completely dry.
6. For a glossy finish, spray an even layer of mod podge or any other clear sealant over the entire mosaic. Let it dry outside for 24 hours.
7. For a shadow box approach, glue plastic pieces into a shadow box with well sealed edges, cover with epoxy resin. Let it dry outside for 24 hours.

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