Ocean Week Canada

Museum, Science Centre & Aquarium Toolkit

Activity #2: Focus on Marine Life & Microplastics

Ocean Week Canada

Introduction

The health of the global ocean and freshwater ecosystems, as well as the biodiversity they each sustain, are critical for our community, cultural, and economic well-being. Pollution, climate change, habitat loss, and many other factors related to human activity pose a risk to our water systems and the species that live there. Action must be taken to not only protect these species, but to actively rebuild their populations. The issue of plastic pollution is a growing problem. Scientists have predicted that by the year 2050, there could be more plastic in the global ocean than fish (by weight). Plastic debris can lead to suffocation and entanglement for marine species. Its ingestion by wildlife can lead to starvation, stunted growth, and reproductive problems; plastics also pose a threat to human health as toxins and microplastics are introduced into our food web. Local waterways flow into watersheds that eventually lead to the ocean, acting as an avenue for any pollution or debris left to travel. Bottom line: we are all connected and our actions matter!

Dive into this hands-on toolkit developed by the Canadian Museum of Nature and Ingenium to promote the importance of aquatic health throughout Canada. A limited number of kits with materials are available to select museums, science centres, and aquariums across Canada; however, all the information and materials required to engage in the activities are detailed in the digital toolkit. You can do it yourself! The activities are targeted for general museum audiences of children, aged 6-12, and their families, and will help museum professionals interpret marine concepts in an encouraging and engaging way. Participants will have the opportunity to program their RiveBot (line tracking robot) to gobble up plastic garbage in a river; use handheld microscopes to investigate aquatic organisms and microplastics samples up close; and then test their knowledge with our water trivia game. By creating a memorable moment of discovery and investigation visitors will feel empowered to support ocean health.

Ingenium Canada's Museums of Science and Innovation Musées des sciences et de l'innovation du Canada

canadian museum of nature nature musée canadien de la nature

Canadian Ocean Literacy Coalition

La coalition canadienne de la connaissance de l'océan

Canada

Focus on the Ocean

Marine Life & Microplastics Magnified

Feeling connected to the ocean and better understanding the impact of our actions on the ocean, can help inform us on how to make better choices to support ocean health. In this activity, we give visitors a chance to see marine animals up close and investigate plastics and microplastics under a microscope.

Instruction Sheet

Learning Objectives

- Feel more connected to marine life and the ocean.
- Gain an increased awareness of the negative impacts of plastics in our waterways.
- Understand the importance of reducing plastic waste to better support ocean health.
- Identify sources of microplastic pollution and ways to mitigate it.

Materials

- 4 hand-held microscopes
- 6 marine animal resin samples
- 4 PetriSlide microplastic samples
- Instruction sheet
- Table
- Roll-up banner

Preparation

- Prepare a space with the microscopes and samples laid out for visitors to investigate
- Setup the roll-up banner nearby
- Ensure microscopes and samples do not leave the area

Try This

1. Use the microscope to look at plastics of different sizes. Microplastics can be smaller than the human eye can see.
2. Look at the marine animal specimens and the microplastics. Use the microscope to closely investigate the animals' mouths and the sizes and shapes of the microplastics.
3. Discuss and compare which animals will be most affected by marine plastics. Discuss the sources of the microplastics. Think about how this may affect us.

Accommodations

The microscopes and resin samples should be on a short table so that they are accessible for small children and visitors using wheelchairs or other mobility aids.

Facilitator Guide

Guiding Questions

How do these animals feed? How might they accidentally ingest plastic?

- Sea stars eat algae, sponges, bivalves, and other benthic invertebrates. Sponges and bivalves are filter feeders who ingest microplastics floating in the water. Sea star polyps (juvenile) feed on phytoplankton and may ingest microplastics during this phase of their life cycle.
- Algae can sometimes grow on, and adhere to, ocean plastics. This can make the plastic look and smell like phytoplankton (food for animals like fish and crabs), who may accidentally ingest it.

Do you recognize these microplastics? Where might they come from?

- Microplastics come from a variety of sources including clothing made from synthetic fibers, small beads in toothpaste, soaps, and other hygiene and cosmetic products, as well as from the breakdown of larger pieces of plastic.

What are the impacts on the ocean and on the food chain if these animals ingest too much plastic? How does this affect us?

- Toxins can adhere to ocean plastics. As animals eat the plastic, and are in turn eaten by other animals, these toxins (along with the plastics) can travel up the food chain in a process called biomagnification. The animals in resin can all bioaccumulate and biomagnify microplastics.
- As the concentration of plastics in the ocean increases, we are starting to find plastics in animals we harvest for food. Recently, scientists in the Netherlands have found plastic particles in human blood. Eating shellfish and other seafood can increase our chances of eating microplastics.
- Toxins that adhere to plastics can cause many problems by harming our organs. The effects of plastic itself are still poorly understood. Plastic has only been widespread on Earth for around 50 years and scientists need more data on how plastics interact with our bodies' various systems before we fully understand the associated risks.

How can we all help to reduce the amount of microplastics that get into the environment?

- Stop using single-use plastics: drinks in plastic bottles; shopping bags; sandwich bags; plastic straws.
- Buy products made from natural elements when possible (organic or recycled cotton clothing; compostable fast-food containers; paper or wax packaging).
- Avoid purchasing or wearing clothing made from synthetic fibers (like polyester).
- Don't use cosmetic products (soaps, toothpaste) containing microplastics (check the ingredients list for words like polyethylene or polypropylene).

Focus on the Ocean
Marine Life & Microplastics Magnified

Dive Deeper

Ocean plastics are found in a wide range of sizes - from big pieces of plastic to microplastics. Microplastics refers to any piece of plastic smaller than 5mm. Some microplastics are microscopic and cannot be seen with the human eye.

As plastics drift through the ocean, they break down into smaller pieces. The waves, water, and sun all contribute to the mechanical breakdown of plastics. Some plastics sink to the bottom of the ocean while others float at the surface; however, most ocean plastics are suspended in the water column. Since plastics are found in many different ocean ecosystems, they affect a wide range of animals - from benthic (where organisms living on or in the bottom) to pelagic (where swimming and floating organisms live) to coastal marine animals.

While many microplastics are formed when larger pieces of plastic break down, there are direct sources of microplastic pollution as well. Canada has banned the use of microbeads since 2018, but many companies still use microplastics in cosmetic products to improve texture or for other uses. Synthetic clothing releases plastic microfibers into the environment when it is worn and washed. Filters are being developed around the world to reduce the amount of plastic microfibers released from washing synthetic clothing, but this is not enough. To protect the health of the ocean, we should avoid using products that contain microplastics.
The unique properties of plastic allow other toxins floating in the ocean to adhere (stick) to the plastic and conglomerate. As microplastics become more abundant in the ocean, they begin to mix into the food web along with the toxins adhered to them. These toxins, and the microplastics themselves, can bioaccumulate in marine animals and cause organ damage. This accumulation of plastic and toxins can affect marine animals' reproduction, metabolism, growth, and more. The plastics and toxins are also biomagnified up the food web, sometimes all the way up to us humans.

Crustaceans, like the crabs and shrimp provided in the resin samples, feed on plankton floating in the water. As algae grows on microplastics, these animals can mistake it for tasty phytoplankton and will ingest it. Zooplankton also mistakenly ingest microplastics, and they are in turn eaten by fish, who can biomagnify the plastic up the food chain. Sea stars are benthic animals that feed on mussels, who are filter feeders and may ingest plastic. While sea stars, crabs, and fish live in different oceanic habitats, they are all affected by ocean plastics. This indicates the depth of the effects of this problem.

Very recently, in March 2022, scientists in the Netherlands detected plastic particles in human blood. Of the 22 people whose blood they sampled, 17 of them had a quantifiable number of plastic particles in their blood. While this is a shocking discovery, we still don't fully understand the associated health risks due to a lack of evidence. Eating shellfish and other seafood increases your chances of ingesting plastic.

Preparing microplastic samples

- PetriSlides purchased from www.emdmillipore.com
- Microplastics made from shredded plastic bag
- Microfibers taken from polyester clothing

Background Information for Science Interpreters

There is one big ocean global ocean

- Local waterways and watersheds eventually lead to the ocean and all the worlds' oceans are connected.
- Local activities can affect the global ocean.
- It is the responsibility of everyone to take care of the ocean.

Oceans play a crucial role in mitigating climate change

- The global ocean acts as a climate regulator and as a sink for atmospheric carbon dioxide (CO_2).
- Atmospheric carbon dioxide (CO_2) diffuses naturally with water (it mixes into the ocean). Here, it undergoes several chemical reactions with water and forms carbonate ions (CO_3^{2-}) and hydrogen ions (H^+). Microscopic planktonic organisms combine these carbonate ions with calcium ions (Ca^{2+}) (rocks dissolved by weathering are the main source of calcium in the ocean) to create calcium carbonate ($CaCO_3$) which they use to build shells and plates necessary for their survival. When these organisms die, they sink to the bottom of the ocean and are buried, taking the CO_2 with them. This is why the ocean is a sink for CO_2. These tiny marine organisms are the basis of the marine food chain. Many of these organisms are phytoplankton and, through photosynthesis, are responsible for producing 50-80% of the world's oxygen.
- With more carbon dioxide in the atmosphere, more is diffused into the ocean. Increased carbon dioxide increases the amount of H^+ ions in the ocean. These extra H^+ ions begin to react with the carbonate (CO_3^{2-}) and create bicarbonate (HCO^{3-}). This reduces the amount of carbonate available for marine organisms to use in building their shells. These extra H^+ ions reduce the pH of the ocean, making it more acidic - this is why the process is called ocean acidification. Normally, since the ocean is so big, it is very difficult to change the equilibrium of its chemistry. But human activities have added so much carbon dioxide to the atmosphere that the ocean cannot keep up. Between 1751 and 2021, the ocean's pH has dropped from 8.25 to 8.1. This represents a 30% increase in H^+ ions in that time (remember, pH is a logarithmic scale, so a change of unit of pH is equal to a tenfold change in H^+ ions). Freshwater environments also seem to be acidifying, but this is much more complex and less understood.
- Climate change has a negative impact on the ocean including: rise in ocean temperature, ocean acidification, deoxygenation, sea level rise, the decrease in polar ice coverage, coastal erosion, and extreme weather events.
- The ocean plays a crucial role in the water cycle.

Health of marine and freshwater ecosystems are critical for our country and they are at risk

- The health of our water systems (marine and freshwater) and the wildlife they sustain are critical to our community, cultural, and economic well-being.
- Climate change, habitat loss, pollution and many other factors related to human activity pose a risk to the species that find their homes in our water systems.
- Action must be taken to not only protect these species, but to actively rebuild their populations.

Human activities are harming Canadian water systems – plastics

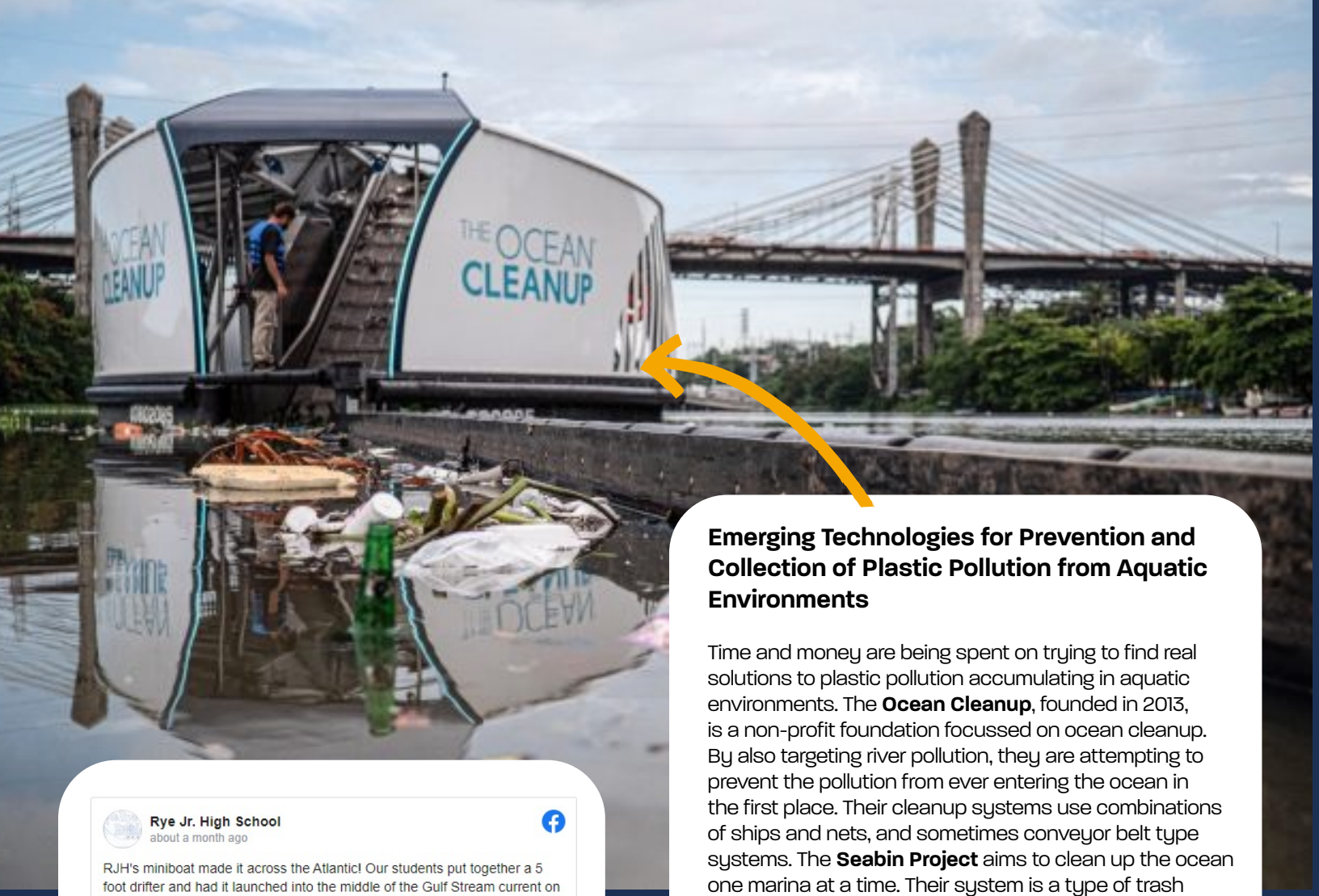
- Human activities can harm aquatic life and are degrading the ocean and waterways.
- This undermines coastal communities' livelihoods and has a negative impact on human health.
- Every year more than 8 million tonnes of plastic are dumped into the ocean.
- Oceanic pollution includes toxic chemicals from industries (including oil, lead, and mercury), land run-off (including fertilizers, petroleum, and pesticides), wastewater, oil spills, and littering.
- Pollution in the ocean has a negative impact on human health, through contaminated water supplies and food chains through affected marine life.
- Pollution has a negative effect on the economy as natural resources are destroyed by pollution.
- Pollution can reduce the ecological benefits of a recreational area and in some cases render it completely unusable, negatively impacting culture.

Where do plastics come from?

- Plastic pollution needs to be stopped at the source
- Alternatives need to be found to single-use plastics; not only are they killing aquatic animals, but they are made using fossil fuels which are affecting our climate.
- Plastic production is projected to quadruple in the next 30 years, and we cannot recycle our way out of that.
- Only 9% of every piece of plastic ever made has been recycled, and some of that is not even recycled – it's downcycled.
- Customers need to be provided a choice of plastic-free options.
- Pollution, including plastics, gets washed down from our streets, parks, and parking lots and into storm drains and small creeks which make their way to bigger waterways, and eventually the ocean.
- Microplastics are found in many of our cosmetic products and microfibers are released from synthetic fabrics. When synthetic plastics are laundered these microplastics find their way into our wastewater. To protect the health of the water systems we should limit our use of products that contain, or are made from, synthetic materials. Microplastic filters that you can attach to your washing machine are being developed. The performance of these filters is still being investigated. This work is important since scientists are saying that textiles may be responsible for up to 35% of microplastic pollution in the ocean.

Why are plastics a problem?

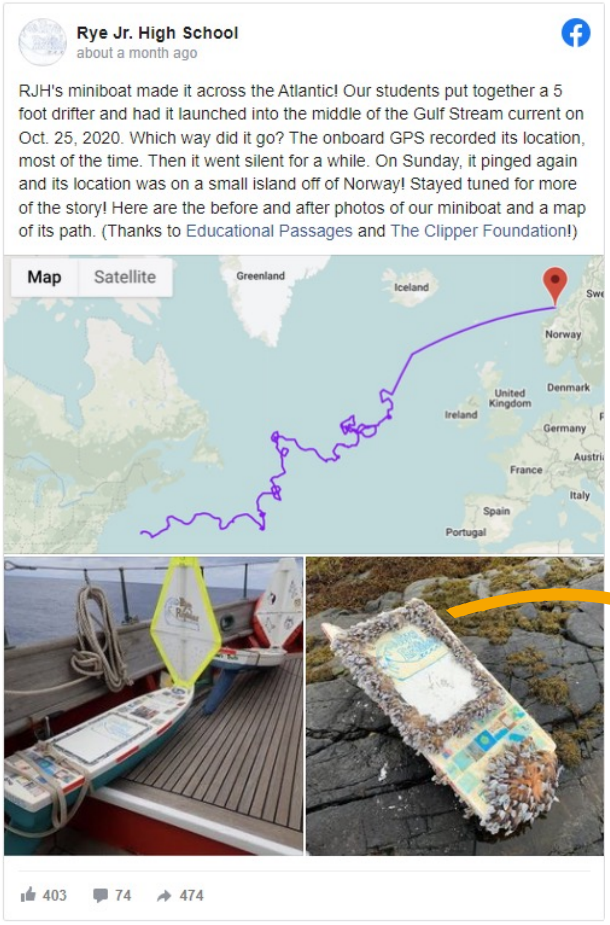
- In 2017, the World Economic Forum and Ellen MacArthur Foundation estimated that by the year 2050 there could be more plastic in the global ocean than fish (by weight).
- In the great garbage patches in the Pacific and Atlantic Ocean, plastic already outnumbers living organisms by 180:1.
- As plastics float around in the ocean, they are broken down into smaller pieces; pieces of plastic smaller than a quarter are called microplastics.
- Microplastics are easily ingested by marine life and produce a series of toxic effects and can lead to starvation as stomachs become filled with plastic.
- Toxins can adhere to plastics and biomagnify up the food chain.
- Plastic can release harmful chemicals into the water and into animals that ingest it.
- Microplastics have been found in Arctic ice, human blood, and even embedded in human lung tissue.



Emerging Technologies for Prevention and Collection of Plastic Pollution from Aquatic Environments

Time and money are being spent on trying to find real solutions to plastic pollution accumulating in aquatic environments. The **Ocean Cleanup**, founded in 2013, is a non-profit foundation focussed on ocean cleanup. By also targeting river pollution, they are attempting to prevent the pollution from ever entering the ocean in the first place. Their cleanup systems use combinations of ships and nets, and sometimes conveyor belt type systems. The **Seabin Project** aims to clean up the ocean one marina at a time. Their system is a type of trash skimmer that is designed to be installed in the water in areas with calm environments, such as marinas. The **Jellyfishbot** is a remote-controlled device that collects marine waste in areas that are inaccessible for cleaners that use nets. The **WasteShark** is an electric marine drone that scoops up floating debris. It can be used in rivers, lakes, and along coastlines. **FRED (Floating Robot for eliminating Debris)**, developed by Clear Blue Sea, runs on solar power, and collects marine debris using booms, belts, and bins.

Photo Credit - The Ocean Cleanup



A small boat made by middle schoolers in New Hampshire made its way to Norway!

In October 2020, a small boat fitted with a GPS tracking device aboard set sail from a small town in New Hampshire. Some 462 days and 13,400 km the boat made its way to the shores of the small Norwegian island of Smøla.

Photo Credit - @RyeJrHigh

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