



How Did My Water Bottle End Up in the Arctic?

Lesson Plan

Ocean

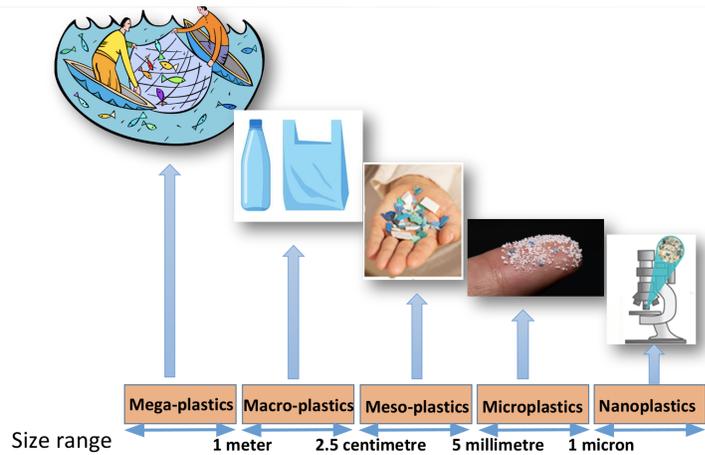
Keywords	Arctic, Oceans, ocean circulation, microplastics, plastics, pollution
Description	This activity is Inspired by an Arctic researcher who studies the distribution and toxicity of marine plastics now found in oceans around the world. It is a group activity connecting sources of local littering to widespread plastic pollution carried to the Arctic through local watersheds into ocean circulation, causing damage to vital ecosystems along the way.
Region	Arctic
Polar Research Theme	Oceans
Intended Audiences	School children ages 10+ community groups and participants
Key Concepts:	<ul style="list-style-type: none">• Plastics are found in every corner of the world including in the Arctic, Antarctic and in us.• Ocean currents bring plastics to the Arctic from subArctic regions.• Plastics break down into different sized particles and 'travel' in different ways• We do not yet understand how plastic in the sea will affect our health and wellbeing.

Introduction

In March 2022 the United Nations Environment Assembly (UNEA) recognised rapidly increasing plastic pollution as a global-scale problem, negatively impacting the environmental, social and economic dimensions of sustainable development.

<https://www.iucn.org/news/marine-and-polar/202203/unea-resolution-end-plastic-pollution-and-iucn-role-implementation-treaty>

At least 12 million metric tons of plastics end up in the ocean each year. The majority of these plastics originate on the land and make their way to the ocean through air or water currents. Some plastics are purposely or inadvertently discarded directly into water. Sources of plastic in the Arctic are both local and distant through the accidental and intentional disposal of plastics into the environment from litter in local bins and sewage systems which wash out into watersheds, to fishing and cargo ships - plastics start out as litter, and travel the globe on ocean currents. Svalbard is a group of Norwegian islands located between 76° and 81° north it is the northernmost permanently inhabited location on the planet. This remote location does not protect Svalbard from plastic pollution. Scientists from the Norwegian Polar Institute have been documenting the presence of plastic debris in the Arctic Ocean.



Plastic pollutants are categorised according to their size from mega plastics (large pieces like bottles) to microscopic nanoplastics (one micron in size). In March 2022 scientists found nanoplastic particles in human blood for the first time. Chemical compounds used to make some plastics have previously been found in human blood samples.

Size range of plastic debris in the Arctic

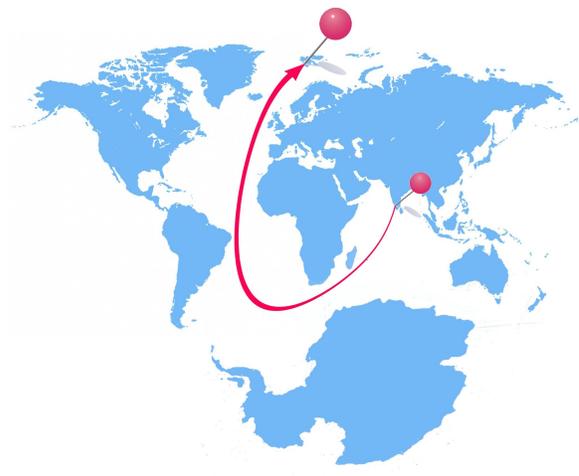
Credit - Neelu Singh, PhD and Geir Wing Gabrielsen, PhD, Norwegian Polar Institute
Source - Neelu Singh

Sources include careless disposal, fibers released from synthetic clothing during laundering, and degradation of fishing nets and buoys, industrial waste, and landfills. Plastic can be carried far away by wind, precipitation, and wastewater.

Plastics may degrade over time, but the basic components do not disappear and will remain in the environment indefinitely.

Understanding the impact of our behavior on the Arctic environment, its people and its ecosystems can help adjusting to responsible plastic use, disposal, and recycling in non-Arctic regions will have positive impacts for us all.

Neelu's Polar Research Story story: From India to the land of the midnight sun



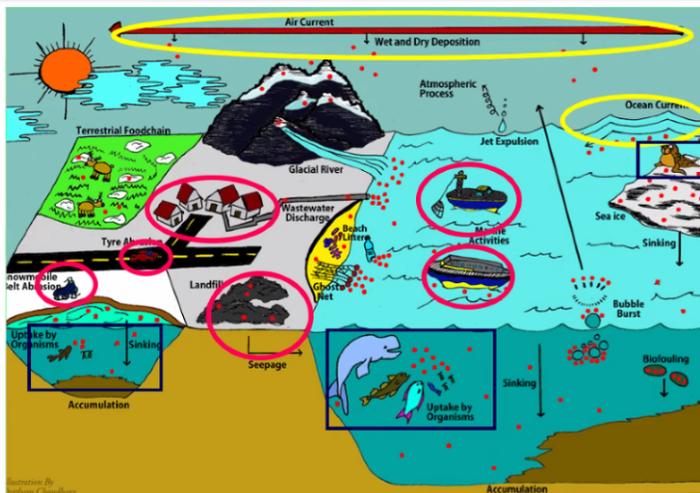
[Photo caption] Dr Neelu Singh - Marine Toxicologist working in Svalbard *courtesy of Dr. Singh*

I live in Longyearbyen, the only major settlement on the remote Arctic island of Svalbard, Norway, where I investigate marine Persistent Organic Pollutants (POPs) in the polar ocean. My research team travels by ship to collect sediment samples from the ocean, and I analyse the plastics we find to understand where they come from and the impact they have on living creatures and the environment.

Svalbard is growing in importance as a summer tourist hub. Located above the Arctic Circle, in summer the sun never sets, and in winter we live in 24 hours of darkness. Many polar researchers also work here, but otherwise the island is shared only with polar bears, seals, reindeer and Arctic birds.

I studied Marine Geochemistry at Mangalore University and then at the National Center for Polar and Ocean Research in India. My journey in the field of polar research began in 2008, when I got the opportunity to participate in the Indian Antarctic Expedition. This was the first time I got the chance to be in Antarctica and to feel personally how pristine and divine the Polar Regions are. The immaculate environment gave a gleam to my dream – to work in Polar Regions.

After completing my doctoral degree, I travelled around 7,530 miles from a tropical country to Svalbard, which is a land of midnight sun. I have spent seven years working in the field of environmental chemistry in polar regions. I now have extensive expertise in the study of Trace Metals and Persistent Organic Pollutants (POPs) in the polar regions.



My research experience and expertise has inspired a deep interest in the connections between Persistent Organic Pollutants, plastics and global climate issues related to environmental pollutants. I am passionate about communicating science and hope that these hands-on activities I have co-developed with educators will help everyone to understand how plastic pollution in their own homeland can end up in the Arctic ocean, due to marine transportation.

Sources and pathways of plastic pollution in the Svalbard area

Credit: Pratham Choudhary Source; Dr Neelu Singh and Dr Geir Wing Gabrielsen, Norwegian Polar Institute

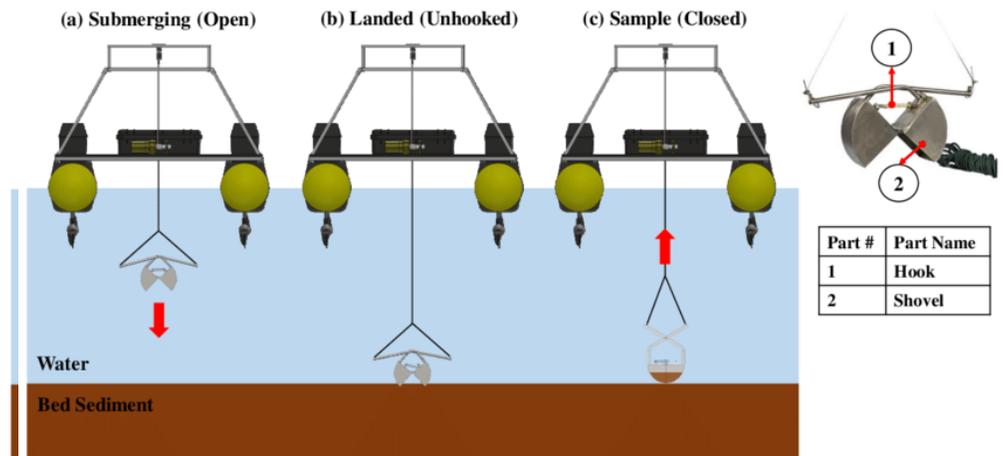
Background



My PhD research project focused on the Assessment of Persistent Organic Pollutants and heavy metals in the Kongsfjorden, Ny-Ålesund in Svalbard. I took part in five Indian Arctic expeditions (between 2012-2015) on board a ship to collect sediment samples from Kongsfjorden.

“Ny-Ålesund is one of four permanent settlements on the island of Spitsbergen in the Svalbard archipelago. It is among the world's northernmost settlements at 78°55'N 11°56'E with a permanent population of 30–35 scientists and support staff”.

On these expeditions, I developed skills in sample preparation (for example, sorting and grinding samples to produce much smaller particles) and analytical techniques. I collected sediment samples using a Van Veen grab sampler (with the help of a colleague from the logistics team!).



[Photo caption] How do you sample sediment with a Van Veen grab sampler?

Credit: Bae, J. H. et al (2019) conference paper DOI: [10.23919/OCEANS40490.2019.8962837](https://doi.org/10.23919/OCEANS40490.2019.8962837)

Source: by kind permission of Dr Yogang Singh

https://www.researchgate.net/publication/338734264_Development_of_an_Unmanned_Surface_Vehicle_for_Remote_Sediment_Sampling_with_a_Van_Veen_Grab_Sampler

Find out more [\[Neelu's story: From India to the land of the midnight sun\]](#)

[Arctic - Oceans - How did my water bottle end up in the Arctic - Additional Resources - Neelu's Story]

Learning Activity

Introduction

On January 1st, 2022 the United Nations tweeted “1 million plastic bottles are sold around the world per minute, adding to the plastic pollution that ends up in our landfills and oceans. We can all make a difference if we simply bring our own refillable bottle”. Polar researchers have raised concerns that Persistent Organic Pollutants (PoPs) like plastic are likely to cause damage to our ecosystems in the Arctic (a source of food for the people who live there) and around the globe and impact sustainability and climate. So **how did your plastic water bottle end up in the Arctic?**

Objectives

- Raise awareness of local watershed, water quality, and presence of litter.
- Learn how local plastic pollution connects to plastic pollution in the Arctic.
- Increase awareness of the source of local plastic pollutants and the types and amount of plastics we use.
- Collaborate and create to inform others that plastic particles are now found in the Arctic environment.
- Act on raising local awareness to mitigate plastic pollution.

Timeline

Preparation Time - around 30 minutes + visit to site.

Activity time - 1 day

Tip: The activities could be spread across several sessions

Tip: Although it may take time to buy or borrow buckets, trash grabbers and work gloves required for the project, once these items are purchased they can be used for future activities.

What you need

- Work gloves for all persons collecting litter.
- 1 Bucket per team (for litter)
- 1 Trash grabber per team.
- 1 Clipboard, pencil, litter collection data sheet ([example](#)) per team. (Or assign one person per team to record the data electronically)
- Large Tarpaulins to use for sorting litter
- Recycling Bags (responsible dispose of collected items)
- Hand sanitizer
- First aid kit

Tip: Using well-made reusable work gloves instead of disposable gloves reduces plastic waste.

Tip: borrowing items on this list reduces plastic waste.

Tip: Permission and release forms may be needed if the activity is taking place out of school or on public property.

Setting up

- Determine what local area you will collect litter from.
- Visit the area, assess the risks and obtain any required permissions.
- Create a map of the areas/zones for litter collection and sorting.

- From the number of participants, workout how many people will be in each team and how many teams there will be
- Arrange for adult helpers to work with younger children
- Organize materials (pencils, clipboards, gloves, litter collection data and buckets) by teams.
- Think through disposal of litter after the activity - arrange for a pick-up with the appropriate agency if needed.

Tip: check there is shelter nearby and a strong mobile phone signal

Step by Step - Instructions

Introduction

The purpose of this lesson is to give personal meaning to lessons about plastics found in waterways by collecting samples from a local environment and to connect this activity to sampling sediment in Svalbard. Evidence of local plastic use and pollution will be connected to plastics found in the Arctic by explaining how water plays an important role in transporting sediment out into the oceans and around the globe.

There are two connected resources available which could be used before or after this activity to supplement learning:

- **Antarctic & Arctic – Oceans – Oceans in Motion: How Surface Currents Work**
- **Antarctic & Arctic – Oceans – Deep Water Circulation**

Before the activity

Prepare an introduction to the flow of plastics from local environments to the Ocean. Participants should be given background information about the ubiquitous presence of plastics in ecosystems, including places like Svalbard in the Arctic. Also, participants should be aware of the connection between plastic litter, especially litter along riparian areas and waterways, and presence of plastic in oceans

Part 1 - Field trip collecting litter that may travel into the ocean through the watershed



[Photo credit] Watershed maps at a creek cleanup

Credit: Regina Brinker

Source: Regina Brinker

Field trip - Step by step

- Collect any required permission forms.
- On arrival at the collection location spread out the tarpaulins in a safe, visible location near the waterway
- Inform and review the purpose of the activity with the participants: They will remove litter that may travel into the ocean through the watershed, and analyze what they find.
- Review safety guidelines with all participants. These include:
 - Work with a partner or team.
 - Wear gloves.
 - Work only in designated areas.
 - Stay out of water.
 - Do not pick up anything that is potentially harmful, including needles, containers of liquids, animal carcasses, or anything the participant is not comfortable retrieving.
- Give each team member a role (participants can switch jobs during the activity).
 - One person uses the trash grabber
 - One person records the type of item and records this on the data sheet.
 - One person carries the bucket in which items are to be deposited.
 - Others collect litter wearing gloves
- Distribute a map if needed, and assign a location for each team to work in..
- Give a clear time limit, and instructions to return to a particular area (e.g. the tarpaulin) to conduct their analysis
- Distribute the resources required to conduct the activity to each team and assign roles.
- Send teams to collect litter and document where it was found. When their collection bucket is full, have them return to a designated place to empty the bucket, review contents and document what has been found, using the data sheet as a guide.
- At the end of the activity, participants should total each type of item collected.
- Carefully sort and bag collected items for recycling or safe disposal
- Gather back the resources used for collection and the materials.
- Collect data sheets or digital logs.
- Wash hands or use hand sanitizer.

Tip: Distribute materials just before the activity is to start to minimize distractions for participants.

Part 2: Data analysis, discussion, proposals



Participants rejoin their team members to review the data.

Each team shares with the class the top five items collected and the total number of items found in each of the five categories.

The data is recorded for the whole group to see.

Discuss the findings with the students.

An example of the data may be found here [Litter Collection Data Example](#)

Part 3: Data Review



[Photo caption]

Credit: Regina Brinker
Source: Regina Brinker

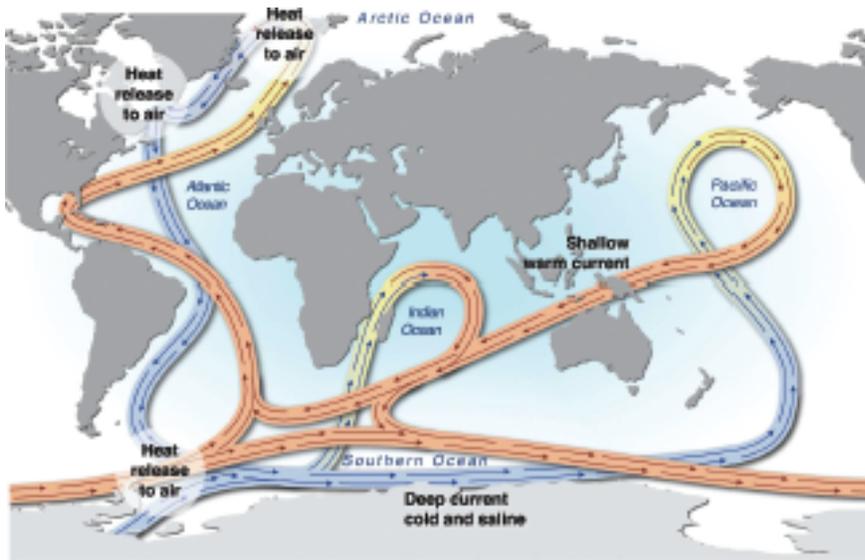
Ask participants the following questions to help draw conclusions from the data

- What are the most common items collected?
- What are the possible sources of these items?
- What are alternatives to using these items? (Select reusable bottles or food containers instead of single-use items.)
- Why did these end up as litter? (Carelessness, lack of trash or recycling containers.)
- What can be done to reduce the litter? (Make others aware of the problem.)
- Are there specific groups that should be targeted for education? (A soccer team that practices on a field where plastic bottles are found, for example.)

Part 4: Connection to the Arctic

How does plastic move through the watershed and into oceans?

- Participants should now identify the primary features of their watershed, including creeks and rivers using maps of the local area.
- Participants should next identify how their watershed connects to an ocean.



Using the diagram “Simplified diagram of global ocean circulation” above, participants can identify the ocean current route closest to their watershed.

Finally, participants can trace the route that items that enter the ocean from their watershed would follow to reach the Arctic. Tip: Participants should understand that this could take years!

[Image caption] Simplified diagram of global ocean circulation
 Polar Science and Global Climate: An International Resource for Education and Outreach, Pearson Education Limited, 2010 Fig 1.30 p.57

Teachers may now ask participants to write a description of how a discarded plastic bottle could move from their watershed, through the oceans, and end up in the Arctic. Participants may also suggest ways to reduce use of plastic and prevalence of litter.

Tip: This activity may be completed whether or not a student participated in the cleanup activity, and may be used as an assessment.

Part 5 - Taking Positive Action

What can the group do to make others aware of this problem and reduce the litter?

- Create an action plan.
- Launch a positive action initiative

Actions could include;

- creating posters, songs, raps, music, videos, or other artistic actions that encourage others to not litter;
- written or video reports for the school or community news or social media.
- communicating results to decision-making agencies and requesting support to reduce littering.

Tips for Community activity day:

- International Coastal Cleanup Day is held annually on the third Saturday of September. Events may be held along any watershed feature.
- World Ocean Day is held annually on June 8th.

Follow-up:

If students created a school-wide campaign to reduce use of plastic or reduce litter, repeat this activity after at least one month. Was less litter found? If so, communicate the results.

Save the data and complete the activity annually. Are fewer plastics being used? Is less litter being found?

Additional resources

Documents

Litter collection [Data sheet](#)

Litter Collection Data [Example](#)

Teaching Tips

Evaluation

Use the written work and creative outputs from Part 5: Taking Positive Action as forms of school assessment or for evaluation and impact

Extension *Assessing Water Quality*

When conducting a cleanup activity near a waterway, participants may also conduct water quality assessments.

These may include measurements of water temperature, pH, and turbidity, plus dissolved oxygen, and total dissolved solids. Ideally, conduct water quality assessments regularly for the site, documenting results for each test. Compare results over time.



[photo caption] Instructor teaching students how to use a turbidity tube

Credit: Regina Brinker

Source: Regina Brinker

Differentiation This activity can be adapted for different settings.

Home: Individual students survey what plastics are used daily or over a week in their household. Students should note if any items are recycled. Students may make suggestions for ways to decrease plastic use. For example, food may be stored in reusable containers rather than single-use plastic bags.

School cafeteria: Students may tally how many single-use plastic bags, containers, and bottles are used during a meal. This may be done by surveying students as they eat, documenting trash as it is disposed of, or sorting through trash/recycling containers at the end of the meal and documenting types of plastics found.

Tasks may be assigned to best meet the student's ability. Collection, mapping, use of app, sorting, quantifying, communicating data

Principles and Practices

Climate Literacy

Principle 6: [Humans Affect Climate](#)

Useful Vocabulary

[Ocean currents](#)

[Plastic](#)

[Pollutant](#)

[Microplastic](#)

[Tributary](#)

[Macroplastic](#)

[Litter](#)

[Nanoplastic](#)

[Watershed](#)

[Mesoplastic](#)

[Riparian](#)

Links to Other Media

Apps

[Debris Tracker](#) “designed to help citizen scientists like you make a difference by contributing data on plastic pollution in your community.” (Directions for use are included on the homepage).

[Litterati](#) “Empowering people to create a cleaner planet by turning information into actionable insight”.

[Coastal Cleanup](#) “Join a global movement to keep beaches, waterways and the ocean trash free. Head out to your favorite beach and use the app to easily record each item of trash you collect”, Ocean Conservancy.

Research Projects

[Plastic in a bottle](#)

“The goal is to see how plastic potentially makes its way from the North Sea and the Baltic Sea into Arctic waters – and to raise awareness about the issue of marine plastic pollution”, Arctic Council.

Articles

[Microplastics in the realm of Svalbard: current knowledge and future perspectives](#)

Neelu Singh *et al* (2020) SESS Report 2020 – The State of Environmental Science in Svalbard

[Our Planet is Choking on Plastic](#)

United Nations Environmental Programme.

[A Guide to Plastics in the Ocean](#)

NOAA (US National Oceanic and Atmospheric Administration).

[Plastic Pollution in the Arctic](#)

Bergmann, M., Collard, F., Fabres, J. *et al.* (2022) *Nat Rev Earth Environ* 3, pp.323–337 .

Lessons

[Follow the Friendly Floatees](#) Ocean Circulation Lesson, National Geographic.

[Moby-Duck: When 28,800 Bath Toys Are Lost At Sea](#)

National Public Radio USA, 32 minute podcast story

[Follow a plastic bottle from Chengdu, China to a remote island in the Pacific Ocean](#)

An online, interactive resource follows a plastic bottle from Chengdu, China to a remote island in the Pacific Ocean

[Where Are Those Microplastics Coming From and Going?](#)

Polar Data Stories - The Polar Literacy Project

Formerly Polar Interdisciplinary Coordinated Education (Polar-ICE)

(divided into 8 lessons, each lesson features a cool dataset, and guides students towards making observations and analyzing the data to discover what's happening in the Polar oceans).

[Microplastics](#) National Geographic

[Discovery and quantification of plastic particle pollution in human blood,](#)

Heather A. Leslie, *et al.* (2022) *Environment International*, Vol. 163 p.107400 (Plastics and Human Health)

Policy

[End Plastic Pollution](#) “The new UNEA Resolution, ‘End Plastic Pollution: Towards a legally binding instrument’, establishes an Intergovernmental Negotiating Committee that will develop the specific content of the new plastic pollution treaty with the aim of completing its work by the end of 2024” The International Union for Conservation of Nature (IUCN)

Dr Neelu Singh - neelu.singh0387@gmail.com

Regina Brinker - brinker.science@gmail.com

Polar Educators International polareducators@gmail.com