From Ocean to Ice: Tracking Plastic Pollution in the Arctic

In the vast expanse of the Arctic, a silent yet pervasive threat lurks beneath the ice: plastic pollution. This remote region, a symbol of natural beauty, is not immune to the global environmental crisis. As the world grapples with the escalating impacts of human activity, scientists engage in critical research to understand the full extent of marine litter in the Arctic, highlighting our profound interconnectedness with nature.

The profound silence was momentarily interrupted by the rhythmic purr of the Zodiac's engine. Deborah Stoll, her face stung by the cold, was returning from a demanding day on Svalbard's icy beaches. "My hands are frozen!," she half-jokes, tucking her hands into her wool-lined jacket. The dinghy is slowly making its way back to the icebreaker - *Le Commandant Charcot*, cautiously navigating through shifting ice and deep blue waters. A large container beside her feet bore the evidence of the day's grimy work: an assortment of plastic waste.

Initially hailed as the saviour of trees, plastic production has surged since the 1950s, hitting 368 million tonnes worldwide annually by 2019. It is estimated that each year, around 19 to 23 million metric tonnes of poorly managed plastic waste flow from land-based sources into global waters.

Contrary to popular belief, the Arctic isn't isolated from the world's problems. In fact, it's a gathering place for pollutants like heavy metals, chemicals such as Polychlorinated biphenyls (PCBs), and marine debris, including plastics, carried there by ocean currents, winds, and river drainage.

Particularly around Svalbard, north of the Arctic circle, the concentration of plastic debris is disturbingly high.

Researchers have noted how plastics can get temporarily trapped within sea ice, only to be released again the following summer, contributing to the yearly buildup of pollution.

From commonplace items like drink bottles and candy wrappers to discarded fishing nets and rope, Stoll's collection painted a sombre picture. "It's surreal to be in such a remote place and still find plastic items from our everyday life washed up on beaches," says Stoll, a Biology Student and assistant researcher from the GEOMAR Helmholtz Centre for Ocean Research Kiel.

Stoll, still early in her career as a researcher, vividly recalls her first expedition to the Arctic the previous year. It was a stark contrast to the structured environment of her research lab back in Germany. "It was a big shift the first time —I'm not sure you ever get used to the polar day, having sunshine at midnight is really odd. It is helpful when you have to work at night though. Sometimes you have to be ready at a moment's notice when an opportunity comes around to collect data. But you quickly learn to adapt to the unpredictable nature of field research out here," reflects Stoll. "I remember feeling a mix of awe and responsibility. Being physically here, right next to the melting glaciers and fragile ice sheets and collecting plastic, made me realise the magnitude of our mission."

Deborah Stoll preparing surface water debris captured by the Manta Trawl Net for analysis. Arctic GOOD-IMDOS science campaign in June 2023. Photo credit: Xavier Boymond.

Despite the prevalence of plastics, the waters between Svalbard and Iceland, encompassing the East Greenland Current, remain under-researched, with scant data on pollution levels. This is why Stoll has returned to the region for a second time, as part of a five-year strategic Arctic observing programme, to participate in a global effort to increase observations of marine litter: the Integrated Marine Debris Observing System (IMDOS).

"While many portray the ocean as housing a 'seventh plastic continent', the reality is that plastic is everywhere in the ocean and we've identified only about one per cent of the plastic we believe is in the ocean," says Dr. Audrey Hasson, co-coordinator of IMDOS and head of the GEO Blue Planet European Office at Mercator Ocean International. The pressing question: Where's the remainder?

Numerous tools are available for identifying and gathering marine plastic data, ranging from community-led science initiatives to sophisticated technologies like satellite imagery, submersibles and Remotely Operated Vehicles (ROVs). But each also has their limitations. While satellites can locate patches of large plastic items that have accumulated on the sea surface, for instance, smaller items or plastics beneath the surface often go unnoticed. On the other hand, ROVs and submersibles have the capability to spot plastics beneath the surface, but dedicated missions are few in number, very expensive and often limited to a relatively small survey area.

"Measuring plastic is among the most challenging tasks we've faced. Given its diverse chemical compositions, shapes, and its ever-evolving nature, there's a pressing need to coordinate as a global community, use uniform methods and develop innovative tools to improve data collection," says Hasson.

Stoll's research aboard the state-of-the-art icebreaker designed for polar tourism is part of ongoing efforts to provide scientists with much-needed access to these regions. With tourism cruise ships regularly travelling to the Arctic, these partnerships give scientists more opportunities to gather crucial scientific data.

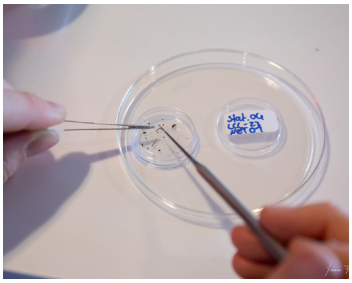
"We're especially lucky as the Charcot has dedicated science facilities so we can access the equipment we need to do the work," says Stoll. Such tools include the Manta Trawl Net, traditionally used for biological sampling, gliding gracefully behind the Zodiac, its metallic wings spread wide, capturing surface water debris in search for microplastics (plastic fragments under 5 millimetres in length).

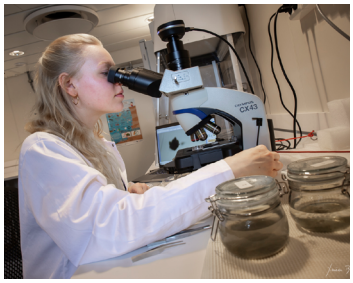
Stoll leans over to inspect the device as it drags in the water, collecting the last sample of the day. "We always sample three transects at each location due to the patchy distribution of plastic particles. It means we get a comprehensive overview of the area," she says, looking at the horde of plastic found at the beach earlier today. "I wish it would come up empty, but given today's findings, that seems unlikely."

The UN Environment Programme (UNEP) is spearheading efforts for an "international legally binding instrument on plastic pollution, including in the marine environment". In Europe, momentum is also building to prohibit certain single-use plastics. From July 2021, items such as straws, cutlery and cotton buds can no longer be sold in EU Member States.

Understanding the plastic origins, movement, and its interactions with marine life is paramount for shaping these policies and formulating strategies to address this universal concern. The goal now is to scale these efforts globally, says Hasson. Adding, "A holistic system to monitor plastics throughout the ocean's depths is essential. While tracking plastic is our main objective, it's also crucial to recognise its role as a base for invasive species and its potential to ferry detrimental toxins and pathogens. It's imperative to unify our efforts under IMDOS, from community-driven beach clean-ups to sophisticated shipborne equipment."

Developed as a joint project between the Group on Earth Observations (GEO) Blue Planet Initiative, the Global Ocean Observing System (GOOS), and the UNEP Global Partnership on Plastic Pollution and Marine Litter (GPML), IMDOS aims to harmonise data, standardise monitoring methods, and strengthen marine debris research.





Analysing microplastics collected in surface water debris.
GOOD-IMDOS science expedition to the Arctic, June 2023.
Photo credit: Xavier Boymond.

In tandem with partners like European Commission's MSFD Technical Group on Marine Litter and Japan's Ministry of Environment, IMDOS is refining data collection and monitoring standards, ensuring consistency and accessibility across various data sources. This not only bolsters research and decision-making but also paves the way for integrating marine litter data into a Digital Ocean Twin.

The engine of the Zodiac abruptly stops. "Listen," Stoll murmurs. The air fills with a series of melodic clicks, resembling the fast crackling of electric currents. Suddenly the water near the dinghy begins to stir, followed by a gentle "pshh" sound, misting Stoll with a fish-scented spray. Her grimace quickly changes to awe. Emerging from the depths, ghostly white figures appear around the boat. It's a pod of beluga whales, their luminous skin contrasting with the ocean's deep blue. Conversations momentarily forgotten, the team onboard watch in silence.

As the belugas gradually move away, the Zodiac's engine hums back to life. "That was incredible!," yells Stoll, her excitement mirrored by the others.

Once back onboard, Stoll eagerly sips at the hot tea made of orange, apple and rosemary offered by the crew. Placing her cup down, she makes her way to the laboratory to begin methodically processing the day's samples. For now, the plastic waste collected from the beach is placed to one side. She rinses the three cod ends of the Manta net, transfers the contents to a glass jar, and begins examining each sample under a microscope, picking out every plastic particle with tweezers. "This is usually when I put my headphones in and listen to my favourite podcast "Helden der Meere" to help pass the time," Stoll says.

These particles will be stored in petri dishes and later analysed at the GEOMAR laboratory in Germany. Eventually, the larger items found on the shore will be compared to the microplastic samples to identify any correlations in plastic debris.

"Guten Tag Deborah," calls Geoffroy, the science officer onboard, stepping into the room. Behind him, a motley group of Charcot's passengers curiously looking around at the array of laboratory equipment. "Might you spare a moment to help us unravel the mysteries of plastic research?"

Stoll smiles, "How long do you have?"

Analysing microplastics collected in surface water debris using Manta Trawl Net, gliding gracefully behind the Zodiac, its metallic wings spread wide, capturing surface water debris in search for microplastics (plastic fragments under 5 millimetres in length).

GOOD-IMDOS science expedition to the Arctic, June 2023.
Photo credit: Xavier Boymond.

The article was written by Kira Coley, an independent scientific journalist, illustrated with photos by photographer Xavier Boymond as part of a communication campaign to showcase EU commitment to and the importance of Arctic Ocean observing and monitoring. Coordinated by the EU4OceanObs team at Mercator Ocean International with funding from the EU, we would like to thank everyone who participated in the campaign, and agreed to be interviewed, photographed, and advise the project along the way – all experts and researchers from the Global Ocean Oxygen Network (GO2NE), the Global Ocean Oxygen Decade (GOOD) initiative, GEOMAR, AWI, the Ponant Science team, the community of IOC UNESCO, the European Commission, ECOTIP, G7 FSOI, among many others.

https://www.eu4oceanobs.eu/oceanobserving-awareness/arctic-observing/

Funded by the European Union

EU4 @cean obs

MERCATOR OCEAN INTERNATIONAL