Microplastic Pollution in the Raquette and Grasse Rivers

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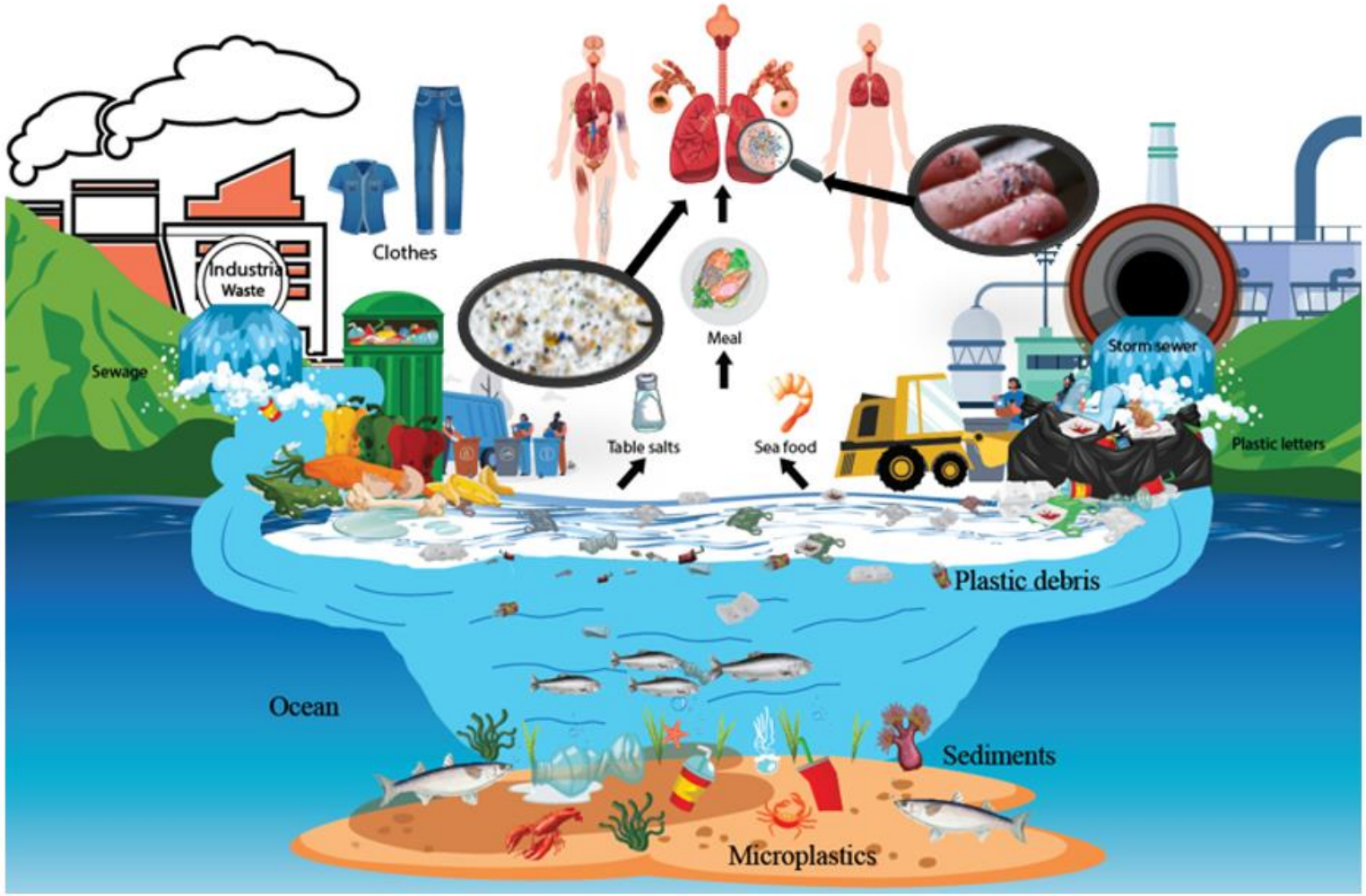
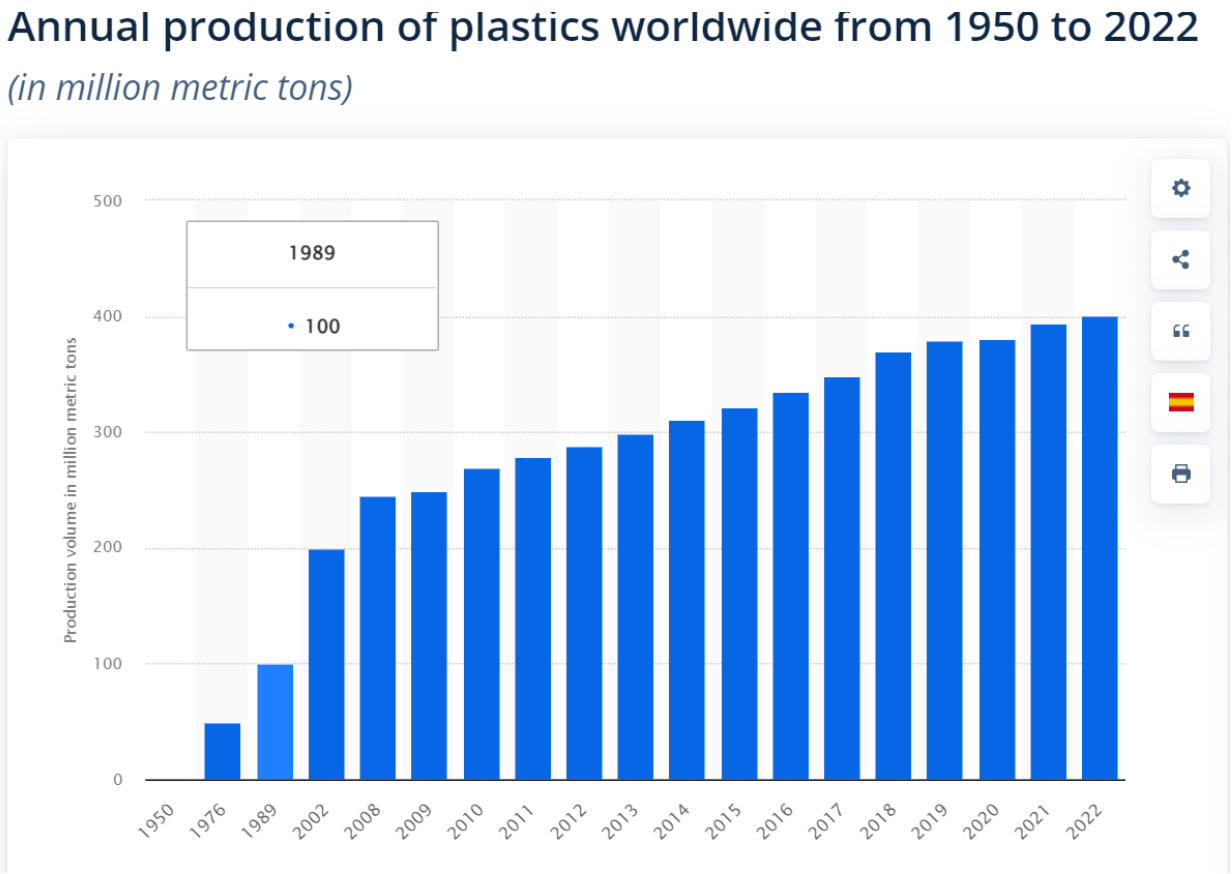
Microplastics: Sources, Type, and Impact



Plastic Life

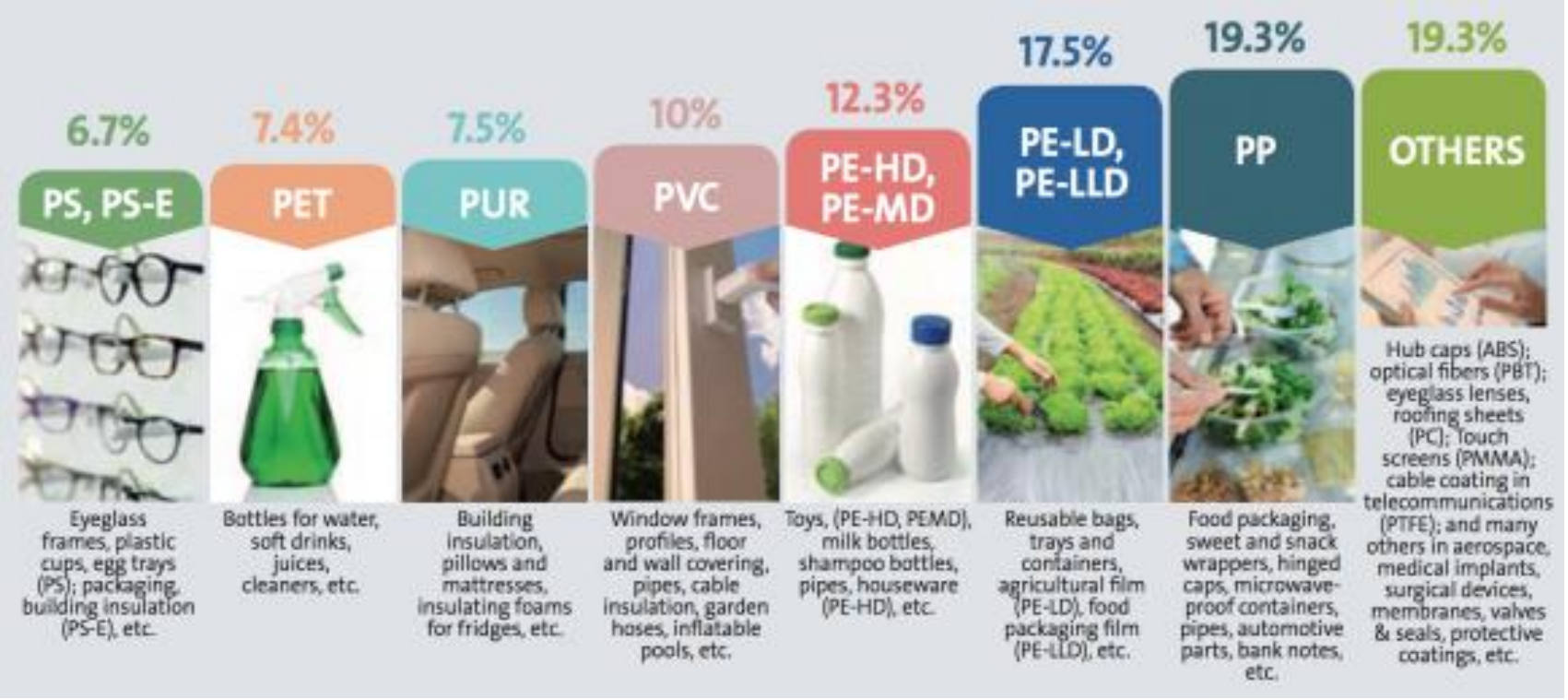
- The mass use of plastic started in the **1950s** and has steadily grown ever since.
- Today, **more than 300 million tons** of plastic are produced **annually.**
- The largest plastic waste comes from the **packaging industry**: two-thirds is generated by **households** and one-third by **industry and commerce.**



Plastic Life

- The popularity of plastic is due to its **low production costs, low weight, acid resistance, and flexibility.**

- The most common types of plastics, known as mass plastics, are **polyethylene, polypropylene, PVC, polystyrene, PET, and polyurethane**.

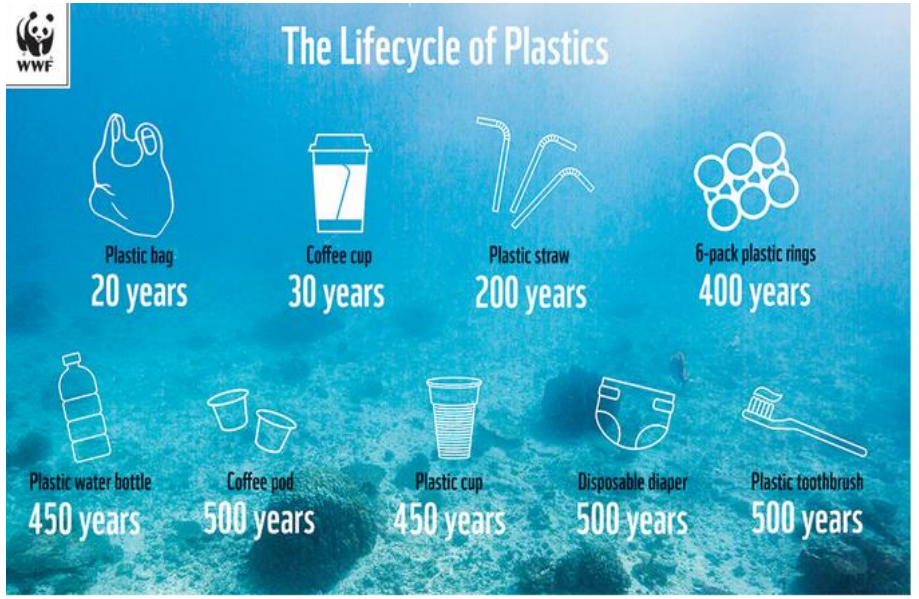


Plastic Waste

Around the world, **one million plastic bottles are purchased every minute**, while up to five trillion plastic bags are used worldwide every year.

In total**, half of all plastic produced is designed for single-use purposes** – used just once and then thrown away.

While the lifespan of plastic products averages around 10 years, **plastics can take up to 500 years to decompose**, depending on their composition and disposal.



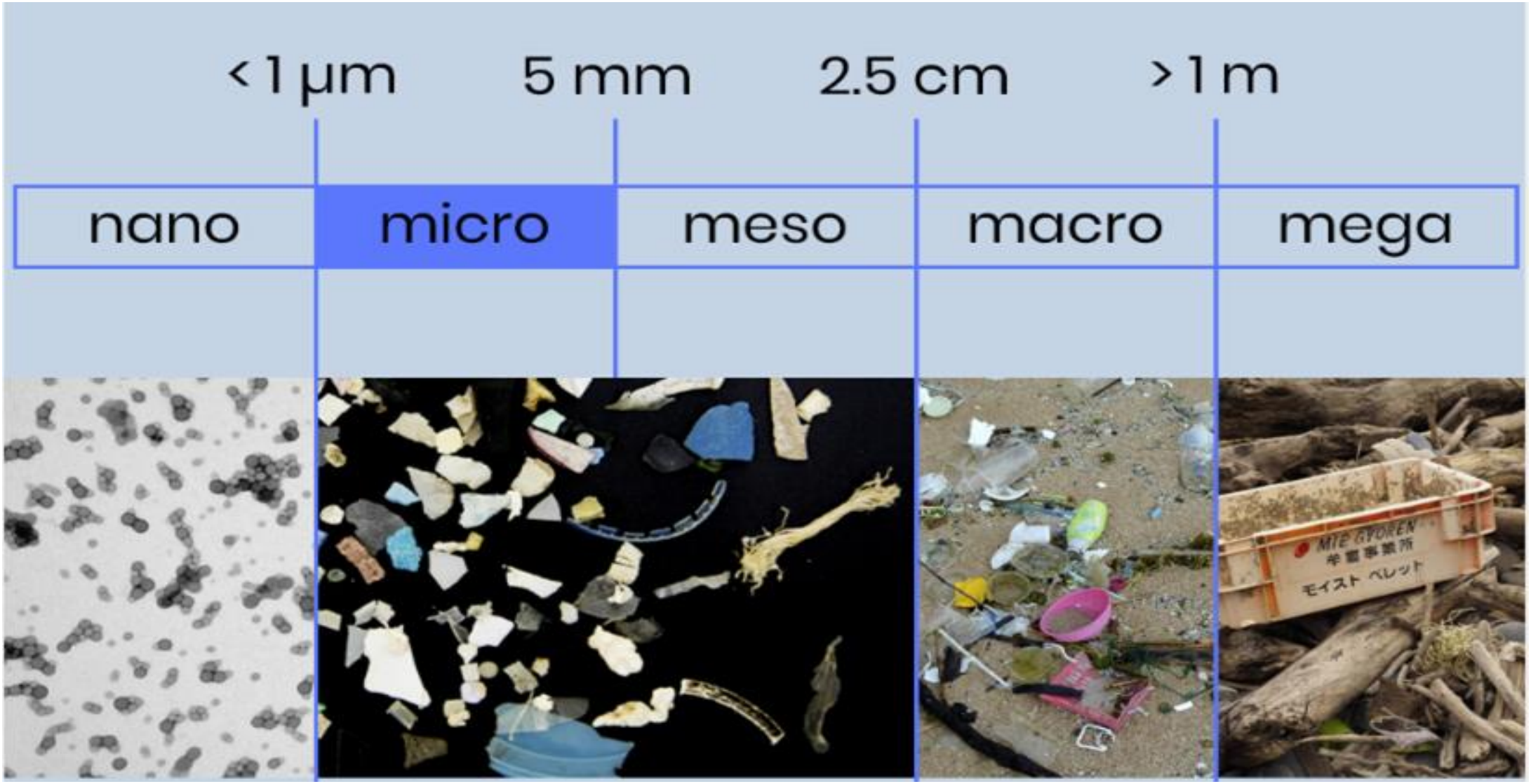
Lesson 2

The Story of Microplastic

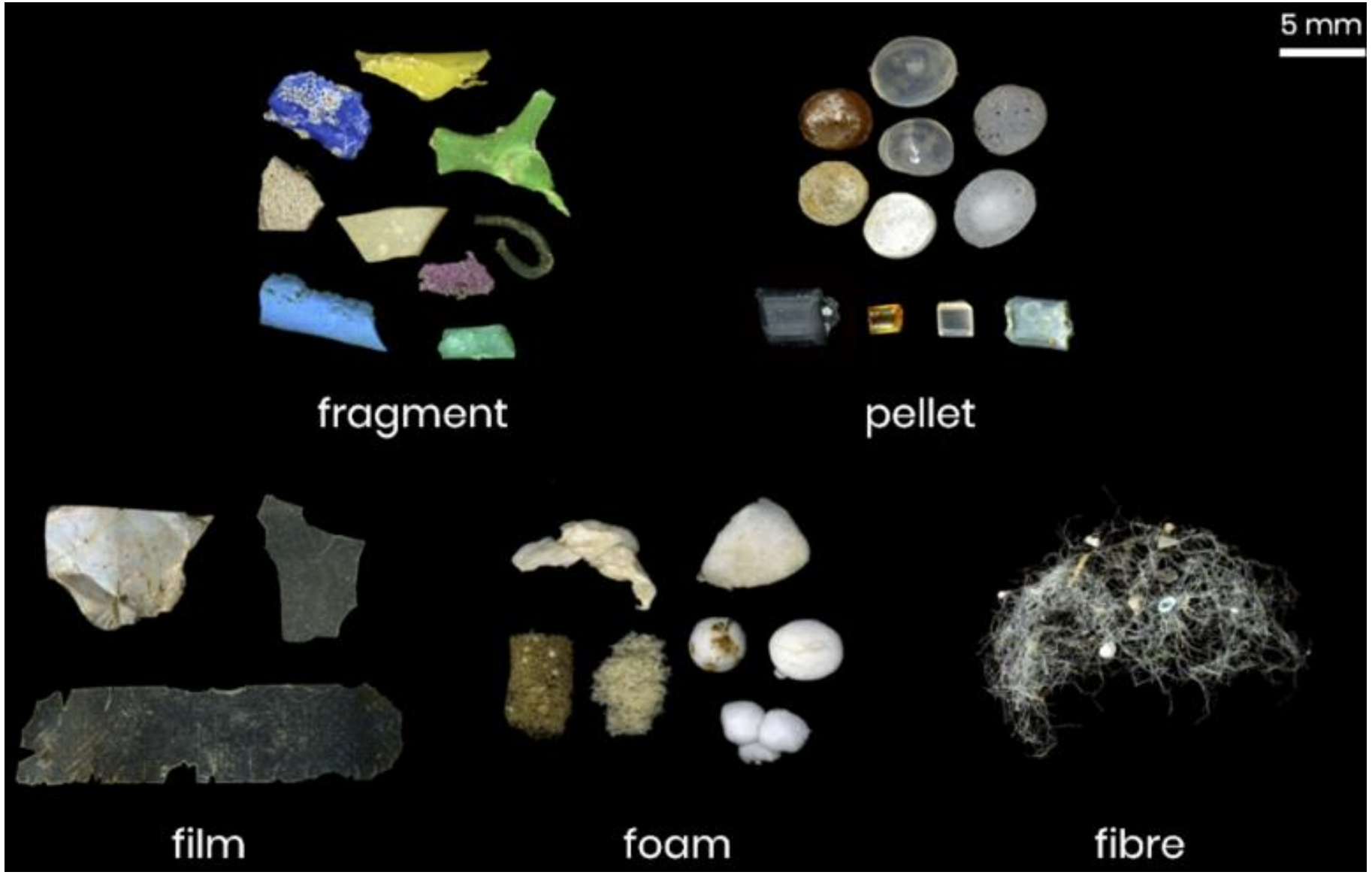
by Jonak Chakrabarti

SUPPORTED IN PART BY A GRANT FROM THE NATIONAL GEOGRAPHIC SOCIETY

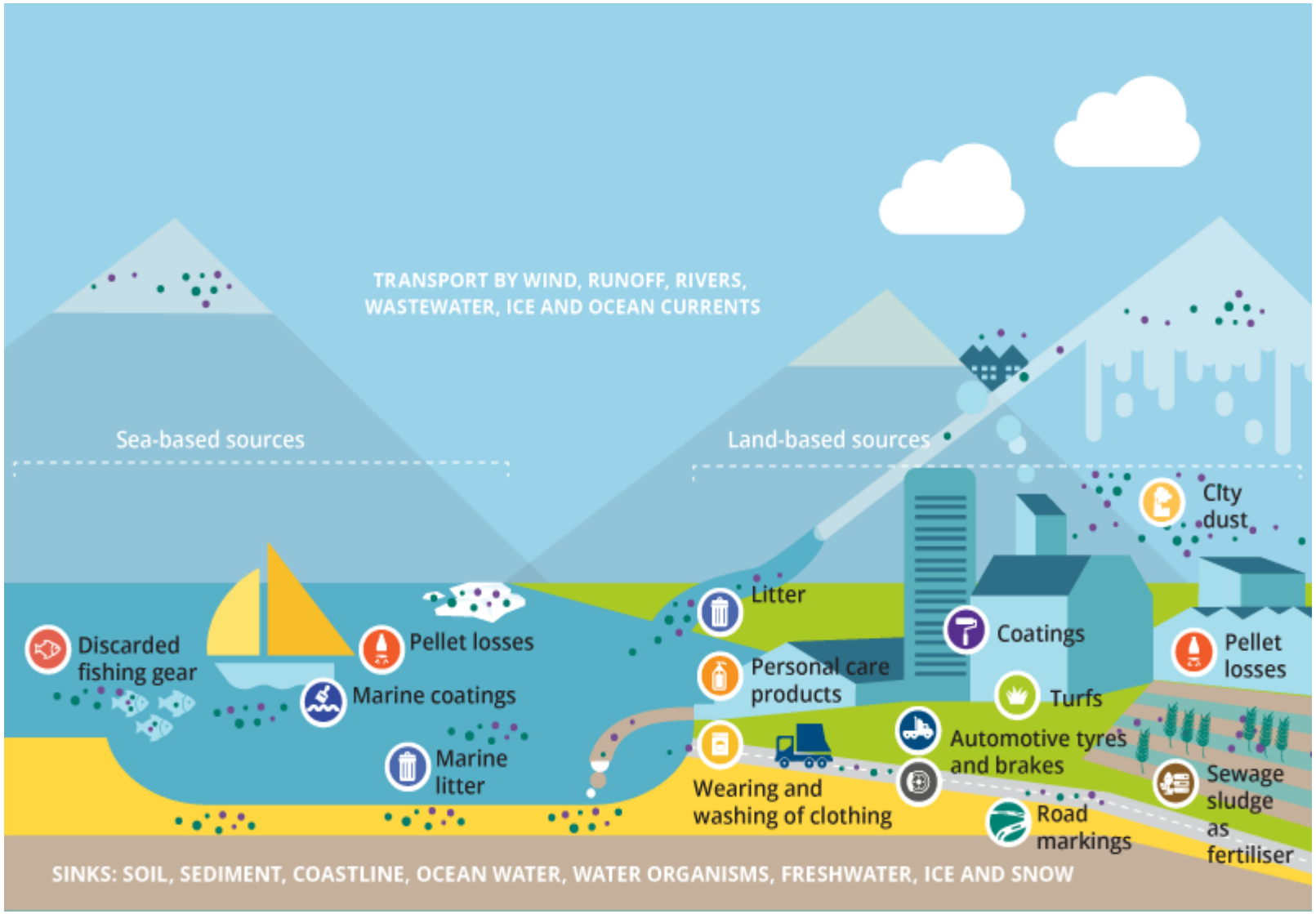
Classification of Plastic Litter

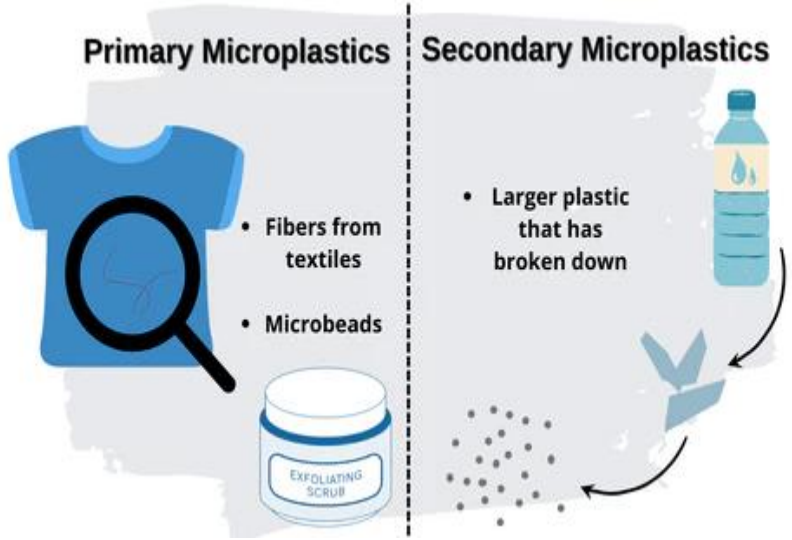


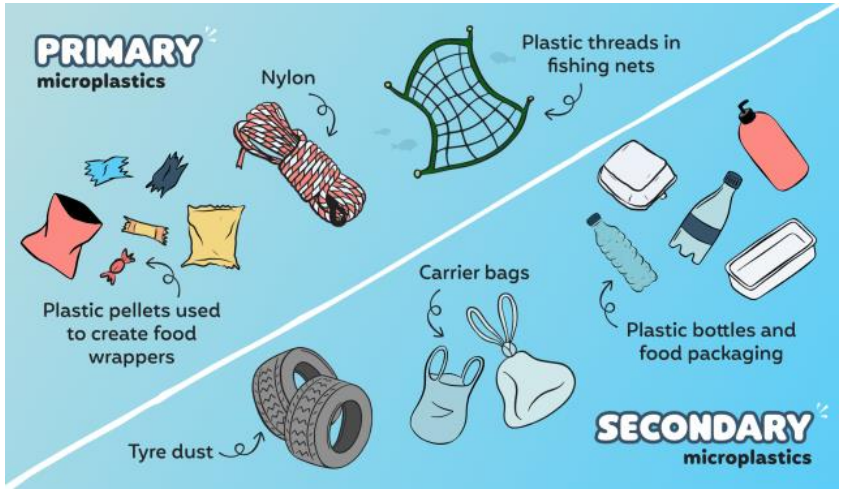
Common Plastic Shapes



Sources of Microplastics







Are we a source?

ARTICLE / 9 AUGUST 2018

Government considers ban on microbeads after water is found to be contaminated

By

Microbeads were only some of the microplastics that the study found in rivers, boreholes and tap water. (The Science Explorer)

Bottled water also contaminated

It is not known how microbeads and other microplastics got into tap water in Gauteng.

Bouwman recommended in his study that the "pathways" of microplastic pollution of freshwater be studied.

South Africa is not alone in having tap water contaminated by microplastics. A study by Orb Media this year of tap water from more than a dozen countries found microplastic contamination in 83% of the samples. The US had the highest contamination rate with 94% of tap water samples containing microplastic, and the UK, Germany and France the lowest rate at about 72%.

Pathways into the Environment

Direct Release from industries through runoff.

Urban Runoff from rainwater

Wastewater Treatment Plants: personal care products, washing machines wastes.

Litter and Waste **Mismanagement**

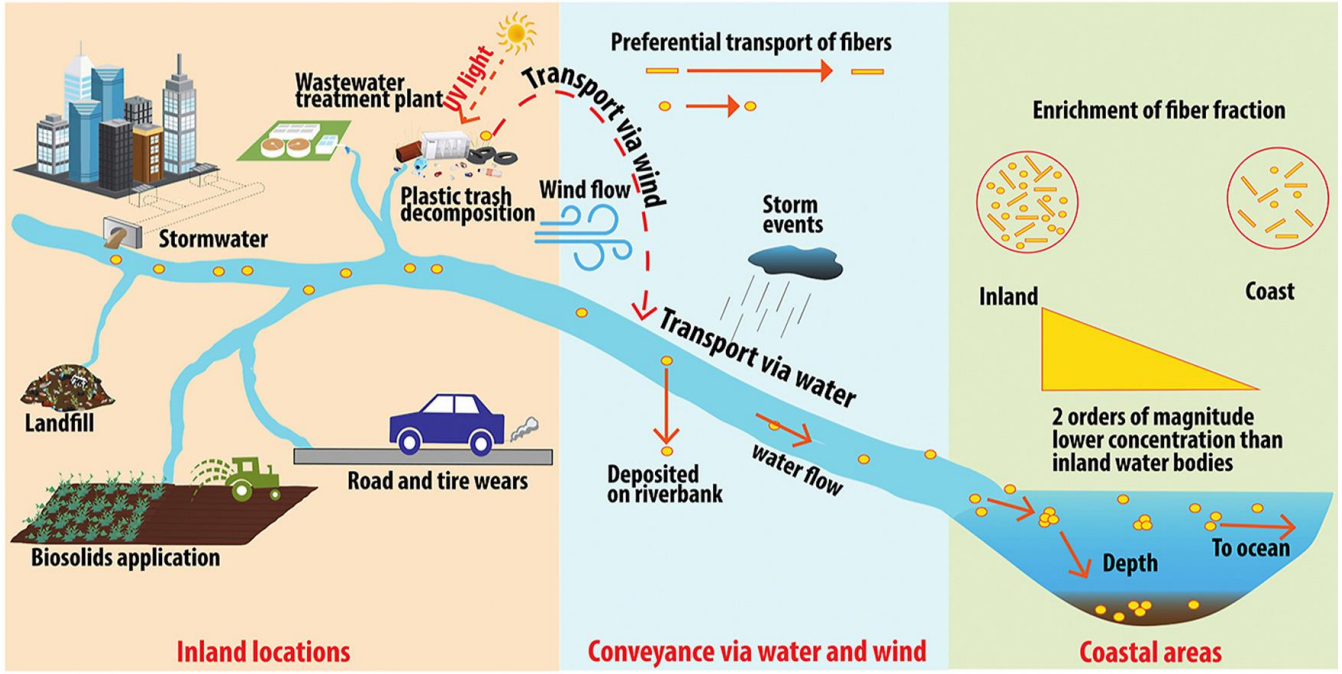
Bioaccumulation in aquatic organisms as they mistake them for food and entering the food chain.

Aquatic Transport by currents, tides, and rivers

Pathways into the Marine Environment

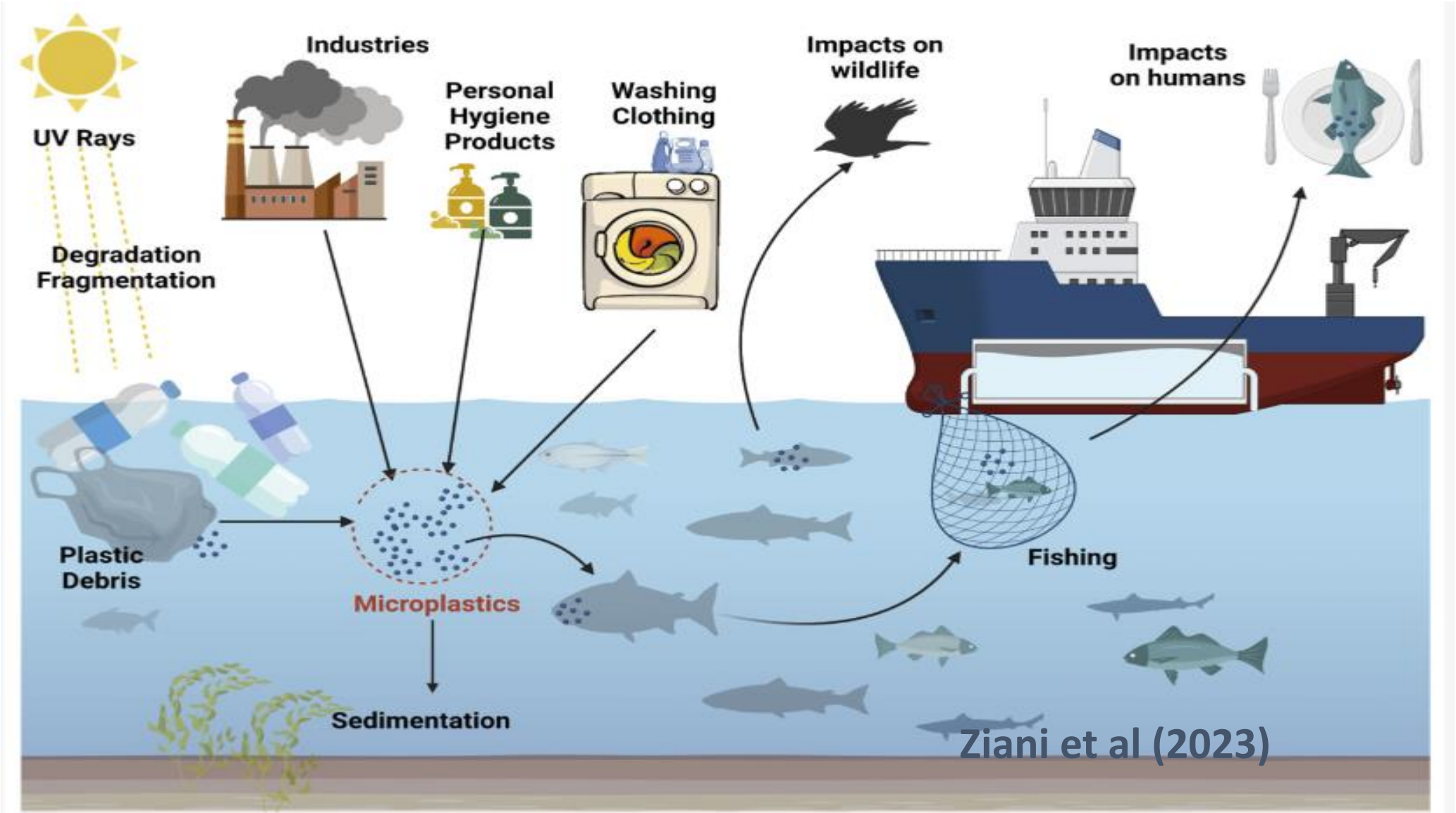
The majority of the microplastics that reaches aquatic environment originates from land-based sources and is assumed to ultimately reach the **sea via streams and rivers**.

"***Without significant action, there may be more plastics than fish in the ocean, by weight, by 2050***" – as noted by World Economic Forum (2016)



(Koutnik et al., 2021)

Microplastics contamination in ecosystem



Ziani et al (2023)

Impacts of Microplastics

Wildlife Ingestion: Accumulation of microplastics in the digestive tracts of animals can cause ***blockages, malnutrition, and even death.***

Disruption and Degradation of Ecosystems: Microplastics can settle in sensitive habitats and Microplastics can disrupt aquatic food chains and alter ecosystem dynamics.

Water Quality and Marine Life: Presence of microplastics in water bodies ***reduce water clarity*** and harm marine life.

Human Inhalation: Airborne microplastics, released from textiles, packaging, and other sources may cause potential ***respiratory effects*** and health risks.

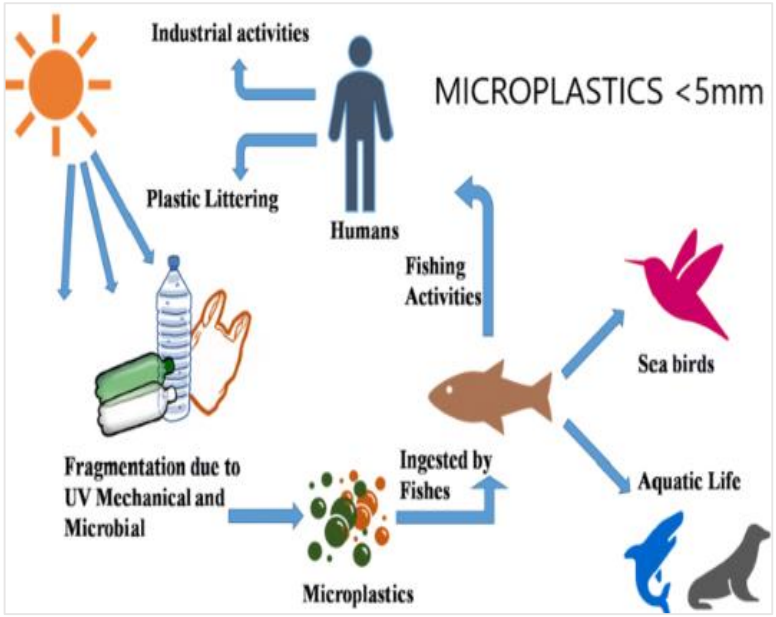
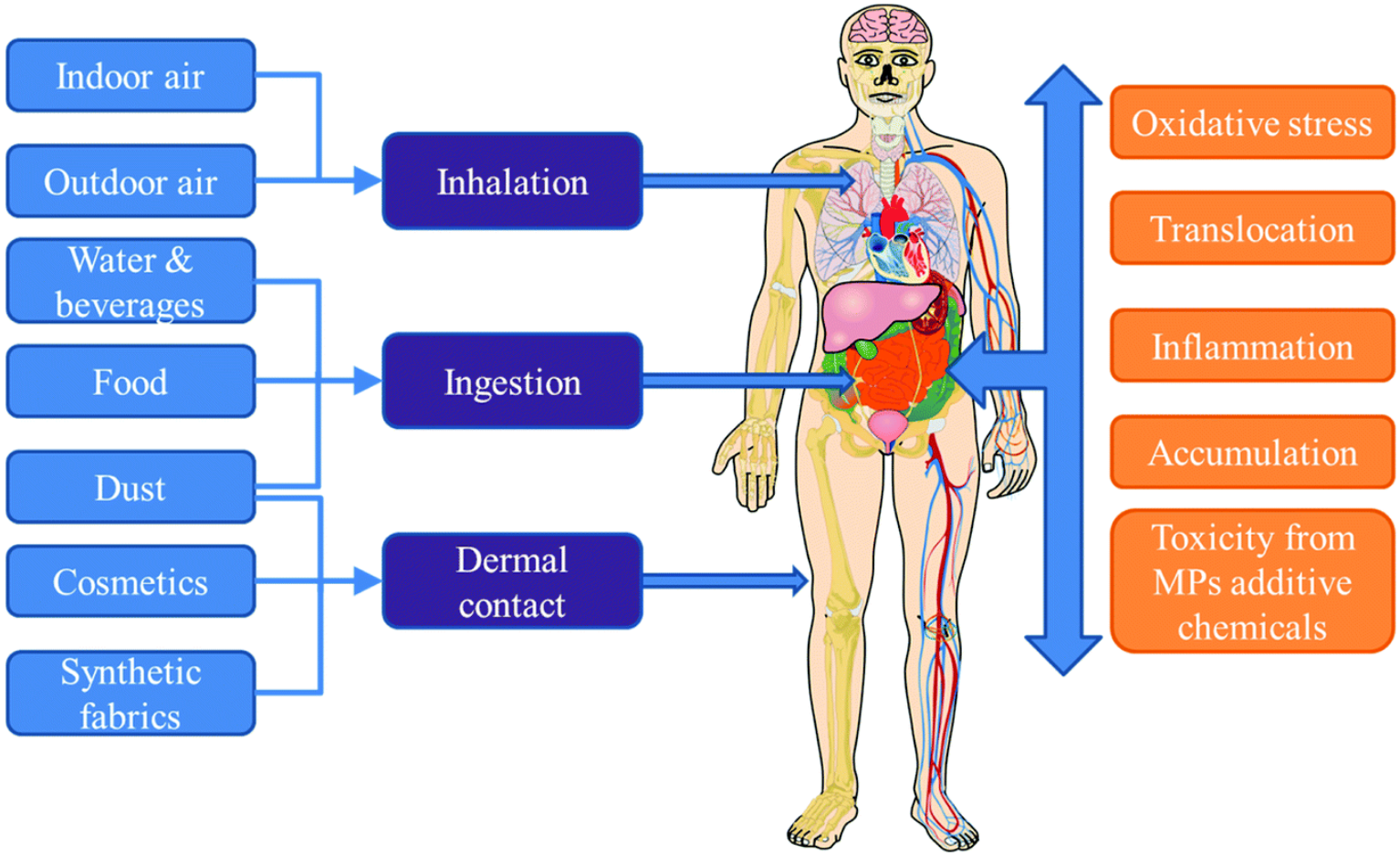


Figure: Microplastic effects in aquatic systems (Issac and Kandasubramanian, 2021).

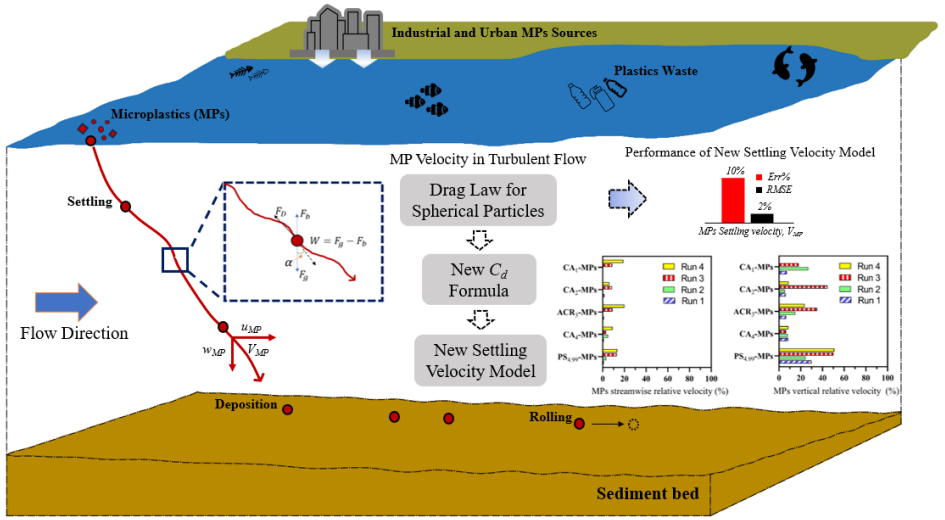
Health Risks with Microplastics

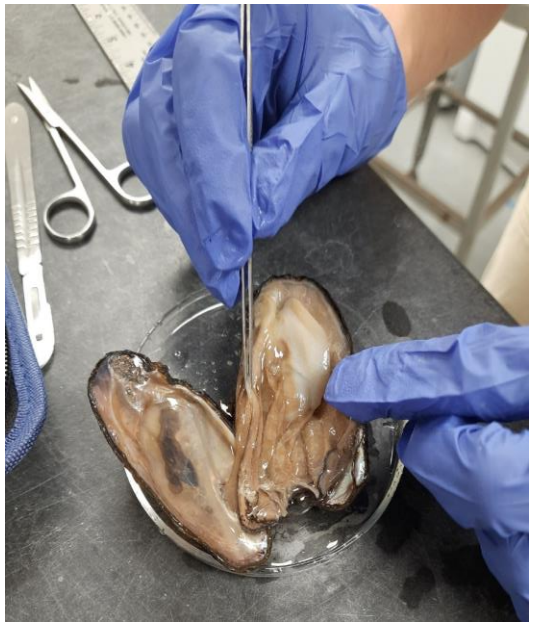
- 7 % of NPs have the potential to pass epithelial cells and reach various organs, including **the brain, heart, thymus, liver, and spleen.**

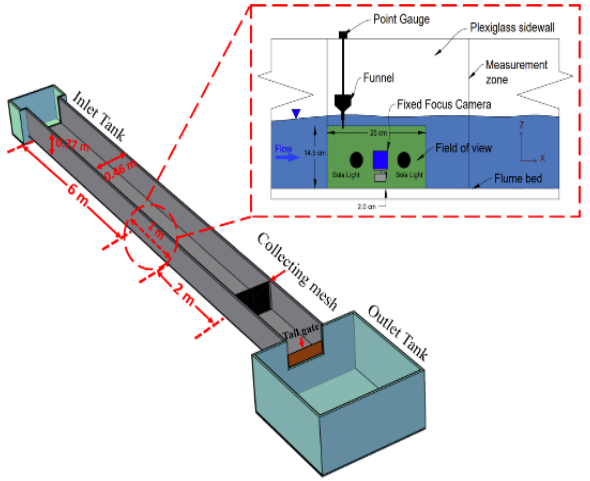
- Particles **<150 µm** can potentially be absorbed through **the intestinal mucosa** and then pass to the lymphatic system, while particles **<110 µm** could enter the **bloodstream** via the portal vein, and particles **<20 µm** have the potential to reach **internal organs.**



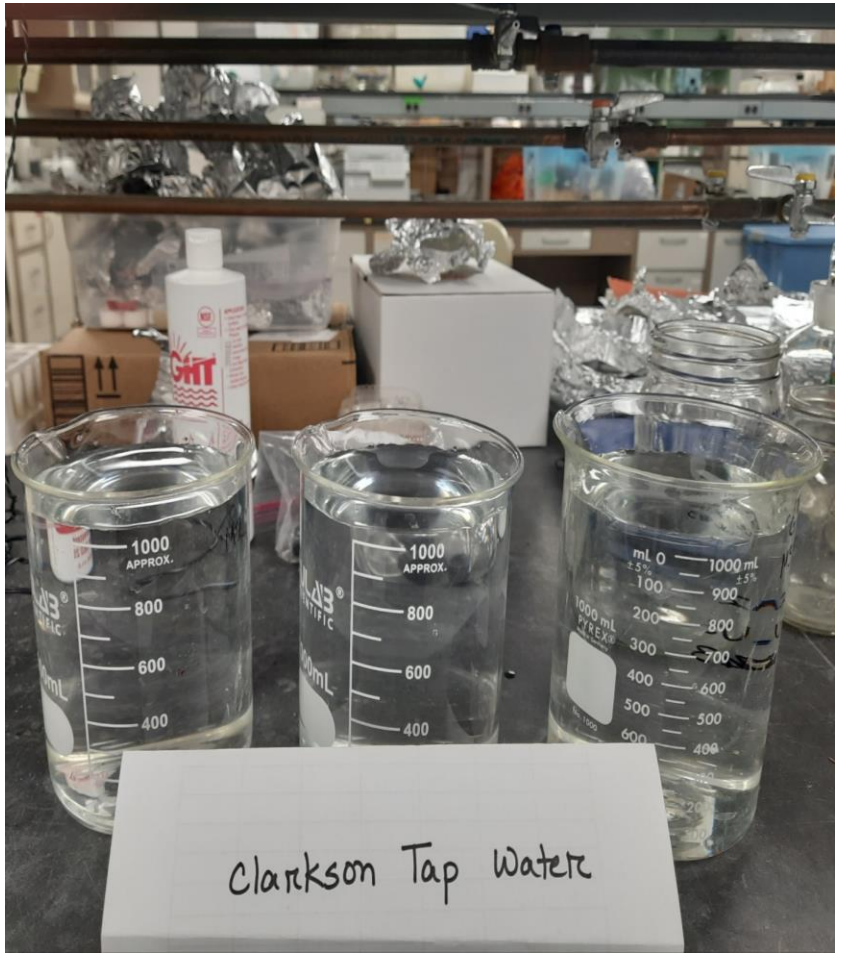
Clarkson University Research on Microplastics

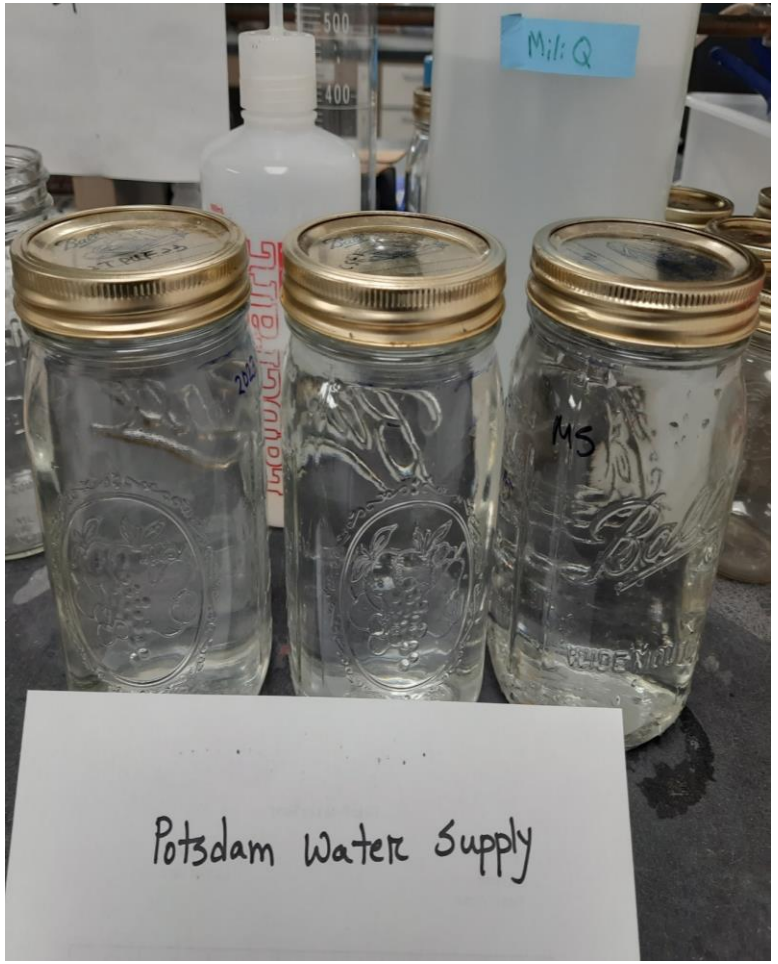






How much microplastics are in tap water?



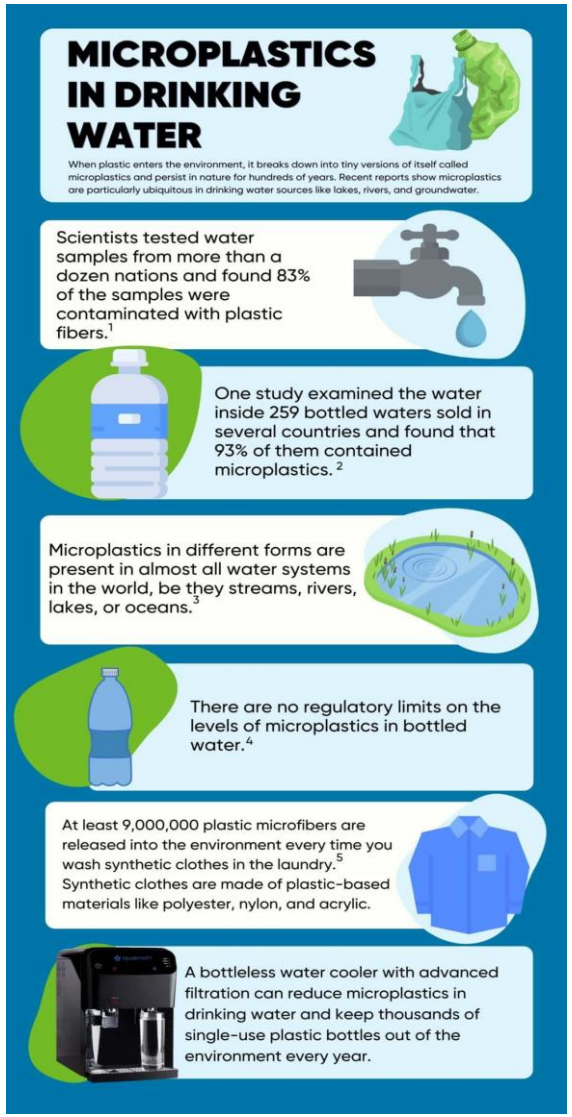


How much microplastics are tap water?

Source	Microplastics Abundance (item/L)
Individual House Tap Water	3
Clarkson Tap Water	3.33
Potsdam Water Supply	5.33

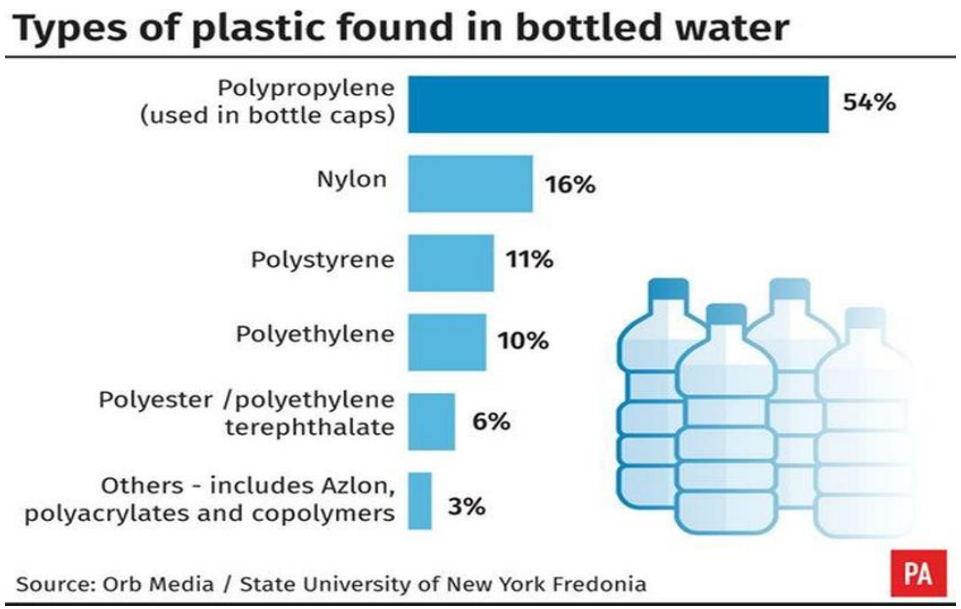
Sample	Country	Detection method[a]	Abundance			Size (μm)	References
			Fragment MPs (%)	Fibrous MPs (%)	Total counts (L^{-1})		
Tap water			2.5	97.5	0–61	1–100	
Tap water	China	μRS	53–100	1–31	0–440	1–50	(Tong et al., 2020)
Tap Water	US	FT-IR	0–61	98.3	5.45	0.1–500	(Kosuth et al., 2018)
					Avg. ~170		

How much microplastics are in bottled water?

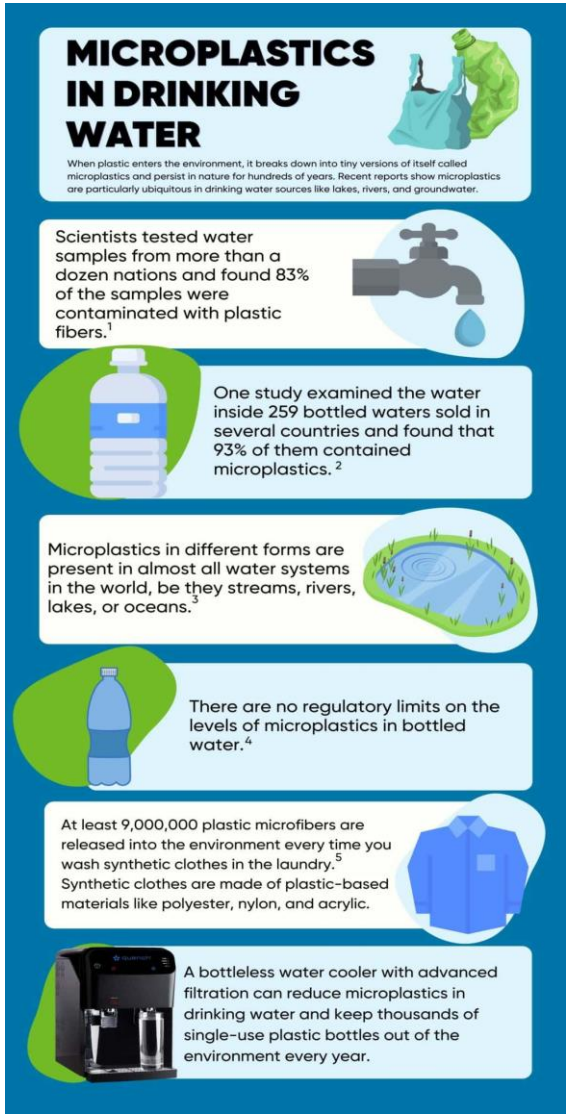


Sample	Country	Detection method[a]	Abundance			Size (μm)	References
			Fragment MPs (%)	Fibrous MPs (%)	Total counts (L^{-1})		
DW	UK	FT-IR	21	45	n/a	50–150	(Mintenig et al., 2019)
DW	Mexico	μRS	29	62	60–91	100–1000	(Shruti et al., 2020b)
DW	North America	μFT-IR	>10	≤90	0–5505	1–500	(Elkhatib and Oyanedel-Craver, 2020)
DW	Mexico	SEM-EDX	28	65	11–860	20–500	(Pérez-Guevara et al., 2022)
DW	US	FT-IR & RS	16–19	65	609	1–500	(De Frond et al., 2022)
DW	Canada	n/a	<10	>90	45–500	10–500	(Cherniak et al., 2022)
DW	China	μFT-IR	20	45	17–44	1–200	(Wu et al., 2022a)
DW	Indonesia	FT-IR	5–7	84–100	8.5–12.3	351–1000	(Radityaningrum et al., 2021)
DW	Czech Republic	FT-IR & RS	7–20	80–90	338–626	1–10	(Pivokonsky et al., 2018)
DW	Denmark	μFT-IR & Py-GCMS	81	19	238	8–374	(Kirstein et al., 2021)
DW	China	μRS	24	67	930	1–10	(Wang et al., 2020a)

Avg. ~ 940



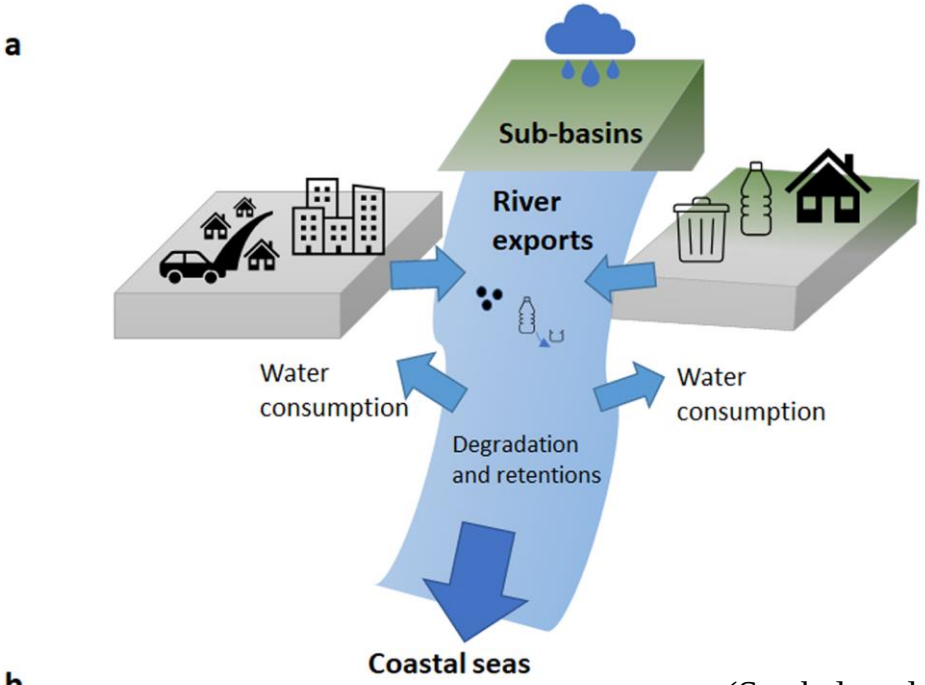
How much microplastics are consumed by human?



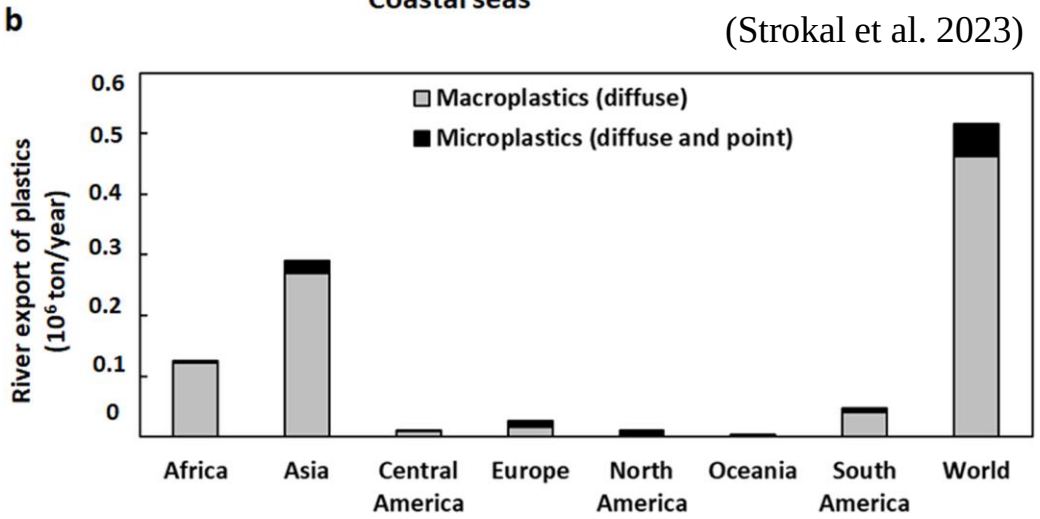
Human exposure to Microplastics

Daily water and MPs consumption	Per person/per day	MPs consumption in a Year	
		Bottled (~ 940/L)	Tap (~ 170/L)
	2 L/day- adult	686,200 MPs/Yr	124,100 MPs/Yr
	1 L/day- children	342,100 MPs/Yr	62,050 MPs/Yr
	0.75 L/day- infants	257,325 MPs/Yr	46,375 MPs/Yr

Microplastic Pollution in Rivers Worldwide



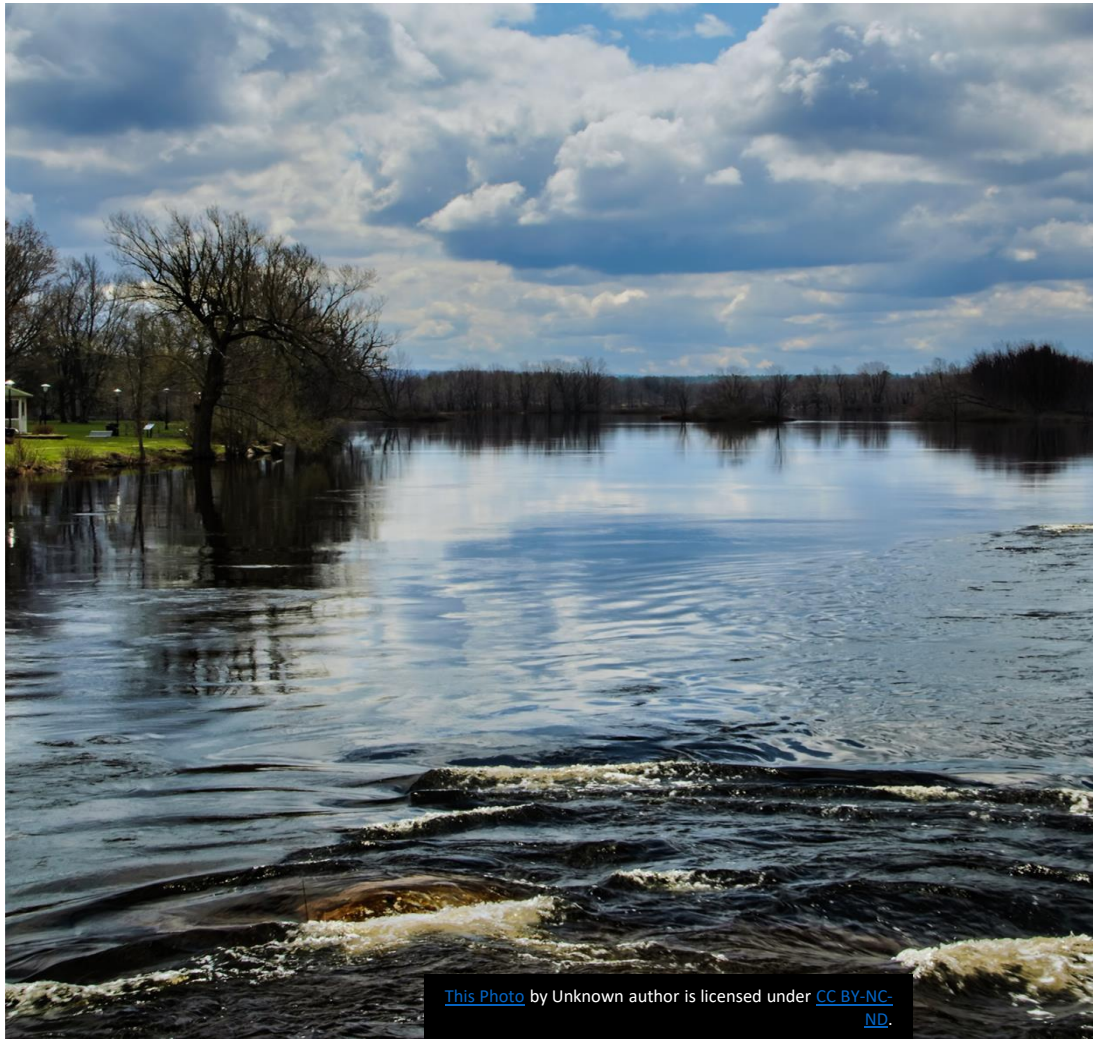
(Strokal et al. 2023)



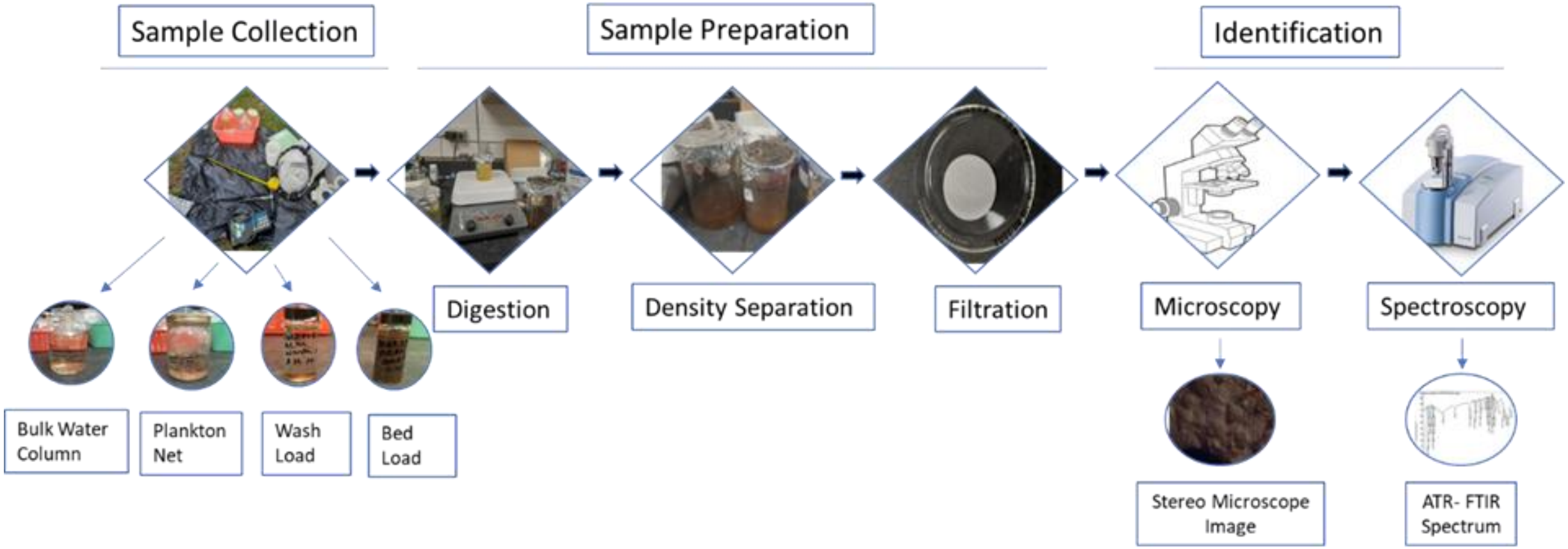
The **Yangtze River** alone pours up to an estimated 1.5 million metric tons into the Yellow Sea.

Credit: Getty Images

Microplastic Pollution in Raquette and Grasse Rivers



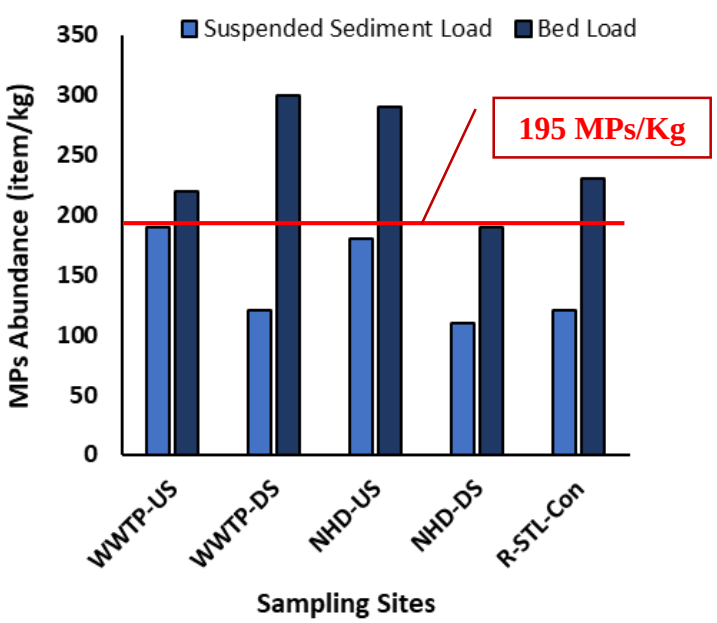
Laboratory-based methodology

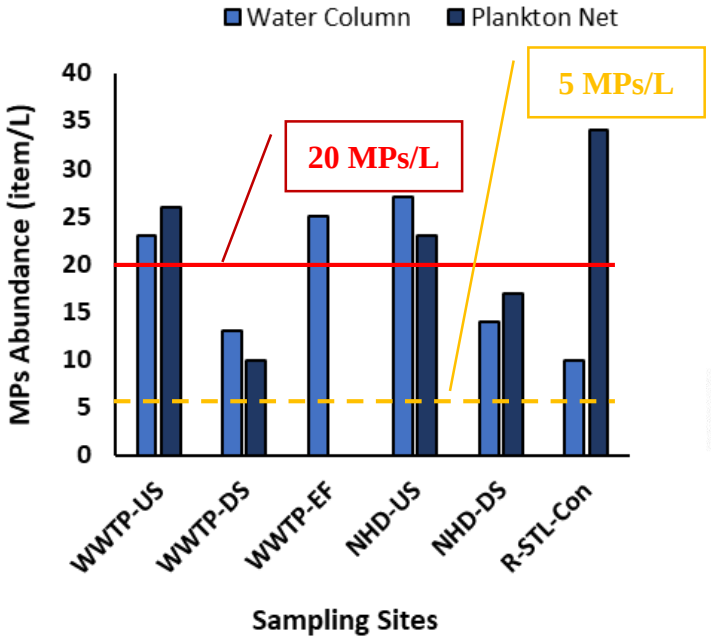


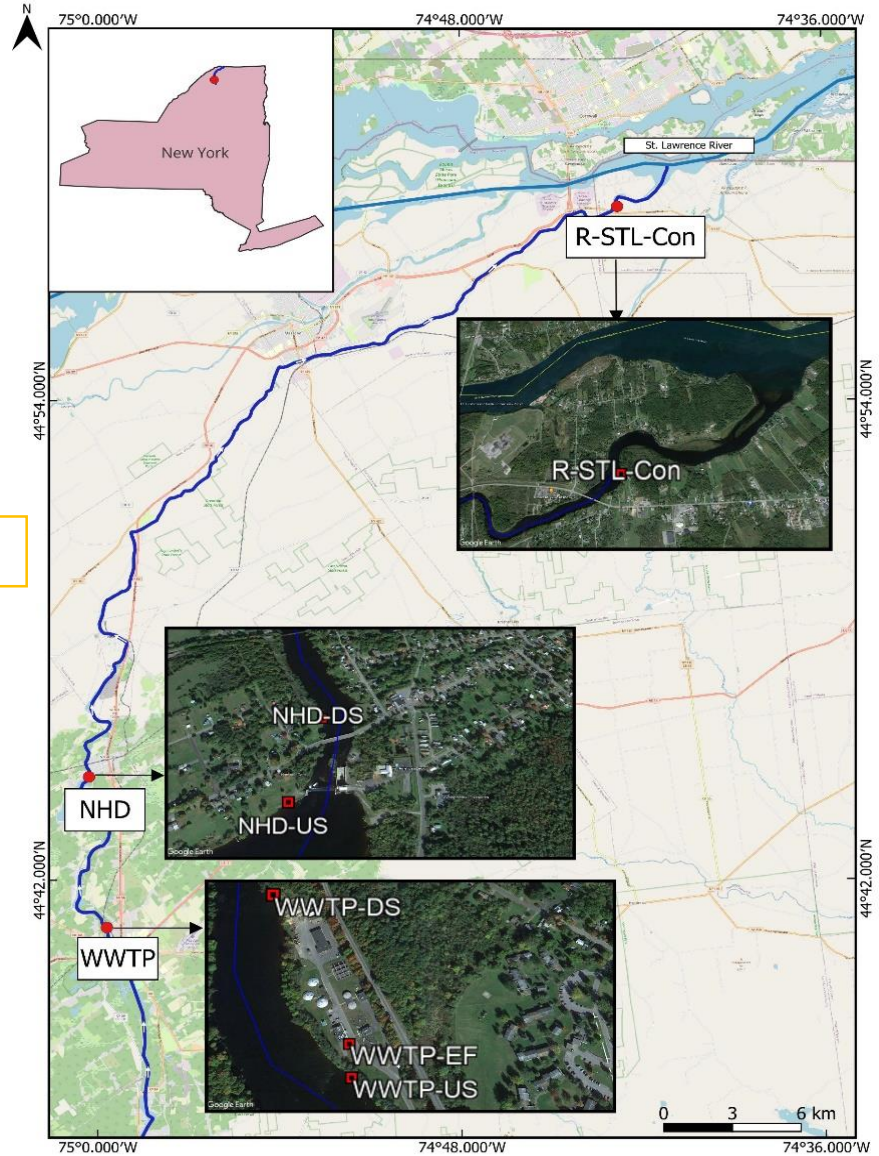
Microplastic Pollution Status in the Raquette River: Abundance

Average microplastics in sediment sample: 195 ± 67.21 items/kg (mean± standard deviation)

Average microplastics in water sample: 20.2 ± 7.86 items/L (mean± standard deviation)

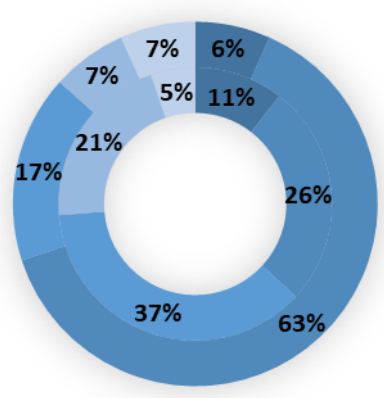




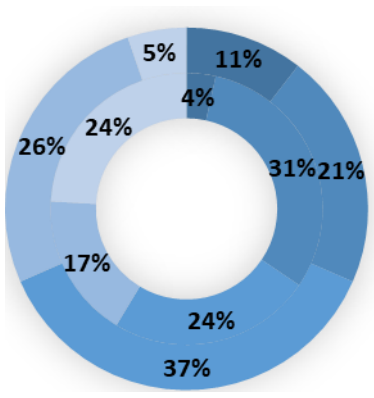


Aquatic life threshold 5 MPs/L by California Environmental Protection Agency

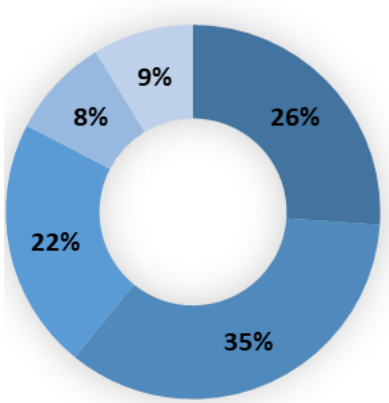
Microplastic Pollution Status in the Raquette River: Size



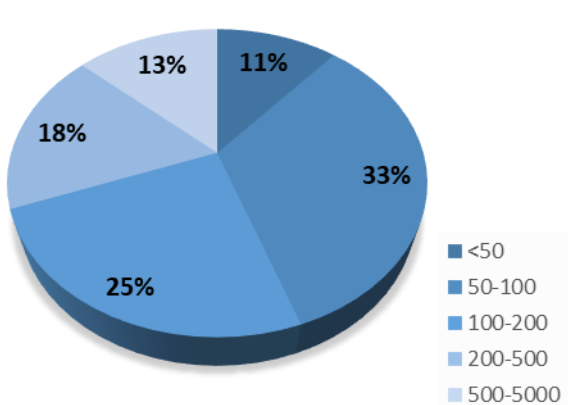
(a) WWTP: sediment



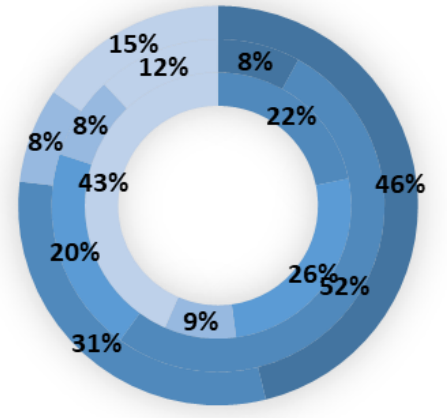
(b) NHD: sediment



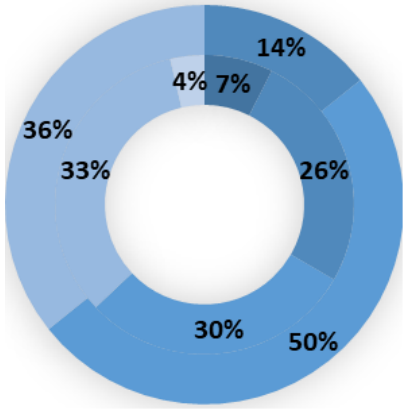
(c) R-STL Con: sediment



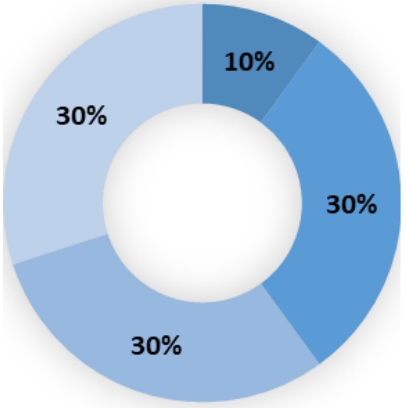
(d) Overall sediment



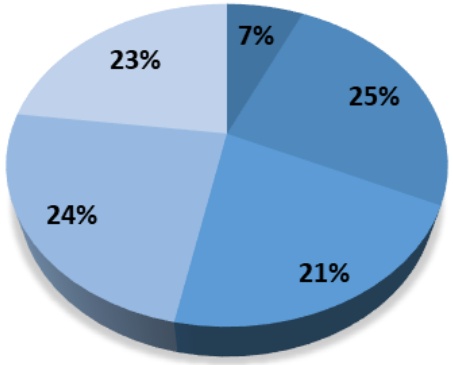
(e) WWTP: water



(f) NHD: water

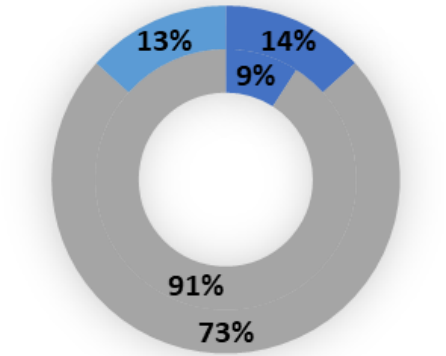


(g) R-STL Con: water

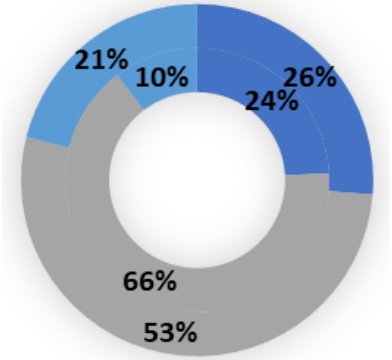


(h) Overall water

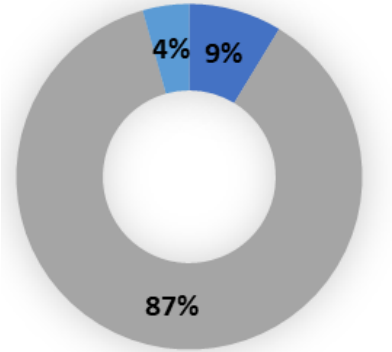
Microplastic Pollution Status in the Raquette River: Shape



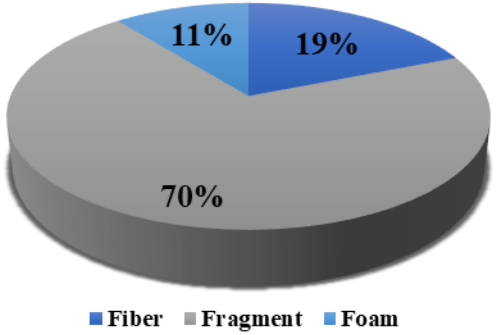
(a) WWTP: sediment



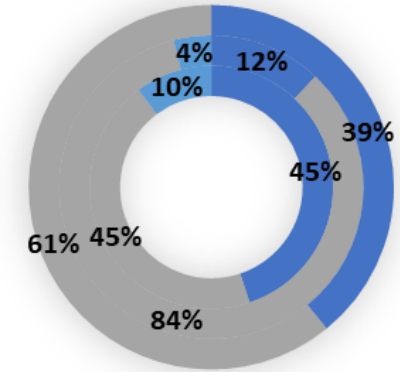
(b) NHD: sediment



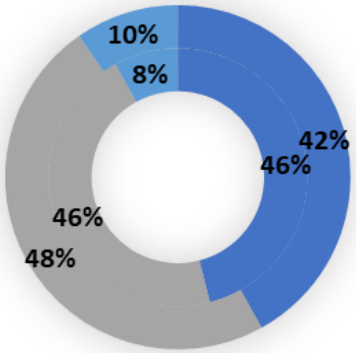
(c) R-STL Con: sediment



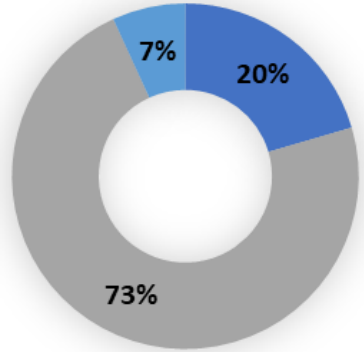
(d) Overall sediment



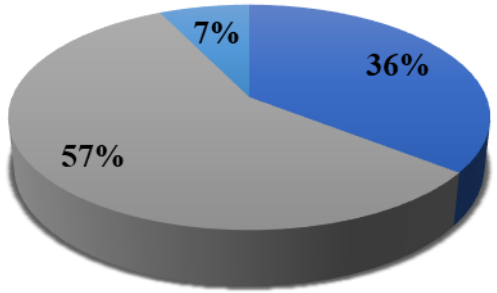
(e) WWTP: water



(f) NHD: water



(g) R-STL Con: water



(h) Overall water

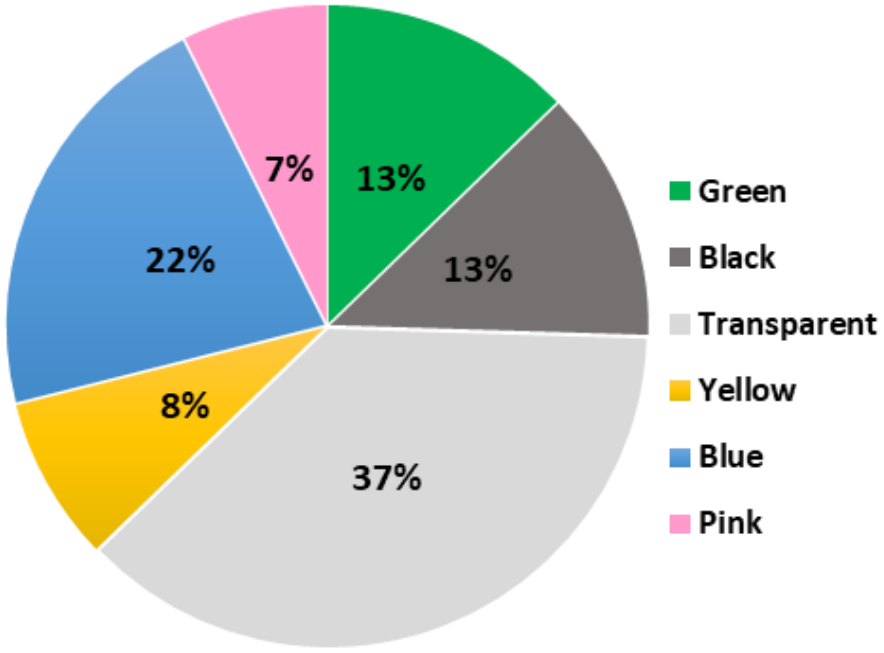
Microplastics observed under the microscope

(a) Fiber

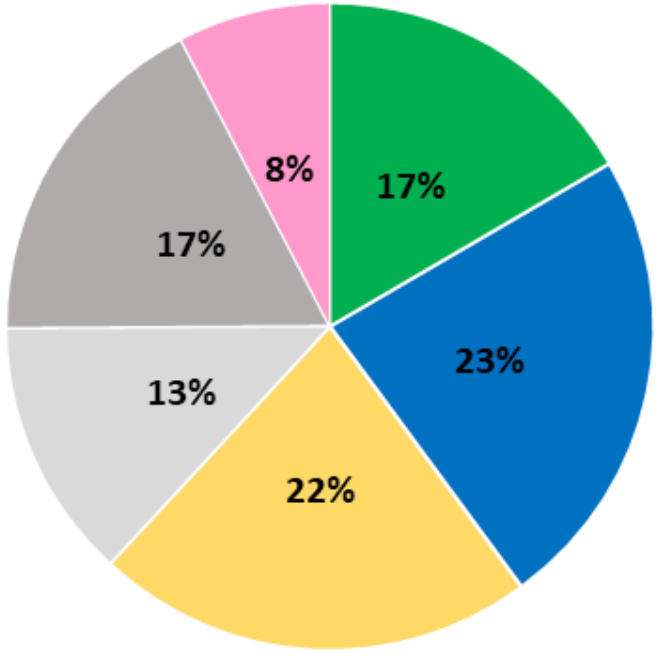
(b) Foam

(c) Fragment

Microplastic Pollution Status in the Raquette River: Color

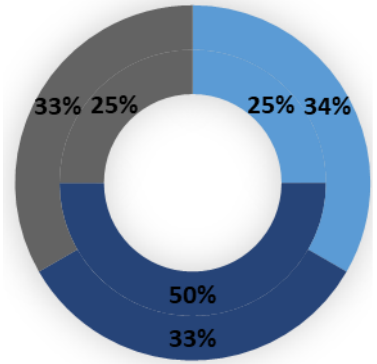


(a) Overall sediment

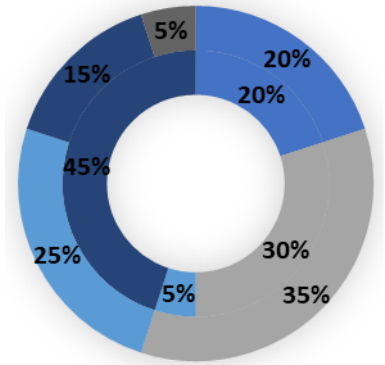


(b) Overall water

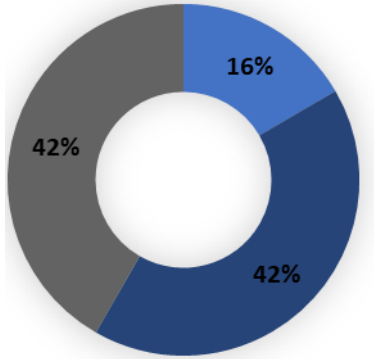
Microplastic Pollution Status in the Raquette River: Polymer Type



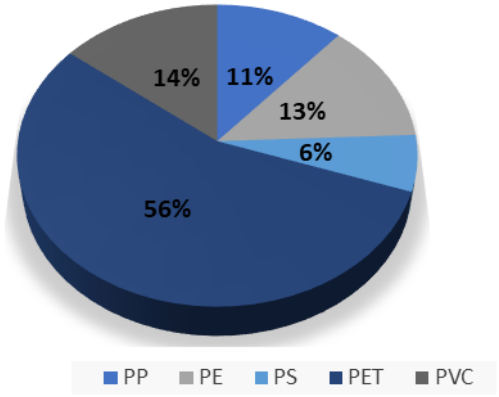
(a) WWTP: sediment



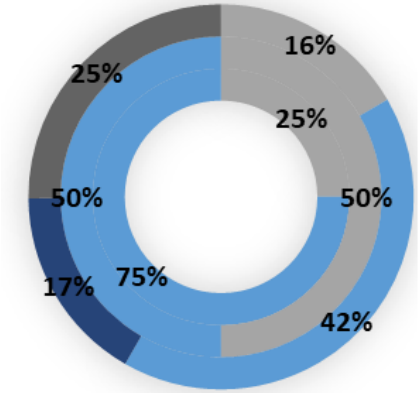
(b) NHD: sediment



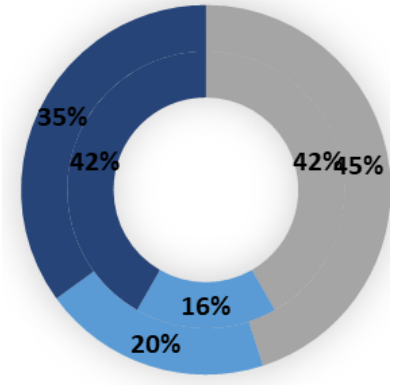
(c) R-STL Con: sediment



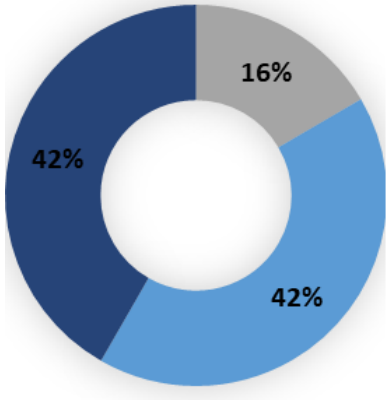
(d) Overall sediment



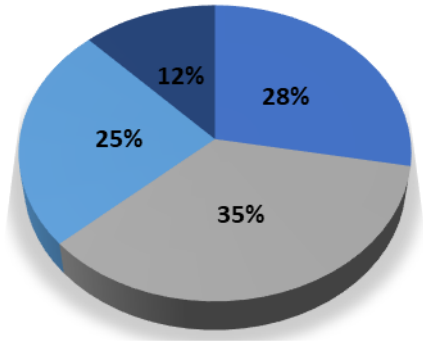
(e) WWTP: water



(f) NHD: water



(g) R-STL Con: water



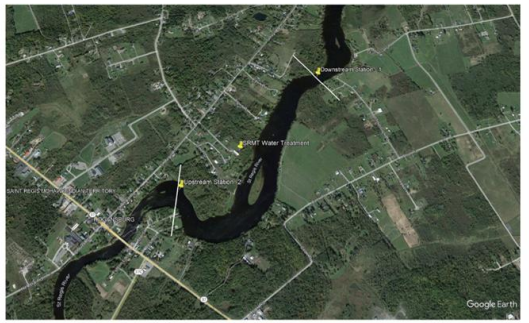
(h) Overall water

Effect of wastewater treatment plants on microplastics in mussels and their surrounding environment

- We collected mussels, water, sediment, and suspended sediment load from the **Grasse and Saint Regis Rivers.**

- The objective of this study was to see the effect of wastewater treatment plants on microplastic type and concentration of freshwater biota **(mussels)** and their surrounding environment.

St. Regis River Site



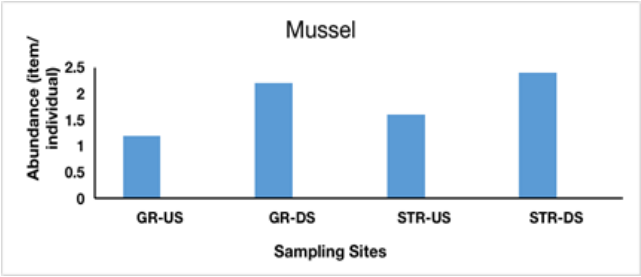
St Regis River		
SRMT Wastewater Treatment Facility.	44.98034	-74.65791
Downstream Station – 1.	44.08689	-74.65234
Upstream Station - 2.	44.97698	-74.66211

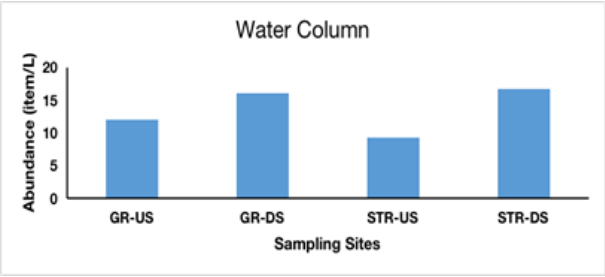
Grasse River Site

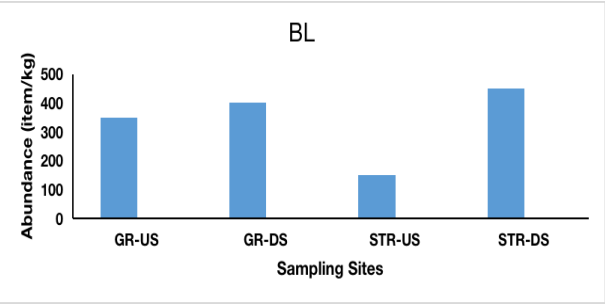
Grasse River		
Massena Wastewater Treatment Plant.	44.93745	-74.87386
Downstream Station – 3.	44.94410	-74.86645
Upstream Station – 4.	44.93338	-74.88064

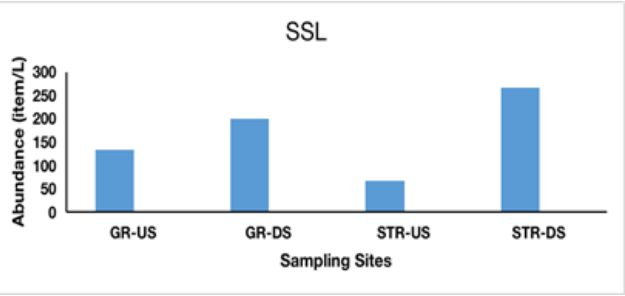
Effect of wastewater treatment plants on microplastics in mussels and their surrounding environment

Sampling Site	Microplastic Abundance Mussels (Item/individual)	Microplastic Abundance Water column (Item/L)	Microplastic Abundance SSL (Item/L)	Microplastic Abundance BL (Item/kg)
Grass River Upstream	1.2± 0.84	12	133.34	350
Grass River Downstream	2.2± 1.30	16	200.01	400
St. Regis River Upstream	1.6± 0.55	9.33	66.67	150
St. Regis River Downstream	2.4± 0.89	16.67	266.68	450

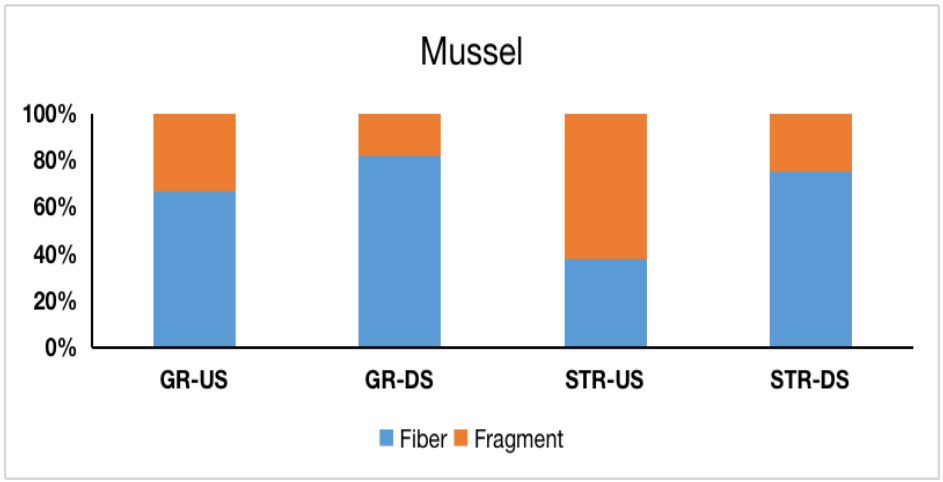


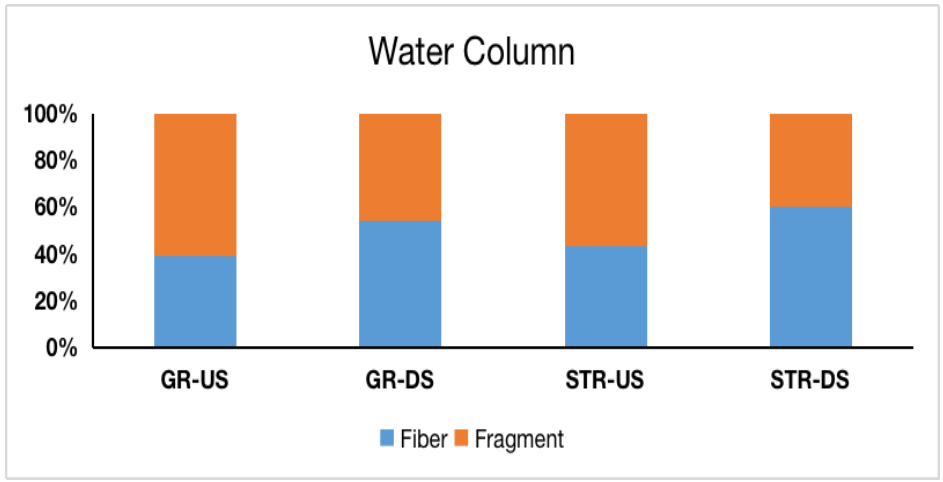


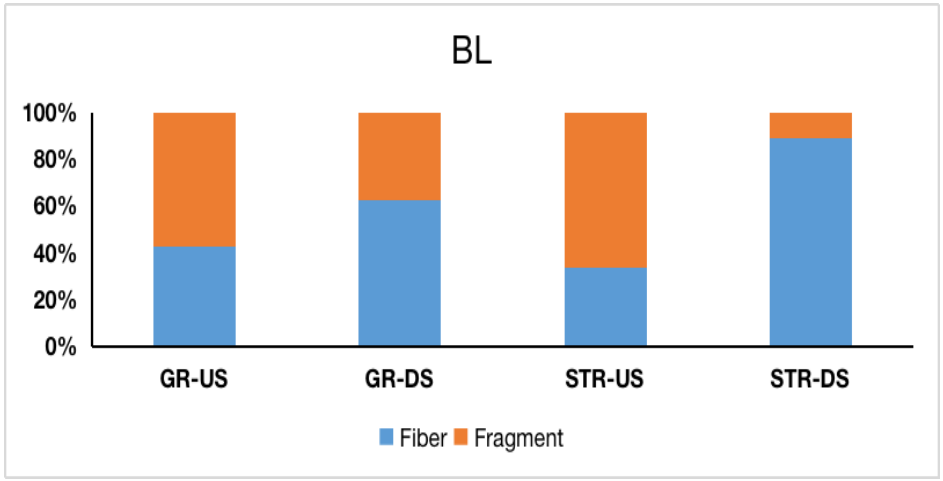


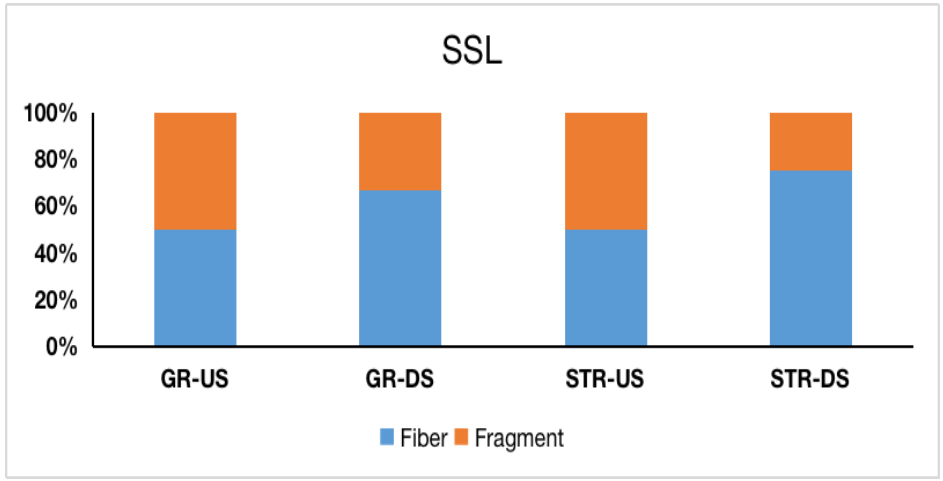


Physical properties of microplastics observed in the study area: Shape

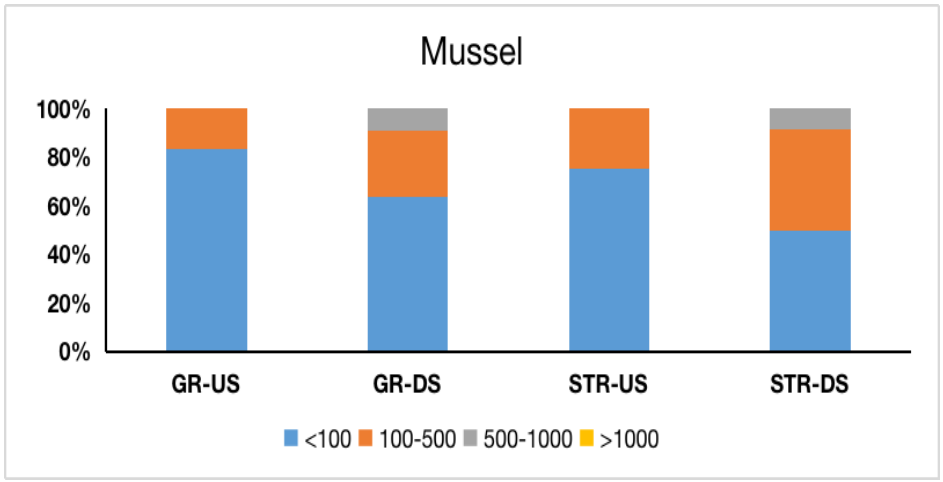


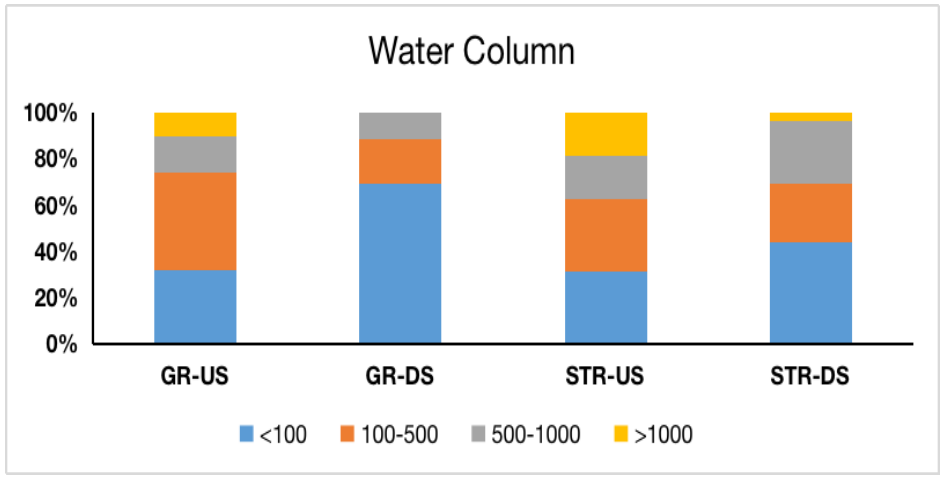


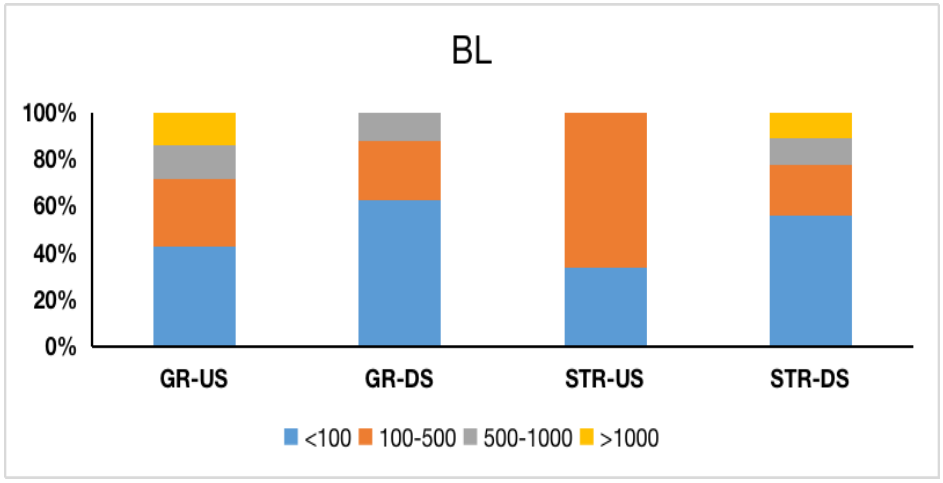


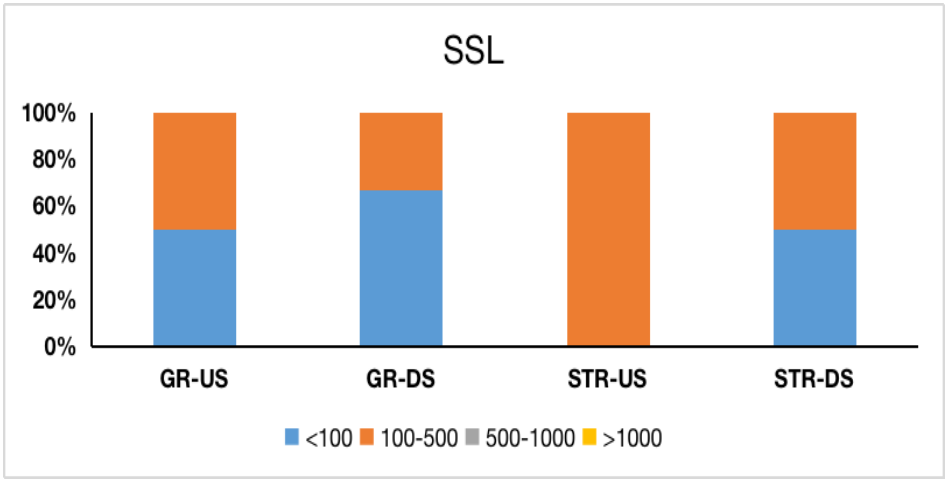


Physical properties of microplastics observed in the study area: Size

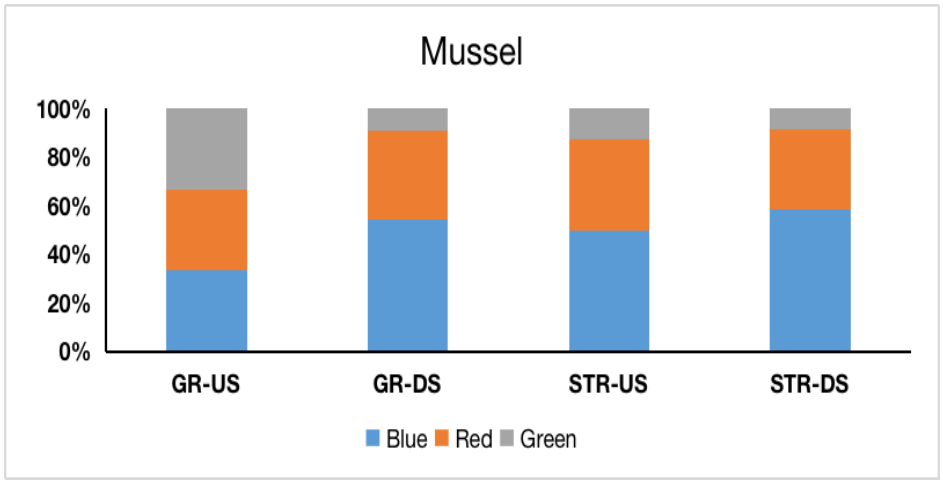


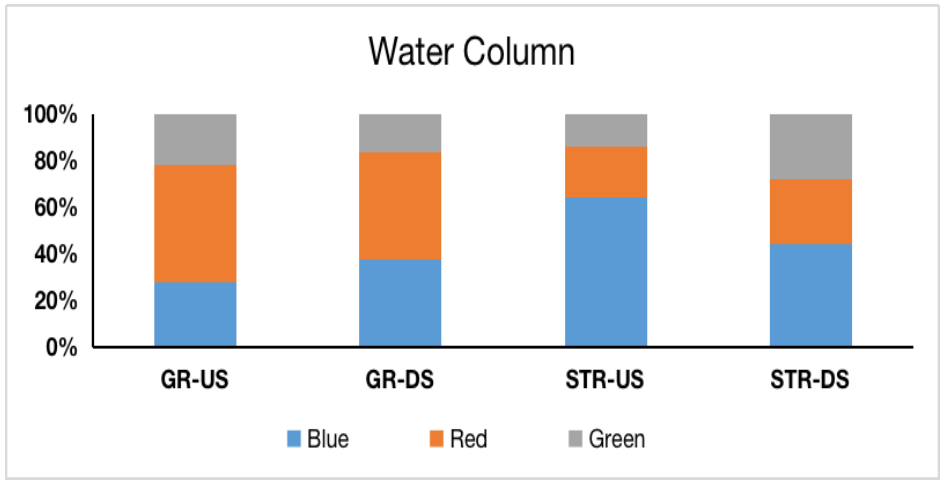


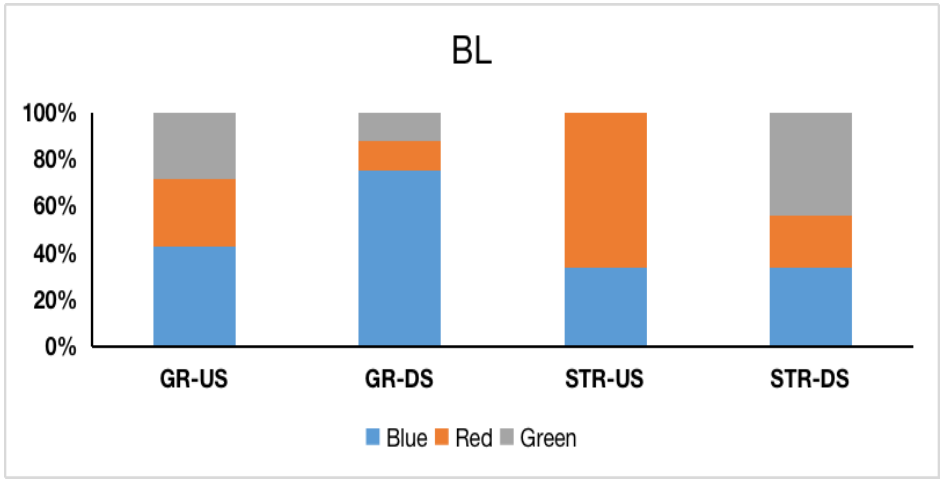


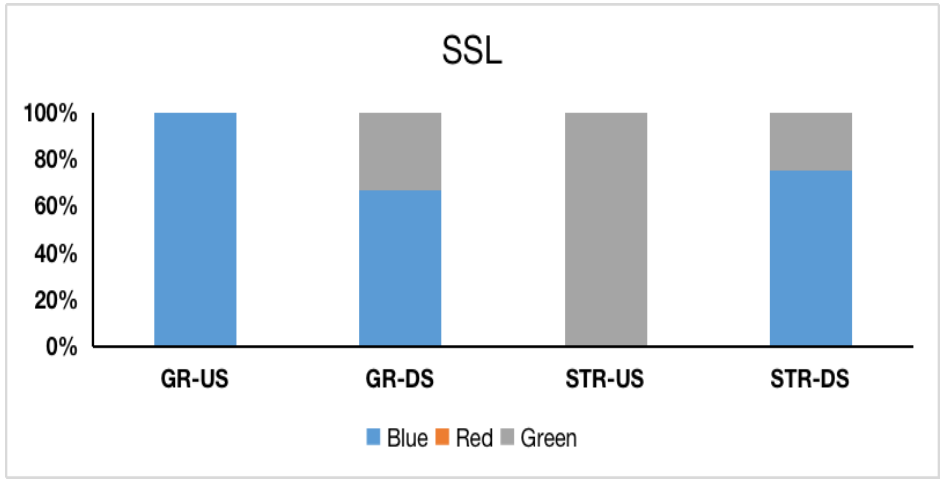


Physical properties of microplastics observed in the study area: Color



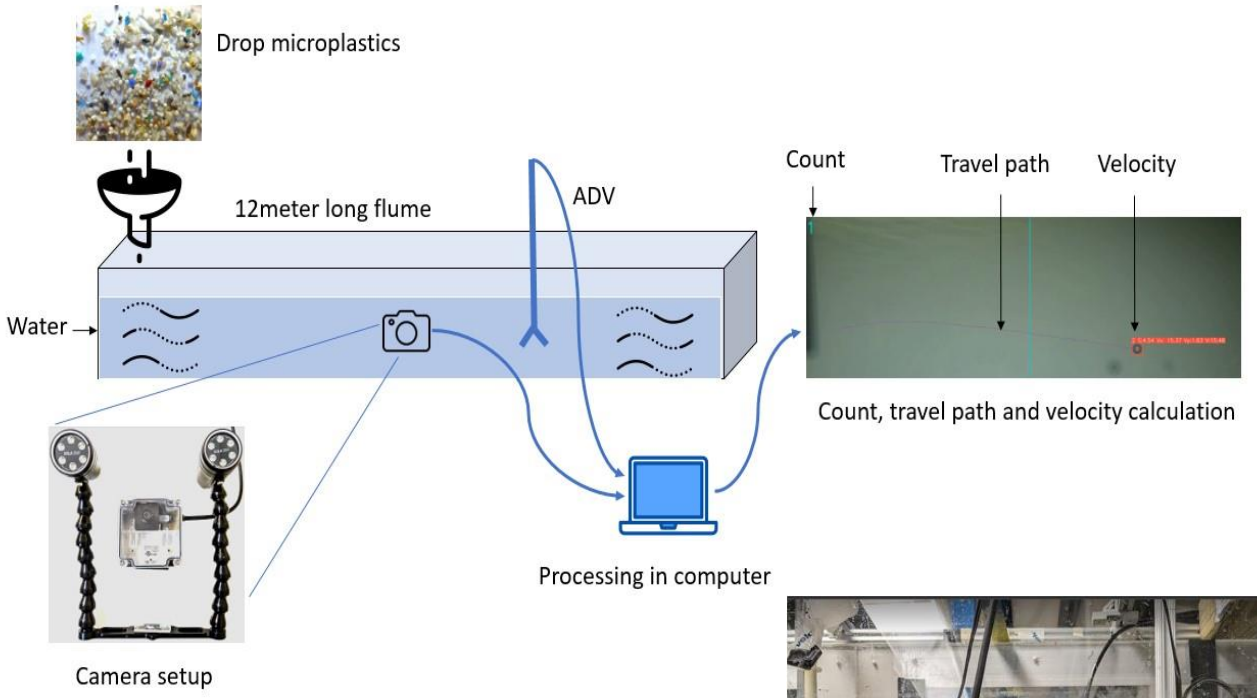


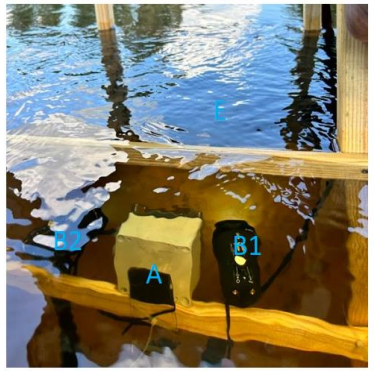


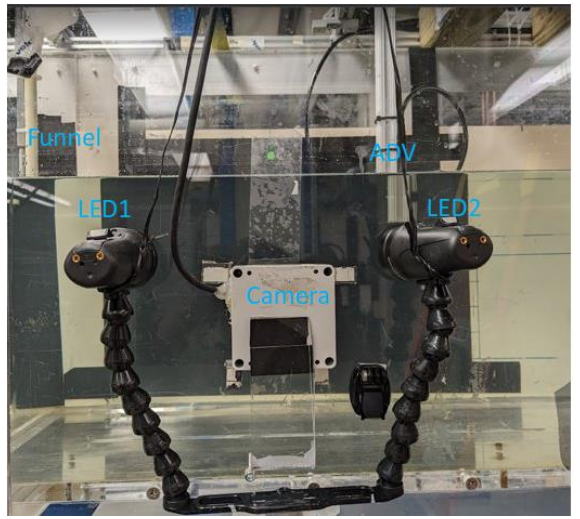


Ongoing Project:

Microplastics Detection Technique based on Artificial Intelligence (AI)-based Camera Sensor

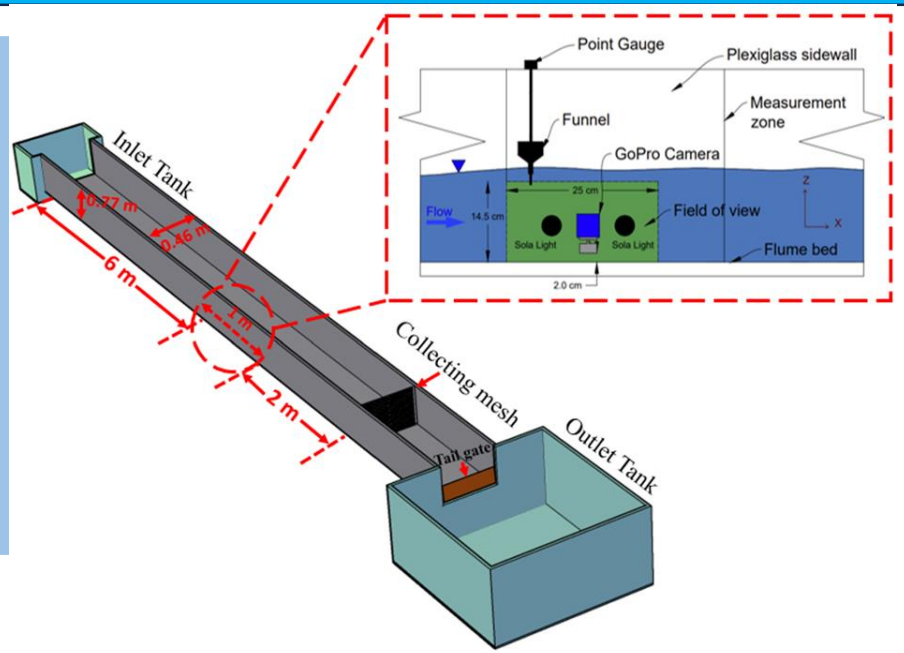


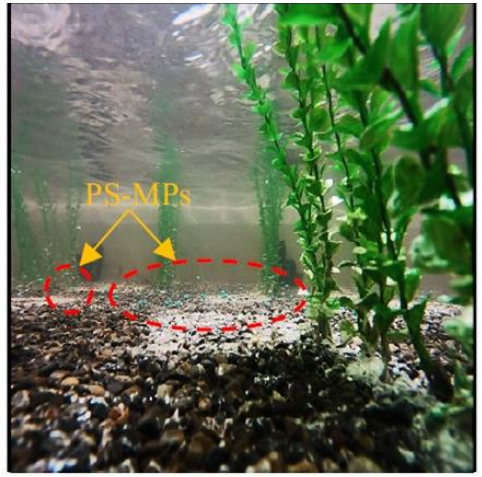


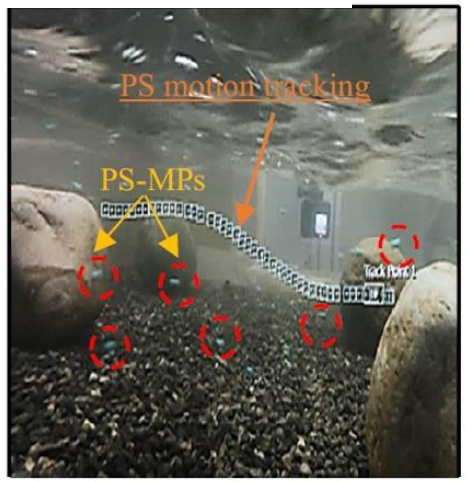


Ongoing Project:

Microplastics' Dynamics



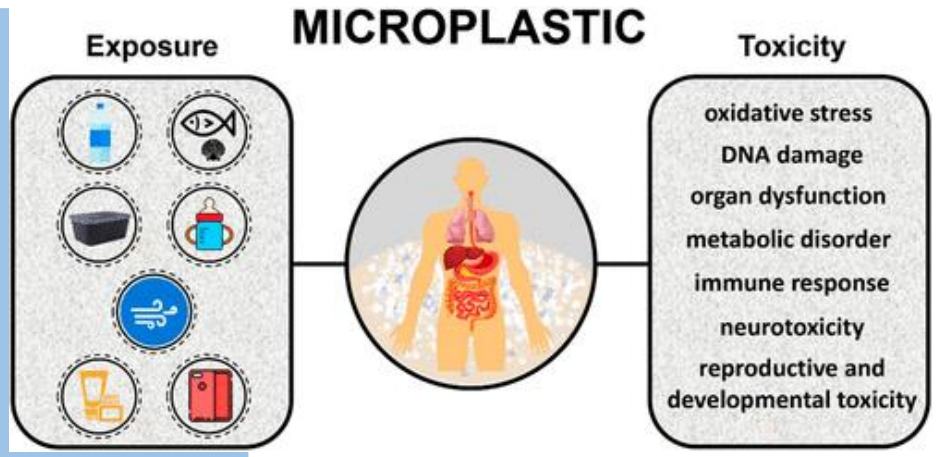




Proposed Project:

Impacts of Microplastics

Removal of Microplastics



Conclusion


How can I reduce my plastic waste?
bring your own bottle
avoid unnecessary packaging
opt for fully recyclable packaging
use reusable cups for to-go drinks
choose tap water instead of bottled water (if possible)
bring your own lunch boxes
bring your own bags for shopping
cook at home instead of ordering takeaway
dispose of plastic recycling correctly
eufic

Acknowledgement

References

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- https://www.google.com/search?sca_esv=5f32bda464ccee7b&rlz=1C1CHBF_enUS1033US1033&q=microplastics+ocean+current&tbm=isch&source=lnms&sa=X&ved=2ahUKEwiKs7eRvJSEAxXamokEHdUqDwAQ0pQJegQIDBAB&biw=1280&bih=585&dpr=1.5#imgrc=wAf_0lEfEcx-BM
- https://www.google.com/search?q=plastic+pollution+in+rivers&tbm=isch&ved=2ahUKEwizhfSovJSEAxX_BmIAHbjjBTUQ2-cCegQIABAA&oq=plastic+pollution+in+riv&gs_lp=EgNpbWciGHBsYXN0aWMgcG9sbHV0aW9uIGluIHJpdioCCAAyBRAAGIAEMgYQABgIGB4yBxAAGIAEGBhI_kRQsxNYiTpwAHgAkAEAmAFzoAHCEaoBBDIyLjO4AQHIAQD4AQGKAgtnd3Mtd2l6LWltZ8ICChAAGIAEGIoFGEPCAg0QABiABBiKBRhDGLEDiAYB&sclient=img&ei=2PjAZbO5PP-NiLMPuMeXqAM&bih=585&biw=1280&rlz=1C1CHBF_enUS1033US1033#imgrc=sDQibSRem_Es9M
- https://medium.com/@astuvinda/the-use-of-plastic-made-material-in-our-daily-life-afae5c034de8

Question-Answer Session