Overview of tested protocols on monitoring microplastics in the marine environment

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Monitoring microplastics in the marine environment

- Monitoring should be easy to implement by non-experts
- Methodologies of extracting microplastics (MP) should be reliable, easy, cost-effective and reproducible

Tested schemes/protocols:

- Plastic Busters MPAs: Toolkit for monitoring marine litter and its impacts on biodiversity in Mediterranean MPAs, 2019 https://plasticbustersmpas.interreg-med.eu/
- BASEMAN: MICROPLASTICS ANALYSES IN EUROPEAN WATERS http://www.jpi-oceans.eu/baseman/main-page
- GESAMP, 2019. Guidelines for the monitoring and assessment of plastic litter and microplastics in the ocean (Kershaw P.J., Turra A. and Galgani F. editors)
- UNEP/MAP (microplastics on the sea surface)

Extract, separate microplastics from (a) seawater

- On each study site, three transects should be conducted from as close as possible to the coast and up to 2 to 3 nautical miles offshore
- At least two surveys, one in autumn and one in early spring (avoid periods with intense zooplankton blooms)
- Manta Net or Manta Trawl is the most commonly used sampling tool (large volumes of water, particles larger than 330μm coupled with organic matter)
- Sampling in calm sea conditions (wind intensity less than 2 Beaufort)
- Trawl for 30 minutes with a speed of 2-3 knots (record the start and end of the track with GPS and the volume of water with a flowmeter)
- The sample is collected in the collection sock (rinse the manta net from the mouth towards the sock)
- The samples are stored in 70% ethanol solution for further analysis

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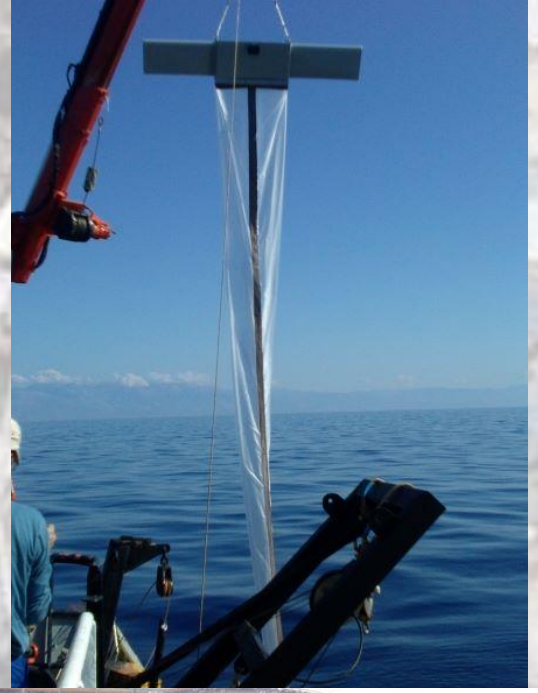
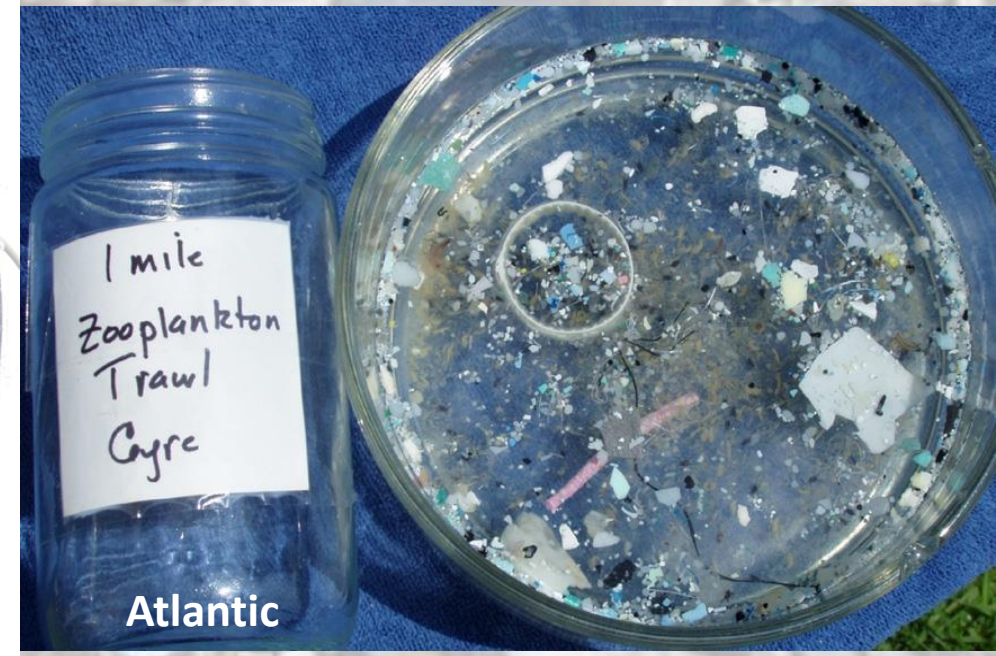
Manta net

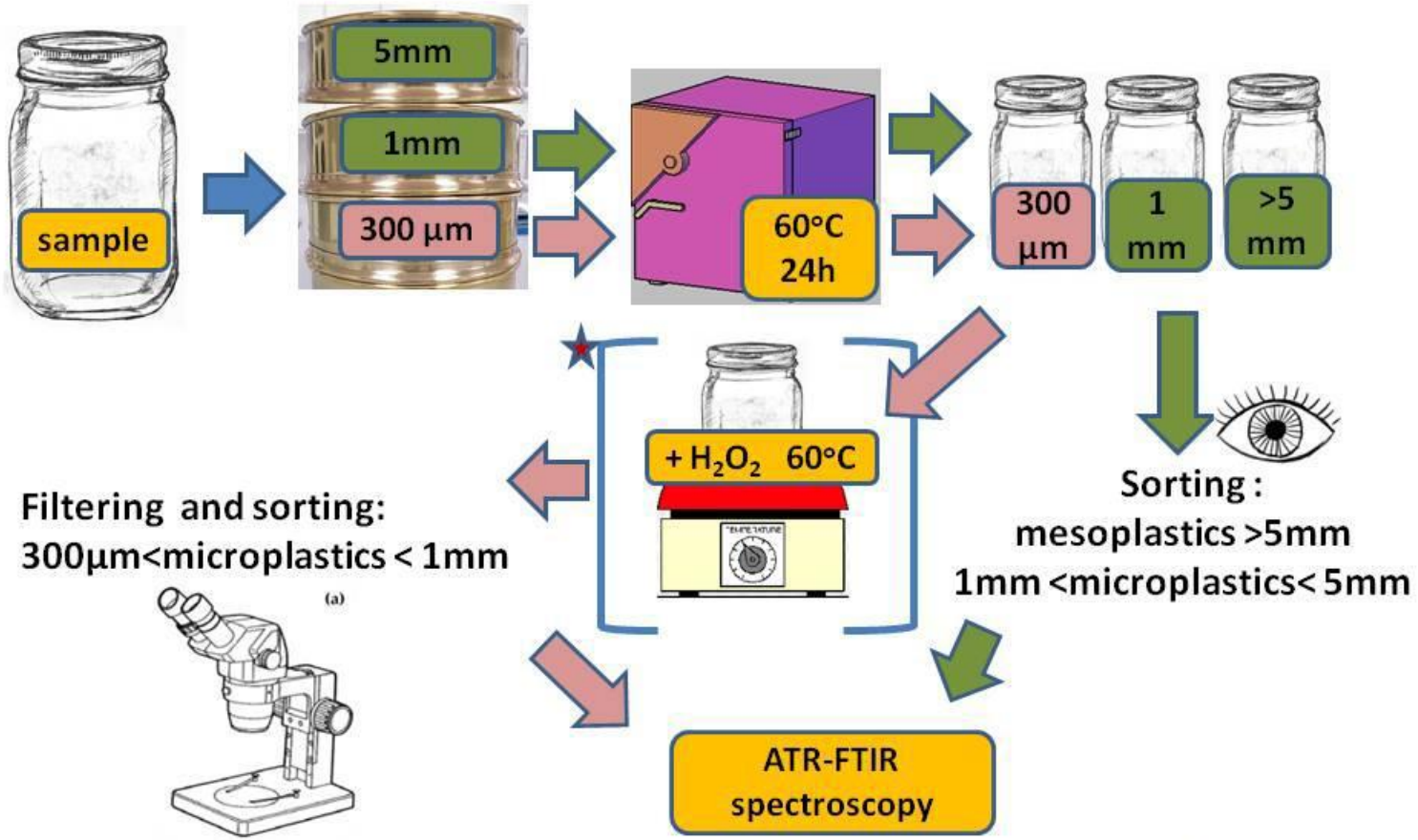



Manta net sock


Aegean sea


1 mile
Zooplankton
Trawl
Gyre
Atlantic

Extract, separate microplastics from (a) seawater



Adapted from Adamopoulou et al., 2015

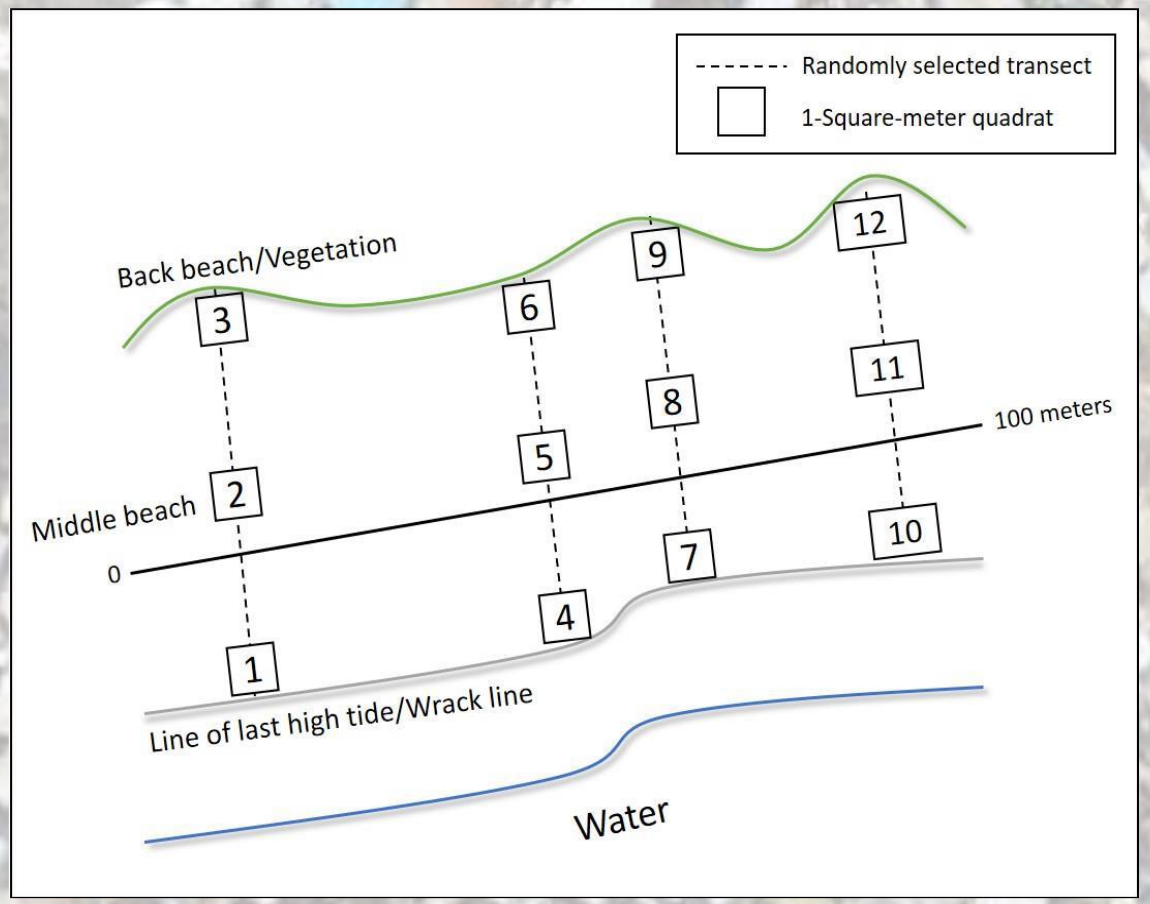
Schematic representation of processing floating meso- and microlitter samples

Expression of the results

- N(g) per km^2 or N(g) per m^2, based on the start - end transect coordinates and the dimensions of the manta net mouth.
- N(g) per Km^3 or N(g) per m^3, based on flow meter indication and relevant formula.

Extract, separate microplastics from (b) beach sand

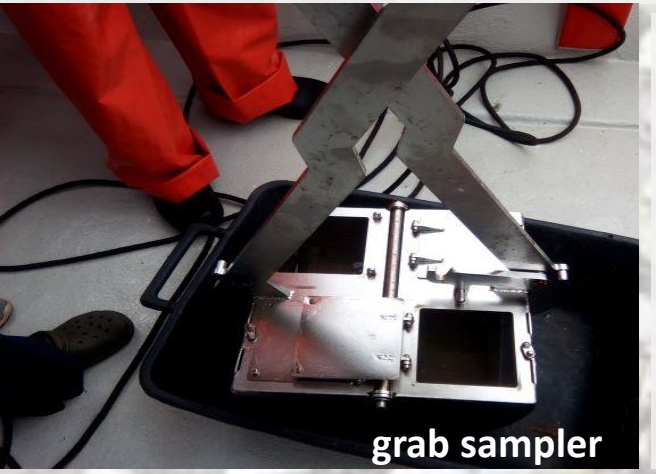
- Microlitter monitored in the same transects as for macrolitter and during the same four seasonal macrolitter surveys wherever possible
- Choose sandy beaches
- **Large microplastics** (1-5 mm) can be separated by sieving the sand samples *in situ*
- **Small microplastics** (<1mm) are separated in the lab by floatation



For **small** microplastics, the sand sample is collected outside each quadrat

- N(g) per m^2 or N(g) per m^3, based on the volume of the sand sample
- N(g) per g of dry sand

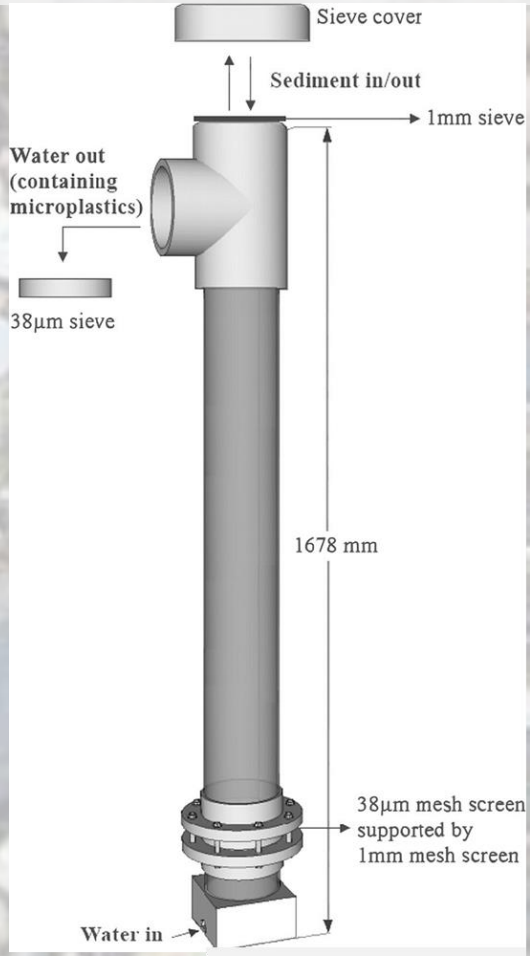
Extract, separate microplastics from (c) seafloor sediment


grab sampler

- At least 3 replicate samples from each sampling site
- Collect the overlying water
- Retrieve the first 5cm of the sediment
- Storage in the freezer

Sediment pre-treatment (H_2O_2) to remove organic matter

Density separation



Classens et al. 2013


sediment core – box corer

- N(g) per kg (wet or dry sediment)
- N(g) per m^3, based on the volume of the wet sediment
- N(g) per m^2, based on the surface of the sampler

Extract, separate microplastics from (c) seafloor sediment

Chemical formula	Reagent name	CAS no.	Density solution (g cm^{-3})	Health Hazard (Toxicity)*	Average price (€ per 250g) †	Safety-Price Index
NaCl	Sodium chloride	7647-14-5	1.0 – 1.2	1 (low)	€ (3)	■
$Na_2WO_4 \cdot 2H_2O$	Sodium tungstate dihydrate	10213-10-2	1.40	2 (low)	€ (70)	■
NaBr	Sodium bromide	7647-15-6	1.37-1.40	2 (low)	€ (3-5)§ €€€€ (430)§	■ ■
$3Na_2WO_4 \cdot 9WO_3 \cdot H_2O$	Sodium polytungstate	12141-67-2	1.40	2 (low)	€€€€ (276)	■
$Li_6(H_2W_{12}O_{40})$	Lithium metatungstate	127463-01-8	1.6	1 (moderate)	€€€€ (360)‡	■
$ZnCl_2$	Zinc chloride	7646-85-7	1.6 – 1.8	3 (high)	€ (45)	■
$ZnBr_2$	Zinc bromide	7699-45-8	1.71	2 (high)	€€€ (200)	■
NaI	Sodium iodide	7681-82-5	1.80	2 (moderate)	€€€ (130)	■

Beach sand

Sea floor sediment

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Abbreviation	Polymer	CAS no.	Density (g cm^{-3})
PS	Polystyrene	9003-53-6	0.01 – 1.06
PP	Polypropylene	9003-07-0	0.85 – 0.92
LDPE	Low-density polyethylene	9002-88-4	0.89 – 0.93
EVA	Ethylene Vinyl Acetate	24937-78-8	0.94 – 0.95
HPDE	High-density polyethylene	9002-88-4	0.94 – 0.98
PA	Polyamide	63428-84-2	1.12 – 1.15
PA 6,6	Nylon 6,6	32131-17-2	1.13 – 1.15
PMMA	Poly methyl methacrylate	9011-14-7	1.16 – 1.20
PC	Polycarbonate	25037-45-0	1.20 – 1.22
PU	Polyurethane	9009-54-5	1.20 – 1.26
PET	Polyethylene terephthalate	25038-59-9	1.38 – 1.41
PVC	Polyvinyl chloride	9002-86-2	1.38 – 1.41
PTFE	Polytetrafluoroethylene	9002-84-0	2.10 – 2.30

Sodium chloride

Sodium tungstate dihydrate

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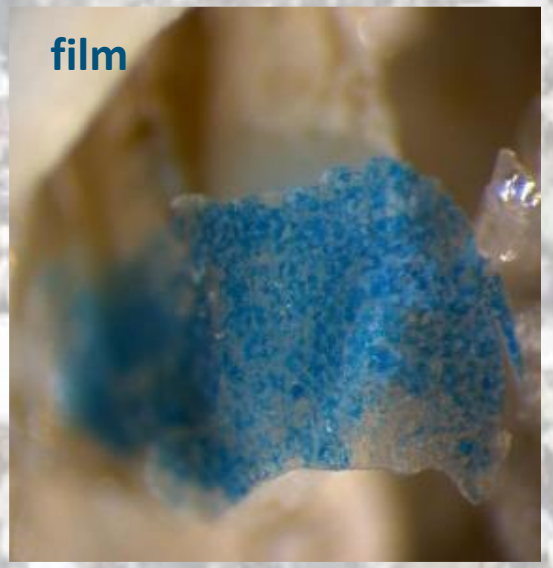
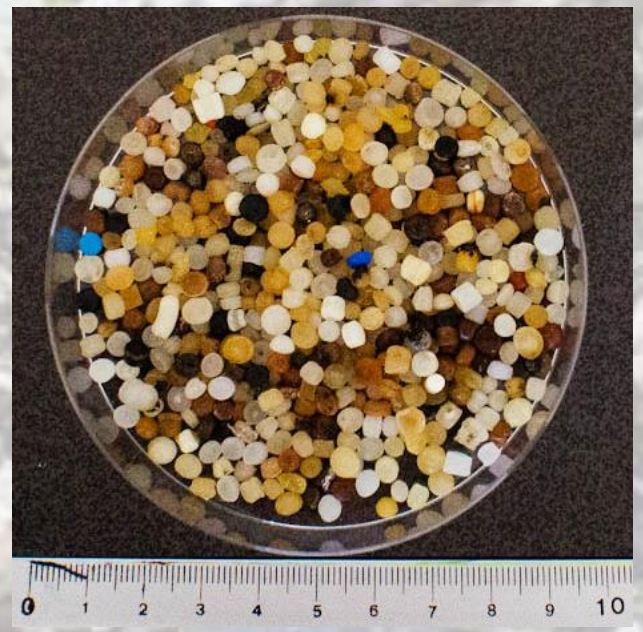
Characterize microplastics from the marine environment (a) shape



Shape categories:

- Fragment: broken hard plastic piece
- Sheet or film: broken soft plastic piece
- Filament or fiber
- Foam or Styrofoam (polystyrene)
- Pellet: cylindrical, ovoid, discoidal, spheroid, flat.

Characterize microplastics from the marine environment (b) color

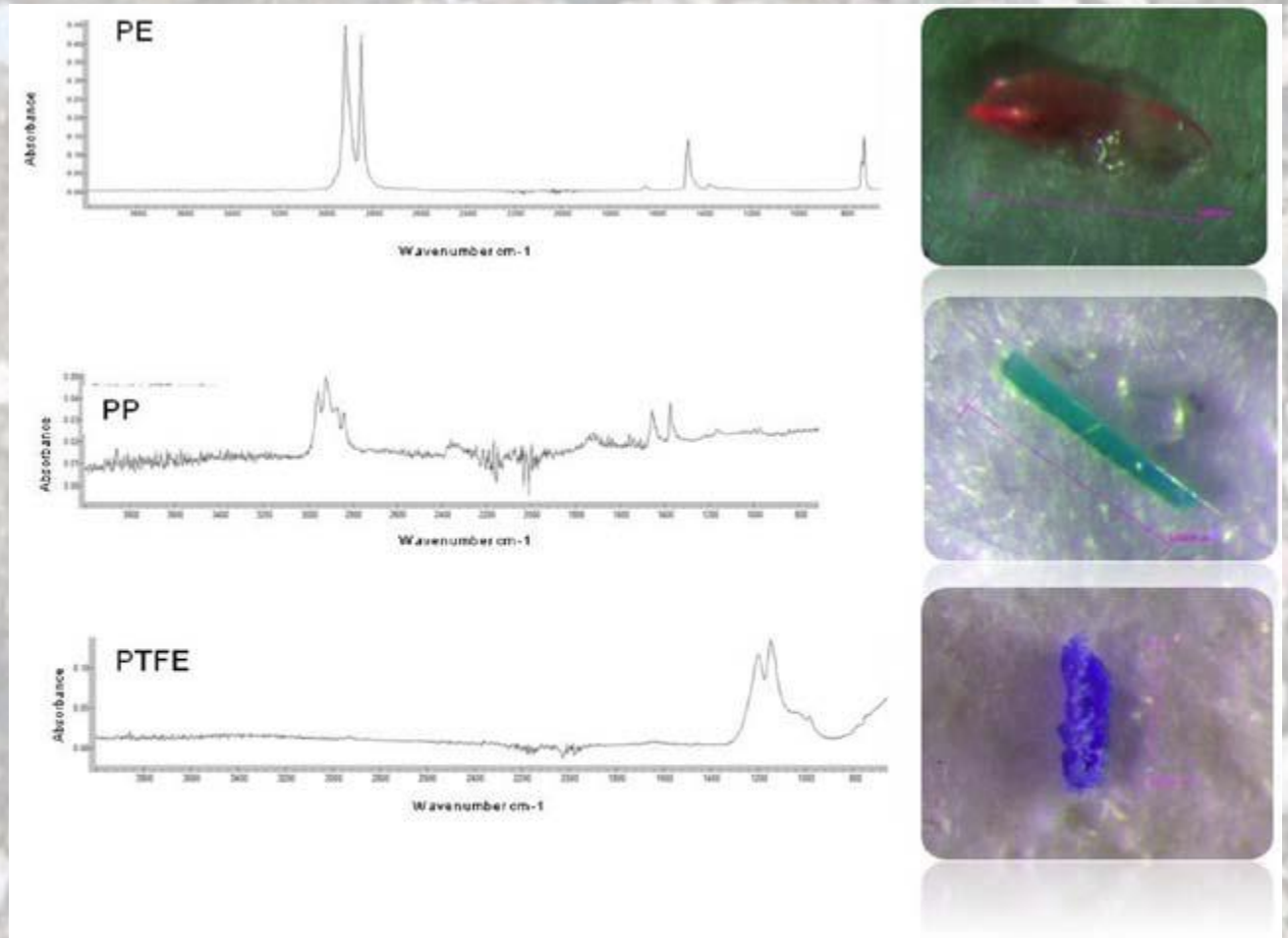


Secondary microplastics, or fragments of macroplastics broken down over time

Primary microplastics (e.g. pellets 1-5mm or plastic microbeads used in cosmetics such as face scrubs).

Black, Blue, White, Transparent, Red, Green, Others

Characterize microplastics from the marine environment (c) polymer type



Comparison with spectra of virgin polymers

Fourier Transform InfraRed – Attenuated Total Reflectance (**FTIR–ATR**) Spectroscopy

Extract, separate and characterize microplastics

Laminar flow hood

Plastic hood

Cross - contamination control

all glassware is microplastic-free

intensive rinsing with filtered water

procedural blanks in parallel to sample processing

laminar flow hood or clean bench or plastic hood

avoid wearing synthetic clothes underneath the lab coat

THANK YOU
FOR YOUR ATTENTION!

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