CEMP Guidelines for the monitoring of microlitter (including microplastics) in seafloor sediments for the OSPAR maritime area

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Definitions

Marine Litter: Any solid material which has been deliberately discarded or unintentionally lost on beaches, on shores or at sea. The definition covers materials transported into the marine environment from land by rivers, draining or sewage systems or winds. It includes any persistent, manufactured or processed solid material (OSPAR, 2021).

Microlitter: Marine microlitter is defined as a size subcategory of Marine Litter, which is, according to Commission Decision 2017/848/EU (EU, 2017, Galgani et al., 2023) and UNEP, 'any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment' (UNEP, 2021). Microlitter is the size subcategory defined as 'marine litter with a length of its maximum dimension below 5 mm'.

Plastic: polymer to which additives or other substances may have been added which is capable of functioning as a main structural component of the final materials and articles (European Commission, 2014).

Threshold values: The Commission Decision 2017/848/EU (EU, 2017) defines TV as "a value or range of values that allows for an assessment of the quality level achieved for a particular Criterion, thereby contributing to the assessment of the extent to which good environmental status is being achieved" and specifies that "threshold values are intended to contribute to MS' determination of a set of characteristics for GES and inform their assessment of the extent to which GES is being achieved".

Abbreviations and acronyms

μATR-FTIR: micro-Attenuated Total Reflection Fourier Transform Infrared (spectroscopy)
μFTIR: micro-Fourier Transform (spectroscopy)
ABS: Acrylonitrile butadiene styrene
CEMP (OSPAR): OSPAR's Coordinated Environmental Monitoring Programme
CN: Cellulose Nitrate
CP: Contracting Party
EPDM: Ethylene propylene diene monomer rubber
EVA: Ethylene-vinyl acetate
PS: Foamed polystyrene
GES: Good Environmental Status
HDPE: High-density polyethylene
ICES: International Council for the Exploration of the Sea
LDPE: Low-density polyethylene
LOD: Limit of detection
MSFD: Marine Strategy Framework Directive
NY: Nylon
OC: Organic Carbon
PA: Polyamide
PA 6,6: Nylon 6,6
PAA: Poly(acrylic acid)
PAN: Polyacrylonitrile
PC: Polycarbonate
PE: Polyethylene
PEEK: Polyether ether ketone
PET: Polyethylene terephthalate
PEST: Polyester
PHA: Polyhydroxyalkanoate
PLA: Polylactic acid
PMMA: Polymethylmethacrylate
POM: Polyoxymethylene
PP: Polypropylene
PS: Polystyrene
PTFE: Polytetrafluoroethylene
PUR: Polyurethane
PVA: Polyvinyl acetate
PVC: Polyvinyl chloride
RA: Rayon
RC: Regenerated cellulose
SBR: Styrene butadiene rubber
TGML: Technical Group on Marine litter (EU)
TOC: Total Organic Carbon

1. Introduction

1.1 Rationale

Plastic pollution is a global challenge with environmental and human health concerns. OSPAR has a vision of a clean, healthy and biologically diverse North-East Atlantic Ocean. Through the North-East Environment strategy (NAES 2030), contracting parties pledge to continue to play a leading role in addressing ocean issues. Its implementation contributes to the achievement of the United Nations Sustainable Development Goals (UN SDGs) under Agenda 2030. NAES strategic objective 4 is specifically relating to marine litter and states to: 'Prevent inputs of and significantly reduce marine litter, including microplastics, in the marine environment to reach levels that do not cause adverse impacts to the marine and coastal environment with the ultimate aim of eliminating inputs of litter. OSPAR is guided by the ecosystems approach, 'the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity'. Actions may include the mitigation measures for plastic pollution. Adaptive management is needed to continue to improve policies and practices as we build on our knowledge and react to changing circumstances. In 2022, OSPAR published its second Regional Action Plan (RAP ML2 2022 – 2030) along with an implementation plan, in order to achieve its objective to significantly reduce amounts of marine litter including microplastics. However, there is currently no monitoring programme in place for microplastics, so this is a priority which needs to be addressed. While the abundance of microplastics in biota and surface waters only represent snapshots of the occurrence of microplastics in the environment, sediments could represent more stable matrices for the short to long term monitoring of microplastics in the marine environment.

The OSPAR Microplastic Expert Group (MPEG) has been set up as a group of experts in the field of microplastic research. MPEG is currently composed of 19 members from the UK (England and Wales), UK (Scotland), UK (Northern Ireland), Ireland, Germany, Denmark, Portugal, Belgium, Spain, France, Sweden, Norway, and the Netherlands. The main goal of MEPG is to share expertise and to work towards a proposal for a candidate indicator on microlitter in sediments.

1.2 Indicator details

OSPAR currently assesses beach litter, seabed litter, and plastic particles in fulmar stomachs. In addition, from 2019, OSPAR added litter ingested by sea turtles as an indicator as part of its monitoring and assessment programme. These allow the abundance, trends, and composition of marine litter in the OSPAR Maritime Area to be determined for different marine compartments. However, to date, monitoring, and assessment of microlitter (including microplastics) are missing and a new indicator is required. The proposed microplastics indicator will address their occurrence and abundance in marine sediments (subtidal and offshore) and will cover the whole OSPAR Maritime Area.

1.3 Aims of the monitoring

The main aim of this proposed OSPAR indicator is to inform and guide efforts to protect the marine environment of the North-East Atlantic. As an indicator, intermediate assessments will be made, and the work will inform and be part of future Quality Status Reports for the North-East Atlantic area. The monitoring will also address the EU MSFD D10 requirements (Galgani et al., 2023), relevant for most OSPAR countries and feed into national reporting. As an indicator, there will be pressure for the establishment of threshold values, which will need to take into consideration regional or subregional specificities.
The main objectives of the guidelines were to i) develop recommendations for the harmonised sampling of seafloor sediments for the OSPAR area, ii) develop recommendations on analytical methods for the

extraction, isolation and quantification for microlitter and microplastics from seafloor sediment matrices, iii) provide recommendations on data reporting for microlitter to improve comparability between datasets from CPs and to allow for future assessments for seafloor microlitter for the OSPAR maritime area.

2. Monitoring strategy

2.1 Monitoring locations

The proposed candidate indicator will utilise the existing OSPAR CEMP and national monitoring programmes for contaminants to collect soft-bottom sediment samples and is applicable for OSPAR regions I, II, III, IV and V (Figure 1). In the case of the use of existing national contaminant monitoring programmes, the number of monitoring locations for each CP will be dependent on the heterogeneity across locations and areas and should represent variations with sub-basins. For shared subregions, there is a shared monitoring responsibility for CPs. Priority should be given to locations close to potential sources of litter and microlitter including river mouths and harbours. It is further suggested for seafloor sediment sampling to include preferably stations with known sediment deposition rates.

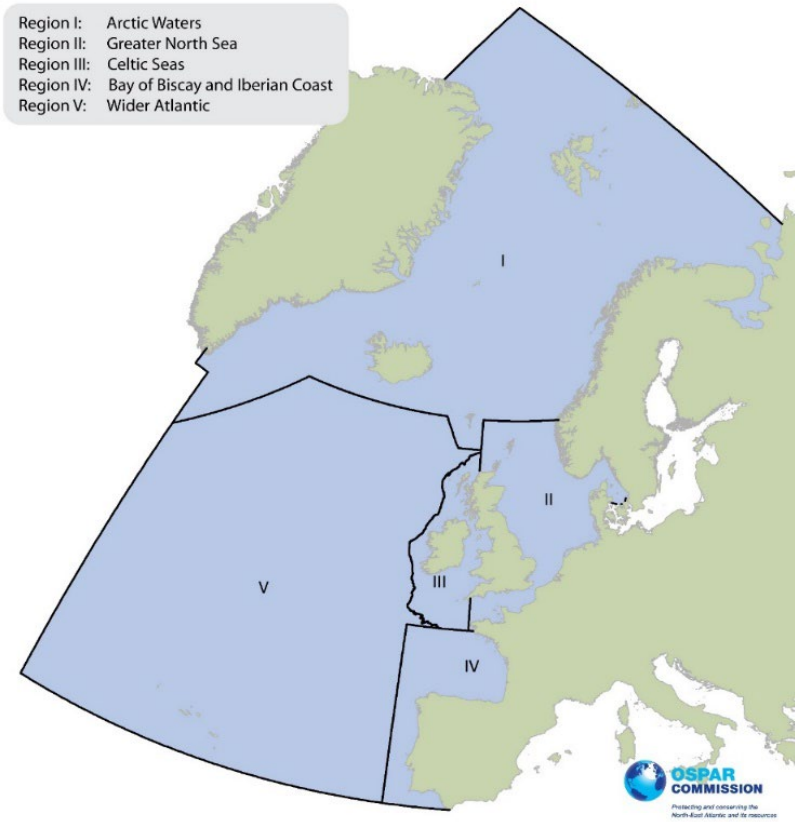


Figure 1 OSPAR regions.

2.2 Monitoring frequency

The frequency of monitoring for microlitter in seafloor sediments is still under discussion. Sampling frequency should be based on expected variabilities and the number of data points needed to derive trends. The sampling time depends on feasibility and whether the sampling is carried out using already existing surveys such as the OSPAR CEMP monitoring programme for contaminants. It is recommended to perform, preferably, annual monitoring or at least every two years. This will enable a trend analysis in six or twelve years, respectively. In view of costs, a single sampling and analysis is usually performed per monitoring year.

3 Guidelines for sample collection

3.1 Sample collection

Collection of samples from the seabed requires a vessel and the use of specialized equipment (i.e. grabs or corers) that is lowered to the seabed to collect the samples (e.g. Van Veen grab, Day grab, box corer, Gemax corer, Kajak corer). It is recommended to sample the top 2 - 5 cm of the collected sediment layer. Samples should be collected in pre-cleaned glass or metal containers. It is also recommended to sample in replicates (2-3 grab samples per station) and to combine the resulting samples to one composite laboratory sample for further analyses (Bäuerlein et al., 2023). Additional QA/QC parameters for sample collection are listed in section 3.2.

3.2 QA/QC measures for seafloor sediment sample collection

Some steps are necessary to ensure reproducibility of sampling as well as the implementation of consistent contamination prevention measures. Those steps include staff competency through training, implementation of preventive contamination measures as well as the collection of field blanks as detailed below:

i. Staff competency
- The use of trained field technicians is recommended for sample collection.

ii. Preventive contamination measures
- The use of glass or metal jars is recommended.
- Glass or metal jars are usually pre-rinsed using reverse osmosis (RO) or ultra-pure (UP) water. It is recommended to rinse the jars upside down to avoid dust deposition. Jars are covered with RO or UP water rinsed aluminium foil and capped.
- Avoid use of synthetic clothing during sample collection.

iii. Collection of field blanks
- Field blanks consist of empty pre-rinsed glass or metal jars exposed to the air for the time necessary to transfer the sediment sample to the sample collection jar.
- Particle counts in the field blanks are not being used for blank correction of the particle count in seafloor sediment samples. Type of microlitter recorded in field blanks is mainly an identification of local ambient atmospheric contamination during the time of sampling and data should therefore be expressed as ‘atmospheric input’.

3.3 Recording of metadata, field sampling and storage procedures

It is necessary to register any information that may assist or hinder comparison of data – not just across the OSPAR region but also between monitoring trips (Table 1). For example, details on local weather pattern may aid in more accurate interpretation of changes in microplastic concentrations, such as sudden decrease due to resuspension of sediment trapped microplastics back into the water column resulting from higher wind and wave action at the time of samples or the days prior.

Table 1. Guidelines for the reporting parameters for metadata (survey identification, sampling parameters and sampling protocols)

Reporting parameters	**Additional details**	**Mandatory or optional**
Country/Campaign		Mandatory
Vessel name		Mandatory
Sampling location	Station code, coordinates	Mandatory
Sampling date		Mandatory
Sampling collection time		Mandatory
Sampling depth (m)		Mandatory
Other observations	i.e., near any substantial anthropogenic inputs	Optional
Sample device description	i.e., type and dimensions	Mandatory
Deployment procedures	Description of procedure	Optional
Local conditions	i.e., wind speed (knots), wind direction (degree), sea state [Douglas scale (0-9) or Beaufort scale (0-12)), Bottom temperature, bottom oxygen, bottom salinity, pH (Frias, 2018)	Optional
Any other parallel sampling campaigns	e.g., water sampling, biota, etc…	Optional
Details of sediment samples	Top layer, within a range of 2-5 cm	Mandatory
Sample collection jars and procedures	i.e., materials (e.g., glass), volumes and mode of preparation (e.g., pre-cleaned with ultra-pure water, foiled and capped in the laboratory)	Optional
Sample transport and storage	i.e., freezer, - 20°C	Optional
Trained field person for sample collection	Training provided?	Optional
Collection of field blanks	Description of procedure	Optional

4 Guidelines for laboratory analysis and reporting

4.1 QA/QC measures for seafloor sediment sample preparation

i. Contamination control

The following steps are recommended for contamination minimisation in the laboratory:

- Clean lab floor as well as bench surfaces. Wait at least 1 hour after completion for any residual dust to settle.
- Pre-clean labware using RO or UP water. Rinse glassware upside down and cover with foil before use.
- Filter all solutions that are added to the sample onto lower porosity filters (e.g., 0.2 µm regenerated cellulose (RC) filters) or any other filter that has a porosity lower than the lowest desired particle detection limit of the sample to remove impurities and contaminants.
- Use laminar flow cabinet or similar when samples are exposed to air.
- Frequently clean the place where analysis is performed using a slightly damp lint-free cleanroom cloth or equivalent.
- Avoid synthetic clothes within the laboratory and wear 100% cotton lab coats.
- Minimise the number of people allowed in the laboratory.
- Avoid plastic labware.
- Minimise transfer steps.
- Negative controls are blank samples introduced to quantify and characterise the extent of background contamination during analysis. Negative controls have to be representative of the whole protocol followed for microlitter analysis (i.e., from density separation to chemical digestion to filtration etc.).
- 3 replicate negative controls per sample batch is recommended.
- Use of recovery tests (i.e. positive controls) with spiked sediment samples with known quantities of reference materials to investigate efficiency of applied extraction techniques.

ii. Recovery tests and extraction efficiency

- Recovery tests using reference materials should be conducted to ensure extraction efficiencies of the applied separation technique.
- Recovery tests should include polymers with a range of morphologies, shapes, sizes, and densities.
- It is recommended that real environmental marine sediment samples should be spiked with at least 30 particles.
- A literature review indicated the prevalence of fragments in seafloor sediments of PP (18%), PE (16%), PA (16%), PVC (10%) followed by PS (8%), PET (7%) and PMMA (6%) and those polymers should be targeted in particular for recovery tests (Fugagnoli, 2022).
- Recovery (%) is calculated for re-detected added reference particles as the mean value accounting for different size categories, morphologies and polymer composition.
- An effective recovery should reach, at least, 80% recovery for particles > 100 µm.
- Fluorescent particles could also be selected for effective tracking and to assess factors impacting on and reduced recovery.
- The mean recovery is reported together with the data to EMODnet and/or ICES DOME.

A list of suppliers for reference materials is suggested in Table3.

iii. Limit of detection (LOD)

Limit of detection (LOD) should be reported alongside the method used to quantify microlitter in seafloor sediments. LOD refers to the lowest concentration level that can be determined to be statistically different from an analytical blank (Wright et al., 2021). The general approach adopted is to calculate the LOD as the mean + 3 x standard deviation of the blank value, which requires the processing of a sufficient number of blanks in order to derive a statistically meaningful standard deviation (Kukkola et al., 2022).

The number of microlitter particles detected within laboratory blank samples is used to define the limit of detection (LOD; mean + 3 x standard deviation of the particle concentration) according to McDougall et al. (1980). Therefore, the LOD reflects the effectivity of the precautionary methods during sampling and sample processing by the respective laboratory. If full spectroscopic data are available, polymer-specific detection limits can be calculated and used (see Table 7). This may provide lower detection limits for specific polymers which are not usually found in blank samples. The LOD is reported within the data to EMODnet and ICES DOME.

A lower size limit of the method should also be reported representing the lowest particle size that can be analysed using a particular analytical method (e.g. micro-FTIR or Nile red tagging of polymers) (Wright et al., 2021). It is worth noting that the lower size limit of the method is not only dependant of the pore size of the filter used but rather dependant on any analytical limitation.

iv. Blank correction of data

While field blanks present useful information on the extent and type of contamination during the sampling step and whole analysis chain, a consensus still needs to be reached on how field blanks need to be treated for data correction. It is recommended to report the blank results (field and laboratory) and the uncorrected sample results separately (i.e, blank values are not subtracted from the results on sediment and samples).

4.2 Sample preparation protocol

4.2.1 Sample homogenisation, drying and weighing.

Sample processing is detailed in Table 2.

Table 2. Guidelines for the reporting parameters for sample preparation (*e.g.,* homogenisation, drying and weighing)

Reporting parameters	**Additional details**	**Comments**	**Mandatory or optional**
Homogenisation technique	i.e., use of a metal spatula for sample homogenisation	Avoid excess force to prevent further fragmentation of microlitter.	Optional
Sub-sampling	i.e., use of aliquots		Optional
Sampling drying time	i.e., until constant weight		Optional
Sampling drying temperature	≤ 40° C	Refer to ISO 11464 – Soil quality: Pre-treatment of samples for physico-chemical analysis.	Mandatory

Use of aliquot for dry weight determination	e.g., moisture content, 105°C, freeze drying of samples	Refer to CSN EN ISO 16720: Soil quality – Pre-treatment of samples by freeze-drying for subsequent analysis (ISO 16720:2005)	Optional
Particle Size Analysis	% Gravel, % Sand, % Silt/clay, median particle size		Mandatory
Sieving	If applicable	Include details on sieve mesh sizes	Mandatory
Amount sediment wet weight or dried weight used for subsequent steps	i.e., for chemical digestion or density separation		Mandatory
Number of replicates	e.g. analysis of the combined samples in triplicate		Mandatory
Organic matter content	i.e., from loss of ignition 550°C (%), TOC (ppm) optional		Optional

4.2.2 Density separation and filtration

A density separation step is recommended for the separation of the lighter plastic items from heavier mineral particles. The selection of the density separation solution will be dependent on the safety of use as well as price. However, a minimum solution density of 1.5 g cm^{-3} is recommended to extract the majority of polymers e.g., polyurethane (PUR, 1.3 g cm^{-3}), polyvinylchloride (PVC, 1.3 – 1.45 g cm^{-3}) and polyethylene terephthalate (PET, 1.39 g cm^{-3}). Commonly used density solutions include zinc chloride ($ZnCl_2$), sodium iodide (NaI), sodium polytungstate ($NaWO_4$), potassium carbonate (K_2CO_3), sodium bromide (NaBr) and potassium formate (HCO_2K), with a minimum density of 1.5 g cm^{-3}. Guidelines for reporting the most relevant parameters at this stage are detailed in Table 3.

Table 3. Guidelines for the reporting parameters for the density separation and filtration of sediment samples

Reporting parameters	Additional details	Comments	Mandatory or optional
Mode of preparation of reference materials	- Specify suppliers - Specify mode of preparation for particles (e.g. sieve mesh size or cryogenic milling)	Non-exhaustive list of suppliers for polymers: https://www.goodfellow.com/uk/en-gb https://www.cospheric.com/ https://www.bam.de/Navigation/DE/Home/home.html	Mandatory
Solution used and density	e.g. $ZnCl_2$ and NaI	The application of solutions with densities of >1.5 g cm^{-3} is recommended since this will distinctly improve the recovery rates of synthetic particles of higher material densities. The use of sodium chloride (NaCl) is not recommended as a number of	Mandatory

		relevant synthetic polymers will not be recovered due to the low solution density.	
Number of extractions	e.g. 2 or 3 consecutive extractions	Specify number of consecutive extractions of the same sample	Optional
Associated recovery rates for main polymers	e.g. PP, PE, PA, PVC, PS, PMMA		Mandatory
Devices and equipment used	e.g., plastic sediment separator, glass beakers, centrifuge, etc…	Specify time of separation, centrifuge speed, etc…	Optional
Filtration	Specify filter type, porosity, diameter		Mandatory

4.2.3 Chemical digestion

Organic residues have been shown to interfere with some analytical steps including density separation of microplastics or polymer identification via spectroscopic and staining methods (Pfeiffer & Fischer, 2020). Therefore, an effective isolation of microplastics from sediment matrices does require the removal of biogenic organic matter with the use of a chemical digestion step. The selection of the digestion solution(s) depends on the final identification method. Suitable digestion protocols cover oxidative, alkaline, and enzymatic treatments or a combination of them. The application of acids for digestion is to be avoided since acids have shown to harm synthetic polymers (Pfeiffer & Fischer, 2020). An increase of temperature to a maximum of 40 °C can improve the digestion efficiency, however higher temperatures are to be avoided due to damaging effects on synthetic polymers. Table 4 lists the recommended parameters to report for the characterisation of the chemical digestion step.

Table 4. Reporting parameters for chemical digestion.

Protocol	**Additional details**	**Mandatory or optional**
Solution used and concentration	e.g. 10% KOH (w:v), 30% (w/w) H_2O_2	Mandatory
Ratio of the amount of samples (g wet weight or dry weight) and % moisture added here and chemical solution (mL)	Additional	Optional
Incubation temperature and incubation time	Use temperatures <40°C as higher temperatures cause accelerated degradation of polymers (Pfeiffer & Fischer, 2020)	Optional
Agitation speed if use of shaker incubator		Optional
If any treatment used before chemical digestion	e.g. applied on wet or dried sediment, applied before or after density separation step	Optional

4.3 Analysis

4.3.1 Optical microscopy

Optical detection is one of the most common and simple approaches widely applied as a tool for the counting of microlitter as well as their structural description according to their physical characteristics (i.e. colour, shape, and size). Nevertheless, microscopic techniques should be coupled with other spectroscopic techniques for the simultaneous identification and quantification of microlitter (Kalaronis et al., 2022). Table 5 lists the recommended parameters to report for the visual observation of filters using optical microscopy.

Table 5. Guidelines for the reporting parameters for the visual observation of filters

Reporting parameters	Additional details	Mandatory or optional
Equipment description		Optional
Magnification and scale bar		Optional
For use of dyes and fluorescence microscopy: fluorescence light wavelength and intensity. Threshold used for plastic identification	Note: use of dyes such as Nile red might be used for better recoveries of some polymers (Erni-Cassola et al., 2017; Nel et al., 2021; Prata et al., 2019).	Optional
Any other probing	e.g., physical test under the microscope e.g., flexibility particles, brittle, rubbery etc.	Optional

4.3.2 Spectroscopic techniques.

For validation purpose, it is recommended to analyse a representative sub-set of at least 10% of particles potentially identified as synthetic items. These particles should cover the range from 100 – 5000 µm in a sample, with a minimum of 20 particles per sample being subjected to such analysis (unless there are fewer than 20 particles in the sample). The selection of particles integrated into the subset should be representative of different size categories and morphologies. Table 6 lists the recommended parameters to report for the spectroscopic identification of microlitter. The recommended parameters should also be compatible with more refined techniques such as FTIR chemical imaging where a lot more information is being captured. Identified polymers should in principle be listed in table 9, in order to improve consistency in polymer reporting.

Table 6. Guidelines for reporting parameters of spectroscopic identification of microlitter

Reporting parameters	**Additional details**	**Mandatory or optional**
Equipment description	e.g. ATR-FTIR, micro-FTIR, Raman	Mandatory
Acquisition parameters	e.g., reflectance, transmittance, etc.	Mandatory
Filter used	e.g., filter material, size and porosity	Mandatory
Libraries used for polymer identification	e.g. Bruker Optics ATR-Polymer Library	Mandatory
Software used for polymer identification	e.g., use of open access software such as SiMPle software, Open Specy, FLOPP-e.	Mandatory
Essential software settings	Any setting that has a substantial effect on the microplastic results. e.g. Threshold Value and the Pearson weight factors used in the siMPle software.	Optional
Spectra post-processing	Specify if spectra were post-processed to increase library match	Optional
Reference materials used for QA/QC	Analysis of a reference materials before analysis of unknown	Optional
Proportion of sample analysed	Report % of final sample extract analysed in case only a subsample was analysed, e.g. of the extract or of the analyzed filter.	Mandatory

4.3.3 Data analysis

Microlitter quantification is mainly achieved from manual or automated counting. Some laboratories are using imaging-based quantification coupled with automated counting. If sub-sampling of the sediment sample is preferred, ensure that the sample is well homogenised to be representative of the whole sample.

5 Data reporting guidelines

Data should be reported by single particle. Therefore, the reporting of dry weight of sediment of the respective samples is a mandatory parameter to re-calculate microlitter concentrations as number of particles kg^{-1} dry weight of sediment.

At this stage, no recommendation on re-calculating number of particles into mass is given. The development of conversion algorithms based on polymer composition and particles size/volume is to be evaluated

(HELCOM, 2022). The reporting parameters for the quantification step of microlitter from sediment samples are listed in Table 7.

Table 7. Guidelines for the reporting parameters for the quantification step of microlitter from sediment samples (Galgani et al., 2023).

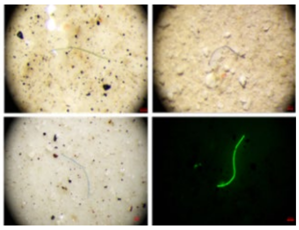
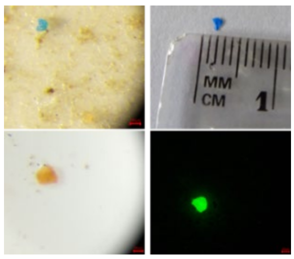
Reporting parameters	**Additional details**	**Mandatory or optional**
Quantification method	Manual counting/Imaging based systems with automated counting tools	Mandatory
Reporting units	Single particles Number of particles per kg dry weight sediment	Mandatory
Size range classes (µm) H03 (EMODnet Microlitter size-class)	• 1000 – 4999 • 300 – 999 • 100 – 299 • 50 – 99 • 20 – 49 • < 20	Mandatory for particles ≥ 100 µm Optional for particles < 100 µm in size
Morphology H01 (EMODnet microlitter morphologies)	• Filaments • Fragments • Films • Foams • Pellets/granules/beads • Undefined microlitter items See Table 8 for a description of these categories of morphology.	Mandatory ≥ 100 µm
Shapes H02 (EMODnet microlitter shapes)	• Angular • Cylindrical • Discoid • Flat • Ovoid • Rounded • Spheroid • Subangular • Subrounded • Other/unclassified	Optional
Particle colour EMODnet Microlitter colour-class H04	• Black • Grey • White (including cream) • Red • Orange • Yellow • Green • Blue (including cyan) • Purple (including violet)	Optional

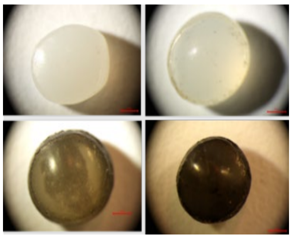
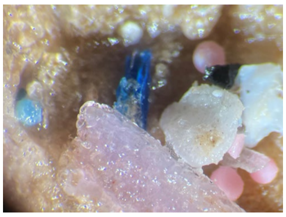
	• Pink (including magenta) • Brown (including tan) • Multicolour (i.e. particle made up of two or more different colours) • Colourless (i.e. Particles without added dyes, pigments and/or other additives (e.g. carbon black in rubbers). This class also excludes particles that get natural colours during their production (e.g. ABS gets a natural pale-yellow colour during production)	
Transparency H06 (EMODnet microlitter transparency classes)	• Opaque • Transparent/translucent	Optional
Microlitter material or polymer type	• See Table 9 for list of polymer types for data reporting • Include "not identified" if a particle is not being successfully identified	Mandatory
LOD	Calculated using the laboratory negative controls. If full spectroscopic data are available, polymer-specific detection limits can be calculated. See section 4.1.	Mandatory
QA/QC - Number of items on blanks	Negative controls (mean values (n))	Mandatory
QA/QC - Recoveries from spiked samples	Positive controls (i.e., recoveries) (%)	Mandatory
Sediment grain size	Microlitter amount reported alongside PSA data (% gravel, % sand, % silt/clay) -	Mandatory
Other co-parameters	e.g., TOC (ppm), Loss on Ignition (LOI) (%)	Optional

<u>Morphology</u>

The term morphology is used here to describe the structure or shape of the microlitter items. The morphology of all identified particles should be recorded according to the following morphology classes listed in Table 8.

Table 8. Morphological description and characteristics for microlitter reporting

Description	**Characteristics**	**EMODnet microlitter type identifier**	**Example**
Filaments	Slender thread-like microlitter particles	H0100004	
Films	Thin planar micro-litter particles of arbitrarily limited maximum thickness, in which the thickness is very small compared to the length and width (adapted from ISO definition for film https://www.iso.org/obp/ui/#iso:std:iso:5148:ed-1:v1:en:term:3.1). In the micro-litter nomenclature, particles of type "films" are more flexible than particles of type "fragments" with the latter tending to break easily (Isobe et al., 2019).	H0100005	
Foams	Flexible microlitter particles in which material cells are all or partly intercommunicating (adapted from ISO definition for foam (https://www.iso.org/obp/ui/#iso:std:iso:tr:20342:-7:ed-1:v1:en).	H0100006	
Fragments	Irregularly-shaped microlitter particles with broken off edges that may be rounded or angular.	H0100002	

Pellets	Microlitter particles from industrial origin only. In comparison with granules, pellets are usually flat on one side, rough surface and irregular, round shapes. Normally bigger in size.	H0100003	
Granules	Microlitter particles with smooth spherical shape. In comparison with pellets, they have a rounder shape and are smaller in size (adapted from (Matiddi et al., 2021) (https://accedacris.ulpgc.es/bitstream/10553/114417/1/Report_Monitoring-microlitter-ingestion-in-marine-fish.pdf).	H0100009	
Undefined microlitter items	A term to be used when the microlitter morphologic type has not been defined.	H0100010	

Polymer types for data reporting

It is suggested to align the polymer types according to the following list (Table 9; copied with permission from Galgani et al., 2023).

Table 9. Polymer types for data reporting

	Polymer type name	**Examples of materials**
Artificial synthetic and semi-synthetic polymers	Acrylonitrile based	acrylonitrile butadiene styrene (ABS), polyacrylonitrile (PAN)
	Cellulose based	cellulose acetate (CA), cellulose nitrate (CN)
	Polyamide based	all types of polyamide (PA) like various nylons
	Polycarbonate based	polycarbonate (PC)
	Polychlorinated polymers	polyvinyl chloride (PVC), chlorinated PE, various chlorinated polymers
	Polyester based	polyethylene terephthalate (PET), all other types of polyesters
	Polyethylene based	Includes high-density polyethylene (HDPE), low density polyethylene (LDPE), and copolymers with a major PE fraction including ethylene-vinyl acetate copolymer (EVA)
	Polyfluorinated polymers	polytetrafluoroethylene (PTFE)
	Polymeth(ester)acrylate based	all types of polymeth(ester)acrylate (PM(ester)A)
	Polypropylene based	polypropylene (PP) and copolymers with a major PP fraction
	Polystyrene based	polystyrene (PS) and copolymers with a major PS fraction
	Polyurethane based	all types of polyurethane (PUR)
	Varnish/paint particles	If different from PM(ester)A
	Other plastics	polyether ether ketone (PEEK), polyoxymethylene (POM), polyvinyl acetate (PVA), polylactic acid (PLA), polyhydroxyalkanoate (PHA)
	Other semi-synthetic polymers	rayon
Other Microlitter items	Rubbers, automotive	styrene butadiene rubber (SBR), tyre wear
	Other rubbers	Includes ethylene propylene diene monomer rubber (EPDM), silicone, nitrile rubbers and natural rubbers
	Other microlitter materials	metal, glass

<u>Source</u>*: Adapted from EMODnet vocabularies - EU-TGML microlitter guidance document* (Galgani et al., 2023)

6 Data repositories and visualisation

Existing databases are being considered for the reporting of microlitter including microplastics for the OSPAR Maritime Area. Two options are being considered by MPEG, namely the EMODnet chemistry database and the ICES DOME database. It must be noted that EU member states will have to report to EMODnet, as obligated by the MSFD. The reporting to or harvesting of data through ICES DOME is currently under discussion. A list of parameters (mandatory and optional), EMODnet codes and descriptions where available and suggestions for modifications or the integration of further parameters following the discussions and suggestions provided within these draft guidelines and first evaluations through EMODnet is given in Appendix I. Parameters and related attributes are under continuous development. Therefore, it is recommended to consult the latest tables and vocabularies online at the NERC Vocabulary Server (NVS). ICES DOME database is currently being updated and a list of parameters will be provided as an additional Appendix.

7 References

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Technical Annex I. Guidelines and formats for gathering and management of microlitter data to the European Marine Observation and Data Network (EMODnet).

The following lists (**Table A1**) comprise parameters (mandatory and optional), EMODnet codes and descriptions where available and suggestions for modifications or the integration of further parameters following the discussions and suggestions provided within these draft guidelines and first evaluations through EMODnet.

Parameters and related attributes are under continuous development. Therefore, it is recommended to consult the latest tables and vocabularies online at the NERC Vocabulary Server (NVS).

Table A1. Current list of default (green), mandatory(orange) and optional (light orange) parameters to be reported (from HELCOM, 2022, modified from Vinci et al., 2021, p7).

Label/column header	Concept id	Use	Comments
Cruise		metadata/mandatory (ODV Default)	
Station		metadata/mandatory (ODV Default)	
Type		metadata/mandatory (ODV Default)	The suggestion is to use type "B". From manual: 'B' for bottle profile data. For time series and trajectories set to 'B' for small (<250) row groups
YYYY-MM-DDThh:mm:ss.sss		metadata/mandatory (ODV Default)	Start date/time. Format must be adapted to the date value (for example YYYY-MMDDThh:mm is second are not available)
Longitude [degrees_east]		metadata/mandatory (ODV Default)	start point coordinates
Latitude [degrees_north]		metadata/mandatory (ODV Default)	start point coordinates
LOCAL_CDI_ID		metadata/mandatory (ODV Default)	
EDMO_code		metadata/mandatory (ODV Default)	EDMO_CODE of the data centre distributing the data (the one connected to the CDI service)

Bot. Depth [m]		metadata/mandatory (ODV Default)	Field empty if no data
MinimumObservation Depth [m]	MINWDIST	mandatory in ODV micro-litter	
MaximumObservation Depth [m]	MAXWDIST	mandatory in ODV micro-litter	
SampleID:INDEXED_TEXT	SAMPID01	mandatory in ODV micro-litter	
Microlitter_Type:IND EXED_TEXT	MLITTYPW	mandatory in ODV micro-litter	Type of the item (H01 SDN vocabulary)
Microlitter_Size:INDE XED_TEXT	MLITSIZW	mandatory in ODV micro-litter	Size classes (H03 SDN vocabulary)
Microlitter_Count [Dimensionless]	MLITCNTW	mandatory in ODV micro-litter	Number of items collected. It's the official mandate from MSFD to provide the count of collected microplastics.
EventEndDateTime [YYYY-MMDDThh:mm:ss.sss]	ENDX8601	additional/optional	End date/time
EventEndLongitude [degrees_east]	ENDXXLON	additional/optional	End point coordinates. Either End Lat/Lon or SamplingEffort are mandatory
EventEndLatitude [degrees_north]	ENDXXLAT	additional/optional	End point coordinates. Either End Lat/Lon or distance are mandatory.
Microlitter length	NEW	additional/optional	

Microlitter_Weight [g]	MLDWWD01	additional/optional	Weight of the collected items, not mandatory Information in grams
Microlitter_Shape:INDEXED_TEXT	MLITSHPW	additional/optional	Shape of the item (H02 SDN vocabulary)
Microlitter_Color:IN DEXED_TEXT	MLITCOLW	additional/optional	Colour classes (H04 SDN vocabulary)
Microlitter_Transparency:INDEXED_TEXT	MLITROPW	additional/optional	Transparency classes (H06 SDN vocabulary)
Microlitter_Polymer_type:INDEXED_TEXT	MLITPOLW	additional/optional	Polymer type of the micro-litter (H05 SDN vocabulary)
WMO_Sea_State [Dimensionless]	WMOCSSXX	additional/optional	Sea conditions following the Douglas scale
Wind_direction [degT]	EWDAZZ01	additional/optional	Direction relative to true north from which the wind is blowing
Wind_speed [m/s]	WSBZZ01	additional/optional	Sustained speed of the wind (distance moved per unit time by a parcel of air) parallel to the ground at a given place and time.
Sampling_protocol	SAMPPROT	additional/optional	The name of, reference to, or description of the method or protocol used to produce the sample